

[72]	Inventor	John A. Gingrich Toronto, Canada	3,443,668	5/1969	Hall et al.	187/29
[21]	Appl. No.	592,186	2,827,981	3/1958	Eames et al.	187/29
[22]	Filed	Nov. 4, 1966	2,960,187	11/1960	Bruns et al.	187/29
[45]	Patented	Feb. 9, 1971	3,080,944	3/1963	Burgy et al.	187/29
[73]	Assignee	Dover Corporation New York, N.Y. by mesne assignments	3,146,858	9/1964	Leroux et al.	187/29
			3,315,765	4/1967	Dinning.	187/29
			3,376,952	4/1968	Inuzuka et al.	187/29
			3,378,107	4/1968	Madison.	187/29
			3,379,284	4/1968	Yeasting.	187/29
[32]	Priority	Nov. 5, 1965	Primary Examiner—Oris L. Rader			
[33]		Great Britain	Assistant Examiner—W. E. Duncanson, Jr.			
[31]		47,065	Attorney—Brumbaugh, Free, Graves & Donohue			

[54] **ELEVATOR GROUP SUPERVISORY CONTROL SYSTEM**
54 Claims, 50 Drawing Figs.

[52]	U.S. Cl.	187/29
[51]	Int. Cl.	B66b 1/20
[50]	Field of Search.	187/29

[56]	References Cited	
	UNITED STATES PATENTS	
3,371,747	3/1968	Gingrich et al. 187/29

ABSTRACT: The disclosure relates to an elevator group supervisory control system in which bits of information, as to registered demands for service, position of the cars, and the degree of availability of the cars relative to the number of calls for service each is capable of answering without undue delay, are successively and repetitively scanned to control the respective movement of the cars.

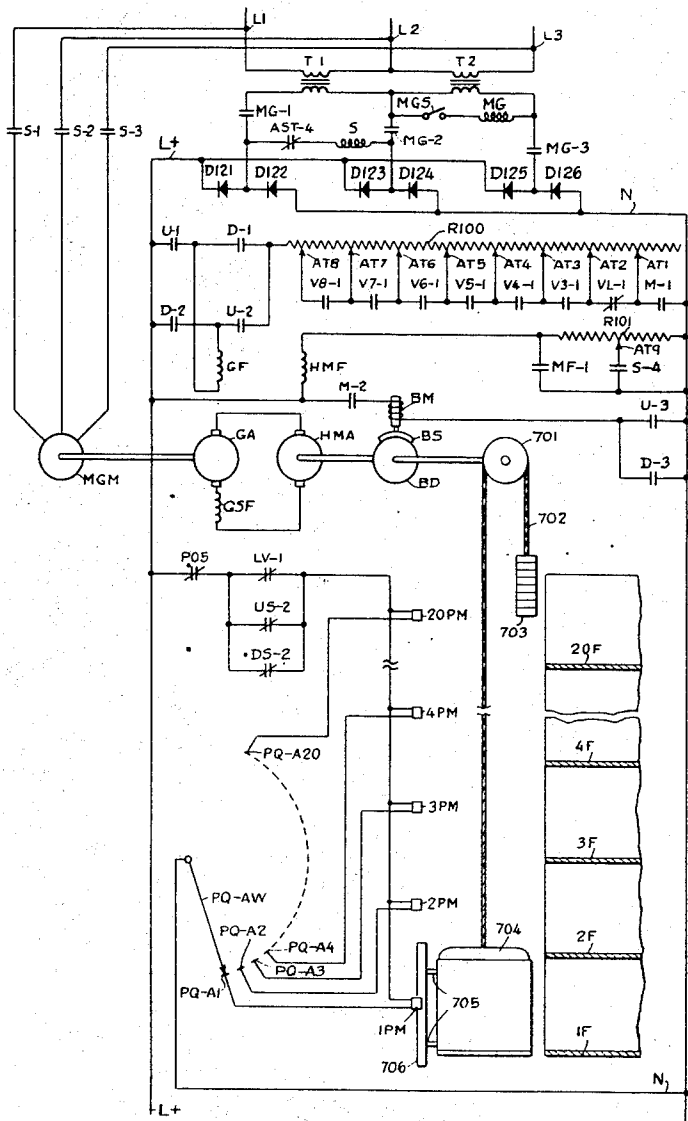
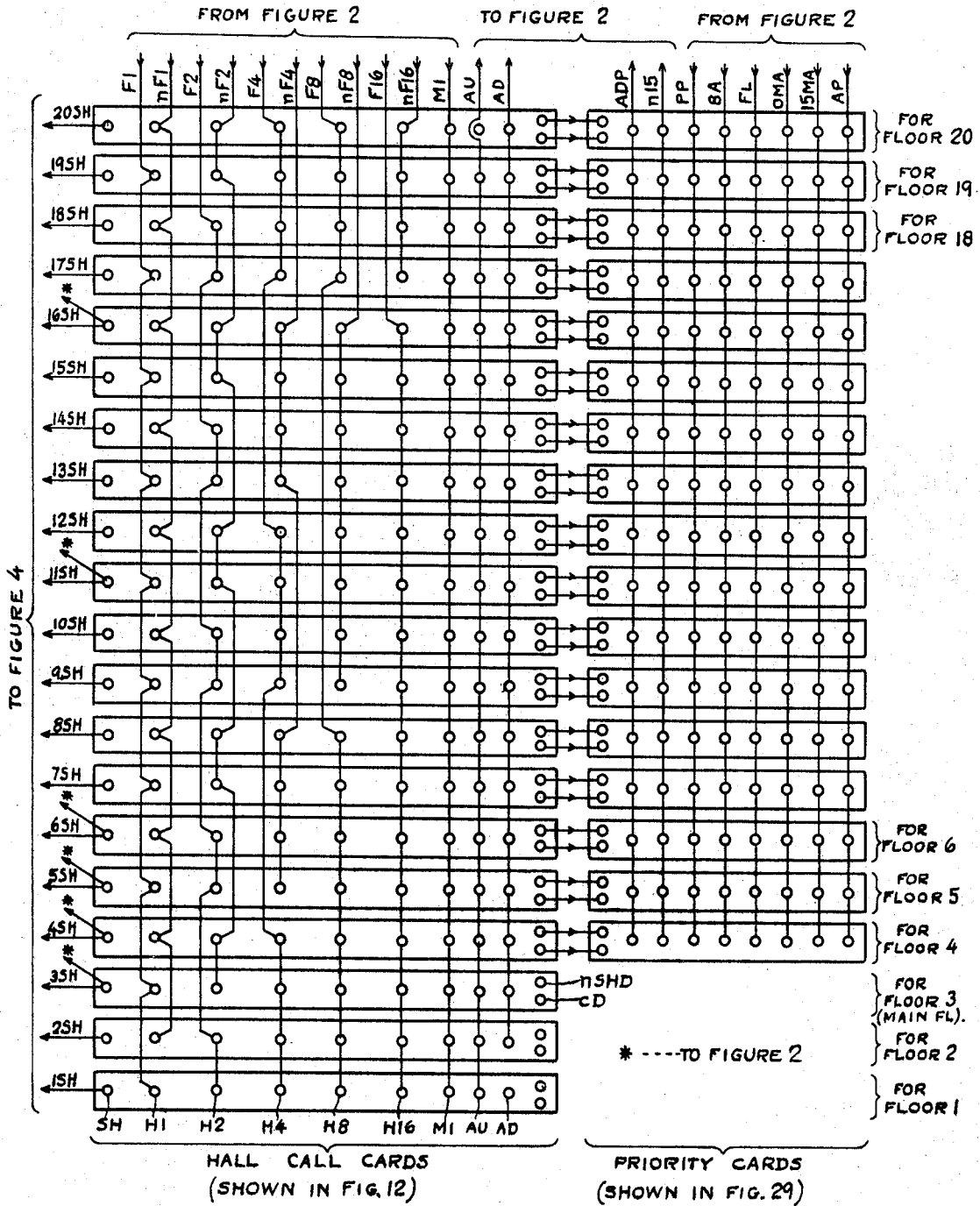


Fig. 1.



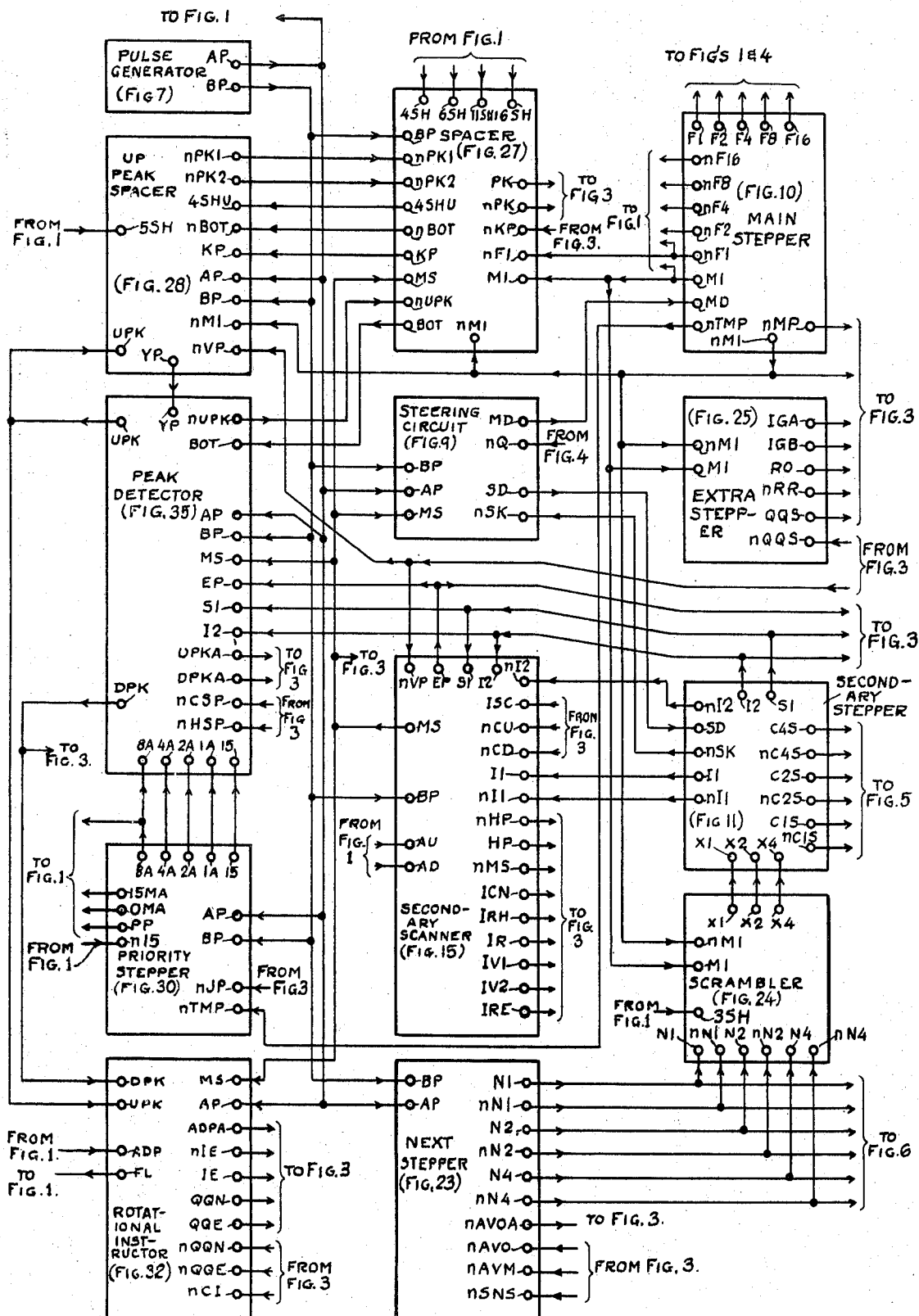


Fig. 4.

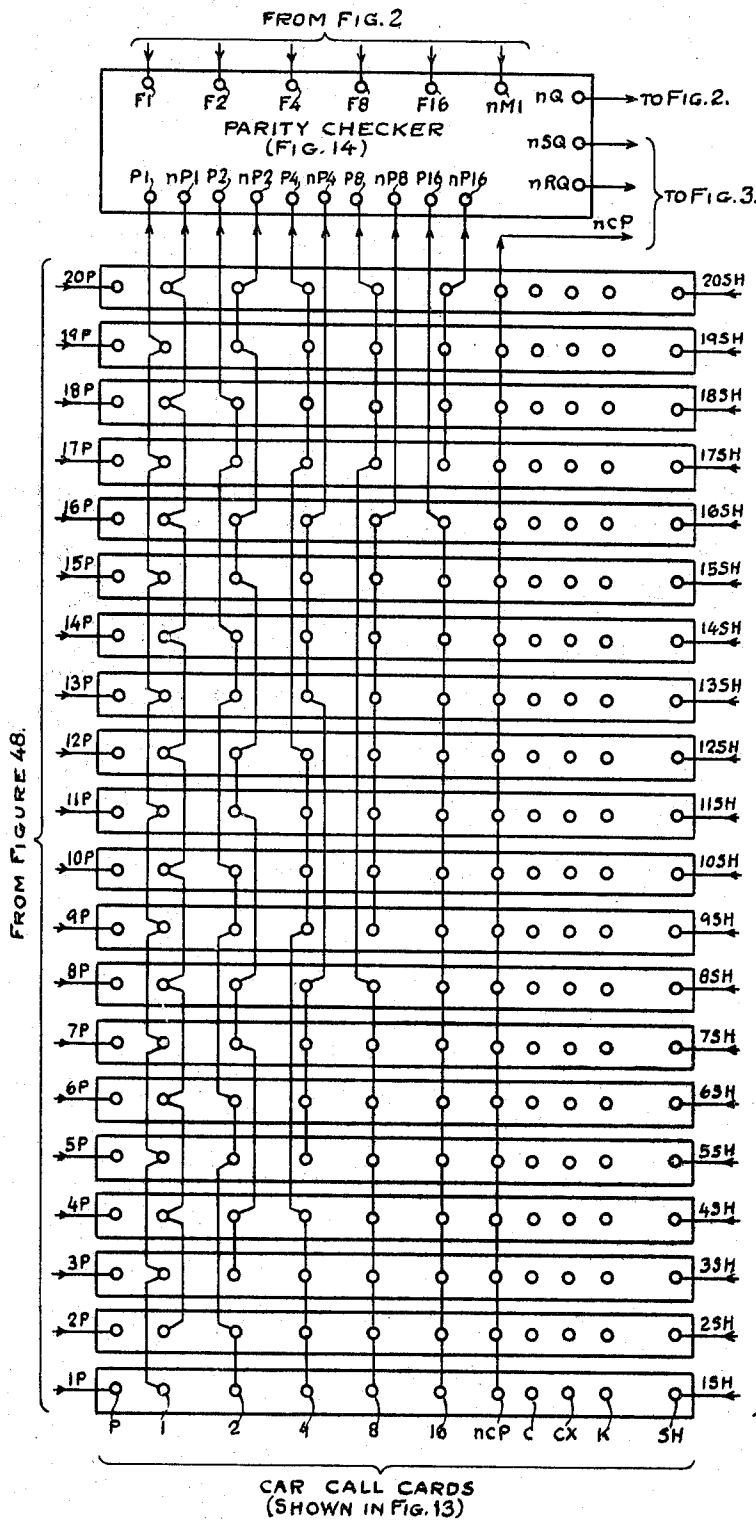


Fig. 5.

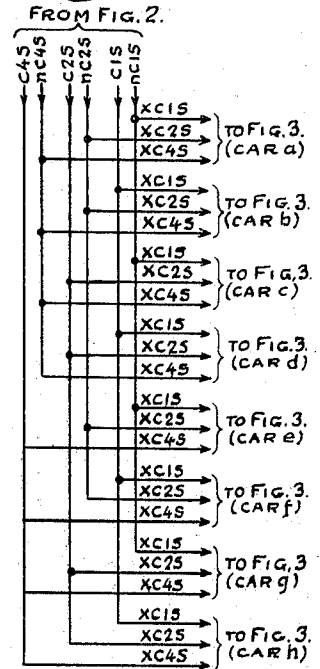


Fig. 6.

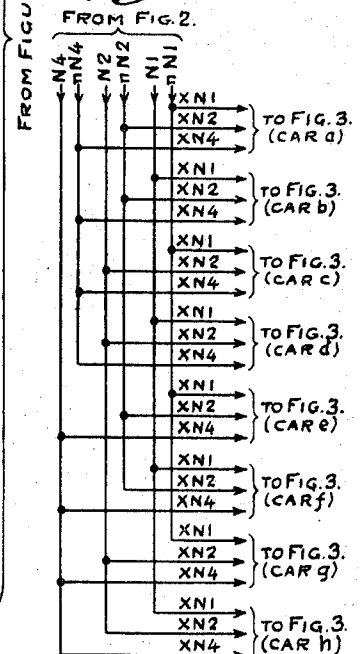


Fig. 7.

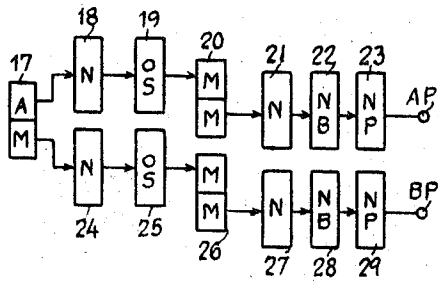


Fig. 8.

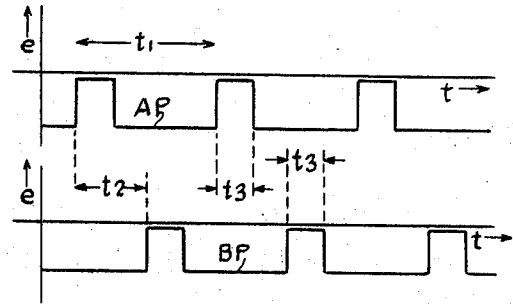


Fig. 9.

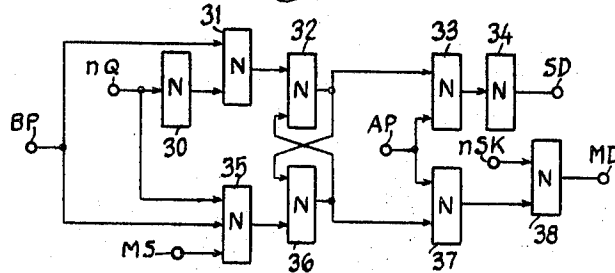


Fig. 10.

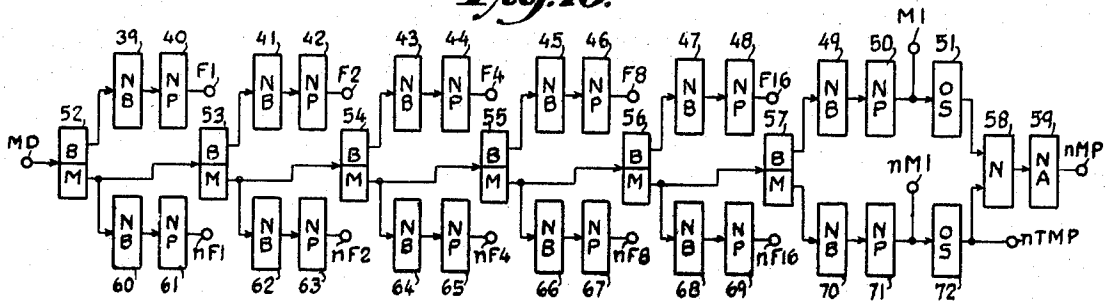
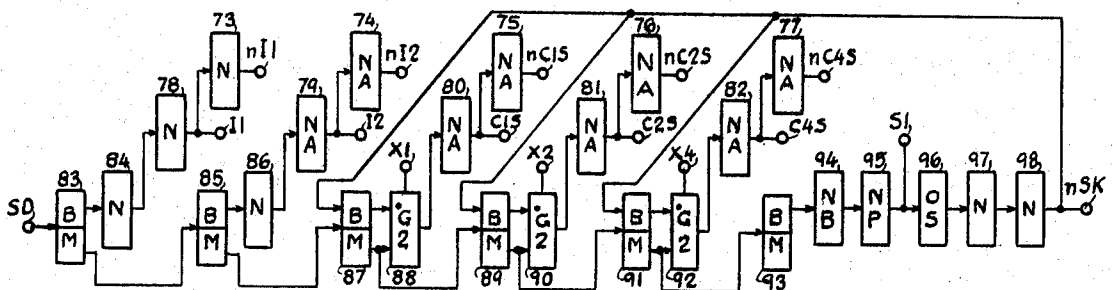
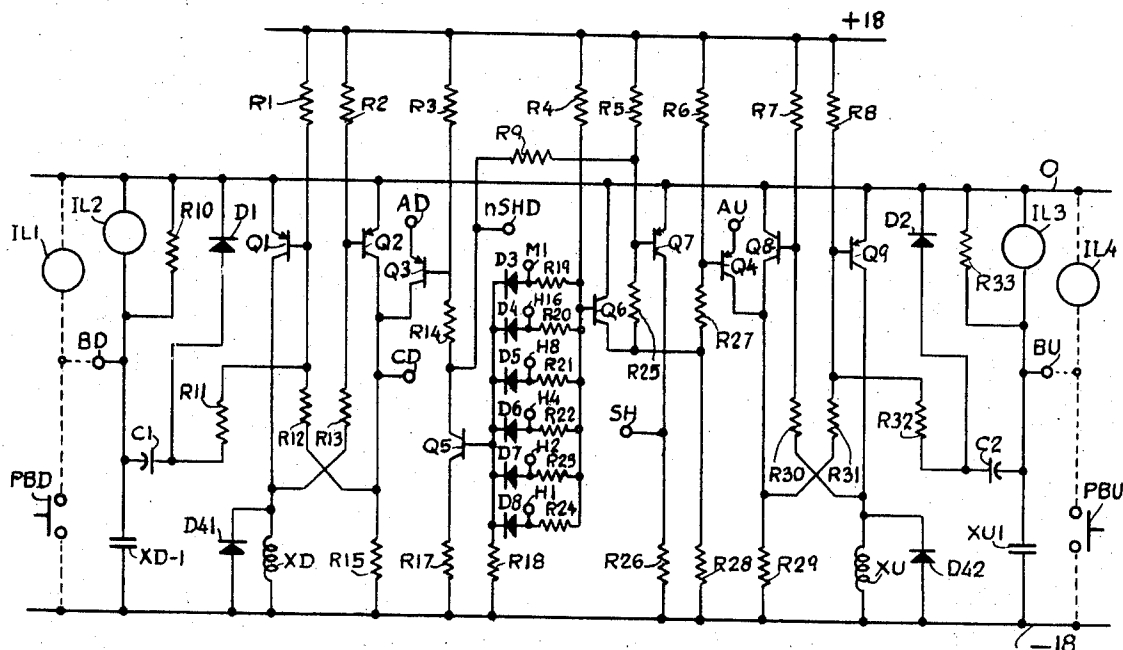


Fig. 11.



Ecc. 12.



Etc. 13.

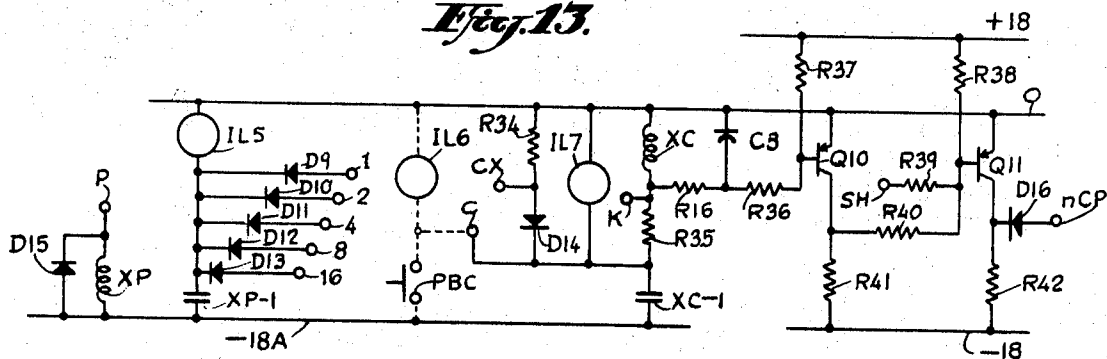
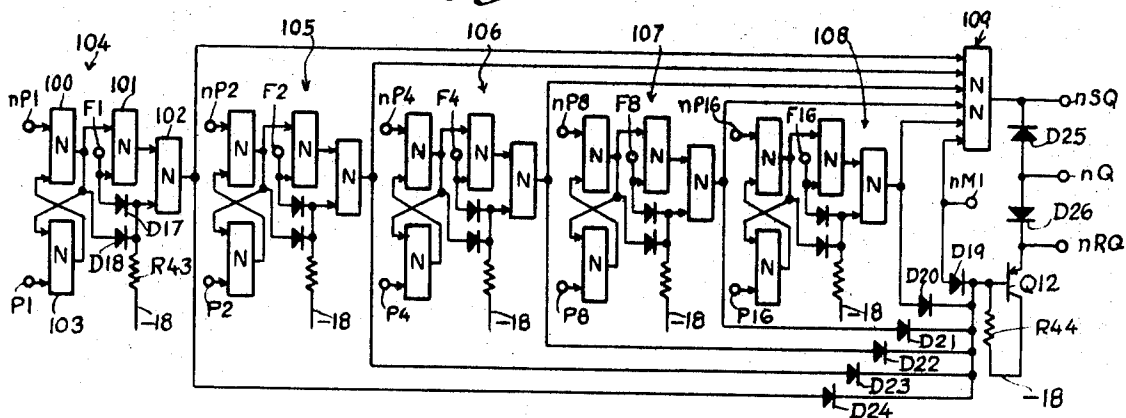


Fig. 14.



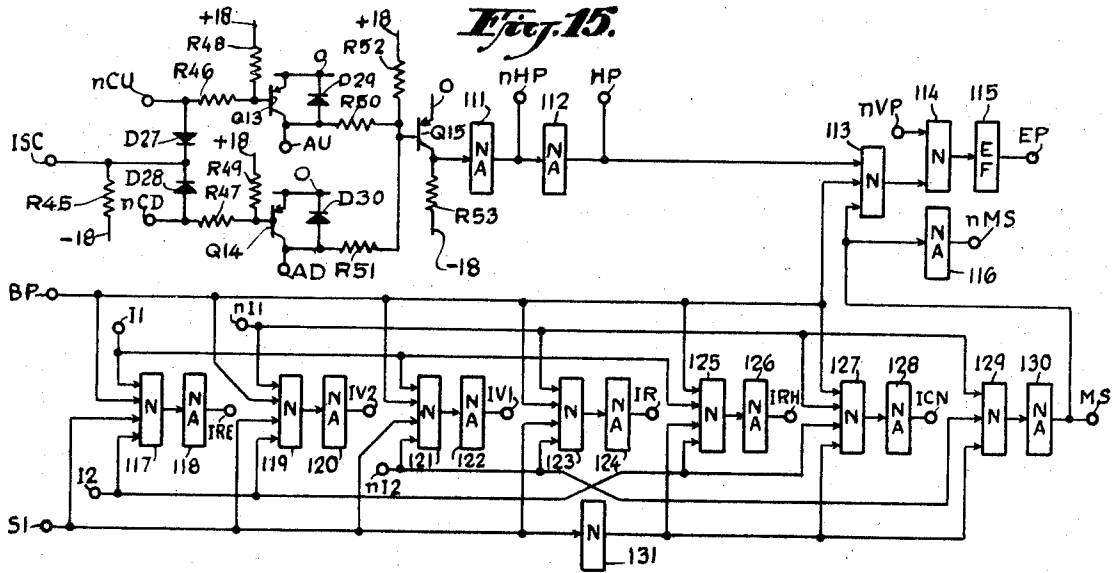


Fig. 16.

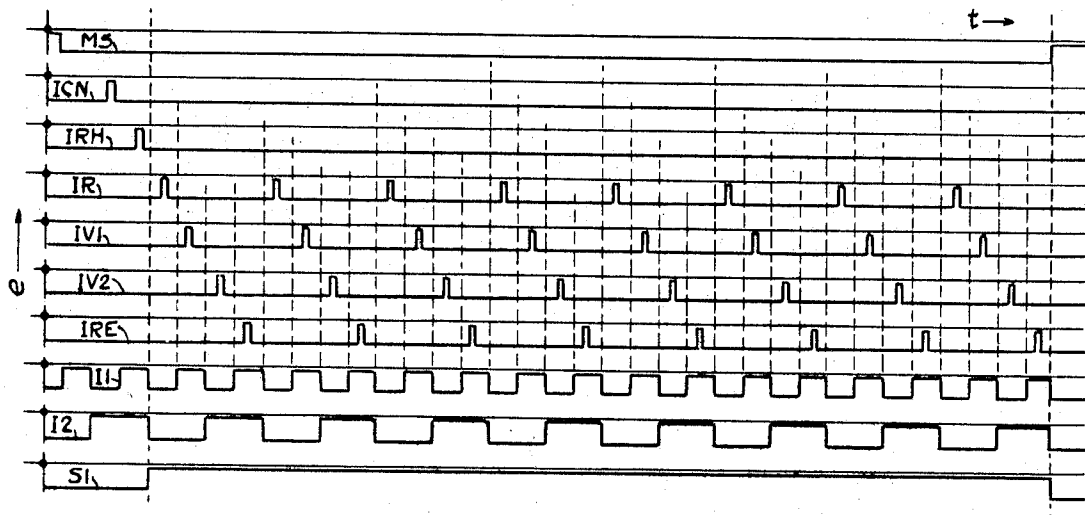


Fig. 17.

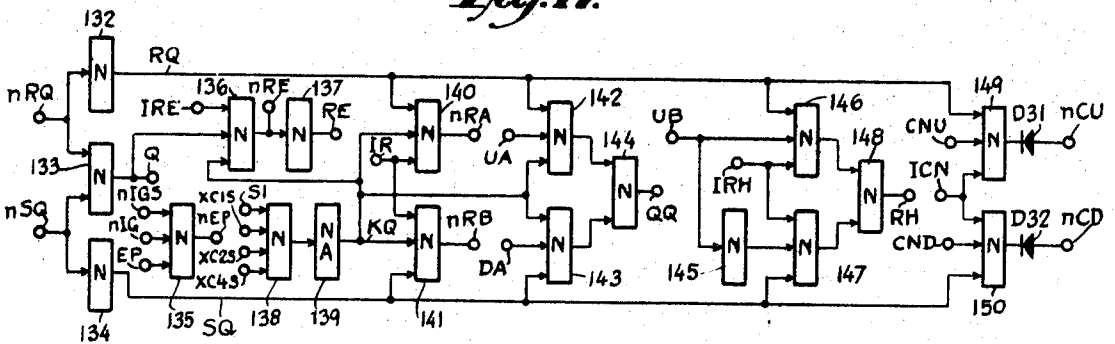


Fig. 18.

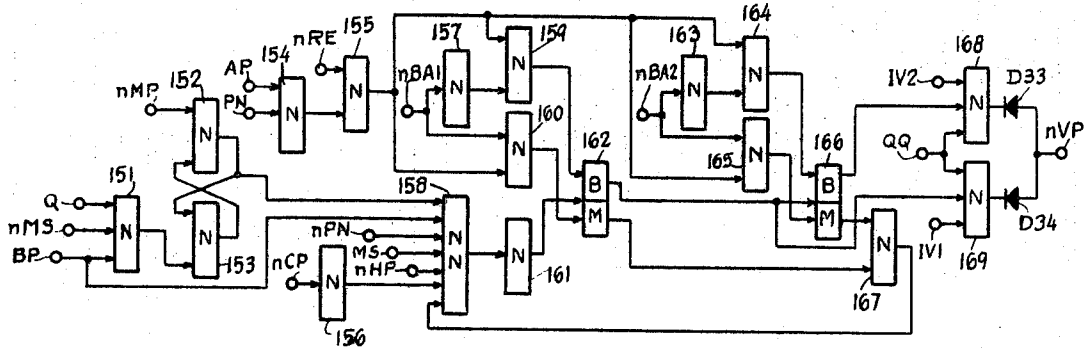


Fig. 19.

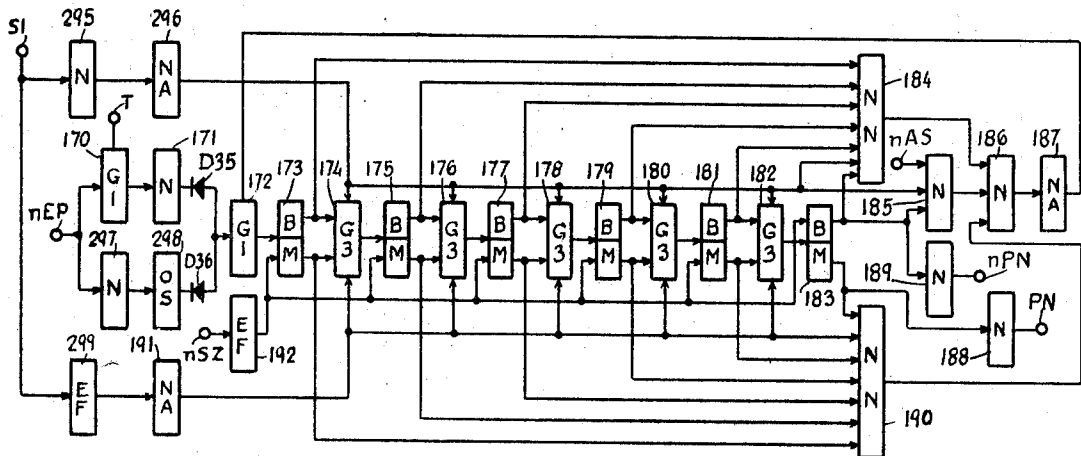


Fig. 20.

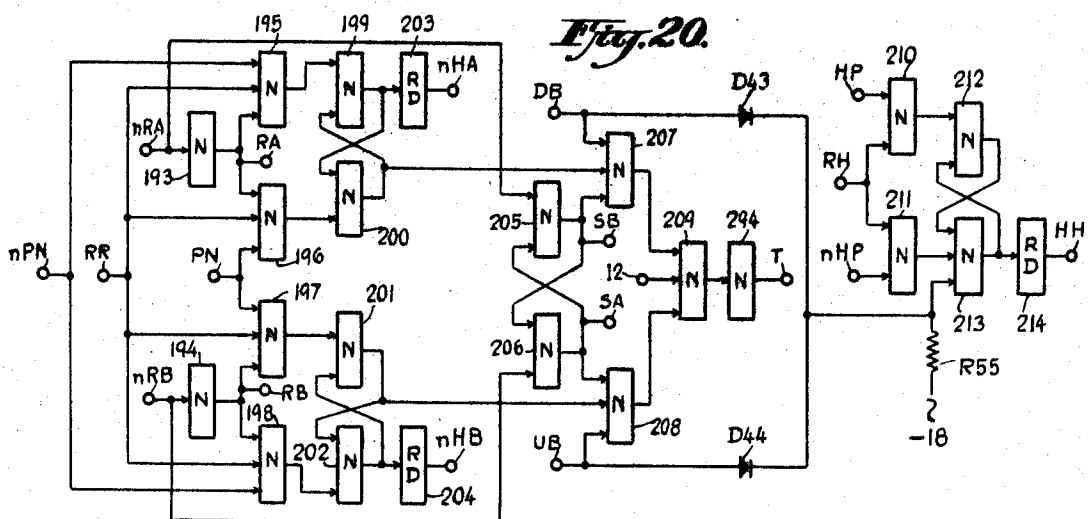


Fig. 21.

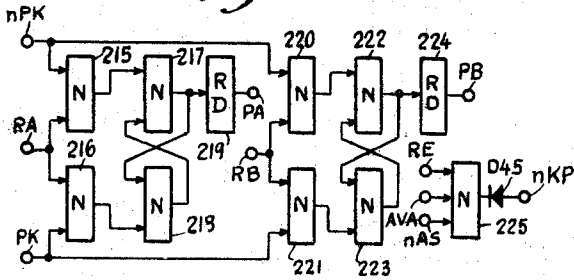


Fig. 22.

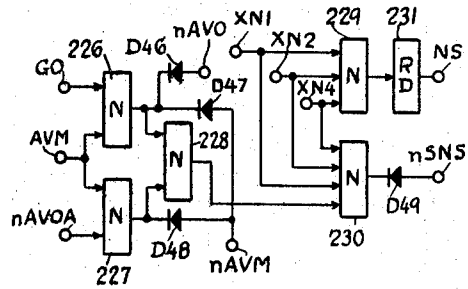


Fig. 23.

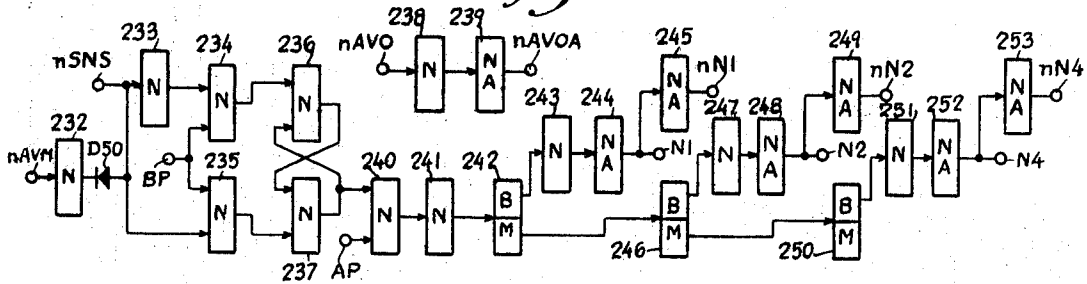


Fig. 25.

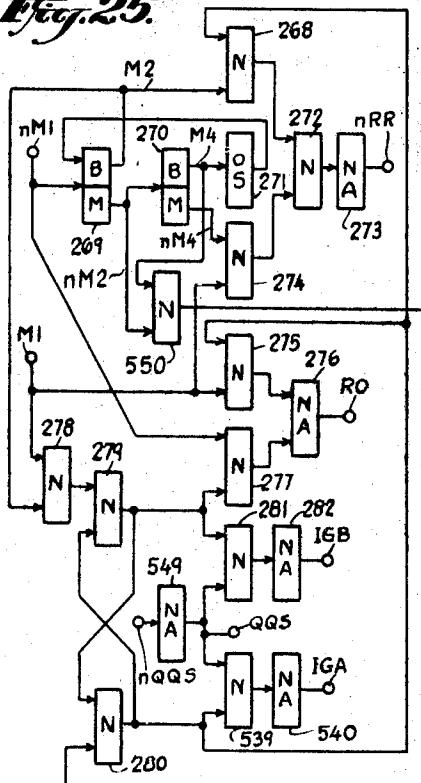


Fig. 24.

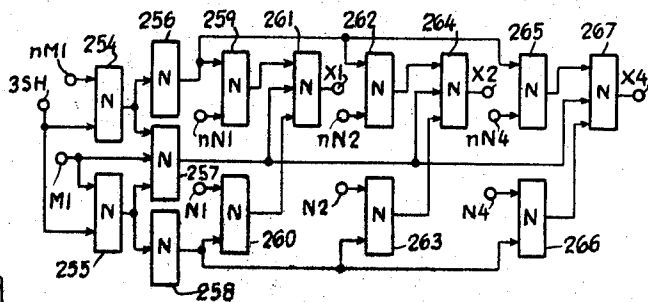


Fig. 26.

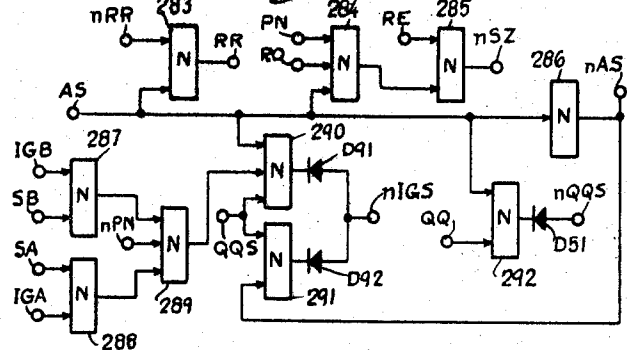


Fig. 27.

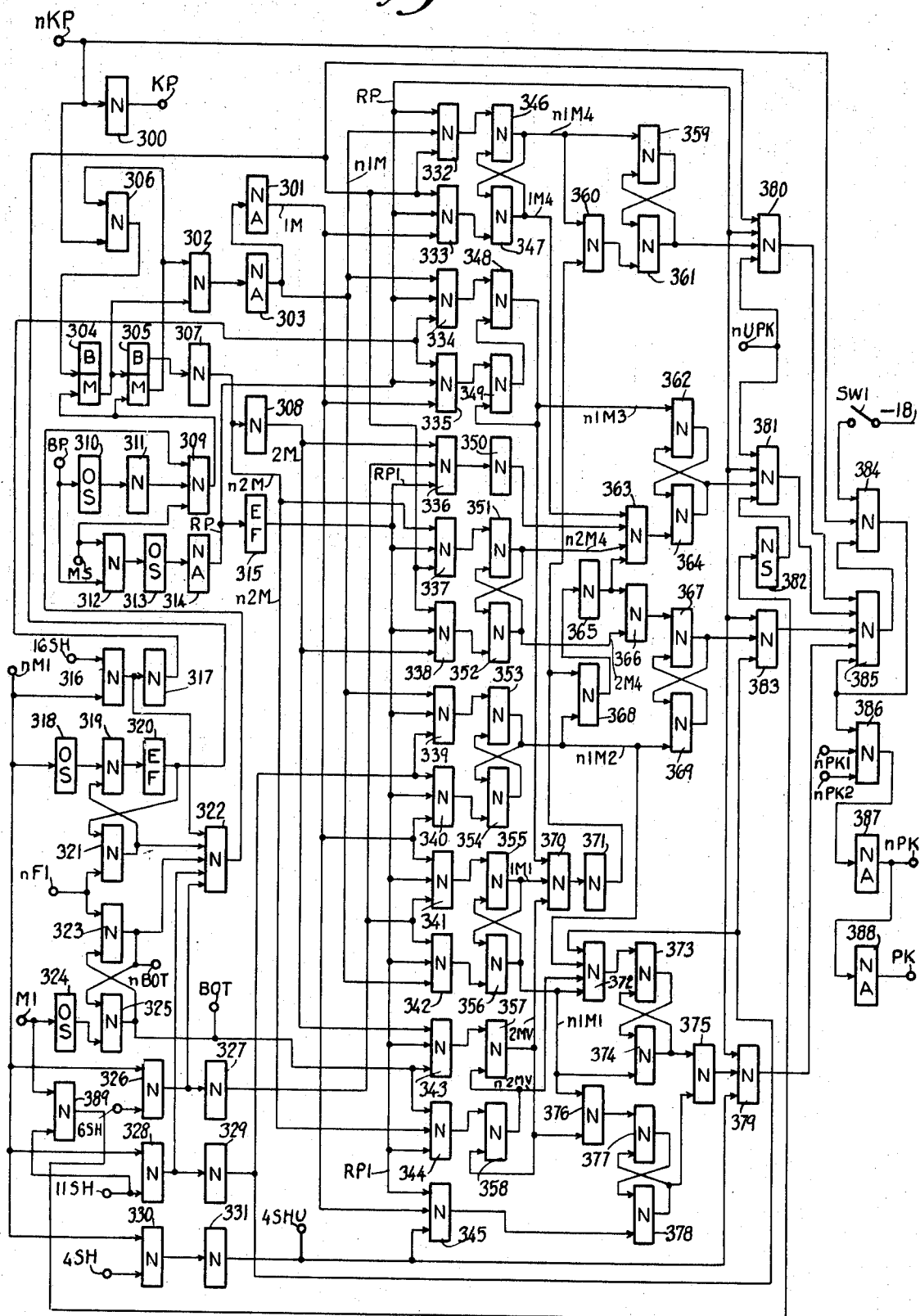


Fig. 28.

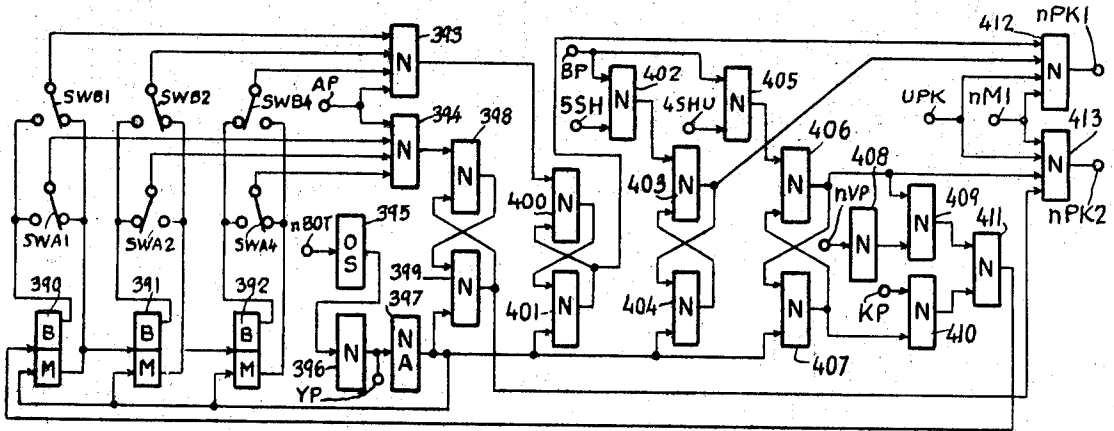


Fig. 29.

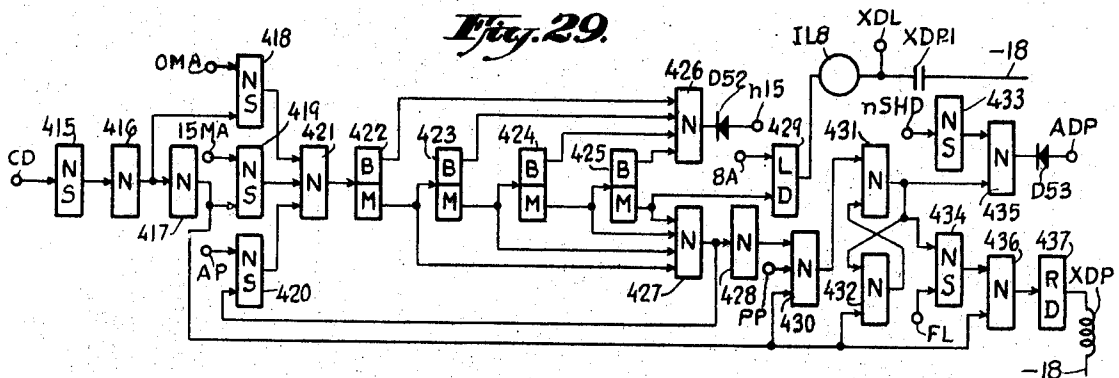


Fig. 30.

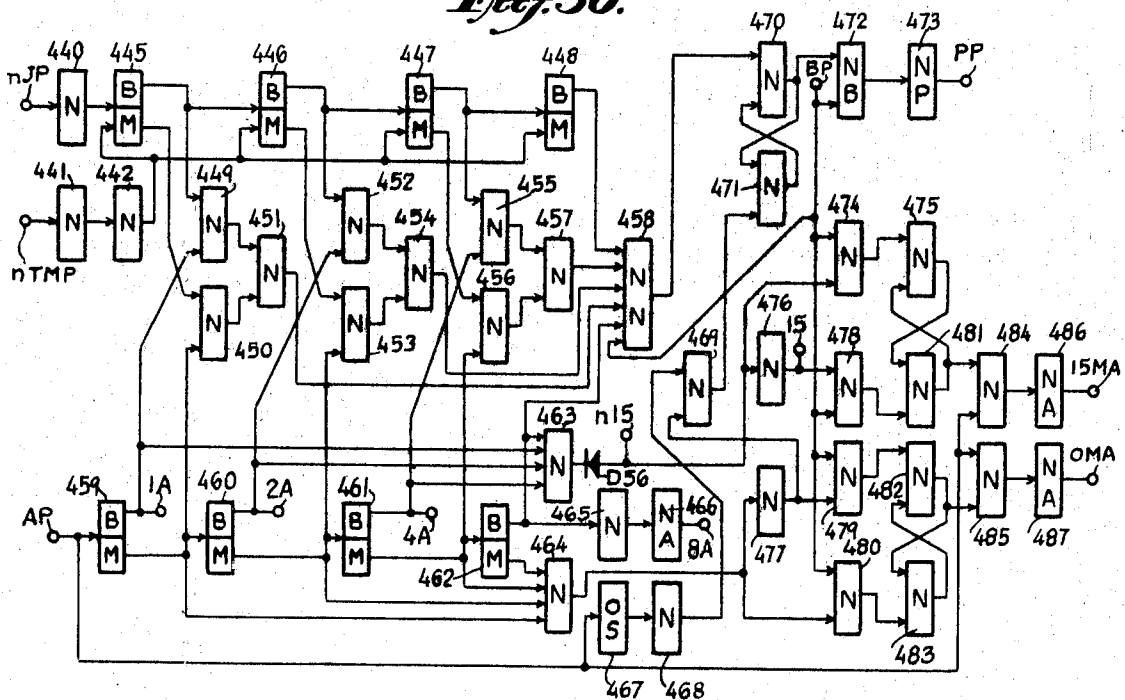


Fig. 31.

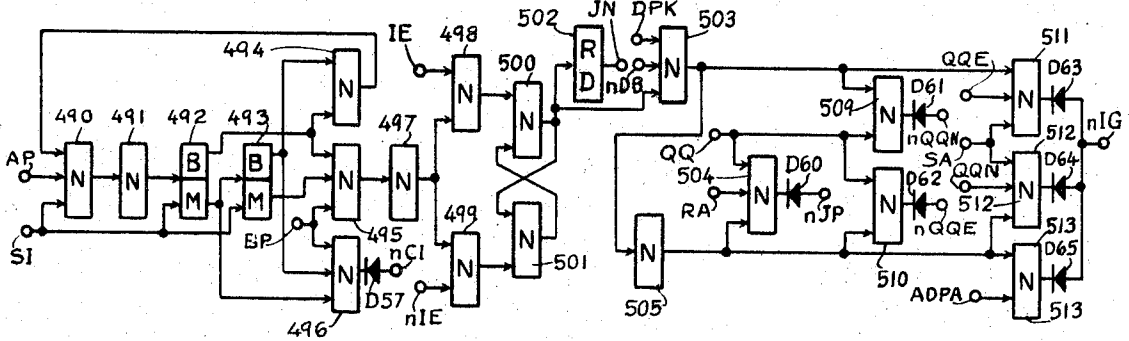


Fig. 32.

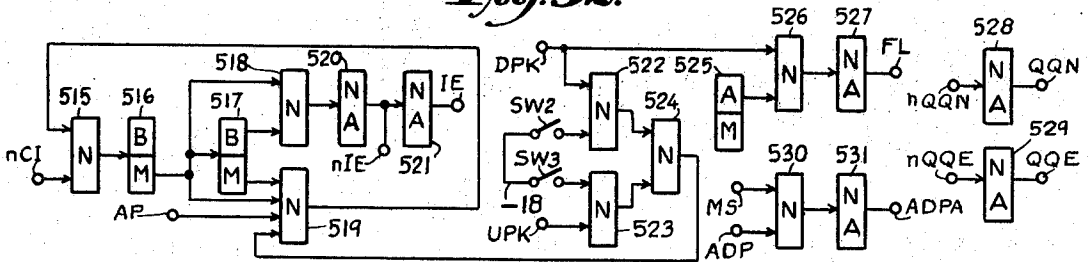


Fig. 33.

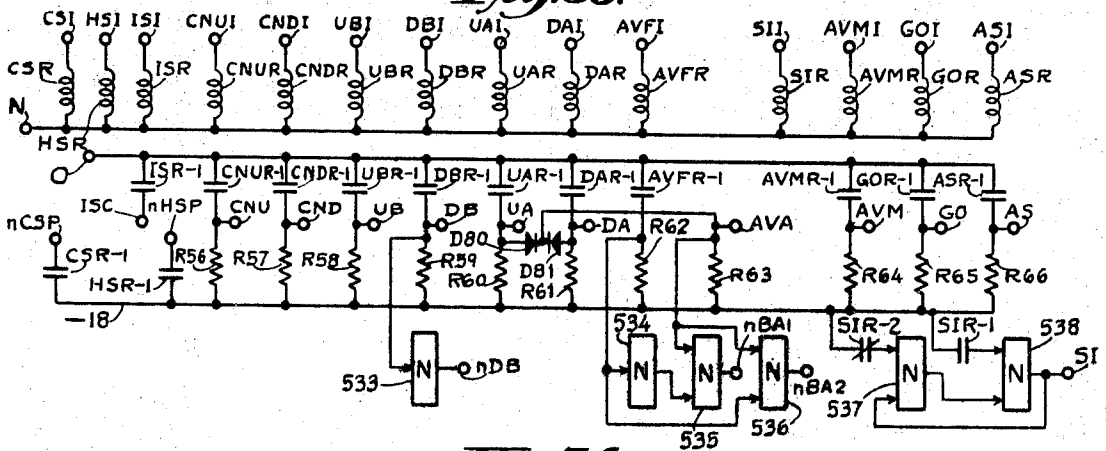


Fig. 34.

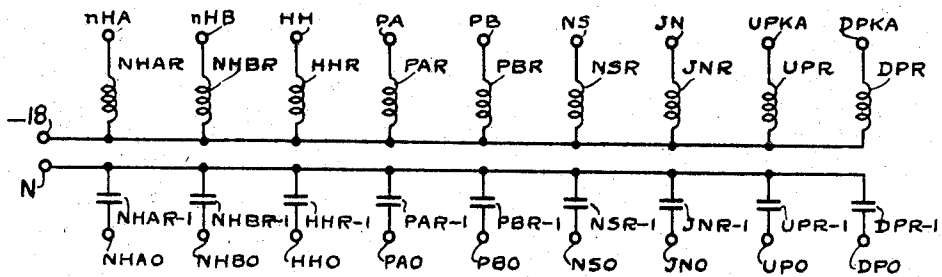


Fig. 35.

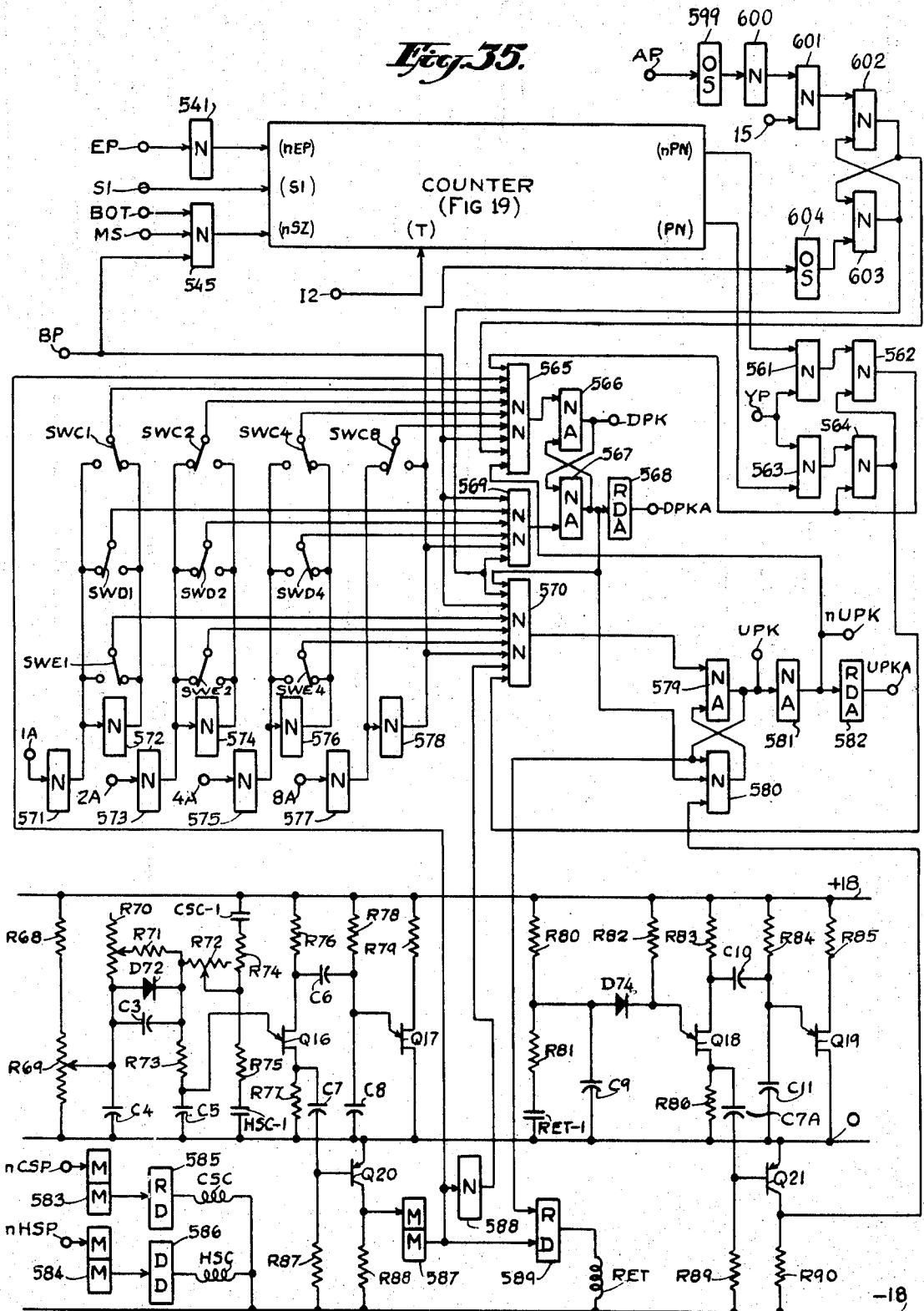


Fig. 36.

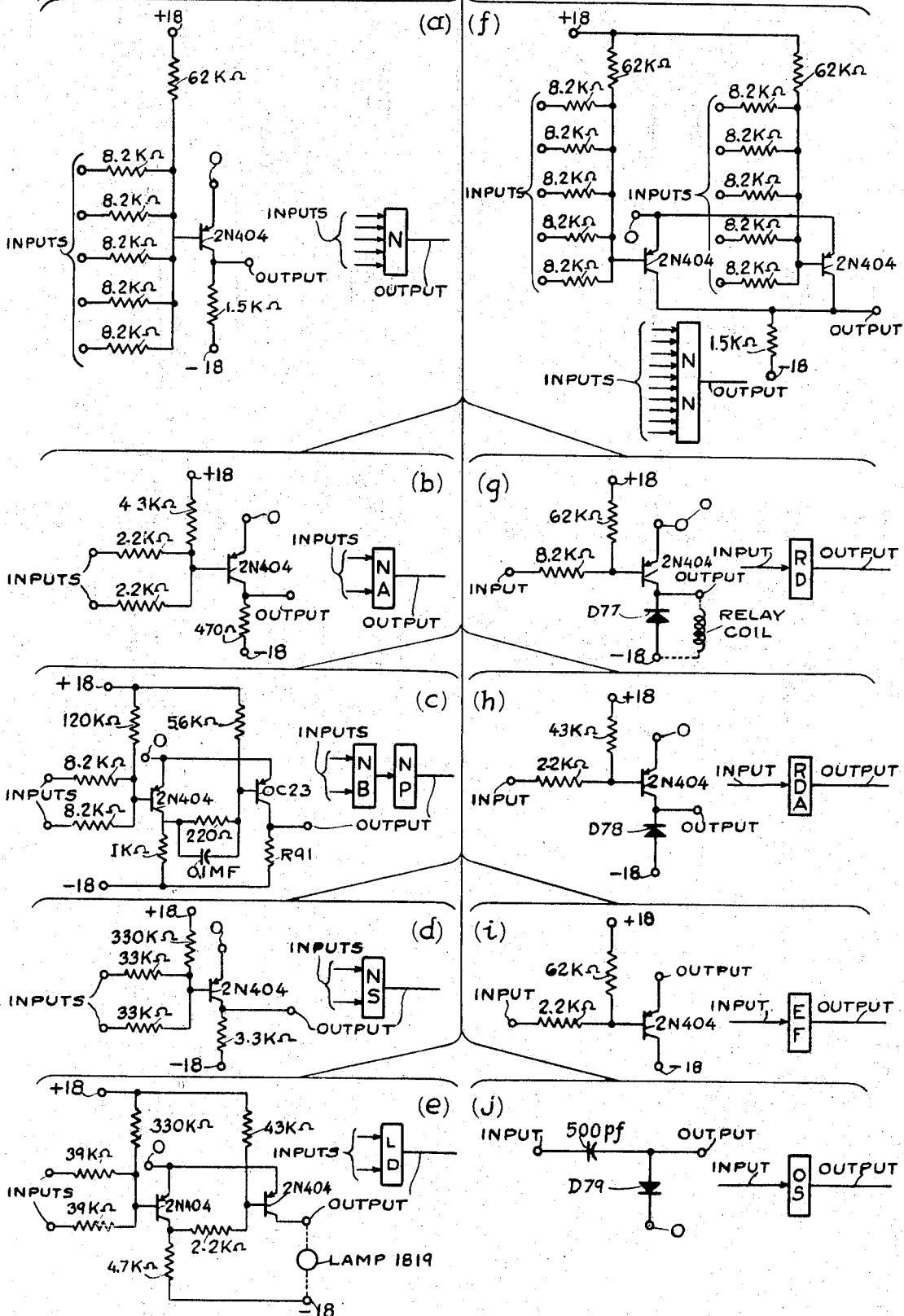


Fig. 37.

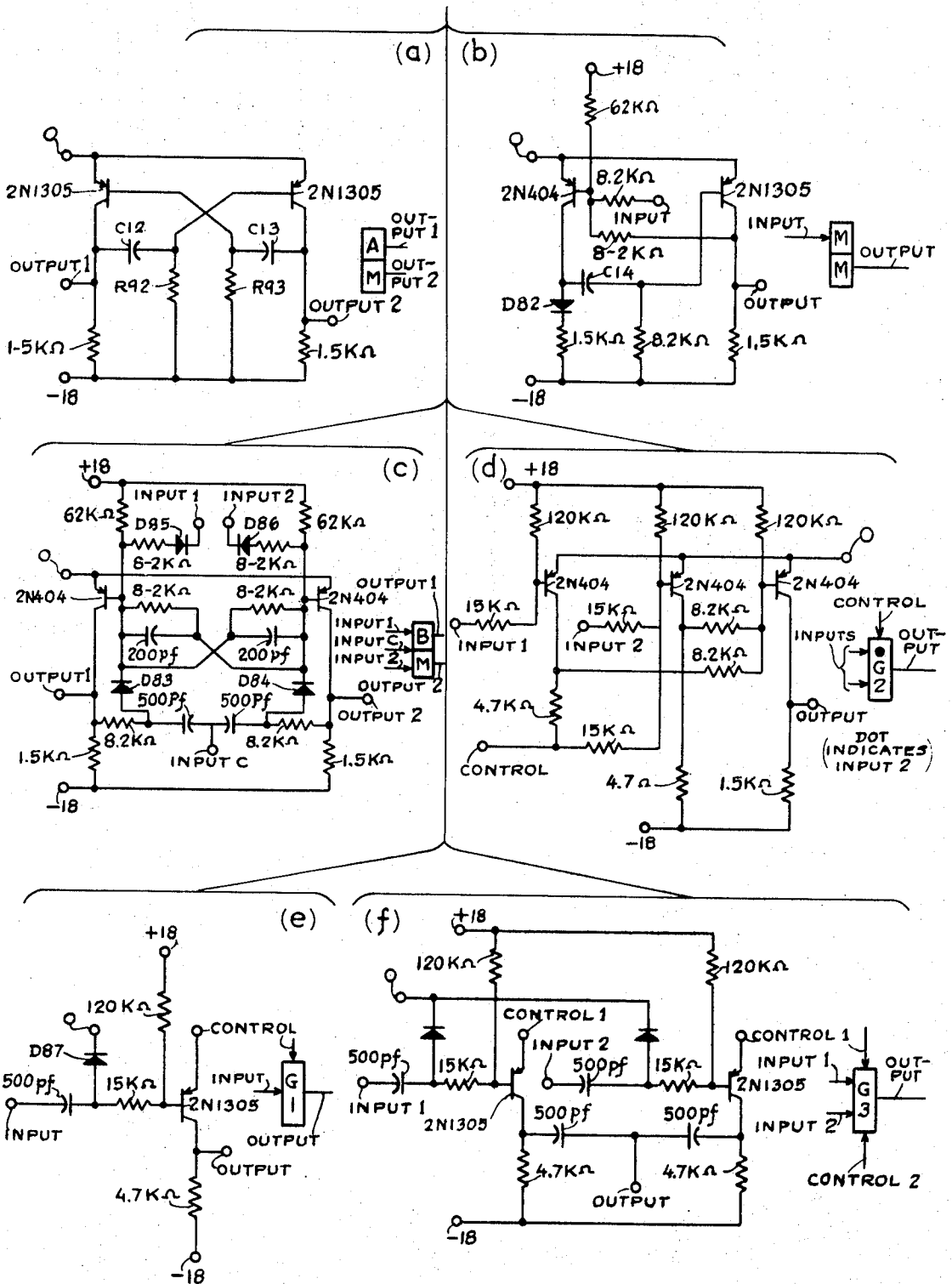


Fig. 38.

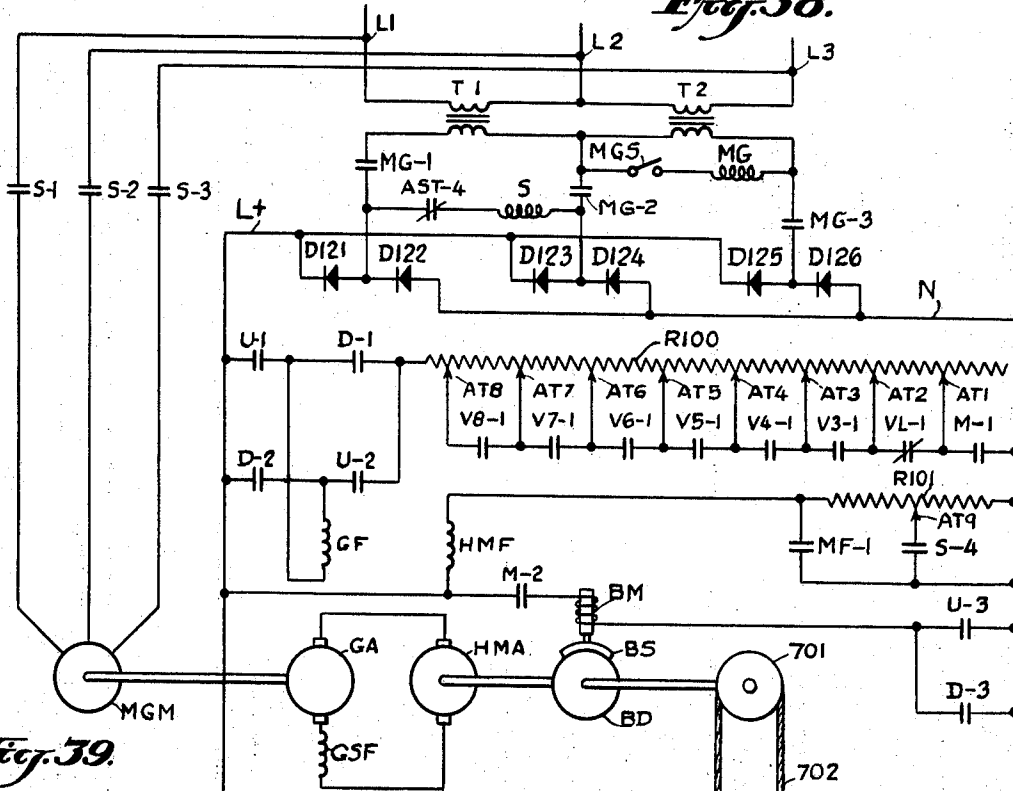


Fig. 39.

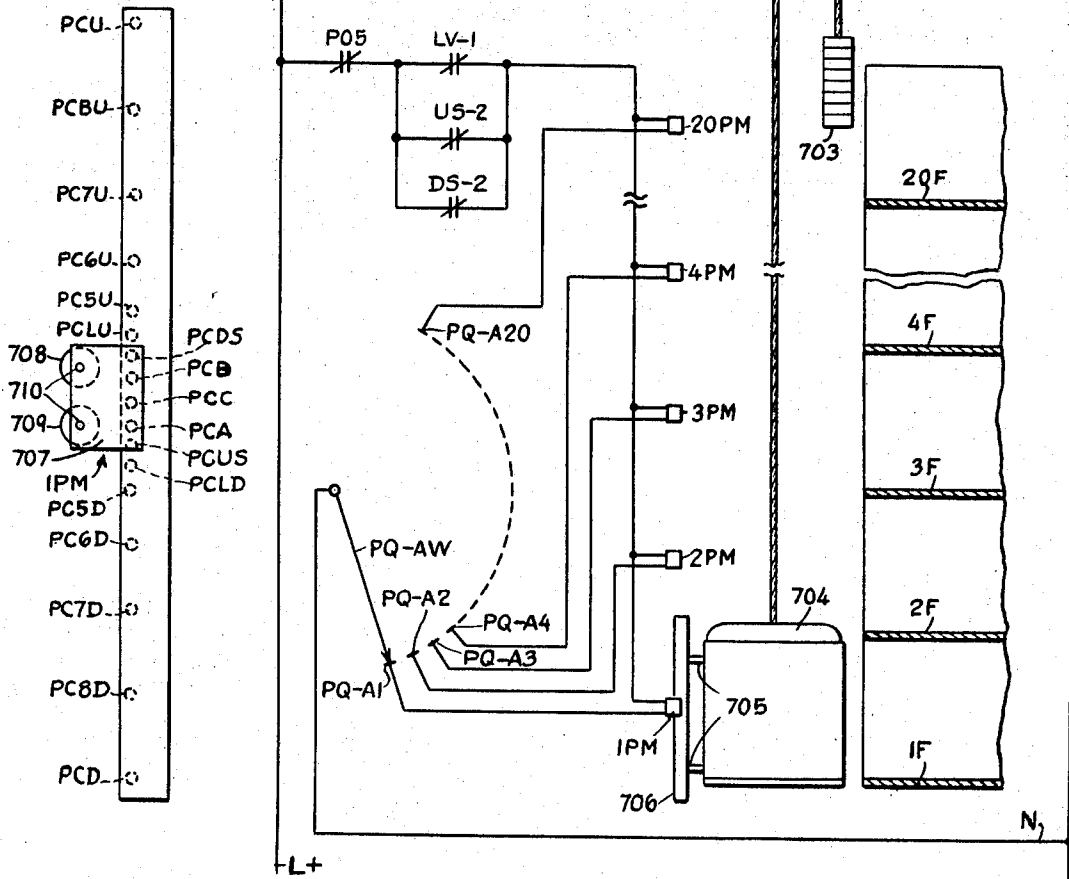


Fig. 40.

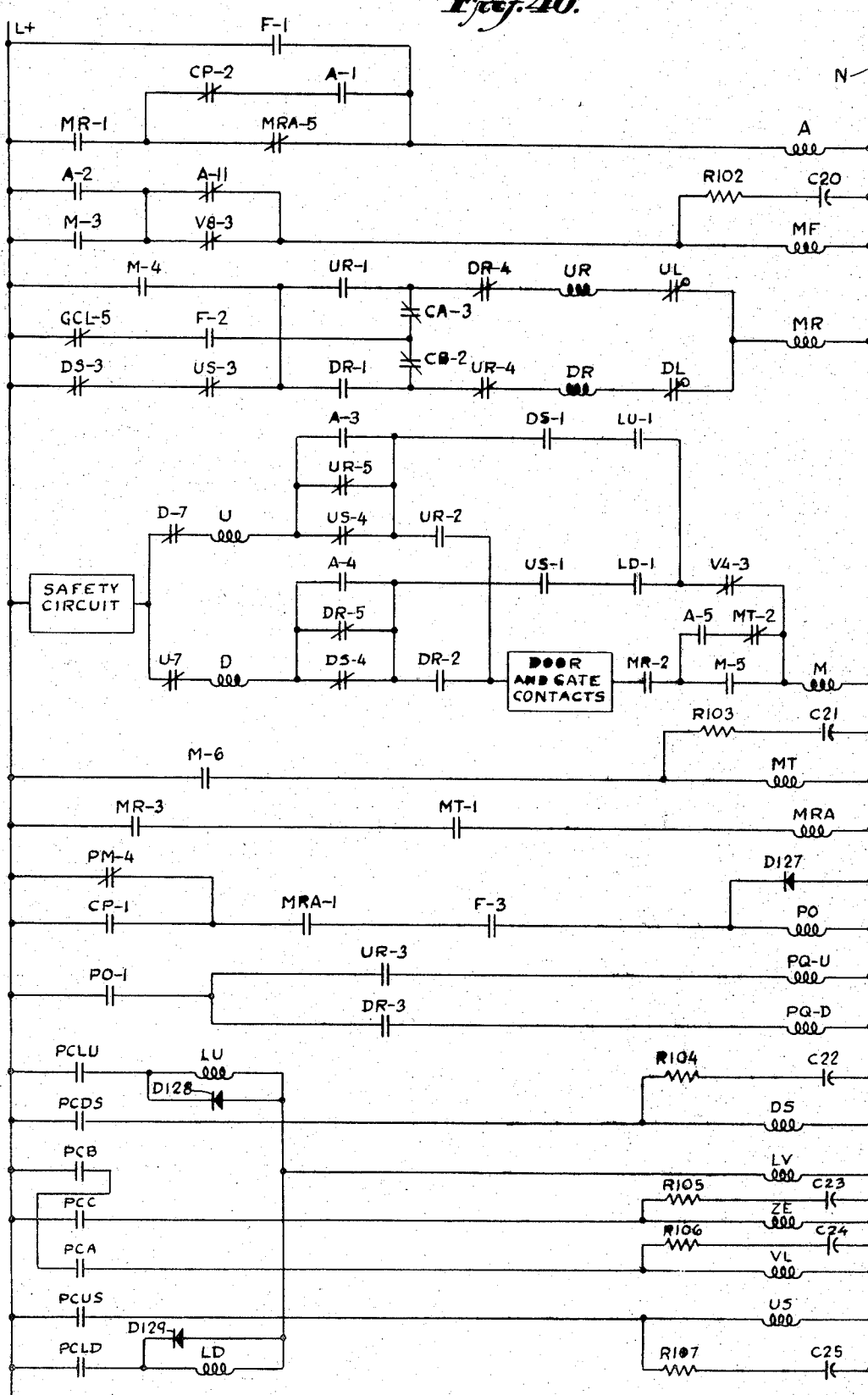


Fig. 41.

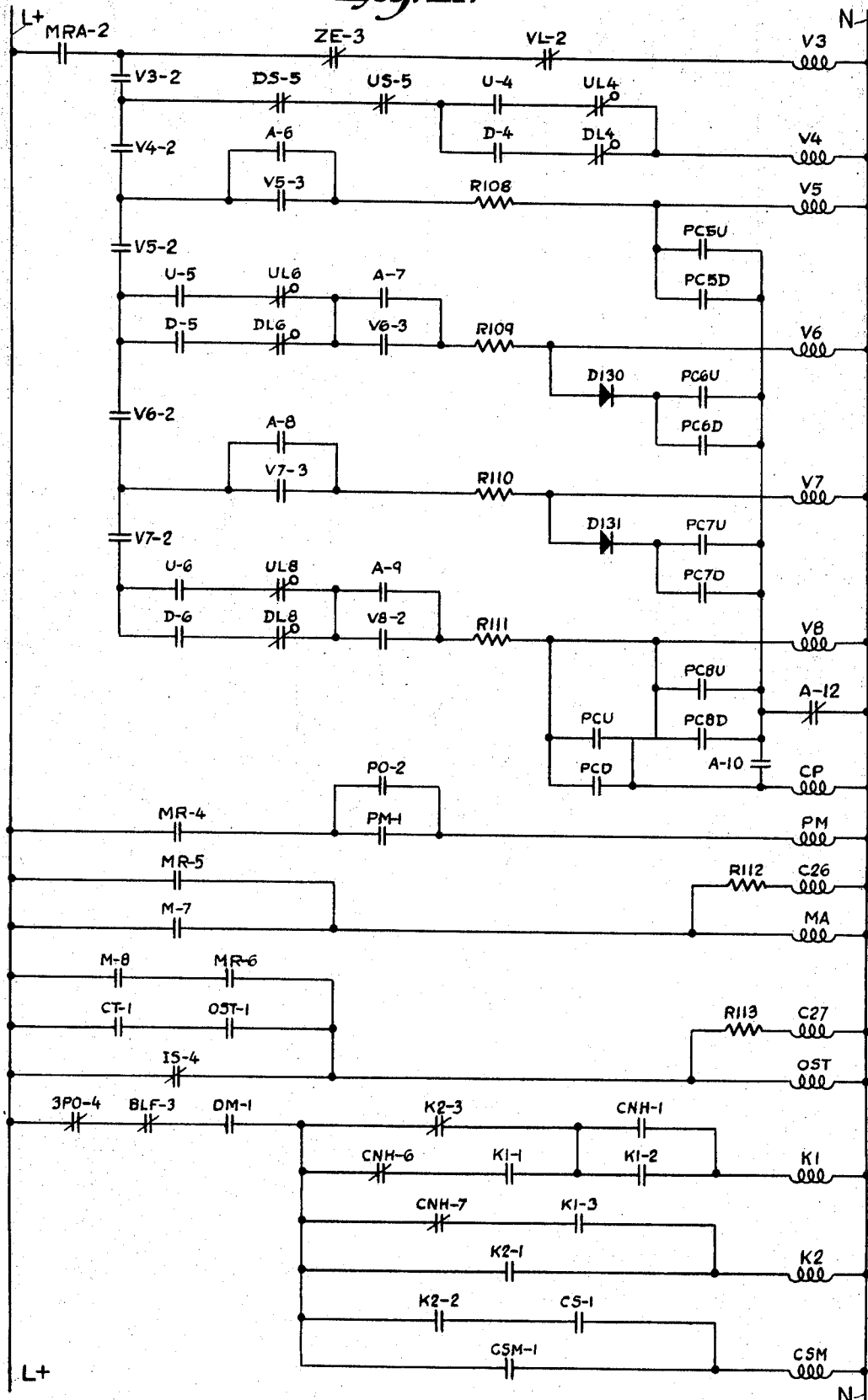


Fig. 42.

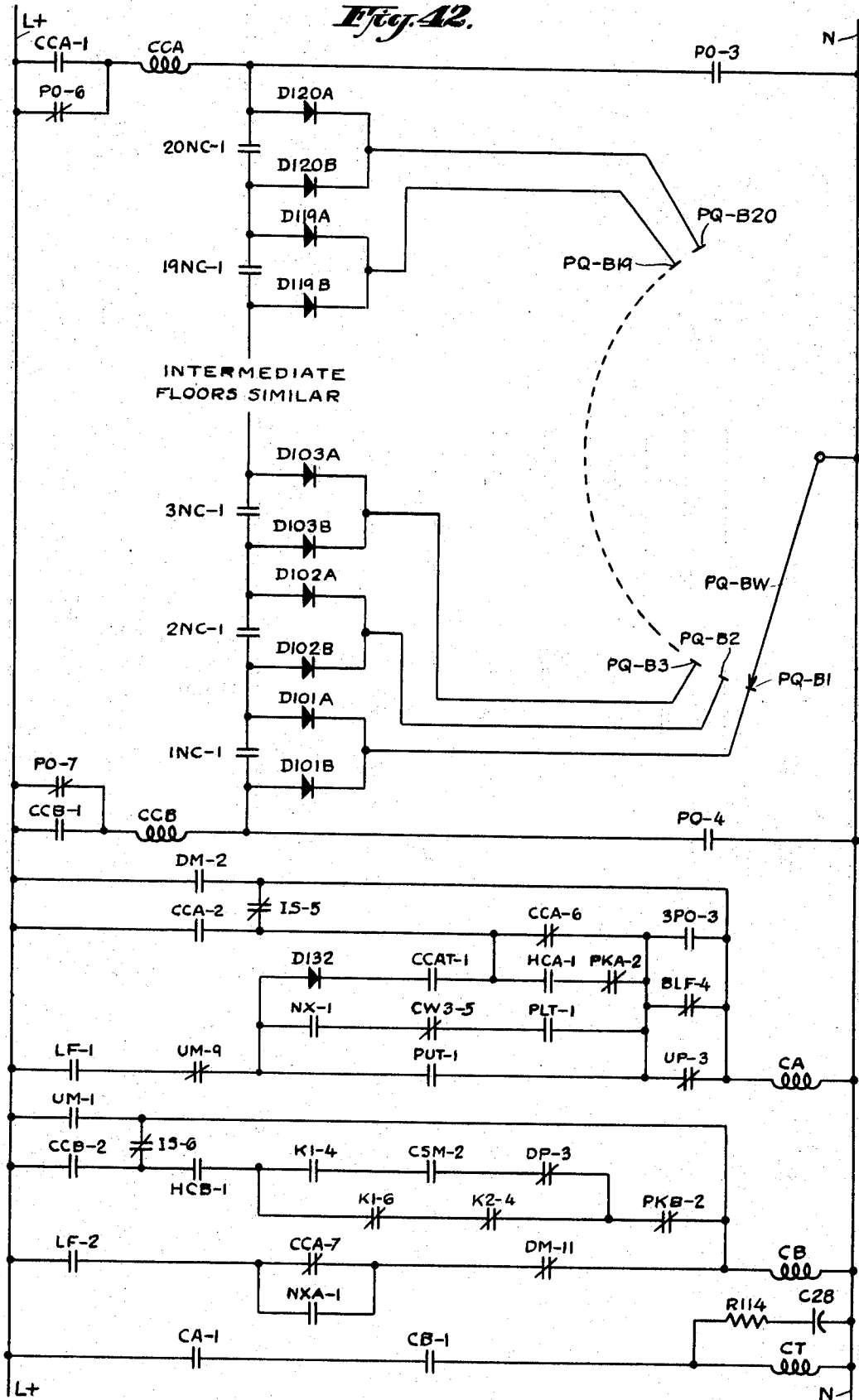


Fig. 43.

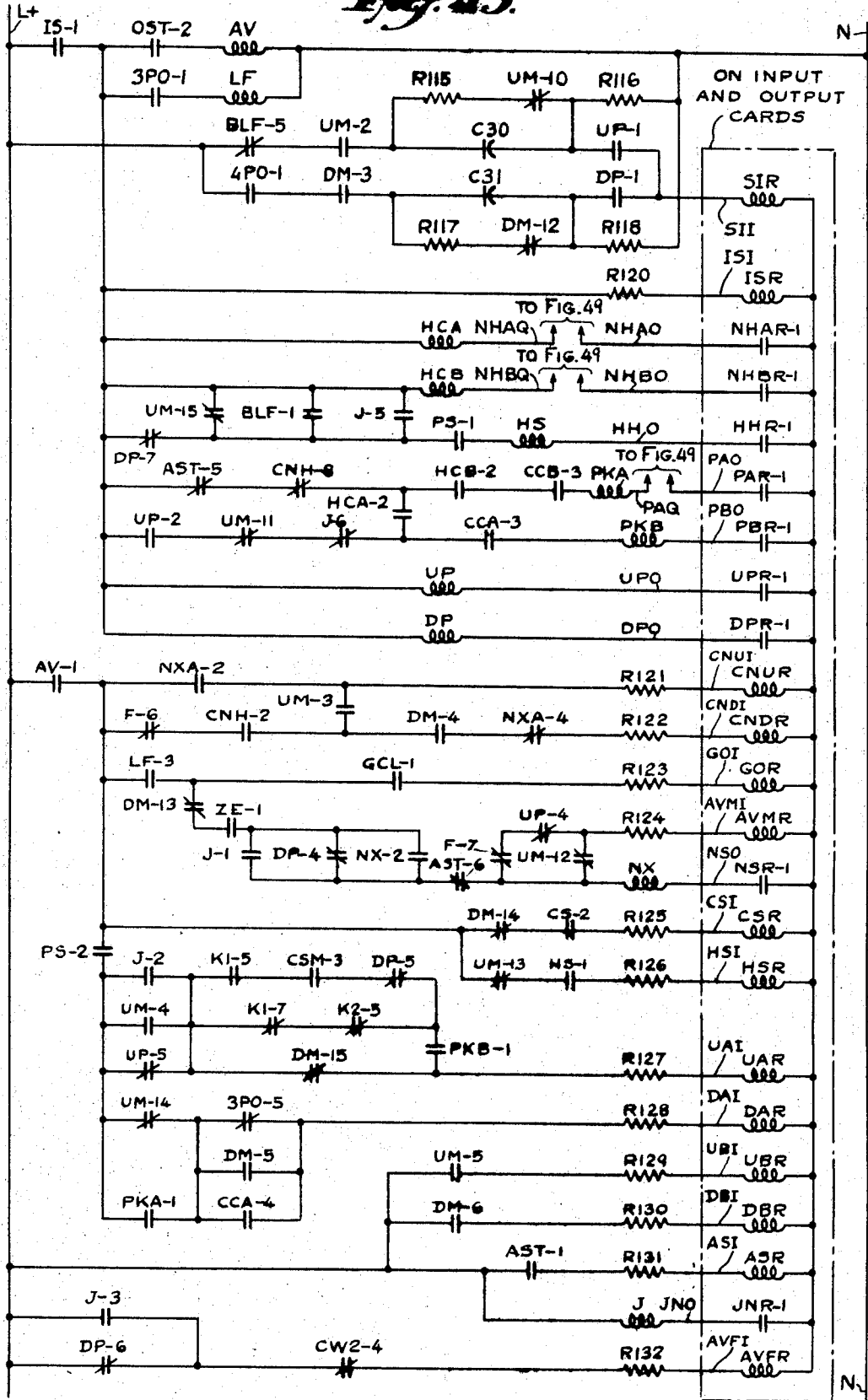


Fig. 44.

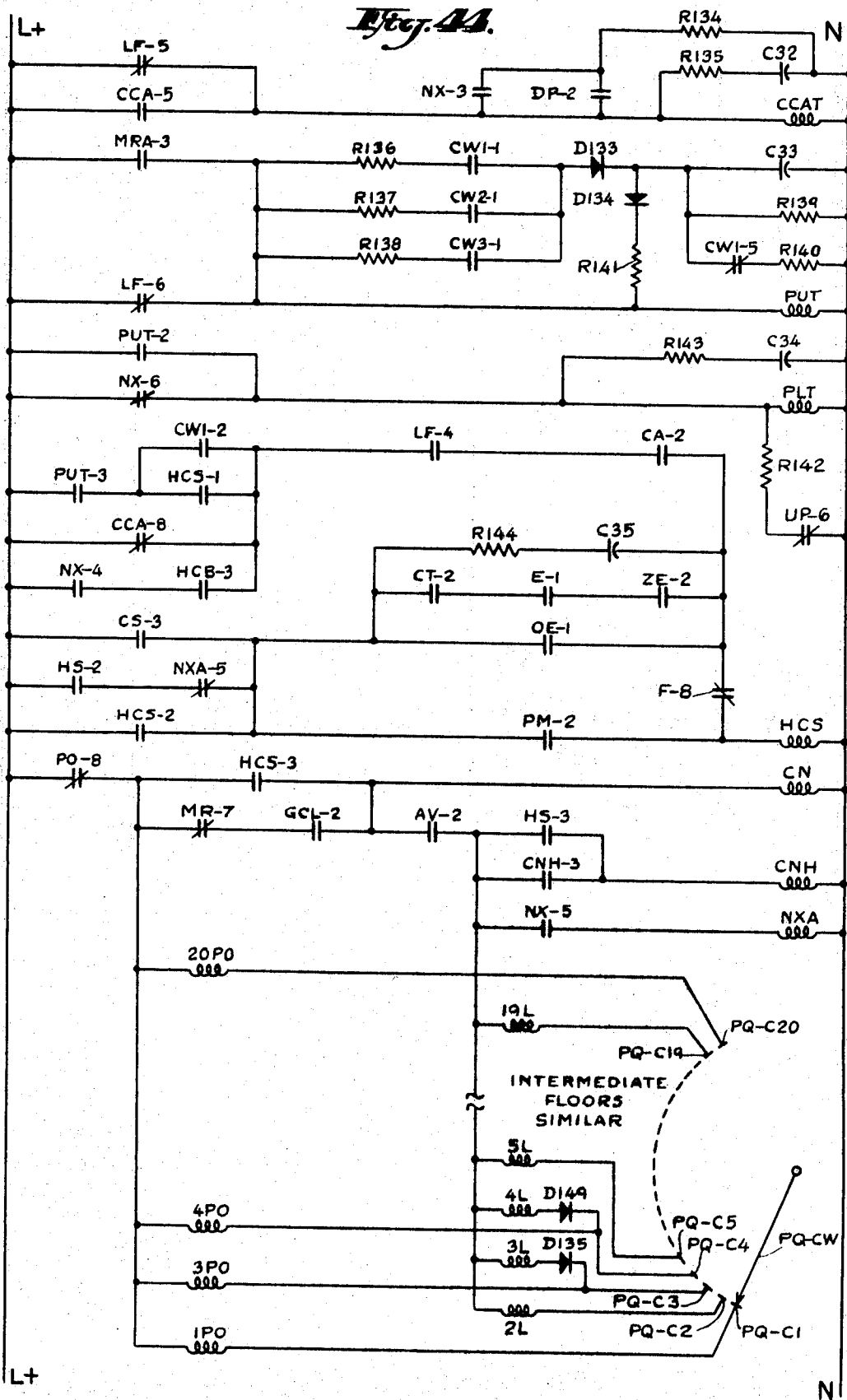


Fig. 45.

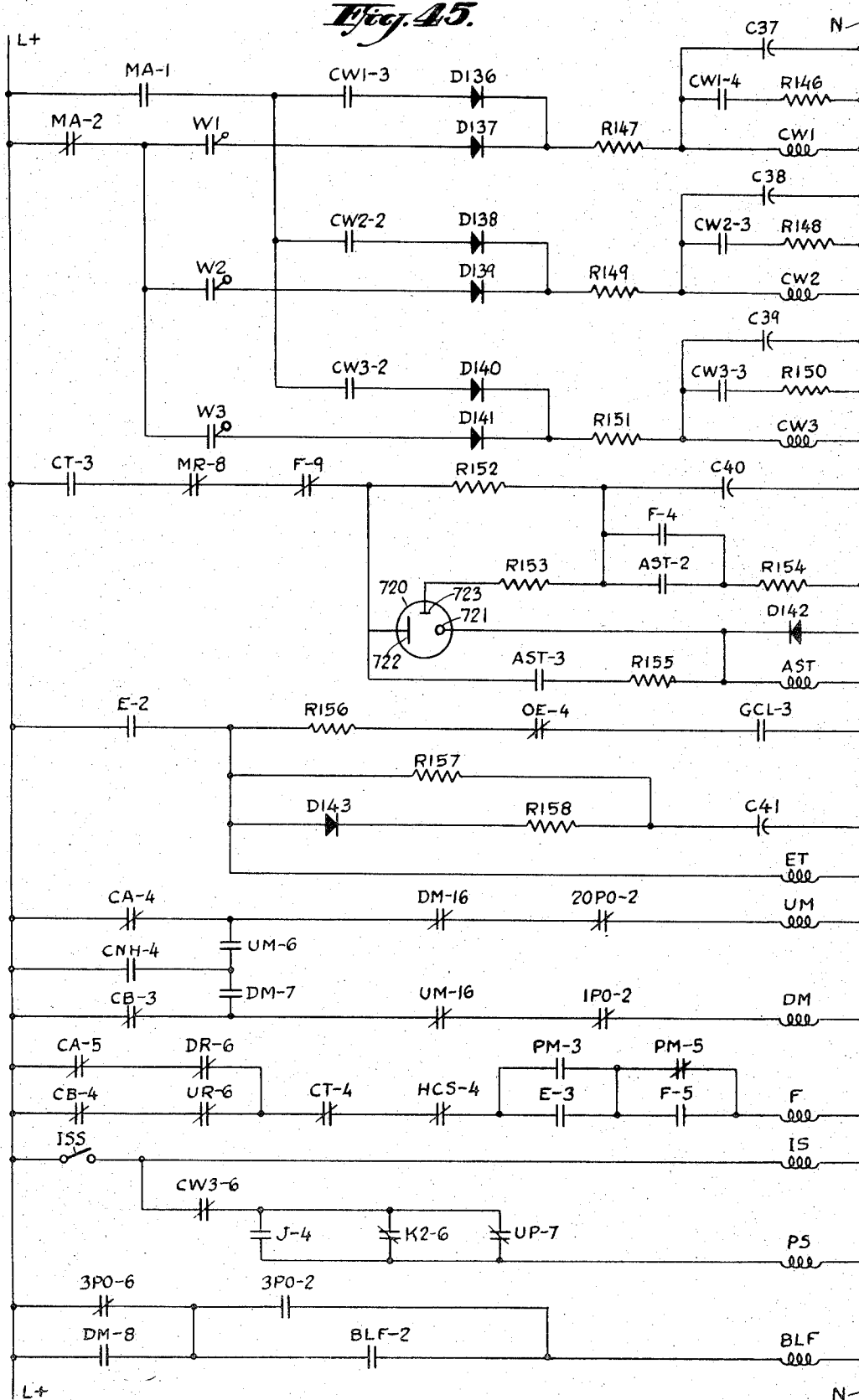


Fig. 46.

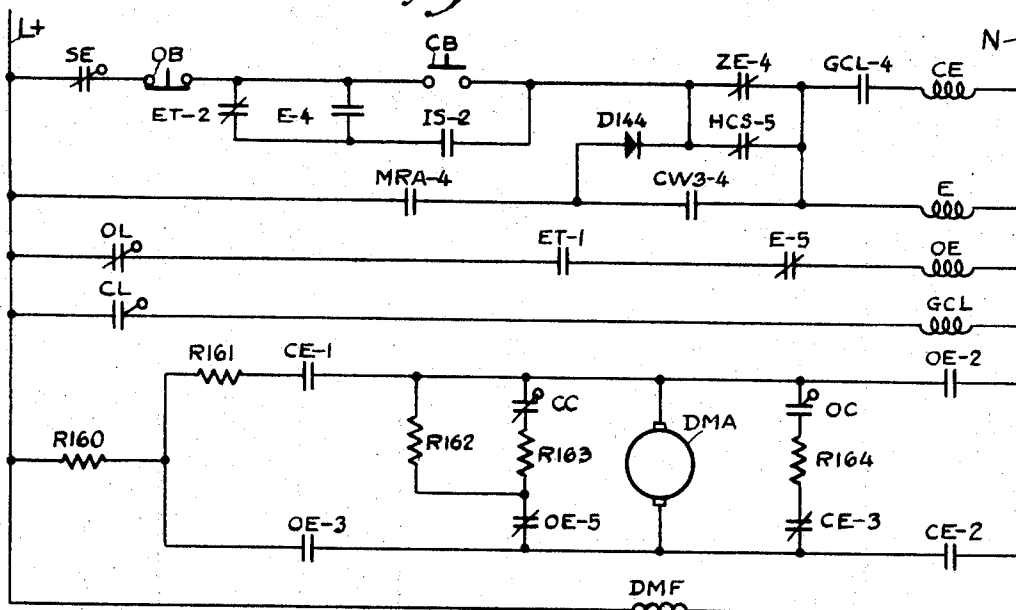
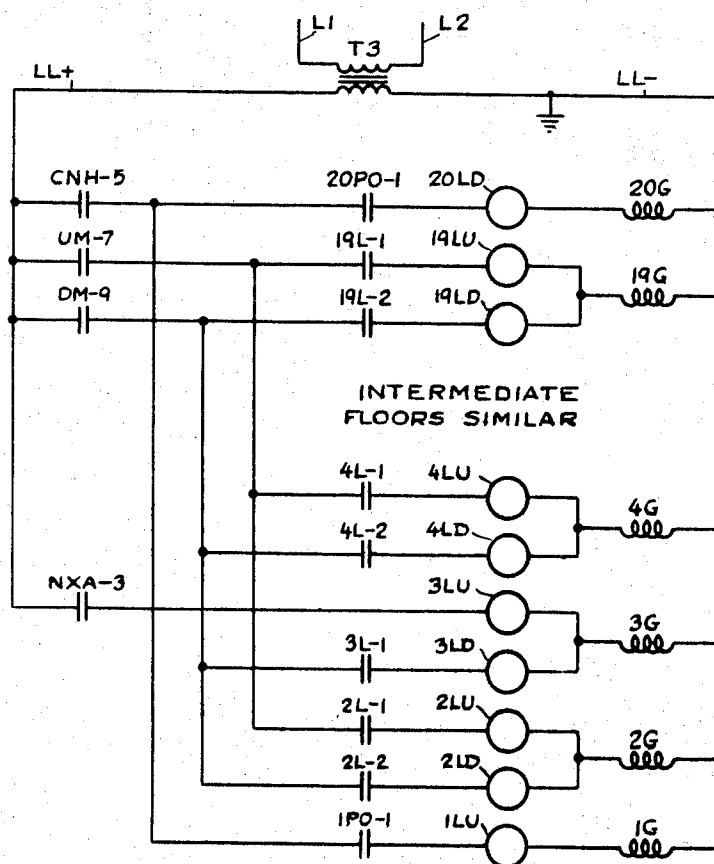


Fig. 47.



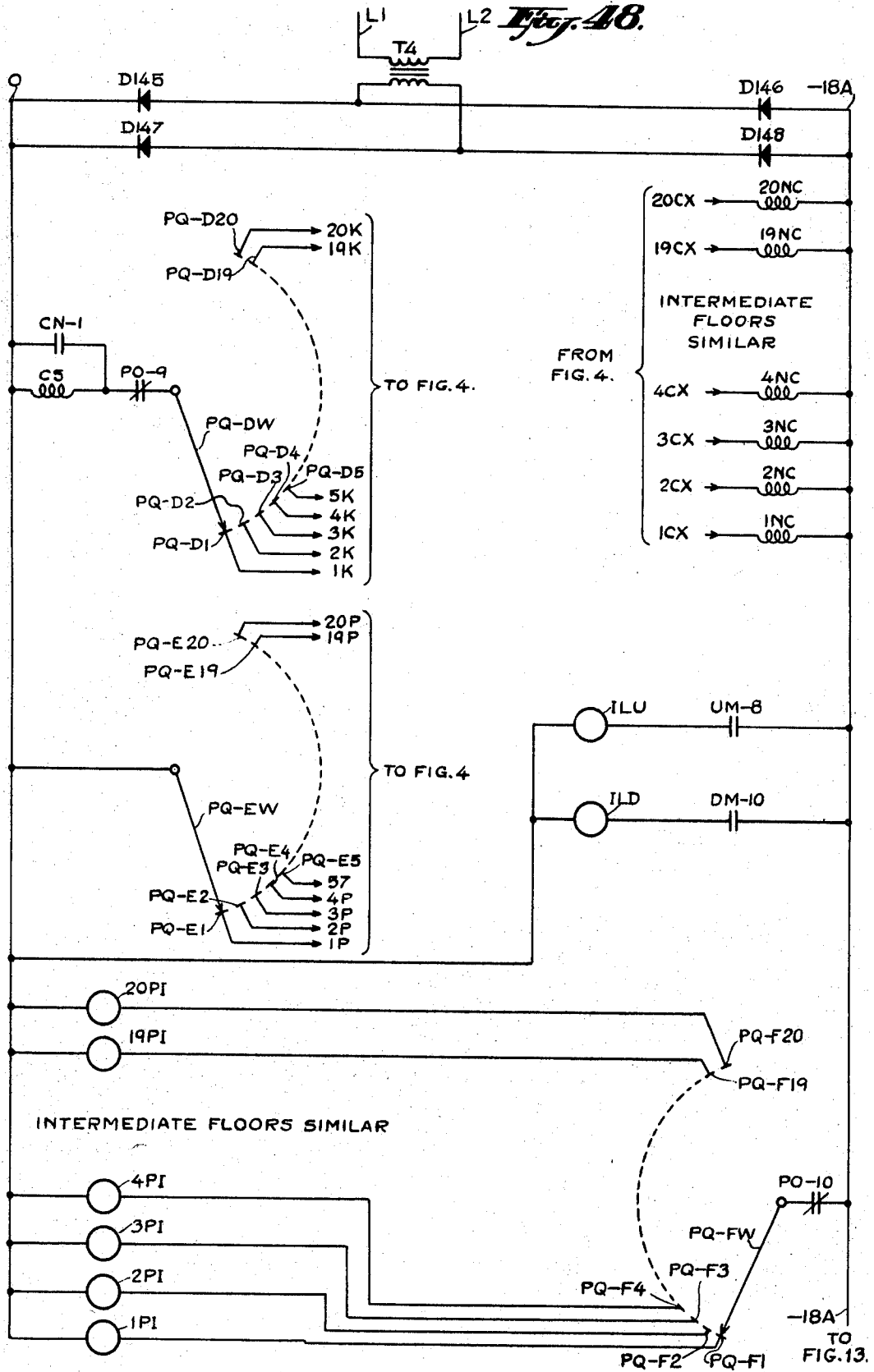


Fig. 49.

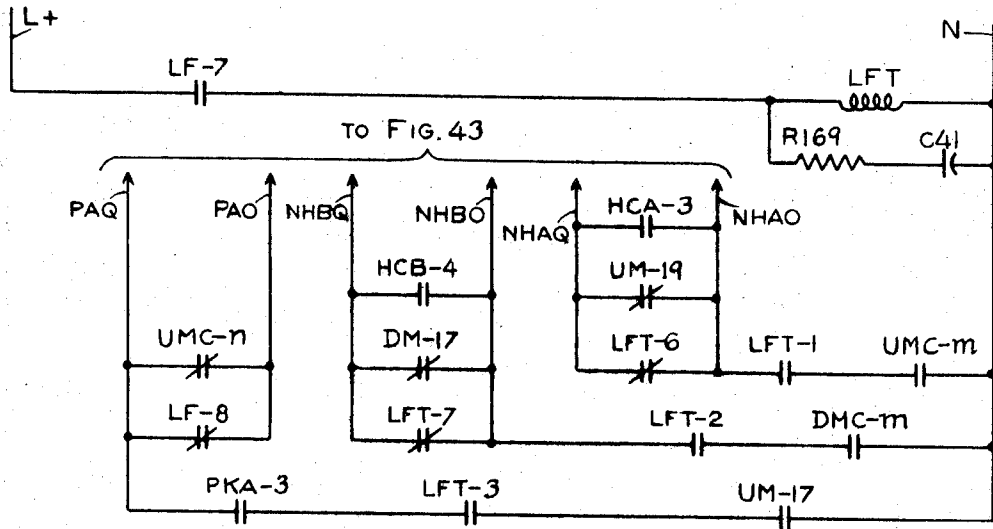
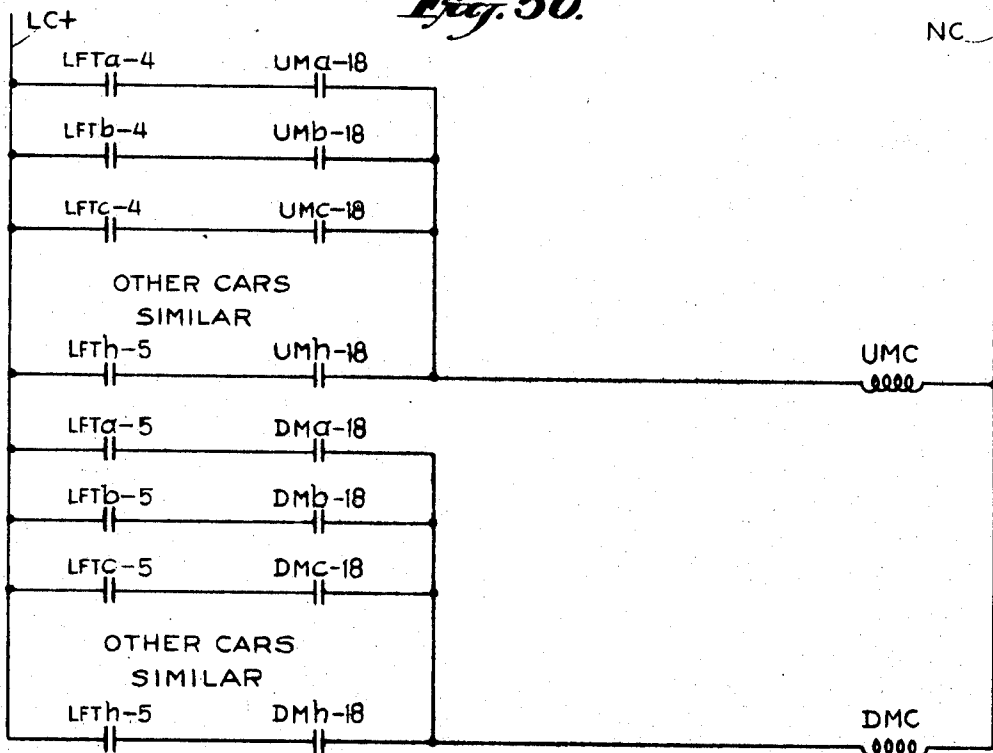


Fig. 50.



ELEVATOR GROUP SUPERVISORY CONTROL SYSTEM

This invention relates to control systems for controlling the movement of elevator cars and particularly to a control system for positioning and moving a plurality of elevator cars serving several floors in a building.

In a building having several floors and substantial amounts of traffic, such as an office building, it is the practice to provide several elevator cars, usually automatic, i.e., unattended, and to control their positioning and movement by means of various automatic controls so as to attempt to answer passengers' calls with a minimum of delay and to handle various traffic conditions, e.g. balanced, up-peak, down-peak and off-hours. Since a limited number of cars are available to serve a large number of conditions various compromise control systems have been adapted in the past which do not use the available equipment with maximum efficiency. In general, previous control systems are unsatisfactory because of the use of overall system conditions or time to determine the parking of cars and their dispatching to various floors and the use of terminal parking for all or most of the cars and terminal-to-terminal or terminal-to-high call trips for the cars.

It would be desirable to control the cars so that each car need not continue on to a terminal floor to await dispatch, but could remain at the floor where service was last required, or could be sent to park at some floor to improve the spacing of the cars in anticipation of further hall calls. This would eliminate the necessity of dispatching cars on a timed basis in the absence of hall calls. Such a system would require control equipment capable of dispatching cars from all floors, rather than just from two terminal floors.

The difficulties encountered in designing a system such as this can be illustrated by considering the relatively simple case of four elevators serving 11 floors. At each intermediate floor, a car could be considered to be in any one of four conditions: completely available; upbound; downbound; and not available. At terminal floors a car could be considered to be either available or not available. This results in 36 conditions for the nine intermediate floors, and four conditions for the terminal floors, or a total of 40 possible conditions for each car. In an eleven floor building, there are normally 10 up hall pushbuttons, and 10 down hall pushbuttons. Each hall call registered by such pushbuttons may be either registered or not. The total number of combinations of hall calls which may be registered is therefore 2 raised to the 20th power. Thus, the total number of possible situations which the control system must be able to recognize is 40 raised to the 4th power multiplied by two raised to the 20th power. This is equal to 2,684,354,560,000! For each one of these situations, the control system must have an answer. The magnitude of the problem can now be seen and this is the reason why previous systems have resorted to the simplified methods described earlier. It would appear that equipment capable of dispatching elevators from all floors would be prohibitively expensive unless major compromises were made to simplify the system.

Although the total number of combinations of conditions may be astronomically high, as illustrated earlier, the actual number of individual pieces of information is not great. This information is essentially that which is already available, on many installations, in the form of indicating lamps in a display panel at the main floor, which is often called a dispatcher's panel. This panel shows, by illuminated lamps, the position and direction of travel of each car, and also shows which hall calls are registered. Equipment to provide this information is well-known in the art, and forms a part of all such elevator installations, regardless of whether or not the information is displayed on indicating lamps at the main floor. Further information is desirable for this invention, so that the degree of availability of each car to answer hall calls is also established.

All of this information is in binary form, or can be readily converted into binary form. This simply means that a given piece of information is either "on" or "off", or "yes" or "no". For example, a given hall call is either registered or not. A given car is either available at a certain floor or it is not. If it is

available at a certain floor, it is not available at any other floor. Such a piece of information is called a "bit" of information.

Therefore, it is possible to employ high speed, digital computer techniques in the control of a group of elevator cars in such a manner that the demands for service and availability of cars to supply such demands are almost continuously recorded and compared and the movement and parking of the cars is almost continuously coordinated with the demands for service and with each other. In effect, it is possible for each car to survey almost continuously, and at least at a rapid rate relative to the variation in demands and movement of the cars, the demands for service in the system and the availability of other cars to answer such demands and to respond to such demands if they cannot be met within a reasonable period of time by another car. In the system of the invention each car may park at a floor where the last demand for service to be answered by such car has been answered, and it will be subsequently dispatched from such floor when the service demands require the service of the car. Thus, in one embodiment of the invention, cars may be dispatched from any of the floors at which they have parked or have answered a demand for service.

Briefly, a control system of the invention comprises apparatus for converting service demand information, e.g. hall call and/or car calls, and car information, e.g. car position and/or availability, into code form, e.g. binary digit form, substantially continuously, for scanning such information at a rate which is rapid, e.g. several times per second, and for directing the parking and movement of each of the cars dependent upon the results of such scanning and so that cars are not moved unnecessarily and calls are answered with relatively short delay. Such system comprises counters and memory devices corresponding to each car, and means for scanning the bits of information rapidly and supplying the information as to conditions ahead of and behind each car to the circuits corresponding to such car which in turn determine the movement or lack of movement required for each car.

In a modified form of the invention, the control apparatus is modified so as to permit shutdown of the motor-generator sets of one or more of the cars, if they are so equipped, after a predetermined idle time with the balance of the cars handling the service demands but with the shutdown cars ready to assist the other cars if such other cars are not able to answer demands efficiently.

In a further modified form of the invention, the control apparatus is modified to permit stopping or parking of cars in predetermined regions of the building whereby the cars are spaced from each other and readily available to answer calls quickly regardless of where the calls are placed.

In a further modified form of the invention, the control apparatus of the invention is modified so as to more efficiently handle up- and down-peak traffic conditions, and in such modification, the exact order of registration of down calls is recorded at all times, and during down-peak, one or more cars provide special service to those down hall calls which have been registered longest, whereas one or more other cars provide service to all other hall calls. During up-peak, cars are returned to a parking floor either at or near the main lower floor, preferably the latter, cars are moved to the main floor as needed, and if desired, other cars park at other than the main or parking floors. Preferably, peak conditions are detected by measuring the down hall calls, car availability and car stops.

The control system of the invention may be used with or without the modifications described above or the further modifications described hereinafter. However, since the modifications improve the service rendered by the elevator system and make the system more efficient under a wider variety of traffic conditions, it is preferred to employ the basic control system in combination with the modifications.

The object of this invention is to provide a system which is able to dispatch elevators from all floors, which is able to continuously direct the actions of each car which has been so dispatched, which is capable of taking into consideration the

car calls registered for each car in directing the actions of other cars, and which is capable of many modifications and special features, at reasonable cost without substantial compromises.

It is a further object of this invention to assure an equitable distribution of cars, particularly when there are no hall calls registered, and to handle situations in which some of the cars have their motor-generator sets shut down automatically, while other cars have their motor-generator sets running. This provides an operating programme so flexible that it can handle all traffic situations in the building except up-peak and down-peak.

A further object of this invention is to provide a system which can be easily modified to handle up-peak and down-peak traffic.

Other objects and advantages of my invention will be apparent from the following detailed description of preferred embodiments thereof, which description should be considered in conjunction with the accompanying drawings in which:

FIGS. 1 and 2 are combined block and circuit diagrams showing the electrical interconnections between certain sub-assemblies or "cards" common to all cars;

FIGS. 3 and 4 are combined block and circuit diagrams showing the electrical interconnections between certain sub-assemblies which are individual for each car;

FIGS. 5 and 6 are circuit diagrams showing the electrical interconnections between portions of the apparatus shown in other FIGS.;

FIG. 7 is a combined block and circuit diagram of a pulse generator employed in the system of the invention;

FIG. 8 is a graph illustrating the voltage wave forms at the outputs of the pulse generator shown in FIG. 7;

FIG. 9 is a combined block and circuit diagram of a "steering" circuit employed in the system of the invention;

FIGS. 10 and 11 are combined block and circuit diagrams respectively of a main stepper and a secondary stepper employed in the system of the invention;

FIGS. 12 and 13 are circuit diagrams respectively for hall call cars and car call cards;

FIG. 14 is a combined block and circuit diagram of a parity checker employed in the system of the invention;

FIG. 15 is a combined block and circuit diagram of a secondary scanner employed in the system of the invention;

FIG. 16 is a graph illustrating the voltage wave forms obtained at certain outputs of the secondary scanner shown in FIG. 15;

FIG. 17 is a combined block and circuit diagram of a master card employed in the system of the invention;

FIG. 18 is a combined block and circuit diagram of an availability card employed in the system of the invention;

FIG. 19 is a combined block and circuit diagram of a counter card employed in the system of the invention;

FIG. 20 is a combined block and circuit diagram of a read-out card employed in the system of the invention;

FIG. 21 is a combined block and circuit diagram of a spacing read-out card employed in the system of the invention;

FIG. 22 is a combined block and circuit diagram of a "next" read-out card employed in the system of the invention;

FIG. 23 is a combined block and circuit diagram of a "next" stepper card employed in the system of the invention;

FIG. 24 is a combined block and circuit diagram of a scrambler employed in the system of the invention;

FIG. 25 is a combined block and circuit diagram of an extra stepper employed in the system of the invention;

FIG. 26 is a combined block and circuit diagram of an extra scan control employed in the system of the invention;

FIG. 27 is a combined block and circuit diagram of a car spacer employed in the system of the invention;

FIG. 28 is a combined block and circuit diagram of an up peak spacer employed in the system of the invention;

FIG. 29 is a combined block and circuit diagram of a call priority card employed in the system of the invention;

FIG. 30 is a combined block and circuit diagram of a call priority stepper employed in the system of the invention;

FIG. 31 is a combined block and circuit diagram of an instruction read-out card employed in the system of the invention;

FIG. 32 is a combined block and circuit diagram of a rotational instructor employed in the system of the invention;

FIG. 33 is a combined block and circuit diagram of an input card employed in the system of the invention;

FIG. 34 is a circuit diagram of an output card employed in the system of the invention;

FIG. 35 is a combined block and circuit diagram of a peak detector employed in the system of the invention;

FIG. 36(a) illustrates the circuit diagram and the symbol for a NOR circuit used in the apparatus employed in the system of the invention;

FIG. 36(b) illustrates the circuit diagram and the symbol for an amplifying NOR circuit used in the apparatus employed in the system of the invention;

FIG. 36(c) illustrates the circuit diagram and the symbol for a combined NOR preamplifier and power amplifier circuit used in the apparatus employed in the system of the invention;

FIG. 36(d) illustrates the circuit diagram and the symbol for a "sensitive" NOR circuit used in the apparatus employed in the system of the invention;

FIG. 36(e) illustrates the circuit diagram and the symbol for a lamp driver circuit used in the apparatus employed in the system of the invention;

FIG. 36(f) illustrates the circuit diagram and the symbol for a combination of two NOR circuits used in the apparatus employed in the system of the invention;

FIG. 36(g) illustrates the circuit diagram and the symbol for a relay driver circuit used in the apparatus employed in the system of the invention;

FIG. 36(h) illustrates the circuit diagram and the symbol for a modified relay driver circuit used in the apparatus employed in the system of the invention;

FIG. 36(i) illustrates the circuit diagram and the symbol for an emitter follower circuit used in the apparatus employed in the system of the invention;

FIG. 36(j) illustrates the circuit diagram and the symbol for a "one-shot" circuit used in the apparatus employed in the system of the invention;

FIG. 37(a) illustrates the circuit diagram and the symbol for an astable multivibrator used in the apparatus employed in the system of the invention;

FIG. 37(b) illustrates the circuit diagram and the symbol for a monostable multivibrator used in the apparatus employed in the system of the invention;

FIG. 37(c) illustrates the circuit diagram and the symbol for a bistable multivibrator used in the apparatus employed in the system of the invention;

FIG. 37(d) illustrates the circuit diagram and the symbol for a two-input, direct current gate used in the apparatus employed in the system of the invention;

FIG. 37(e) illustrates the circuit diagram and the symbol for a one-input, alternating current gate used in the apparatus employed in the system of the invention;

FIG. 37(f) illustrates the circuit diagram and the symbol for a two-input, alternating current gate used in the apparatus employed in the system of the invention;

FIG. 38 is a combined block and circuit diagram illustrating the power circuits, including the motor-generator set and hoist motor which may be used to operate the cars in the system of the invention and the equipment employed to provide indications for speed control purposes of the distance between a car and the various floors served;

FIG. 39 is an enlarged schematic drawing of the proximity contact column shown as part of FIG. 38;

FIG. 40 is a combined block and circuit diagram of circuits employed in connection with speed control of the cars;

FIG. 41 is a circuit diagram of further circuits used in connection with speed control of the cars and of other circuits;

FIG. 42 is a circuit diagram of circuits for detecting car calls and for establishing car travel direction;

FIG. 43 is a circuit diagram illustrating the interconnections between the relay circuits for one car and circuits on cards illustrated in other FIGS.;

FIG. 44 is a circuit diagram of other relay circuits employed in the system of the invention;

FIG. 45 is a circuit diagram illustrating load weighing and motor-generator shutdown apparatus employed in the system of the invention;

FIG. 46 is a circuit diagram of a simplified form of car and hall door operating circuit;

FIG. 47 is a circuit diagram of hall lantern operating circuits;

FIG. 48 is a circuit diagram illustrating further signal lamp operating circuits and further interconnections between relay circuits and cards shown in other FIGS.;

FIG. 49 is a circuit diagram showing other relay circuits employed in the system of the invention;

FIG. 50 is a circuit diagram showing the circuits for several relays which are common to all cars.

GENERAL DESCRIPTION

In the system of this invention, there is a systematic surveying of the bits of information on which control of the cars is to be based in a predetermined order, over and over again at high speed. This process is known as scanning. In order to accomplish this scanning, a number is assigned to each bit of information. Although a numbering system based on 10, or on any other number, could be used, the aims of this invention can be most conveniently met if binary numbers are used.

Each digit of a binary number can be either 0 or 1, and thus a single wire can be made to represent this digit if it has two discrete levels of voltage. One level of voltage represents 0; the other level represents 1. Thus, a group of such wires can collectively represent all of the digits of a binary number. For example, 5 such wires could collectively represent any one of 32 possible numbers, depending on the voltage levels of the individual wires.

In this invention, a means is provided for generating rapidly changing signals on a group of wires, so that their voltage levels represent, in numerical succession, binary numbers. Each bit of information has associated with it a circuit capable of recognizing when the rapidly changing binary number, as indicated by the group of wires, coincides with the binary number assigned to this bit of information. During such coincidence of binary numbers, this equipment causes its bit of information to be applied to a common wire. Thus, each bit of information, continuously showing in part of the equipment, is intermittently applied to the common wire such that only one such bit is applied at one time, and so that each such bit is allocated, by its assigned binary number, a particular period for applying its signal to the common wire. This common wire then contains the entire information, one bit at a time in a predetermined order.

Although the aims of this invention could be accomplished by scanning the information in various orders, the preferred and best method is to scan upwardly through the down direction information, then downwardly through the up direction information, before repeating. Down information consists of down hall calls, at various floors, and cars available to go down from those floors. Up information consists of up hall calls at various floors, and cars available to go up from those floors. This order of scanning this information is opposite to the order in which cars would be capable of stopping for the various hall calls.

This scanned information is divided into two parts for each car, namely that part which represents conditions above the car and that part which represents conditions below the car. What is above for some cars may be below for others, and vice versa.

Each car is equipped with a binary counter which is reset to zero at the commencement of each part of each scan. A subtraction of one is made at each point in the scan where a hall

call is detected. Thus, if hall calls are registered, a negative number indicating the number of hall calls above or below would be accumulated on the counter at the end of each part of each scan. However, an addition of one or two (generally two) is made each time an available car is detected during the scan, it being one or two depending on the degree of availability of such car to answer calls. Such addition is not allowed to make the accumulated count positive. Thus, the availability of other cars to answer some or all of these hall calls is taken into consideration so that at the end of each part of each scan the accumulated count on the counter indicates, if zero, that this car need not and if negative, that it should, answer hall calls. Readings of the accumulated count taken at the ends of the above parts of each scan indicate whether or not the car should go up to answer hall calls above, and readings taken at the end of the below part indicate whether or not the car should go down to answer hall calls below.

These readings are taken only intermittently, but two memories for each car are used to retain the information between the reading points. The scanning is done so rapidly that changed conditions are detected with very little delay, even though the output of a memory remains in the previous condition until the correct part of the scan allows a reading to be made, to change the memory.

The result of such scanning is that up hall calls are normally answered by the nearest suitable car below, and down hall calls are normally answered by the nearest suitable car above. However, if there are more than two hall calls for any one car to answer, another car is started to assist if possible, and such other car may reverse its direction of travel from up to down, in order to answer a down hall call, even when there are hall calls above it, if the other car is capable of answering those other calls. A similar reversal from down to up direction is also possible when there are hall calls below which another car is capable of answering.

If there is no suitable car below, an up hall call is answered by the nearest suitable car above. If there is no suitable car above, a down hall call is answered by the nearest suitable car below. It would be possible to modify this scanning system so that the first hall call to be registered is answered by the nearest suitable car, regardless of whether it is above or below. However, the slight advantage so gained is probably not worth the extra expense and complication of the circuit.

The principal bits of information which are used for my preferred scanning system are: the condition of each hall call memory; and the position and availability of each car in the group. The condition of each car call memory, for each car, is not used directly in the scan, but, as will be described later, may be used to change the availability of cars depending on whether there are car calls which must be answered before hall calls, thereby lengthening the waiting time for service to such hall calls. Separate circuitry, unrelated to the scanning, is required for each car to allow it to keep a continuous record of whether or not there are car calls for above floors, and whether or not there are car calls for below floors. One purpose of the scanning is to allow each car to determine when there are hall calls above, which it should answer, and similarly to determine when there are hall calls below, which it should answer.

As in previously known systems, in my system there are two buttons at each intermediate floor operable by intending hall passengers. One button is called an up hall button, and the other is called a down hall button. At the lowest floor there is only one button, an up hall button. At the top floor, there is only one button, a down hall button. Each one of these buttons has a memory associated with it, and this memory has two stable conditions. Operation of a hall button causes the associated memory to go to an "on" condition to indicate that a call has been registered. The arrival of a suitable car at the floor where the hall button is located causes the associated memory to return to the "off" condition indicating that this call is no longer registered. Thus, each hall call memory provides one bit of information.

As in previously known systems, in my system the position of the elevators in their shafts is converted from analogue to digital form for supervisory control purposes. Thus, as an example, for supervisory control purposes an elevator is never between floors 7 and 8 but is either at 7 or 8. For speed control purposes, of course, the actual position of the car with respect to each floor must be known.

Also, as in previously known systems, in my system the digital position of the elevator for supervisory control purposes is not necessarily the floor which it is closest to; it is instead, an advanced position which represents the nearest floor at which the car is capable of making a normal stop from whatever speed it has attained. For example, when the car is stopped at the 11th floor, its advanced digital position is, of course, 11. As soon as it starts to go down, the advanced digital position is changed to floor 10. As the car accelerates and moves down at increasingly higher speeds, eventually a critical position is reached between the 11th and 10th floors where it can just make a normal stop at the 10th floor. If it travels any further, it is too late to make a stop at the 10th floor without overshooting. At this time, the advanced digital position changes from 10 to 9 unless the car intends to stop at the 10th floor.

Similarly, the car will eventually reach another critical position where it can just make a normal landing at the 9th floor. The car may or may not have reached full speed, and the critical position depends on the speed. This critical position may occur while the car is still above the 10th floor but nevertheless the advanced digital position changes from 9 to 8 unless the car intends to stop at the 9th floor. Once the car starts to slow down to stop at a floor, the advanced digital position remains at that destination floor while the car catches up with its advanced digital position.

Methods of accomplishing this advancing of the digital position information have been used for many years. A particularly good method of doing so is described in my copending U.S. Pat. application Ser. No. 430,529 filed Feb. 5, 1965. Examples of previous, but not as satisfactory methods are described in Canadian Pat. No. 669,267 and in U.S. Pat. No. 2,657,765. Throughout the description of this invention, when reference is made to the position of an elevator, it is this advanced position that is meant.

The availability of a car for scanning purposes can be classified in two different ways; by the direction in which it is available; and by the degree of availability. A car, if available, may be available to go up, to go down, or to go either up or down. This is its directional availability. The degree of availability of a car is indicated by how many hall calls it is considered capable of answering in a reasonable time. A car, if available, may be considered capable of answering either one or two hall calls. Although my system inherently allows also for a car to be considered capable of answering three hall calls, this capability is not used since it is felt that if a car attempts to answer three existing hall calls in succession, the third of these three hall calls may have to wait too long for service.

Accordingly, normal availability of all cars is selected as two. Cars which have been loaded sufficiently to cause automatic bypassing of hall calls are considered to have an availability of zero; in other words, they are unavailable. Customarily, the load above which automatic bypass occurs is approximately 70 percent if rated load. It is desirable with my system to reduce the availability from two to one when a car is loaded beyond approximately 40 percent of rated load. This availability, considering only the load on the car, will be called the basic availability. The actual availability may be reduced because of car calls. If a car call in a car is so situated with respect to a hall call which this car would normally answer that the car call must be answered before the hall call, then the basic availability preferably is reduced by one to obtain the actual availability. Similarly, if two car calls in a car are so situated with respect to a hall call which this car would normally answer, that they both must be answered before the hall call,

then the availability of this car preferably is reduced by two which, of course, makes it unavailable.

A car which is available to go up will be referred to as a UAV car, and a car which is available to go down will be referred to as a DAV car. A car whose actual availability is two will be referred to as an AV2 car, and a car whose actual availability is one will be referred to as an AV1 car. It is important to realize that a car with no direction of travel established is available to go either up or down, and thus, must be counted as both a UAV and a DAV car. If it were desired to have a car with an availability of three, it could be considered as being both an AV1 and an AV2 car. The abbreviations DAV1, DAV2, UAV1, and UAV2 will also be used, and their meanings are obvious.

There are only six conditions in which a car can normally be, based on its availability:

1. Completely available, i.e., both DAV2 and UAV2;
2. Available to go down for two hall calls, i.e. DAV2;
3. Available to go down for one hall call i.e., DAV1;
4. Available to go up for two hall calls, i.e., UAV2;
5. Available to go up for one hall call, i.e., UAV1; and
6. Unavailable.

INFORMATION SCANNING

The principal bits of information required for my scanning system have now been described. I will now describe the order in which these bits of information must be scanned. Basically, a binary number is assigned to each bit of information, and the order in which the information is scanned is the same as the numerical order of these binary numbers.

92 purposes of illustration, I shall describe the application of my invention to the control of a group of eight automatic elevator cars, *a-h*, serving 32 floors. Fourteen binary digits are used in the preferred system here described, and for convenience, I have named them *i1, i2, c1, c2, c4, s1, f1, f2, f4, f8, f16, m1, m2* and *m4*, such labels and their functions being shown in the following table:

TABLE 1

Extra Scan	Main Scan					Secondary Scan					
	Floors					Cars		Instructions			
m4, m2, m1.....	f16	f8	f4	f2	f1	s1	c4	c2	c1	i2	i1

Thus, the total number of binary numbers is 2 raised to the 14th power, or 16,384. This is considerably more than required for the bits of information to be scanned, but some of these binary numbers represent parts of the scan where no information is considered, but where certain functions are performed by the cars. Also, some of the binary numbers are unnecessary in the preferred system and are bypassed by jumping from one binary number to another.

As an example of numbers which are bypassed, reference is made to the following table:

TABLE 2

	m4	m2	m1	
X.....	0	1	0	} Part 1.
Y.....	0	1	1	
Y.....	1	0	0	} Part 2.
Z.....	1	0	1	
Z.....	1	1	0	} Part 1.
Z.....	1	1	1	

Considering only the final three digits *m1, m2* and *m4*, a total of eight binary numbers is possible but only six are used. Reading downward in table 2, the binary numbers 010 to 111 are

shown in consecutive order. The next number in the series after 111 should be 000, but this number as well as 001 is bypassed or omitted so that the next number used is 010 as shown at the top of table 2. The digits *m2* and *m4* are referred to as the extra scan, and it will be shown later that these digits are used only by cars whose motor-generator sets are shut down automatically.

A similar bypassing of numbers will be shown later when table 4 is explained. The result is that there are only 6,912 numbers in a complete scan instead of 16,384. When the digits

m2 and *m4* are not considered, there are only 2,304 binary numbers, and these constitute what will be referred to as the normal scan. It will be shown later that many of these numbers may also be bypassed, when the corresponding information is absent, so that a normal scan may not consist of more than 624 binary numbers.

To save space I shall not illustrate all 2,304 binary numbers in a single chart with the corresponding bits of information. Thus, six of the digits are shown in the following table 3 and the remaining six digits are shown in the following table 4:

TABLE 3

	m1	f16	f8	f4	f2	f1	Floors	m1	f16	f8	f4	f2	f1
Scan up.....	0	1	1	1	1	1	32	1	0	0	0	0	0
	0	1	1	1	1	0	31	1	0	0	0	0	1
	0	1	1	1	0	1	30	1	0	0	0	1	0
	0	1	1	1	0	0	29	1	0	0	0	1	1
	0	1	1	0	1	1	28	1	0	0	1	0	0
	0	1	1	0	1	0	27	1	0	0	1	0	1
	0	1	1	0	0	1	26	1	0	0	1	1	0
	0	1	1	0	0	0	25	1	0	0	1	1	1
	0	1	0	1	1	1	24	1	0	1	0	0	0
	0	1	0	1	1	0	23	1	0	1	0	0	1
	0	1	0	1	0	1	22	1	0	1	0	1	0
	0	1	0	1	0	0	21	1	0	1	0	1	1
	0	1	0	0	1	1	20	1	0	1	1	0	0
	0	1	0	0	1	0	19	1	0	1	1	0	1
	0	1	0	0	0	1	18	1	0	1	1	1	0
	0	1	0	0	0	0	17	1	0	1	1	1	1
	0	0	1	1	1	1	16	1	1	0	0	0	0
	0	0	1	1	1	0	15	1	1	0	0	0	1
	0	0	1	1	0	1	14	1	1	0	0	1	0
	0	0	1	1	0	0	13	1	1	0	0	1	1
	0	0	1	0	1	1	12	1	1	0	1	0	0
	0	0	1	0	1	0	11	1	1	0	1	0	1
	0	0	1	0	0	1	10	1	1	0	1	1	0
	0	0	1	0	0	0	9	1	1	0	1	1	1
	0	0	0	1	1	1	8	1	1	1	0	0	1
	0	0	0	1	1	0	7	1	1	1	0	0	1
	0	0	0	1	0	1	6	1	1	1	0	1	0
	0	0	0	1	0	0	5	1	1	1	0	1	1
	0	0	0	0	1	1	4	1	1	1	1	0	0
	0	0	0	0	1	0	3	1	1	1	1	0	1
	0	0	0	0	0	1	2	1	1	1	1	1	0
	0	0	0	0	0	0	1	1	1	1	1	1	1

Scan down.

TABLE 4

	s1	c4	c2	c1	i2	i1	
Scan down.....	0	1	1	1	0	0	Main scan (Hall Calls)
	0	1	1	1	0	1	Spare.
	0	1	1	1	1	0	Cancel.
	0	1	1	1	1	1	Read.
	1	0	0	0	0	0	Read.....
	1	0	0	0	0	1	AV1.....
	1	0	0	0	1	0	AV2.....
	1	0	0	0	1	1	Reset.....
	1	0	0	1	0	0	Read.....
	1	0	0	1	0	1	AV1.....
	1	0	0	1	1	0	AV2.....
	1	0	0	1	0	1	Reset.....
	1	0	1	0	0	0	Read.....
	1	0	1	0	0	1	AV1.....
	1	0	1	0	1	0	AV2.....
	1	0	1	0	1	1	Reset.....
	1	0	1	1	0	0	Read.....
	1	0	1	1	0	1	AV1.....
	1	0	1	1	1	0	AV2.....
	1	0	1	1	1	1	Reset.....
	1	1	0	0	0	0	Read.....
	1	1	0	0	0	1	AV1.....
	1	1	0	0	1	0	AV2.....
	1	1	0	0	1	1	Reset.....
	1	1	1	0	0	0	Read.....
	1	1	1	0	0	1	AV1.....
	1	1	1	0	1	0	AV2.....
	1	1	1	0	1	1	Reset.....
	1	1	1	1	0	0	Read.....
	1	1	1	1	0	1	AV1.....
	1	1	1	1	1	0	AV2.....
	1	1	1	1	1	1	Reset.....

To understand the complete sequence, start with digits *f1* to *m1* all at 0 as at the bottom left of table 3, and while these remain at 0 go through the 36 numbers in table 4, starting at 011,100 at the top and ending at 111,111 at the bottom. Then, repeat with the next number in table 3, 000,001, again starting at the top of table 4 and ending at the bottom. Continue with this procedure until the number 011,111 is reached at the top left of table 3. Continue the same procedure going down through the right side of table 3, pausing at each step in table 3 while the 36 numbers in table 4 are considered in numerical order. When this is done, all 2,304 binary numbers are considered in numerical order. Many of these binary numbers represent bits of information, and if these binary numbers are repeated over and over again, they indicate the correct order in which these bits of information preferably should be considered in order to accomplish the aims of this invention.

The bit of information represented by each binary number will now be described. The digits *f1* to *f16* are used to indicate the floors in a building, and the digit *m1* divides the normal scan into two parts so that each floor is seen twice during a normal scan. In table 3, each floor in the building is represented by two 6-digit binary numbers; one is shown in the left side and the corresponding one on the right side in the same row. For example, the binary number 001,010 on the left side and the number 110,101 on the right side both represent the 11th floor. Note that in every case these two numbers add up to 111,111. In the binary system, two numbers which sum to 111,111, are such that whenever a 1 occurs in one number, a zero occurs in the corresponding digit of the other number, and vice versa. This will be apparent by observing corresponding pairs of binary numbers in table 3.

It should be noted that in the preferred system, when these numbers are scanned in numerical order, the floors in the building are scanned upwardly starting at the lowest floor and ending at the top, then downwardly starting at the top and ending at the bottom. This process repeats over and over again many times per second and is called the main scan.

The digit *m1* divides the main scan into two parts: the part where *m1* is 0 is called the ascending scan since the floors are considered in ascending order, and the part where *m1* is 1 is called the descending scan since the floors are considered in descending order. The ascending scan is used to examine down conditions at the various floors, i.e., down hall calls and DAV cars. The descending scan is used to examine up conditions at the various floors, i.e., up hall calls and UAV cars.

The digits *i1* to *s1* are used to indicate various conditions at each floor and to provide periods of time in which cars read and reset the counters which are a part of this system. This is called the secondary scan. While these digits go through the 36 steps shown in table 4, the main scan remains at one floor. It is only when the final number 111,111 at the bottom of table 4 changes to the top number 011,100 that the main scan advances one step. Then the secondary scan repeats its 36 steps, and this time it is examining the conditions at the next floor of the main scan.

Although six binary digits are capable of providing 64 different binary numbers, only 36 are required to accomplish secondary scanning, and thus, binary number 111,111 is immediately followed by 011,100 in the system illustrated, the intervening numbers not being used. This explains why the total number of possible steps in the normal scan is 2,304 or 64 times 36.

The first step in the secondary scan is reserved for considering the bit of information regarding the up or down hall call at the floor represented by the main scan. As mentioned before, digit *m1* determines whether it is the up or the down hall call which is considered. The second step is a spare step, not used for any purpose in the embodiment being described. The third step at binary number 011,110 is used for cancellation of the up or down hall call at this floor if there is a suitable car at this floor, conditioned for such cancellation. The fourth step at binary number 011,111 is used for all cars to read the conditions of the up or down hall call memory at this floor, for reasons to be explained later. It should be noted that for the four steps just described, the digit *s1* is 0. The digit *s1* divides the second-

dary scan into two unequal parts, the part just described and a further 32 steps which will now be explained.

The digits *c1*, *c2* and *c4* divide the second part of the secondary scan into eight parts (corresponding to the number of cars) of four steps each. Each one of these eight parts is used for a different car, up to a maximum of eight cars. Fewer digits could be used for four cars or less, but in my system I recommend the use of three digits regardless of the number of cars. Where the corresponding car is absent, the steps are unused. An additional digit *c8* could be used, if required, for more than eight cars, but the number of cars in a group very rarely exceeds eight.

In table 4, car *a* is shown responding to the binary number 000 as expressed by the digits *c4*, *c2* and *c1* respectively. Similarly, car *b* is shown responding to binary number 001, car *c* to 010, car *d* to 011, etc. This is the condition which would prevail while the main scan is at a floor other than the main floor, and when the digit *m1* is 0. This causes the cars to be scanned in the order *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* during the ascending scan. It will be shown later that it is desirable to scan in a different order when the main scan is at the main floor, depending on which car has been selected to be the "next" up car. It will also be shown that the order in which the cars are scanned at the main floor should be reversed for the ascending scan over what it is for the descending scan. Once this is done, it is easier to also reverse the order of scanning through the cars at other floors for the descending scan compared to the ascending scan. Thus, in my scanning system, the order in which cars are scanned at floors other than the main floor is *h*, *g*, *f*, *e*, *d*, *c*, *b*, *a*, during the descending scan. This is the opposite order to that shown in table 4.

The order of scanning through the cars is of no consequence unless there is more than one car at a floor. Then, where conditions require one of these cars to start, and two or more cars are available, the one seen first in the secondary scan is the one which will be chosen. It will be shown later that it is during the ascending scan that a car decides whether or not to go down. Therefore, when there is a choice between several cars at the same floor, car *a* is preferred over car *b*, car *b* is preferred over car *c*, *c* over *d*, etc. Similarly, car *h* is preferred over car *g*, car *g* is preferred over car *f*, *f* over *e*, etc. for going up. This is not essential to my system. The same order of choice could be used in both cases, but there is a slight advantage to the reversed order, and it is actually easier to do because of the changes adopted in the scanning order at the main floor.

The digits *i1* and *i2* separate the portion of the secondary scan for each car into four parts. Only two of these steps, when the combination of digits *i2* and *i1* is 01 and 10, are used for consideration of bits of information. The other two steps are used so that the counter for each car, to be described later, can be read and reset at the correct times. The 01 step is used for all cars to consider the bit of information indicating whether or not this car is AV1. The 10 step is used for all cars to consider the bit of information indicating whether or not this car is AV2.

It should be noted that during these steps of the secondary scan only one car at a time is indicating its availability, and then only those cars which are at the floor represented by the main scan. Moreover, a car indicates its availability only if the direction of its availability agrees with the condition of digit *m1*. When digit *m1* is 0, only DAV cars indicate their availability, when digit *m1* is 1, only UAV cars indicate their availability.

Thus, it can be seen how the bits of information regarding registered hall calls, and the position and availability of cars, are seen in a particular order. The asterisks at the left side of table 4 show those steps of the secondary scan where bits of information are considered. All other steps are for other purposes. For example, if car *b* is DAV2 at the 17 floor, this bit of information is considered when the scan digits are 010,000,100,110 (17 floor, FIG. 3, ascending main scan and car *b*, DAV2, FIG. 4, secondary scan).

It will now be seen that the complete secondary scan is required only when the main scan represents a floor at which there is one or more cars. In my preferred system, the second-

dary scan remains at binary number 011,100 except when the main scan reaches a floor where there is a car. Only then does the secondary scan go through its extra 35 steps. Hall calls can still be considered at each step of the scan since the secondary scan remains at 011,100. The advantage of doing this is that the total number of steps in any one normal scan is reduced. Each car will cause a secondary scan only at two points in the main scan. If all cars happen to be at the same floor, only 134 steps are required. If there are eight cars, all at different floors, 624 steps are required to complete the normal scan. This is considerably less than the total 2,304 steps.

This modified scan, with secondary scans occurring only when necessary, requires very little extra equipment. The advantage is that a slower rate of scanning can be used, and this may simplify the electronic circuits. The number of normal scans which occur per second is not critical as long as it is not too low. It must be high enough so that, when a car running at maximum speed moves to a new floor, at the worst possible part of the normal scan, at least two more complete normal scans can be completed before the car moves to another floor. Otherwise, if conditions at that floor require the car to stop there, it may not reach the correct reading time in the scan to detect the necessity to stop.

An elevator travelling at 1,200 feet per minute takes only one-half second to travel 10 feet. Thus, at least two scans should appear in one-half second for 10 foot floor heights at 1,200 feet per minute.

I recommend a scanning rate of one step every 100 microseconds. This results in a minimum of 16 normal scans per second and should easily handle the highest expected car speeds at normal floor heights, with the maximum number of cars. Higher rates can, of course, be used if desired, and lower rates could be used at lower car speeds, or with fewer cars.

The advanced digital position (as described hereinbefore) of each car is converted into a 5-digit binary number, and there is a parity checker for each car which compares each digit of this number with the corresponding digit of the f1, f2, f4, f8, and f16 digits of the main scan. If all digits are identical, the parity checker recognizes this as "straight parity." If all digits are opposite, the parity checker recognizes this as "reverse parity." Obviously, straight parity occurs once for each car during the ascending scan, and reverse parity occurs once for each car during the descending scan. In each case, parity occurs only when the main scan represents the floor that the car is at.

Each time the main scan steps to a new floor, it pauses there before stepping again. During this time, the bit of information concerning the hall call at this floor is being considered, and also there is time to determine whether or not any car is experiencing parity. If not, no secondary scan occurs. If one or more cars experienced parity, the main scan is stopped and a secondary scan occurs.

The use of five binary digits allows this system to handle a maximum of 32 floors. An extra digit could easily be added in accordance with the principles described herein to handle up to 64 floors. However, the number of floors served by one group of elevators very rarely exceeds 32. I recommend the use of five digits as a standard for all installations with 32 floors or less; if the number of floors is 16 or less, one digit could be omitted but it is easier to always use five. Thus, table 3 shows a total of 32 floors, but it is understood that when this preferred system is used for a building with less than 32 floors, the binary numbers representing these absent floors still occur in the scan even though they are not used.

In table 4, it can be seen that each car is allotted a sequence of four consecutive steps in the secondary scan. Although the order in which the cars respond is not always as shown in table 4, nevertheless each car is given a chance somewhere in the secondary scan to respond during four steps. This period of response is referred to as "secondary parity." In this case, the parity is between a fixed binary number for each car, and the digits c1, c2, and c4 of the secondary scan. However, as suggested earlier, the digits c1, c2, and c4 should be scrambled in

order to obtain different orders of scanning through the cars at certain times. These scrambled digits will be referred to as c1S, c2S, and c4S. The method of scrambling will be dealt with later when table 5 is described. The fixed binary numbers for each car are arbitrarily selected, and in this description will be assumed to be:

car a	000
car b	001
car c	010
car d	011
car e	100
car f	101
car g	110
car h	111

Thus, secondary parity occurs on each car when the scrambled digits c1S, c2S and c4S coincide with its binary number as shown in the list above. Secondary parity occurs once for each car during each secondary scan. When a car experiences both main parity (floor) and secondary parity (car), a condition exists which will be referred to as "double parity." Obviously, double parity occurs only twice for each car during a normal scan, once during the ascending scan, when straight parity exists, and once during the descending scan, when reverse parity exists. These will be referred to as "straight double parity" and "reverse double parity" respectively.

CAR COUNTERS

The order in which the bits of information are scanned has now been described. I will now describe how this information is used. There is a binary counter for each car which is capable of addition and subtraction. Also, each counter must be capable of being reset so that all digits are 0, and each counter must be capable of adding either one or two at a time. The number of digits required depends on the number of floors and the number of cars. I recommend the use of six digits in all cases, and the following description is based on six digits for each counter. Further special features are used in these counters. They should preferably be arranged so that they cannot add above 011,111 and so that they cannot subtract below 100,000. This allows fewer digits to be used. Actually, for eight cars and 32 floors, seven digits would otherwise be required. For less than eight cars, or less than 32 floors, fewer digits would sometimes be sufficient, but it will be assumed that six digits are always used. Furthermore, each counter should be arranged for a "normal" operation in which addition cannot occur above 000,000, and for a "special" operation in which addition can occur above 000,000. It will be shown later that it is only cars whose motor-generator sets are shut down automatically which use the special operation, and then only for certain parts of the scan.

If a counter has been reset to 0, and is then caused to subtract 1, it will then read 111,111. This is equivalent to -1. A second subtraction of 1 results in 111,110 which is equivalent to -2. If a total of 32 such subtractions is made, the counter reads 100,000, which is equivalent to -32. As previously described, further subtraction is impossible since the counter is arranged to never subtract below this number.

Similarly, if a counter has been reset to 0, and is then caused to add 1, it reads 000,001. As previously described, such addition can occur only during special operations. A second addition of 1 results in 000,010. If a total of 31 such additions is made, the result is 011,111. As previously described, a further addition is impossible.

The reason why it is necessary in the preferred embodiment to prevent such further addition is that the next number would be 100,000 which looks like -32. Similarly, if subtraction

were allowed below 100,000, the next number would be 011,111 which looks like +31.

It can now be seen how the counter can indicate positive numbers up to +31 and negative numbers down to -32. It should be noted that the final (left) digit is an indication of the polarity of the number. If it is 0, the number is positive or zero; if it is 1, the number is negative. It will be seen later that the only information required from the counter is whether or not the number on it is negative and, this information is supplied by the final digit.

CAR COUNTER OPERATION

The basic operation of the counters will now be described. In this description it will be assumed that all cars have their motor-operator sets running, and thus all counters operate normally. This means that they can never indicate a positive number other than zero (zero being considered a positive number herein). Each time a car experiences double parity, it resets its counter to zero on the fourth of the four steps of the secondary scan where the double parity exists. Each time a hall call is seen during the scan, all counters subtract 1 or attempt to do so. Under certain rare conditions, a counter may be unable to do so because it is already at binary number 100,000. Each time an AV1 car is seen on the scan, all counters add one, or attempt to do so. In many cases such additions will be impossible because the counter is already at 000,000. Each time an AV2 car is seen on the scan, all counters add two, or attempt to do so. As before, this will be impossible in many cases because the counter is already at 000,000. In other cases, a counter will only add one for an AV2 car because it is at 111,111, and the addition of two would cause it to add above 000,000.

When the associated car experiences double parity again, a reading is taken of the condition of the final digit of its counter on the first of the four steps of the secondary scan when this double parity exists. The next two steps are used for this car to indicate to other cars whether or not it is AV1 or AV2. This causes all counters, including the one for this car, to add one or two if possible. The fact that this car's counter has made an addition here is of no consequence since a reading was taken a step earlier, and the counter will be reset on the final of the four steps, as was described earlier.

The preceding description of the operation of a counter takes place during part of a normal scan. Another complete cycle, similar to the one just described, takes place during the remainder of a normal scan. Each car goes through two such periods of read the counter, indicate availability, and reset the counter during each normal scan, once during straight double parity, and once during reverse double parity.

Each car counter is performing a similar counting operation. All car counters are attempting to add and subtract the same amount each time, but some are unable to do so because of the restrictions on addition and subtraction which have been described. Each car counter is starting and ending its two counting periods at different times in the ascending and descending scans, depending on the location of each car, and thus in general, each car has a different condition on its counter at the two reading points in each scan. Thus, all cars do not respond in the same way to a given situation.

This reading of the counters for each car at particular parts of the scan is sufficient to indicate for each car whether or not there are hall calls above, which it should answer, and whether or not there are hall calls below, which it should answer. This simple information can then be used, in conjunction with conventionally produced information regarding the presence or absence of car calls above and below each car, to produce a superior dispatching system which is capable of many unique features and modifications and, in particular, a dispatching system which dispatches cars from all floors.

As described above, the two periods of double parity divide the scan up into two parts for each car: the "above" part from straight double parity to reverse double parity, and the "be-

low" part from reverse double parity to straight double parity. When a car is near the 32 floor, its above scan is short, and its below scan is long. When a car is near the bottom floor, its above scan is long, and its below scan is short.

During the above part of the scan, the bits of information which a car sees are those representing conditions above this car. During the below part of the scan, the bits of information which a car sees are those representing conditions below this car. It should be noted here that an up hall call at a floor is considered to be a condition above a car at the same floor, and that a down hall call at a floor is considered to be a condition below a car at the same floor. This apparent inconsistency has an advantage in that it allows a hall call, at the floor where a car is waiting, to establish the correct direction of travel in that car in a manner which will be described later. Also, it should be noted here that for any car, other cars at the same floor may appear to be conditions either above or below depending on the order in which cars are scanned during the secondary scan.

CAR MEMORIES

The indication of whether or not a particular car has hall calls above or below it, which it should answer, is available only briefly during the two reading periods. Thus, two memories are used for each car to store this information for the rest of the scan. These memories will be referred to as the HAM and HBM memories. Each of these two memories has two conditions which will be called "on" and "off." When the HAM memory for a car is on it indicates for this car that there are hall calls above which it should answer. When the HBM memory for a car is on it indicates for this car that there are hall calls below which it should answer. During the first step of straight double parity for a car, the HBM memory is set to the on or off condition depending on whether or not the final digit of the counter for that car is 1 or 0 respectively. This information is then retained on the HBM memory for the remainder of the ascending scan, for the entire descending scan, and for part of the next ascending scan until double parity is experienced again. If conditions have changed in the meantime, the final digit of the counter may have changed, and then the HBM memory is set accordingly during the first step of double parity. If the final digit has not changed, then the HBM memory remains unchanged.

Similarly, during the first step of reverse double parity for a car, the HAM memory is set to the on or off condition depending on whether or not the final digit of the counter for that car is 1 or 0 respectively. This information is then retained on the HAM memory for the remainder of the descending scan, for the entire ascending scan, and for part of the next descending scan until double parity is experienced again. As before, the HAM memory may or may not be changed at this time.

Thus, it can be seen that the inputs to these memories are intermittent, but the outputs provide a continuous indication of whether or not there are hall calls above or below which this car should answer. Whenever there is a change in conditions, the output of these memories does not show the new situation immediately, but only when the appropriate double parity is experienced again by this car. The rate of scanning is, of course, fast enough so that this brief delay does not matter.

A third memory, called the HHM memory, is used for each car to remember the reading taken in step 4 of the secondary scan. Note that this is the fourth step of the secondary scan, when the digit *s*1 is still 0, and is not the fourth step of double parity for any car. Note also that this reading is taken only on cars which are experiencing main parity. Such a reading taken during straight parity indicates whether or not there is a down hall call at the floor where this car is, and a reading taken during reverse parity indicates whether or not there is an up hall call at this floor.

Two memories would be required to remember both of these bits of information, but it is never necessary to know both at once. Therefore, the system is arranged so that only

one memory, HHM, is used. A car with the up direction of travel established reads during reverse parity, but otherwise, the reading is taken during straight parity.

Therefore, the output of the HHM memory for any car gives a continuous indication of whether or not there is a down hall call at the floor where this car is, except when the up direction of travel is established. In the latter case, the output of the HHM memory gives a continuous indication of whether or not there is an up hall call at this floor. The purpose of the HHM memory is to indicate, to a car which is running, when it should stop for a hall call, and to indicate to a car, when it is stopped with its doors closed waiting for a call, when it should open its doors in response to a hall call at the same floor.

There is a possibility that such a hall call may be registered at a floor where more than one car is waiting, with its doors closed, for a call. Then, there would be a tendency for more than one car to open its doors. This is overcome by having each car ignore the output of its HHM memory unless it actually has the up or down direction established. When such a hall call is registered, the scanning system indicates to only one of the cars, the one seen first in the secondary scan, that there is a hall call above (in the case of an up hall call) or below (in the case of down hall call) which this car should answer. This causes the selected car to establish the appropriate direction of travel. Although this car would normally prepare to run in the selected direction once the direction is established, a slight deliberate time delay is introduced into the starting of cars after the HAM or HBM memory first indicates the necessity to run. The establishment of direction of travel then conditions the HHM memory to read at the correct part of succeeding secondary scans, and this reading, indicating a hall call at this floor corresponding in direction to the established direction of travel of this car, now causes it to open its doors. If it had been a hall call at some other floor which caused the car to establish a direction of travel, the HHM memory would not have indicated a hall call at this floor, and thus, the car would have started after a slight delay.

CAR OPERATION

The operation of the counter and associated memories for each car has now been described. I will now show how the counter is able to correctly indicate when a car should go up or down in response to hall calls. It is important to realize that the HAM and HBM memories are not used merely to instruct a car when to start for hall calls, but also to indicate how long a car should continue in either direction. Thus, they indicate when a car need no longer travel in the same direction because of a lack of hall calls ahead, which this car should answer.

In the following examples, it will be assumed that all cars have their motor-generator sets running. Then, the counting is normal—subtraction below 000,000 is possible, but addition above 000,000 is not possible.

Consider first a situation in which there are no hall calls registered. Then, the car counters will never be called upon to subtract. They may receive numerous add instructions on each scan by AV1 and AV2 cars, but they cannot add above 000,000. Therefore, all counters will remain continuously at 000,000, and the result of reading the final digit of the counters will indicate on all cars that they need not start for hall calls. Obviously, the result of the scanning is correct because there are no hall calls.

Now consider a situation in which a single down hall call is registered at some floor where there is no car. Then, when the ascending scan reaches that floor, all car counters subtract one because of the down hall call there. Since there is only one hall call registered, all car counters were previously at 000,000 from the previous resetting operations in the descending scan or in that part of the ascending scan prior to the down hall call. The counters remain in this condition in spite of any available cars seen in this part of the scan since

they cannot add above 000,000. Therefore, the subtraction of 1 causes all counters to go to 111,111. Each car has, in effect, "seen" this down hall call and noted it.

Assume that there is at least one DAV (down available) car above this down hall call. Then, when the main scan reaches the first such car (the lowest one) a secondary scan occurs during which this car indicates its availability to all cars. All counters then attempt to add 2 and are thus returned to 000,000. The cars have now noted the additional fact that there is a DAV car situated above the down hall call, and thus very suitably located to answer this call and that therefore they need not answer this call. This is made known to the cars when their counters are read later in the scan.

The DAV car, which caused all of this, reads the condition of its counter just before indicating its availability. Thus, its counter was still at 111,111 at the time of reading, and since this reading occurred during the ascending scan, it is the HBM memory which is set to the on condition at this time. The HAM memory will remain in the off condition since this car's counter will be 000,000 at the time of reading during the descending scan. Therefore, the nearest DAV car above the down hall call sees, via its HBM memory that it should go down in response to this down hall call.

While this car prepares to go down, successive scans have the same result over and over again. As this car travels down, the secondary scan which it causes during the ascending scan occurs earlier and earlier as it moves from floor to floor, but the results of the scanning are still always the same, and this car's HBM memory stays in the on condition. When this car arrives at the floor where the down hall call is registered, the HBM memory indicates that the car must stop here. This causes this car to prepare for and make a landing at this floor. When a landing is prepared for, this car is considered to be conditioned for canceling and it cancels the down hall call. A particular step in the secondary scan is allotted for cancellation. Just prior to cancellation, the car must seal or lock in its down direction because when the down hall call is canceled, the HBM memory no longer indicates the necessity to travel down. However, this car must maintain the down direction of travel until it has stopped, opened its doors, and until the doors have closed again in order to allow the passenger who registered the down hall call sufficient time to enter the car and register a car call for his destination floor, which is assumed to be below. Otherwise, the up direction of travel might be established by subsequent registration of hall calls above.

The preceding description illustrates how my scanning system chooses the nearest DAV car above to respond to a down hall call. The nearest car above is not always a DAV car. A car in this condition, i.e., above a down hall call, but not DAV, still "sees" this call via its HBM memory, but does not indicate any availability at this point. Therefore, not only does the nearest DAV car above a down hall call see this call, but any intervening cars which are not DAV also see this call. If one of these cars suddenly becomes DAV it may now be closer to the down hall call than the DAV car which is already headed for this call. When this occurs, the original DAV car now sees, via its HBM memory, no need to travel down, and it stops and allows the nearer DAV car to take the call instead.

If there is no DAV car above a down hall call, the highest UAV car resets the counters for all lower UAV cars so that they indicate that the highest UAV car is capable of answering the down hall call. If this UAV car is above the down hall call, it must complete its up trip before it can go down to answer the down hall call. If this UAV car is below the down hall call, it may be able to stop for the down hall call on its upward trip, and reverse its direction at that floor, provided that there are no other hall calls above which it should answer and no car calls for above floors. Otherwise, it may travel above the down hall call and then will complete its up trip before it can go down to answer the down hall call. It must be remembered that there is always the possibility that other UAV cars below the highest UAV car, but above the down hall call, may suddenly become DAV and then, of course, the highest UAV car

no longer sees the necessity to run down since the newly available DAV car is more advantageously located.

Next consider a situation in which a single up hall call is registered at some floor where there is no car. Then, when the descending scan reaches that floor, all car counters subtract 1 because of the up hall call there. Since there is only one hall call registered, all car counters were previously at 000,000 from the previous resetting operations in the ascending scan or in that part of the descending scan prior to the up hall call. The counters remain in this condition in spite of any available cars seen in this part of the scan since they cannot add above 000,000. Therefore, the subtraction of 1 causes all counters to go to 111,111. Each car has, in effect, "seen" this up hall call and noted it.

Assume that there is at least one UAV car below this up hall call. Then, when the main scan reaches the first such car (the highest one) a secondary scan occurs during which this car indicates its availability to all cars. All counters then attempt to add 2 and are thus returned to 000,000. The cars have now noted the additional fact that there is a UAV car situated below the up hall call, and thus very suitably located to answer this call and therefore they need not answer this call.

The UAV car, which caused all of this, reads the condition of its counter just before indicating its availability. Thus its counter was still at 111,111 at the time of reading. Since this reading occurred during the descending scan, it is the HAM memory which is set to the on condition at this time. Therefore, the nearest UAV car below the up hall call sees, via its HAM memory that it should go up in response to this up hall call.

The operation just described where the nearest UAV car below an up hall call answers this call is similar to the previously described situation where the nearest DAV car above a down hall call answers this call. As before, successive scans continue to reveal the same necessity to go up as the car approaches the up hall call. When the car arrives at that floor, the HAM memory now indicates that there is an up hall call at this floor since the up direction of travel is established. In the previously described operation the HAM memory indicated a down hall call because the up direction of travel was not established. A car which travels up and answers an up hall call must maintain its up direction after it has canceled the call until the car has stopped, opened its doors, and closed them again to allow the passenger to enter and place his car call for some floor above without any chance of hall calls below establishing the down direction. This is similar to the previously described maintaining of the down direction when answering a down hall call.

The nearest car below an up hall call is not always UAV. As before, the highest UAV car below the up hall call sees this call and attempts to answer it, but intervening cars which are not UAV also see this call and if one of them suddenly becomes UAV it may then be the highest UAV car below the call, and then the other UAV car which was heading for the call stops and allows the nearer car to answer the call. Also, as before, if there is no UAV car below an up hall call, the lowest DAV car is the one chosen to answer the call. This lowest DAV car may be below the up hall call in which case it must complete its down trip before it can go up to answer the call, or it may be above the up hall call and may be able to stop and reverse its direction in order to answer this call if there is no need for it to travel farther down. Again, this is similar to the previous description for a single down hall call.

Going back to the previous example of a single down hall call, it can be seen that if there had been two down hall calls with no DAV car between, the result of the scanning would have been the same provided that the DAV car which was chosen to answer these calls was DAV2. The second of these two down hall calls would have caused a second subtraction of 1 from all counters leaving them at 111,110 but the addition of 2 would have restored them all to 000,000. The DAV car chosen to answer this call would still see, at the time of reading, the digit 1 as the final digit, indicating a negative number.

However, if there had been three hall calls with no DAV car between them, the three separate subtractions of 1 and then the addition of 2 for the first DAV car seen on the scan after the down hall calls would have left all counters at 111,111 except the nearest DAV car above the down hall calls which reset its counter just after indicating its availability. Thus, the other cars, in effect, see one of these three down hall calls as being one which cannot be answered in reasonable time by the one car. Another car will then be chosen to assist in answering these three down hall calls in a manner similar to the choosing of a suitable car to answer a single down hall call. Either another higher DAV car is brought down or a UAV car is brought up from below.

In either case, it is very likely that one of these three down hall calls will be answered, and thus canceled, by the first of these two cars. In this case, the second of these two cars will immediately see that conditions have changed and that it no longer needs to travel because there are now only two down hall calls, with a suitable car advantageously situated to answer them. Thus, the purpose in starting the extra car would not be accomplished. This problem is overcome in my system by arranging each car so that whenever it has a direction of travel established, and the HAM or HBM memory for the opposite direction indicates no need to travel in the opposite direction, the car, in effect, takes a pessimistic attitude toward the availability of the other cars, and always interprets AV2 as AV1. This is very easily accomplished by simply arranging the counter so that it cannot add 2, but only 1, whenever it is instructed to add, when the previously mentioned conditions exist.

A good example of the operation of the modification just described occurs when there are three down hall calls above all cars. The highest UAV car answers the highest of these three calls, and although the establishment of the up direction of travel on this car may cause it to pessimistically interpret the availability of other cars seen on its above scan, this is of no consequence since this is the highest UAV car. The second highest UAV car is started up since on its above scan it subtracts three because of the down hall calls and it only adds two because of the higher UAV car. However, once the up direction of travel has been established on this car, it adds only one each time this higher UAV car is seen. In many cases the higher of these two cars will arrive at and cancel the highest of these three down hall calls before the lower car has reached the lowest of these three calls. If it were not for this modification, the lower car would now see no further need to travel up, and would stop at the next floor without having been of any use in assisting the other car to answer these three down hall calls. However, this modification causes the lower car to continue upward since it is still subtracting two for the down hall calls, but is now only adding one for the other car above. Therefore, the lower car continues upward until it arrives at the floor at which the lowest of the original three down hall calls is situated.

At this point, this down hall call no longer appears as being above this lower car, but now appears as being below. This causes the HBM memory to indicate that there are calls below that this car should answer, and thus it reverts to correct interpretation of the availability of the other car above. However, in this particular instance, it would not have mattered because the highest of the original three down hall calls has already been canceled, and thus, this car sees above it only one remaining down hall call with a suitable DAV car situated above it. The result of this sequence of events is that the highest UAV car answers the two highest down hall calls, and the other UAV car makes a reversal at the lowest down hall call. This reversal is similar to the familiar "high call reversal," but it has not occurred at the highest call. It has, instead, occurred where the lower UAV car has found no hall calls above it, which it should answer. Such reversals as this occur frequently in my system, and will be called "expediency reversals." Similar reversals at the lowest call which a car should answer are also possible and will be referred to by the same name.

In the preceding example, it was assumed that the higher of the two cars reached the highest of the three down hall calls before the lower car reached the lowest call. In some cases, the lower car reaches the lowest call first. Then, the arrival of this lower car at the lowest of the three down hall calls results in its seeing two down hall calls above, and one suitable UAV car whose availability, although actually two, is being interpreted as one. However, as mentioned in the preceding example, the lowest down hall call appears as being below the lower car and this sets its HBM memory accordingly, and thus, this car returns to correct interpretation of availability. This causes it to make an expediency reversal at the floor where the lowest down hall call is.

The result of this second example is basically the same as the first one. The higher car answers the highest two of the three calls, and the lower car answers the lowest one. However, in the first example, if further hall calls had been placed below the lower car, and if these calls had set the HBM memory on this car, it would have stopped and reversed its direction at some floor below the lowest of the three down hall calls if the higher car reached the highest down call first. The higher car would then have answered all three of the down hall calls.

Similarly, four down hall calls above all cars would cause the highest two UAV cars to start up. In many cases, the higher car would answer the highest two calls, and the lower car would answer the lower two. But in some cases, the arrival of the higher car at the highest of these four calls before the lower car arrives at the lowest of these four calls, causes cancellation of the highest call, so that there are now only three. The lower car now makes an expediency reversal at the lowest of the original four calls, and thus, the higher car answers three of the calls, and the lower car only one. In either case, this operation is much superior to conventional systems where the highest upbound car might make a high call reversal at the highest call, but the next upbound car below it would undoubtedly go through to the upper dispatching floor to await downward dispatch, and would probably force the other car to answer all four of these down hall calls. Even if it were dispatched down from the top floor in time to answer one or more of the four calls, it would have made an unnecessary trip to the top dispatching floor.

The preceding examples indicate some of the advantages of my system. Although many further examples could be given, a general analysis will be given instead. Consider a typical normal scan for any one car. Its counter is of course reset to zero during straight double parity. Any further cars seen on the remainder of this secondary scan may attempt to add 1 or 2 to this car's counter, but the counter cannot go above zero and thus, it is still at zero at the end of the secondary scan. As the ascending scan continues, each time a down hall call is seen, this car's counter subtracts 1 to indicate a call which this car might have to go up to answer. The accumulated count represents, in the form of a negative number, how many such calls exist. Each time a DAV car is seen when the accumulated count is negative, this car causes the addition of 1 or 2, depending on its availability, so as to reduce, in effect, the number of such calls. The important thing is that DAV cars seen when the accumulated count is zero are cars so situated that there are no down hall calls below them (and above this car) which they should answer. Thus, although these cars are available to go down, their availability is of no use at this time, and therefore must not be counted. This is accomplished by simply preventing the counter from adding above zero.

Any DAV car seen when the accumulated count is negative is obviously a car suitably situated to answer some of the down hall calls represented by this negative number because the calls were seen first, and are thus situated below the car. In some cases, the accumulated count is only -1, and the next DAV car seen on the scan may be AV2. Then it would attempt to add two, but the restriction on adding above zero forces the counter to only add 1, just as if this car's availability were only one. It should be noted that the scanning is done in reverse order to the direction in which cars would travel to answer the

calls, and this automatically assesses correctly the relative positions of cars with respect to hall calls, so as to determine whether or not a given car is suitably situated to answer those hall calls seen during the scan.

When the ascending scan is complete, the descending scan continues this counting operation, but now it is up hall calls and UAV cars which are considered, and the floors are considered in descending order. This is still the opposite order in which cars would travel to answer these calls. The accumulated count at the end of the ascending scan is the starting point for the descending scan; further additions and subtractions may occur during the descending scan, and as before, up hall calls cause the subtraction of one, and UAV cars, if suitably located below such hall calls, cause the addition of one or two depending on their availability.

When this car experiences reverse parity, the up hall call at that floor can cause a subtraction of 1 just as the up hall calls above can. A secondary scan occurs now, and any other cars at this floor may be seen either before or after this car experiences double parity. Those which are seen before are capable of adding 1 or 2 to this car's counter if the accumulated count is negative. Thus these cars, in effect, appear to be above this car, and may bring this car's counter up to zero so that its HAM memory sees no need to travel up since there are other cars at this floor with preference for up travel.

The reading of the accumulated count during the first step of double parity then gives the correct indication of whether or not there are hall calls above this car, or an up call at this floor, which the car should answer. The bits of information which have been scanned are those representing conditions above, and up conditions at this floor. These are the only conditions which should establish the up direction of travel for hall calls. Moreover, the various bits of information have been scanned in such an order that the relative locations of the various cars and calls has been properly taken into consideration in making the decision as to whether or not to go up.

An up hall call below all higher UAV cars obviously must result in a negative number on the counter at the time of reading since the counter can never be above zero, and thus a subtraction of 1 for this up hall call causes this car's counter to become negative if it is not already so. Similarly, an excess of hall calls over the availability of the cars above will result in a negative number at the time the counter is read.

During reverse double parity, this car's counter may attempt to add 1 or 2 to indicate this car's availability, but this is of no consequence since the counter is reset immediately afterward. During the remainder of this secondary scan, other cars at this floor may attempt to add 1 or 2 to this car's counter, but it remains at zero. During the remaining part of the descending scan, up hall calls below the car cause subtraction of 1, but suitably located UAV cars capable of answering these calls cause the addition of 1 or 2. The accumulated count at the end of the descending scan is the starting point for the ascending scan. Now, it is down hall calls and DAV cars which are seen. The operation is similar to the previous description for the above part of the scan, and when straight parity is experienced by this car the down hall call at that floor can cause subtraction of 1, and any other DAV cars at this floor, seen before double parity, can add 1 or 2. Thus, as before, the accumulated count at the time of reading is an exact indication of whether or not this car should establish its down direction. The bits of information seen on this part of the scan are those representing conditions below, and down conditions at this floor.

Each car's response to the HAM and HBM memories, and to the conditions regarding car calls above and below, is apparent from the foregoing description. Once a car has established the up direction of travel, it continues in the up direction, regardless of conditions below, as long as there are car calls for above floors, or hall calls above which this car should answer, as indicated by the HAM memory. Similarly, once a car has established the down direction of travel, it continues in the down direction, regardless of conditions above,

as long as there are car calls for below floors, or hall calls below, which this car should take, as indicated by the HBM memory. It is possible to have both the HAM and HBM memories indicating together that this car should go up and down for hall calls. In this case the direction of travel first established takes precedence.

MODIFIED CAR SELECTION BY DIGIT SCRAMBLING

The desirability of scrambling the c1, c2 and c4 digits of the secondary scan was indicated earlier. If all cars parked with their doors closed at all floors, no scrambling would be needed. However, in normal buildings, passenger traffic enters and leaves the building at a particular floor which will be referred to as the main floor. This is often the lowest floor served by the elevators, but there may be floors below. Any such floors below will be referred to as basements.

With present systems, it is customary to have one or more cars parked at the main floor whenever possible, and when there are no cars there, steps are taken to get one or more cars back to the main floor as soon as possible. With my scanning system, it is easy to do this, but an improved system will be described which assures that whenever possible, there will be one or more cars near, but not necessarily at, the main floor.

Nevertheless, with my system there may be several cars at the main floor, and it is desirable to choose one of these cars in advance to be the next one to travel up from the main floor. This car is called the "next up" car and it parks with its doors open and with its up hall lantern, or "this car up" sign, illuminated. Any other cars at the main floor may park there with their doors open or closed, as desired, but preferably with their doors closed, as will be described later in this application.

It is desirable then to change the order in which cars are scanned, during a secondary scan at the main floor, so that the "next up" car is scanned first during the descending scan, and last during the ascending scan. This assures that the "next up" car will be the one to start up for hall calls above instead of some other car at the main floor. It also assures that the "next

up" car will not be chosen to travel down from the main floor for basement hall calls below as long as there is another car there. Even then, its selection to go down is subject to certain provisions which will be described later. The order in which the other cars are scanned at the main floor is not important as long as the "next up" car is first during the descending scan and last during the ascending scan.

The selection of one of the cars at the main floor in advance, to be the next up car, is accomplished as in previously known systems. However, for my scanning system, the information regarding which car is next up must be in binary form. Three digits are used to allow for up to eight cars. These digits will be called n_4 , n_2 and n_1 . The eight different binary numbers obtained from these three digits represent the eight different cars in a manner similar to the way in which each car responds to the scrambled digits c_4S , c_2S , and c_1S . Thus, when the digits n_4 , n_2 and n_1 are all zero, they indicate that car a is the next up car. When only the digit n_1 is one, this indicates that car b is the next car up, etc., as shown below:

car a 000

car b 001

car-c 010

car d 011

care	100
------	-----

car f 101

car g 110

car *h* 111

40 The process of scrambling consists of inversion of some or
all of the digits $c1$, $c2$ and $c4$ to produce $c1S$, $c2S$ and $c4S$
respectively. Inversion means replacing zero with 1 and 1 with
zero. For floors other than the main floor, no digits are in-
verted during the ascending scan, but all digits are inverted
45 during the descending scan.

The following table 5 shows the manner in which these digits are scrambled both for the main floor and for other floors, for both the ascending and descending scans.

TABLE 5

		M A I N										F L O O R									
CM1	CM2	CM3	CM4	CM5	CM6	CM7	CM8	CM9	CM10												
		Car a Next	Car b Next	Car c Next	Car d Next	Car e Next	Car f Next	Car g Next	Car h Next												
	All Floors Except Main	n4 n2 n1 0 0 0 X X X	n4 n2 n1 0 0 1 X X	n4 n2 n1 0 1 0 X X	n4 n2 n1 1 1 1	n4 n2 n1 1 0 0 X X	n4 n2 n1 1 0 1 X	n4 n2 n1 1 1 0 X	n4 n2 n1 1 1 1												
m1 c4 c2 c1	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s	c4s c2s c1s											
0 0 0 0	0 0 0 a	1 1 1 h	1 1 0 g	1 0 1 f	1 0 0 e	0 1 1 d	0 1 0 c	0 0 1 b	0 0 0 a	0 0 0 a	-RW1										
0 0 0 1	0 0 1 b	1 1 0 g	1 1 1 h	1 0 0 e	1 0 1 f	0 1 0 c	0 1 1 d	0 0 0 a	0 0 1 b	0 0 0 a	-RW2										
0 0 1 0	0 1 0 c	1 0 1 f	1 0 0 e	1 1 1 h	1 1 0 g	0 0 1 b	0 0 0 a	0 1 1 d	0 1 0 c	0 0 1 b	-RW3										
0 0 1 1	0 1 1 d	1 0 0 e	1 0 1 f	1 1 0 g	1 1 1 h	0 0 0 a	0 0 1 b	0 1 0 c	0 1 1 d	0 1 0 c	-RW4										
0 1 0 0	1 0 0 e	0 1 1 d	0 1 0 c	0 0 1 b	0 0 0 a	1 1 1 h	1 1 0 g	1 0 1 f	1 0 0 e	0 1 1 d	-RW5										
0 1 0 1	1 0 1 f	0 1 0 c	0 1 1 d	0 0 0 a	0 0 1 b	1 1 0 g	1 1 1 h	1 0 0 e	1 0 1 f	0 1 0 c	-RW6										
0 1 1 0	1 1 0 g	0 0 1 b	0 0 0 a	0 1 1 d	0 1 0 c	1 0 1 f	1 0 0 e	1 1 1 h	1 1 0 g	1 1 1 h	-RW7										
0 1 1 1	1 1 1 h	0 0 0 a	0 0 1 b	0 1 0 c	0 1 1 d	1 0 0 e	1 0 1 f	1 1 0 g	1 1 1 h	1 1 1 h	-RW8										
	X X X		X	X	X X	X	X	X X	X X X	X X X	-RW9										
1 0 0 0	1 1 1 h	0 0 0 a	0 0 1 b	0 1 0 c	0 1 1 d	1 0 0 e	1 0 1 f	1 1 0 g	1 1 1 h	1 1 1 h	-RW10										
1 0 0 1	1 1 0 g	0 0 1 b	0 0 0 a	0 1 1 d	0 1 0 c	1 0 1 f	1 0 0 e	1 1 1 h	1 1 0 g	1 1 0 g	-RW11										
1 0 1 0	1 0 1 f	0 1 0 c	0 1 1 d	0 0 0 a	0 0 1 b	1 1 0 g	1 1 1 h	1 0 0 e	1 0 1 f	1 0 1 f	-RW12										
1 0 1 1	1 0 0 e	0 1 1 d	0 1 0 c	0 0 1 b	0 0 0 a	1 1 1 h	1 1 0 g	1 0 1 f	1 0 0 e	1 0 1 f	-RW13										
1 1 0 0	0 1 1 d	1 0 0 e	1 0 1 f	1 1 0 g	1 1 1 h	0 0 0 a	0 0 1 b	0 1 0 c	0 1 1 d	0 1 1 d	-RW14										
1 1 0 1	0 1 0 c	1 0 1 f	1 0 0 e	1 1 1 h	1 1 0 g	0 0 0 a	0 0 1 b	0 1 0 c	0 1 1 d	0 1 0 c	-RW15										
1 1 1 0	0 0 1 b	1 1 0 g	1 1 1 h	1 0 0 e	1 0 1 f	0 1 0 c	0 1 1 d	0 0 0 a	0 0 1 b	0 0 1 b	-RW16										
1 1 1 1	0 0 0 a	1 1 1 h	1 1 0 g	1 0 1 f	1 0 0 e	0 1 1 d	0 1 0 c	0 0 0 a	0 0 1 b	0 0 0 a	-RW17										
											-RW18										
											-RW19										
											-RW20										
											-RW21										
											-RW22										

Column CM1 of table 5 shows in rows RW5 to RW12, the eight parts of an ascending secondary scan, when digit *m1* is zero, as represented by the digits *c1*, *c2* and *c4*, in the order in which they occur reading from top to bottom. This represents the second part of a secondary scan when the digit *s1* is one. Similarly, in column CM1, rows RW15 to RW22, the similar eight steps of a descending secondary scan, when the digit *m1* is one, are shown.

The upper part of column CM2 shows the scrambled digits *c1S*, *c2S* and *c4S* for an ascending secondary scan at any floor except the main floor. Note that none of the digits is inverted, and thus, the scrambled digits are identical with the *c1*, *c2* and *c4* digits. Thus, the cars respond in the order *a*, *b*, *c*, *d*, *e*, etc., as shown in table 4. The lower part of column CM2 shows the scrambled digits for a descending secondary scan at any floor other than the main floor. Note that all digits have been inverted here. The letter X is used in the left three parts of column CM2, row RW14, to indicate digits which are inverted. It will be seen that the binary number 000 to which car *a* responds, occurs last; similarly, the binary number 001 to which car *b* responds, occurs second last. Examination of each of these binary numbers, and its associated car reveals that the order of scanning is exactly opposite, with car *h* first and with car *a* last, to what it was during the ascending secondary scan. It will be seen in table 5, that whenever all digits are inverted, the order in which the cars are seen or scanned is completely reversed.

Columns CM3 to CM10 show the manner in which the digits are scrambled at the main floor. As before, the upper part shows the scrambling for an ascending secondary scan and the lower part shows the scrambling for a descending secondary scan. As before, the letter X appearing in rows RW3 and RW14 shows respectively the digits which are inverted for the ascending and descending scans. In row RW3 it is shown that for the ascending scan, the digits which are inverted correspond to those digits which are zero in the binary number representing the next up car. Similarly, in the row RW14 the digits which are inverted for the descending scan correspond to those digits which are one in the binary number representing the next up car. Rows RW1 and RW2 show the condition of the digits *n1*, *n2* and *n4* in each case. The binary digits in columns CM2 to CM10 are simply the original digits from column CM1 inverted where indicated by the letter X. In the right hand part of each of these columns a lower case letter has been placed corresponding to the car associated with each binary number. For example, wherever the binary number 101 occurs, the letter *f* is placed to indicate that car *f* responds to this number. As before, the order in which cars are scanned is seen by reading down from top to bottom in either the upper or lower half of these columns. For example, if car *d* is the next up car, during the ascending scan the order in which the cars are scanned at the main floor is *e*, *f*, *g*, *h*, *a*, *b*, *c*, *d*; the reverse order, *d*, *c*, *b*, *a*, *h*, *g*, *f*, *e*, occurs during the descending scan. Thus car *d* is the first one to be seen on the descending scan and the last one to be seen on the ascending scan. This is shown in column CM6. Examination of table 5 will show that regardless of which car is next up, it is always the first one to be scanned on the descending scan, and is always the last one to be scanned on the ascending scan.

Thus, it can be seen that the scrambling of the digits *c1*, *c2* and *c4* to produce *c1S*, *c2S* and *c4S*, can be easily and systematically accomplished by inverting those digits corresponding either to the ones or the zeros in the binary number indicating which car is next up. It should be noted here that there is frequently no next up car at the main floor, and the three binary digits do not allow any indication of this ninth possibility. However, the order in which cars are scanned at the main floor when there is no next up car is not important, and such secondary scans rarely occur, and the circuit is arranged so that the binary digits *n1*, *n2* and *n4*, remain at the

previous indication when there is no next up car. The arrival of a new suitable next up car at the main floor immediately changes these digits to the new indication.

MODIFICATION FOR CAR SHUTDOWN

In previous systems, a "night service" or "intermittent" program is normally used to handle periods in which traffic is very light. Actually, the purpose in providing such a program is not to give better service because the best service would be obtained by allowing the cars to operate in slack periods the same way they operate in normal, nonpeak periods. The main reason for having such a program is the use at the present time of motor-generator sets (MG sets) for speed control purposes. It is undesirable to keep more of these MG sets running than is necessary to just handle the existing traffic. Thus, a system for automatically shutting down some or all of the MG sets, for optimum utilization of cars whose MG sets are not shut down and for starting new MG sets when more service is required, is desirable on installations using MG sets. The elimination of the need for MG sets on high speed elevators may be possible in the future, and no special program would then be needed for slack periods. My scanning system lends itself very well to a superior method of handling traffic when some of the cars have their MG sets shut down automatically. Therefore, it will be assumed in this application that MG sets are used, but it must be understood that some of the features of my system are required only because of the MG sets.

I recommend that each car have its own automatic shutdown timer arranged to automatically shut down its MG set when the car has been idle for a period of about 3 to 4 minutes. If desired, a single timer could be used to shut down all cars at once, when all cars have been idle for a predetermined time. Both of these systems have been commonly used in the past and my system utilizes such practices for MG shutdown. However, my system is able to easily and efficiently handle a situation in which some of the MG sets have been automatically shut down, and the remaining cars carry on as if they comprised the entire system. Those cars whose MG sets are shut down are, nevertheless, continuously assessing the traffic situation, and when the number of hall calls exceeds the availability of cars with MG sets running, the most advantageously located shutdown car starts its MG set.

Throughout the following description, a car whose MG set has been shut down automatically will be called an "AS" car. A car whose MG set has been shut down manually is not considered to be an AS car, but is considered to be completely unavailable. Basically, AS cars still indicate that they are both UAV2 and DAV2, but cars whose MG sets are still running ignore these indications of availability. Thus, these cars with MG sets running carry on as if they comprised the entire system, but the method of scanning used by the AS cars must be altered so that their HAM and HBM memories remain in the off condition until a situation occurs in which there are not enough cars with MG sets running to handle the existing hall calls. When the HAM or HBM memory on an AS car goes to the on condition, it is an indication that this car must start its MG set, and only the most advantageously located AS car (or cars, if necessary) should see the necessity to start.

In table 2, the sequence of binary numbers obtained from extra digits *m2* and *m4* is shown. Their purpose will now be explained. Table 2 shows how three complete normal scans are required before these extra digits repeat again. It will be convenient to apply the names X, Y and Z to these three normal scans, as shown in table 2. Each of these three can, of course, be divided into ascending and descending parts.

The complete sequence of events for these three normal scans for an AS car will now be described. During reverse double parity in the Z scan, the counter is reset to zero. For the

remainder of this descending scan, and during the ascending X scan, until straight double parity occurs, the operation of the counter is modified so that it can add above zero, as well as subtract below zero. The availability of any AS cars is ignored during this part of the scan. If the accumulated count is negative at straight double parity, the counter is reset to zero. If it is positive, the counter is not reset and the binary number on the counter represents the excess availability of cars below whose MG sets are not shut down. This number will remain on the counter as the starting point for the next part of the scan where it will be decided whether or not this car needs to start its MG set to travel upward.

During the remaining part of the ascending X scan, and during the first part of the descending X scan, until reverse double parity is reached, the operation of the counter is modified again so that it now recognizes the availability of all cars, even AS cars, but the counter will add above zero only for cars whose MG sets are running, and will not add above zero for AS cars. Thus the counter continues to show, if its accumulated count is positive, the excess availability of cars whose MG sets are running, but if sufficient calls are seen on this part of the scan, the counter's accumulated count may go negative to indicate hall calls above that this car may have to answer, but succeeding cars, AS or not, can bring this count back to zero if they are more suitably located for answering these calls.

At reverse double parity during the descending X scan, a normal reading of the final digit of the counter is taken and applied to the HAM memory. This car has now considered conditions both above and below it in deciding whether or not it should go up, but the conditions below cannot cause this car to go up, since only a positive count is allowed to carry over from the below part of the scan into the above part. Conditions below can only prevent this car from starting up, where it otherwise would, if cars below, with MG sets running, are available to handle hall calls above this AS car.

Although the counter may be reset during reverse double parity on the descending X scan, it is not necessary since the remaining part of the descending X scan and the first part of the ascending Y scan, up until straight parity occurs, is an idle period from which no information is to be extracted, and the counter will be reset again during straight double parity on the ascending Y scan without a reading being taken here.

During the remaining part of the ascending Y scan, and during the first part of the descending Y scan, the counter is modified as before so that it can add above zero as well as subtract below zero. The availability of any AS cars is ignored during this part of the scan. If the accumulated count at reverse double parity is negative, the counter is reset to zero. If it is positive, the counter is not reset and the binary number on the counter represents the excess availability of cars above whose MG sets are not shut down. This number will remain on the counter as a starting point for the next part of the scan, where it will be decided whether or not this car needs to start its MG set to travel downward.

During the remaining part of the descending Y scan, and during the first part of the ascending Z scan, until straight double parity is reached, the operation of the counter is again modified as before so that it now recognizes the availability of all cars, even AS cars, but the counter will add above zero only for those cars whose MG sets are running, and will not add above zero for AS cars. Thus the counter continues to show, if its accumulated count is positive, the excess availability of cars whose MG sets are running, but if sufficient calls are seen on this part of the scan, the counter's accumulated count may go negative to indicate hall calls below that this car may have to answer, but succeeding cars, AS or not, can bring this count back to zero if they are suitably located for answering these calls.

At straight double parity during the ascending Z scan, a normal reading of the final digit of the counter is taken and applied to the HBM memory. This car has now considered conditions both below and above it in deciding whether or not it should go down, but the conditions above cannot cause this

car to go down, since only a positive count is allowed to carry over from the above part of the scan into the below part. Conditions above can only prevent this car from starting down, where it otherwise would, if cars above with MG sets running are available to handle hall calls below this AS car.

Although this counter may be reset during straight double parity on the ascending Z scan, it is not necessary since the remaining part of the ascending Z scan and the first part of the descending Z scan, up until reverse parity occurs, is an idle period from which no information is to be extracted, and the counter will be reset again during reverse double parity on the descending Z scan without a reading being taken here.

From the preceding description it should be apparent that when a single hall call is registered, and one or more cars has its MG set running, no AS car will be started in response to this call, and the most suitable one of the cars whose MG set is running will be chosen. Thus, the car which is chosen is not necessarily the nearest car, but a car farther away may be chosen instead to avoid unnecessary starting of MG sets. If all cars are AS, the selection of a suitable car is still done with the extra scanning just described, but the final result is the same as it would have been if all cars had their MG sets running. This is because no positive number will be carried over from the below part of the scan into the above, or vice versa. Once a single car has been started in this way, so that all other cars are AS, this car answers all hall calls as long as it is capable of providing reasonable service. If it is idle for a period of about 3 or 4 minutes, its MG set is shut down again. If more hall calls are registered than can be satisfactorily answered by the cars with MG sets running, another car, the most suitably located, starts its MG set. These two then answer all hall calls as long as they are capable of providing reasonable service. Further cars may be started, if necessary, or both of these cars may shut down if they are idle long enough. Generally, their MG sets will not shut down simultaneously due to variations in the timing interval of their automatic shutdown timers, or due to one becoming idle before the other.

CAR PARKING

It is desirable to assure that the cars maintain a reasonable distribution, particularly during idle periods, so that any future hall call is not too far away from the most suitably located car. It is important that this spacing system be not too rigid, otherwise a single hall call may start one car to answer the call and several other cars may also start to respace themselves to replace the car which answered the call. It is best to keep such spacing maneuvers to a minimum to avoid a waste of power. With my system, no harm results from two or more cars remaining at the same floor, so long as the other cars are so placed that no large gaps exist. It is also desirable to use a spacing system which will automatically handle any number of cars in service, and which will automatically adjust to suit the number of cars whose MG sets are running. A car's MG set preferably should not be started for spacing purposes.

My scanning system is very flexible and allows for many possible spacing systems. I will describe a preferred spacing system which is considered to meet the above requirements at reasonable cost. For spacing purposes, it will be assumed that the building is divided into four approximately equal regions as follows:

- Region 1—comprising approximately the lower quarter of the building and including the main floor;
- Region 2—extending from region 1 up to approximately the middle floor;
- Region 3—extending from region 2 up to approximately the three-quarter point in the building; and
- Region 4—comprising the remaining floors above region 3.

For spacing purposes, a car is considered to be available if it is either UAV or DAV with its MG set running. When there is only one available car, the preferred spacing system to be described is satisfied when this car is situated anywhere in region 1 or region 2. If this car is taken above region 2, by car or hall calls, it is returned down to the top floor of region 1.

When there are two or more cars available, the parking system is not satisfied unless there are one or more available cars in region 1. Whenever there are no available cars in region 1, the lowest available car is instructed to travel down for spacing reasons. The lowest available car may be travelling up in response to car or hall calls above it, but it ignores these spacing instructions until it is free to go down. As the lowest available car travels up in response to car or hall calls above, it may pass other available cars which are not upbound. Then, of course, the original car is no longer the lowest available car, and now another car is the one which is instructed to go down for spacing reasons. Once region 1 has been lacking in available cars, the spacing system is not satisfied until there is an available car at or below the main floor. Thus a car which is brought down from higher regions does not stop upon entering the top of region 1, but continues on to the main floor. However, it is possible that another car has been at or below the main floor but has been unavailable for some reason, such as held for an excessive length of time. This other car could suddenly become available because it is no longer held, and this would then eliminate the necessity for the original car to continue travelling down.

When the spacing requirements for region 1 are satisfied, the spacing system next checks to see if there is an available car in region 3; if so, the spacing requirements are completely met. The cars are considered to be satisfactorily spaced if there is at least one car in each of these two regions, regions 1 and 3; the remaining cars may be distributed anywhere in any of the regions.

If there is no available car in region 3, the system then checks the available cars in regions 2 and 4. If each of these two regions has one or more cars, the parking system is satisfied in spite of the lack of cars in region 3. If both regions 3 and 4 are unoccupied, the highest available car is instructed to go up for spacing reasons, and this instruction continues until there is an available car in region 4. As before, cars ignore spacing instructions as long as they are travelling in response to car or hall calls. Also, as before, the highest available car may be downbound, and as it travels down it may pass other cars so that it is no longer the highest available car. The spacing instructions are then transferred to the new highest available car. It is also possible that an unavailable car in region 4 may become suddenly available, and this of course erases the previous spacing instruction to the original highest available car. The more usual operation, however, is for the highest available car to travel up to the bottom floor of region 4 whenever both regions 3 and 4 are unoccupied.

If both regions 2 and 3 have no available car, the system then checks the number of available cars in region 4. If it is two or more, the lowest available car above region 2 is instructed to travel down for spacing purposes, and this instruction continues until there is one or more cars in region 2. Normally, the lowest car in region 4 travels down until it is at the top of region 2, but, as before, a car may suddenly become newly available in region 2, or a car may enter region 2 from below, and in either case this erases the spacing instruction on the lowest available car above region 2.

If regions 2 and 3 are both unoccupied, and there is only one car in region 4, this car is not instructed to go down. Instead, the system checks to see how many available cars are in region 1; if there is only one such car, the spacing system is satisfied. If there are two or more cars available in region 1, the highest such car is instructed to go up for spacing reasons, and this instruction exists until there is an available car in region 3. This normally results in the highest car in region 1 travelling up until it is at the bottom of region 3, but, as before, another car becoming available in region 3, or entering region 3 from above, cancels this parking instruction.

It can be seen from the preceding description that cars ignore any spacing instructions as long as they are travelling in response to car or hall calls. In addition, a car presently obeying spacing instructions will immediately start ignoring such instructions whenever its HAM or HBM memory indicates

that there are hall calls which it should answer. The registration of a new car call can likewise cause a car to ignore spacing instructions, but this does not usually occur since a car responding to spacing instructions is usually an empty car.

It can also be seen that this spacing system strives to keep region 1 occupied at all times, and to make sure that no two adjacent regions are unoccupied. However, attempts to move cars to satisfy the spacing requirements interfere in no way with the answering of car or hall calls. A car can, of course, often satisfy both spacing requirements and handle car or hall calls at the same time if these both tend to take the car in the same direction.

It should also be noted that this spacing system is so designed that a car is normally never called up to travel only one or two floors for spacing reasons, but once started usually continues completely through one region into another before stopping. Previous systems have been arranged to always try to keep one or more cars at the main floor. Cars taken below the main floor automatically return to the main floor in such systems. It would be better to allow a car to remain below the main floor because there is a good possibility for hall calls to be placed where the car is standing. Such a car is almost as good as a car at the main floor because it is poised, immediately available because its doors are closed; the pressing of the up hall button at the main floor causes this car to start immediately, and it can reach the main floor very quickly.

Similarly, in my spacing system, the main floor is considered to be adequately served as long as there is a car somewhere in region 1. Region 1 can be made as small as desired. It is not considered necessary or desirable to always have a car waiting at the main floor, as long as the pressing of the main floor up hall button results in prompt service. A car waiting with its doors closed one or two floors above the main floor can very quickly start down and provide very prompt service when required at the main floor. However, whenever it is necessary to send a car down to improve the spacing situation near the main floor, such a car might just as well be taken all the way down to the main floor, rather than into the top of region 1. This is what my system does.

A very important advantage of my scanning system is that no special circuits are required for selecting a suitable car to travel down below the main floor in response to hall calls. Previous systems have required a complicated circuit for basement selection. In my system, the main floor may have below it any number of basement floors, but the handling of the associated hall calls is the same as for any other hall calls, as previously described.

MODIFICATIONS FOR UP- AND DOWN-PEAKS

A system has now been described which has one basic, very flexible, program which is capable of providing excellent service for all traffic conditions, except up-peak and down-peak. Special operation is needed to handle these two situations, but my scanning system can be easily adapted to provide excellent operation during up-peak and down-peak. The methods for detecting up-peak and down-peak will be described later. The operation of the cars during down-peak will now be described.

Each down hall call above the main floor has associated with it, circuitry to record the exact order in which these calls have been registered. Such circuitry does not require stepping switches, and gives an exact digital indication of priority.

During down-peak, rotational instructions will be given to the cars as they approach the main floor in the down direction. Some cars will be instructed to be "normal cars" during their next up trip, and other cars will be instructed to be "special cars" during their next up trip, in the following sequence: special, special, special, normal. Alternatively, if desired, the sequence may be: special, special, normal.

Normal cars will operate essentially the same as before, but they will ignore the availability of upbound special cars during the above part of their scan. Normal cars are capable of answering up hall calls. At any given time, there may be several

normal cars, but often there will be only one, and sometimes there will be none. A car which has been normal on one trip may be given the same instructions again at the next approach to the main floor, or it may become a special car this time. Any car can be selected to be either normal or special.

Upbound special cars operate somewhat differently. They ignore up hall calls above the main floor, they ignore the availability of normal cars during the above part of their scan, and they ignore all down hall calls, except "prior" calls. The prior calls are those which have been waiting longest for service, and the number of such prior calls preferably is made at all times equal to the number of upbound special cars. Moreover, the availability of special cars is only one and not two. Downbound cars, either special or normal, operate normally.

Down hall calls registered at floors low in the building, which tend to be continually bypassed by loaded downbound cars in previous systems, have a much better chance of being answered promptly in my system because the floors at which cars make expediency reversals are often low in the building. However, if such a call is continually bypassed, it eventually becomes a prior call and one of the upbound special cars, probably with no passengers in it, will make an express trip up from the main floor and will make an expediency reversal at the floor where the prior call is.

This excellent handling of down hall calls low in the building is not accomplished at the expense of down hall calls high in the building. Such calls have an excellent chance of being answered by normal cars, but if any such call remains unanswered too long, it eventually becomes a prior call and will be answered promptly by a special car. The recording of the exact order of registration of all down hall calls above the main floor during down-peak provides the most equitable way of giving equal service to all floors. Previous systems have generally divided the upper floors into two or more zones, but they still tend to give good service to the upper floors of each zone, and the lower floors in each zone frequently wait too long for service as loaded downbound cars automatically bypass them. Such systems frequently resort to special timers to detect when such a call has waited too long, and then, drastic measures are taken to bring an empty car up from the main floor for this long wait call without any regard to its possible effect on the service to other floors. With a priority system, a much more equitable service is provided because the absolute waiting time is of no importance, only the relative waiting time, and the upbound special cars concentrate on those calls which have waited longer than all others. These cars are not only providing excellent service to the prior calls by making expediency reversals with a normally empty car for them, but they are also tending to give good service to nonprior calls because they do not all have to travel up to the highest call as in previous systems, but are reversing sometimes low in the building, sometimes high in the building and sometimes near the middle, depending on the location of prior calls.

Basement hall calls may be answered by any car in the normal manner during down-peak, if good service is required there, or basement hall calls may be handled by normal cars only, if it is desired to favor the upper floors over the basement floors. If so desired, service to basement floors may be entirely suspended during down-peak. The choice of one of these three alternatives depends on the building and the customers' wishes.

The major requirement for handling up-peak traffic is to assure prompt return of cars to the main floor, regardless of whether or not the up hall button at the main floor is pressed. Previous systems have been arranged so that all cars operate on high call reversal and return to the main floor after completion of their up trip. My scanning system can have its spacing arrangement easily modified to do this. However, certain other features are readily obtainable with my scanning system, which would have been difficult on previous systems, but which have advantages. In previous systems, up hall calls placed at floors above the main, but low in the building, have

tended to be continually bypassed by upbound loaded cars during up-peak. It is important that service to such up hall calls, and in fact to any hall calls above the main floor, not interfere with the handling of the up-peak traffic originating at the main floor. However, there are usually pauses in the up-peak traffic during which time a car could be used advantageously to handle these hall calls without any serious effect on the up-peak operation.

Conventional systems end up with many cars at the main floor during a pause in the up-peak traffic. Only one or two cars, or perhaps three, are actually needed at the main floor at any time. It would be better if the remaining cars could be located above the main floor but close enough that they may be quickly brought down one at a time as loaded cars start up from the main floor. Then, in many cases, one of these cars parked above the main floor could be used to give prompt service with an unloaded car to up hall calls above the main floor. Ideally, this parking floor would be one floor above the main floor. Then, it would possibly be sufficient to keep only one car at the main floor and when this car is loaded, another car could be brought down very quickly to the main floor to be loaded.

This would avoid the problem of passengers at the main floor entering a wrong car, e.g. a car which is not next up, when such a car first arrives at the main floor and opens its doors. This problem can also be avoided, of course, by not opening the doors on a car arriving at the main floor unless necessary, until it has been selected as the next up car. The things which would necessitate the opening of the doors on arrival at the main floor would be the presence of a main floor car call and perhaps also the detecting of a small amount of weight, representing if possible only one person, on the car.

My system alters the normal spacing system described heretofore so that during an up-peak a predetermined number of cars, easily adjustable on each installation, is automatically returned to the main floor. Another adjustment determines readily the number of cars which automatically return to a second parking floor above the main floor. This parking floor can be another floor, but preferably it is made to be the floor immediately above the main floor. Of course, during the heavy part of the up-peak downbound cars continue down past this parking floor in order to satisfy the requirements at the main floor. It is only when the number of cars at the main floor meets the predetermined requirements that succeeding downbound cars stop at the second parking floor. Passengers in such downbound cars may, of course, cause them to go to or beyond the main floor in response to car calls.

If desired, the up-peak spacing system can be so adjusted that when the predetermined number of cars has been parked at the main floor, and another predetermined number of cars has been parked at the second floor, a car or two may be left over and these cars would then remain at the floors where service was last required of them. They would do so, however, only when the parking requirements are met, and during most of the up-peak period they would not have a chance to do so.

Rotational instructions are issued to each car at the commencement of its up trip during up-peak. Each car is instructed to be either "normal" or "special" and these instructions are issued in the following order: special, special, special and normal. Alternatively, if desired, the order may be: special, special and normal.

Special cars must continue through to the main floor before the up direction of travel can be established. They may stop to park at the second parking floor, but they cannot be started up from this floor. Special cars are allowed to stop only for one down hall call, and after that they bypass down hall calls for the duration of the down trip.

Normal cars are allowed to start in the up direction from the second parking floor, and they may be allowed to make an expediency reversal from the down direction to the up direction if desired. A car which has reversed in this manner will, of course, receive a new instruction after it has started its up trip, and it will likely be special car at this time. There is no restric-

tion on the number of down hall calls which a normal car may answer, except that it will bypass hall calls when sufficiently loaded.

Thus, it can be seen that this up-peak system handles a heavy up-peak in a manner similar to previous systems, but it has the additional capability of handling hall calls above the main floor, especially up hall calls, in a manner superior to previous systems without appreciably affecting the handling of traffic at the main floor.

UP- AND DOWN-PEAK DETECTION

The methods which I propose to use to determine when the down-peak and up-peak programs should be placed in effect will now be described. It is important in the preferred system, that the down-peak program be put into effect only when there are down hall calls registered. Previous systems may hold the down-peak program in effect during a brief pause in the down-peak, when no down hall calls are registered, but with my preferred system this is not done. In my preferred system three conditions must exist before the down-peak program begins as follows:

1. The number of down hall calls registered must exceed a predetermined number;
2. The number of hall calls registered must exceed the total availability of all cars; and
3. "Up-peak" conditions must not exist. Once the down-peak program has been placed in effect, it continues until the number of registered down hall calls has been reduced to a lower predetermined number. The detection of "up-peak" conditions will be described later.

In my preferred system, three conditions must exist before the up-peak program begins:

1. The number of down hall calls registered must be less than a predetermined number;
2. The number of hall calls registered must not exceed the total availability of all cars; and
3. "Up-peak" conditions must exist. Once the up-peak program has been placed in effect, it continues for at least a predetermined time, about 2 minutes, and in general it continues until the three conditions have not been all met for this predetermined time interval. Each time the three conditions are met, the timer is reset.

The detection of up-peak conditions is accomplished in the system to be described by measuring the voltage on a condenser. Each time a car stops for a car call in the up direction, the voltage on the condenser is increased slightly. Each time a car stops for a down hall call, voltage on the condenser is decreased slightly. In addition to this, the condenser is arranged to slowly discharge. Thus, if the cars are making frequent stops for car calls in the up direction, and are not stopping for many down calls, the voltage on the condenser rises and when it reaches a predetermined level, up-peak conditions have been detected. During periods of light traffic, the voltage on the condenser cannot rise high enough to indicate an up-peak. During periods of heavy traffic, the condenser voltage will rise only if the traffic is predominantly up-peak traffic; during down-peak, few stops are made for car calls in the up direction, and many stops are made for down hall calls, so that the condenser tends to be held in a nearly discharged condition.

BASIC CIRCUITS

The manner in which my system works has now been described in general terms, and I will now describe the preferred circuits used to provide such a system. It is obvious that because of the speed at which the scanning must operate, conventional relays and stepping switches are inadequate because they will not operate fast enough, and they would wear out much too rapidly. Therefore, solid-state or electronic circuits are used for at least part of the circuit. For simplicity, conventional relay circuits will be illustrated for that part of the circuit which handles for each car the speed control, door

control, car call registration, detection of car calls above and below, and associated circuitry. For the remainder of the circuit, including hall call registration, scanning, counting, determination of hall calls above and below each car, which each car should answer, spacing, detection of up-peak and down-peak, and associated circuitry, transistorized circuits will generally be used. It is important to realize that this part of the circuit could use vacuum tubes, magnetic amplifiers, or other techniques without changing the basic principles of the invention. The economics of these various systems indicates that it is currently best to use transistors, and the circuits which I will use to describe my invention will use transistors. It should be clearly understood that this does not in any way limit my invention to the use of transistors.

There are various well known methods for producing logic elements using transistors, such as diode logic, resistor-transistor logic, etc., using either PNP or NPN transistors, and it will be understood by those skilled in the art that any one of these systems could be used. In my description, I will use one of the most common of these systems, and the one which I presently believe to be most suited for this application. I shall describe herein the use of the familiar NOR logic circuit.

The basic building block which will be used extensively is the NOR logic element and in addition, other well-known logic elements such as emitter followers, multivibrators, and gates will be used. FIGS. 36 and 37 show the circuit symbols for these various logic elements which will be used in the other FIGS., and a suggested circuit for each logic element based principally on using a 2N404 transistor with an 18-volt power supply. This power supply must have two output terminals providing +18 volts and -18 volts with respect to a zero voltage terminal which is at ground potential. It must be understood that many other transistors and voltages could be used without altering the principles of the system.

Information is conveyed from one logic element to another by wires which normally assume either one of two possible conditions. These two conditions are frequently referred to as 0 and 1. However, since binary numbers are also used extensively in this description, I shall use the terms "high" and "low" for these two conditions to avoid confusion. A wire in the high condition is a fraction of a volt negative with respect to the zero voltage output of the power supply. A wire in the low condition is at least -9 volts, and may be as low as -18 volts, depending on the amount of load it drives. Each logic device, with few exceptions, is designed to accept anything between -9 and -18 volts as the low condition, and to accept anything within about 1 volt of zero as the high condition.

FIG. 36a shows at its left with circuit values the circuit for a 5-input NOR, and the symbol which will be used hereinafter to represent such a NOR is shown at the right of FIG. 36a. The operation of such a NOR is known. If all the inputs are high, the output is low, but if one or more inputs is low, the output is high. Input power connections to +18, 0, and -18 are required to each NOR, but they are omitted from the symbol for convenience. If less than 5 inputs are required, the associated resistors may be omitted, or the associated input terminals may be left unconnected, or they may be connected to 0, and only the required number of inputs will be shown in the symbol. For example, in FIG. 28, NOR 393 has only four inputs. Similarly in FIG. 18, NORs 151, 153, and 156, have respectively, three, two and one inputs. The same values for the resistors, as shown in FIG. 36a, are used in these NORs with some of the input resistors omitted if desired. Such a NOR is capable of driving four other similar NORs, and will be referred to as a "standard" NOR.

Similarly, FIG. 36b shows a circuit and the symbol for a NOR with a maximum of 2 inputs which is capable of driving 15 standard NORs. Such a NOR will be referred to as an "amplifying" NOR. However, a standard NOR can drive only one of these amplifying NORs. As before, the symbol will only show one input, as in amplifying NOR 74 in FIG. 11, when two are not required. One of the input resistors may then be omitted if desired.

FIG. 36c shows a combination of a two input NOR, acting as a preamplifier, driving a one input NOR, acting as a power amplifier. These two are always used together, and the connection between them does not use the same voltage for the low condition as it used elsewhere. The collector resistor R91 can be made 125 ohms to drive 50 standard NORs, or it can be made 62 ohms to drive 100 standard NORs. The input resistors are the same size as for standard NOR, but the maximum number of inputs is two.

FIG. 36d shows a "sensitive" NOR with higher input resistors, but capable of driving only two standard NORs, with a maximum of two inputs.

FIG. 36e shows a circuit for a lamp driver with a maximum of two inputs. Note that when both inputs are high, the lamp is illuminated. The lamp is shown with dotted connections in FIG. 36e and it is not actually part of the lamp driver. The lamp is connected between the output of the lamp driver and -18.

FIG. 36f shows how the components from two standard NORs can be put together with a common collector resistor to produce a NOR with a maximum of 10 inputs. As before, only those inputs which are actually needed are shown in the symbol. For example, in FIG. 18, NOR 158 has only seven inputs.

FIG. 36g shows the circuit for a "relay driver". It is the same as a standard NOR with only one input, but with the collector resistor replaced with a diode D77. Actually, up to five inputs could be used if desired, but only one input is required in almost all cases in this invention. It is assumed that the relays driven by these relay drivers have a resistance equal to or greater than 1,500 ohms. Each relay driver will drive only one such relay and since only one normally open contact is required on each such relay, a "reed" type relay is ideal for this application.

FIG. 36h shows how the circuit for a one input amplifying NOR can similarly have its collector resistor replaced with a diode D78 so as to produce a relay driver capable of driving fifteen relays.

FIG. 36i shows the circuit for an emitter follower, and the corresponding symbol. It has only one input, and a standard NOR is capable of driving only one emitter follower. The output of the emitter follower is amplified without inversion so that it is capable of driving ten standard NORs. Thus, when the input is high the output is high and vice versa.

FIG. 36j shows the circuit for a "one-shot." This consists mainly of a capacitor so that each time the input becomes low, the output is low for a very short time only, and then reverts to high. When the input goes high, the capacitor is discharged through diode D79. No amplification takes place and this one-shot is normally placed between the output of one NOR and the input of another.

FIG. 37a shows a circuit for an astable multivibrator. It has no inputs, and two outputs. Output 1 has a rectangular waveform, and the length of time it remains in the high and low conditions is determined by the values of capacitors C12 and C13 and of resistors R92 and R93. If these resistors and capacitors are equal, the voltage at output 1 has a square waveform. The voltage at output 2 is similar to output 1, but inverted, i.e., when output 1 is high, output 2 is low, and vice versa.

FIG. 37b shows a circuit for a monostable multivibrator, and the symbol used for it. It has one input and one output. The input is normally kept high, and the output is also normally high. When the input goes either briefly or continuously low, the output goes low for a length of time determined by capacitor C14, and then reverts to the high condition.

FIG. 37c shows a circuit for a bistable multivibrator, and the symbol used for it. It has three inputs and two outputs. Inputs 1 and 2 are normally high. If input 1 is made momentarily low, output 1 becomes high, or remains high if that was its previous condition. Output 2 is always opposite to output 1, i.e., when output 2 is high, output 1 is low, and vice versa. If input 2 is made momentarily low, output 2 becomes high, or remains high if that was its previous condition. Input C has no effect

except when it goes from low to high; then it causes the state of the multivibrator to change so that it is opposite to its previous state. For example, if output 2 is high, input C becoming suddenly high causes output 2 to become, and remain, low.

FIG. 37d shows the circuit for a two input DC gate, and the symbol used for it. It has two inputs, a control, and an output. When the control is high, input 2 determines the condition of the output; when the control is low, input 1 determines the condition of the output. In either case, there is no inversion between the input and the output. In the symbol, a dot is used to indicate which of the inputs is input 2.

FIG. 37e shows the circuit for a one input AC gate, and the symbol used for it. It has an input, a control and an output. When the control is low, the output is low. When the control is high, the output goes high only briefly whenever the input changes from high to low.

FIG. 37f shows the circuit for a two input AC gate, and the symbol used for it. It is basically equivalent to two one input AC gates, with a common output. The controls are arranged externally so that when control 1 is high, control 2 is low, and when control 2 is high, control 1 is low.

When control 1 is high, a brief positive pulse occurs on the output whenever input 1 changes from high to low. When control 2 is high, a brief positive pulse occurs on the output whenever input 2 changes from high to low.

TIMING PULSE GENERATOR

The transistorized part of the circuits of my system will now be described, and the symbols shown in FIGS. 36 and 37 will be used wherever possible, to simplify the illustration of these circuits. The entire scanning operation is timed by a pulse generator whose circuit is shown in FIG. 7.

In FIG. 7, astable multivibrator 17 is arranged so that its outputs remain for 50 microseconds in one condition, and for 50 microseconds in the other conditions. If the circuit of FIG. 37a is used for this astable multivibrator, capacitors C12 and C13 should be 0.0039 mfd. and resistors R92 and R93 should be 18 kohms. Output 1 is inverted by NOR 18 and fed through one-shot 19 to the monostable multivibrator 20. Thus, the input of this multivibrator consists of negative pulses spaced apart by 100 microseconds. The purpose of NOR 18 and one-shot 19 is to improve the squareness of the output of the astable multivibrator.

Monostable multivibrator 20 is arranged so that its output remains negative for 25 microseconds. If the circuit of FIG. 37b is used, capacitor C14 should be 0.0047 mfd. The output of monostable multivibrator 20 is inverted by NOR 21 and the amplified by NORs 22 and 23 to produce signal AP. The waveform of signal AP is shown in FIG. 8 and t_1 is 100 microseconds, and t_2 is 25 microseconds.

Similarly, the other output of astable multivibrator 17 is inverted by NOR 24 and fed through one-shot 25 to the monostable multivibrator 26 which is also arranged so that its output remains negative for 25 microseconds. Its output is inverted by NOR 27 and amplified by NORs 28 and 29 to produce signal BP. The waveform of this signal is shown in FIG. 8 and t_2 is 50 microseconds. The signals AP and BP will be referred to as the A pulse and the B pulse respectively.

It can be seen from FIG. 8 that a complete cycle of the A and B pulses consists of: a 25 microsecond period in which AP is high, a 25 microsecond pause, a 25 microsecond period in which BP is high, and another 25 microsecond pause. When the term A pulse is used, the 25 microsecond period when AP is high is what is meant; similarly, the term B pulse refers to that 25 microsecond period in which BP is high.

STEERING CIRCUIT

FIG. 2 shows that the two outputs AP and BP of the pulse generator are fed to many other circuit subassemblies or cards, and in particular, to the steering circuit. FIG. 9 shows the circuit for the steering circuit. NORs 32 and 36 are connected together to form a flip-flop. During the main scan, the

output of NOR 32 is low, and the output of NOR 36 is high. Each time signal AP is high, the output of NOR 37 is low, and thus, the output of NOR 38 is high. Hence, the signal at terminal MD, which is used to drive the main stepper, carries the same information as signal AP. However, it will be shown later that whenever any car experiences main parity, the signal at terminal nQ becomes low and this causes the output of NOR 30 to become high. This occurs very shortly after the beginning of an A pulse, and thus, when the next B pulse occurs, both inputs to NOR 31 are high, its output is low, and the flip-flop consisting of NORs 32 and 36, is changed so that now the output of 32 is high, and the output of 36 is low. Therefore, the next A pulse will not make signal MD high, but will instead make signal SD high because both inputs to NOR 33 are high, and thus its output is low causing the output of NOR 34 to be high. When the signal SD goes high, the secondary stepper steps one step, and it will be shown later that this causes signal at terminal MS to become low. This holds the output of NOR 35 high during the entire secondary scan so that the flip-flop cannot change. The signal at nQ could become high if the car experiencing main parity moved to another floor during a secondary scan, but normally, it too remains low during a secondary scan.

Thus, it can be seen that the steering circuit steers the A pulses normally to output terminal MD, but steers them instead to output terminal SD when a secondary scan is required. The input MS assures that the secondary stepper is taken through its entire 36 steps before the main scan can be resumed. The input nQ determines when a secondary scan is required. The input nSK receives a negative pulse from the secondary stepper each time it goes from binary number 111,111 to 011,100. This causes the output MD to become momentarily high so that the main stepper is driven on to the next step.

STEPPING CIRCUITS

The steering circuit has only two outputs. Output MD goes to the main stepper (FIG. 10) and SD goes to the secondary stepper (FIG. 11). FIG. 10 shows the circuit for the main stepper, and it has only one input, MD. It consists mainly of a six digit binary counter using bistable multivibrators 52, 53, 54, 55, 56 and 57, and amplifiers for both outputs of all these multivibrators. Each time input MD becomes high, bistable multivibrator 52 changes its condition and output 1 thereof is amplified by NORs 39 and 40 to produce output F1, and output 2 is amplified by NORs 60 and 61 to produce output nF1. These two outputs represent the digit f1 as described earlier in connection with table 3. When output F1 is high, it indicates that the digit f1 is 1; when output nF1 is high, it indicates that the digit f1 is 0. Output 2 of bistable multivibrator 52 also connects to input C of bistable multivibrator 53, so that each time it becomes high, bistable multivibrator 53 changes its condition. This occurs when output nF1, which is carrying the same signal, but amplified, as output 2 of bistable multivibrator 52, goes high. This corresponds to the digit f1 going from 1 to 0. In table 3, it can be seen that each time digit f1 goes from 1 to 0, digit f2 changes. Therefore, bistable multivibrator 53 has outputs which indicate the condition of digit f2, and these outputs are amplified by NORs 41, 42 and 62, 63 to produce outputs F2 and nF2 respectively.

Output 2 of bistable multivibrator 53, which when amplified produces output nF2, connects in a similar manner to input C of bistable multivibrator 54, and its condition represents the digit f4. Its outputs are amplified by NORs 43, 44 and 64, 65 to produce outputs F4 and nF4 respectively. This causes digit f4 to change each time digit f2 goes from 1 to 0, and this agrees with table 3.

Similarly, the remaining three bistable multivibrators 55, 56 and 57 are connected so that they represent the digits f8, f16 and m1 respectively. Their outputs are amplified by NORs 45 and 46, 47 and 48, and 49 and 50 to produce outputs F8, F16 and M1 which, when high, indicate that the corresponding

digit is 1 and are amplified by NORs 66 and 67, 68 and 69, and 70 and 71 to produce outputs nF8, nF16 and nM1 which, when high, indicate that the corresponding digit is 0.

The outputs of NORs 50 and 71, which create outputs M1 and nM1, are connected to the inputs of one-shots 51 and 72, and their outputs connect to NOR 58. Thus, 58 has both its inputs normally high, but one of its inputs becomes momentarily low at the completion of the ascending scan when nM1 becomes low, and also at the completion of the descending scan when M1 becomes low. In either case, the output of NOR 58 becomes momentarily high, and this signal is then amplified and inverted to create signal nMP which therefore is normally high, but has brief low pulses at the changeover from ascending to descending scans, and also at the changeover from ascending to descending scans.

The operation of the main stepper has now been described. Most of its outputs are required to show the condition of the main scan, and FIG. 2 shows that these outputs connect to various other cards, wherever this information is required. Output nMP, as shown in FIGS. 2 and 3, connects to the availability card for each car. Its purpose will be described later. Also, output nTMP, from one-shot 72, is used on the priority stepper.

FIG. 11 shows the circuit for the secondary stepper which has an input SD, similar in purpose to input MD of the main stepper, and also has inputs X1, X2 and X4 from the scrambler which is described hereinafter. The secondary stepper consists mainly of a six digit binary counter, using bistable multivibrators 83, 85, 87, 89, 91 and 93, and amplifiers for the outputs of these multivibrators. Each time input SD goes high, bistable multivibrator 83 changes its condition, and its output 1 is amplified by NORs 84 and 78 to produce output I1, and NOR 73 inverts I1 to produce output nI1. These two outputs represent the digit i1 as described earlier in connection with table 4. When output I1 is high, it indicates that the digit i1 is 1, and when output nI1 is high, it indicates that the digit i1 is 0. Output 2 of bistable multivibrator 83 connects to input C of bistable multivibrator 85 so that each time it goes high, bistable multivibrator 85 changes its condition. This occurs at the same time that output nI1 goes high, corresponding to the digit i1 becoming 0. Thus the condition of bistable multivibrator 85 represents the digit i2 because, as shown in table 4, each time digit i1 becomes 0, digit i2 changes. Output 1 of bistable multivibrator 85 is amplified by NORs 86 and 79 to produce output I2. NOR 74 inverts and amplifies I2 to produce output nI2. When output I2 is high, it indicates that digit i2 is 1, and when output nI2 is high, it indicates that the digit i2 is 0.

Output 2 of bistable multivibrator 85 connects to input C of bistable multivibrator 87 so that each time it goes high, bistable multivibrator 87 changes its condition. Thus, it can be seen that it represents digit c1. However, it is not digit c1 which is needed as an output, but rather digit c1S. Therefore, gate 88 has its two inputs connected to the two outputs of bistable multivibrator 87 so that when the control of this gate is low, output 2 of the multivibrator determines the output of the gate, and when the control is high, output 1 of the multivibrator controls the output of the gate. The output of gate 88 is amplified and inverted by NOR 80 to produce output C1S. NOR 75 amplifies and inverts C1S to produce output nC1S. When output 1 of bistable multivibrator 87 is high, it indicates that digit c1 is 1. When output 2 is high, it indicates that digit c1 is 0. When the control of gate 88 is low, outputs C1S and nC1S behave as they would if they represented digit c1 in a similar manner to the other digits previously described. However, when the control of gate 88 is high, the conditions of outputs C1S and nC1S are inverted from what they otherwise would be, and this corresponds to the inversion of a digit for scrambling purposes as described in connection with table 5.

Output 2 of bistable multivibrator 87, which when high indicates that the digit c1 is 0, connects to input C of bistable multivibrator 89, so that each time it goes high, which corresponds to the digit c1 becoming 0, bistable multivibrator 89

changes its condition. Thus, its outputs indicate the condition of digit *c2*, for, as in table 4, each time the digit *c1* becomes 0, digit *c2* changes. In a similar manner to the preceding digit, gate 90, and NORs 81 and 76 produce outputs *C2S* and $\bar{n}C2S$ such that when the control of gate 90 is low, these outputs show the condition of digit *c2*, *C2S* being high indicating that digit *c2* is 1, and $\bar{n}C2S$ being high indicating that digit *c2* is 0. However, when the control of gate 90 is high, these outputs are inverted so as to give the opposite indication. This also corresponds to the inversion of a digit for scrambling purposes.

In a similar manner, output 2 of bistable multivibrator 89 connects to input C of bistable multivibrator 91 so that it corresponds to the digit *c4*. As before, gate 92 and NORs 82 and 77 provide outputs *C4S* and $\bar{n}C4S$ which represent the condition of scrambled digit *c4S*. It can now be seen that input terminals X1, X2 and X4 determine which of these three digits, *c1*, *c2* and *c4* are inverted in order to accomplish the scrambling as shown in FIG. 5. These input signals are obtained from the scrambler which will be described later.

Output 2 of bistable multivibrator 91 connects to input C of bistable multivibrator 93, and thus, one of its outputs represents the digit *s1*, and this output is amplified by NORs 94 and 95 to produce output S1. The corresponding inverted output is not required. S1 also connects to the input of one-shot 96 so that each time S1 goes low, at the end of a secondary scan, its output goes briefly low, and this signal is amplified by NORs 97 and 98 to produce output $\bar{n}SK$. This output connects, as shown in FIG. 2 to a similarly named input on the steering circuit, to provide the pulse required to cause the main stepper to move ahead by one step, as described earlier. The signal $\bar{n}SK$ also connects to input 1 of bistable multivibrators 87, 89 and 91 so that they are set to conditions indicating that digits *c1*, *c2* and *c4* are all 1; these digits would otherwise have been 0. This causes the secondary stepper to skip from the binary number 111,111 to 011,100 and this agrees with the secondary scan as illustrated in table 4.

HALL CALL CIRCUITS

FIG. 12 shows a circuit for a hall call card, one such card being required for each intermediate floor. A simpler circuit would be sufficient at the top and bottom floors, where there is only one associated hall pushbutton, but it will be assumed that the same card is used for all floors, in which case, part of the circuit in the cards for these two terminal floors is then unused. FIG. 12 will be described as if it were used for an intermediate floor.

On the left side of FIG. 12, a down pushbutton PBD and an indicating lamp IL1 are shown connected between 0 and -8 with the wire between them connected to terminal BD. Dotted lines are used here since the pushbutton and lamp are not part of the hall call card, but are located in the pushbutton station located at the floor represented by this hall call card.

Transistors Q1 and Q2, resistors R1, R2, R12, R13 and R15, and the coil of relay XD form a flip-flop used to record the down hall call at this floor. Pressure on pushbutton PBD causes immediate illumination of indicating lamp IL1 located in the pushbutton station, and of indicating lamp IL2 located on the hall call card. It also completes a circuit from 0 through the emitter to the base of transistor Q1, through resistor R11 and through capacitor C1, which causes the transistor Q1 to be turned on so that its collector is brought up close, in voltage, to 0. This causes resistors R2 and R13, acting as a voltage divider, to hold the base of transistor Q2 sufficiently positive, with respect to 0, to turn off transistor Q2. This provides an alternate path for the base current of transistor Q1 through resistors R12 and R15. The previous path for base current was through capacitor C1 which quickly charges and prevents further flow of current through this path. The flip-flop has, however, changed its state to record the call, and the relay XD is now energized through the transistor Q1, and its contact XD-1 closes maintaining current to indicating lamps IL1 and

IL2. Release of pressure on the pushbutton PBD has no further effect. Thus, it can be seen that momentary operation of pushbutton PBD results in illumination of the lamps IL1 and IL2, and in the recording of the down hall call via the flip-flop on the hall call card. The relay XD is used mainly as an amplifier capable of driving several lamps which may be required in the pushbutton PBD, in another similar pushbutton at the same floor if two risers are used, and in the hall call card itself. This amplification could be done, if desired, by a power transistor but for the purposes of this application it is considered better to use a reed relay with one normally open contact because of its high amplification.

On the right of FIG. 12, a similar pushbutton PBU and indicating lamp IL4 are shown with dotted line connections since they are located in the same pushbutton station as button PBD, and not in the hall call card. Momentary operation of button PBU similarly causes illumination of lamp IL4 which may illuminate the pushbutton, of lamp IL3 in the hall call card, and causes transistor Q9 to be turned on because of its base current flowing through resistor R32 and condenser C2. This energizes relay XU, resulting in the closing of contact XU-1, and it causes the voltage divider consisting of resistors R7 and R30 to take the base of transistor Q8 sufficiently positive to turn it off and allow resistors R29 and R31 to keep base current flowing from transistor Q9 so that it remains turned on. This circuit is similar to the previously described circuit for the down hall call.

The manner in which operation of an up or down hall button results in the remembering of this call by the associated flip-flop has now been explained. There is a similar card for each floor connected to the corresponding buttons in the pushbutton station there. The method by which these calls are canceled will be described later.

The voltage on the collector of transistor Q2 is an indication of whether or not the associated down hall is registered; if it is high, the call is not registered, and if it is low, the call is registered. The collector of transistor Q2 is connected to output terminal CD, which is required for the priority cards which will be described later. Similarly, the voltage on the collector of transistor Q8 is an indication of whether or not the associated up hall call is registered.

Transistor Q3 is normally operated with its base sufficiently positive to keep it turned off with very little leakage, but at one point of each ascending scan, this transistor is turned on so as to transfer an indication of the condition of the collector of transistor Q2 to the terminal AD which is connected to a similar terminal on all other hall calls cards, except the one for the bottom floor where there is no down hall button. If it is desired to cancel the down hall call at this floor, AD must be made high by circuits not yet described, located in the secondary scanner, during the time when transistor Q3 is turned on. This causes the collector of transistor Q2 to be brought up close to 0 in spite of its being turned off. This allows the voltage divider consisting of resistors R1 and R12 to drive the base of transistor Q1 sufficiently positive to turn it off. This deenergizes the coil of relay XD, not completely, because of resistor R13, but sufficiently to open its contact; this also causes transistor Q2 to be turned on because of the flow of base current through resistor R13 and the coil of relay XD. The flip-flop has thus been restored to its original condition indicating that there is no longer a down hall call registered at this floor. The condenser C1 discharges through diode D1 and through the indicating lamps. Resistor R10 is provided in case both of these lamps are removed or burned out. The opening of contact XD-1 extinguishes lamps IL1 and IL2. It should be noted here that continuous pressure on the pushbutton, or a pushbutton stuck closed, does not prevent such cancellation. It is only when contact is first made in the pushbutton that a call can be registered.

Similarly, transistor Q4 is normally operated with its base sufficiently positive to keep it turned off with very little leakage, but at one point of each descending scan, this transistor is turned on so as to transfer an indication of the

condition of the collector of transistor Q8 to the terminal AU which is connected to a similar terminal on all other hall call cards, except the hall call card for the top floor at which there is no up hall button. If it is desired to cancel the up hall call at this floor, AU must be made high by circuits not yet described, located on the secondary scanner, during the time when transistor Q4 is turned on. This causes the collector of transistor Q8 to be brought up close to an 0 in spite of its being turned off. This allows the voltage divider consisting of resistors R8 and R31 to drive the base of transistor Q9 sufficiently positive to turn it off. This deenergizes the coil of relay XU, not completely, because of resistor R30, but sufficiently to open its contact. This also causes transistor Q8 to be turned on because of the flow of base current through resistor R30 and the coil of relay XU. The flip-flop has thus been restored to its original condition indicating that there is no longer an up hall call registered at this floor. The condenser C2 discharges through diode D2 and through the indicating lamps. Resistor R33 is provided in case both of these lamps are removed or burned out. The opening of contact XU-1 extinguishes lamps IL3 and IL4.

It was indicated in the preceding paragraphs that a reading is taken on the condition of the flip-flop associated with the down hall call at a particular point in the ascending scan, and that a similar reading is taken of the other flip-flop associated with the up hall call at a particular point in the descending scan. These two points at which readings are taken are obviously when the digits of the main scan indicate the floor with which this particular hall call card is associated. Information regarding digit *m*1 is transmitted from the main stepper to each hall call card via connection M1 as shown in FIGS. 1 and 2. This provides an indication of whether it is the up or down flip-flop whose condition is to be read. Information regarding the remaining digits of the main scan is transmitted to each hall call card via input terminals H1, H2, H4, H8 and H16 on each card. On each card, terminal H1 is connected either to F1 or $\bar{F}1$, terminal H2 is connected either to F2 or $\bar{F}2$, H4 is connected either to F4 or $\bar{F}4$, H8 is connected either to F8 or $\bar{F}8$, and H16 is connected either to F16 or $\bar{F}16$. This is done in a systematic manner as shown in FIG. 1 so that each card is connected in a different manner. Twenty such cards are shown in FIG. 1 and this shows how the connections would be made for an installation with 20 floors. For installations with fewer floors, simple omission of the unused cards results in the appropriate connections. For installations with more than 20 floors, the wiring of the additional cards must be done in the same systematic way, which should be obvious from examination of FIG. 1.

Inputs M1, H16, H8, H4, H2 and H1 are connected through diodes D3, D4, D5, D6, D7 and D8 to resistor R18, as shown in FIG. 12, so that if any one of these six inputs is high, the base of transistor Q5 is high. Transistor Q5 is used as an emitter follower and its emitter, which connects to output terminal $\bar{n}SHD$, is thus normally high, and is made low only when all six of these previously mentioned inputs are low.

Inputs M1, H16, H8, H4, H2 and H1 are also connected through resistors R19, R20, R21, R22, R23 and R24 to the base of transistor Q6, as shown in FIG. 12, so that if any one of these six inputs is low, transistor Q6 is turned on. Thus transistor Q6 is normally turned on, and is turned off only when all six of these inputs are high. Thus it can now be seen that when all six of these inputs are low, the emitter of transistor Q5 is also low, and this turns on transistor Q3 to allow the condition of the down flip-flop to be transferred to output AD or to allow cancellation of the down hall call if AD is made high. Similarly, when all six of these inputs are high, transistor Q6 is turned off and this allows transistor Q4 to turn on because of the flow of base current through resistors R27 and R28, and this allows the condition of the up flip-flop to be transferred to output AU or to allow cancellation of the up hall call if AU is made high.

Examination of FIG. 1 shows that the hall call card for floor 1 has all of its six inputs low during the first step of the ascend-

ing scan, and has these six inputs all high during the last step of the descending scan. Similarly, the hall call card for floor 2 has its six inputs all low during the second step of the ascending scan, and has these six inputs all high during the second last step of the descending scan. The remaining hall call cards are connected in a similar manner so that they respond, one at a time in ascending order, while the condition of the down flip-flops is examined or canceled, and they respond one at a time in descending order, while the condition of the up flip-flops is examined or canceled. This accomplishes the order of scanning shown in chart form in table 3. A complete picture of the registered down hall calls is seen by the waveform on AD, and a complete picture of the registered up hall calls is seen by the waveform on AU. These two connections need not be separated. One connection would be sufficient but to eliminate any problem due to the adding up of all the leakage currents for the transistors at floors where a reading is not being taken, it is considered best to have separate AU and AD connections.

Referring back to FIG. 12, it can be seen that transistor Q7 is turned on whenever transistor Q3 or transistor Q4 is turned on. Thus output SH is normally low, but goes high once during each ascending scan, and once during each descending scan, whenever the digits of the main scan represent this floor. The SH output of each card is connected principally to a correspondingly named input on the car call cards for each car, for the same floor.

CAR CALL CIRCUITS

FIG. 13 shows the circuit for a car call card. One such card is required for each car for each floor served. The operation of the car call cards for one car will be described, and it is assumed that each other car has a similar set of car call cards. A pushbutton PBC and an indicating lamp IL6 are shown connected between 0 and -18A with the wire between them connected to terminal C. Dotted lines are used here since the pushbutton and lamp are not part of the car call card, but are located in the car panel in this car. The wire -18A is assumed to originate in a separate power supply for each car, instead of from the -18 wire which supplies the majority of the transistorized part of the circuit and which is common to all cars. This assures that a failure of this common power supply will not prevent the cars from being operated from their car pushbuttons.

Operation of pushbutton PBC energizes lamp IL6 in the pushbutton, lamp IL7 in the car call card and the coil of relay XC through resistor R35. This causes contact XC-1, on relay XC, to close. This provides an alternate path for the current to the two lamps and to the coil of relay XC. Thus momentary operation of any car button results in energization of the XC relay in the associated car call card, and in illumination of the push button and the corresponding indicating lamp in the car call card. The relay XC indicates, when energized, that a car call has been placed. Such a car call can be canceled by connecting terminal K to 0 so as to short out the coil of relay XC. The circuit for accomplishing this will be shown later. Resistor R35 allows the coil to be shorted out without drawing excessive current from the supply. Resistor R34 and diode D14 are connected as shown in FIG. 13 to provide a further terminal CX. Its purpose is to allow connection to a second relay, on another piece of equipment to be described later, whose coil will be connected between CX and -18A. Thus, when the car call is not registered, this second relay is energized through resistor R34. When the car call is registered, terminal CX is held by diode D14 almost as negative as wire -18A and therefore this second relay has its coil deenergized. It has one normally open contact which provides essentially the same information as would a normally closed contact on relay XC. Such a contact is used, as will be shown later, to detect car calls above and below.

Terminal K indicates, by its voltage, whether or not the car call is registered; if it is high, the car call is not registered. If it

is low, the car call is registered. When the car call is registered, terminal K is low and transistor Q10 is turned on because of the flow of base current through resistors R16 and R36. This causes the collector of transistor Q10 to be high, and then, whenever the main scan reaches the floor that this car call card is representing, input SH, from the hall call card, is also high and thus transistor Q11 is normally high, but goes briefly low when the car call is registered and the scan is at this floor. When the car call is not registered, resistors R37, R36 and R16 keep the base of transistor Q10 slightly positive so that it is turned off and it allows resistors R40 and R41 to turn on transistor Q11. This holds its collector high. Capacitor C8 allows the -18A supply to be unfiltered, without ripple getting through to transistor Q10. It is preferable to not use capacitive filtering on line -18A because the load on this line is quite variable, and capacitors would make the voltage regulation poor. The -18 line, however must be well filtered, or perhaps regulated. The diode D16 connects the collector of transistor Q11 to output terminal nCP, and this terminal is connected to similar terminals on each other car call card for this car. Thus, the waveform on nCP gives a complete picture of which car calls are registered for this car. The complete picture is seen in ascending order during the ascending scan, and again in descending order during the descending scan. This nCP signal is used as an input to the availability card which will be described later.

The car call card also contains equipment for converting digital information regarding the position of this car into binary form, as is required on the parity checker which will be described next. A relay XP has its coil connected between input terminal P and wire -18A. Equipment located elsewhere, which will be described later, energizes only one of these XP relays at a time, and the one which is energized corresponds to the advanced digital position of this car. The closing of contact XP-1 on this relay causes illumination of indicating lamp IL5 on this card, and also causes, by diodes D9, D10, D11, D12 and D13, output terminals 1, 2, 4, 8, and 16 to be brought down in voltage almost to -18A. These terminals on each car call card are connected in a systematic way, as shown in FIG. 4, to terminals on the parity checker. Terminal 1 connects to either P1 or nP1, terminal 2 connects to either P2 or nP2, terminal 4 connects to either P4 or nP4, terminal 8 connects to either P8 or nP8, and terminal 16 connects to either P16 or nP16. This systematic connection is the same as the systematic connections shown in FIG. 1 for the hall call cards. These inputs to the parity checker are normally high, and are caused to be low when any one of the XP relays connects them to -18A through diodes. Thus, for example, when the XP relay on the car call card for the lowest floor is energized, its terminals 1, 2, 4, 8 and 16, all become low, and thus terminals P1, P2, P4, P8 and P16, on the parity checker are caused to be low, and its other terminal nP1, nP2, nP4, nP8 and nP16, are still high. This presents to the parity card in binary form the information that the car's advanced digital position is 1. Similarly, when the XP relay is energized in the car call card for the second floor, nP1 is low rather than P1, and this presents to the parity checker the information that the car's advanced digital position is 2. The same applies for all other floors. Diode D15 provides a discharge path for current from relay XP, to protect the contacts feeding it, from arcing, when XP is deenergized.

PARITY CHECKER

FIG. 14 shows the circuit for the parity checker. Its purpose is to compare the binary number which represents the car's advanced digital position with the binary number representing the condition of the main scan so that straight and reverse parity can be detected for this car. As described earlier, straight parity occurs once during the ascending scan when the floor it is representing coincides with the floor this car is at, and reverse parity occurs once during the descending scan when the floor it is representing coincides again with the floor

this car is at. Straight parity is recognized by all digits of the two binary numbers coinciding exactly, and reverse parity is recognized by each digit of one binary number being exactly opposite to the corresponding digit of the other number.

The parity checker also includes a flip-flop for each digit representing the car's position so that during the gap between the opening of the contact of the XP relay for one floor, and the closing of the XP contact for the next floor, the original digits are remembered so that there is no gap in the advanced digital information. Also, these flip-flops prevent the inevitable bounce of the contacts as they close from causing harm, the first bounce being sufficient to set the flip-flops to the new condition.

NORs 100 and 103 are connected together to form a flip-flop so that the output of NOR 100 is high when input nP1 is low, and the output of NOR 100 is low when input P1 is low. NORs 101 and 102 are used in conjunction with diodes D17 and D18 and resistor R43 to indicate whether the digit f1 is the same as, or opposite to, the corresponding digit representing this car's position as indicated by the flip-flop consisting of NORs 100 and 103. If the output of NOR 100 is high and input F1 is also high, the output of NOR 100 is low; if the output of NOR 100 is low, and the input F1 is also low, diodes D17 and D18 allow resistor R43 to cause the other input of NOR 102 to be low. Thus, the output of NOR 102 is high for either one of two cases: F1 and the output of NOR 100 both high, or F1 and the output of NOR 100 both low. The other two cases, where these two are one high and one low, result in the output of NOR 102 being low. Thus the output of NOR 102 indicates either correspondence of the two digits, by being high, or indicates that the two digits are opposite, by being low.

This entire circuit, consisting of NORs 100, 101, 102 and 103, diodes D17 and D18, and resistor R43, is labeled 104 in FIG. 14. A similar circuit 105 is used for the next digit. Similarly, its output is high if the digit f2 is the same as the corresponding digit representing this car's advanced digital position, and its output is low if these digits are opposite.

Similar circuits 106, 107 and 108 are used for the remaining three digits. The outputs of these five circuits are connected to five of the six inputs of NOR 109. The other input is connected to nM1. Thus, if all of these inputs are high, it is an indication that all five digits correspond during the ascending scan when nM1 is high, and thus the output of NOR 109 becomes low only when straight parity is experienced by this car. This output connects to output terminal nSQ which is normally high, but which goes low to indicate straight parity.

Similarly, the same five outputs plus nM1 are connected through diodes D19, D20, D21, D22, D23 and D24 to resistor R44 so that it is only when all of these are negative that the base of transistor Q12 is low. This occurs only during descending parity when all digits are opposite and nM1 is low. Transistor Q12 operates as an emitter follower, and it causes terminal nRQ to be normally high and to become low to indicate reverse parity.

Diodes D25 and D26 cause output terminal nQ to be normally high, but to become low during both straight parity and reverse parity.

SECONDARY SCANNER

FIG. 15 shows the circuit for the secondary scanner. Its main purpose is to extract information from the digits of the secondary scan and distribute this information to all the cars so that there is not a duplication of equipment because of each car creating this information itself from the secondary scan digits. It is desirable to have an indication of whether the secondary scan is resting at the binary number 011,100, as it does during the main scan, or whether the main scan has been stopped and the secondary scan is at one of the other 35 steps. The former condition is called the main scan, and output terminal MS of the secondary scanner is arranged to be high to indicate this. Referring back to table 4, it can be seen that this condition is entirely represented by the digits i1, i2 and s1

being all 0. This condition exists on none of the other 35 steps. Thus NOR 129 has its three inputs connected to $n11$, $n12$ and the output of NOR 131 which inverts input $S1$. Therefore, the output of NOR 129 becomes low during the main scan, and this signal, when amplified and inverted by NOR 130, creates signal MS . NOR 116 inverts signal MS to create nMS which of course is low during the main scan, and which is needed on the availability cards for each car. Signal MS is required in many places, including the steering circuit which was described earlier.

The third step of the secondary scan, where digit $i1$ is 0 and digit $i2$ is 1, has been reversed for cancellation, as shown in table 4. Output ICN is used to indicate to all cars that this is the step of the secondary scan during which cancellation may be done. It can be seen from table 4 that this step can be completely identified by the digits $i1$, $i2$ and $s1$, and thus NOR 127 is connected to $n11$, $i2$ and the output of NOR 131; it also has an input connected to BP so that the output of NOR 127 is normally high and goes low only for the duration of the B pulse at the correct step of the secondary scan. NOR 128 inverts and amplifies this signal to create output ICN which is required on the master cards for each car.

Similarly, NOR 125 is connected to BP , $i1$, $i2$ and the output of NOR 131 so that its output can be amplified and inverted by NOR 126 to create output IRH which is normally low and which goes high only during the B pulse of the fourth step of the secondary scan. This output is required also on the master cards for each car, as an indication of the correct part of the secondary scan where the HHM memory may be set.

The outputs IR , $IV1$, $IV2$ and IRE are created in a likewise manner by NORs 123 and 124, 121 and 122, 119 and 120 and 117 and 118 respectively. In each case, the signal is created by a four-input NOR feeding a second NOR for amplification and inversion. In each case, BP is one of the inputs so that these outputs are high only during the B pulse; also, in each case, $S1$ is an input so that these inputs can be high only during the second part of the secondary scan when the digit $s1$ is 1. The remaining two inputs are connected to either $i1$ or $n11$ and to either $i2$ or $n12$ as required to cause the appropriate output to be high at the correct time to indicate the four different instructions to each car. Output IR is connected to the master card for each car to indicate the correct time for each car to read the condition of its counter provided that the car is experiencing double parity. Outputs $IV1$ and $IV2$ are connected to the availability cards for each car to indicate, respectively, when it should indicate its availability as being either $AV1$ or $AV2$, but again this occurs only when a car is experiencing double parity. Output IRE is connected to the master card for each car to indicate the correct time in the secondary scan for a car to reset its counter, but again each car does so only when it is experiencing double parity.

Thus, on a secondary scan, each car receives first an indication via ICN that it may cancel the hall call represented by the main scan, then an indication via IRH that it may set its HHM memory here, and in both cases the car may do so only when it is experiencing parity. Then, each car receives instructions from IR , $IV1$, $IV2$ and IRE over and over again eight times in that order, but any one car can respond to these four instructions only once during a secondary scan, and then only if it is experiencing double parity.

As mentioned previously, the AU and AD wires together contain complete information regarding which hall calls are registered. AU does so during the descending scan, and is high during the ascending scan, and AD does so during the ascending scan, and is high during the descending scan. Resistors $R50$, $R51$, $R52$ and $R53$ and transistor $Q15$ comprise a NOR which should have somewhat different values from those shown in FIG. 36(a), and it combines the signals from AU and AD since either one of them going low causes the collector of transistor $Q15$ to be high, and AU and AD are never both low at the same time.

Transistors $Q13$ and $Q14$ are normally turned off so that wires AU and AD are allowed to become low at each step of

the scan where there is an up hall call or a down hall call respectively. When a particular car is conditioned for canceling an up hall call, it causes input nCU to be low during the allotted part of the secondary scan (when ICN is high) during that part of the descending scan when this car experiences parity. This causes transistor $Q13$ to turn on briefly, and wire AU becomes briefly high, and this results in cancellation of the up hall call at this floor as previously described in connection with the circuit for the hall call cards. Similarly, when a particular car is conditioned for canceling a down hall call, input nCD becomes briefly low, turning on transistor $Q14$, and thus wire AD is made briefly high to cancel the down hall call at this floor.

The collector of transistor $Q15$ is connected to the input of NOR 111 so that the information regarding which hall calls are registered is inverted and amplified to create output nHP which is normally high, but which becomes low each time a hall call is seen during the scan. This information is required on the availability card on each car. This signal is inverted again and amplified by NOR 112 to create output HP . This information is required on the readout card on each car.

It should be noted that nHP and HP are uninfluenced by the secondary scan, and thus they indicate the presence or absence of a hall call during the secondary scan. However, the information regarding which hall calls are registered is also required to operate the counters for each car, and for this purpose the information is wanted only during the main scan. Whenever a secondary scan occurs, the hall call, if any, at the floor represented by the main scan, must influence the counters only when the digits of the secondary scan are 011, 100 and not during the remainder of the secondary scan. Thus, NOR 113 has as inputs, HP , MS and BP . Input BP is high for a 25 microsecond period during each step of the scan, after a generous allowance of time for all of the bistable multivibrators and NORs associated with the scanning to complete any operations which commenced at the beginning of the A pulse. Thus, the output of NOR 113 becomes intermittently low to indicate the complete information regarding which hall calls are registered, but can do so only during the main scan, when MS is high, and only during the B pulse, when BP is high. The output of NOR 113 is combined with input nVP by NOR 114 whose output is then amplified by emitter follower 115 to produce output EP . Input nVP is obtained from the availability cards which have not yet been described. A diode in each availability card allows it to cause wire nVP to be low at the correct time of a secondary scan to indicate the availability of the associated car. Wire nVP can be low only during a secondary scan, and the output of NOR 113 can be low only during the main scan. Thus output EP contains the complete information regarding the availability and position of all cars, as well as complete information regarding which hall calls are registered. Wire EP is normally low, but becomes high whenever a hall call is encountered during the main scan, and whenever an available car is encountered during the secondary scan. Such pulses indicating cars can indicate the floor at which the car is available by which step of the main scan the pulse occurs at, can indicate the direction in which the car is available by whether it is the ascending or the descending scan, and can indicate whether the car's availability is 1 or 2 by occurring when outputs $IV1$ or $IV2$ respectively are high.

The principal purpose of output EP is to provide an indication to all counters of when an addition or a subtraction must be made; other inputs to the counter determine whether it is an addition of 1 or 2 or a subtraction. Output EP is, however not connected directly to the counters. It is connected instead to the master card for each car since further processing of this signal is required by each car to allow it to ignore certain hall calls, and certain cars during down-peak, or when some cars have their MG sets shut down automatically.

Input ISC is normally held high by normally open contacts of each ISR relay in parallel and there is one of these relays in each input card, arranged to be energized when the associated car is "in service." If all cars are out of service, all of these

contacts are open, and thus wire ISC is no longer held high, and resistor R45 and diodes D27 and D28 hold inputs nCU and nCD continuously low so as to cause continuous cancellation of all hall calls. This circuit then prevents registration of hall calls if there are no cars in service, as is customary with conventional systems.

FIG. 16 shows the waveforms of the principal outputs of the secondary scanners; MS, ICN, IRH, IR, IV1, IV2, and IRE. Below these are shown the three principal inputs, I1, I2 and S1 from which these outputs are derived. Output MS is high only when inputs I1, I2 and S1 are all low. The other six outputs are high only during the B pulse. Outputs ICN and IRH occur once each in the appropriate locations in the first part of the secondary scan when S1 is low. Outputs IR, IV1, IV2 and IRE become high, one after the other, eight times as shown in FIG. 21. This agrees with the circuit and description of the secondary scanner.

MASTER CARD

FIG. 17 shows the circuit for the master card, one such card being required for each car. The master card collects and processes various information in order to coordinate the various functions, such as counting, which each car must perform.

Input nRQ is obtained from the parity checker previously described, and it is low when reverse parity is experienced. NOR 132 inverts this information to create signal RQ. Similarly, input nSQ , which is low during straight parity, is inverted by NOR 134 to create signal SQ. NOR 133 has both nRQ and nSQ as inputs, and thus, its output Q is high during both straight and reverse parity. Signals RQ and SQ are high only during reverse and straight parity respectively.

The inputs to NOR 138 are S1, XC1S, XC2S and XC4S. The latter three inputs are obtained from the secondary stepper which was previously described, but the connections are different for each car. FIG. 5 shows the manner in which these connections are made in order to make the cars experience secondary parity in the correct order to suit table 5. For example, car *d* is connected to C1S, C2S and $nC4S$. Each car is connected in a different way so that only one experiences secondary parity at a time. Input S1 assures that no car can respond during the first part of a secondary scan, where the digits c1, c2 and c4 can, when scrambled, indicate any car, but where no car should respond. Thus, the output of NOR 138 is low only when the associated car experiences secondary parity. This signal is inverted and amplified by NOR 139 to create signal KQ which is therefore high only during secondary parity.

NOR 136 has inputs Q, KQ and IRE, and output nRE . These three inputs are all high only when the car is experiencing both main and secondary parity, and only when the reset instruction is received from the secondary scanner via wire IRE. Thus, the output nRE is low only when the car should reset its counter. This information is required in this form by the availability card, but is inverted by NOR 137 to create output RE which is high to indicate when the counter should be reset. This information is required in several places, but requires further processing in the extra scan control before it is suitable for the counter, since the instruction to reset is sometimes ignored by a car whose MG set is shut down automatically.

The principal input to NOR 135 is EP, obtained from the secondary scanner which was just described. Normally, the other two inputs nIG and $nIGS$ are high, and the EP signal is simply inverted to create output nEP which supplies to the counter the indication of when it should add or subtract. However, input nIG may become briefly low during down peak to instruct this car to ignore certain down hall calls, or certain cars, as will be explained later. Similarly, input $nIGS$ may become briefly low to instruct this car to ignore certain other cars whose MG sets are shut down automatically. In either case, a low input to NOR 135 causes the output nEP to remain high in spite of input EP being high.

The output nRA of NOR 140 becomes briefly low at only one point in the descending scan when this car should read the condition of its counter. This occurs when the three inputs RQ, KQ and IR are all high, when this car experiences reverse double parity and when the signal IR from the secondary scanner indicates the correct part of the secondary scan for such a reading to be taken. Similarly, NOR 141 causes its output nRB to be low when this car experiences straight double parity and when input IR is high. Outputs nRA and nRB are required by the readout card.

NORs 142 and 143 have inputs RQ, UA, and KQ, and SQ, DA and KQ, respectively, and their outputs feed NOR 144 whose output is QQ. Inputs UA and DA are obtained from the input card, not yet described. UA is high only when this car is UAV (i.e. available to go up) and DA is high only when this car is DAV. Thus, output QQ is high only during double parity, and then only if the car is UAV during reverse double parity or DAV during straight double parity. This information is required on various other cards.

Another output of the input card which is supplied to the master card is UB. It is high only when this car has its up direction of travel established, and such a car can be described as "upbound." NOR 145 inverts this signal so that its output is low only when this car is upbound. If input UB is low, the output of NOR 145 is high, and thus the output of NOR 147 is low, causing the output RH of NOR 148 to be high, at that part of the secondary scan where this car experiences straight parity during that step of the secondary scan reserved for reading the condition of the hall call memory at this floor. Input IRH indicates when this reading is to be taken. Similarly, when input UB is high, the output of NOR 146 is low, causing the output RH of NOR 148 to be high, at that part of the secondary scan where this car experiences reverse parity when input IRH is high. The result is that output RH normally becomes briefly high during straight parity, when input IRH is high, but when the car is upbound, output RH becomes briefly high during reverse parity instead.

A further output CNU from the input card is arranged to be high whenever this car is conditioned for canceling the up hall call at the same floor. This signal would normally be continuously high during slow down, while the doors are opening, and until the doors start to close. NOR 149 has CNU as an input along with RQ and ICN. Thus, when input CNU is continuously high, the output of NOR 149 becomes briefly low only during reverse parity, and only during that part of the secondary scan reserved for cancellation, as indicated by signal ICN from the secondary scanner. The output of NOR 149 is transmitted to output terminal nCU through diode D31, so that this car can force nCU to become low for cancellation purposes, and any other car can also do so, for the nCU terminals of all the master cards are connected together and also to the input terminal nCU of the secondary scanner. When the output of NOR 149 is high, diode D31 allows wire nCU to be taken low by any other car.

Similarly, the output CND of the input card is arranged to be high whenever this car is conditioned for canceling the down hall call at the same floor. NOR 150 and diode D32 are connected in a similar manner to NOR 149 and diode D31 to create output nCD which connects to the similarly marked terminal on the secondary scanner. NOR 150 causes nCD to become briefly low for cancellation only during straight parity, and only during that part of the secondary scan reserved for cancellation.

AVAILABILITY CARD

FIG. 18 shows the circuit for the availability card, one such card being required for each car. There is only one output, nVP , and the entire purpose of the availability card is to produce this output which is required mainly on the secondary scanner. Each car causes wire nVP to be briefly low at the correct points in the secondary scan to indicate its position and availability. Many inputs are required, particularly because

the availability card must alter the basic availability depending upon the relative positions of car calls with respect to hall calls.

Information regarding the basic availability is obtained from the input card via inputs $nBA1$ and $nBA2$. A car whose basic availability is 2 has $nBA2$ low; a car whose basic availability is 1 has $nBA1$ low; a car which is not available has both $nBA1$ and $nBA2$ high; it would be possible, as far as the availability card is concerned, to indicate an availability of 3 by having both $nBA1$ and $nBA2$ low, but this is not provided for in the illustrated circuit for the input card.

The actual availability is indicated by the conditions of bistable multivibrators 162 and 166. These multivibrators are set initially to a condition corresponding to the basic availability, but subtractions can be made from time to time during a scan so that when it becomes time to indicate availability on output nVP , a lesser availability may be indicated. The setting of these two multivibrators to a condition representing the basic availability occurs each time the counter is reset, and also occurs when the accumulated count on the counter becomes 0 or positive. A subtraction is performed by these two multivibrators whenever the following conditions are met:

1. a car call is seen during the scan;
2. there is no hall call at this floor;
3. the accumulated count of the counter is negative; and
4. parity has not yet occurred on this half of the scan.

It can be seen that if there are no hall calls, the accumulated count on the counter is always positive (normally 0) and thus no subtraction occurs, and the actual availability remains the same as the basic availability, regardless of the number of car calls. Similarly, if there are no car calls, no subtractions take place, regardless of the number of hall calls. It is only when a car call is seen after a hall call which this car is likely to answer (as indicated by a negative count on the counter, which may subsequently become 0 if further suitable cars are seen) that a subtraction is made. Such a car call is so located that the car must stop for this car call before it can reach the hall call, because the order in which these items are seen on the scan is the opposite order in which the car reaches them. It is then logical to reduce this car's availability by 1. However, no reduction is made for a car call for the same floor as a hall call which this car is likely to stop for, since this car call does not increase the number of stops to be made.

For example, assume that there are up hall calls registered at floors 10 and 12, and that the nearest UAV car below is up-bound at the fifth floor, and that a car call has already been placed in this car for floor 8. Then, during the ascending scan, when double parity is experienced, the counter for this car is reset to 0, and at the same time, the two bistable multivibrators are set to correspond to this car's basic availability, which will be assumed to be 2. Slightly later in the ascending scan, the car call at floor 8 will be detected but this will not change the availability for two reasons: the accumulated count is 0; and parity has already occurred on this half of the scan (i.e. the ascending half).

During the descending scan, the up hall calls at floors 12 and 10 each cause the main counter to subtract 1 so that the accumulated count is negative when the car call at floor 8 is seen. This time, all of the four previously listed requirements are met, and thus a subtraction of 1 is made by bistable multivibrators 162 and 166, so that they now show the actual availability to be 1 instead of 2. When reverse double parity is experienced, this car indicates, via wire nVP , an actual availability of 1 although its basic availability is still 2.

Thus, other cars see that only one of these two up hall calls can be handled conveniently by the UAV car, and another car, if available, will be brought into play to assist in answering these two up hall calls. Otherwise, the higher of these two calls, at floor 12, would wait longer than desirable for service while the UAV car makes two intermediate stops: at floor 8, for the car call; and at floor 10 for the up hall call.

In the preceding description, it was shown that it is necessary in the preferred system to ignore any car calls seen after

parity since this part of the scan does not truly represent the reverse order in which the various car and hall calls will be stopped for, and since the same car calls will be seen in proper order in the first part of the next half of the scan. NORs 151, 152 and 153 are used to separate each half scan into the two parts, before and after parity. NORs 152 and 153 constitute a flip-flop. The output of NOR 151 becomes briefly low at each of the 35 extra steps of the secondary scan when parity is experienced. The first such pulse sets the flip-flop to a condition where the output of NOR 153 is high, and the output of NOR 152 is low, which represents that part of the scan where car calls are not considered. The flip-flop remains in this condition until input nMP , obtained from the main stepper, becomes briefly low at the changeover from ascending to descending scans, or vice versa. Then, the output of NOR 152 becomes high, and the output of NOR 153 becomes low, NOR 151 has inputs Q, nMS and BP; input Q is high when parity occurs, and input nMS is high for the 35 extra steps of the secondary scan. This input, along with input BP assures that the flip-flop will not be set until the secondary scan has progressed to the first step.

NOR 156 has its input terminal nCP connected to a similarly named output terminal on all of the car call cards for this car. As previously described, this wire becomes briefly low whenever a car call is seen during the scan. Thus, the output of NOR 156 becomes high to indicate a car call. NORs 158 and 161 constitute an AND circuit to drive input C of the bistable multivibrator 162 high whenever all of the inputs to NOR 158 are high. This causes a subtraction to be made whenever the four requirements, stated earlier, occur. The first requirement is met by the input which is connected to the output of NOR 156, and this input is high only when a car call is seen. The second requirement is met by input nHP which is high if there is no hall call here. The third requirement is met by input nPN , which is obtained from the counter (not yet described) and which is high when the accumulated count on the counter is negative. The fourth requirement is met by the output of NOR 152 which is high for only part of each half scan, until parity occurs.

Further inputs to NOR 158 are required to make this circuit operate successfully. Input MS assures that car or hall calls are seen only once at each step of the main scan, when secondary scans occur; otherwise, inputs nCP or nHP , which indicate car and hall calls respectively throughout a secondary scan, could appear to be 36 successive car or hall calls. Also, BP is required so that a subtraction occurs only at the beginning of the B pulse, when changed conditions arising at the beginning of the A pulse have had sufficient time to stabilize at the new conditions. NOR 167 has its two inputs connected to output 2 of bistable multivibrators 162 and 166, so that when the actual availability has been reduced to 0, the output of NOR 167 is low, and is connected to an input of NOR 158, so that it prevents any further subtraction.

Output 1 of bistable multivibrator 162 is connected to input C of bistable multivibrator 166. This output, when high, is considered to be an indication that the actual availability is 1. Thus, if these multivibrators are initially set to indicate an availability of 2, output 1 of BM 162 is low, and output 1 of BM 166 is high. Then, when input C of BM 162 becomes high to indicate that a subtraction should be made, BM 162 changes its condition so that output 1 is now high, indicating an actual availability of 1, and this causes BM 166 to also change its condition so that its output 1 is now low, no longer indicating an actual availability of 2. Similarly, a second change of input C to BM 162 from low to high causes it to change once more, so that output 1 becomes low again, but this time BM 166 does not change, and both of them now have output 1 low, indicating an availability of 0, and both of them now have output 2 high, so that NOR 167 has a low output which prevents further subtraction.

NOR 155 is arranged so that its output becomes high whenever it is desired to set BMs 162 and 166 to represent the basic availability. As mentioned before, this must occur at the time

the counter is reset, as well as when the accumulated count on the counter is not negative. Input nRE , obtained from the master card, becomes low at the time the counter is reset, and thus causes the output of NOR 155 to be high at this time. NOR 154 is arranged to have its output low in order to cause the output of NOR 155 to be high when the accumulated count of the counter is positive. This is indicated by input PN from the counter (the inverse of input nPN previously mentioned) which is high when the count is 0 or positive. Input AP assures that this setting of BMs 162 and 166 occurs at the beginning of the A pulse, so that the condition of the counter, which changes at the beginning of the B pulse, has had sufficient time to stabilize before the information on input PN is used.

NORs 159 and 160 are used to set BM 162. When the output of NOR 159 is low, it sets BM 162 so that its output 1 is high, indicating a basic availability of 1. When the output of NOR 160 is low, it sets BM 162 the opposite way. Only one of these two NORs can have its output low, and then only when the output of NOR 155 is high. The one of these two outputs which is low is determined by the input $nBA1$. If it is high, indicating a basic availability of 0 (or 2), NOR 160 has its output low to set BM 162 accordingly. If $nBA1$ is low, the output of NOR 157 is high, and then it is NOR 159 which causes BM 162 to be set to indicate an availability of 1, when the output of NOR 155 is high.

A similar circuit, comprised of NORs 163, 164 and 165, causes BM 166 to be set in accordance with the condition of input $nBA2$ whenever the output of NOR 155 is high.

NORs 168 and 169 have an input QQ obtained from the master card. As previously described, QQ is positive only during double parity, and then only if the direction of the car's availability agrees with the scan, i.e. UAV during the descending scan, or DAV during the ascending scan. In addition, NOR 168 has an input connected to output 1 of BM 166, and a further input IV2 obtained from the secondary scanner. Thus, NOR 168 causes, via diode D33, output nVP to become low to indicate, at the correct part of the secondary scan, that this car has an actual availability of 2. Similarly, NOR 169 has an input connected to output 1 of BM 162, and a further input IV1 obtained from the secondary scanner. Thus NOR 169 causes, via diode D34, output nVP to become low to indicate, at the correct part of the secondary scan, that this car has an actual availability of 1. Diodes D33 and D34 allow this car, at the appropriate time, to make wire nVP low, and also allow this wire to be taken low by any other car when this car is not indicating its availability. Thus, wire nVP which connects from all the availability cards to the secondary scanner and also to the up-peak spacer, contains complete information regarding the position and availability of all available cars.

CAR COUNTER CIRCUIT

FIG. 19 shows the circuit for the counter, which is an important part of this scanning system. The counter contains six bistable multivibrators 173, 175, 177, 179, 181 and 183. Gates 174, 176, 178, 180 and 182, are connected between these bistable multivibrators to form a counter which can add and subtract. Input S1 is amplified by NORs 295 and 296 so that control 1 of each of these gates is high during the major portion of a secondary scan, when S1 is high. Input S1 is also amplified, without inversion, by emitter follower 299, and its output is further amplified and inverted by NOR 191, so that control 2 of each of these gates is high during the main scan, and, incidentally, during the first 3 steps of each secondary scan, when S1 is low. This causes the counter to add when S1 is high, since each gate then transmits a positive pulse to the next BM each time output 1 of the preceding BM changes from high to low. Conversely, the counter subtracts when input S1 is low.

BM 173 receives the incoming pulses to be counted, from gate 172. Thus, this BM represents the lowest digit of the binary number associated with the counter, BM 175 represents

the second lowest digit, and so on for the remaining BMs. In other words, BM 173 represents 1, BM 175 represents 2, BM 177 represents 4, BM 179 represents 8, BM 181 represents 16, and BM 183 represents 32, giving a total count of 64 (from 0 to 63). In each case except BM 183, output 1 of the associated BM indicates, when high, that the digit is 1, and when low, that the digit is 0. Output 2, of course, is always opposite to output 1. Outputs 1 and 2 of BM 183 have been assigned opposite duties to simplify the drafting of FIG. 19. The opposite input, 1 instead of 2, is thus used in the resetting circuit, which will be described later.

If the counter is indicating binary number 011,111 and input S1 is high, all inputs to NOR 184 are high, and thus its low output, applied to NOR 186, causes its output to be high, and this causes the output of NOR 187 to be low. This makes the control of gate 172 low so that further incoming pulses are ignored. This prevents the counter from adding above 011,111. Similarly, if the counter is indicating binary number 100,000 and input S1 is low, all inputs to NOR 190 are high, and thus its low output, applied to another input of NOR 186, causes the control of gate 172 to be low. Thus, subtraction below 100,000 is prevented.

Input nEP obtained from the master card, contains the complete information regarding hall calls and cars, such that whenever nEP becomes low, either an addition or a subtraction must take place; input S1 determines whether it is addition or subtraction which should occur. Input nEP is connected to gate 170 and to NOR 297 so that each time nEP becomes low, the output of gate 170 is briefly high and thus the output of NOR 171 is briefly low provided that the control of gate 170 is high, and also whenever input nEP becomes high again, the output of NOR 297 becomes low, and the output of one-shot 298 is thus briefly low. Diodes D35 and D36 allow either one of these two events, nEP becoming low (when control of gate 170 is high), or nEP becoming high again, to cause the input of gate 172 to be briefly low. Thus, if input T, which is connected to the control of gate 170, is high, two separate negative pulses are given to the input of gate 172 for each pulse of input nEP but if input T is low, only one pulse is given to the input of gate 172. Thus, input T determines whether the counter will add one or two.

Input nSZ is obtained from the extra scan control, and is arranged to be normally high, and to go briefly low whenever it is necessary to reset the counter to 0. This input is amplified by emitter follower 192 and applied to input 2 of all the BMs except BM 183. Input 1 is used on BM 183. When nSZ is made low, input 2 or all BMs except BM 183 is made also low, and thus output 1 is made low, so that all of these BMs represent the digit 0. BM 183 is also set to 0, but this is represented by output 2 made low rather than output 1.

The condition of BM 183 indicates whether the binary number represented by the counter is negative or not; if the number is negative, output 2 is high, and output 1 is low. Otherwise, output 1 is high and output 2 is low. These two outputs of BM 183 are amplified by NORs 188 and 189 to create outputs PN and nPN . When the binary number is 0 or positive, PN is high and nPN is low, and when the binary number is negative, PN is low and nPN is high.

A further requirement of the counter is that normally it must not add above 0. This is accomplished by NOR 185. Input nAS is normally high (and becomes low when this car's MG set is shut down automatically). When addition is called for, input S1 is high, and if the accumulated count is 0, output 1 of BM 183 is also high. Thus, all three inputs to NOR 185 are high, and thus its output is low and this has the same result as that described earlier where NOR 184 or 190 caused the output of NOR 186 to be high. Gate 172 then blocks any further attempts to add. It can now be seen why it is desirable to use a two-pulse circuit to add 2 rather than to feed into BM 175 (which would appear simpler) since the attempted addition of 2 from an initial count of 111,111 must result in an actual addition of 1. The two-pulse circuit gives two separate add pulses, and the second of these two pulses is simply ignored under the circumstances just described.

READOUT CARD

FIG. 20 shows the circuit for the readout card, one such card being required for each car. The principal purpose of the readout card is to contain the HAM, HBM and HHM memories. In addition, several other important outputs are readily obtainable from information already available on this card. NORs 199 and 200 comprise a flip-flop which acts as the HAM memory. Similarly, NORs 201 and 202 comprise a flip-flop which acts as the HBM memory.

Input nRA is obtained from the master card, and is arranged to become low whenever the condition of the counter is to be transferred to the HAM memory. NOR 193 inverts this signal to create output RA which is required on the spacing readout card, and it also connects to inputs of NORs 195 and 196. Similarly, input nRB is inverted by NOR 194 to create output RB which is high whenever the condition of the counter is to be transferred to the HBM memory. This output is also required on the spacing readout card, and it connects to inputs of NORs 197 and 198.

Input RR is obtained from the extra scan control, which has not yet been described. RR is normally high, but may be occasionally low during automatic shut down when it is desired to have such a car omit reading the counter in order to accomplish the special scanning already described. RR connects to one input of NORs 195, 196, 197 and 198. Obviously, if RR is low, the outputs of these four NORs are all high and no change in the HAM or HBM memories can take place.

Inputs nPN and PN are obtained from the counter which was just described and are connected to NORs 195 and 198, and 196 and 197 respectively. Thus, when RA is high to indicate that the HAM memory is to be set, either NOR 195 or NOR 196 has its output low, depending upon whether nPN or PN is high, and this causes the flip-flop, comprised of NORs 199 and 200, to be set accordingly. Of course, in many cases, the flip-flop is already set to that condition, and no change actually occurs. The output of NOR 199 feeds relay driver 203 whose output terminal nHA is low to indicate that there is a hall call above that this car should answer. Output nHA is connected to the coil of relay $NHAR$ which is located on the output card, which has not yet been described.

The HBM memory can be similarly set by NORs 197 and 198 when RB is high, and again, inputs nPN and PN determine which of NORs 197 and 198 has a low output. The output of NOR 202 feeds a relay driver 204 whose output nHB is low to indicate that there is a hall call below which this car should take. Output nHB is connected to the coil of relay $NHBR$ which is also located on the output card.

The HHM memory consists of NORs 212 and 213. These two NORs are connected to form a flip-flop which can be set to either of its two conditions by either NOR 210 or NOR 211 having a momentarily low output. However, as long as no direction of travel is established, both inputs UB and DB are low, and this allows resistor $R55$ to turn on the transistor in NOR 213 so that the flip-flop is held in the condition representing no hall call at this floor regardless of NOR 210. If either the up or down direction of travel is established, either UB or DB is high, and this prevents resistor $R55$ from turning on the transistor in NOR 213, because either diode $D43$ or $D44$ carries current through resistor $R55$ to make the corresponding input to NOR 213 high, and this allows the flip-flop to be set to either condition when input RH is high. The reason for holding this memory in one condition when no direction of travel is established was described earlier. This allows other circuits to choose which of several cars shall respond to a hall call at the same floor, so that only the car so chosen has a direction of travel established, and thus only this car sets its HHM memory and opens its doors. The output of NOR 213 feeds relay driver 214 so that its output HH is normally low, but becomes high when there is a hall call corresponding in direction to the established direction of travel, and at the same floor where this car is. Output HH is connected to the coil of relay HHR which is located in the output card.

Input HP , from the secondary scanner, contains complete information regarding which hall calls are registered. Input nHP contains the same information in inverted form. Input RH , from the master card, is arranged to be briefly high at the correct part of a normal scan in order to read whether or not there is an up hall call (if RH high during the descending scan) or a down hall call (if RH high during the ascending scan) at the floor where the car is. Thus, the condition of inputs HP and nHP is transferred to the HHM memory when input RH is high. If HP is high when RH is briefly high, both inputs to NOR 210 are high, and its output becomes briefly low to set the flip-flop to the condition where the output of NOR 212 is high, indicating a hall call here. Otherwise, nHP is high when RH is briefly high, and NOR 211 has a briefly low output to set the flip-flop the other way.

The presence of inputs nRA and nRB on the readout card makes it convenient to locate the flip-flop, which divides the scan into the above and below parts for this car, on the readout card. NORs 205 and 206 comprise this flip-flop. During straight double parity, when nRB becomes briefly low, the flip-flop is set so that the output SA of NOR 206 is high, and the output SB of NOR 205 is low, indicating that it is now the above part of the scan. Similarly, during reverse double parity, when input nRA becomes briefly low it sets the flip-flop to the opposite condition so that output SB of NOR 205 is now high, and SA is low, indicating that it is now the below part of the scan. The flip-flop serves as a memory to retain this information between the periods of double parity.

It is also convenient to locate four further NORs on the readout card to create signal T which is required on the counter. Normally, the output of NOR 209 is the inverse of input $I2$, and the output T of NOR 294 is the same as $I2$. Thus, T is high, indicating that the counter must add 2 instead of 1, whenever the digit $i2$ of the secondary scan is 1. In table 4, the only steps of the secondary scan at which the counters add or subtract are indicated by asterisks at the left. It can be seen that the digit $i2$ is 0 at all of these asterisks except those indicating steps where cars are indicating an availability of 2. Thus, the output T is automatically correct to cause subtraction of 1 for hall calls, and to cause addition of either 1 or 2 to suit the availability of cars. Of course, the information indicating whether it is subtraction or addition which is needed, is obtained separately from output $S1$ of the secondary scanner.

It was previously described how the indicated availability of other cars must be pessimistically interpreted as 1 instead of 2 by cars which already have a direction of travel established. This pessimism must only apply to the above part of the scan for upbound cars, or to the below part of the scan for downbound cars. Also, this pessimism applies only when there are no hall calls which this car could answer, in the opposite direction to which it is travelling. This is accomplished by NORs 207 and 208. When the car is downbound, with no hall calls above which it should answer, the output of NOR 200 is high and input DB to NOR 207 is also high. Thus, during the below part of the scan, SB is high so that all three inputs to NOR 207 are high, and thus its output is low causing the output of NOR 209 to be high and the output T of NOR 294 to be low regardless of the condition of input $I2$. This causes the counter to be incapable of adding 2, so that the previously described pessimism is obtained during the below part of the scan.

Similarly, when the car is upbound, with no hall calls below which it should answer, the output of NOR 208 is low during the above part of the scan, and this similarly forces the output of NOR 209 to be high, and output T to be low.

SPACING READOUT CARD

FIG. 21 shows the circuit for the spacing readout card, one such card being required for each car. The spacing readout card contains two memories very similar in operation to the HAM and HBM memories, except that these are used to provide continuous indications of when a car should travel up or

down for spacing purposes. The actual information regarding spacing is available only intermittently on inputs nPK and PK which are somewhat similar to inputs nPN and PN on the readout card.

Inputs nPK and PK are obtained from the spacer, which has not yet been described. They are arranged so that PK is high during the ascending scan to indicate that a car should travel down for spacing reasons, and so that PK is high during the descending scan to indicate that a car should travel up for spacing reasons. Input nPK is always the inverse of PK . The condition of inputs nPK and PK indicates whether or not a car should move for spacing purposes only during that part of double parity where either inputs RA or RB , obtained from the previously described readout card, are high. Thus, for example, if two cars happen to be at the same floor, and one of them is to be moved for spacing purposes, the PK input would be high until the first of these two cars has completed the four steps of the secondary scan allotted to it, and then PK would become low so that the other car would not be instructed to move.

During reverse double parity, when RA becomes briefly high, the output of either NOR 215 or 216 becomes briefly low, depending on which of PK and nPK is high, and this sets the flip-flop consisting of NORs 217 and 218 to the appropriate condition. The output of NOR 217 is connected to the input of relay driver 219, so that its output PA is high to indicate that the car must travel up for spacing reasons.

A similar circuit consisting of NORs 220, 221, 222 and 223, and relay driver 224 creates output PB which is high to indicate that the car must go down for spacing purposes. Outputs PA and PB are connected to the coils of relays PAR and PBR in the output card.

The spacing readout card also contains NOR 225 and diode D45; their purpose is to create output nKP which is somewhat similar to nVP , and which is required for the spacer which has not yet been described. Basically, nKP is normally high, but becomes briefly low at two points of the normal scan, once during straight double parity, and once during reverse double parity. It is only during the last of the four steps of double parity, when input RE (from the master card) is high, that the output of NOR 225 is low. Also, the car must be available, as indicated by input AVA (from the input card) being high, and the car must not have its MG set shutdown automatically, as indicated by input nAS (from the extra scan control) being high. The diode D45 allows NOR 225 to cause wire nKP , which is connected between the spacing readout cards for all cars and the spacer, to become low, but when the output of NOR 225 is high, the diode allows other cars to cause nKP to be low. Thus, the wire nKP contains complete information regarding the positions of all cars suitable for spacing purposes. The position is seen both during the ascending and descending parts of the normal scan, but no distinction is made between upbound and downbound cars. In order to be suitable for spacing purposes, a car must not have its MG set automatically shut down.

CAR SELECTION CIRCUITS

FIG. 22 shows the circuit for the next readout card, one such card being required for each car. FIG. 23 shows the circuit for the "next" stepper, and only one of these is required for the entire bank of elevators. The purpose of the "next" stepper and the "next" readout cards is to produce circuitry for choosing the "next up" car at the main floor.

The next stepper contains bistable multivibrators 242, 246 and 250 connected as a counter. If the output of NOR 237 is high, input AP is inverted by NOR 240 and inverted again by NOR 241 so that BM 242 changes its condition at the beginning of each A pulse. Thus, the three BMs can be stepped rapidly through the eight different conditions represented by three binary digits. Each one of these eight conditions is used to represent which car, of a maximum of eight, is the next car up. It is realized that there is frequently

no next up car at the main floor, but it is not necessary to assign a particular condition of the BMs for this purpose. It is advantageous to hold the previous condition when there is no next up car.

The basic operation of the next stepper is that whenever there is one or more cars suitable for dispatch at the main floor, the counter consisting of the three BMs is stepped rapidly until its condition coincides with one of these suitable cars. It then stops at this condition, and remains there as long as this car remains suitable at the main floor. When this car becomes unsuitable, generally due to this car being dispatched away from the main floor, the counter remains at its previous condition unless there is some other suitable car at the main floor. Then, the counter steps until its condition coincides with the new car.

Output 1, of BM 242 is amplified by NORs 243 and 244 to create output $N1$. This is again inverted and amplified by NOR 245 to create output $nN1$. Similarly, output 1 of BM 246 is amplified by NORs 247 and 248 to create output $N2$, which is further amplified and inverted to create $nN2$. Similarly, NORs 251, 252 and 253 create outputs $N4$ and $nN4$ which represent the condition of BM 250. These six outputs are required by the scrambler, which will be described next, and they also connect to the next readout cards, but in a different way for each car. FIG. 6 shows the manner in which these connections are made, and it will be seen that it is similar to the connections shown in FIG. 5 for connecting each master card in a different way to the secondary stepper. This causes each car, on its "next" readout card, to respond to a particular binary number, the same binary number to which this car responds on the master card. Table 5, shows how digits $n1$, $n2$ and $n4$ are used in this way to represent which car is next up. The digit $n1$ is represented by BM 242, digit $n2$ is represented by BM 246, and digit $n4$ is represented by BM 250. Thus, output $N1$ is high to indicate that digit $n1$ is 1, and output $nN1$ is high to indicate that digit $n1$ is 0. A similar relationship exists for the other two digits.

Referring now to FIG. 22, input AVM is obtained from the input card, and is arranged to be high when this car is at the main floor, and suitable for being a next up car. Another input GO , also obtained from the input card, is arranged to be high if this car has its door open at the main floor. Any car which is both suitable for becoming a next up car, and has its doors open, causes the output of NOR 226 to be low and thus diode D46 causes output $nAVO$ to also be low. This output terminal connects to similar output terminals on the next readout cards for all other cars, and to a similarly marked input terminal on the next stepper in FIG. 23. This signal is then amplified by NORs 238 and 239 to create output $nAVOA$ which connects to a similarly marked input terminal on each of the next readout cards. This causes the output of NOR 227 on all cars to be high. The purpose served by input GO , and by NORs 227, 238 and 239, will be apparent later.

Generally, however, AVM being high on any car results in output $nAVM$ being low, either through NOR 226 and diode D47, if this car has its doors open, or through NOR 227 and diode D48, if this car does not have its doors open, and no other suitable car at the main floor has its doors open. Output $nAVM$ connects between all of the next readout cards and a similarly marked input terminal to the next stepper, to NOR 232. Thus, when input AVM is high on any car, $nAVM$ becomes low, and the output of NOR 232 becomes high, and, assuming input $nSNS$ to be free to go high, diode D50 allows NOR 233 to have a high input so that its output is low. This causes the output of NOR 235 to become either immediately low, if input BP is high, or to become low at the commencement of the next B pulse. This sets the flip-flop consisting of NORs 236 and 237 so that the output of NOR 237 is high. This allows the A pulses to be transmitted to NOR 240, as previously described, to step the counter rapidly through its binary numbers.

This sequence of events was caused by AVM being high on one or more cars, and the output of either NORs 226 or 227

on at least one of these cars is low, and thus the output of NOR 228 is high on at least one car. Therefore, the counter will eventually reach such a count that it causes inputs XN1, XN2 and XN4 to be simultaneously high along with the output of NOR 228 on one of the cars, so that the output of NOR 230 on that car becomes low. This causes diode D49 to force output $\bar{n}SNS$ low, and this results in either an immediate change in the flip-flop consisting of NORs 236 and 237, if input BP is already high, or results in such a change at the commencement of the next B pulse. This is done via NOR 234; the output of NOR 233 is now high because $\bar{n}SNS$ is now low.

The operation of NORs 232 to 237 in FIG. 23 has now been illustrated. Their purpose is to start and stop the counter in accordance with commands from the next readout cards. As long as the three BMs represent a car which is suitable for being next up car, input $\bar{n}SNS$ is low and this causes the counter to be stopped, or prevents it from starting. Also, when there is no suitable car, $\bar{n}AVM$ is high, and its output keeps $\bar{n}SNS$ low, through diode D50, to keep the counter stopped. Otherwise, the counter operates, stepping at the beginning of each A pulse. The flip-flop consisting of NORs 236 and 237 is provided so that after each step of the counter, which occurs at the commencement of the A pulse, conditions are given a chance to stabilize before the B pulse can change the flip-flop.

The operation of NORs 226, 227 and 228 has been partially illustrated. Their operation can be better understood by assuming that input GO is always low on all cars. The selection of the next up car is then similar to conventional systems. Output $\bar{n}AVO$ is then always high, and thus $\bar{n}AVOA$ is always high. Therefore, whenever $\bar{AVM}$ is high, the output of NOR 227 is low, and the output of NOR 228 is high. Diode D48 then causes $\bar{n}AVM$ to be low so that the counter is started, and NOR 230 causes $\bar{n}SNS$ to become low to stop the counter at the correct step. Thus, the arrival of the first suitable car at the main floor causes its $\bar{AVM}$ input to become high, and the counter, if not already representing this car, steps until it does. When this car is dispatched, the counter will either remain at its previous condition, if there is no other suitable car at the main floor, or it will step again, in a similar manner, until it reaches a condition representing one of the suitable cars at the main floor.

The purpose of input GO, and of NORs 226, 238 and 239 is to give preference, in the selection of a next up car, to a car which already has its doors open. Such a car has its input GO high, so that NOR 226 and diode D46 make $\bar{n}AVO$ low, and thus $\bar{n}AVOA$ is low for all cars, including this one, and thus the output of NOR 227 is high on all cars. This means that the only cars which can stop the counter are those with input GO high because they are the only ones which can have the output of NOR 228 high. Normally, when this happens, there is only one suitable car with its doors open.

This feature is desirable since, at the time it is necessary to choose a new next up car, there is frequently another car at the main floor with its doors closed, suitable for becoming the new next up car, and there is sometimes a further car which has just arrived at the main floor and has its doors open to discharge passengers. Previous systems would allow selection of the car with its doors closed, and this causes confusion to passengers in the lobby. Frequently they enter the wrong car, without noticing which car has its up hall lantern illuminated. With my system, the car with its doors already open is always chosen in preference to the car with its doors closed. Also, it is desirable to arrange each car so that if someone enters this car when it is at the main floor, but is not the next up car, and registers a car call, the doors of this car are automatically held in the open position; otherwise, the passengers are in a car with its doors closed, which cannot start because it has not been selected as the next up car. My system then gives preference to any such car when it is time to choose a new next up car.

In FIG. 22, inputs XN1, XN2 and XN4 also connect to NOR 229 whose output feeds relay driver 231 to create output signal NS which is high when this car has been selected as the next up car. This output connects to the coil of relay NSR

located in the output card. This relay may, of course, remain energized after this car has left the main floor, if there is no other car there to be chosen. Also, relay NSR for any car can be very briefly energized as the counter passes this car in its search for a suitable car. This brief period of energization is insufficient to operate the relay.

DIGIT SCRAMBLER

FIG. 24 shows the circuit for the scrambler, one scrambler being sufficient for the entire bank. The purpose of the scrambler is to operate outputs X1, X2 and X4, which are required on the secondary stepper to accomplish the scrambling of digits c1, c2 and c4 of the secondary scan, as described earlier in connection with table 5. Input 3SH is obtained from output SH of the hall call card for floor 3, which is assumed to be the main floor. This input is normally low, but becomes high when the main scan is representing floor 3. This occurs once on each ascending scan, and once on each descending scan.

The operation of the scrambler will first be described for the case where input 3SH is low. Then, the outputs of NORs 254 and 255 are high, and thus the outputs of NORs 256 and 258 are low, and the output of NOR 257 is determined directly by input M1. Thus, the outputs of NORs 259, 260, 262, 263, 265 and 266, are all high. Therefore, the outputs X1, X2 and X4 of NORs 261, 264 and 267 are the inverse of the output of NOR 257, and are thus the same as M1. Therefore, during the ascending scan when M1 is low, X1, X2 and X4 are all low, and this causes no inversion so that the order of scanning through the cars is in alphabetical order, as shown in the upper part of column CM 2 in table 5. Similarly, during the descending scan when M1 is high, X1, X2 and X4 are all high, and this causes inversion of all three of the digits c1, c2 and c4, so that the order of scanning through the cars is reverse alphabetical order, as shown in the lower half of column CM2 in table 5.

The operation of the scrambler will now be described for the case where input 3SH is high. This establishes the revised scanning order at the main floor. During the ascending scan, NOR 254 has its output low since both 3SH and $\bar{n}M1$ are high. NORs 257 and 255 have a high output since M1 is low. Therefore, the outputs of NORs 256 and 258 are high, and low respectively. This causes the outputs of NORs 260, 263 and 266 to be all high. Thus, the lower two inputs of NORs 261, 264 and 267 are all high, and therefore, outputs X1, X2 and X4 are determined entirely by the remaining inputs which are controlled by NORs 259, 262 and 265. These, in turn, are controlled directly by inputs $\bar{n}N1$, $\bar{n}N2$ and $\bar{n}N4$, since the upper input of NORs 259, 262 and 265 are already high because the output of NOR 256 is high. Therefore, output X1 is the same as input $\bar{n}N1$, output X2 is the same as input $\bar{n}N2$, and output X4 is the same as input $\bar{n}N4$. This causes inversion of only those digits corresponding to the digit 0 in the binary number representing which car is next up, as shown in the upper half of columns CM3 to CM10 in table 5.

During the descending scan, when 3SH is high, the outputs of NORs 254 and 255 are the opposite to what they were previously, since 3SH and M1 are now both high to cause the output of NOR 255 to be low, and the output of NOR 254 is now high because $\bar{n}M1$ is now low. The output of NOR 257, however, remains unchanged from what it was in the preceding description, since one of its inputs, the one obtained from NOR 255, is low. Now, the output of NOR 256 is low so that the outputs of NORs 259, 262 and 265 are now high, as is the output of NOR 258. Therefore, the outputs X1, X2 and X4 are determined by the lower input to NORs 261, 264 and 267, and these, in turn, are controlled by inputs N1, N2 and N4, so that now output X1 corresponds with input N1, output X2 corresponds with input N2, and output X4 corresponds with input N4. This causes inversion of only those digits corresponding to digit 1 in the binary number representing which car is next up, as shown in the lower half of columns CM3 to CM10 in table 5.

EXTRA STEPPER FOR MG SHUT-DOWN

FIG. 25 shows the circuit for the extra stepper. Its purpose is to create the two extra digits $m2$ and $m4$ which are, in effect, an extension of the main scan. This allows a differentiation to be made between three successive normal scans, to allow for the special scanning required by AS cars. One extra stepper is sufficient for the entire bank, and it works in conjunction with the extra scan control cards for each car.

The output $nM1$ of the main stepper is connected to input $nM1$ of the extra stepper, and this is used to drive input C of BM 269. Output 2 of BM 269 is connected to input C of BM 270 via wire $nM2$, so that BM 269 represents the digit $m2$, and BM 270 represents the digit $m4$. When output 1 of BM 270 is high, it indicates that digit $m4$ is 1. Output 1 of BM 270 is connected to one-shot 271 via wire $m4$, so that each time the digit $m4$ goes from 1 to 0, the output of one-shot 271 becomes momentarily low. This causes input 1 of BM 269 to set it to the condition indicating that digit $m2$ is 1 rather than 0, as it would otherwise have been. This causes the extra scan to skip one of its four possible conditions to achieve the sequence shown in table 2.

It is convenient to label these three successive normal scans, which together constitute a complete scan, as X, Y and Z, as shown in table 2. Thus, the X scan is a normal scan, identified by the digit $m4$ being 0. The following normal scan is a Y scan, identified by the digit $m2$ being 0. Finally, the next normal scan is a Z scan, identified by both the digits $m2$ and $m4$ being 1. Each of these is, of course, further subdivided by the digit $m1$ into ascending and descending parts.

It is also convenient to divide a complete scan into two parts:

Part 1. the part where conditions are assessed in order to determine when a car must go up, for hall calls above.

This consists of the descending half of the Z scan, and both halves of the X scan; and

Part 2. the part where conditions are assessed in order to determine when a car must go down, for hall calls below.

This consists of both halves of the Y scan, and the ascending half of the Z scan. A flip-flop consisting of NORs 279 and 280 is used to distinguish between these two parts. The commencement of part 1 is recognized by the digits $m1$ and $m2$ both becoming high, and NOR 278 then has its output low so that the flip-flop is set to a condition where the output of NOR 279 is high. Output 1 of BM 269 is called $M2$ since it is high when the digit $m2$ is 1. Wire $nM2$ remains low during all of part 1, and thus NOR 550 has its output high, and NOR 280 remains with its output low. During the descending half of the X scan, $M1$ and $M2$ are again both high, and NOR 278 again attempts to set the flip-flop, but now it is already set to that condition.

At the end of part 1, the digit $m2$ becomes 0, and thus wire $nM2$ becomes high, and also wire $M4$ becomes high because digit $m4$ becomes 1; thus the output of NOR 550 becomes low, and this causes the flip-flop to revert to the opposite condition, so that now the output of NOR 280 is high, and the output of NOR 279 is low. This condition is remembered by the flip-flop throughout part 2 in spite of wire $M2$ becoming high during the ascending Z scan. Thus, the outputs of NORs 279 and 280 indicate at all times whether it is part 1 or part 2 of the complete scan. The output of NOR 279 is high for part 1, and the output of NOR 280 is high for part 2.

The purpose of NOR 550 is to ignore the brief, unstable step when all the digits $m1$, $m2$ and $m4$ are zero. This lasts for only a very brief time until one-shot 271 sets BM 269 to indicate 1 rather than 0. During this time, wire $nM2$ may be briefly high (and wire $M2$ briefly low) but wire $M4$ is low, and thus the output of NOR 550 remains high. If NOR 550 were not used, wire $M2$ would be used as the bottom input to NOR 280, but its brief negative pulse would falsely set the flip-flop 279 and 280 prematurely, before part 1 is finished.

There are only two parts of the complete scan where an AS car should read its counter, i.e., during the descending X scan and during the ascending Z scan. The first of these is identified entirely by the digit $m1$ being 1 and the digit $m4$ being 0. NOR 274 recognizes this condition since it has $M1$ and $nM4$ as inputs, its output being low at this time. The second of these two is identified entirely by the digit $m2$ being 1 during part two of the complete scan. NOR 268 recognizes this condition since its inputs are $M2$ and the output of NOR 280, its output being low at this time. Thus, NOR 272 has its output high during each of these two reading periods since its inputs are obtained from NORs 268 and 274. NOR 273 inverts and amplifies this signal to create output nRR which is normally high, but which becomes low during the descending X scan and during the ascending Z scan. This information is required on the secondary scan control for each car.

Similarly, there are two points in a complete scan where an AS car must ignore the resetting instructions if the output of its counter is 0 or positive. This occurs during the ascending X scan and during the descending Y scan. The first of these two periods is completely identified by the digit $m1$ being 0 in part one of the complete scan. NOR 277 recognizes this condition since its inputs are $nM1$ and the output of NOR 279. The second of these two periods is completely identified by the digit $m1$ being 1 in part two. NOR 275 recognizes this condition since its inputs are $M1$ and the output of NOR 280. In either case, the output of NOR 276 becomes high, so that output RO is normally low, but becomes high during the ascending X scan and during the descending Y scan. This information is also required on the extra scan control for each car.

Input $nQQS$ to NOR 549 is obtained from the extra scan controls, and is arranged to be low whenever the QQ wire is high on an AS car. Such a car is generally ignored by non-AS cars, and by some AS cars, and the output QQS is obtained by inverting and amplifying $nQQS$, and is fed to all cars so that they know which cars are AS and which cars are non-AS. It should be noted here that AS cars continue to indicate their availability in the normal manner, and it is signal QQS which enables cars, particularly non-AS cars, to properly distinguish available AS cars from available non-AS cars.

Signal QQS is combined with the output of NOR 279, in NOR 281, and this is inverted and amplified by NOR 282 to create output IGB. It is normally low, but becomes high whenever an AS car is seen in part 1 of the complete scan. Similarly, the output of NOR 280 is combined with signal QQS in NOR 539, and this inverted and amplified by NOR 540 to create signal IGA which is normally low, but which becomes high whenever an AS car is seen in part two. These two outputs are also required on the extra scan controls which will now be described.

EXTRA SCAN CONTROL

FIG. 26 shows the circuit for the extra scan control, one of these being required for each car. Input AS is obtained from the input card, and it is normally low, but becomes high when the MG set is shut down automatically. Thus, the output RR of NOR 283 is normally high, but when AS is high during automatic shutdown, output RR is determined by input nRR . As previously described, nRR becomes low only at those parts of the complete scan where the counter should be read. Thus, output RR becomes high only during the descending X scan and the ascending Z scan. At all other times RR is low, and this signal prevents the readout cards from taking a reading.

Similarly, the output of NOR 284 is normally high, since AS is low, and thus output nSZ of NOR 285 is determined by input RE, so that when the master card makes RE high, nSZ becomes low to cause the counter to be reset. However, when AS is high, this resetting of the counter is prevented if both inputs RO and PN are high since all inputs to NOR 284 are high, and its low output holds nSZ high regardless of the condition of RE. As previously described, input RO is high during the ascending X scan and during the descending Y scan. It is then

that resetting of the counter must be prevented provided that the output of the counter is 0 or positive. Input PN provides this information.

NOR 292 combines the information from wires QQ (from the master card) and AS so that its output is low if this car is AS, during that period when this car is indicating its availability. A diode D51 in each extra scan control combines the outputs of the NORs 292 so that output nQQS, which connects all of the extra scan controls (one for each car) to the extra stepper, meets the requirements already described for input nQQS on the extra stepper.

NOR 286 inverts the AS input to provide signal nAS which is needed on this card as well as in the counter and in the spacing readout card.

NOR 291 has inputs QQS and nAS so that its output is low if this car is a non-AS car, whenever an AS car is indicating its availability. When this occurs, diode D92 causes output nIGS. to be low, and it is an input to NOR 135 on the master card, so that nEP then remains high in spite of input EP being high to indicate the availability of this AS car, and thus this non-AS car does not perform an addition on its counter for this AS car.

NOR 290 is also capable, via diode D91, of causing output nIGS. to become low in order to ignore an AS car. This occurs only when this car is AS, and can occur for three different possibilities, each represented by a different input to NOR 289. For example, if input nPN is low, representing a positive count on the counter, the output of NOR 289 is high so that if QQS is also high, the output of NOR 290 is low and the corresponding AS car is ignored by this AS car. Similarly, if input IGB from the extra stepper is high during the below part of the scan when SB is also high the output of NOR 287 is low, and this results in a different input of NOR 289 being low, so that again, an AS car will be ignored by this AS car. As previously described, IGB is high only when an AS car is encountered during part 1 of the complete scan. Also, if input IGA is high during the above part of the scan when SA is also high, the output of NOR 288 is low, and this again results in NOR 289 having a low input, so that this AS car ignores the other AS car.

The circuit in FIG. 26 thus provides for all of the requirements of the special scanning described earlier, which is needed to handle situations where one or more cars have their MG sets shutdown automatically. The results of such modified scanning have already been described.

CAR SPACING CONTROL CIRCUITS

FIG. 27 shows the circuit for the spacer. The spacing readout cards have already been described, and the chief purpose of the spacer is to provide outputs PK and nPK for the spacing readout cards, to accomplish the method of spacing the cars, which was described earlier. Basically, the spacer counts the total number of suitable cars during the descending scan, and it determines the number of suitable cars in each region during the ascending scan. From this, it determines which cars should be moved, if necessary, and in which direction, to achieve a reasonable distribution of cars.

Output nKP from the spacing readout card is connected to input nKP on the spacer. As previously described, it is normally high, but becomes briefly low whenever a suitable car is seen during either the descending scan or the ascending scan. A car is not suitable if its MG set is shutdown. NOR 300 inverts input nKP to create output KP which is required on the up-peak spacer.

A two digit counter consisting of BMs 304 and 305 is used to count the number of cars for spacing purposes. It is only necessary to know whether the number of suitable cars, either the total number, or the number in a region, is one or more, or two or more. Obviously, if it is not one or more, it is zero, and if it is one or more, but not two or more, it is one. Thus, these two bits of information provide for three recognizable cases: 0, 1, or 2 or more. Two BMs, inherently capable of counting

from 0 to 3, are thus sufficient for this counting. NOR 302 has two inputs, obtained from output 2 of BMs 304 and 305. Thus, its output is low to indicate 0 cars. NOR 303 amplifies and inverts this signal to create signal n1M which is high to indicate 0 cars, and is low to indicate a count of one or more. This signal is inverted again by NOR 301 to create signal 1M which is high to indicate a count of 1 or more.

Output 1 of BM 305 is high to indicate a count of 2 or more. This is inverted by NOR 307 to create signal n2M which is low to indicate a count of 2 or more. NOR 308 inverts this signal again to create signal 2M which, like output 1 of BM 305, is high to indicate a count of 2 or more. Thus, NORs 301, 302, 303, 307 and 308 convert the count information on BMs 304 and 305 into signals 1M, n1M, 2M and n2M which are required elsewhere on the spacing card.

Output 2 of BM 305 is also connected to one input of NOR 306. Initially, it is high and thus signal nKP, which is the other input to NOR 306, is inverted by NOR 306 and fed to input C of BM 304. Thus, each time a suitable car is seen during the scan, nKP becomes low and input C to BM 304 becomes high so that the counter consisting of BMs 304 and 305 adds one. However, when the count reaches two, output 2 of BM 305 becomes low, and thus the output of NOR 306 is held high regardless of the condition of input nKP. Thus, no further counting can occur until the counter is reset.

The output of NOR 309 is normally high, but is made momentarily low whenever it is desired to reset the BMs to the condition representing 0. This, of course, is done through input 2 on each BM. Input BP connects to one-shot 310 which feeds NOR 311, and its output, which is one of the inputs to NOR 309, is briefly high at the end of a B pulse. This allows the counter to be reset only at the end of a B pulse. Also, input MS from the secondary scanner allows resetting to occur only during the main scan, and not during a secondary scan. Resetting of the counter occurs five times during a normal scan: at the beginning of the ascending scan, at the division between regions 1 and 2, at the division between regions 2 and 3, at the division between regions 3 and 4 and at the end of the ascending scan. The condition of the counter immediately prior to these five resetting operations indicates the following information: the total number of suitable cars, the number of suitable cars in region 1, the number of suitable cars in region 2, the number of suitable cars in region 3 and the number of suitable cars in region 4, respectively. Also, the number of suitable cars at or below the main floor is indicated by the count on the counter when the main scan steps to the floor immediately above the main floor. Any cars at the main floor will cause a secondary scan there, during which these cars, if suitable for spacing purposes, will be counted.

The output of NOR 322 must be high in addition to the two previously mentioned conditions in order for the output of NOR 309 to be low to reset the counter. The five inputs to NOR 322 are normally high, but one at a time they become low to cause the five resetting operations.

A circuit consisting of one-shot 324 and NORs 323 and 325 connected as a flip-flop, is used to create a brief pulse at the commencement of the ascending scan, which is applied to one of the five inputs of NOR 322. The input M1 becoming low at the commencement of the ascending scan causes the output of one-shot 324 to be briefly low, and this sets the flip-flop so that the output BOT of NOR 325 is high. This condition is retained on the flip-flop until the main scan steps to floor 2, where the digit f1 becomes 1, and then input nF1 becomes low and the flip-flop is changed so that the output nBOT of NOR 323 is now high. The result of this circuit is that nBOT is normally high, but becomes low during the first step of the ascending main scan. If a secondary scan occurs here, nBOT remains low during this entire secondary scan. This causes the output of NOR 322 to be high for a similar period of time, but the actual resetting of the counter, by NOR 309 can only occur at the end of the B pulse during the main scan, and not during the secondary scan. Thus, this circuit causes the counter to be reset at the commencement of the ascending

scan, but a short time is allowed, from the beginning of the A pulse which stepped the main stepper to 000,000, to the end of the following B pulse, during which a reading can be taken of the condition of the counter, before the resetting actually occurs.

Input 6SH to NOR 326 is obtained from the SH output of the hall call card for floor 6. This signal is high only when the main scan is at floor 6, and this occurs twice in each normal scan, once during the ascending scan and once during the descending scan. The output of NOR 326, however, becomes low only when floor 6 is encountered on the ascending scan because it also has input $nM1$. Thus, the output of NOR 326 causes a different input to NOR 322 to be low at the correct time to cause resetting of the counter at the division between regions 1 and 2. Actually, the true division between regions 1 and 2 occurs between floors 5 and 6, but it is necessary to reset from input 6SH, rather than 5SH, in order that any cars at floor 5 be counted during the secondary scan which occurs before input 6SH becomes high. Obviously, the division between regions 1 and 2 can be adjusted readily by connecting the input of NOR 326 to the SH output of the appropriate hall call card.

Similarly, NOR 328 has inputs 11SH (obtained from the SH output of the hall call card for floor 11) and $nM1$. Thus, it causes resetting of the counter at the division between regions 2 and 3, which is here assumed to be between floors 10 and 11, but which is readily adjustable, if desired.

Similarly, NOR 316 has inputs 16SH and $nM1$ so that its output causes resetting at the division between regions 3 and 4.

A circuit consisting of one-shot 318, NORs 319 and 321 and emitter follower 320, is used to create a brief pulse at the commencement of the descending scan, which is applied to the last of the five inputs of NOR 322. This circuit is similar in operation to the previously described circuit consisting of one-shot 324 and NORs 323 and 325, except that emitter follower 320 is required to amplify the output of NOR 319, without inversion, because of the number of other NORs which the output of NOR 319 must feed. The input to one-shot 318 is connected to $nM1$ instead of $M1$ (as one-shot 324 is) so that the pulse created by this circuit occurs at the beginning of the descending scan, instead of the beginning of the ascending scan. NOR 321 has $nF1$ as an input, the same as NOR 323, so that the digit $f1$ becoming 1 at the commencement of the second step of the descending scan defines the end of this pulse.

The circuits for providing for the five resetting operations of the counter consisting of BMs 304, 305 and 306, has now been described. It is necessary that a reading be taken of the condition of the counter just prior to each resetting. The same principles required to determine the correct resetting periods is also used for determining the correct reading time, but inversion of the five signals is required. This is accomplished by using the opposite output BOT of the flip-flop consisting of NORs 323 and 325, by inverting the output of NOR 326 with NOR 327, by inverting the output of NOR 328 by NOR 329, by inverting the output of NOR 316 with NOR 317, and by using the output of emitter follower 320 instead of the output of NOR 321. In addition, a further reading must be taken, without a corresponding resetting, to determine the number of suitable cars at or below the main floor. This is accomplished by NORs 330 and 331. Thus, the output 4SHU of NOR 331 becomes high during the ascending scan, when floor 4 is encountered. The actual reading, as will be seen later, occurs before a secondary scan can occur at floor 4, so that only cars at or below the main floor are counted. Output 4SHU is required on the up-peak spacer.

A restriction on the taking of these readings is required, and this is provided by a circuit consisting of NORs 312 and 314, one-shot 313 and emitter follower 315. The output of NOR 312 becomes low during the B pulse at each step of the main scan, due to inputs BP and MS being both high, but not during a secondary scan. Thus, one-shot 313 creates a brief negative

pulse at the beginning of the B pulse of each step of the main scan. This is amplified and inverted by NOR 314 to create output RP, and this signal is further amplified, without inversion, by emitter follower 315 to provide signal RPI. These signals are normally low, but become briefly high at the beginning of each B pulse during the main scan to restrict any reading of the counter to this period. Note that circuitry previously described allows any resetting of the counter to occur at the end of such a B pulse. This assures that the counter is not reset until sufficient time has elapsed for a reading to be taken.

FIG. 27 contains a vertical column of 14 NORs, from 332 to 345. Each of these NORs has three inputs; one of these inputs is either RP or RPI, a second input to each of these NORs is either 1M, $n1M$, 2M or $n2M$, which provide indications of the condition of the counter as previously described and the third input of each of these NORs is derived from the previously described circuits for causing reading and resetting to occur at the correct five points of the scan. Thus, the outputs of all these NORs are normally high, but may become briefly low at only one point in the scan to indicate briefly information regarding the number of cars in the region just scanned.

The information conveyed when the outputs of these NORs are briefly low will now be listed:

NOR 343 indicates two or more cars;

NOR 344 indicates one or less cars;

NOR 345 indicates one or more cars at or below the main floor;

NOR 341 indicates one or more cars in region 1;

NOR 342 indicates no cars in region 1;

NOR 336 indicates two or more cars in region 1;

NOR 340 indicates one or more cars in region 2;

NOR 339 indicates no cars in region 2;

NOR 335 indicates one or more cars in region 3;

NOR 334 indicates no cars in region 3;

NOR 333 indicates one or more cars in region 4;

NOR 332 indicates no cars in region 4;

NOR 338 indicates two or more cars in region 4; and

NOR 337 indicates one or less cars in region 4. In the preceding list, it is assumed that the word "cars" means cars suitable for spacing purposes.

A second vertical column of 13 NORs contains six pairs of NORs connected as flip-flops to provide continuity of some of the information available briefly from the previously described 14 NORs. NORs 357 and 358 provide output 2MV which is high to indicate two or more cars suitable for spacing, and inverted output $n2MV$. NORs 355 and 356 provide output 1M1 which is high to indicate one or more suitable cars in region 1, and inverted signal $n1M1$. NORs 353 and 354 create output $n1M2$ which is low to indicate one or more suitable cars in region 2. NORs 348 and 349 create output $n1M3$ which is low to indicate one or more suitable cars in region 3. NORs 346 and 347 create output 1M4 which is high to indicate one or more suitable cars in region 4, and inverted output $n1M4$. NORs 351 and 352 create output 2M4 which is high to indicate two or more suitable cars in region 4, and inverted output $n2M4$. NOR 350 also appears in this column of 13 NORs, but it is not part of a flip-flop. Instead, it inverts the output of NOR 336 to provide an output which is briefly high to indicate two or more suitable cars in region 1.

The circuits of FIG. 27, which have now been described, provide the basic information required to accomplish the spacing system described earlier. The remaining circuits in FIG. 27, which process this basic information, will now be described.

The principal outputs of the spacer are PK and its inverse nPK , which are connected to the similarly named inputs on each spacing readout card. Thus, all cars see the same information regarding spacing. However, these outputs are generally changing several times during a scan so that each car, reading the condition of signals PK and nPK at different points of the scan, depending upon its position, receives generally different instructions from the spacer. If a car finds signal PK to be high when it experiences straight double pari-

ty, it interprets this as meaning that this car should go down for spacing reasons. Similarly, if a car finds signal PK to be high when it experiences reverse double parity, it interprets this as meaning that this car should go up for spacing reasons. Thus, if it is desired to bring a car down into region 1 because there is no suitable car there, output PK must be high during the first part of the ascending scan, but must become low after the first car is seen on the ascending scan, so that only one car is brought down.

A flip-flop consisting of NORs 384 and 385 is used to maintain the PK output high until the first suitable car is seen. Four different inputs to NOR 385 allow it to be set to a condition corresponding to output PK being high, at a suitable point in the scan, and input nKP to NOR 384 causes the flip-flop to revert to its other condition as soon as a suitable car has been seen. It should be noted that nKP is arranged so that it becomes momentarily low to indicate a suitable car only on the last step of double parity for any car, so that output PK is returned to the low condition only after the car involved has had a chance to read the condition of output PK, which occurs during the first step of double parity. Switch SW1 is provided on the spacer so that it can be closed for testing purposes to hold the flip-flop in a condition such that no spacing operations occur (except during up-peak).

NOR 386 allows not only the output of the previously described flip-flop to influence outputs PK and nPK , but also allows two further inputs $nPK1$ and $nPK2$, obtained from the up-peak spacer, to cause spacing operations during up-peak. These two inputs are normally high, but can become low during up-peak in order to accomplish the special spacing required to achieve the up-peak operation previously described. NOR 387 is used to give sufficient amplification to output nPK , and NOR 388 inverts and amplifies to provide output PK.

NOR 372 has inputs $n2MV$, $n1M1$, $n1M2$ and the output of NOR 329, so that its output is briefly low if there is only one suitable car, and it is not in regions 1 or 2. Actually, the output of NOR 372 would also be briefly low if there were no suitable cars, but this situation need not be considered since no cars would be able to obey the commands given by the spacer. This causes a flip-flop consisting of NORs 373 and 374 to be set to the condition where the output of NOR 374 is low, and it will be explained later how this instructs the suitable car to travel down for spacing reasons. This flip-flop remains in this condition until $n1M1$ becomes low, indicating usually that this suitable car has entered the top of region 1, or perhaps that some other previously unsuitable car became suitable in region 1. In either case, the flip-flop is changed back to its original condition where the output of NOR 374 is high.

The purpose of using the output of NOR 329 as one of the inputs to NOR 372 is to delay the setting of the flip-flop 373 and 374 until floor 11 is reached on the ascending scan. By then, signals $n1M1$ and $n1M2$ correctly indicate the presence or absence of a suitable car in regions 1 or 2. Without this input to NOR 372, a car travelling up from region 1 to region 2 would momentarily disappear from region 1 before entering region 2, and would falsely set the flip-flop.

A more usual situation is for there to be two or more suitable cars, and then $n2MV$ is low so that the flip-flop described in the preceding paragraphs must remain in a condition where the output of NOR 374 is high. NOR 376 has inputs $n1M1$ and $2MV$ so that if there are two or more suitable cars, but none in region 1, a flip-flop consisting of NORs 377 and 378 is changed so that the output of NOR 378 is low. This also causes the lowest suitable car to be instructed to travel down for spacing reasons, in a similar manner to the instructions issued when NOR 374 was low, except that previously there was only one suitable car. This flip-flop remains in this condition until there is a suitable car at or below the main floor, as indicated by the output of NOR 345 becoming briefly low, as previously described. This operation normally causes, when there is no car in region 1, the lowest car above to be brought down not just into region 1, but to the main floor. Of course, it

is also possible for this lowest suitable car to be stopped in its downward spacing trip if another previously unsuitable car becomes suitable at or below the main floor.

Regardless of whether it is NOR 374 having a low output, for one of the two previously described downward spacing trips, or NOR 378 for the other type of trip, NOR 375 has a high output. NOR 379 has as inputs the output of NOR 375, and RP and 4SHU. Thus, it has a briefly low output over and over again during each ascending scan as long as either one of these two spacing trips is needed, and it is low only at the beginning of the B pulse which occurs immediately after the main scan has stepped to floor 4 during the ascending scan. This causes the setting of previously mentioned flip-flop 384 and 385 at the correct part of the scan, so that a down spacing command can only be given to a car above the main floor, and of course it will be given only to the first suitable car seen, and since it is given during the ascending scan, this car is instructed to go down. This command is given repetitively to the lowest suitable car, and the memory previously described, in the spacing readout card for this car, transforms this into a continuous signal.

NOR 370 has inputs $2MV$, $1M1$, and $n1M3$. Thus, it has a low output to indicate a potentially unsatisfactory spacing of the cars where there is one or more suitable cars in region 1, but none in region 3. NOR 371 inverts this signal, and feeds it to NORs 360 and 368. NOR 360 has an additional input $n1M4$, so that its output is low if there are also no cars in region 4. This is considered to be an unsatisfactory spacing of the cars since the upper half of the building, consisting of regions 3 and 4, has no suitable cars. It should be noted here that the information obtained from NOR 371 is such that the output of NOR 360 is low provided that there are two or more suitable cars, but none of them in regions 3 or 4. This low output of NOR 360 causes a flip-flop consisting of NORs 359 and 361 to be set to the condition where the output of NOR 361 is high. The flip-flop remains in this condition until $n1M4$ becomes low to indicate that there is now a suitable car in region 4. NOR 380 is arranged so that its output becomes low at the correct time in the scan to instruct the highest suitable car to travel up for spacing reasons. The output of emitter follower 320 is one of the inputs to NOR 380, and this plus input RP assures that the output of NOR 380 can become low only at the beginning of the first B pulse to occur on the descending scan. Also, this can occur only when input $nUPK$ is high, and when the output of NOR 361 is high. This causes the previously described flip-flop 384 and 385 to be set at the beginning of the descending scan so that the first suitable car seen on the scan (obviously the highest suitable car) is instructed to travel up for spacing reasons, and this car, via input nKP resets the flip-flop so that no further cars are instructed to travel up. As before, this instruction is given repetitively to the highest suitable car (and also to any higher unsuitable cars, which ignore this instruction) but now it is given during the descending scan so that the other memory in the spacing readout card provides a continuous output indicating that this car can travel up for spacing purposes. The result of this is that whenever regions 3 and 4 are unoccupied, and there are two or more suitable cars below, the highest suitable car is taken up through region 3 until it reaches the lowest floor in region 4. This does not occur during up-peak, when input $nUPK$ is low.

It has been described how the output of NOR 371 is high to indicate a condition where there are two or more suitable cars, one or more of them in region 1, but with none in region 3. It has also been described how the additional emptiness of region 4 results in unsatisfactory spacing. If region 4 has one or more suitable cars, an unsatisfactory spacing of the cars can still exist if region 2 is unoccupied. This leaves a large gap unoccupied between the lowest region, 1, and the highest region, 4. NOR 368 detects this condition since it has input $n1M2$ in addition to the output of NOR 371, and its output is inverted by NOR 365 so that its output is high to represent this condition. Its output feeds NORs 363 and 366. The corrective

measures required to improve this unsatisfactory spacing depend upon the number of cars in region 4. If there are two or more suitable cars in region 4, NOR 366, which has an additional input 2M4, has a low output which causes a flip-flop consisting of NORs 367 and 369 to be set to the condition where the output of NOR 367 is high, and this condition remains until there is one or more cars in region 2, as indicated by $n1M2$ becoming low. The output of NOR 367 is arranged to cause the lowest suitable car above region 2 (presumably in region 4) to be brought down until it is at the top floor of region 2. To do this, the flip-flop 384 and 385 must be set during the ascending scan only after it has progressed completely through region 1, so that cars in this region are not falsely instructed to go down, but preferably only after it has progressed completely through region 2. This is done by NOR 383 whose output can be low only at the beginning of the B pulse which occurs immediately after the main scan has stepped to the lowest floor in region 3. Of course, nKP changes flip-flop 384 and 385 back again after the first suitable car has been instructed to go down.

The preceding description showed what happens under the stated conditions when there are two or more suitable cars in region 4. If there is only one such car in region 4, it is not desirable to move it out of region 4, and thus the circuit is arranged to bring a car up from region 1 provided that there are at least two suitable cars there. If not, no steps are taken to improve the spacing.

NOR 363 detects this final unsatisfactory spacing of the cars since it has, in addition to the input obtained from NOR 365, inputs $n2M4$, 1M4, and the output of NOR 350, which is briefly high to indicate two or more suitable cars in region 1. The combination of inputs 1M4, indicating one or more cars, and $n2M4$, indicating less than two cars, together indicate exactly one suitable car in region 4. The output of NOR 363, when low, sets a flip-flop consisting of NORs 362 and 364 to the condition where the output of NOR 364 is high. This condition remains until $n1M3$ becomes low to indicate that there is now a suitable car in region 3. NOR 381 is arranged in a similar manner to NORs 380, 383, and 379 to set flip-flops 384 and 385 at the correct part of the scan to instruct the highest suitable car in region 1 to go up. Since this suitable car must travel up out of region 1 and through region 2, it is necessary to set this flip-flop during the descending scan at the beginning of the first B pulse after it has stepped to the bottom floor in region 3. NOR 389 has inputs M1 and 11SH, so that its output, when inverted by NOR 382, provides a suitable input to NOR 381 which, when combined with RP and the output of NOR 364, causes this setting of flip-flop 384 and 385 at this time. This cannot occur during up-peak because of input $nUPK$ to NOR 381.

The operation of the spacer has now been described, and it will be seen that it causes the spacing of the cars to agree with the earlier description of the spacing system. This system is satisfactory for all types of traffic, including down-peak, but should be changed for up-peak. Basically, those spacing operations requiring upward travel of cars are deleted during up-peak by input $nUPK$, but further downward spacing requirements are provided by the up-peak spacer, which will now be described, through inputs $nPK1$ and $nPK2$.

UP-PEAK SPACER

FIG. 28 shows the circuit for the up-peak spacer, only one of these being required for the entire bank, and its outputs $nPK1$ and $nPK2$ operate through the spacer to instruct the cars. The up-peak spacer contains a counter similar to the counter in the spacer, consisting of BMs 390, 391 and 392. These are reset at the beginning of each ascending scan since input $nBOT$, obtained from the spacer, causes the output of one-shot 395 to be briefly low at this time, and its output is amplified by NORs 396 and 397, so that input 2 to these three BMs is made briefly low to reset them at the beginning of each ascending scan. The output of NOR 396 supplies output ter-

minal YP which is required on the peak detector, which has not yet been described.

The counter is arranged to count suitable cars during the ascending scan, but once the ascending scan has progressed above the main floor, upbound cars are not considered suitable for up-peak spacing purposes. Therefore, a flip-flop consisting of NORs 406 and 407 is set at the beginning of each ascending scan by NOR 397, to the condition where the output of NOR 407 is high, and this continues until the output of NOR 405 becomes low to revert the flip-flop to its original condition. This occurs, because of inputs 4SHU (from the spacer) and BP, at the beginning of the first B pulse after the ascending scan first steps to floor 4. During this short portion of the ascending scan, the output of NOR 407 is high, and this allows input KP to be inverted by NOR 410; at the same time, the output of NOR 406 is low, and thus the output of 409 is high. Therefore, the output of NOR 411 is determined by KP, so that the counter is driven by KP, and thus, it counts cars below and at the main floor regardless of whether or not they are upbound.

For the remainder of the ascending scan, the outputs of NORs 406 and 407 are reversed, so that the output of NOR 410 remains high, and input nVP is inverted by NOR 408, and inverted again by NOR 409, so that it causes NOR 411 to advance the counter by one step whenever nVP is low to indicate a DAV car. Thus, upbound cars are not counted during this time. During the descending scan, the counter actually continues to count UAV cars, and may go beyond binary number 111 and start again at 000, but this is of no consequence since the readings of this counter are taken during the ascending scan. The commencement of the next ascending scan causes reset of the counter as previously described.

Switches SWA1, SWA2 and SWA4 allow selection of either output 1 or output 2 of BMs 390, 391 and 392, respectively for the purpose of determining via NOR 394 when a predetermined number of cars has been counted by the counter. This NOR also has input AP so that whenever the counter steps to a new condition (and this occurs at the commencement of a B pulse), sufficient time is allowed for conditions to stabilize before the output of NOR 394 is allowed to become low to indicate that the predetermined count has been reached. When this occurs, a flip-flop consisting of NORs 398 and 399 is set, and this condition is retained until the output of NOR 397 reverts the flip-flop to its previous condition at the beginning of the next ascending scan. The setting of these switches shown in FIG. 28 would cause detection of two cars. The count to which this circuit responds is determined by adding together the last digit of the names of those switches whose blades are switched to the left.

A similar group of switches SWB1, SWB2 and SWB4, a NOR 393 similar to NOR 394, and a flip-flop consisting of NORs 400 and 401 which are similar to NORs 398 and 399, are provided so that this new flip-flop is set when a different, larger, predetermined number of cars has been counted, and again, this is retained until the flip-flop is reset at the beginning of the next ascending scan. The setting of these switches shown in FIG. 28 would cause detection of four cars since it is only the blade of switch SWB4 which is to the left. It is the setting of the A switches which determines how many cars there must be at or below the main floor in order to satisfy the up-peak spacing requirements. The setting of the B switches determines how many cars there must be at or below some other higher floor, in order to satisfy the up-peak spacing requirements. Preferably, this higher floor should be the floor immediately above the main floor. In this example, it is floor 4, and input 5SH, obtained from the SH output of the hall call card for floor 5 is therefore used as an input to NOR 402.

A further flip-flop consisting of NORs 403 and 404 is provided so that when the first B pulse commences after the ascending scan has stepped to floor 5, the output of NOR 402 causes this flip-flop to be set to a condition which is retained until the beginning of the next ascending scan, at which time it

is reverted to its original position in a similar member to the other flipflops in the up-peak spacer.

The purpose of NORs 412 and 413 will now be described. Their outputs are normally high, and can become low only during up-peak, when input UPK is high, and only during the ascending scan when $nM1$ is high. At the beginning of the ascending scan, the outputs of NORs 403 and 406 are both low, so that the outputs $nPK1$ and $nPK2$ of NORs 412 and 413 are both high. When the scan has progressed past floor 3, the counter has counted all cars at or below the main floor, and the output of NOR 406 becomes high. If the number of cars at or below the main floor is lower than the predetermined requirements, the output of NOR 399 is also high, and this causes output $nPK2$ to be low until the required number of cars has been detected by the counter. This causes output PK on the spacer to be high, so as to instruct cars to travel down for spacing purposes, until enough of them have been so instructed as to meet the predetermined requirements for the number of cars at or below the main floor. Any upbound car seen during this part of the scan ignores the spacing command, and is not counted by the counter.

Similarly, when the scan has progressed past floor 4, the counter has counted all cars at or below floor 4, and the output of NOR 403 becomes high. If the number of cars at or below floor 4 is lower than the predetermined requirements, the output of NOR 401 is also high, and this causes output $nPK1$ to be low until the required number of cars has been detected by the counter. This causes the PK output on the spacer to be high, so as to instruct cars to travel down for spacing purposes, until enough of them have been so instructed.

Such spacing commands continue to be received by cars only until they reach the main floor, or perhaps only until they reach floor 4, if there are enough cars at or below the main floor. No attempt is made here to automatically return cars up to the main floor from below, during up-peak, but it is probably best to do so, and a circuit to do this will be described later when the relay circuits are described.

CALL PRIORITY CONTROL

FIG. 29 shows the circuit for a priority card, one such card being required for each floor above the main floor. These cards operate in conjunction with the priority stepper to record the exact order in which down hall calls are registered. Each time a new down hall call is registered, its associated priority card determines the priority of this call based on how many other down hall calls (excluding the main floor and floors below) are already registered. For example, if there are already four down hall calls registered, a newly registered down hall call has a priority of 5. The down hall call which has waited longest has a priority of 1. The down hall call which has waited longer than all other registered down hall calls, except the one with priority 1, has a priority of 2. Thus, high priority calls have a low number representing their priority, and calls with lower priority (i.e. calls which have waited a shorter time) have a higher number representing their priority. Whenever a down hall call is canceled other registered down hall calls with higher priority retain the same priority, but other registered down hall calls with lower priority all lower their priority number by 1, so that they still retain the same relative priority as before.

This is accomplished by having a counter in the priority stepper which is continually stepping through its complete sequence of binary numbers without interruption, and it steps to a new number at the beginning of each A pulse. Each priority card has a similar counter which keeps in step with the counter in the priority stepper as long as its associated down hall call is not registered. When its associated down hall call is registered, its counter becomes out of step with the master counter in the priority card by an amount corresponding to the priority. The advantage in using this method of determining priority is that the number of connections between the priority cards and the priority stepper is kept low, and does not

depend on the number of down hall calls whose priority can be stored.

The circuits shown in FIGS. 29 and 30 have only four bistable multivibrators for each of these counters. This enables the priority of up to 15 down hall calls to be stored, and this is considered adequate for buildings with more than 15 floors above the main floor, on the basis that it is very unlikely that all of these down hall calls will be registered at once. However, another BM could easily be added to each of these counters in a manner which is obvious from the description of the preferred embodiment, to allow for the storage of the priority of up to 31 down hall calls without any change in the number of interconnecting wires.

In order to keep the counter in a priority card in step with the master counter, when the associated hall call is not registered, and to keep it with the correct number of steps out of phase when the hall call is registered, the counter in each priority card is arranged to stop at the count of 0000 and then wait for a command from the priority stepper before stepping on to binary number 0001. When the associated down hall call is not registered, the counter in a priority card is arranged to step from 0000 to 0001 whenever a special output OMA of the priority stepper is high. The circuits on the priority stepper are arranged so that output OMA, which feeds all of the priority cards, is high only during the A pulse at the commencement of which the priority stepper steps from 0000 to 0001. Thus, if the counter in such a priority card is not in phase with the master counter, it stops the next time it reaches the count of 0000, and then waits until the master counter has reached the corresponding step, and then it resumes its stepping. It should then continue to stay in step, and although it stops responding to the incoming A pulses each time it reaches 0000, input OMA becomes high during the next A pulse, and thus there is no interruption in the stepping of this counter. If any disturbance causes such a counter to become out of step with the master counter, restoration to the in step condition occurs automatically since the counter pauses at 0000 until the master counter catches up.

When the associated down hall call is registered, the counter in each priority card is still arranged to stop at the count of 0000, but now it waits for a different command, via input 15MA, before stepping to 0001. The output 15MA on the priority stepper is arranged so that it is high during each A pulse when any one of the counters, either the master counter in the priority stepper or any of the counters in the priority cards, is stepping from 1111 to 0000.

When there are no down hall calls registered above the main floor, all of the counters are completely in step. The first such down hall call to be registered causes its counter to remain stopped for 15 consecutive steps of the master counter the next time it reaches 0000. This is because it no longer responds to input OMA. It responds instead to input 15MA which occurs one step before OMA. Thus, this counter is now one step ahead of the master counter, and it tends to stay with this relationship relative to the master counter because each time it reaches the count of 0000 it stops following the A pulses, but at this time the master stepper is at 1111, and thus when the master counter steps to 0000, it causes output 15MA to be high so that this counter is instructed to step to 0001.

The output 15MA of the priority stepper is now high for two consecutive A pulses: first, when the counter representing this one registered down hall call steps from 1111 to 0000 (while the master stepper steps from 1110 to 1111) and secondly, when the master counter steps from 1111 to 0000. It is the second of these two pulses on OMA which causes the counter representing the down hall call to step from 0000 to 0001. The first of these two pulses has no effect on any counters, since the only one which responds to 15MA is the one which is causing this pulse, and thus it is occurring one step before this counter has arrived at step 0000 where it could make use of 15MA signal to step from 0000 to 0001. The purpose of the first of these two pulses is to keep the counter for the next down hall call two steps ahead of the master counter, indicating a priority of two.

Thus, when a second down hall call is registered above the main floor, its counter stops the next time it reaches 0000, and remains stopped for 14 consecutive steps of the master counter at which time the counter for the other down hall call steps from 1111 to 0000 and causes output 15MA of the priority stepper to be high, so that this counter now resumes its stepping. It remains in this relationship with the master counter, for each time it reaches 0000, 15MA is made high during the next A pulse, and it can then step to 0001. This counter now causes a third pulse to occur on 15MA immediately before the previously mentioned two, but this has no effect on any of the priority cards, but is necessary to establish the proper relationship between the counter of a third down hall call and the master counter, if such a call is registered.

Thus, it can be seen that this system records the exact order in which down hall calls have been registered such that the priority of each is indicated by the number of steps by which the associated counter leads the master counter. Whenever any of these down hall calls is canceled, calls of higher priority have no change in their associated counters. The counter associated with the canceled call stops when it reaches 0000, and waits for the master counter to catch up, before resuming the normal in step operation as previously described. Thus, there is now one gap in the successive pulses on 15MA where this counter previously caused a pulse. This results in the counter for the call with priority one step lower than the canceled call to miss one step because it must wait one more step before receiving a high 15MA input, and thus it now becomes one step less advanced than it was before, so that it now shows the same priority as the canceled call. Similarly, other calls of lesser priority each miss one step in the same way so that they each, in effect, step up to a condition representing slightly higher priority than previously, but with still the same relative priority.

Since there are 16 steps to a complete cycle of the master counter, the total length of time for one cycle is approximately 1.6 milliseconds if the A pulses occur every 100 microseconds. Two down hall calls registered during this 1.6 millisecond period could be assigned equal priority by this system, but this is very unlikely to happen often, and if it does, no harm results. Similarly, down hall calls registered when there are 15 previously registered down hall calls will have the same priority as the last of these 15 to be registered, and thus it is possible for several down hall calls to have the same priority. This, of course can occur only if the number of floors above the main floor exceeds 15, and then only rarely, and no harm results from this.

PRIORITY CARD

The circuits in FIG. 29 will now be described. Input AP to NOR 420 normally causes its output to be low, and thus causes the output of NOR 421 to be high, during each A pulse. Thus, the counter consisting of BMs 422, 423, 424 and 425 is caused to step to a new count at the commencement of each A pulse. However, when the count of 0000 is reached, output 2 of each BM is high, and the output of NOR 427 is low, and this forces the output of NOR 420 to be high in spite of input AP so that incoming A pulses no longer drive the counter.

When the associated down hall call is not registered, input CD is high, and the output of NOR 415 is low and the output of NOR 416 is high so that when input OMA is also high, the output of NOR 418 is low, and this causes the output of NOR 421 to be high, causing the counter to advance one step. Similarly, when the associated down hall call is registered, input CD is low, the output of NOR 416 is low, and thus the output of NOR 417 is high. Then, when input 15MA is also high, the output of NOR 419 becomes low so that the output of NOR 421 is high to cause the counter to advance one step. NORs 415 and 416 are provided to amplify input CD so that the loading of transistor Q2 in the hall call card is not unduly increased by this extra output.

When the counter represents binary number 1111, output 1 on each BM is high, and thus the output of NOR 426 is low so that it forces output 15 to be low. Diode D52 allows any priority card to cause 15 to be low, and it will be shown later how this is used to create output 15MA of the priority stepper.

As previously mentioned, the down-peak system requires that a certain number of down hall calls with high priority be considered as "prior" calls, and that the number of such prior calls is variable to correspond with the number of special UAV cars. Input PP is obtained from the priority stepper, and is arranged so that it is high during each B pulse of a portion of the complete cycle of the master counter. The portion during which PP is high is variable to suit the desired number of prior calls. It is an input to each priority card which tells it whether or not the down hall call it represents is a prior call. If input PP is high when the counter for this floor is at 0000, this is an indication that this is a prior call. Otherwise, PP would be low at this time.

The output of NOR 427 is inverted by NOR 428 so that its output is high when the count is 0000. Thus, if the associated down hall call is registered, the output of NOR 417 is high, and if input PP is also high when the output put of NOR 428 is high, all three inputs to NOR 430 are high, and thus its output is low to set the flip-flop consisting of NORs 431 and 432 to a condition indicating that this is a prior call. This flip-flop remains in this condition as long as this call is registered, and is reverted back to its original condition when the output of NOR 417 becomes low due to input CD becoming high when the call is canceled.

Input FL, obtained from the rotational instructor which has not yet been described, is arranged to be alternately high and low, at a rate of about 2 cycles per second, during down-peak only. Otherwise, it is low. Thus, the output of NOR 434 is normally high, but becomes intermittently low if, during down-peak, this call is a prior call.

A relay XDP has its coil connected to the output of relay driver 437 which in turn is fed from NOR 436. Normally, when the output of NOR 434 is high, the coil of this relay is energized whenever the down hall call associated with this priority card is registered. This is because the output of NOR 417 is high when the call is registered, and this causes the output of NOR 436 to be low so that the output of the relay driver 437 is high, energizing the relay. However, during down-peak, if this call is a prior call, the intermittently low output of NOR 434 causes the relay coil to be intermittently rather than continuously energized. Its contact XDP-1 is connected between -18 and terminal XDL so that, if desired, the down hall call register lights in the display panel at the main floor may be connected between terminal XDL (for the corresponding floor) and 0. Then, these lights flash intermittently to indicate which of the down hall calls are prior calls; the lights for nonprior calls do not flash.

Input 8A, obtained from the priority stepper, is arranged to be high for half of the complete cycle of the main stepper. Lamp driver 429 has inputs 8A and output 2 of BM 425 so that its output is high to energize the lamp IL8 only when these two inputs are simultaneously high. This condition exists for only one-sixteenth of the cycle of the master counter if this call has top priority. On the priority card representing a call with priority 2, the output of the lamp driver is high for two-sixteenths of the cycle; similarly, on the priority card representing the call with priority 3, the lamp is energized for only three-sixteenths of the cycle. Thus, the relative brightness of these lamps indicates the relative priority of the down hall calls, with the calls of higher priority having the dimmest lamps. This is provided for maintenance purposes only, and the lamps IL8 are located on the priority cards; if more than eight down hall calls are registered, calls with priority higher than eight have progressively dimmer lights. Extra expense would be required to properly control the brightness of all lamps in direct accordance with priority, and this is not needed for normal maintenance.

Input n SHD is obtained from the corresponding hall call card, and is low to indicate that the ascending scan is at the floor corresponding to this card. NOR 433 inverts this signal. Thus, when its output is used along with the output of NOR 431 as inputs to NOR 435, the output of NOR 435 is normally high, but becomes momentarily low if this call is a prior call, at the correct part of the main scan. A diode D53 in each priority card causes the outputs of each of the NORs 435 to be transferred to wire ADP so that it contains information indicating which of the registered down hall calls are prior calls, in a similar manner to wire AD which was previously described in connection with the secondary scanner. Wire ADP is normally high, but becomes briefly low at each step of the ascending scan where there is a prior call.

PRIORITY STEPPER

FIG. 30 shows the circuit for the priority stepper. BMs 459, 460, 461 and 462 constitute the master counter, and input AP causes it to step to a new condition at the commencement of each A pulse. When the counter first steps to the condition representing the binary number 0000, the output of NOR 464 becomes low in a similar manner to the operation of NOR 427 in the previously described priority card, and the output of NOR 477 becomes high. Then, at the beginning of the next B pulse, input BP becomes high and thus the output of NOR 479 becomes low, and this sets a flip-flop consisting of NORs 482 and 483 to the condition where the output of NOR 482 is high. This condition is retained on the flip-flop until the beginning of the next B pulse, and now the counter has been advanced one step by the intervening A pulse, and thus the output of NOR 464 is no longer low, but is high so that the output of NOR 480 becomes low to change the flip-flop such that the output of NOR 482 is now low again. Thus, output OMA is caused to be high only during the intervening A pulse since it is created by NOR 487 whose input is the output of NOR 485, and this output is low only when input AP is high, and only when the flip-flop is in the correct condition. Thus, output OMA is high during that A pulse at the commencement of which counter steps from 0000 to 0001.

A similar circuit is used to create output 15MA. The NORs in this new circuit correspond to the previously described NORs in the following manner: NOR 476 to NOR 477; 478 to 479; 474 to 480; 481 to 482; 475 to 483; 484 to 485; and 486 to 487. Since its operation is so similar to the previously described circuit, no further explanation is needed. The input to NOR 476 is derived from terminal n 15 which is low whenever any one of these counters is at binary number 1111. The circuits whereby each priority card can cause n 15 to be low have already been described. A similar NOR, 463, is provided on the priority stepper so that when the master counter is at 1111, it too, via diode D56, can cause n 15 to be low.

BM 462 is the last stage of the 4-digit master counter, and thus its outputs divide the complete cycle into two equal parts. Output 1 of BM 462 is amplified by NORs 465 and 466 to create output 8A which, as previously described, must be high for half of this cycle to control the relative intensity of the lamps in the priority cards.

A further counter consisting of BMs 445, 446, 447 and 448 is provided to count the number of special UAV cars. Input n TMP is obtained from the main stepper, and is normally high, but becomes briefly low at the commencement of each descending scan. This signal is amplified by NORs 441 and 442 so that input 1 to each of these BMs is made momentarily low to reset the counter at the commencement of each descending scan. Input n JP is obtained from the instruction readout card, which has not yet been described, and it is arranged to be normally high, but to become briefly low whenever a special UAV car is encountered during the descending scan. This signal is inverted by NOR 440 so that the counter is advanced one step each time such a car is seen. Therefore, for the entire ascending scan the condition of this counter remains fixed at a count representing the number of special

UAV cars. It should be noted, however, that it is output 1 of each BM which is connected to input C of the next stage in each case, rather than output 2 as in most previous counters. This causes subtraction rather than addition, so that a binary count of 1111 represents one such car, a binary count of 1110 represents two such cars, a binary count of 1101 represents three such cars, etc.

A circuit consisting of NORs 449, 450 and 451 is used to compare the outputs of BMs 445 and 459. If they represent the same binary number, either both of the inputs of NOR 449 are high, or else both of the inputs of NOR 450 are high; in either case, the output of NOR 451 will be high.

Similarly, a circuit consisting of NORs 452, 453 and 454 compares the outputs of BMs 446 and 460, and if they both are in the same condition, the output of NOR 454 is high. Similarly, the circuit consisting of NORs 455, 456 and 457 is arranged so that the output of NOR 457 is high when the binary numbers represented by BMs 447 and 461 are identical.

When there are no special UAV cars, the output of BM 448 remains always low, and thus the output of NOR 458 remains high. If one special UAV car has been counted, output 1 of BMs 445, 446, 447 and 448 are all high, and thus when the corresponding outputs of BMs 459, 460, 461 and 462 are similarly all high, all inputs to NOR 458 are high during the B pulse, and thus the output of NOR 458 becomes low to cause a flip-flop consisting of NORs 470 and 471 to be set to the condition where the output of NOR 470 is high. This condition remains until the end of the A pulse which causes the master counter to step to 0000. The output of one-shot 467 is momentarily low at the end of each A pulse, and this causes the output of NOR 468 to become briefly high, and when this occurs with the master counter at 0000, the output of NOR 477 is also high, and thus the output of NOR 469 is briefly low to reset the flip-flop 470 and 471 to its original condition. In the preceding example, the output of NOR 470 would become high for a very short time, from the beginning of one B pulse to the end of the following A pulse. The output of NOR 472 would thus be low only during the duration of this B pulse, and thus output PP of NOR 473 would be high only during this one B pulse, and since this occurs when the master counter is at 1111, it occurs when a counter representing the down hall call with the priority of 1 is at 0000, and it has already been described how such a priority card recognizes input PP as indicating that this call is a prior call if it occurs when the counter is at 0000.

Similarly, if two special UAV cars have been counted by the counter, BMs 445, 446, 447 and 448 are such as to indicate the binary number 1110, and when the master counter reaches this same condition, all inputs to NOR 458 will be high during the B pulse, and this will set flip-flop 470 and 471 to the condition where the output of NOR 470 is high one step earlier than previously. Then, output PP is high for two consecutive B pulses, when the master counter is at binary numbers 1110 and 1111. When it is at binary number 1110, the counter for a priority card representing the down hall call with priority 2 will be at 0000, and thus, it too, in addition to the priority card for the call with highest priority, will be instructed that it is a prior call.

In a similar manner, if three special UAV cars are counted by the counter, output PP will have three consecutive pulses so that the three priority cards representing those three down hall calls with highest priority, are instructed that their calls are prior calls. Similarly, the number of special UAV cars determines how many of the registered down hall calls are prior calls. Since there are not more than eight cars in the bank, the output of BM 448 remains with output 1 high (a ninth special UAV car would cause output 1 of BM 448 to become low), once the first special UAV car has been counted on the descending scan. Thus, output 1 of BM 448 is an indication of whether or not there is a special UAV car, and if there is not, the output of NOR 458 is held high continuously. Similarly, since the maximum number of cars is eight, it is never necessary to set flip-flop 470 and 471 earlier in the cycle

than when the output of BM 462 becomes high, and thus output 1 of BM 462 connects to one of the inputs of NOR 458. This results in a simplification of the circuit since only three of the four digits of the two counters need be checked by circuits such as NORs 449, 450 and 451.

Although the count on BMs 445, 446, 447 and 448 represents the true number of special UAV cars, only after the last such car has been seen during the descending scan, and for the duration of the ascending scan, there is more than sufficient time for the flip-flops consisting of NORs 431 and 432 in each priority card to correctly be instructed whether or not it is representing a prior call. During the earlier parts of the descending scan, it is tending to indicate too low a number of prior calls, but eventually it indicates the correct number, and once a priority card sets this flip-flop, it remains so until the call is canceled, regardless of subsequent behavior of input PP.

SPECIAL CAR CONTROL

FIG. 31 shows the circuit for the instruction readout card, one such card being required for each car, and they operate in conjunction with the rotational instructor whose circuit is shown in FIG. 32. The main purpose of these cards is to provide the rotational instructions which are issued to each car at a particular time in its trip to accomplish the up-peak and down-peak systems previously described. These instructions assign to each car either a normal or a special duty which determines its behavior until new instructions are received.

Input SI to each instruction readout card is obtained from the input card for each car, and it is arranged to be normally low, but to become high when the corresponding car seeks instructions. It will be shown later how a car is arranged to seek new instructions each time it approaches the main floor from above, during down-peak, and each time it starts up (except below the main floor) during up-peak. When input SI is low, BMs 492 and 493 are held in a reset condition, and the output of NOR 490 is held high regardless of its other inputs, so that the output of NOR 491 is held low, and no stepping of these BMs can occur.

When input SI becomes high, the counter consisting of BMs 492 and 493 commences stepping either immediately, if input AP is already high, or at the beginning of the next A pulse, and it continues counting at the beginning of each A pulse until it has stepped three times, and then output 1 of both BMs is high, and thus the output of NOR 494 is low, and this prevents any further stepping. The counter remains in this condition until input SI becomes low again, and then the BMs are set and held as described before. The counter has thus gone through a total of four steps, three in quick succession after input SI first became high, and one step when SI becomes low.

After the counter has made its first step, output 1 of BM 492 and output 2 of BM 493 are both high, and during the immediately following B pulse, the output of NOR 495 is low, and this causes the output of NOR 497 to be high. It is during this time that a reading is taken on the condition of inputs IE and nIE, which are obtained from the rotational instructor, to indicate whether this car should be normal or special for its next trip. If this car is to be special, input IE is high and input nIE is low, but if this car is to be normal, these inputs are reversed. Thus, when the output of NOR 497 becomes briefly high, either the output of NOR 498 becomes briefly low to indicate a special car, or the output of NOR 499 becomes briefly low to indicate a normal car. This causes a flip-flop consisting of NORs 500 and 501 to be set to a new condition, if required, which will be remembered until this car seeks new instructions again on its next trip.

After the counter has made its second step, output 2 of BM 492 and output 1 of BM 493 are both high, and during the immediately following B pulse, the output of NOR 496 is low so that diode D57 causes output terminal nCI to be low to indicate to the rotational instructor that it should advance to a new instruction ready for the next car to seek instructions.

During the third step of the counter, at which it rests until input SI becomes low again, nothing happens.

Relay driver 502 is fed from the output of NOR 500 so that its output JN, which is connected to the coil of relay JNR in the output card, is high to energize relay JNR when this car is instructed to be normal. Otherwise, relay JNR is deenergized. It is only during up-peak and down-peak that cars seek instructions, but they will retain the previous instruction during nonpeak periods, ready for the next peak.

NOR 503 obtains one of its inputs from the output of NOR 500 which is high if this car has been instructed to be a special car. If this car is also not downbound, as indicated by input nDB being high during down-peak when input DPK is high, the output of NOR 503 is low, and the output of NOR 505 is high. Otherwise, the output of NOR 503 is high and the output of NOR 505 is low. This latter condition is the more common one, and it results in the outputs of NORs 510, 512 and 513 being high, and also, as will be seen shortly, the output of NOR 511 is also high so that diodes D63, D64 and D65 allow output nIG to be high, and thus allows the master card to take the incoming up pulses and send them on via wire nEP to the counter. The reason why the output of NOR 511 is high is because input QQE, obtained from the rotational instructor, is low because the output of NOR 510 for each car is high, and this allows output nQQE to cause NOR 529 in FIG. 32 to make output QQE low. This causes the output of NOR 511 to be high on all cars.

Each time input QQ is high, it causes the output of NOR 509 to be low, or, if the car is special, and not downbound during down-peak, it causes the output of NOR 510 to be low instead. Diodes D61 and D62 connect these outputs to wires nQQN and nQQE which connect to NORs 528 and 529 in FIG. 32, and these signals are then amplified and inverted to create signals QQN and QQE. QQN is high whenever a car is seen during the scan except when that car is special and not downbound during down-peak, in which case QQE is high instead.

When a car is upbound with the special instructions during down-peak, the output of NOR 505 is high, as previously mentioned, and thus, during the above part of the scan, when input SA is high, each time a normal car is seen, input QQN becomes high, and thus the output of NOR 512 is low so that diode D64 causes output nIG to be low and this arranges the master card so that the incoming EP signal is ignored and such cars are, in effect, not seen by this special upbound car. Also, this special upbound car ignores all hall calls except prior calls, since input ADPA, obtained from the rotational instructor, is normally low, but becomes high whenever the main scan is at a floor where there is no prior down hall call. This causes diode D65 to cause output nIG to be low to cause the master card to similarly ignore incoming EP pulses which result from hall calls. Output ADPA of the rotational instructor is arranged to be low during the secondary scan so that NOR 513 and diode D65 cannot cause output nIG to be low during a secondary scan. The result of this is that these special upbound cars ignore other normal cars above, and see only prior down hall calls, to meet the previously described means of handling down-peak traffic.

When a car is not such a special upbound car, the output of NOR 503 is high, and this causes this car to ignore the special cars during the above part of the scan because of inputs QQE and SA to NOR 511. Thus, the output of NOR 511 becomes low and causes diode D63 to force output nIG low at the correct parts of the scan to ignore these special cars above.

NOR 504 is provided to create output nJP which is required on the previously described priority stepper, so that the number of special UAV cars can be counted during down-peak. The output of NOR 505 is high on such cars, and when inputs QQ and RA are both high, the output of NOR 504 becomes low and causes diode D60 to force output nJP low. This occurs only during the first step of reverse double parity when input RA is high, and each car causes nJP to be low at only one point in the scan. Input QQ is required because,

although it is high during the four steps of double parity, it is high during reverse double parity only if the car is UAV.

Part of FIG. 32 has already been described. NORs 528 and 529 amplify incoming signals π QQN and π QQE from the instruction readout cards to create amplified and inverted outputs QQN and QQE. The remainder of the circuits in FIG. 32, for the rotational instructor, will now be described.

As previously described, each time a car seeks instructions, it momentarily causes π CI to be low in order to advance the instructions ready for the next car to seek instructions. When input π CI becomes low, the output of NOR 515 becomes high so that it advances a counter consisting of BMs 516 and 517 by one step. Thus, this counter goes through its four different conditions over and over again, with each step occurring when input π CI first becomes low. NOR 518 responds to one of these four steps, since its output is low when output 2 of BM 516 is high and output 1 of BM 517 is low. This signal is amplified and inverted by NOR 520 to create output π IE which is then further amplified and inverted by NOR 521 to create output IE. These outputs are connected to the similarly marked terminals on the instruction readout cards for each car, and, as previously described, give an indication to each car of whether it should be special or normal. Thus, output IE is high for three of the four steps, and low for the other step. Output π IE is high for only one step, and low for three steps. Thus, the circuit so far described issues instructions in the following order: special, special, normal and special.

If the bottom input to NOR 519 is high, then when the counter is at the first of these four steps, output 2 of BMs 516 and 517 are both high so that the output of NOR 519 becomes low during one A pulse. This causes the output of NOR 515 to be high during the A pulse regardless of the condition of input π CI, so that it immediately steps to the next step. The result of this is that the instructions are issued in the following order: special, normal and special. Now, every third car is normal instead of every fourth car. Switch SW2 determines which of these two possibilities exists during down-peak. If, during down-peak, switch SW2 is open, the output of NOR 522 is low and thus the output of NOR 524 is high, and every third car is normal. If switch SW2 is closed, every fourth car is normal. Similarly, switch SW3, if open, causes the output of NOR 523 to be low during up-peak, so that the output of NOR 524 is high, and every third car is normal. If this switch is closed, every fourth car is normal during up-peak.

It is convenient to locate on the rotational instructor, equipment to create output FL which, as previously described, is used to cause intermittent illumination of the down hall call register lights in the display panel at the main floor. A stable multivibrator 525 is arranged so that its output is intermittently high and low at the rate desired for flashing these lamps. A pleasing rate of flashing can be obtained by making C12 and C13 25 mfd. and by making resistors R92 and R93 8.2 and 15 Kohms, respectively in FIG. 37(a). Normally, input DPK to NOR 526 holds its output continuously high so that the output FL of NOR 527 is low. However, during down peak input DPK is high, and the output of NOR 526 is the inverse of the output of AM 525, and this is amplified and inverted by NOR 527 so that signal FL can feed all of the priority cards with an intermittently high signal.

NOR 530 has as inputs MS and ADP. During the main scan, when MS is high, NOR 530 inverts input ADP, and this signal is amplified and inverted again by NOR 531 to create output ADPA which is required on each instruction readout card. Input MS assures that during any secondary scan, ADPA is kept low so that it cannot falsely cause special cars to ignore other cars during a secondary scan.

INPUT CARD

FIG. 33 shows the circuit for the input card, one such card being required for each car. Its purpose is to receive information from conventional relay circuits, which have not yet been described, and process this information so that it is suitable as

inputs to the low-voltage transistorized circuits. The method used here is to use "reed relays" which consist of a single normally open reed contact sealed with an inert gas in a glass envelope, and surrounded by a small coil. Such a relay is small and requires low power to operate, but its chief advantage here is the reliability and long life of the contacts. Conventional relays might create problems of contact failures if used in such a low-voltage circuit. Also, it is not desirable to use large relays in close proximity to sensitive transistorized circuits because of the possibility of magnetically inducing unwanted voltages into these circuits. Bistable multivibrators, for example, might be falsely triggered in this way. These reed relays do, however, have the disadvantage of contact bounce, particularly when the contact closes. For most of the circuits on the input card, contact bounce causes no harm, but contact bounce cannot be tolerated in the circuits creating output SI since such bouncing would appear to the instruction readout cards as separate cars seeking instructions, instead of one car. One method of eliminating the effects of such contact bounce will be shown for output SI. Other methods are possible, and any of them could be applied to other outputs of the input card if required.

The input card contains 13 relays with one normally open contact each, and one relay, SIR, which requires one normally open and one normally closed contact arranged so that when the relay is energized, the normally closed contact opens early, and remains open regardless of the bounce of the normally open contact. Similarly, when the relay is deenergized, the normally open contact must open early and remain open regardless of the bounce of the normally closed contact. One side of the coils of all of these relays is connected to input N which is preferably the grounded side of the power supply for the relay circuits.

Input CSI is arranged to briefly energize relay CSR each time this car stops for a car call, except when traveling down. Contact CSR-1 then closes to connect output π CSP to -18. This output is required on the peak detector, which has not yet been described. Similarly, input HSI is arranged to briefly energize relay HSR each time this car stops for a hall call, except when travelling up. Contact HSR-1 then closes to connect output π HSP to -18. This output is also required on the peak detector.

Input ISI is arranged to energize relay ISR whenever this car is "in service." A car is considered to be in service as long as it is not being operated on independent service, is not being operated on "maintenance" or "inspection" control and is supplied with power so that the car can operate. Thus, this relay is energized almost continuously, and contact ISR-1 is generally closed, and output ISC is held high by at least one car, so that input ISC to the secondary scanner allows registration of hall calls.

Input CNUI is arranged to energize relay CNUR whenever this car is conditioned for canceling up hall calls. Contact CNUR-1 then connects output CNU to 0, making it high. Otherwise, resistor R56 holds CNU low. Similarly, output CND is normally held low by resistor R57, but is made high by the closing of contact CND-1 when input CNDI causes relay CNDR to be energized.

Input UBI is arranged to energize relay UBR when the up direction of travel is established, and contact UBR-1 then closes to connect output UB to 0 to make it high. Otherwise, resistor R58 makes UB low. Similarly, input DBI is arranged to energize relay DBR whenever the down direction of travel is established, and contact DBR-1 then closes to make output DB high. Otherwise, resistor R59 keeps output DB low. NOR 533 inverts signal DB to create output π DB which is therefore low to indicate that the down direction of travel is established.

Inputs UAI, DAI and AVFI, provide information regarding the availability of this car. If it is available to go up (UAV), input UAI energizes relay UAR. If it is available to go down (DAV), input DAI energizes relay DAR. Input AVFI normally energizes relay AVFR, but is arranged to deenergize this relay when the car's basic availability is reduced from 2 to 1. Thus,

these inputs can indicate the six conditions in which a car may be, in the following manner:

	Condition of relays		
	UAR	DAR	AVFR
Condition of Car:			
AV2.....	*	*	*
UAV2.....	*	*	*
DAV2.....	*	*	*
UAV1.....	*	*	*
DAV1.....	*	*	*
Not Available.....			(1)

¹ Either way.

In this chart, an asterisk indicates that the corresponding relay is energized. When the car is not available, relays UAR and DAR being not energized is sufficient to indicate this, and the condition of relay AVFR has no meaning.

Resistors R60 and R61 make outputs UA and DA low when contacts UAR-1 and DAR-1 are open. Contact UAR-1 closes to make output UA high; contact DAR-1 closes to make output DA high. Thus, outputs UA and DA provide information regarding the directional availability, which is needed on the master card. Also, resistor R63 keeps output AVA low unless UA being high causes diode D80 to make AVA high, or DA being high causes diode DA1 to make AVA high; thus, AVA is normally high, but becomes low if this car is not available.

Resistor R62 and contact AVFR-1 are arranged to cause inputs of NORs 534 and 536 to be high if this car has availability of 2, and to be low if the availability is 1. Thus, the output of NOR 536 is low to indicate that this car has a basic availability of 2; if the car is not available, AVA is low to cause nBA2 to be high; if the basic availability is only 1, resistor R62 causes the other input of NOR 536 to be low to also cause nBA2 to be high. Similarly, NOR 535 causes output nBA1 to be low when this car has a basic availability of 1. If it is not available, AVA is low to cause nBA1 to be high. If its basic availability is 2, the output of NOR 534 is low to cause nBA2 to be high.

Input SII is arranged to energize relay SIR when this car seeks new instructions. Normally, contact SIR-2 holds the output of NOR 537 high, so that the output SI of NOR 538, which together with NOR 537 constitutes a flip-flop, is low. When relay SIR is energized, the opening of contact SIR-2 does not change the condition of the flip-flop, but when contact SIR-1 closes after further motion of the armature or reed of this relay, the output of NOR 538 becomes high, and remains so due to the flip-flop action, regardless of any bounce of contact SIR-1. Output SI then remains high until the relay is deenergized. The opening of contact SIR-1 makes no change to the flip-flop, but when contact SIR-2 closes, it reverts the flip-flop back to the original condition where output SI is low, and further bounces of this contact cause no harm. Thus, a circuit has been provided to assure that contact bounce cannot falsely make a car seek instructions several times when relay SIR is energized.

Input AVMI is arranged to energize relay AVMR whenever this car is at the main floor, and is suitable for being chosen as the next up car. When the car is in this condition, contact AVMR-1 closes to make output AVM high. Otherwise, resistor R64 keeps AVM low. Similarly, input GOI causes relay GOR to be energized if this car has its doors open at the main floor. Resistor R65 normally keeps output GO low, but contact GOR-1 closes to make GO high when the doors are open at the main floor.

Finally, input ASI causes relay ASR to be energized whenever this car has its MG set automatically shut down. Resistor R66 normally keeps output AS low, but allows contact ASR-1 to make AS high during automatic shut down. This completes the description of FIG. 33. The outputs of this input card are required in various places, in order to submit basic information to the various cards regarding the condition of this car as determined by other circuits, essentially conventional elevator circuits, which will be described later.

OUTPUT CARD

FIG. 34 shows the circuit for an output card, one such card being required for each car. Its purpose is to contain reed relays which are driven by the various relay drivers on other cards. Contacts of these relays are required to drive other larger relays which form a part of the more conventional relay circuits for each car. The output card thus provides electrical isolation between the low-voltage transistorized circuits and the high-voltage relay circuits, but allows the outputs of the scanning system to be fed to the relay circuits for each car. One side of each of these contacts is shown connected to terminal N, which should preferably be the grounded side of the relay power supply. One side of each coil of these relays is connected to -18 so that they are energized by the associated relay driver.

Input nHA from the readout card energizes relay NHAR when there are no hall calls above which this car should answer, and contact NHAR-1 then connects output NHAO to N. Similarly, when there are no hall calls below that this car should answer, nHB from the readout card energizes relay NHBR so that contact NHBR-1 connects terminal NHBO to N. Similarly, input HH from the readout card energizes relay HHR when there is a hall call that this car should stop for, or open its doors for, and this causes contact HHR-1 to connect terminal HHO to N.

In a similar manner, inputs PA and PB from the spacing readout card operate relays PAR and PBR whose contacts PAR-1 and PBR-1 connect outputs PAO and PBO, respectively, to N when the car is being instructed to go up or down for spacing reasons.

Input NS from the next readout card energizes relay NSR to show that this car is selected by the next stepper, to become a next up car if otherwise suitable. This causes contact NSR-1 to connect output NSO to N. Input JN from the instruction readout card causes relay JNR to be energized when this car is instructed to be a normal car; this causes contact JNR-1 to connect output JNO to N. Finally, inputs UPKA and DPKA from the peak detector energizes relays UPR and DPR to indicate that the system is on either up-peak or down-peak respectively. Contacts UPR-1 and DPR-1 can connect outputs UPO or DPO to N to indicate either of these two conditions.

PEAK DETECTOR

FIG. 35 shows the circuit for the peak detector, its purpose being to determine when traffic conditions are such that either the up-peak or the down-peak program must be used in order to provide the best service. As mentioned previously, this scanning system provides a basic program so flexible that it will handle all traffic situations except up-peak and down-peak. This basic program is normally used, and it is only when the peak detector detects up-peak or down-peak traffic that operation is transferred from this basic program to one of the two peak programs. Thus, in effect, the peak detector determines which of these three programs is best suited to the prevailing traffic.

Part of the circuit of FIG. 35 is used to determine whether or not the number of hall calls registered exceeds the total availability of all cars. This is accomplished by using a counter almost identical with the counter required for each car, which was described in FIG. 19. This counter, is, however, read and reset at only one point during each normal scan, at the commencement of each ascending scan. This counter has similar restrictions on adding above 011,111 and on subtracting below 100,000. It does not have the optional restriction of adding above 0, which the other counters have. Thus, this counter subtracts 1 for each hall call seen during the scan, and adds 1 or 2, depending on the availability, for each car seen on the scan. Admittedly, some cars may be counted twice because they are both UAV and DAV, but this occurs only when there is surplus availability. As the number of hall calls increases, more and more cars are started and are then either UAV or DAV, but not both, and thus, when the number of hall calls registered becomes high enough so that there are in-

sufficient cars, this condition is truly determined by the accumulated count on this counter just prior to a resetting. If the count is 0 or positive, the number of hall calls registered does not exceed the total availability of all cars. If the count is negative, there is an excess of hall calls, exceeding the availability of the cars.

Since the counter required in FIG. 35 is so similar to the counter shown in FIG. 19, the circuit will not be repeated here. Instead, a large labeled rectangle is used to represent the counter. The inputs and outputs of this counter are identified by names in brackets, corresponding to the inputs and outputs of the counter of FIG. 19. Slight simplification can be made, however, in the counter for use in FIG. 35. NOR 185 may be omitted, since it is not required, but if it is not omitted, $\bar{n}AS$ should be connected to -18 source terminal. NORs 189 and 190 (which are required for amplification only) may be omitted and, output (PN) is obtained from output 1 of BM 183, and output ($\bar{n}PN$) is obtained from output 2 of BM 183.

Input EP is inverted by NOR 541 to create a signal equivalent to the input $\bar{n}EP$ of FIG. 19. Thus, the counter in FIG. 35 counts the pulses of wire EP in the same manner as the counter in FIG. 19, except that in FIG. 19 the input $\bar{n}EP$ is sometimes caused to remain high when EP is high, in order to ignore certain other cars, or certain hall calls, as explained previously. This does not occur on the counter of FIG. 35. Input T of the counter of FIG. 19 is normally the same as signal I2, but can sometimes remain low in spite of I2, so that this car pessimistically interprets the availability of other cars either above or below as 1 instead of 2. The corresponding input to the counter of FIG. 35 is therefore I2 so that this counter correctly interprets the availability of all cars at all times.

When signal M1 becomes low at the beginning of each ascending scan, output $\bar{n}BOT$ of the spacer becomes low, and this causes output YP of the up-peak spacer to become briefly high. This is used to determine the reading point of this counter. All of this occurs at the beginning of an A pulse. During the succeeding B pulse, input BOT to NOR 545 is still high, and input MS is also high, so that input BP causes the output of NOR 545 to be low. Although input BOT remains high as long as the main scan is at this bottom floor, input MS assures that the resetting cannot continue throughout a secondary scan here. Thus, the output of NOR 545 is low for the duration of only one B pulse, the first one to occur after the ascending scan has started. This is applied to input ($\bar{n}SZ$) of the counter to cause it to be reset to zero at the beginning of each ascending scan.

Input S1 is required to this counter to indicate whether it is addition or subtraction which must occur.

As mentioned previously, input YP is arranged to be high at the correct time to read the condition of the counter just prior to resetting. As before, with the counter of FIG. 19, the condition of the final digit of the counter is an indication of whether or not the accumulated count on the counter is 0. Thus, if output ($\bar{n}PN$) is high at the time of reading, the output of NOR 561 is low and it sets a flip-flop consisting of NORs 562 and 564 to the condition where the output of NOR 562 is high, to represent that the accumulated count of the counter was negative. Similarly, if output (PN) is high at the time of reading, the output of NOR 563 is briefly low so as to set the flip-flop to the opposite condition, where the output of NOR 564 is now high to indicate that the accumulated count on the counter was 0 or positive.

As previously mentioned, the number of down hall calls which are registered must be known to assist in determining the commencement of up- and down-peaks, and the ending of down-peak. For this purpose, it is only down hall calls above the main floor that are of significance. The priority stepper contains information regarding how many such down hall calls are registered. Signal $\bar{n}15$ is normally low only when the master counter is at the counter of 1111. However, if there is one down hall call registered, signal $\bar{n}15$ is low also when the counter is at the count of 1110. Also, if there are two down

hall calls registered, signal $\bar{n}15$ is low for three consecutive steps of the main counter, from 1101 to 1111. Similarly, for any number of down hall calls (up to 15), signal $\bar{n}15$ becomes low at such a time that it remains low for a number of counts equal to the number of down hall calls plus one, ending when the counter reaches the count of 1111. Therefore, if the condition of signal $\bar{n}15$ is noted at a particular step of the main counter of the priority stepper, it gives an indication of whether or not the number of down hall calls registered above the main floor exceeds a certain number. This number is determined by which step of the main counter the reading was taken at.

The preceding description regarding the information contained in wire $\bar{n}15$ does not apply immediately after a down hall call is canceled, if there are other calls of lower priority. Then, the $\bar{n}15$ pulse caused by the priority card at that floor disappears momentarily, as a signal to the call of next lower priority that it should stop for one step to properly show its new priority. It then causes another brief disappearance of the $\bar{n}15$ pulse, to cause the call of next lower priority to stop for one step. This process continues until all calls of lower priority (lower than the call being canceled) have stopped, in turn, for one step so that they now indicate their new priorities.

This brief loss of the $\bar{n}15$ signal could cause a momentary false measurement of the number of down hall calls, which might cause incorrect termination of the down-peak. To prevent this, a flip-flop consisting of NORs 602 and 603 is used to define the period from the first time $\bar{n}15$ becomes low, until the master stepper (in the priority stepper) steps from 1111 to 0000. Normally, $\bar{n}15$ would remain low during this period anyway, but when a down hall call is canceled, $\bar{n}15$ may not remain continuously low, as just explained.

Each time signal AP goes from high to low, at the end of each A pulse, the output of one-shot 599 becomes briefly low, and the output of NOR 600 becomes briefly high. If input I5 is also high at this time, the output of NOR 601 becomes briefly low, and the flip-flop 602 and 603 is set so that the output of NOR 602 is high.

This condition remains until the master stepper goes from 1111 to 000; then signal 8A goes from high to low, the output of NOR 578 also goes from high to low, and the output of one-shot 604 is briefly low. This sets the flip-flop back to its original condition. Thus, the output of NOR 602 is equivalent to signal I5, but corrected for the false indications which can occur when a down hall call is canceled. Similarly, the output of NOR 603 corresponds to signal $\bar{n}15$.

The condition of each digit of the binary number represented by the main counter in the priority stepper is transferred to the peak detector via inputs 1A, 2A, 4A and 8A. These signals are then inverted by NORs 571, 573, 575 and 577, so as to be sufficiently amplified to be used in connection with a series of switches which will be described soon. A further inversion of these signals is performed by NORs 572, 574, 576 and 578, for a similar purpose. Thus, switches SWC1, SWD1 and SWE1, can be set to select a signal either equivalent to or opposite to 1A. Similarly, switches SWC2, SWD2 and SWE2, can select a signal either equivalent to or opposite to 2A. Further switches SWC4, SWD4 and SWE4, can select a signal either equivalent to or opposite to 4A. Finally, switch SWC8 can select a signal either equivalent to or opposite to 8A.

NOR 565 is arranged so that its output is normally high, but becomes intermittently low whenever conditions indicate that the down-peak program should be placed in effect. This, of course, occurs only when all of its 9 inputs are high. One of these 9 inputs is derived from NOR 562 whose output is high only if the number of hall calls registered exceeds the availability of all cars. Obviously, if the number of hall calls registered is less than the availability of all cars, there is no need for switching to a down-peak program since all hall calls, including down hall calls, have a reasonable expectation of being answered within a reasonable time.

A second input of NOR 565 is derived from monostable multivibrator 587 whose operation will be described later. Its output is normally high, but becomes low to indicate up-peak conditions, and thus it prevents the system from going onto down-peak when up-peak conditions exist. Another input of NOR 565 is $nUPK$ which assures that the system cannot simultaneously be on up-peak and down-peak. If the system is already on up-peak, $nUPK$ is low.

The remaining inputs to NOR 565 are required to prevent establishment of down-peak unless the number of down hall calls registered above the main floor exceeds a predetermined number determined by the conditions of switches SWC1, SWC2, SWC4 and SWC8. The four inputs derived from these switches will all be high only for one of the 16 steps of the main counter in the priority stepper. If, during a B pulse, when input BP is high, input 15 is also high, it is an indication that the number of such down hall calls exceeds the predetermined number, and thus all of these inputs to NOR 565 will be high together for the duration of a B pulse.

Thus, the output of NOR 565 becomes low only if the following conditions are met: lack of up-peak conditions, lack of availability of cars, no up-peak existing, and more than a predetermined number of down hall calls above the main floor. This results in the setting of a flip-flop consisting of NORs 566 and 567 so that output DPK is high indicating that the bank is now operating on the down-peak program. Signal DPK is transmitted to the rotational instructor and to the instruction readout card for each car to place in effect all those features previously described, which constitute the down-peak system. Relay driver 568 also causes output DPKA to become high at this time, and it energizes relay DPR on each output card to indicate to each car that it must modify its operation for down-peak purposes.

Switches SWC1, SWC2, SWC4 and SWC8 are shown in FIG. 35 in the positions they would assume if it were desired to have 10 down hall calls the number required to establish down-peak. The predetermined number of down hall calls established by the setting of these switches can be determined by adding the final digits of the names of those switches whose blades are to the left. For example, if switches SWC4 and SWC1 were the only ones so positioned, the predetermined number would be 5.

NOR 569 is arranged so that its output is normally high, but becomes intermittently low if the number of down hall calls registered above the main floor is less than a predetermined number established by switches SWD1, SWD2 and SWD4, which must be lower than the predetermined number required to establish down-peak. No switch is provided to select an input to NOR 569 either equivalent to or opposite to 8A. Instead, this input is connected to the output of NOR 578, so that the maximum predetermined setting is seven, rather than 15. In other words, the fourth switch is omitted and a connection made as if this switch were always to the right.

At a particular step of the counter in the priority stepper, as determined by switches SWD1, SWD2 and SWD4, and by the output of NOR 578, all inputs to NOR 569 will be high during one B pulse if input $n15$ is high at the same time. It will be so only if the number of down hall calls above the main floor is less than the predetermined number. Then, the output of NOR 569 becomes intermittently low, and the first such pulse resets flip-flop 566 and 567 to end the down-peak.

NOR 570 has nine inputs which are somewhat similar to the nine inputs of NOR 565. The output of NOR 570 is normally high, but becomes intermittently low whenever conditions indicate that the up-peak program should be placed in effect. This, of course, occurs only when all of its nine inputs are high. One of these nine inputs is derived from NOR 564 whose output is high only if the number of hall calls registered is less than the availability of all cars. Obviously, if the number of hall calls registered exceeds the availability of all cars, it would not be desirable to put the up-peak program into operation.

A second input to NOR 570 is derived from NOR 588 which inverts the output of monostable multivibrator 587. The out-

put of NOR 588 is normally low, but becomes high when up-peak conditions are detected by a circuit which has not yet been described. Another input of NOR 570 is derived from the output of NOR 567 which is low during down-peak, so that the system cannot switch to up-peak when it is already on down-peak.

The remaining inputs to NOR 570 are all high together only during one of the 16 B pulses which occur during a complete cycle of the main counter in the priority stepper, and in a similar manner to the similar inputs of NOR 569, these are all high only when the number of down hall calls registered above the main floor is less than a predetermined number determined by switches SWE1, SWE2 and SWE4. In FIG. 35, only switch SWE2 has its blade showing to the left, and, therefore, the predetermined number is two.

Accordingly, the output of NOR 570 becomes low only if the following conditions are met: up-peak conditions exist, there is no lack of availability of cars, down-peak does not presently exist and there is less than a predetermined number of down hall calls above the main floor. This results in the setting of a flip-flop consisting of NORs 579 and 580, so that the output UPK of NOR 579 is high, indicating that the bank is now operating on the up-peak program. NOR 581 amplifies and inverts this signal to create output $nUPK$ which is low during up-peak. These two outputs, UPK and $nUPK$, are required on various other cards to obtain those features previously described, which constitute the up-peak system. Relay driver 582 also causes output UPKA to become high during up-peak, and it energizes relay UPR on each output card to indicate to each car that it must modify its operation for up-peak purposes.

Once the up-peak program has been placed in operation, flip-flop 579 and 580 remains in this condition until up-peak conditions have ceased for approximately 2 minutes, and then transistor Q21, which is normally turned on, turns off intermittently and the first such turning off allows resistor R90 to cause one of the inputs of NOR 580 to be low, so that the flip-flop is returned to its original condition, indicating no up-peak. A further input to NOR 580 is obtained from the output of NOR 567 as an interlock between the flip-flops for up-peak and down-peak, so that they cannot simultaneously indicate up-peak and down-peak.

UP-PEAK DETECTION

The circuit which detects up-peak conditions will now be described. Input $nCSP$ is normally high, but becomes low for a short time each time any car, which is in service, stops for a car call while travelling in the up direction. This causes the output of monostable multivibrator 583 to become low and remain low for approximately 50 milliseconds. The beginning of this 50 millisecond period coincides with input $nCSP$ first becoming low, and the end of this period is uninfluenced by how soon $nCSP$ is restored to its normal high condition. Thus, relay driver 585 is turned on to energize the coil of relay CSC for about 50 milliseconds each time a car stops for a car call in the up direction.

A similar circuit involving monostable multivibrator 584 and relay driver 586 is arranged so that each time a car stops for a down hall call, as indicated by $nHSP$ becoming low, relay HSC is energized for about 50 milliseconds.

Capacitor C3, whose suggested value is 56 mfd., has discharge resistors R70 and R71 permanently connected across it so that it tends to slowly discharge with a time constant of several minutes. The rate of this discharge can be adjusted by resistor R70. One side of this capacitor is connected to a voltage divider consisting of resistors R68 and R69, so that R69 can be adjusted to change the voltage at which this end of the capacitor is held. The other end of capacitor C3 can be connected to +18 through resistors R72 and R74 by the closing of contact CSC-1, or to 0 through resistors R72 and R75 by the closing of contact HSC-1. Thus, this side of capacitor C3 tends to drift slowly toward the voltage determined by

the adjustment of resistor R69, but it is caused to become more positive by a small amount whenever contact CSC-1 closes due to any car stopping for a car call in the up direction. Similarly, this side of capacitor C3 is caused to become more negative by a small amount whenever contact HSC-1 closes due to any car stopping for a down hall call.

During nonpeak periods, the number of stops for car calls in the up direction is not too different from the number of stops for down hall calls. Capacitor C3 then tends to be sometimes charged one way, and sometimes charged another way, but is never able to become very highly charged in either polarity. If the number of stops for down hall calls is high, and there are few stops for car calls in the up direction, as would exist during heavy down traffic, or during a down-peak, this side of capacitor C3 would tend to become more negative, closer to O. Diode D72 prevents the polarity from reversing, which might damage the capacitor if it is electrolytic. If the cars are stopping predominantly for car calls in the up direction, and seldom for down hall calls, capacitor C3 tends to be charged in the opposite way, provided that such stops for car calls are occurring frequently enough, as they do when up-peak traffic occurs. Thus, if this side of capacitor C3 becomes sufficiently positive, it is an indication that up-peak conditions exist.

Unijunction transistor Q16 is used to detect this condition. It must do so without appreciably affecting the charge on capacitor C3. Therefore, a unijunction transistor such as 2N2647, which has high input impedance, is used for this purpose, and the resistor R73 is made quite high, preferably 22 megohms. As the right side of capacitor C3 becomes more and more positive, resistor R73 charges condenser C5, whose suggested value is 0.01 mfd., so that the emitter of transistor Q16 is essentially always at the same voltage as the right side of capacitor C3. When this has become sufficiently high, usually about seven-tenths of the voltage between base 1 and base 2, transistor Q16 fires. Capacitor C5 assures that sufficient emitter current can flow to cause this firing, since resistor R73 is too large to permit such a flow of current. The firing of transistor Q16 quickly discharges capacitor C5, and it charges again through resistor R73. If the voltage on the right side of capacitor C3 is still high enough, Q16 fires again, and transistor Q16 is caused to fire intermittently when up-peak conditions exist.

A further circuit is needed to enable transistor Q16 to fire with such a high input resistance, since the leakage from the emitter to base 1, as the firing point is approached, would prevent capacitor C5 from charging to a high enough voltage. Therefore, a circuit consisting of a further unijunction transistor, Q17, resistors R76, R78 and R79, and capacitors C6, and C8, is provided. Capacitor C8 charges through resistor R78 until the emitter of transistor Q17 reaches its firing point. Then, the impedance between base 1 and base 2, and between the emitter and base 1, becomes low so that capacitor C8 is quickly discharged, and, incidentally, current flows through resistor R79. Thus, the voltage on the right side of capacitor C6 rises slowly and falls rapidly, to create a sawtooth waveform with a frequency determined by R78 and C8, and preferably about 50 cycles per second. This can be obtained by making R78 390 Kohms, capacitor C8 0.05 mfd. and by using a 2N2646 transistor.

Capacitor C6, whose value is 0.001 mfd., and resistor R76, whose value is 470 ohms, cause the base 1 of transistor Q16 to be made briefly about 1 volt more negative than normal approximately once each 20 milliseconds.

This causes the firing voltage of transistor Q16 to be momentarily lowered at this rate, and this effectively increases its sensitivity in a well-known manner since the emitter current is now caused to be high enough to cause firing, if the emitter voltage is sufficiently high, regardless of the previously mentioned difficulty due to leakage current.

Each time transistor Q16 fires, current flows through resistor R77 whose value is 27 ohms, and this causes capacitor C7, whose value is 0.005, to momentarily turn off transistor Q20, which is normally turned on by the flow of its base cur-

rent through resistor R87, whose value is 39 Kohms. The collector resistor R88 is 1.5 Kohms.

Thus, the result of this circuit is that when up-peak conditions exist, the output of transistor Q20, which is normally high, is caused to be briefly low as a series of negative pulses. Monostable multivibrator 587 is provided so that its output remains essentially constantly low whenever up-peak conditions exist. Its capacitor must be of such a size that its output remains low for at least the duration of one complete cycle of the 16 steps of the counter in the priority stepper. Otherwise, the circuits previously described consisting of NORs 565 and 570 might find one of their inputs low, due to monostable multivibrator 587, at a time when all other outputs are high.

Relay driver 589 has input UPK as well as the output of MM 587, so that it causes relay RET to be normally energized, and to be deenergized only during up-peak, and then only when up-peak conditions no longer exist. The opening of contact RET-1 allows capacitor C9 to be charged through resistor R80. The values of these two components are 2 mfd. and 66 megohms, respectively. Thus, if contact RET-1 remains open for approximately two minutes continuously, capacitor C9 charges to a sufficiently high voltage that diode D74 causes unijunction transistor Q18 to fire, and this causes capacitor C9 to be discharged through diode D74, transistor Q18 and resistor R86. The flow of current through resistor R86, whose value is 27 ohms, causes base 1 of transistor Q18 to become briefly high enough in voltage to turn off transistor Q21 which is normally held turned on by resistor R89, whose value is 39 Kohms. This, as previously explained, sets flip-flop 579 and 580 back to the condition representing no up-peak.

Resistor R82 is provided to partially compensate for the leakage of transistor Q18 and may have a value of 15 megohms. Resistor R81 is provided so that the contact RET-1, which normally prevents charging of capacitor C9, can discharge this capacitor quickly if, during up-peak, up-peak conditions are again detected by the previously described circuit.

Then, the timer is reset so that it starts out for a new two minute timing period when up-peak conditions are no longer detected.

A further circuit, consisting of unijunction transistor Q19, resistors R83, R84 and R85, and capacitors C10 and C11, is provided to allow transistors Q18 to fire, in spite of the tendency for its leakage current to prevent capacitor C9 from charging to a sufficiently high voltage. The values of these components are all the same as the values of the similar ones in the previously described circuits. Transistor Q18 is 2N2647, the same as Q16, and transistor Q19 is 2N2646, the same as Q17.

When the transistor Q18 fires, it discharges capacitor C9, and normally results in the end of up-peak, and thus contact RET-1 immediately closes to prevent further charging of capacitor C9. If it did not close, this circuit would continue to give a briefly low output from the collector of transistor Q21 at intervals of approximately 2 minutes.

ASSOCIATED CONTROLS

The transistorized circuits required to accomplish my scanning system have now been described. The remainder of the circuits, associated mainly with speed control, door control, determining whether there are car calls above or below, canceling car calls, the determination of direction of travel, etc., need not be transistorized, but may be if so desired. These circuits can be essentially conventional elevator circuits, and a circuit designer skilled in the art would have no difficulty producing such a circuit to provide for the few inputs required to the transistorized circuits, as already described. The outputs available from the transistorized circuits are such that it would be very easy for such a circuit designer to use them to make the system operate in the desired manner. For example, having all decisions regarding when there are hall calls above or below each car, which it should

answer, simplifies tremendously the design of such a circuit. Similarly, the spacing outputs make it unnecessary for the designer to spend much time with this aspect of the circuit. Also, most of the "next" selection circuits is already done for him, as is the detecting of peaks. Also, for a night service program, all that is needed is a conventional automatic shutdown timer for each car, such is frequently used on a single variable voltage elevator.

One example of a relay circuit suitable for use with these transistorized circuits will now be described. These circuits are shown as an example only, and are not intended to restrict in any way the scope of this invention. A relay circuit has been chosen instead of a transistorized circuit since such relay circuits are so well known, and can thus be more readily understood. The relay circuits are identical for each car. FIGS. 38 to 48 show this relay circuit for one car, and an identical circuit is required for each other car in the bank.

This relay circuit which will be illustrated shows some, but not necessarily all, of the features which would normally be supplied with such a system. For example, a very simple door system is shown but various means of determining when the doors should close, using timers, beams of light, etc., are well-known, but are not shown here since they do not form part of this invention. A variable voltage speed control system is shown in order to illustrate one of the important features of this invention, the ability of the system to handle easily situations in which one or more cars have their MG sets automatically shut down. At the present state of the art, a variable voltage system would normally be required for any installation using this invention, but it must be understood that if this invention were used on an installation having no MG sets, the transistorized circuits could be simplified by removal of those circuits, particularly the extra stepper, and the extra scan control for each car, which are associated with automatic MG shut down.

The variable voltage system shown in these relay circuits is also simplified by the omission of such well-known and conventional elements as a regulator, suicide circuit, overload relays, etc. The method used for controlling the various steps of slowdown, as well as indicating the advanced digital position is the same as that shown in my said copending patent application, Ser. No. 430,529. It should be understood, however, that this invention is not restricted in any way to use with this system, and could be used with any other suitable system including one which controls the elevator speed continuously, rather than in steps. For simplicity, only one column of proximity devices is shown on the car, with a corresponding single column of position magnets with only one magnet for each floor. This arrangement is suitable only for lower speeds, and usually there would be two or more columns of proximity devices on the car, with corresponding columns of position magnets. The principle of operation is still the same, and thus the simpler arrangement is sufficient for the purposes of describing the invention.

CAR OPERATING APPARATUS

In FIG. 38, incoming 3-phase power is supplied to lines L1, L2 and L3. Transformers T1, and T2 transform this voltage to some lower voltage which, when rectified by diodes D121 to D126 connected in 3-phase bridge, provides a suitable direct voltage for operating the brake, fields, relays, etc. A switch MGS is provided to allow for complete manual shutting down of this elevator. Normally, it is closed, and relay MG is continuously energized. Contacts MG-1, MG-2 and MG-3 are then closed to connect the rectifier to the output of the transformers. The coil of contactor S is also energized through AST-4, except during automatic shutdown. Thus, contacts S-1, S-2 and S-3 connect the AC drive motor MGM of the MG set to the three supply lines, so that it rotates at essentially constant speed; it is coupled mechanically to the armature GA of the MG set.

The output of generator armature GA is connected electrically through a series field GSF, on the generator, to the armature HMA of the hoist motor. Armature HMA is connected to brake drum BD and either directly or through gears to sheave 701. Hoist cable 702 passes over sheave 701 and connects to counterweight 703 and to car 704 so that rotation of sheave 701 imparts vertical motion to the car in a conventional manner. Brake shoe BS is normally held tightly against drum BD by a spring, but can be released by the energization of brake magnet BM.

A proximity contact column 706 is attached to the car by brackets 705. Stationary position magnets 1PM, 2PM, 3PM, etc., are arranged in a vertical column so that column 706 can pass between the two vertical plates of each position magnet. These magnets are so located that when the car is level at a floor, the corresponding position magnet is centered on the column 706, so that certain proximity contacts located therein are within the range of influence of this magnet. The car is shown level with floor 1F, and with column 706 centered on position magnet 1PM. If the car were level with floor 2F, column 706 would be similarly centered on position magnet 2PM. A similar alignment of each other position magnet occurs when the car is level at the corresponding floor. Although the highest floor shown is 20F, since the circuits for only 20 floors were shown previously, it will be understood that more or fewer floors can of course be served depending on the installation.

The shunt field HMF of the hoist motor is continuously energized through resistor R101. As long as the MG set is running, contact S-4 is closed so that a portion of this resistance, as determined by adjustable tap AT9, is shorted out to determine the standing field current. Contact MF-1 closes during acceleration and slowdown to increase the field current to the maximum value so that full torque can be obtained from the hoist motor.

The shunt field GF on the generator is energized through contacts U-1 and U-2 for up travel, or through contacts D-2 and D-1 for down travel, and also through resistor R100 and contact M-1. Adjustable taps AT1 to AT8 allow adjustment of landing speed, various intermediate speeds, and top speed, respectively. Contact VL-1 is open when the car is stopped, and closes very early in the accelerating sequence. It is followed by subsequent closing of contacts V3-1, V4-1, V5-1, etc., so that when all of these contacts are closed, most of resistor R100 is shorted out to obtain top speed, as determined by tap AT8. During slowdown, these contacts open in the reverse order, starting with V8-1, and ending with VL-1, to slow the car down in steps until landing speed is reached. Final stopping at the floor results in complete deenergization of the generator field GF by the deenergization of contactors U and M, or D and M.

Brake magnet BM is energized through contacts M-2 and either U-3 or D-3 whenever it is necessary to lift brake shoe BS clear of brake drum BD in order to operate the hoist motor either for normal running or for releveling.

A telephone-type stepping switch PQ is provided so that its position corresponds with the advanced digital position of the elevator. One of its levels, consisting of a wiper PQ-AW and contacts PQ-A1, PQ-A2, PQ-A3, etc., is used to selectively energize the position magnets. Thus, only one position magnet can be energized at one time (except that a terminal floor position magnet may also be energized, if desired, as indicated in said application Ser. No. 430,529), and the one which can be energized is determined by the position of the wipers of stepping switch PQ. Contact PO-5 is arranged to open when the stepping switch PQ is moving from one position to another so that the delicate contacts of the stepping switch are protected from damage due to making or breaking the inductive load of a position magnet. Further contacts LV-1, US-2 and DS-2 are required for reasons to be described later, under the description of operation of relay LV.

CONTACT COLUMN

FIG. 39 shows an enlarged elevation view of the column 706 and a typical position magnet, such as 1PM, in the relationship they have when the car is level at a floor. Further position magnets for the floors immediately above and below could also be in a position to influence other parts of the column, but are not shown here.

The position magnet 1PM consists of two upright rectangular side plates 707, of which only the nearer one shows in this view. The other one is on the other side of the column 706, but directly in line with the nearer plate. Two bolts 710 hold these two plates in correct alignment and spacing, and coils 708 and 709 surround these two bolts. Thus, when these two coils are connected, either in series or in parallel, to a suitable source of direct current, one of these two plates becomes a north pole, and the other becomes a south pole, so that magnetic flux is caused to flow in a substantially horizontal direction from one plate to the other through the column 706 which is constructed of some nonmagnetic material such as aluminum.

The proximity contact column 706 contains a vertical column of magnetic proximity contacts PCD, PC8D, PC7D, PC6D, PC5D, PCLD, PCUS, PCA, PCC, PCB, PCDS, PCLU, PCSU, PC6U, PC7U, PC8U, and PCU. These consist preferably of normally open "reed" contacts, similar to those already described for use in the relays used in the input and output cards, and consisting of two reeds sealed with an inert gas in a glass envelope. Magnetic flux flowing lengthwise along such a reed contact causes magnetic attraction of the two reeds so that they bend and touch to complete the electrical circuit. Each of these reed contacts is horizontally located in the column 706, so that they are seen in end view as small circles. The vertical position of each is adjustable to allow adjustment of the distance from a floor at which the corresponding step of slowdown occurs.

In the up direction, the reeds close in the following order as the car approaches, and lands at, a floor from full speed: PCU, PC8U, PC7U, PC6U, PC5U, PCLU, PCDS, PCB, PCC, PCA and PCUS. The first five of these open again after approximately 12 inches of car travel, but the remaining ones normally remain closed when the car becomes level at the floor, except that a circuit is provided to momentarily deenergize the magnet for the purpose of causing reed PCLU to open and remain open. The closing of each of these contacts results in a step of slowdown except that the closing of reeds PCLU and PCB are not used for steps of slowdown in the up direction. Similarly, in the down direction the order of closure is PCD, PC8D, PC7D, PC6D, PC5D, PCLD, PCUS, PCA, PCC, PCB and PCDS, with all of these causing steps of slowdown, except PCLD and PCA.

The remaining FIGS. can best be explained by first describing the purpose and operation of each of the various relays used. This will be done in alphabetical order, with numerals listed after letters.

- A Acceleration relay. Energized while the doors are closing in preparation for a run, and while the car is accelerating and running at full speed. Deenergized at the commencement of slowdown. 60
- AST Automatic shutdown timer. Energized after car has been idle for about 4 minutes, and remains energized until car is required to run again.
- AV Available relay. Energized provided that this car is in service, and has not been held for an excessive length of time after it otherwise would have started. 65
- BLF Below lobby floor. Energized when this car travels below the main floor.
- CA Call above. Deenergized to indicate that there is a car or hall call above, which this car should answer, or some other reason for this car to travel up, such as for spacing. 70
- CB Call below. Deenergized to indicate that there is a car or hall call below, which this car should answer, or some other reason for this car to travel down, such as for spacing. 75

- CCA Car call above. Deenergized when there is a car call above.
- CCAT Car call above timer. Deenergized when the car is at the main floor, and there is a car call registered for an above floor. Drops out after a time delay.
- CCB Car call below. Deenergized when there is a car call for a floor below.
- CE Close contactor for doors (entrances). Energized to apply closing power to the door operator.
- CN Canceling relay. Energized to cancel car calls.
- CNH Canceling relay. Energized to cancel hall calls.
- CP Critical position relay. Energized when the car has reached a position relative to the advanced digital position where a stop can just be made at that floor from the speed presently attained, but beyond which a stop cannot be made.
- CS Car call stop. Energized to initiate a stop for a car call.
- CSM Car call stop memory. Energized to remember that the car has stopped for a car call, in the down direction, after having stopped for a down hall call. 20
- CT Call timer. Deenergized when either relay CA or CB drops and drops out after a very brief time delay.
- CW1 Car weight relay. Picks up when the weight in the car exceeds approximately 10 percent of rated load.
- CW2 Car weight relay. Picks up when the weight in the car exceeds approximately 40 percent of rated load. 25
- CW3 Car weight relay. Picks up when the weight in the car exceeds approximately 70 percent of rated load.
- D Down contactor. Energized to run the hoist motor in the down direction. 30
- DM Down master relay. Energized when the down direction of travel is established.
- DP Down-peak relay. Energized when the system is operating on down-peak.
- DR Down run relay. Energized just prior to the starting of the car in the down direction (but not for releveing. Remains energized until the car stops at the destination floor, regardless of any interruption to the safety circuit, such as the pressing of the stop button. 35
- DS Down stopping relay. Energized when the car becomes approximately one-half inch above the destination floor, when travelling down, or about 11 inches below the floor, when travelling up.
- E Entrance relay. Energized to close the doors, and keep them closed. Deenergized to open the doors, and keep them open. 45
- ET Entrance timer. Basically, deenergized when the doors have become fully opened, and drops out after a time delay to cause automatic closing of the doors if other requirements, such as lack of pressure on the safety-edge, are met. Also, deenergized with long delay when doors are supposed to be opening. The dropping of relay ET then allows the opening sequence to be interrupted if the doors fail to open properly, so that the car can start again.
- F Forecasting relay. Energized while the doors are closing to indicate an impending run. Remains energized once the car has started, until stepping switch PQ steps to some floor other than the one from which the trip originated, at which there is some reason for this car to stop. The dropping out of F thus indicates an impending stop. 50
- GCL Gate close limit relay. Energized through the close limit on the door operator. Thus, this relay is energized for all positions of the car door (gate) except fully closed.
- HCA Hall call above relay. Deenergized when there is a hall call above this car, which it should answer.
- HCB Hall call below relay. Deenergized when there is a hall call below this car which it should answer.
- HCS Hall or car call stopping relay. Energized to initiate a stop for a car or hall call. Also energized to initiate opening of the doors for a hall call at the same floor, or when this car becomes the next up car. Once energized, it remains so while the car is slowing down, if applicable, while the doors are opening, and for a short time after the doors have become fully open. Remains energized on a car which is next up, until it is ready to leave. 55

HS Hall call stop relay. Energized to initiate a stop for a hall call.

IS In service relay. Energized when this car is in service, and deenergized if this car is operating on independent service, or is completely shut down.

J Journey relay. Energized to indicate that this car is a normal car for up-peak and down-peak purposes.

K1 Down hall stop counting relay. Energized when this car has stopped for only one down hall call in the down direction on this trip. Deenergized if the car stops for further down hall calls.

K2 Down hall stop counting relay. Energized if this car has stopped for one or more down hall calls on its trip.

LD Level down relay. Energized if the car is high, to indicate that it should level down.

LF Lobby floor relay. Energized when this car is at the main floor.

LU Level up relay. Energized if the car is low, to indicate that it should level up.

LV Level vibrate relay. Energized intermittently during releveling to intermittently deenergize the position magnet, so that the effective pickup and dropout positions of relays LU and LD are uninfluenced by the inherent hysteresis of the reed contacts.

M Main contactor. Energized with either U or D.

MA Timed auxiliary to M and MR. Energized during a normal run, or during releveling. Timed to drop out a short time after such motion stops.

MF Motor field contactor. Energized during acceleration and deceleration to increase the motor field from standing strength to full strength.

MG Motor generator relay. Normally energized and can be deenergized to completely shut down this elevator.

MR Main running relay. Energized with either DR or UR.

MRA Auxiliary to MR. Normally energized and deenergized by relay MR, but delayed slightly when the car is starting. Drops out after a time delay if the car makes an emergency stop.

MT Timed auxiliary to M. Energized when M picks up and timed to drop out approximately three seconds after M drops.

NX Next relay. Energized when this car is suitable for being the next up car, and has been so selected.

NXA Auxiliary to NX.

OE Open contactor for doors (entrances). Energized to apply opening power to the door operator.

OST Out of service timer. Deenergized whenever the car is not running, but should be and timed to drop out approximately 15 seconds later, to indicate that this car is no longer available. Picks up again when the car starts to run and, in normal operation, it should seldom drop out.

PKA Park above relay. Energized to indicate that this car should go up for spacing purposes.

PKB Park below relay. Energized to indicate that this car should go down for spacing purposes.

PLT Passenger loading timer. Deenergized only when this car is next up and has had its doors open long enough for passengers to unload. Timed to drop out after a suitable time has elapsed for incoming passengers to enter the car.

PM Pulse memory. Energized when stepping switch PQ is first pulsed one step at the beginning of a run and remains energized until the car stops at the destination floor.

PO Pulse relay. Energized briefly whenever it is necessary to pulse stepping switch PQ from its present position to the next position.

PQ Position stepping switch. The position of this stepping switch indicates the advanced digital position of this car.

PS Pass relay. Normally energized, but drops out to cause this car to automatically bypass hall calls.

PUT Passenger unloading timer. Deenergized only when this car is stopped at the main floor, and timed to drop out after a suitable delay, which depends on the load on the car, has elapsed for passengers to unload from the car.

S Starting contactor for MG set. Normally energized, but drops out to stop the MG set during automatic shut down, or when this car is completely shut down.

U Up contractor. Energized to run the hoist motor in the up direction.

UM Up master relay. Energized when the up direction of travel is established.

UP Up-peak relay. Energized when the system is operating on up-peak.

UR Up run relay. Energized just prior to the starting of the car in the up direction (but not for releveling) and remains energized until the car stops at the destination floor, regardless of any interruption to the safety circuit, such as the pressing of the stop button.

US Up stopping relay. Energized when the car becomes approximately one-half inch below the destination floor, when travelling up, or about 11 inches above the floor, when travelling down.

VL Velocity relay for landing speed. Energized whenever the car is within about 2 inches of the floor where the position magnet is energized. Drops out before the car has moved 2 inches during acceleration, due to the deenergization of the position magnet.

V3 Velocity relay, third speed. Energized early in the acceleration, after VL has dropped. Deenergized when the car reaches a point approximately 6 inches from the floor during slowdown.

V4 Velocity relay, fourth speed. Picks up early in the acceleration, after V3 has picked up, and deenergized when the car reaches a point approximately 11 inches from the floor during slowdown.

V5, V6, V7, V8 Velocity relays. Energized in sequence to accelerate the car and deenergized at various distances from the floor during slowdown.

ZE Zone relay. Energized when the car is within approximately 6 inches of the floor where the position magnet is energized.

1NC Inverted auxiliary to relay XC on the car call card for floor 1. Deenergized when there is a car call registered for floor 1.

1PO Position relay for floor 1. Energized when stepping switch PQ is at a position representing floor 1.

2L Lantern relay for floor 2. Energized to illuminate the up or down hall lantern at floor 2.

2NC Inverted auxiliary to relay XC on the car call card for floor 2. Deenergized when there is a car call registered for floor 2.

3L Lantern relay for floor 3. Energized to illuminate the up or down hall lantern at floor 3.

3NC Inverted auxiliary to relay XC on the car call card for floor 3. Deenergized when there is a car call registered for floor 3.

3PO Position relay for floor 3. Energized when stepping switch PQ is at a position representing floor 3. Switch relays 4L, 5L, 6L, etc., are used to illuminate the corresponding hall lanterns at all other floors except the top floor, which has no such relay. Similar relays 4NC, 5NC, 6NC, etc., are required for all other floors, so that each such relay is deenergized to indicate that there is a car call registered for the corresponding floor. Similarly, a relay 4PO shows that the stepping switch is at a position representing floor 4, and a relay 20PO is used (assuming a total of 20 floors) to indicate that the stepping switch is at a position representing the top floor.

LFT Timed auxiliary to LF; picks up with LF, drops about one-fourth second after LF drops.

DMC Common auxiliary to DM; picks up when any car at the main floor has its own direction of travel established.

UMC Common auxiliary to UM; picks up when any car at the main floor has its up direction of travel established.

CAR POSITION OPERATED CONTROLS

The basic operation of the stepping switch PQ, the column of proximity contacts 706 and the position magnets will now be described. It is assumed that the height of the side plates of each position magnet is 10 inches, and that the effective height, for actuating the proximity contacts, is approximately 11-1/2 inches. For simplicity, the column 706 will be referred to as the "stick" and the proximity contacts located in it will be referred to as "reeds."

Normally, when the car is stopped at a floor, stepping switch PQ is at a position representing this floor, so that the position magnet is energized at this floor, and reeds PCDS, PCB, PCC, PCA, and PCUS, are all closed. Assume that the car is level at floor 1; then, FIG. 38 shows this condition. Assume that a call is placed at floor 4, and that this car is started up in response to this call. Then, just as the car starts to move, stepping switch PQ is caused to step one step, by a brief energization of relay PO, so that its wiper PQ-AW now connects to stationary contact PQ-A2. This results in deenergization of position magnet 1PM, and in energization of position magnet 2PM. Thus, the previously listed centrally located reeds all open. Another reed, such as PC7U or PC8U, may close if the position magnet 2PM for the next floor above is suitably located. This, of course, depends on the floor to floor distance, and on the location of these reeds. However, their closing has no immediate effect.

As the car accelerates, relay V4, V5, V6, V7 and V8, pick up in sequence. When V4 picks up, reeds PC5U and PC5D become "active." A reed is considered to be active if it is capable of energizing relay CP. Shortly after, reeds PC6U and PC6D become active also, due to relay V5 picking up. Similarly, the picking up of relay V6 makes reeds PC7U and PC7D active. Finally, the picking up of relay V7 causes the remaining two reeds at each end of the stick, PC8U, PCU, PC8D, and PCD, to become active. Thus, the active length of the stick is increased in steps as the car accelerates, so that the portion which is active corresponds to the number of steps of acceleration which have occurred, and thus corresponds approximately to the speed attained. The downward spreading of the active portion of the stick in the lower half is not used for this up trip. It is the upward spreading of the active portion of the stick in the upper half which assures that, when a critical position has been reached with respect to floor 2, relay CP is energized.

The energization of relay CP is an indication that the car has now reached a critical position relative to floor 2. If the car is going to stop at floor 2, it must commence doing so now by preventing further acceleration. A stop can still be made at floor 2 by holding stepping switch PQ at its present position. The closing of the reeds as they enter the energized position magnet 2PM can control each step of slowdown to stop the car promptly at floor 2. Otherwise, if no stop is to be made at floor 2, stepping switch PQ must be pulsed on to the next floor, floor 3.

In this example, it is assumed that there is no need to stop at floor 2, and, therefore, the energization of relay CP causes stepping switch PQ to step to a position such that its wiper PQ-AW now connects to contact PQ-A3. This can occur as early as the closing of reed PC5U, if the distance between floors 1 and 2 is very small (as might occur with front and rear entrance), or as late as the closing of reed PCU, if the distance between floors 1 and 2 is large, or if the stick is relatively short, as it would be if the contact speed were low.

Thus, position magnet 2PM is deenergized, and position magnet 3PM is energized, although the car is still below floor 2. By now, it is likely that enough steps of acceleration have occurred so that all reeds are active. Now, when the car reaches a point such that the distance to floor 3 is exactly the slowdown distance, as determined by the setting of reed PCU, relay CP is again energized to show that the car has now reached a critical position relative to floor 3. Since it is as-

sumed that there is no need to stop at floor 3, this results in a further pulsing of stepping switch PQ so that it now moves to a position representing floor 4. This causes deenergization of position magnet 3PM, and energization of position magnet 4PM. Thus, reed PCU is probably the only reed to close due to position magnet 3PM. The car is still below floor 3, but now too close to stop there. The stepping switch indicates floor 4 to other circuits, including the transistorized circuits.

Since it was assumed that there is a call to be answered at floor 4, relay F is deenergized to forecast a stop at floor 4. This assures that the stepping switch cannot move on to floor 5, and remains at floor 4. The car continues at full speed for one more floor, until it reaches the critical position relative to floor 4. Then, the picking up of relay CP initiates a slowdown, and the closing of the reeds in succession causes each associated step of slowdown to occur at the correct distance from floor 4. When the car is finally level at floor 4, position magnet 4PM is centered on the stick in a similar manner to the centering of position magnet 1PM at the commencement of this trip.

This example illustrates how this system, as claimed in my said copending Pat. application Ser. No. 430,529, causes stepping switch PQ to keep always ahead of the car so that a stop can always be made at the floor so indicated, but each time PQ steps to a new floor, it does so only at the last possible moment, allowing as much time as possible for a later call to be answered. Normally, a call existing at a floor prior to the time that stepping switch PQ first moves to that floor, results in detection of the impending stop when the car is one floor away from the point at which slowdown will commence. This allows for even earlier cancellation of such a call, and for illumination of the appropriate hall lantern at the destination floor, than previous systems. This, of course, does not occur for late calls, or on single floor runs. Then, cancellation of the call and illumination of the hall lantern occur at the commencement of slowdown. On a single floor run, slowdown may commence before full speed has been attained, whenever relay CP is energized.

Further levels on stepping switch PQ are shown in FIGS. 42, 44 and 48. They are all shown with their wipers connecting to a contact representing floor 1. As the stepping switch steps to floors 2, 3, etc., these additional wipers move in synchronism with the previously described wiper, although for convenience in drawing, some are shown as if viewed from the opposite side, so that they rotate in the clockwise instead of the counterclockwise direction for the up direction of car travel.

FIG. 40 shows some of the circuits required to obtain the operation described above, such circuits being substantially the same as those shown and described in said Pat. application Ser. No. 430,529. Relay A is energized through contact F-1 while the doors are closing (or are fully closed) in preparation for a run. Contact F-1 remains closed, once the car has started, until stepping switch PQ has stepped to a floor where a stop is to be made. Then, contact F-1 opens. Relay A, however, remains energized through contacts MR-1, CP-2 and A-1 until the critical position, for the floor being approached, is reached. Then, contact CP-2 opens and deenergizes relay A since contact MRA-5 is open. The opening of contact A-1 assures that relay A will remain deenergized after CP-2 closes again. Contact MRA-5 is provided to allow an alternate pickup circuit for relay A, through contacts MR-1 and MRA-5, so that relay A will pick up to restart the car after it has performed on emergency stop during slowdown. If this happens with contact F-2 open, the car makes a short run to the floor it was originally approaching, without any further stepping of PQ. Contacts of relay A are required in various parts of the speed control circuits, such as for relays V5, V6, V7 and V8.

Relay MF is energized through contacts A-2 and V8-3 when the doors are closing in preparation for a run, and during acceleration. When the car approaches full speed, the opening of contact V8-3 deenergizes relay MF and it drops out a short time later after condenser C20 has discharged into the coil of MF through resistor R102. At the commencement of slow-

down, relay A drops out, and relay MF is energized through contacts My3 and A-11. Relay MF then drops out a few seconds after the car stops due to the opening of contact M-3. Thus, contact MF-1 causes the motor field to be strengthened for acceleration and deceleration, and weakened for full speed and when the car is not running.

When the car is about to make an up trip, the arrival of the doors at the fully closed position results in relay GCL being deenergized. Then relays UR and MR are energized through contacts GCL-5, F-2, CA-3, DR-4 and up limit UL. These relays then remain energized through contact M-4, or later through DS-3 and US-3; they remain energized until the car has stopped at the floor represented by stepping switch PQ. Only at this floor will relays DS or US be energized. Normally, the opening of M-4, when the car stops, deenergizes relays UR and MR; but if an emergency stop is made, and the car has not yet reached the point where US or DS can be energized, relays UR and MR remain picked up.

Similarly, relays DR and MR are picked up for a down trip, through contacts CB-2, UR-4 and down limit DL. Contacts of UR and DR are required in various parts of the relay circuits. Relay MR acts as an auxiliary relay common to both UR and DR.

Contactors U and M must pick up for upward movement of the car, either running or releveling; contactors D and M must pick up for downward movement. In either case, they can be energized only when all of the contacts in the "safety circuit" are closed; this includes contacts on such devices as safeties, governor, and overtravel switches, as well as the stop button in the car. Also, these contactors can only be energized when the car door (gate) contact is closed and when the hall door interlock contacts are all closed, although a bypass circuit through contacts DS-1, LU-1 and V4-3 or through contacts US-1, LD-1 and V4-3, is provided to allow releveling to occur with the doors open, and to allow the doors to be opened during the last few inches as the car approaches a floor. These contacts restrict movement, with the doors open, to a zone near the floor represented by stepping switch PQ.

For an up trip, contactors U and M are energized through contacts D-7, A-3 (later US-4), UR-2, MR-2 and A-5 and MT-2 (later M-5). Contacts U-7, A-4 (later DS-4) and DR-2 are used for a down trip, to energize D instead of U. After any stop (and particularly after an emergency stop) U and M or D and M cannot pick up for a brief time delay, until contact MT-2 closes. Contacts UR-5 and DR-5 are required to pick up these contactors for releveling.

The opening of US-4 (or DS-4 for a down trip) causes deenergization of U and M (or D and M) to stop the car at floor level. Contacts of U, D and M are used in the brake and generator field circuits.

Relay MT is energized through contact M-6 whenever the car is running; it drops out after a time delay of several seconds due to resistor R103 and condenser C21.

Relay MRA is normally equivalent to an auxiliary relay for MR, and is energized through contacts MR-3 and MT-1. But if an emergency stop is made, MR may remain energized, but MRA drops out after a few seconds, when contact MT-1 opens.

Relay PO is energized briefly through contacts PM-4, MRA-1 and F-3 whenever the car starts a trip; contact PM-4 opens shortly afterwards, and drops out relay PO. Also, each time the car reaches the critical position, relay PO is energized briefly through contacts CP-1, MRA-1 and F-3 except that this does not occur after a stop has been forecast by the opening of contact F-3.

The purpose of relay PO is to cause stepping switch PQ to advance one step. This is done through contact PO-1; contacts UR-3 and DR-3 determine whether it is the up coil PQ-U or the down coil PQ-D which is energized.

Relays, DS, ZE and US are energized directly through proximity contacts PCDS, PCC and PCUS. Relay VL is energized through proximity contacts PCB and PCA in series. Thus, these relays are energized during the latter part of deceleration,

as the corresponding reeds close at predetermined distances from the floor where the position magnet is energized. Condensers C22, C23, C24 and C25, and resistors R104, R105, R106 and R107 are provided to keep these relays in the picked-up position during any brief deenergization of the position magnet, such as occurs when the car stops, and during releveling. Reed PCLU energizes relays LU and LV; reed PCLD energizes relays LD and LV. Relays LU and LD are required for releveling, to sense whether the car must level up or level down. But, because of the inherent hysteresis effect of the reed, there is a difference of several inches between the pickup point and the dropout point of a reed. This is unsuitable for releveling, but relay LV compensates for this. During a releveling operation, relay LV may vibrate rapidly to intermittently deenergize the position magnet through contact LV-1, to make the pickup point of the reeds, rather than the dropout point, determine the energization of relays LV and LD. Diodes D128 and D129 keep LU and LD picked up during such brief deenergizations, while LV vibrates. Also, each time the car makes a normal stop, LV stays in briefly after US-2 and DS-2 are both open. This deenergizes the position magnet until reed PCLU or PCLD drops out relay LV. One such deenergization is enough to clear reed PCLU or PCLD to its open condition.

FIG. 41 shows the circuit for relays V3, V4, V5, V6, V7 and V8. When the car commences a trip, relay V3 is energized through contacts MRA-2, ZE-3 and VL-2. Next, relay V4 is energized through contacts V3-2, DS-5, US-5, and either U-4 and up limit UL4 or D-4 and down limit DL-4. Similarly, relays V5, V6, V7 and V8 pick up in sequence. Contacts A-6, A-7, A-8 and A-9 are all closed to allow this. Some means of delaying slightly the pick up of each of these relays is desirable, but not shown here. The adjustment of pickup time of these relays determines the rate of acceleration of the car. When relay V5 is energized, reeds PC5U and PC5D become "active" and thus capable of energizing relay CP. Similarly the remaining reeds become progressively active.

When a slowdown is commenced, relay A drops out and prevents any more of these "V" relays from picking up. Also, contact A-12 closes so that the closing of the reeds shorts out the coil of the associated relay. For example, reed PC8U shorts out the coil of relay V8, thus deenergizing it. The opening of contact V8-2 keeps relay V8 deenergized after reed PC8U (or PC8D) opens again.

Thus, relays V8, V7, V6 and V5 are dropped out at predetermined distances from the destination floor by the closing of the corresponding reeds. Diodes D130 and D131 prevent false energization of relays V6 and V7 if there is an "overlap of reeds"; reeds PC5U and PC6U could, for example, be so closely spaced that both can be closed at once the same position magnet.

Relay V4 drops out during slowdown when contact DS-5 or US-5 opens. Similarly, relay V3 drops out when contact ZE-3 opens. Contact VL-2 assures the later dropping out of relay V3 if relay ZE fails to pick up.

Relay PM is energized near the beginning of each trip, through contacts MR-4 and PO-2. Its energization indicates that stepping switch PQ has been pulsed one step. Relay PM then remains energized through contacts MR-4 and PM-1 until the trip has been completed.

Relay MA is energized through either contact MR-5 or M-7; thus it picks up for both normal trips, and releveling. Contacts on relay MA are required for the load weighing circuits of FIG. 45.

In FIG. 41, relay OST is energized through contacts M-8 and MR-6 whenever the car is running, but not when the car is releveling, since contact MR-6 is then open. When the car stops with no further calls for it to answer, contact CT-1 closes and holds relay OST energized through its own contact OST-1. However, as long as there is a call registered which this car should answer, contact CT-1 is open, and relay OST is deenergized each time the car stops. If it then fails to start within a reasonable time, relay OST drops out, and locks out due to the

opening of contact OST-1, and remains out in spite of subsequent closing of contact CT-1 if other cars answer the hall calls which were originally causing CT-1 to be open. A further contact IS-4 is arranged to energize relay OST whenever this car is not in service, so that when it is first switched into service, condenser C27 is fully charged so that OST has full timing.

Relays K1, K2 and CSM can be energized only when the car is downbound, as indicated by contact DM-1 being closed, and only when the car is above the main floor. If it is below, contact BLF-3 is open; if it is at the main floor, contact 3PO-4 is open. Initially, when a car becomes downbound above the main floor, all of these relays are deenergized. When the car first stops for a down hall call, relay CNH picks up and causes relay K1 to be energized through contacts 3PO-4, BLF-3, DM-1, K2-3, and CNH-1. After the car has stopped for this down hall call, and has closed its doors in preparation for starting down again, relay CNH drops out and causes relay K2 to be energized through contacts CNH-7 and K1-3. Relay K2 then holds itself energized through contact K2-1. The opening of contact K2-3 does not drop relay K1 since it now maintains itself through contacts CNH-6, K1-1 and K1-2. However, if a second stop is made for a down hall call, relay K2 remains energized, and since K2-3 is open, the opening of contact CNH-6 drops out relay K1, and it cannot pick up again since K1-1 is now open. Thus, relays K1 and K2 being both in, indicates that the car has stopped for only one down hall call; relay K2 being in alone indicates that the car has stopped for two or more down hall calls. While the car is stopping for the first of these down hall calls, K1 only is in.

After the car has stopped for one or more down hall calls, relay CSM is energized through contacts K2-2 and CS-1 if the car later stops for a car call. Relay CSM then holds itself energized through contact CSM-1. When the car ceases to be downbound, or arrives at the main floor, all of these three relays are deenergized. The purposes of these relays will be apparent later.

CAR CALL CIRCUITS

The upper part of FIG. 42 shows a circuit for determining when there are car calls registered above or below the floor represented by stepping switch PQ. If there are no car calls above, relay CCA is energized through contact PO-6, and through the various contacts 20NC-1, 19NC-1, 18NC-1, etc., and finally, through one of the diodes, such as D103A to the associated stationary contact, such as PQ-B3, to the wiper PQ-BW. If there is a car call above the position of PQ, relay CCA is deenergized.

Similarly, if any one of contacts INC-1, INC-2, etc., for those floors below the position of PQ, is open, relay CCB is deenergized. The wiper PQ-BW of stepping switch PQ is arranged to work in conjunction with the diodes so as to connect the appropriate point to line N, so that the NC relay for the corresponding floor has no effect on relays CCA and CCB, so that the NC relays for floors above influence relay CCA, and so that the NC relays for floors below influence relay CCB.

Contacts PO-3 and PO-4 close when the stepping switch is moving to a new floor, so that relays CCA and CCB, if energized, are not deenergized by the stepping switch contacts which have a gap during which the wiper does not connect to any stationary contact. Also, contacts PO-6 and CCA-1 assure that relay CCA cannot be picked up through the stepping switch contacts, but only after the stepping is complete, as indicated by the closing of contact PO-6. Contacts PO-7 and CCB-1 perform a similar duty for relay CCB. The result of this circuit is that the previous condition of relays CCA and CCB is maintained during the stepping operation, so that the stepping switch does not have to either make or break the current to these relays.

Relay CA is arranged to be deenergized whenever there is any reason for this car to travel up. The principal reasons are for a car call above, as indicated by the opening of contact

CCA-2, or for a hall call above, which this car should answer, as indicated by the opening of contact HCA-1. Also, the opening of contact PKA-2 drops out relay CA to indicate that this car should go up for spacing reasons. All of these contacts are bypassed by contact DM-2, so that relay CA is held energized as long as the down direction of travel is established. At all floors, except the main floor, contact LF-1 is open, so that the normal path for energizing relay CA is through contacts CCA-2, HCA-1, PKA-2 and UP-3. If the car is not in service, contact IS-5 is closed and contact LF-1 is always open, so that it is only car calls above, as indicated by contact CCA-2 opening, which can drop out relay CA.

During up-peak, contact UP-3 is open, so that this car is automatically returned up to the main floor by the opening of additional contact BLF-4 whenever the car is below the main floor. This drops out relay CA, and keeps it out as long as the car is below the main floor.

Contact CCA-6 has no effect, when the car is not at the main floor, since when it is closed to short out contacts HCA-1 and PKA-2, contact CCA-2 is open. However, when the car is at the main floor awaiting dispatch, contacts LF-1, UM-9 and CCAT-1 are closed; the registration of the first car call for any floor above the main results in deenergization of relay CCA, and the closing of contact CCA-6 prevents this car from being dispatched up in spite of hall calls above opening contact HCA-1, or the opening of contact PKA-2 for spacing purposes. This condition prevails for an adjustable time delay, as determined by relay CCAT. When contact CCAT-1 opens, relay CA is allowed to drop, indicating that the car should start up, provided that contact PUT-1 is open to indicate that this car has been stopped long enough for unloading, and provided that contact PLT-1 is open to indicate that this car has been a next up car long enough for loading. Thus, immediate dispatch after registration of the first car call is prevented because of the possibility of further passengers entering the car.

Normally, relay HCA can drop out, if the car is at the main floor, only if this car is a next up car, since it is the first one to be seen on the descending secondary scan at the main floor. The opening of contact HCA-1 then deenergizes relay CA to cause this car to be dispatched up, but only after sufficient time for unloading has elapsed since the car stopped here, as indicated by contact PUT-1 being open, and also only after sufficient time for loading has elapsed since this car first became next up, as indicated by contact PLT-1 being open. However, if the car should become loaded before the timing has finished on relay PLT, the opening of contact CW3-5 when the car is loaded to approximately 70 percent, allows CA to drop. This would normally only happen during up-peak, when the timing on PLT is considerably higher, perhaps 15 seconds. At other times, the timing on PLT is approximately 5 seconds.

Diode D132 assures that when contact LF-1 is open, contacts CCAT-1, NX-1, CW3-5, PLT-1 and PUT-1, have no effect on relay CA. Contact UM-9 allows an upbound car from below the main floor to pass the main floor, if there is no need to stop there, or to ignore the special loading and unloading time allowances if it stops at the main floor while proceeding beyond.

The basic operation of relay CB is similar to CA. While the up direction of travel is established, contact UM-1 holds relay CB energized. Otherwise, the normal circuit for energization of relay CB is through contacts CCB-2, HCB-1, K1-6, K2-4 and PKB-2. Thus, relay CB is deenergized to indicate that the car should travel down for car calls below, as indicated by the opening of contact CCB-2, for hall calls below, which this car should answer, as indicated by the opening of contact HCB-1, or by the opening of contact PKB-2 which indicates that this car should travel down for spacing purposes.

Whenever the car stops for its first down hall call above the main floor, contact K1-6 opens, and contact K2-4 opens later, just as the car leaves this floor. Contact K1-4 closes when contact K1-6 opens, but contact CSM-2 is still open. Thus, when-

ever the car stops for a down hall call above the main floor, relay CB is held out so that the car automatically proceeds toward the main floor regardless of the registration of any car calls for floors below. The reason for this is that many passengers are accustomed to previous systems in which a downbound car always returns to the main floor; such passengers frequently fail to register a main floor car call. With this invention, however, low call reversals are allowed, and thus it is desirable to not return this car to the main floor if the incoming passenger places a car call for some floor above the main floor. If this happens, contact CSM-2 closes when the car first responds to this car call, and if no other intervening stops have been made for other down hall calls, contact K1-4 is still closed, and thus the circuit is completed between contacts HCB-1 and PKB-2, so that this car need no longer travel downward towards the main floor unless necessary. However, once two or more down hall calls have been stopped for, both contacts K1-4 and K2-4 are open, and the car must return to the main floor. During down-peak, contact DP-3 is open, and thus the car automatically returns to the main floor after only one down hall call has been stopped for, regardless of any other conditions.

When a car is next up at the main floor, the registration of car calls for floors below the main is normally prevented. Such circuits would preferably be used with this system, but are not shown here. However, contacts LF-2, NXA-1 and DM-11 prevent relay CB from dropping out when a car is next up at the main floor. If hall calls below the main floor are registered which would require this next up car to travel down, circuits not yet described cause the doors to close, and when they are fully closed contact NXA-1 opens. If there are still no car calls registered for floors above, contact CCA-7 is open, and relay CB is allowed to drop to allow the car to travel down below the main floor. If the call which caused this sequence is the down hall call at the main floor, the car reopens its doors and shows a down hall lantern. Otherwise, it proceeds directly down. If, however, there were car calls registered for floors above, contact CCA-7 would have been closed, and relay CB would not have dropped, and the car would have started up after the doors closed.

Contact DM-11 assures that a downbound car can pass the main floor, stopping if necessary, without contacts LF-2 and CCA-7 falsely preventing it from going below the main floor.

Contacts CA-1 and CB-1 energize relay CT so that when it is found necessary to start up or to start down from any floor, relay CT is deenergized, but capacitor C28 and resistor R114 causes a slight delay on the dropping out of relay CT. This assures a slight delay in the starting of the car in case the dropping out of relays CA or CB occurred because of an up or down hall call at the same floor where the car is. In this delay, sufficient time is allowed for relay HCS to be energized to cause opening of the doors.

RELAY INTERCONNECTIONS WITH OTHER CIRCUITS

FIG. 43 shows some of the interconnections between the transistorized circuit and the relay circuit. The coils and contacts of the reed delays on the input and output cards are repeated here for better understanding of the circuits. In addition, relays AV and LF are shown on FIG. 43 in order to utilize contact IS-1. Thus, relay AV can be energized only when this car is in service, as indicated by contact IS-1 being closed, and only when this car has not been held excessively, as indicated by contact OST-2 being closed. Relay LF is energized through contacts IS-1 and 3PO-1, so that it is energized whenever the car is at the main floor, provided that it is in service.

Each time the car starts up from any floor except below the main floor, capacitor C30 is charged through contact BLF-5 and UM-2 and through resistor R116. Thus, a brief pulse of charging current flows through resistor R116. Capacitor C30 is discharged through resistor R115 and contact UM-10 whenever the car ceases to be upbound, with no flow of current through resistor R116.

Similarly, each time the car passes floor 4 in the down direction, capacitor C31 is discharged through contacts 4PO-1 and DM-3 and through resistor R118. Thus, a brief pulse of charging current flows through resistor R118. Capacitor C31 is discharged through resistor R117 and contact DM-12 whenever the car ceases to be downbound, with no flow of current through resistor R118.

During up-peak, contact UP-1 is closed so that each time the car starts up from any floor except below main, part of the charging current of capacitor C30 flows through the coil of relay SIR so that it is briefly energized. Similarly, during down-peak, the coil of relay SIR is briefly energized through contact DP-1, whenever the car passes floor 4 in the down direction. Thus, relay SIR is briefly energized only during those times when this car seeks instructions, as previously described.

In the remaining circuits of FIG. 43, resistors R120 to R132 are provided in series with each reed relay on the assumption that the maximum voltage for which it is convenient to wind the coils of these relays is considerably lower (perhaps 24 volts) than the voltage available from lines L+ and N (normally about 125 volts). Thus, these resistors are required to limit the current to these relays. Otherwise, these resistors could be omitted.

Relay ISR is energized through contact IS-1, so that it is energized only when this car is in service. Relays HCA, HCB, UP and DP are energized through contacts NHAR-1, NHBR-1, UPR-1 and DPR-1, respectively, and they are all energized through contact IS-1. Thus, when the car is in service, relay HCA drops out to indicate that there is a hall call above which this car should answer, relay HCB drops out to indicate that there is a hall call below which this car should answer, relay UP is energized during up-peak and relay DP is energized during down-peak. Further contacts modify the operation of relays HCA and HCB; these are shown in FIG. 49 and will be explained when this FIG. is described.

Relay HS is similarly energized by contact HHR-1, but also through contact PS-1 in addition to IS-1, so that relay HS picks up to indicate that a stop should be made for (or the doors open for) a hall call, but only if this car is in service, and is not automatically bypassing hall calls.

Also, during down-peak, contact DP-7 is open, and thus when the car is upbound at or above the main floor, both contacts UM-15 and BLF-1 are open so that HS cannot be energized unless this car is a normal car, in which case contact J-5 is closed. This causes this car to bypass up hall calls when it is an upbound special car during down-peak, but allows it to stop for up hall calls below the main floor. It is necessary to do this bypassing without dropping out relay PS (as would normally be done for bypassing hall calls) since this would cause this car's availability to be zero, and other special cars would not see it, and would thus not perform properly during down-peak.

Relays PKA and PKB are similarly energized, by contacts PAR-1 and PBR-1 respectively, through contact IS-1, but additional contacts are used so that parking instructions issued by the transistorized circuits are ignored if this car already has car or hall calls which it should answer, or if this car has its MG set automatically shut down. Thus, relay PKA cannot be energized to cause this car to go up for spacing reasons, unless there are no hall calls below, which it should answer, as indicated by contact HCB-2, and unless there are no car calls below, as indicated by contact CCB-3. Similarly, relay PKB cannot be energized to indicate that this car should travel down for spacing reasons, unless there are no car calls above, as indicated by contact CCA-3, and, except during up-peak, PKB cannot be energized unless there are also no hall calls above, which this car should answer, as indicated by contact HCA-2. Further contacts, shown on FIG. 49, modify the operation of relay PKA, and are described in connection with that FIG.

Contact AST-5 is open when this car's MG set is automatically shutdown to prevent relays PKA or PKB (except during up-peak) from being energized. Contact CNH-8 performs a

similar duty when this car is responding to a hall call. Contacts UP-2, UM-11 and J-6 assure that once a special car has completed its up trip during up-peak, nothing will prevent this car from being returned to the main floor except the registration of a car call above.

The circuit for energizing relay CNUR consists normally of contacts AV-1, F-6, CNH-2 and UM-3, so that energization of relay CNUR, for canceling an up hall call, can occur only when this car is in service and not held, as indicated by contact AV-1, only when the up direction of travel is established, and only when this car is responding to a hall call, as indicated by contact CNH-2. Contact F-6 causes deenergization of relay CNUR when the doors start to close, so that cancellation ceases then, and if the doors subsequently reverse and reopen, contact F-6 closes again and relay CNUR may pick up again. Thus, cancellation commences when this car first responds to the hall call, and continues during slowdown, and during the opening of the doors, and until the doors start to close.

A similar circuit, including contacts DM-4 and NXA-4 instead of UM-3, causes similar energization of relay CNDR to cause cancellation of a down hall call. Contacts NXA-2 and NXA-4 assure that relay CNUR, but not CNDR, is energized when this car is the next up car, and its doors are open; this holds the up hall call at the main floor canceled.

Relay GOR is energized through contacts AV-1, LF-3 and GCL-1, so that it picks up whenever this car is available at the main floor, with its doors open. Relay AVMR is energized through contacts AV-1 and LF-3, so that it picks up when this car is suitable for being selected a next up car, by being available at the main floor. However, other contacts are inserted in the circuit for relay AVMR to take care of the other requirements for suitability to be a next up car. Contact DM-13 assures that this car is not suitable if its down direction of travel is established. Contact ZE-1 assures that this car is suitable only if it is within about 6 inches of the main floor. This means that, when this car arrives at the main floor, it cannot be chosen as a next up car until it is close enough for the doors to open. Thus, the up hall lantern (or the "this car up" sign) is not illuminated well in advance of the arrival of the car as it is at other floors. This is considered desirable for two reasons. It is better to not have early hall lantern illumination at the main floor since it often results in incoming passengers crowding prematurely around the elevator entrance, and thus impeding outgoing passengers. Also, the amount of time between illumination of a hall lantern, and the opening of the doors varies widely between single floor runs and express runs, so that delaying the choosing of a next up car until the time at which door opening can occur assures that the first one to do so is the chosen one.

Normally, during nonpeak periods, contacts DP-4 and UP-4 are both closed. Thus, a car ceases to be suitable for next selection when it has its up direction of travel established, as indicated by the opening of contact UM-12, and when it also has its doors closing, as indicated by the opening of contact F-7. This will result in the choosing of a new next up car, if another one is available. Otherwise, this car will continue to be the next up car until it has left this floor. This is done by having relay NX fed from just ahead of contacts F-7 and UM-12; relay NX is also controlled by contact NSR-1. Thus, when a car is being started up from the main floor, it is not until its doors actually start to close that a new next up car is chosen. However, during up-peak, the opening of contact UP-4 allows earlier choosing of a new next up car, when this car first establishes its up direction.

Contact AST-6 opens when this car has its MG set automatically shut down, and prevents this car from being selected as a next up car. If this car is already a next up car when AST-6 opens, it immediately ceases to be a next up car, and thus its doors close since relay NX drops out, and this drops out relay HCS. Another car with its MG set running may then be chosen as a next up car, if there is one at the main floor.

In previous systems, AS cars parked with doors closed have been allowed to be next up as long as there are no non-AS cars

at the main floor. The arrival of a non-AS car can "rob" the next up duty from the AS car. This has been necessary because in previous systems there must always be a next up car at the main floor, if one is available there. With my system this is not necessary. If there is no next up car at the main floor, the scanning system can still choose one of the cars there, in a similar manner to the choosing of cars for dispatching at all other floors. Now, instead of a next up car being scanned first or last at the main floor, the order is the same as it was for the previous next up car.

During down-peak, contact DP-4 is open, so that only normal cars, with contact J-1 closed, can be chosen a next up car. This is to prevent illumination of the up hall lantern on special cars during down-peak, so that incoming passengers are discouraged from entering. If passengers enter such cars and register car calls, such calls may cause this car to travel higher than it otherwise would in attempting to give fast service to prior calls. Contact NX-2 is provided so that at the commencement of down-peak, when contact DP-2 first opens, a car which is already next will not cease to be next even if it is a special car.

Relay CSR is energized through contacts AV-1, DM-14 and CS-2 so that it is briefly energized whenever this car is available, and not downbound, and stops for a car call. The picking up of relay CS is normally followed immediately by cancellation of the car call, so that contact CS-2 is closed only briefly. Similarly, relay HSR is energized briefly through contact AV-1, UM-13 and HS-1 whenever this car, if available, stops for a hall call, except when upbound, i.e., whenever it stops for a down hall call.

Relays UAR and DAR are fed through contact PS-2, in addition to AV-1, so that they can indicate that this car is available only if it is also not bypassing hall calls. Normally, contact DM-15 drops out relay UAR, to indicate that this car is no longer UAV, whenever the down direction of travel is the result of the closing of contact pKB-1, and if the down direction is not being maintained because of a previous stop for a down hall call, relay UAR may be energized when this car is downbound, because it is downbound for spacing purposes, and is available to go up if required. Notice that the array of contacts consisting of K1-5, CSM-3, DP-5, K1-7, and K2-5 is similar to the array in the circuit for relay CB, which causes maintenance of down direction for the reasons previously described.

During up-peak, contact UP-5 is open so that special cars, with contact J-2 open, are UAV only when upbound as indicated by contact UM-4. Thus, special cars, when downbound, are destined for the main floor, with a possible pause at the second parking floor, and thus do not energize relay UAR since they are not UAV.

Normally, contact UM-14 drops out relay DAR, to indicate that this car is no longer DAV, whenever the up direction of travel is established. However, if the up direction of travel is established by the closing of contact PKA-1, because this car is upbound for spacing reasons, relay DAR may be energized when the car is upbound, to indicate that it is DAV.

A car at the main floor, as indicated by contact 3PO-5 being open, which has a car call registered above, as indicated by the opening of contact CCA-4, does not energize relay DAR unless the down direction of travel is established, as indicated by contact DM-5. Thus, although the next up car is normally considered DAV, it ceases to be DAV as soon as an incoming passenger registers a car call for a floor above. A downbound car at the main floor may also have a car call registered above, and thus contact DM-5 is needed to assure that this car is DAV.

Contacts UM-5, DM-6 and AST-1 energize relays UBR, DBR and ASR respectively, to indicate that this car is upbound, downbound, or automatically shut down. Relay J is energized through contact JNR-1 so that it picks up when this car has the "normal" instructions.

Relay AVFR is normally energized through contacts DP-6 and CW2-4, indicating that this car's availability is 2. How-

ever, if this car is loaded beyond about 40 percent of its rated capacity, contact CW2-4 opens to deenergize relay AVFR. Also, contact DP-6 is open during down-peak, so that only normal cars, with contact J-3 closed, have an availability of 2.

The circuits of FIG. 44 will now be described. Relay CCAT is normally energized through contact LF-5, but when the car is at the main floor, with a car call registered for floors above, both contacts LF-5 and CCA-5 are open, so that relay CCAT is deenergized. It does not drop out immediately, however, since capacitor C32 must first discharge through resistor R135, and through the coil of relay CCAT. The timing so obtained would normally be adjusted to about 15 or 20 seconds, but when this car is next up, contact NX-3 connects resistor R134 in parallel with the coil of relay CCAT, so that the timing is reduced to a lesser value, perhaps 5 to 6 seconds. Similarly, during down-peak, contact DP-2 shortens the timing on this relay by a similar amount. The normal purpose of this relay is to prevent immediate dispatch after the registration of the first car call in the next up car; and the lesser amount of time prevails then. However, if someone falsely enters a nonnext car at the main floor, and registers a car call for floors above, relay CCAT prevents dispatch of this car for a longer period, in the hope that it will then become a next up car. The registration of such a car call causes this car to park with its doors open, so that it is given priority when a new next up car is to be chosen. If this does not occur, the dropping out of relay CCAT allows this car to go up in response to the car call, in spite of its not being next. Previous systems have customarily prevented registration of such car calls, or at least have prevented dispatch of such a car until it has become a next car. This has caused considerable confusion to passengers, and it is felt that it would be best to accept such car calls, as long as these passengers do not get preferred service because of immediate dispatch of such nonnext cars. With previous systems, where timed dispatch is used, allowing such a car to be dispatched out of turn spoils the advantages of timed dispatch. With the system of this invention, such dispatch of a nonnext car has very little ill effect on the system.

Similarly, relay PUT is normally energized through contact LF-6. At the same time capacitor C33 may be charged to some lesser voltage if relay CW1 is energized, as determined by the voltage divider consisting of the resistors R136 and R139. Also, capacitor C33 may be charged to some higher value if contact CW2-1 is also closed to connect resistor R137 in parallel with resistor R136. Finally, the capacitor C33 may be charged to an even higher value if contact CW3-1 is also closed to connect further resistor R138 in parallel with resistors R136 and R137. Thus, capacitor C33 is charged to a voltage which is dependent upon the load in the car, in three coarse steps, as determined by relays CW1, CW2 and CW3.

When this car approaches the main floor, contact LF-6 opens, and when the car has stopped there, contact MRA-3 also opens. This deenergizes relay PUT, but it does not necessarily drop out immediately since there may be some charge on capacitor C33, and thus it may discharge through diode D134, resistor R141, and the coil of relay PUT. If there had been no load on the car, there would be no delay in the dropping out of relay PUT since the capacitor C33 would have no charging circuit, and would be discharged by contact CW1-5 and resistor R140. If the load on the car is between 10 percent and 40 percent, relay CW1 is energized, and there is some delay on the dropping out of relay PUT. If the load on the car is between 40 percent and 70 percent, relay CW2 is also energized, and the timing on relay PUT is longer. If the load on the car is over 70 percent, the timing on relay PUT is longest. The values of resistors R136, R137 and R138 can be adjusted so that the corresponding timing on relay PUT approximates the length of time it takes for the corresponding number of passengers to leave the car. Diode D133 assures that these resistors have no effect on the discharge of capacitor C33 into the coil of relay PUT. Thus, this circuit acts as a memory to remember the condition of relays CW1, CW2 and

CW3 prior to deenergization of relay PUT. However, if the load on the car is reduced to below 10 percent before relay PUT has dropped out, contact CW1-5 closes to connect resistor R140 in parallel with capacitor C33 so that it is quickly discharged, and relay PUT drops almost immediately. Diode D134 prevents capacitor C33 from being charged fully by resistor R141. Thus, the effect of this circuit is to cause relay PUT to drop out approximately when the car is unloaded, or when a sufficient time for unloading has elapsed.

Similarly, relay PLT is normally energized through contact NX-6. When this car becomes the next up car, contact NX-6 opens, and when sufficient unloading time has also elapsed from the previous arrival of the car, contact PUT-2 is also open, so that relay PLT is deenergized. It does not drop immediately, since capacitor C34 must first discharge through resistor R143 and the coil of relay PLT. Normally, contact UP-6 is closed, so that capacitor C34 discharges also through resistor R142, and thus the timing on relay PLT is reduced to possibly about 5 seconds. However, during up-peak, contact UP-6 is open, and the timing of relay PLT is increased to about 15 or 20 seconds. The purpose of this relay is to assure that the doors remain open for sufficiently long time after this car becomes next, or after this car has unloaded, whichever occurs last, so that passengers may enter the car without any attempt of the doors to close. A longer allowance of time is desired for up-peak, and if the car becomes loaded before the timing has expired on relay PLT, the car is allowed to start when relay CW3 picks up.

The circuit for relay HCS is arranged so that it is energized whenever a call is detected which this car should stop and open its doors for, or should simply open its doors for, if already stopped. When the car is running, contact PM-2 is closed, and when contact CS-3 closes to indicate an impending stop for a car call, or when contact HS-2 closes to indicate an impending stop for a hall call, relay HCS is energized, and locks itself in through contact HCS-2, so that it must remain in at least until the car has come to a stop, at which time contact PM-2 opens. However, the picking up of relay HCS results in the dropping out of relay F, so that contact F-8 closes. Normally, the arrival of the car at a point about 6 inches from the floor results in energizing of relay ZE, and in dropping out relay E, which causes relay OE to pick up to open the doors. Thus, contact OE-1 closes before PM-2 opens, and relay HCS is held energized until the doors have opened fully. Then, the opening of contact OE-1 allows current to continue flowing through contact HCS-2, resistor R144, capacitor C35, contact F-8 and the coil of relay HCS. Thus, the drop out of relay HCS is delayed for about 1 or 2 seconds after the doors have become fully opened. During this time, the doors are held open regardless of pressure on the close button.

When the car is standing idle, with its doors closed, contacts CT-2, E1, ZE-2 and F-8, are all closed, so that the closing of either contact CS-3 or contact HS-2 (and in particular contact HS-2), can cause relay HCS to be energized, particularly for a hall call at the floor where the car is. This time, the picking up of relay HCS causes relay E to drop out, opening contact E-1, and other contacts on E cause relay OE to be energized to open the doors. In the brief interval when contacts E-1 and OE-1 are both open, capacitor C35 prevents relay HCS from dropping out, and thus HCS remains energized, as before, until a short time has elapsed after the doors have become fully opened.

Contact ZE-2 is required so that if the car stops between floors, with HCS energized, HCS is allowed to come out, since otherwise the car should not start again. Contact CT-2 is required so that a stuck car button cannot falsely hold relay HCS energized through contact CS-3, if there are other calls registered elsewhere. A stuck hall button, as explained in connection with the hall call card, should not cause relay HS to stay in.

When the car is at the main floor, contact LF-4 is closed, and further contacts are allowed to energize relay HCS. Normally, contact CA-2 is closed when a car arrives at the main

floor from above, and remains so until this car is allowed to start up from the main floor. Thus, any car arriving at the main floor with more than 10 percent load on the car, causes relay HCS to be energized through contacts PUT-3, CW1-2, LF-4, CA-2, and F-8. This assures that the doors will open automatically upon arrival at the main floor, regardless of whether or not the main floor car button has been pressed, if there is more than 10 percent load on the car. Furthermore, once HCS has been energized, and contact HCS-1 has closed at the main floor, HCS is held in until PUT-3 opens to indicate that sufficient time for unloading has elapsed.

Contact CCA-8 is provided so that if a car call is registered in a car which is not next, the doors are caused to remain open, as previously described, until relay CA drops.

The purpose of contact NX-4 is to cause the doors of the car selected to be next to open, if closed, and to remain open, due to the energization of relay HCS. Contact HCB-3 is normally closed at this time. The purpose of contacts HCB-3 and NXA-5 is to obtain the operation previously described, which occurs when the next up car must be sent down below the main floor. Then, the opening of contact HCB-3 allows relay HCS to drop, provided that there are no car calls registered for floors above, causing the doors to close, and when they have fully closed, the closing of contact NXA-5 allows HCS to be picked up again, to reopen the doors, if there is a down hall call at the main floor, as indicated by contact HS-2 being closed.

The purpose of contact F-8 is to prevent pressure on the car button, or a hall button at this floor, from energizing relay HCS and so preventing the car from leaving this floor. Contact PM-2 closes only after the stepping switch PQ has been given a pulse to first move it on to a new floor.

The purpose of relays 2L, 3L, 4L, etc., is to operate the hall lanterns at intermediate floors. The wattage of the lamps used in most hall lanterns is too high to be handled without damage by the delicate contacts of most stepping switches. Thus, these relays are energized through a further level of stepping switches PQ, consisting of wiper PQ-CW, and contacts PQ-C1, PQ-C2, PQ-C3, etc., and also through contacts PO-8, HCS-3 (or MR-7 and GCL-2), and AV-2. The purpose of contact PO-8 is to assure that the stepping switch contacts are not required to make or break this circuit. Contact AV-2 assures that the hall lanterns are illuminated only if this car is in service, and causes them to be extinguished if this car fails to start within a reasonable time.

The hall lanterns are energized by contact HCS-3 when a call is first detected, so that the appropriate lantern is illuminated as soon as possible. In most cases, this occurs very shortly after stepping switch PQ has just stepped to this floor. Contacts MR-7 and GCL-2 maintain energization of the appropriate hall lantern relay until the doors have opened fully, and closed again, since as long as the doors are open, contact GCL-2 is closed. Contact MR-7 prevents energization of hall lanterns if the car door is opened between floors, since MR does not drop until the car has stopped at the destination floor. Relays 3L and 4L have diodes D135 and D149 in series with their coils to allow the corresponding contacts PQ-C3 and PQ-C4 to energize relays 3PO and 4PO from the same contacts, without affecting the operation of relays 3L and 4L.

The hall lanterns for terminal floors are illuminated by a slightly different circuit, and thus, there is no need for a relay 1L or a relay 20L. This leaves contacts PQ-C1 and PQ-C20 free to operate relays 1PO and 20PO, which are required for other purposes, including the hall lanterns at terminal floors.

The coil of relay CN is connected through the same array of contacts as the previously described relays 2L, 3L, etc., except that contact AV-2 is not used. Actually, the desired contacts for operating relay CN are HCS-3, MR-7 and GCL-2. Additional contact PO-8 does no harm since it does not open once relay CN is energized. Thus, duplication of these three contacts is avoided by connecting the coil of relay CN as shown. Thus, relay CN is energized as soon as a call (either car or hall) is detected, and it remains energized, holding the car call canceled at this floor, until the doors have opened and closed.

Similarly, the circuit for energizing relay CNH makes use of existing contacts previously described, to avoid duplication. Additional contacts HS-3 and CNH-3 assure that this relay can be energized only when the car is stopping for a hall call. Otherwise, contacts HS-3 does not close. Finally, relay NXA is connected in a similar manner to relay CNH, through additional contact NX-5. The purpose in doing this, is so that relay NXA, although normally just an auxiliary to relay NX, drops out when the doors of the next up car have been closed in preparation for responding to calls which may take it below the main floor, as previously described.

LOAD WEIGHING

The circuits of FIG. 45 will now be described. Load weighing switch W1 is located on the car, and is arranged to close if the weight of the load on the car exceeds approximately 10 percent of rated load. Similarly, contact W2 is arranged to close if this weight exceeds approximately 40 percent, and contact W3 is arranged to close if this weight exceeds approximately 70 percent of contract load. These contacts show the correct load on the car only when the car is stationary (or travelling at constant speed). During acceleration and deceleration, these contacts would give a false indication of the load, and, therefore, the circuit is arranged so that the condition of these contacts is applied to corresponding relays CW1, CW2 and CW3, only when the car is stopped, as indicated by contact MA-2 being closed. This contact opens whenever the car is running, or about to run, and remains open for a short time after the car has stopped, to assure that it is completely stopped.

Resistor R147 and capacitor C37 are provided to delay the picking up of relay CW1 when contact W1 closes, so that oscillation of the car due to the stretch of the hoist cable, or due to a spring hitch, does not falsely energize relay CW1. Capacitor C37 then provides, inherently, a considerably longer delay on the dropping out of relay CW1. Resistor R146 and contact CW1-4 are provided to allow reduction of this drop out time to a reasonable value.

Similarly, resistors R148 and R149, capacitor C38, and contact CW2-3 are provided for relay CW2. Also, similar components R150, R151, C39 and CW3-3 are provided for relay CW3.

When relay MA picks up, the opening of contact MA-2 cuts off the effect of contacts W1, W2 and W3, and the previously mentioned capacitors hold in relays CW1, CW2 and CW3, if previously in, until contact MA-1 completes a sealing circuit through contacts CW1-3, CW2-2 and CW3-2. Thus, whenever relay MA picks up, it holds relays CW1, CW2 and CW3, in their previous condition, and prevents any change in their condition. Diodes D136 to D141 are required to prevent sneak circuits from altering the condition of these relays.

MG SHUTDOWN

As mentioned earlier, it is best if each car has its own automatic shutdown timer, such as would be supplied on a single variable voltage elevator. Such a circuit is shown for relay AST. A cold cathode triode 720, such as an OA4G or 1C21, consisting of a cold cathode 721, an anode 722, and a firing anode 723, is used. As long as this car is in use, at least one of contacts CT-3, MR-8 and F-9, is open, so that relay AST cannot be energized, and capacitor C40 cannot be charged. Each time the car runs, contact F-4 closes so that capacitor C40 is discharged through resistor R154.

When this car has no further calls to answer, contact CT-3 is closed. When it is stopped, contact MR-8 is closed and if it is not intending to run, contact F-9 is closed. Then, capacitor C40, whose value might be 15 or 30 mfd., but which has very low leakage resistance, charges slowly through resistor R152, whose value might be 10 or 20 megohms. If this condition of idleness exists for approximately 4 minutes, without interruption, capacitor C40 becomes sufficiently charged so that the firing anode 723 is brought up to the firing voltage, approxi-

mately 90 volts. Then, current flows from the starting anode to the cathode, limited by resistor R153, whose value is approximately 100 Kohms, and this causes transfer of the firing to the main anode 722, so that the tube switches on, and energizes relay AST. Contact AST-3 then closes, to provide an alternate path through resistor R155, so that tube 720 does not have to continuously carry the current to hold relay AST energized.

Thus, relay AST picks up to cause automatic shutdown of the MG set, and remains picked up until calls are placed which require this car to start, as indicated by the opening of contact CT-3. Contact AST-2 also closes, so that capacitor C40 is discharged through resistor R154, ready for the next timing cycle. If, at any time during the approximately 4-minute timing period, before relay AST has picked up, the car runs again, contact F-4 discharges capacitor C40 so that it is reset for a full 4-minute timing cycle the next time.

DOOR CONTROL

The purpose of relay ET is to determine the length of time the doors remain open at each stop, except that further circuits operate elsewhere when the car is at the main floor, to hold the doors open longer. Each time the doors start to open, they do so because of the dropping out of relay E, and thus contact E-2 deenergizes relay ET at this time. Capacitor C41 then discharges through resistor R157 and the coil of relay ET, to hold relay ET picked up for a period of time, and this period of time might be about 15 seconds. While the doors are opening, contact OE-4 is open, and it opens before contact GCL-3 closes, so that resistor R156 has no effect. Then, when the doors have reached the fully opened position, relay OE drops, and contact OE-4 closes, and thus resistor R156 is connected in parallel with the coil of relay ET, causing the timing to be reduced to a much smaller value, perhaps about 3 or 4 seconds.

The dropping out of relay ET, a few seconds after the doors have fully opened, causes the doors to close automatically, provided that the open button is not pressed, and the safety-edge, etc., is not actuated. The purpose in deenergizing relay ET when the doors first start to open, with a long time delay, is to cause relay ET to drop out, and thus interrupt the opening sequence, if the doors fail, for any reason, to open or to open fully. Diode D143 and resistor R158 are provided so that capacitor C41 can be quickly charged, to give the full timing period to relay ET, even if relay E is only briefly energized, as occurs when the doors are reversed after only closing an inch or two.

Relay UM is energized through contacts CA-4, DM-16 and 20PO-2. Thus, relay UM picks up whenever there is any reason for this car to travel up, as indicated by the closing of contact CA-4. Similarly, the closing of contact CB-3 energizes relay DM through contacts UM-16 and 1PO-2. Contacts DM-16 and UM-16 act as electrical interlocks, so that relays UM and DM cannot be energized simultaneously. Contact 20PO-2 assures that relay UM cannot be falsely energized when the car is at the top floor, due to any failure of relay CA. Similarly, contact 1PO-2 prevents relay DM from being falsely energized when the car is at the bottom floor.

Contact CNH-4, UM-6 and DM-7 provide a sealing circuit, so that whenever the car responds to a hall call, no change in the condition of relays UM and DM can occur until the car has slowed down and stopped for this call, and until the doors have opened and closed fully. It should be noted that when the car is travelling up, and reverses direction in order to answer a down hall call, relay CNH does not pick up until after relay CA has picked up to drop relay UM, and thus, the closing of contact CB-3 energizes relay DM, which seals in through contacts CNH-4 and DM-7. This all happens before the car starts slowing down for this call. Thus, contact CNH-4 maintains the correct condition of relays UM and DM for such a high call reversal. A similar sequence can occur when this car is downbound, and reverses direction for an up hall call.

When there are no calls above or below, which this car should answer, contacts CA-5, CB-4 and CT-4 are all open, so that relay F remains dropped out. If the car is idle with its doors closed, contacts DR-6, UR-6, HCS-4, E-3 and PM-5, are all closed. Then, the dropping out of either relay CA or CB, if accompanied by the subsequent dropping out of relay CT, results in energization of relay F. This causes the car to start. If CA or CB had dropped only because of an up or down hall call at this same floor, the timing on relay CT would have prevented energization of relay F until contact HCS-4 opened; CA or CB would pick up again after cancellation of the hall call, but would likely drop out again due to registration of a car call by the incoming passenger.

When the car is travelling up, contact UR-6 is open, and when relay CA picks up to indicate no further need to travel up, relay F is deenergized by the opening of contact CA-5. Similarly, the opening of contact CB-4 causes deenergization of relay F, when the car is going down and contact DR-6 is open. In either direction, the opening of contact HCS-4 causes relay F to be deenergized to indicate the impending stop. Once relay F has dropped out, it locks out due to the opening of contact F-5, because contact PM-5 is open, and remains locked out until the car has come to a stop. Normally, however, it could not pick up then because HCS-4 would likely be open, as well as contact E-3.

When the doors are open, relay F can pick up only while the doors are closing, as indicated by contact E-3, and then only if the car is preparing to start, as indicated by contact CT-4. The purpose of contact PM-3 is to prevent deenergization of relay F if the car makes an emergency stop between floors, and the doors are then opened.

Relay IS is energized through switch ISS, located preferably in the car, so that when this switch is closed, the car is considered to be "in service," and when this switch is open, the car is considered to be on "independent service."

Relay PS is also fed through switch ISS, so that this car will not stop for hall calls unless it is in service. Normally, relay PS is energized to allow stops for hall calls. However, if this car is loaded beyond about 70 percent of rated capacity, contact CW3-6 opens, and relay PS is deenergized. Also, during up-peak, when contact UP-7 is open, a special car, with contact J-4 open, will drop out relay PS after one stop has been made for a down hall call, as indicated by the opening of contact K2-6. Thus, cars automatically bypass hall calls in either direction when loaded beyond 70 percent, and bypass down hall calls during up-peak, after one stop has been made for a down hall call, unless the car is normal, in which case there is no restriction on the number of down hall calls which it can answer.

Relay BLF is arranged to be energized whenever the car travels below the main floor. Actually, relay BLF picks up when the car is at the main floor, with the down direction established, through contacts DM-8 and 3PO-2. This condition is remembered while the car is below the main floor through contacts 3PO-6 and BLF-2. When this car returns to, or travels past, the main floor, contact DM-8 is open, and thus the opening of contact 3PO-6 causes relay BLF to drop out.

DOOR OPERATION

FIG. 46 shows a simplified door operator circuit. Relay E is arranged to control the door operation and when it is picked up, it causes the doors to close and remain closed. When it is dropped out it causes the doors to open and remain open. While the car is running, relay E is held energized through contact MRA-4, diode D144, and contact ZE-4. If the car makes an emergency stop, relay MRA drops out after a time delay, and allows relay E to be deenergized, to open the car door, only if the open button OB in the car is pressed.

When the car is approaching a floor, contact ZE-4 opens when the car is approximately 6 inches away, and if contact HCS-5 is also open, relay E drops to cause the doors to open. However, if the load on the car exceeds 70 percent of rated load, contact CW3-4 is closed, and relay E remains energized

until the car stops, as indicated by the opening of contact MRA-4. Diode D144 then prevents contact CW3-4 from holding the doors closed.

While the doors are opening, and for a second or two after, contact HCS-5 remains open to prevent energization of relay E. Contact ZE-4 remains open when the car is stopped within 6 inches of the floor. Then, when HCS-5 closes, relay E can be energized through the contact SE on the safety-edge, if it is not actuated, through the open button OB, if it is not pressed, and through the close button CB, if it is pressed. Otherwise, relay E is energized slightly later when contact ET-2 closes, provided that the safety-edge and open button are not pressed.

Contact E-4 assures that momentary pressure on close button CB is sufficient to cause closing of the doors, and also to bypass contact ET-2 which opens when contact E-2 closes. Contact IS-2 is closed when the car is in service, to give the operation just described. When this car is operated on independent service, contact IS-2 is open, and the doors do not close automatically, and constant pressure is required on close button CB in order to close the door to start the car. On a car which is next up, contact HCS-5 is open to prevent the closing of the doors.

When relay E is energized, contactor CE is also energized through further contact GCL-4 unless the doors are fully closed. Thus, when E picks up to close the doors, contractor CE is also energized, but drops out when the doors are fully closed, due to the opening of contact GCL-4.

Open limit OL is arranged to be closed for all positions of the car doors except fully open. Thus, when relay E drops out, contact E-5 closes to energize contactor OE, and when the doors are fully open, contactor OE is deenergized by the opening of open limit OL. Contact ET-1 is usually closed whenever the doors are to be opened, but may drop out, in order to deenergize contactor OE, if there has been any failure of the doors to open. It is necessary to deenergize contactor OE in order for contact OE-1 to drop relay HCS to allow the doors to close and the car to start.

Close limit CL is arranged to be closed for all positions of the car door, except fully closed. This contact energizes relay GCL, so that GCL is energized for all positions of the car doors, except fully closed.

A door motor consisting of armature DMA and field DMF is arranged mechanically to drive the car doors. The field DMF is energized continuously. The armature DMA is energized through resistors R160 and R161, and through contacts CE-1 and CE-2, in order to cause it to rotate in the correct direction to close the doors. Resistor R162 is connected in parallel with armature DMA, by contact OE-5, to cause a lower closing speed than the motor is capable of. This is desirable on an automatic elevator. Initially, close checking contact CC is open, but as the doors approach the fully closed position, contact CC closes to connect resistor R163 also in parallel with armature DMA to give a lower final speed. While the doors are closing, contact CE-3 is open, so that resistor R164 has no effect.

The armature DMA is energized through resistor R160 and through contacts OE-3 and OE-2 to cause it to rotate in the correct direction to open the car doors. Contact OE-5 is open during this time, and thus resistors R162 and R163 have no effect. The opening speed is thus higher than the closing speed. Open checking contact OC is initially open, but as the doors approach the fully opened position, contact OC closes to connect resistor R164 in parallel with armature DMA to give a lower final speed. It is assumed that the hall doors are actuated by the car doors through clutches, as is well-known in the art, and that the initial movement of the car door in the opening direction causes unlocking of the hall door to which it is clutched. Therefore, no retiring cam circuit is shown.

HALL LANTERNS

FIG. 47 shows the circuit for the hall lanterns. Transformer T3 reduces the voltage obtained from one phase, L1 and L2,

of the 3-phase power supply, to a voltage, frequently 115 volts, suitable for illuminating the hall lanterns. The hall lantern at an intermediate floor, such as floor 4, consists of a single stroke gong 4G, a lamp 4LU to illuminate that portion of the hall lantern which indicates the up direction, and a similar lamp 4LD to illuminate that portion of the hall lantern which indicates the down direction. The resistance of the gong coils is normally small compared to the operating resistance of the lamps. The cold resistance of a lamp is much lower, and thus when a lamp and gong are energized in series, the current is initially high, causing the gong to strike, but when the lamp has become illuminated, most of the supply voltage, from lines LL+ and LL-, appears across the lamp. Similar lamps and gongs, such as 2LU, 2LD, 2G, 19LU, 19LD and 19G are used at other intermediate floors.

At terminal floors, only one lamp is needed. At the bottom floor lamp 1LU indicates the up direction only, and at the top floor, lamp 20LD indicates the down direction only. It has been assumed that floors 1 and 2 are basements, and that the main floor is floor 3. Therefore, lamp 3LU illuminates what is nominally the up hall lantern at the main floor, but which is customarily a more elaborate fixture which may contain the words "this car up."

Relays 2L, 3L, 4L, etc., are already arranged to be energized only when the corresponding hall lantern should be illuminated. Thus, the only additional contacts required for intermediate hall lanterns are UM-7 and DM-9, so that a lantern corresponding to the established direction of travel is illuminated. For example, if the car is going up, and is reversing at floor 19 in order to answer a down hall call there, contact UM-7 opens, and contact DM-9 closes before relay 19L is energized, and this happens generally well ahead of the arrival of the car at floor 19. Thus, lamp 19LD and gong 19G are energized through contacts DM-9 and 19L-2.

Lamp 3LU is energized differently, through contact NXA-3, so that it is illuminated only when this car is next up at the main floor. It has already been shown that when the next up car first starts to close its doors in preparation for travelling up from the main floor (or, during up-peak, when the next up car first establishes its up direction), it ceases to be a next up car if there is another suitable car at the main floor, and thus the lamp 3LU is extinguished on this car, and immediately illuminated on another car. Otherwise, this car remains a next up car until its doors have closed fully, and lamp 3LU remains energized until then.

A different circuit is used for illuminating the hall lanterns at the top and bottom floors. Contact 20PO-1 closes whenever the car is at the top floor, but lamp 20LD is energized only when contact CNH-5 closes, and this occurs only when this car is stopping for a down hall call at the top floor. Similarly, lamp 1LU is energized through contacts CNH-5 and 1PO-1 whenever this car answers the up hall call at the bottom floor. If the car arrives at a terminal floor for any other reason, such as for a car call, the lantern does not illuminate.

SIGNAL LAMPS

Finally, FIG. 48 shows further signal lamps, and further interconnections between the relay circuit and the transistorized circuit. Power from lines L1 and L2 is transformed by transformer T4, and is rectified by diodes D145, D146, D147 and D148, to provide a direct voltage on lines 0 and -18 A which may have the usual waveform obtained from such single phase, full-wave rectification without filtering, but which has the same average voltage as between lines 0 and -18 of the transistorized circuits. If this is 18 volts, a secondary voltage of approximately 22 volts would be suitable for transformer T4.

The coil of relay INC is connected between -18 A and terminal CX on the car call card for floor 1, via wire 1CX. Thus, as already described, this coil is normally energized, and is deenergized whenever the car call for floor 1 is registered. Thus, contact INC-1 which was previously described, operates as required. Similarly, the coils of relays 2NC, 3NC,

4NC, etc., are connected between -18 A and the CX terminal of the corresponding car call card, so that their contacts also operate, as previously described, to open whenever the corresponding car call is registered.

A further level of stepping switch PQ, consisting of wiper PQ-DW, and contacts PQ-D1, PQ-D2, PQ-D3, etc., is arranged to connect the coil of relays CS, through contact PO-9, between 0 and the K terminal of the car call card corresponding to the position of the stepping switch, via wires 1K, 2K, 3K, etc. Normally, these wires are at the same voltage as wire 0, and relay CS is deenergized. Each time stepping switch PQ steps to a new position, contact PO-9 opens during the stepping, so that the contacts of this level of the stepping switch need never make or break a circuit. After PQ has stepped to a floor at which there is a car call registered, and after contact PO-9 has closed, relay CS will be energized in parallel with the XC relay on the car call card for the same floor. This lowers the voltage on this XC relay, but without dropping it out. The coil of relay CS is designed to be strong enough to actuate its contacts from this lower voltage. The contacts of CS have already been described, and the energization of this relay initiates a stop for this car call.

The cancellation of this call normally follows almost immediately, by the closing of contact CN-1 which shorts out the coils of both relays CS, and the XC relay in the car call card. Resistor R35 in the car call card allows this shorting out to be done without shorting the power supply. Thus, the call is canceled by the dropping out of the XC relay, which now remains out until this call is registered again. Contact CN-1 remains closed after the call has been canceled to prevent further registration of this car call while the car is at this floor, but this cancellation ceases after the car has opened its doors, and closed them fully again.

A further level on stepping switch PQ, consisting of wiper PQ-EW, and contacts PQ-E1, PQ-E2, PQ-E3, etc., is used to energize the XP relay on the car call card corresponding to the position of the stepping switch. This is done by connecting terminal P on the car call card, via wires 1P, 2P, 3P, etc. to wire 0. Since the coils of the XP relays are connected to -18 A, this results in energization of the correct one of them. Only one such relay is energized at a time, and there is always one of them energized, except during the brief period when wiper PQ-EW leaves one stationary contact and steps to the next one. No contact of relay PO is used in this circuit, so that there is a minimum delay in indicating, to the transistorized circuits, the new position of the car. It is, of course, the advanced digital position which is indicated. The stepping switch contacts are adequate to handle the very small amount of power required to energize a reed relay XP, and a diode D15 across each such coil suppresses the arc on the stepping switch contacts.

Lamp 1LU is energized through contact UM-8 to illuminate an up direction arrow, generally located in the car. Further lamps may be connected in parallel with lamp 1LU for illuminating up direction arrows located elsewhere, such as at the main floor. Similarly, lamp 1LD, and any other similar lamps which might be connected in parallel with it, are energized by contact DM-10 to illuminate down direction arrows.

A final level on stepping switch PQ, consisting of wiper PQ-FW, and contacts PQ-F1, PQ-F2, PQ-F3, etc., is used to energize a position indicator illuminated by lamps 1PI, 2PI, 3PI, etc. Such a position indicator is normally located in the car, and similar lamps for other position indicators at other places, such as the main floor, may be connected in parallel.

Further circuits are used to prevent the scrambler from causing faulty operation at the main floor. When it is necessary to start a car up from the main floor, for either spacing purposes or to answer a hall call, the scrambler causes a different order of scanning through the cars during each secondary scan at the main floor. This causes the next up car to be started up, rather than some other car. But when the next up car starts to close its doors, it ceases to be the next up car, if another is available there and some other car becomes the next up car.

The scrambler then changes the scanning order so that now the new next up car is instructed that it no longer needs to go up. A similar trouble could occur if, while a car is preparing to start down from the main floor, a new scrambling occurs because of a change in which car is next up. Then another car could be chosen to go down from the main floor.

Circuits to prevent this are shown in FIGS. 49 and 50. Relay LFT is energized through contact LF-7 so that it is an auxiliary relay to LF. Resistor R169 and condenser C41 are provided so that the dropout of relay LFT is delayed by approximately one-fourth second.

In FIG. 50, a power supply which is common to all cars is used to supply relays UMC and DMC, also common to all cars, via lines LC+ and NC. Relay UMC is energized through contacts LFT-4 and UM-18 in series, for all cars, and these pairs of contacts are then wired in parallel. Thus relay UMC is energized whenever any car has its up direction established at the main floor. When such a car leaves the main floor, relay LFT drops out shortly after stepping switch PQ moves to the next floor. Similarly, relay DMC is energized through contacts LFT-5 and DM-18 for any car, when any car has the down direction of travel established at the main floor.

In FIG. 49, the circuit shown is repeated for each car; a contact UMC-*m* is shown. This means a separate contact of relay UMC for each car. For example, car *a* could use UMC-1, car *b* could use UMC-2, car *c* could use UMC-3 etc. Similarly, contact DMC-*m* means a separate contact of relay DMC for each car. Contact UMC-*n* represents a further separate normally closed contact for each car.

Whenever any car is starting up from the main floor, all the UMC-*m* contacts are closed, and contact LFT-1 on any car at the main floor causes wire NHAO to be connected to N so that contact NHAR-1 (on FIG. 43) is shorted out. Thus any tendency for NHAR to drop out on some other car because of the new scrambling cannot falsely drop out relay HCA on such a car. However, the car at the main floor which has legitimately been started up due to HCA dropping, has contacts HCA-3, UM-19 and LFT-6 all open so that it retains relay HCA out in spite of the UMC-*m* contacts and in spite of closing of contact NHAR-1 due to new scrambling. After such a car has actually started to move, stepping switch PQ moves to the next floor above, relay LF drops out, and this car now is preferred above the others at the main floor for going up to answer hall calls above, and relay NHAR correctly indicates this on all cars. When relay LFT drops out, the circuit is restored to normal since relay UMC drops out and unshorts all the NHAR-1 contacts, and LFT-6 closes on the upbound car.

A similar circuit involving contacts DMC-*m*, LFT-2, LFT-7, DM-17 and HCB-4 assures that once a car has the down direction of travel established at the main floor, it prevents all others at the main floor from dropping out relay HCB until its stepping switch PQ has moved down to the next floor below.

The circuit involving contacts UM-17, LFT-3, PKA-3, LF-8 and UMC-*n* serves a similar purpose for the case where a car is starting up from the main floor for spacing reasons, due to the picking up of relay PKA. The opening of all the contacts UMC-*n* opens the circuit to the PKA relays of all cars at the main floor (with contact LF-8 open). A car legitimately starting up, with PKA in, holds it energized through PKA-3, LFT-3 and UM-17 until stepping switch PQ has stepped one step. Then contact LF-8 closes so that PKA relay is again controlled by contact PAR-1 (FIG. 43); contact LFT-3 opens about one-fourth second later.

Typical relay circuits, suitable for use with the transistorized circuits, have now been described. It is important to realize that these are only suggested circuits, and that many other circuits, relay or transistorized, could readily be used with my scanning system.

BASEMENT SERVICE

It has already been mentioned that this scanning system automatically handles basement floors without any need for the

special basement selection circuits required with conventional systems. However, it is often desirable to provide restricted service to basement floors during up-peak, or during down-peak, or during both peaks. This restriction may be complete cutting out of basement service, or it may be a partial reduction in travel below the main floor. With my system, the information contained in the J relays on each car would provide an excellent means of allowing only one car in three, or one car in four, to answer basement calls. No such circuit, however, is shown here.

Situations are occasionally encountered, particularly with basement floors, where certain floors are not served by all of the elevators in the group. If such floors are served by only one car of the group, the circuit design is straightforward. Obviously, whenever a hall call is registered at such a floor, only one car in the group can respond to it. However, when two or more cars, but not all cars, serve certain floors, a situation results which has been inherently difficult to design circuits for; particularly if efficient service is desired, with conventional systems. With my system, such situations can be handled efficiently and easily.

In such a building, most hall calls are served by all cars, and these hall calls will be called "normal" hall calls. Other hall calls are not served by all of the cars, and these will be called "extended" hall calls. Although it is possible to have some extended hall calls served by a certain number of the cars, and to have some further extended hall calls served by a lesser number of the cars, this situation will not be considered here. It can, however, be handled by my scanning system, but buildings requiring such service are extremely rare. Therefore, hall calls are either normal, or extended, and cars which serve these extended hall calls will be called "extended" cars, while the other cars will be called "normal" cars.

For example, if floor 7 is served by only cars *a* and *b*, the up and down hall calls at floor 7 would be extended calls, and cars *a* and *b* would be extended cars. As a further example, if there were only one basement, and only cars *c* and *d* served this basement, then the up hall call at the basement, and the down hall call at the main floor would both be extended hall calls, and cars *c* and *d* would be extended cars.

To handle such situations with my system, normal cars would be arranged so that the EP signal applied to their master cards would omit the pulses representing extended hall calls. Thus, they would not respond to such calls, but would see all other cars. Extended cars would have identical circuits, but each would have in addition another counter, and another readout card arranged so that its nEP input would contain pulses only for extended cars and extended hall calls. Thus, the outputs of this extra readout card for an extended car would indicate when it should travel up or down, or stop or open its doors, for an extended hall call. The outputs nHA, and nHB from this extra readout card would then energize relays whose normally open contacts would be wired in series with contacts NHAR-1 and NHAR-2 respectively. Such cars would then drop out relay HCA for either normal or extended hall calls above, and they would drop out relay HCB for either normal or extended hall calls below. The output HH of this extra readout card could be connected to the similarly marked terminal on the normal readout card, so that relay HHR could be energized by relay driver 214 in either of the two readout cards, to indicate when this car should stop for, or open its doors for, a hall call, either normal or extended.

Thus, it can be seen how this scanning system can be easily modified with standard or slightly modified components such as counters and readout cards, to easily and efficiently handle extended hall calls. As before, the nearest extended car above normally responds to an extended down hall call, and the nearest extended car below normally responds to an extended up hall call. An excess of extended hall calls, above the availability of one extended car, will cause a second extended car to be started to assist in answering some of these calls.

This scanning system has been described with two basement floors below the main floor. Obviously, more than two base-

ment floors could be easily handled; basically, all that is necessary on the transistorized part of the circuits, is to connect the 3SH input of the scrambler to the SH output of whichever hall call card represents the main floor. More changes are required in the relay circuits, particularly using contacts of relay 4PO, or 5PO, etc., as required, instead of contacts on relay 3PO. Such changes would be obvious to a circuit designer skilled in the art.

If there is only one basement, or if there is no basement, it is obvious that simple deletion of the associated car and hall call cards is sufficient to change the circuit shown, into one suitable for the fewer basement floors. Corresponding changes in the relay circuits also require deletions which would be obvious to one skilled in the art.

Although 20 floors have been shown, it is obvious that fewer or more floors can be handled easily by using fewer or more car call cards, hall call cards and priority cards. The circuits have been described generally for one car, and all other cards are identical, so that simple addition or deletion of the appropriate circuits, such as shown on FIGS. 3 and 4, allows for any number of cars from two to eight.

I claim:

1. In an elevator system comprising a plurality of elevator cars serving a plurality of floors, car position means controlled by the positions of said cars, call registering means for registering calls for service by said cars for said floors, means for successively and repetitively scanning on a continuous basis said call registering means and said position means, controlling means responsive to said scanning means for controlling the movement of at least one of said cars dependent upon the relative positions of said calls to said cars, further comprising passenger responsive means for each car operable by the passengers in a car, direction means for each car controlled by the direction of movement for which a car is available to move, and means for indicating the degree of availability of each car relative to the number of calls for service it is capable of answering without undue delay controlled by said passenger responsive means and said direction means, and wherein said scanning means also scans said availability means and said controlling means controls the movement of said cars and selectively causes a car to answer hall calls dependent upon the condition of said availability means and the number and location of said hall calls in relation to said last-mentioned car and to said other cars.

2. A system as set forth in claim 1 wherein said passenger responsive means comprises weighing means for weighing the load in a car and said availability indicating means has a first and a second condition when said load is respectively less than and at least a predetermined value.

3. A system as set forth in claim 1 wherein said passenger responsive means comprises weighing means for weighing the load in a car and said availability indicating means has a first condition when said load is less than a first predetermined value, a second condition when said load is at least equal to said first predetermined value but less than a second predetermined value and a third condition when said load is at least equal to said second predetermined value.

4. A system as set forth in claim 2 wherein said passenger responsive means also comprises car call registering means in each said car, said means for registering calls include means at said floors for registering hall calls at said floors, and said availability indicating means also is controlled by said car call means and has conditions dependent upon the number of car calls registered in a car and their floor position relation to registered hall calls.

5. A system as set forth in claim 1 wherein said passenger responsive means comprises car call registering means in each said car and said availability indicating means is controlled by said car call means and has different conditions dependent upon the number of car calls registered in a car and their floor position relation to registered hall calls.

6. In an elevator system comprising a plurality of elevator cars serving a plurality of floors, hall call means at said floors

for registering calls at said floors, car call means in said cars for registering calls for said floors, position means for each car controlled by the position of said car and direction means controlled by the direction of movement in which a car is available to move, the combination therewith of control means for controlling the movement of said cars, said control means availability means for each car controlled by said car call means and said direction means for indicating the availability of a car for movement in response to hall calls, said availability means having a plurality of conditions corresponding to the availability of its associated car and to availability numbers as follows:

1. availability number N; car available to move up and/or down and no car calls;
2. availability number N-C: car available to move up or down and there is a number C of car calls registered for a floor or floors between the car and the floor of the next registered hall call in the direction in which the car is available to move, wherein C is less than N and greater than O; and
3. availability number O and unavailable:
 - a. car directionally available to move up or down but the number of registered car calls for a floor or floors between the car and the floor of the next registered hall call in the direction in which the car is available to move is equal to or greater than N;
 - b. car unavailable, being out of service, or not available to move in the direction of a registered hall call or calls means for repetitively scanning on a continuous basis with respect to each car said hall call registering means and said availability means, and dispatching means responsive to said scanning means for directing an answering car to answer registered hall calls whenever:
 1. said answering car is up-available and the scanning shows that there is an up hall call above said answering car and there is no other up-available car between said answering car and the last-mentioned call; or
 2. said answering car is down-available and the scanning shows that there is a down hall call below said answering car and there is no other down-available car between said answering car and the last-mentioned call; or
 3. the scanning shows, with respect to said answering car, that the number of scanned hall calls above said answering car has a predetermined relation to the sum of the availability numbers corresponding to the availability means theretofore scanned for other cars located above said answering car; or
 4. the scanning shows, with respect to said answering car, that the number of scanned hall calls below said answering car has a predetermined relation to the sum of the availability numbers corresponding to the availability means theretofore scanned for other cars located below said answering car.
7. A system as set forth in claim 6 wherein N is equal to 2, said first predetermined number is equal to 1, said second predetermined number is equal to 2 and said predetermined relation is a number of said hall calls greater than the sum of said availability numbers.
8. A system as set forth in claim 6 further comprising load means for each car responsive to the load therein and wherein said availability means is also controlled by said load means and said availability means also has said condition (3) and availability number zero when the load exceeds a predetermined value.
9. A system as set forth in claim 6 wherein said control means in the absence of car calls holds each car at the floor at which it stopped for its last call until the car is directed to answer a hall call by said dispatch means.
10. A system as set forth in claim 6 wherein one of said floors is a main floor and wherein said control means parks cars which are not answering hall or car calls at floors within predetermined groups of floors and parks at least one said car at a floor within a group of floors comprising a predetermined

number of lower floors including said main floor, said last-mentioned number being less than about half the total number of floors.

11. A system as set forth in claim 6 wherein said dispatching means comprises a counter for each car, each such counter having means for adding an amount corresponding to said availability number and means for subtracting an amount corresponding to registered hall calls, and directing means responsive to said counter for directing a car to answer registered hall calls whenever the sum algebraic of said availability numbers and hall calls has a predetermined value and wherein said scanning means supplies information as to availability numbers and hall calls to each counter as follows:

1. in a direction away from a car, the hall calls for service in a first direction and the availability numbers of cars in such away direction;
2. in a direction toward a car, the hall calls for service in a second direction and the availability numbers of cars in said away direction;
3. in a direction away from a car, opposite to the direction away from the car set forth in (1), the hall calls for service in said second direction and the availability numbers of cars in said away direction first-mentioned in this subparagraph (3);
4. in a direction toward a car, opposite to the direction toward a car set forth in (2), the hall calls for service in said first direction and the availability numbers of cars in said last-mentioned away direction;

said scanning means scanning the availability means and hall call registering means in the numerical order of the floors at which cars and hall calls are located whereby the status of hall calls and the cars available to answer such hall calls is substantially continuously indicated to the dispatching means for each operating car in the system.

12. A system as set forth in claim 11 wherein a car available for service is directed to answer a hall call for service whenever the sum of availability numbers and the hall calls is less than zero and wherein said scanning means supplies information as to availability numbers and hall calls to each counter as follows:

1. in the up direction from a car, the down hall calls and availability numbers for cars above said car;
2. in the down direction to said car, the up hall calls and availability numbers for cars above said car;
3. in the down direction below said car, the up hall calls and availability numbers for cars below said car;
4. in the up direction to said car, the down hall calls and availability numbers for cars below said car;

whereby the hall call registering means and availability means are scanned in the order of their floor positions commencing at each car upwardly to the highest floor, downwardly to the lowest floor and then upwardly to said last-mentioned car.

13. A system as set forth in claim 11 wherein said dispatching means further comprises modifying means for reducing the amount corresponding to an availability number added by a counter when the car corresponding to said last-mentioned counter has been directed to answer hall calls as a result of a hall call beyond another car available to move in the direction of said last-mentioned hall call.

14. A system as set forth in claim 6 wherein one of said floors is the main floor and further comprising means for detecting down-peak traffic conditions and peak traffic modifying means responsive thereto for modifying the operation of said system including means for selecting cars in a predetermined order of their arrival at the main floor to be "special" and "normal" cars, means for preventing the scanning means from supplying to the dispatching means for "normal" cars information as to condition of the availability means of upbound "special" cars, means for preventing upbound "special" cars from answering up hall calls above said main floor and means for preventing the scanning means from supplying to the dispatching means for upbound "special" cars information as to the condition of the availability means of "normal" cars above.

15. A system as set forth in claim 14 wherein said modifying means further comprises means for recording a predetermined number of down hall calls in the time order of registration and means for preventing the scanning means from supplying to the dispatching means for upbound "special" cars information as to down hall calls other than recorded down hall calls.

16. A system as set forth in claim 14 wherein said modifying means further comprises means for reducing the availability number of "special" cars.

17. A system as set forth in claim 14 further comprising means for detecting up-peak traffic conditions and wherein said modifying means is also responsive to said last-mentioned means for modifying the operation of said system and includes the following which operate when up-peak traffic conditions are detected:

1. means for returning a predetermined number of cars to said main floor and other cars to a floor above the main floor after they have answered their hall and car calls and for parking the remainder, if any, at their last call stop,
2. means for selecting up trip cars in a predetermined order to be up-peak "special" and up-peak "normal" cars, and
3. means for preventing down bound, up-peak "special" cars from reversing direction before travelling to the main floor and from stopping to answer more than a predetermined number of down hall calls.

18. A system as set forth in claim 17 wherein said modifying means further comprises means operable when up-peak traffic conditions are detected, for causing up-peak "normal" cars to reverse direction at floors other than said main floor when there is no demand for service therefor in said direction and there is a demand for service in the opposite direction.

19. A system as set forth in claim 17 wherein said means for detecting peak traffic conditions comprises means for counting the number of down hall calls, means for counting hall calls, means for totaling the car availability numbers, means for comparing the number of hall calls with the sum of the car availability numbers, means for comparing the rate of car stops for car calls with the rate of car stops for down hall calls, and means responsive to said counting, totaling and comparing means for operating said modifying means as follows:

1. For down-peak traffic when:
 - a. there are at least a predetermined number of down hall calls;
 - b. the total hall calls have a predetermined relation to the sum of the car availability numbers; and
 - c. the ratio of the rate of car stops for car calls to the rate of car stops for down hall calls is less than a predetermined value.
2. For up-peak traffic when:
 - a. there are less than a predetermined number of down hall calls, said last-mentioned number being no greater than the predetermined number in subparagraph 1a hereof;
 - b. the total hall calls have a predetermined relation to the sum of the car availability numbers different from that for down-peak; and
 - c. the ratio of the rate of car stops for car calls to the rate of car stops for down hall calls is at least equal to said predetermined value in subparagraph 1c hereof.

20. A system as set forth in claim 19 wherein said predetermined relation for down-peak traffic and said predetermined relation for up-peak traffic are respectively hall calls greater in number than and hall calls not greater in number than the sum of the car availability numbers.

21. In an elevator system having a plurality of elevator cars serving a plurality of floors, means at said floors for registering calls for service from said floors, means in said cars for registering calls for service to said floors and means for stopping said cars at floors for which calls are registered, the combination therewith of means responsive to said registering means and said stopping means for comparing the rate of car stops for car calls with the rate of car stops for down hall calls and controlling means responsive to said comparing means for controlling the movement of said cars.

22. A system as set forth in claim 21 further comprising counting means for counting hall calls and wherein said controlling means is also responsive to said counting means.

23. A system as set forth in claim 22 further comprising load means responsive to the load in said cars and availability means responsive to said load means and said car calls means and wherein said controlling means is also responsive to said availability means.

24. A system as set forth in claim 21 wherein one of said floors is a main floor and wherein said controlling means is conditioned to dispatch cars so as to provide preferential service away from said main floor when the ratio of the rate of car stops for car calls to the rate of car stops for down hall calls is at least equal to a predetermined value and said controlling means is conditioned to dispatch cars so as to provide preferential service toward said main floor when said ratio is less than said predetermined value.

25. A system as set forth in claim 24 further comprising means for counting hall calls including down hall calls, availability means for each of said cars, said availability means having different conditions dependent upon the directional availability of a car and the degree of availability of a car to answer hall calls, said conditions corresponding to predetermined availability numbers, totaling means controlled by said availability means for providing information as to the sum of the car availability numbers, and means for comparing the number of hall calls with the sum of the car availability numbers, and wherein said controlling means is conditioned not only by the ratio of the rate of car stops for car calls to the rate of car stops for down hall calls but also by said counting, totaling and comparing means so as to provide control of said cars as follows:

1. preferential service toward said main floor when:
 - a. there are at least a predetermined number of down hall calls;
 - b. the total hall calls have a predetermined relation to the sum of the car availability numbers; and
 - c. said ratio of the rate of car stops for car calls to the rate of car stops for down hall calls is less than said predetermined value set forth in claim 26.
2. preferential service away from said main floor when:
 - a. there are less than a predetermined number of down hall calls, said last-mentioned number being no greater than the predetermined number in subparagraph 1a hereof;
 - b. the total hall calls have a predetermined relation to the sum of the car availability numbers different from that in subparagraph 1b. hereof; and
 - c. said ratio of the rate of car stops for car calls to the rate of car stops for down hall calls is at least equal to said predetermined value set forth in paragraph 1c hereof.

26. In an elevator system having a plurality of cars serving a plurality of floors, car call means in said cars operable by passengers therein for registering car calls for said floors, hall call registering means at said floors operable by intending passengers for registering hall calls, position means for each of said cars for providing information as to the positions of said cars and direction means for each of said cars for providing information as to the direction in which said cars are available to move, the combination therewith of means for controlling the movement and parking of said cars comprising availability means for each of said cars responsive to said car call means and said direction means for providing electrical signals corresponding to the directional and call availability of the corresponding car; counter means for each of said cars; scanning means; subtracting means responsive to said scanning means and to said hall call registering means for supplying subtract signals to the counter for each car for hall calls above each car and alternately for hall calls below each car; adding means responsive to said scanning means and to said availability means for supplying add signals to the counter for each car for cars above each car which are available to answer hall calls above each car and alternately for cars below each car which

are available to answer hall calls below each car; reset means to reset said counter to a predetermined count condition between the supplying of subtract signals for hall calls above and the supplying of subtract signals of hall calls below to a counter; and control means responsive to the counter for each car for causing the car corresponding to a counter to answer hall calls when the count condition of the corresponding counter is other than said predetermined count condition just prior to resetting of the counter for said last-mentioned car and said last-mentioned car is in-service and capable of answering hall calls.

27. A system as set forth in claim 26 wherein said scanning means comprises code means for providing electrical signals in binary digital code corresponding successively to each of said floors and the direction of scanning with respect to the numerical order of the floors and for providing, for each of the floors at which a car is positioned, electrical signals in binary digital code successively corresponding to each of said cars; further comprising position code means for each of said position means for providing electrical signals in binary digital code corresponding to the position of the corresponding car; further comprising parity means for each of said cars connected to said scanning means and said position code means for comparing the floor position signals of the corresponding car; wherein said control means comprises memory means for each of said cars, the memory means of each car being operable by said scanning means to cause said memory means to record a hall call at a floor at which the car is positioned; and said scanning means comprising operation means controlled by said parity means and controlling said availability means, said operation means being operable when said parity means indicates that there is a car at the floor position of the scan of said scanning means for causing the following operations as to each car at said last-mentioned floor:

- a. reading by said memory means of the output of the car's corresponding counter;
- b. supplying of an add signal from the availability means, if the car is available, to at least all of said counters for cars other than at said last-mentioned floor;
- c. resetting of the car's counter to zero.

28. In an elevator system having a plurality of cars serving a plurality of floors, car call means in said cars operable by passengers therein for registering car calls for said floors, hall call registering means at said floor operable by intending passengers for registering hall calls, position means for each of said cars for providing information as to the positions of said cars and directions means for each of said cars for providing information as to the direction in which said cars are available to move, the combination therewith of means for controlling the movement and parking of said cars comprising position code means for each of said position means for providing electrical signals in binary digital code corresponding to the position of the corresponding car; first scanning means for providing electrical signals in binary digital code successively corresponding to each of said floors and the direction of scanning with respect to the numerical order of the floors, said scanning means providing signals corresponding successively to the lowest and then higher floors and then providing signals corresponding successively to the highest and then lower floors; three memory means for each of said cars, a first memory means for hall calls above the cars, a second memory means for hall calls below the car and a third memory means for hall calls at the floor at which the corresponding car is located; a counter for each of said cars; parity means for each of said cars connected to said first scanning means and said position codes means for comparing the floor position signals of the scan with the floor position signals of the corresponding car; availability means for each of said cars controlled by said direction means and said car call means of the corresponding car for providing electrical signals corresponding to the directional and call availability of the corresponding car; second scanning means operable by said first scanning means each time the scan of said first scanning means steps to a dif-

ferent floor, said first scanning means also being controlled by said second scanning means and being stepped to a different floor after completion of a scan by said second scanning means; hall call comparing means connected to said scanning means, said hall call registering means and said counters for providing a subtract signal to said counters when the first scanning means signals corresponds to the floor of the hall call registering means and a hall call is registered thereat; said second scanning means also controlling said third memory means of a car at said last-mentioned floor to cause said third memory means to record a hall call which may be registered at said last-mentioned floor and said second scanning means being operable when said parity indicates that there is a car at the floor position of the scan of said first scanning means for causing the following operations as to each car at said last-mentioned floor:

- a. reading by one of said first and second memory means, depending on the direction of movement of the scan of said first scanning means, of the output of the car's corresponding counter;
- b. supplying of an add signal from the availability means, if the car is available to at least all of said counters for cars other than at said last-mentioned floor;
- c. resetting of the car's counter to zero; and control means for each car responsive to said memories for causing the corresponding car to move or park dependent upon the conditions of said memory means and the availability of the car.

29. A system as set forth in claim 28 wherein said counters comprise means for preventing further addition when the count therein is zero.

30. A system as set forth in claim 28 wherein said second scanning means causes said operations in a predetermined sequence with respect to said cars when a plurality thereof are at the same floor other than a predetermined lower floor and when said first scanning means is scanning in the direction from lower to upper floors and causes said operations in a sequence which is reversed with respect to said predetermined sequence when a plurality of said cars are at the same floor other than said predetermined floor and said first scanning means is scanning in the direction from the upper to lower floors.

31. In an elevator system comprising a plurality of elevator cars serving a plurality of floors, car position means controlled in accordance with the positions of said cars, car direction means controlled in accordance with the direction in which a car is available to move, call registering means for registering calls for service by said cars for said floors, availability means controlled at least by said car direction means for providing information as to the availability of a car to answer registered calls, scanning means for successively and repetitively scanning the information provided by said call registering means, said position means and said availability means in a predetermined normal sequence for floors other than a predetermined floor, and controlling means responsive to said scanning means for controlling the movement of said cars dependent upon the number and relative position of said calls to said cars and the availability of cars to answer said calls, the combination therewith of selecting means for selecting a predetermined car at said predetermined floor and modifying means controlled by said selecting means upon selection of said predetermined car for modifying the operation of said scanning means in its scanning operation at said predetermined floor to provide a scanning sequence different from said normal sequence at said predetermined floor.

32. The combination as set forth in claim 31 wherein said scanning means, when modified in operation, scans with respect to the selected car first when scanning the information corresponding to the direction in which said selected car is set to move and scans with respect to the selected car last when scanning the information corresponding to the direction opposite to the direction in which said selected car is set to move.

33. The combination as set forth in claim 32 wherein said selecting means selects the car next to depart from said predetermined floor.

34. In an elevator system comprising a plurality of elevator cars serving a plurality of floors, car position means controlled in accordance with the positions of said cars, car direction means controlled in accordance with the direction in which a car is available to move, call registering means for registering calls for service by said cars for said floors, availability means controlled at least by said car direction means for providing information as to the availability of a car to answer registered calls, means for successively and repetitively scanning on a continuous basis the information provided by said call registering means, said position means and said availability means, controlling means responsive to said scanning means for controlling the movement of said cars dependent upon the number and relative positions of said calls to said cars and the availability of cars to answer said calls, and automatic car shutdown means for removing a car from service when the demands for service therefor fall below a predetermined level, the combination therewith of modifying means responsive to said shutdown means for preventing response of the controlling means corresponding to a car which has not been shut down to the scanning of information provided with respect to a car which has been shut down and for modifying the response of the controlling means corresponding to a shutdown car.

35. The combination as set forth in claim 34 wherein the controlling means of a shutdown car, when modified, responds to said scanning means when it is scanning information corresponding to cars which have not been shut down and responds differently in different scanning cycles to scanning information corresponding to shutdown cars.

36. The combination as set forth in claim 35 wherein during one scanning cycle, the controlling means of a shutdown car, when modified, responds to said scanning means when it is scanning information corresponding to shutdown cars located in a predetermined direction with respect to said shutdown car and does not respond to said scanning means when it is scanning information corresponding to shutdown cars located in a direction opposite to said predetermined direction with respect to said shutdown car.

37. A method of controlling a plurality of elevator cars to serve a plurality of floors, comprising continuously providing bits of information representing some or all of hall calls and car position and availability to answer the calls, repetitively scanning on a continuous basis said bits of information in a predetermined order and sufficiently rapidly that the cars do not effectively change their positions during each scan, and dispatching the cars in response to the scanned information from wherever the cars happen to be, in which the hall call information comprises, for each floor, information as to up and down hall calls registered from that floor, and the car position and availability information comprises, for each car, its availability to go up, its availability to go down, a car position corresponding to the nearest floor for which the car is available, and the degree of availability of the car.

38. A method as claimed in claim 37, in which the degree of availability of a car is the number of hall calls that the car is arbitrarily allowed to answer without requiring assistance from other cars.

39. A method as claimed in claim 38, in which car calls and car loading are used to reduce the degree of availability of the car.

40. A method as claimed in claim 37, in which the hall call information as to down hall calls at the various floors and the car position and availability as to cars available to go down are scanned in ascending order from the lowest to the highest floor, and then the hall call information as to cars available to go up are scanned in descending order.

41. A method as claimed in claim 40, in which for each floor the hall call information is scanned and then the car availability information as to each car whose position is represented at that floor.

42. A method as claimed in claim 41, in which the information as to one car is scanned before the information as to another car whose position is represented at the same floor.

43. A method as claimed in claim 42, in which the predetermined order of scanning through the bits of information indicating car availability is altered during that portion of the descending scan when conditions at the main floor are being examined, so that the bits of information representing the availability of the next up car are scanned first, before the corresponding bits of information representing the availability of other cars, and in which the predetermined order of scanning through the bits of information indicating car availability is altered during that portion of the descending scan when conditions at the main floor are being examined, so that the bits of information representing the availability of the next up car are scanned last, after the corresponding bits of information representing the availability of other cars at the main floor have been scanned.

44. A method as claimed in claim 42, in which two consecutive bits of information are used to indicate a car's degree of availability, one of them to indicate whether or not this car is available to answer two hall calls, and the other of them to indicate whether or not this car is available to answer one hall call, so that the combination of these consecutive bits can indicate that this car is available to answer none, one, two or three hall calls.

45. A method as claimed in claim 44, in which each car is normally available to answer two hall calls, but in which a car is available to answer only one hall call if loaded beyond a predetermined load, or if an intervening car call would require this car to make two stops before being able to answer the second of two existing hall calls, and in which a car becomes unavailable if loaded beyond a higher predetermined load, or if two intervening car calls would require this car to make two stops before answering an existing hall call.

46. A method as claimed in claim 45, in which it is determined whether there are hall calls above a car which the car should answer by resetting a counter at a point in the ascending scan during scanning of the conditions at the floor where the car is represented to be, by subtracting one each time a hall call is scanned, by adding two each time a car with an availability of two is scanned, by never allowing the accumulated count on the counter to be a positive number, and by reading the accumulated count on the counter at a point in the descending scan during scanning of the conditions at the floor where the car is represented to be, and in which a negative accumulated count is an indication that there are hall calls above, which this car should answer; and in which it is determined whether there are hall calls below a car which the car should answer by resetting a counter at a point in the descending scan during scanning of conditions at the floor where the car is represented to be, by subtracting one each time a hall call is scanned, by adding one each time a car with an availability of one is scanned, by adding two each time a car with an availability of two is scanned, by never allowing the accumulated count on the counter to be a positive number, and by reading the accumulated count on the counter at a point in the descending scan during scanning of the conditions at the floor where the car is represented to be, and in which a negative accumulated count is an indication that there are hall calls below, which this car should answer.

47. A method as claimed in claim 46, in which when the up direction of travel is established for a car, and when there are no hall calls below it which it should answer, its counter adds one, instead of two, each time a car above with an availability of two is seen during the scan; and when the down direction of travel is established for a car, and when there are no hall calls above it which it should answer, its counter adds one, instead of two, each time a car below with an availability of two is seen during the scan.

48. A method as claimed in claim 46, in which cars whose MG sets are running do not respond to the bits of information regarding the availability of cars whose MG sets are shut down automatically, and in which for each car whose MG set is au-

tomatically shut down it is determined when there are hall calls above it, which require it to start its MG set in order to answer some or all of these hall calls, by resetting a counter at a point in the descending scan during scanning of the conditions at the floor where the car is represented to be, by subtracting one each time a hall call is scanned, by adding one each time a car with an availability of one, and whose MG set is running, is scanned, by adding two each time a car with an availability of two is scanned, whose MG set is running, by allowing the accumulated count to be a positive number as well as a negative number, by continuing this counting until a point in the ascending scan is reached where the conditions at the floor where the car is represented to be is being scanned, by resetting the counter at this point only if the accumulated count on the counter is negative, by continuing to subtract one each time a hall call is scanned, by adding one each time a car with an availability of one is scanned, provided that the accumulated count is negative or that the car has its MG set running, by adding two each time a car with an availability of two is scanned, provided that the accumulated count is negative or that the car has its MG set running, and by not allowing such addition of two to take the accumulated count from a negative number to beyond zero except for a car whose MG set is running, and by reading the accumulated count on the counter at a point in the descending scan when conditions at the floor where the car is represented to be are being scanned, and in which a negative accumulated count is an indication that this car should start its MG set, and go up to answer hall calls above; and in which for each car whose MG set is automatically shut down it is determined when there are hall calls below it, which require it to start its MG set in order to answer some or all of these hall calls, by resetting a counter at a point in the ascending scan during scanning of the conditions at the floor where the car is represented to be, by subtracting one each time a hall call is scanned, by adding one each time a car with an availability of one, and whose MG set is running, is scanned, by adding two each time a car with an availability of two is scanned, whose MG set is running, by allowing the accumulated count to be a positive number as well as a negative number, by continuing this counting until a point in the descending scan reached where the conditions at the floor where the car is represented to be are being scanned, by resetting the counter at this point only if the accumulated count on the counter is negative, by continuing to subtract one each time a hall call is scanned, by adding one each time a car with an availability of one is scanned, provided that the accumulated count is negative or that the car has its MG set running, by adding two each time a car with an availability of two is scanned, provided that the accumulated count is negative or that the car has its MG set running, and by not allowing each addition of two to take the accumulated count from a negative number to beyond zero except for a car whose MG set is running, and by reading the accumulated count on the counter at a point in the ascending scan when conditions at the floor where the car is represented to be are being scanned, and in which a negative accumulated count is an indication that this car should start its MG set, and go down to answer hall calls below.

49. A method as claimed in claim 37, in which the floors are divided into at least four groups of floors of which the lowest group contains the main floor, and in which cars are dis-

tributed throughout the building, when not otherwise required for the answering of car or hall calls, such that, as long as a predetermined number of cars more than one are available, in the absence of cars in the lowest group of floors the lowest car is brought down to the main floor, in the absence of cars in the upper two groups of floors the highest car travels up until it is at the lowest floor of the upper group of floors, in the absence of cars in any intermediate two immediately adjacent groups of floors the lowest car in a group of floors above the two adjacent groups, provided that there are two or more such cars there, travels down until it is at the top floor of the lower of these two intermediate adjacent groups of floors, or, if there are less than two cars in the group of floors, above the two adjacent groups, and there are no cars in the two intermediate adjacent groups of floors, the highest car in a group of floors below the two adjacent groups travels up until it is at the bottom floor of the higher of these two intermediate adjacent groups of floors, provided that there are at least two cars in the lowest group of floors.

50. A method as claimed in claim 37, in which the floors are divided into four groups of floors of which the lowest group contains the main floor, and in which cars whose MG sets are running are distributed throughout the building, when not otherwise required for the answering of car or hall calls, such that, as long as two or more cars have their MG sets running, in the absence of cars with MG sets running in the lowest group of floors the lowest car with MG set running is brought down to the main floor, in the absence of cars with MG sets running in the upper two groups of floors the highest car with MG set running travels up until it is at the lowest floor of the upper group of floors, in the absence of cars with MG sets running in the middle two groups of floors the lowest car with MG set running in the upper group of floors, provided that there are two or more such cars there, travels down until it is at the top floor of the lower of these two middle groups of floors, or, if there are less than two cars with MG sets running in the upper group of floors, and there are no cars with MG sets running in the middle two groups of floors, the highest car with MG set running in the lowest group of floors travels up until it is at the bottom floor of the higher of these two middle groups of floors, provided that there are at least two cars with MG sets running in the lowest group of floors.

51. A method as claimed in claim 37, in which the order of registration of down hall calls, for floors above the main floor, is continuously recorded, and in which, during down-peak, one group of cars answers long-wait down hall calls, and another group of cars answers other calls including up hall calls.

52. A method as claimed in claim 51, in which, upon arrival at the main floor during down peak, cars are allocated to said one group and remain in said one group only until they commence their next down trip, cars not so allocated and all cars in their down trip belonging to said other group.

53. A method as claimed in claim 52, in which the allocation of cars to said one group or to said other group upon arrival at the main floor follows a predetermined sequence independent of whether a car has previously been allocated to said one group.

54. A method as claimed in claim 53, in which the number of calls treated as long-wait calls equals the number of cars allocated to said one group.

J-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,561,571 Dated February 9, 1971

Inventor(s) John A. Gingrich

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 115, line 6, delete "said control means".

Signed and sealed this 14th day of December 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patent