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(54) CONTROL SYSTEM FOR A VENDING MACHINE

(71) We, NIPPON COINCO CO., LTD. a company incorporated under the laws of Japan, No. 5—8, Kitaaoyama 2-chome, Minato-ku, Tokyo-to, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a control system for a vending machine and a method of controlling such a machine.

In vending machines of a conventional type, a "shortage of change" test is conducted if the amount of stored change becomes less than a predetermined amount, which is normally determined as a maximum required amount of change such, for example, as 90 yen, for the purpose of avoiding an occasion on which it is impossible to pay out change to a purchaser.

The prior art method of detecting "shortage of change" has a coin detection switch such as an empty switch located at a predetermined position in a change coin storage tube, normally in the vicinity of a position which corresponds to the maximum amount of change which could be required in a transaction, for detecting a "shortage of change" state on the basis of the output of this switch.

One way of improving the vending efficiency of a vending machine is to prevent occurrence of a "shortage of change" state so far as possible, so as to always maintain the vending machine in a state in which it is capable of vending articles stored therein.

This factor is particularly important for a recently developed type of vending machine which can handle a large amount of money for a single vending operation. More particularly, such a new type of vending machine functions to continuously vend a plurality of articles upon selection by a purchaser in a single vending operation starting with insertion of coins by the purchaser and ending with depression of a clear button (or switch). As a result, the total vending price becomes a large amount and, accordingly, the total value of the inserted coins is large.

It is probable that increasing the amount of money required for purchasing the article in the machine will cause a corresponding increase in the amount of change to be paid out or money to be returned upon cancellation of purchase of the article. Accordingly, a "shortage of change" state may frequently occur unless sufficient consideration is given to the afore-mentioned point in designing the vending machine.

It has recently been proposed to provide an auxiliary coin storage device specially for paying out coins, which device will hereinafter be called an "auxiliary tube", for the purpose of ensuring provision of a sufficient amount of change coins.

The conventional vending machine originally had only a single coin storage tube as a change or payout coin storage device, which will hereinafter be called a "main tube", to which coins inserted by a purchaser are automatically supplied. The above-mentioned recently proposed method is intended to ensure sufficient provision of change coins by additionally providing the auxiliary tube specially for paying out coins with which it has been supplied manually by a supervisor of the vending machine. An effective method of detecting "shortage of change" in respect to the main and auxiliary tubes has not yet been found. One may consider, for example, a method of attaching respective empty switches of the aforesaid type to the main and auxiliary tubes. As the number of the main and auxiliary tubes increases, the number of the empty switches also increases. This not only increases cost, but requires a large space for mounting a large number of switches, resulting in bulkiness of the coin acceptor of the machine. Furthermore, if the aforementioned empty switches are provided at respective coin storage tubes, a coin payout operation is prevented when the amount of stored coins falls below the position of each switch, and accordingly, all vending operations of the machine requiring payout of change are prohibited in a state wherein coins falling short of the predetermined amount are retained in the respective tubes. Since the total amount of the coins retained in one or other of the main and auxiliary tubes sometimes becomes so large that it will be sufficient to pay out the change, this method is extremely inefficient in that the vending operation is stopped notwithstanding that change can be paid out.

Another difficulty, which occurs when an auxiliary tube is employed specially for paying out coins, is the control of change-over between the coin payout tubes, i.e. when payout is to change from the main tube to the auxiliary tube or vice versa.

There has heretofore been proposed a method of providing a further coin-level switch on the main tube side in addition to the empty switch. If the number of stored coins in the main tube falls below the position of this further switch, the switch becomes OFF and payout is transferred from the main tube to the auxiliary tube.

However, this method has a disadvantage that it requires space for mounting the switch for detecting the switched position, and also has an additional disadvantage that as the number of tubes increases, the number of the further switches increases.

Our copending Application No. 17253/77 (Serial 1,566,201) relates to a method of controlling an automatic vending machine comprising the steps of storing the aggregate value of each denomination of a plurality of denominations of coins inserted into the vending machine, sequentially transferring value from the stored value of coins of a higher denomination to the stored value of coins of a lower denomination until the stored value of the least denomination coins becomes higher than a vend price, subtracting the vend price from stored value of the least denomination coins after said transfer, and paying out as change the balance of the stored values after said transfer and subtraction preferentially in the higher denomination coins.

According to this invention, in one aspect, there is provided a method of controlling an automatic vending machine, comprising directing coins inserted into said vending machine to main coin storage means, maintaining a count of the number of coins in the main coin storage means by adding the number of coins directed thereto and subtracting the number of coins paid out therefrom, manually inserting coins of a predetermined denomination into auxiliary coin storing means, paying out coins from said main coin storing means until the count of the number of coins therein reaches a predetermined value and then transferring payout from said main coin storing means to said auxiliary coin storing means and transferring payout from said auxiliary coin storing means back to said main coin storing means if coins are not paid out from said auxiliary coin storing means as a result of an operation thereof.

According to the invention, in another aspect, there is provided a control system of an automatic vending machine comprising main coin storing means, coins stored therein being automatically supplemented by coins inserted into said vending machine, a counter circuit for adding the number of coins supplemented and for subtracting the number of coins paid out from said main coin storing means, auxiliary coin storing means for storing coins of a predetermined denomination which are placed therein manually, means for paying out coins from said main coin storing means until the count of said counter circuit reaches a predetermined value, means for transferring payout from said main coin storing means to said auxiliary coin storing means when the count of said counter circuit reaches said predetermined value, detection means for detecting whether a coin is paid out from said auxiliary coin storing means as a result of each operation thereof and means responsive to the detection means for transferring payout from said auxiliary coin storing means to said main coin storing means when coins are not paid out from said auxiliary coin storing means in response to actuation thereof.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic explanatory view of one preferred embodiment of the control system for a vending machine constructed according to this invention, as to the mechanical portion of the coin acceptor,

Figure 2 is a flow chart of the embodiment of the control system for explaining a coin payout tube transferring system,

Figure 3 is a detailed block diagram of half of the control circuit of the embodiment of the control system for the machine constructed according to this invention, and

Figure 4 is a detailed block diagram of the other half of the control circuit of the embodiment of the control system.

Referring first to Figure 1, which shows a coin flow path in the coin acceptor mechanism of a vending machine, a coin inserted from a coin insertion slot 1 is detected to be true or false and its denomination identified by a coin detector 2, a false coin being returned to a return path 4, a 100 yen true coin directed to an escrow device 5, a 10 yen true coin to a main tube 6, and a 50 yen true coin to a main tube 7 based on the detected results by a classifying mechanism 3. The inserted 10 yen coins are automatically supplied to the 10 yen coin main tube 6, which will hereinafter be called the "A tube" for convenience of description. The inserted 50 yen coins are automatically supplied to the 50 yen coin main tube 7, which will hereinafter be called the "B tube" for convenience of description. An auxiliary tube 8 serves to store 10 yen or 50 yen coins manually supplied thereto and will hereinafter be called the "C tube" for convenience of description. The tube 8 (the C tube) may preferably be formed with the diameter of the 10 yen coin. An auxiliary tube 9 serves to store only 10 yen coins supplied manually thereto and will hereinbelow be called the "D tube" for convenience of description. The A, B and C tubes 6, 7 and 8 are assembled integrally in a standard type coin acceptor, and the D tube 9 may be optionally assembled separately. An auxiliary tube or tubes may be optionally provided in addition to the D tube 9 as long as space for attaching said tube is allowed. This auxiliary tube need not only be of cylindrical shape but may be of hopper shape. Further, the auxiliary tube including the D tube 9 may be separated from the coin acceptor as partitioned by a chain-dotted broken line 10 in Figure 1, and if the tube is separate, D tube separation memory flip-flop 20 is set, as is to be described later with reference to Figure 4.

At a predetermined position in the 10 yen coin main tube (A tube) 6, for example, at the height of a stack of nine coins, is provided an empty detection device 36 for detecting an "empty" state of the A tube in the event of interruption of the mains power supply.

A coin payout mechanism 12 for the A, B and C tubes is driven by a first coin payout motor M_{01} for paying out the coins from the A tube 6 upon energization of A tube payout solenoid 141 and for paying out the coins from the C tube 8 upon energization of C tube payout solenoid 142 in response to the rotation of the motor M_{01} to be described later in detail. When the motor M_{01} is rotated with both the solenoids 141 and 142 deenergized, coins are paid out from the B tube 7. When a second coin payout motor M_{02} is rotated, coins are paid out from the D tube 9 via a payout mechanism 13. A carrier switch 143 is provided at the motor M_{01} and a carrier switch 195 is provided at the motor M_{02} for proving one revolution of the motors M_{01} and M_{02} required for paying out one coin, as will be described later with reference to Figure 4.

The coins paid out from the respective tubes 6 to 9 are directed to a coin payout path 14 to operate a payout coin detection switch 150 provided thereat to be described later.

Figures 3 and 4 together comprise a detailed block circuit diagram of a control system for a vending machine for use with the coin acceptor shown in Figure 1. A flow chart illustrating the operation of the payout control system of this invention is shown in Figure 2.

The example of the operation of the control system shown in Figure 2 employs the C tube 8 as a 50 yen coin auxiliary tube and D tube 9 as a 10 yen coin auxiliary tube.

'START' in Figure 2 shows the depression of a clear button for requiring inserted coin return or payout of change.

"$R_B \neq 0$" represents the condition that the counted content R_B in a 50 yen coin counter 30, to be described later in more detail, is not zero.

"YES" indicates the satisfaction of the condition, "NO" means no satisfaction of the condition in the control system.

"$R_A \neq 0$" represents the condition that the counter content R_B in a 10 yen coin counter 29, to be described later in more detail, is not zero.

The line of "$R_B \neq 0$" and YES is a control line for paying out 50 yen coin or coins from the main tube (B tube) 7 or the auxiliary tube (C tube) 8, and "$R_A \neq 0$" and YES line is a control line for paying out 10 yen coin or coins from the main tube (A tube) 6 or auxiliary tube (D tube) 9.

"F" represents the condition whether a flip-flop (173) (to be described later) is set or not set. The flip-flop (173) is set if it is necessary to pay out the amount to be paid by the intermediate denomination coin (50 yen coin) by transferring to the minimum denomination coin (10 yen coin). "F" becomes "YES" when the flip-flop is set and becomes "NO" when it is reset.

"F set" represents the setting operation of the flip-flop (173), while "F reset" means the resetting operation of the flip-flop (173).

"Sale" represents the condition that a vending operation is executed. When this is "NO", the inserted coins are all returned without any vending operation in the machine. "Sale" becomes "YES" when a vend memory flip-flop 70 (to be described in detail later) is set.

"R_{BN}=0" represent the condition that the counted content R_{BN} of 50 yen coin storage counter 33 to be described in detail later corresponding to the intermediate denomination coin storage coin counting circuit previously described is zero.

"R_{AN}=0" represents the condition that the counted R_{AN} of 10 yen coin storage counter 32 is zero. The 10 yen coin storage counter 3, which will be described in detail later corresponds to the minimum denomination coin storage coin counting circuit previously described.

"$\overline{CE}$" indicates the condition that C tube 8 is not empty.

"B tube", "C tube", "A tube" and "D tube" mean the operations for paying out coins from B tube 7, C tube 8, A tube 6 and D tube 9, respectively.

"empty detection" listed after the payout operation blocks of the respective tubes represents detection of the fact that the tube has become empty. This empty detection is achieved by the fact that no coin is paid out notwithstanding that the coin payout motors M_{01} and M_{02} are driven.

"CE set" represents the operation of the empty memory of C tube 8. Thus operation is to set C tube empty memory flip-flop 19 to be described in detail later.

"CE reset" means the resetting operation of the C tube empty memory flip-flop 19. That is, this operation means that "$\overline{CE}$" becomes "YES".

"transfer" represents the condition that the amount to be paid in intermediate denomination coins (50 yen coin) is paid by transferring it to be paid in minimum denomination coins (10 yen coin) previously described.

"lock" means the condition when the coin to be paid out is caught in the coin payout mechanism 12 so that the motor M_{01} does not complete its movement.

"Motor three times rotation" means rotation of the motor three times, i.e. in normal, reverse and normal rotations under conditions of "lock" and "YES" as previously described.

"lock release" represents the release of "lock" state as a result of "motor three times rotation".

"$\overline{DR}$" represents the condition that D tube (auxiliary tube or hopper shape auxiliary storage tube) is not separated from the coin acceptor body. "$\overline{DR}$" YES means that D tube separation memory flip-flop 20 is reset to be described in detail later.

"END" represents the completion of a coin payout operation.

"STOP" represents the stoppage of the operation of the vending machine due to trouble occurred in the machine.

It is to be noted that although there is no line for "motor three times rotation" at "lock" with respect to the C and D tubes in the flow chart shown in Figure 2, they may be provided as required.

It will be appreciated that a flow chart of the case wherein C and D tubes 8 and 9 are employed as 10 yen coin auxiliary tubes is not particularly disclosed herein, but it may be easily constructed by those skilled in the art, based on the previous description and Figure 2.

A preferred embodiment of the control system of the vending machine according to the invention will be described in detail with reference to the single circuit diagram shown in Figures 3 and 4. The part of the circuit shown in Figure 3 is connected to the part shown in Figure 4 via lines 18, 111, 116, 125, 176, 177 and 196. Although there are additional wiring connections between the circuits in Figures 3 and 4 in practice, they are omitted from the drawings because their presence is not necessary to enable the invention to be understood. The control circuit shown in Figure 3 mainly relates to a coin collection control system of the vending machine, and a major portion of the control circuit shown in Figure 4 relates to a payout tube switching control system. However, these control circuits are merely divided for convenience of disclosure, and they are not clearly distinguished from each other in respect of their functions.

When a 10 yen true coin is detected by the aforementioned coin detector 2, one 10 yen coin detection pulse P_{10} is applied to the terminal T_1. When a 50 yen true coin is detected by the aforesaid coin detector 2, one 50 yen coin detection pulse P_{50} is applied to the terminal T_2. When a 100 yen true coin is detected similarly, one 100 yen coin detection pulse P_{100} is applied to the terminal T_3.

The pulse signals corresponding to the numbers of 10 yen, 50 yen and 100 yen true coins to be applied to the terminals T_1, T_2 and T_3, respectively are delivered to AND gates 21, 22 and 23, respectively.

To another input of the AND gates 21, 22 and 23 is applied a coin insertion prohibit signal on a line 24 via an inverter 25 to be described in detail later. Further, to still another input of the AND gate 21 is applied an output signal from a 10 yen coin receipt limiting circuit 43A, to another input of the AND gate 22 is applied an output signal from a 50 yen coin receipt limiting circuit 43B, and to another input of the AND gate 23 is applied an output signal from a 100 yen coin receipt limiting circuit 43C. Assuming that the signal on the line 24 is "0", and the output from the respective limiting circuits

43A, 43B and 43C are "1", the AND gates 21, 22 and 23 will pass the pulse signals applied to the terminals T_1, T_2 and T_3, respectively. Thus, the pulse signals are applied to 10 yen, 50 yen and 100 yen coin counters 29, 30 and 31, via OR gates 26, 27 and 28, respectively.

The 10 yen, 50 yen and 100 yen coin counters 29, 30 and 31 serve to count the 10 yen, 50 yen and 100 yen coin detection pulses P_{10}, P_{50}, and P_{100} from the terminals T_1, T_2 and T_3, respectively, for counting the numbers of the inserted 10 yen, 50 yen and 100 yen coins or a total amount thereof for each of denominations of the 10 yen, 50 yen and 100 yen coins.

If, for example, three 10 yen coins, one 50 yen coin and two 100 yen coins are inserted in the machine, the 10 yen coin counter 29 counts 30, the 50 yen coin counter 30 counts 50, and the 100 yen coin counter 31 counts 200.

The 10 yen coin detection pulses P_{10} from the terminal T_1 via the AND gate 21 and the 50 yen coin detection pulses P_{50} from the terminal T_2 via the AND gate 22 are respectively applied to 10 yen and 50 yen coin storage counters 32 and 33.

While the 10 yen, 50 yen and 100 yen coin counters 29, 30 and 31 count the amount of the inserted coins and are reset to "0" every time when the vending operation is completed, the 10 yen and 50 yen coin storage counters 32 and 33 serve to continuously add the numbers of inserted 10 yen and 50 yen coins and to continuously subtract the number of the paid out coins so as to keep a running total of the difference between the number of the inserted coins and the number of the paid out coins added to the number of 10 yen and 50 yen coins stored at the start of use of the vending machine.

The 10 yen and 50 yen coin storage counters 32 and 33 serve to detect a state wherein the numbers of 10 yen and 50 yen change coins in the machine have become insufficient for change payout, which state will be hereinbelow called "empty".

More specifically, the counted values of the counters 32 and 33 are applied to an empty detection circuit 34. The empty detection circuit 34 functions to produce an output signal "1" when the numbers of the 10 yen and 50 yen coins become, for example, less than four and one respectively or less than nine 10 yen coins with no 50 yen coins, on the basis of the counted values from the counters 32 and 33, which signal "1" is applied to an empty treatment device 35.

When the signal "1" is applied to the empty treatment device 35 the empty treatment device 35 displays shortage of change. In this stage the vending operation in the machine is conducted only when amount of inserted coins coincides with a set vend price.

Thus, the "empty" state is detected on the basis of the counted values of the 10 yen and 50 yen coin storage amount counters 32 and 33. If the power supply to the vending machine is shut off due to an electricity supply failure, the counters 32 and 33 are cleared to "0". Accordingly, when the electricity is again supplied to the vending machine, the "empty" state cannot be accurately detected.

In order to eliminate such difficulty, there is provided the empty detection device 36 for directly detecting the number of residual coins in the 10 yen coin tube in addition to the aforementioned counters 32 and 33.

The empty detection device 36 may, for example, have a coil arranged at a predetermined position on the main tube, the "empty" state being detected on the basis of variations of the inductance of the coil, or a limit switch arranged at a predetermined position on the main tube for detecting the "empty" stage in dependence on the ON or OFF of the limit switch. The device 36 produces a signal "1" when the number of coins in the main tube becomes less than the minimum number required for the payout of change, which signal "1" is applied to one input of an AND gate 37.

To the other input of the AND gate 37 is applied a signal from a comparator circuit 38 for producing a signal "1" only when all the counted values of the counters 29, 30 and 31 are "0".

Accordingly, the AND gate 37 cannot produce a signal 1 unless all the counters 29, 30 and 31 produce signal "0". The signal 1 from the AND gate 37 is applied to the empty detection circuit 34 to cause it to apply a signal 1 to the empty treatment device 35 as previously described.

It will be noted that the aforementioned circuit arrangement is such that the signal from the empty detection device 36 is applied to the empty detection circuit 34 via the AND gate 37 only when all the counted values of the counters 29, 30 and 31 are "0", i.e., when the vending machine is in a ready for operation mode, but the signal is not applied thereto while the machine is performing a vending operation. This arrangement is employed for eliminating the inconvenience which might occur if the empty detection device 36 was operated during a vending operation of the machine, for example, during paying out of change, for, in such a case, no change would be paid out due to the operation of the device 36.

The vending machine is constructed to prohibit the insertion of the coins if an article selection button (not shown) is depressed when all the counted values of the counters 29, 30 and 31 are "0".

When the article selection button is depressed, an article selection signal PU is applied to one input of an AND gate 39 via the terminal T_5.

To the other input of the AND gate 39 is applied a signal from the comparator circuit 38 which becomes "1" only when all the counted values in the counters 29, 30 and 31 are "0".

Accordingly, if the article selection button is depressed when the counted values in the counters 29, 30 and 31 are all "0", the output of the AND gate 39 becomes "1", which is applied to a coin insertion prohibit device 42 via OR gates 40 and 41 and the line 24.

The coin insertion prohibit device 42 serves to prohibit the insertion of coins in the machine upon receipt of a signal "1", for example by way of a pin projected to the coin insertion slot to prohibit the insertion of the coin, or by way of the structure such that even if the coin is inserted in the machine, the inserted coin is not detected by the coin detector but is directly returned to the return outlet.

Thus, if all the counted values in the counters 29, 30 and 31 are "0", no coin can be inserted in the machine even if the article selection button is depressed.

It is anticipated that if a large number of coins of the same denomination are inserted in a single transaction or the entire amount of money inserted in the machine is higher than the value of an article to be vended, there may arise imbalance in the number of coins retained in the machine resulting in shortage of change and exchange of money between high and low denominations.

Therefore, there is a limit on the maximum number of inserted coins of each denomination (10 yen, 50 yen and 100 yen) per transaction and a maximum amount of all inserted coins.

More specifically, the outputs of the counters 29, 30 and 31 counting number of inserted coins of each denomination are applied to 10 yen, 50 yen and 100 yen coin receipt limiting circuits 43A, 43B and 43C, respectively of a highest limit detecting section 43. The respective limiting circuit 43A, 43B and 43C produce a signal "0" when the contents of the counters 29, 30 and 31 reach limiting values such as, for example, 320 yen for 10 yen coins, 800 yen for 50 yen coins, and 700 yen for 100 yen coins, which signal "0" serves to cause the prohibition of the insertion of coins into the machine depending upon the kind of the coins. Further, the output of each of the counters 29, 30 and 31 is also applied to a total inserted coin highest amount limiting circuit 43D, and when the total amount of the inserted coins reaches the set highest value (arbitrarily set), the limiting circuit 43D produces a signal "1", which is applied to the coin insertion prohibit device 42 for prohibiting the insertion of all the coins thereafter.

The outputs of the counters 29, 30 and 31 which separately count the inserted 10 yen, 50 yen and 100 yen coins are applied to a comparator circuit 44.

In the meanwhile, a vend price of an article is set by a vend price setting circuit 45. The output signal from the circuit 45 is applied to a series register 46 which outputs in series the signal from the circuit 45. This output is applied to one input of the comparator circuit 44.

The vend price setting circuit 45 is adapted to set a binary signal corresponding to the vend price, for example, by closing one or more selected switches. The circuit 45 therefore sets plural vend price signals corresponding to respective articles in the vending machine when a variety of types of article are offered for sale and produces an output for the set vend price of the article selected upon depression of an article selection button (not shown). The arrangement will not be described in detail.

The comparator circuit 44 compares a total inserted coin amount

$$K(=R_A+R_B+R_C)$$

which is the sum of the counted values R_A, R_B and R_C of the counters 29, 30 and 31 with the set vend price R_{SP} from the register 45.

When the amount K is equal to the price R_{SP} as a result of comparison in the comparator 44 ($K=R_{SP}$), a signal "1" is produced from the comparator 44 on a line 47 and is applied to one input of an AND gate 49 via an OR gate 48.

When the amount K is larger than the price R_{SP} ($K>R_{SP}$), a signal "1" is produced from the comparator 44 on a line 50 and is thus applied to one input of an AND gate 51. To the other input of the AND gate 51 is applied an inverted signal of the output from the detector 34. When the output of the detector 34 is zero, i.e., sufficient coins are retained for paying out change, the AND gate 51 is opened to gate out the signal "1" on the line 50 via the OR gate 48 to the one input of the AND gate 49 in the same manner as the signal on the line 47.

To two other inputs of the AND gate 49 are applied inverted signals of signals on lines 52 and 87 (both become signal "1" during vending operation of the machine).

Therefore, when the machine is not already occupied in vending, the AND gate 49 is opened to apply the signal "1" via a terminal T_7 to a vending section (not shown) as a vend signal V_e.

The vending section starts to control the dispensing of the article to be sold upon receipt of the vend signal Ve, and simultaneously applies a vend start signal Se to a terminal T_4.

The construction of the vending section will not be further described since it does not relate to this invention.

The signal Se ("1") applied to the terminal T_4 is delivered via an OR gate 53 to a timer 54.

The timer 54 has a predetermined delay time and is constructed to produce an output signal rising from "0" to "1" when the predetermined delay time has elapsed after receipt of the signal "1". The output of the timer 54 is applied to one input of an AND gate 55.

To another input of the AND gate 55 is applied the signal Se from the terminal T_4, and if the signal Se applied to the terminal T persists for the duration of the delay time of the timer 54, the AND gate 55 gates out a signal "1" to the set input of a vend start signal holding flip-flop 56 to cause the flip-flop 56 to be set and also to gate out the signal "1" to the set input of a delay flip-flop 58 via an OR gate 57 to cause the flip-flop 58 to be set. The set output "1" of the flip-flop 58 is applied to the timer 54 via the OR gate 53 to cause the timer 54 to be operated.

Further, the set outputs "1" of the flip-flops 56 and 58 and the output of the timer 54 are applied to the inputs of an AND gate 59.

When the flip-flops 56 and 58 have delivered their outputs "1" and the timer 54 has completed its delay time to produce an output "1", i.e., the vend start signal Se is confirmed, the AND gate 59 will receive all "1" signals at the inputs thereof and will thus gate out an output signal "1" to an AND gate 60.

To another input of the AND gate 60 is applied an article selection signal PU (signal "1") representing the depression of the article selection button via a terminal T_5. Accordingly, the AND gate 60 receives all "1" signals at its inputs when the vend start signal Se is confirmed and gates out a signal "1" to an article selection memory 61.

The memory 61 also receives the signal representing the vend article from the register 46 at the input thereof to store the selection of the article.

In the meanwhile, if a signal "1" representing the selection of a desired article has not been stored in the memory 61 upon lapse of a predetermined time (a time required for dispensing the article) after the flip-flop 56 is set. i.e., after the vend start signal Se is confirmed, occurrence of a fault in the machine is assumed and the operation of the vending machine is stopped at this time.

This operation is conducted in the following manner.

The set output "1" of the flip-flop 56 is applied to a timer 63, which is constructed and operated in the same manner as the timer 54 but has a delay time t_1 (a time sufficient for completing the normal dispensing operation of the article) for producing a signal rising from "0" to "1" upon lapse of the time t_1 after receipt of the signal "1".

The output "1" of the timer 63 is applied to one input of an AND gate 64.

To another input of the AND gate 64 is applied a signal consisting of the inverse of the output of the memory 61. Accordingly, if when the delay time of the timer 63 has elapsed, the signal "1" is not stored in the memory 61, the AND gate 64 produces an output "1" which is applied to a stoppage circuit 65 to stop the operation of the machine and to cause the circuit 65 to produce a signal "1" which is applied to the device 42 via the OR gate 41 to prohibit the insertion of further coins into the machine.

Thus, if the flip-flop 56 is set and the signal "1" representing the selection of the article has not been stored in the memory 61 when the delay time of the timer 63 has elapsed, the operation of the machine is stopped. If the machine is operating normally, the signal "1" representing the selection of the article is stored in the memory 61 before the delay time of the timer 63 has elapsed. Then, an article dispensing signal So (signal "1") representing the completion of dispensing of the article is applied from a terminal T_6 to one input of an AND gate 66.

To another input of the AND gate 66 is applied the signal Se from the terminal T_4 and the output signal from the flip-flop 56 via an OR gate 67.

Accordingly, if the signal So is applied to the AND gate 66 when the signal Se is applied via the terminal T_4 to the AND gate 66 or the set output "1" from the flip-flop 56 is applied to the AND gate 66, signals "1" are applied to all the input of the AND gate 66 to cause the gate 66 to gate out a signal "1" which is applied to a set input of an article dispensing signal holding flip-flop 68 to set the flip-flop 68.

An AND gate 69 receives the set output "1" of the flip-flop 68, the output "1" of the AND gate 59 and the output "1" of the memory 61.

When the set output of the flip-flop 68 is applied to the AND gate 69, the output of the AND gate 59 applied to the AND gate 69 becomes "1", and the signal "1" is stored in the memory 61 i.e the vending operation is started upon insertion of a true coin, the selection of the article is carried out, and the dispensing operation of the article is completed, the signals "1" are applied to all the inputs of the AND gate 69 to cause the AND gate 69 to gate out a signal "1".

The output signal "1" from the AND gate 69 is applied to a set input of a vend memory flip-flop 70 to set the flip-flop 70.

The output signal "1" from the AND gate 69 is also applied to a collection command circuit 71 for starting the collection of inserted coins, to be described in detail later, and also to a respective input of each of two AND gates 72 and 73.

To another input of the AND gate 73 is applied a set output signal from an exact calculation signal holding flip-flop 74 which is set upon receipt of an exact calculation signal MN from a terminal T_8 upon depression of the exact calculation button (not shown), and to another input of the AND gate 72 is applied an inverted signal of set output signal from the flip-flop 74.

Accordingly, if the set output of the flip-flop 74 has been applied to the AND gate 73 by depression of the exact calculation button when the output of the AND gate 69 is a signal "1", signals "1" are applied to all the inputs of the AND gate 73 to cause the AND gate 73 to gate out a signal "1" which is applied via an OR gate 740 to a change payout command circuit 75 to command a change payout operation to be described in detail later.

If the flip-flop 74 has not been set because the exact calculation button has not been depressed when the output of the AND gate 69 becomes "1", signals "1" are applied to all the input of the AND gate 72 which gates out a signal "1" which is applied via an OR gate 76 to still another input of the memory 61 and reset input of the flip-flops 68, 56 and 58 to reset these flip-flops 68, 56 and 58 for preparing subsequent vending operation of the machine in continuous vending operations.

When an article sending out signal So is not applied to terminal T_6 so that the article sending out signal flip-flop 68 is not set before the delay operation of the timer 63 terminates, in spite of the setting of the vend start signal holding flip-flop 56 and the delay flip-flop 58, this state signifies that no article was sent out. Accordingly, if the clear button has been depressed, the coins are returned or the change coins are paid out, whereas if the clear button has not been depressed, the article selection memory 63 and flipflops 56, 58, 70 and 74 should be reset to prepare for the next vending operation in a manner to be described hereinafter. Firstly, it is assumed that the clear button has been depressed and the clear signal holding flip-flop 74 has been set.

The outputs of the clear flip-flop 74, the timer 63, the AND gate circuit 59 and the article selection memory 61 are applied to the inputs of an AND gate circuit 77.

The AND gate circuit 77 is enabled when vending start signal holding flip-flop 56 and the delay flip-flop 58 are set whereby AND gate circuit 59 is enabled and, when "1" is stored in the article selection memory 61 and the delay action of the timer 63 has completed, signal "1" is applied to one input of each of the AND gate circuits 79 and 80 via a OR gate circuit 78.

To the other input of the AND gate circuit 80 is applied the output of the vend memory flip-flop 70 and to the other input of the AND gate circuit 79 is applied the inverted output of the vend memory flip-flop 70.

The vend memory flip-flop 70 is constructed so that it is set at each vending operation and is in reset when the clear button is depressed and the clear operation (to pay out change and to return coins) has been completed so that when not even a single vending operation has been made, the vend memory flip-flop 70 has not been set thereby enabling the AND gate circuit 79. Accordingly, signal "1" is applied to a coin return command circuit 81 thereby commencing the operation of returning amount of the inserted coins as will be described later.

When at least one vending operation has been made so that the vend memory flip-flop 70 has been set, the AND gate circuit 80 is enabled.

Consequently, signal "1" is applied to a change payout command circuit 75 to commence payout of the change.

Assume now that the clear button has not been depressed so that the clear signal holding flip-flop has not been set. Under these conditions the ouput from the exact calculation signal holding flip-flop 74 and a signal from terminal T_4 are applied to the inputs of a NOR gate circuit 82. This NOR gate 82 circuit applies a signal "1" to one input of a AND gate circuit 83 when the clear signal holding flip-flop 74 is not set and the signal from terminal T_4 is "0" (that is the vend start signal has not been applied). The other inputs of the AND gate circuit 83 are connected to receive the outputs of the timer 63, the AND gate circuit 59 and the article selecting memory 61.

Consequently, when the AND gate circuit 69 is not enabled because an article send out signal is not applied thereto until the termination of the delay time of the timer 63 although the vend start signal has been confirmed and signal "1" has been stored in the article selection memory 61, and when memory 61, flip-flop 56, 58 and 74 are not reset, the AND gate circuit 83 is enabled whereby a signal "1" is applied to the reset terminal of memory 61 and flip-flops 56, 58, 74 and 70 via OR gate circuit 76 thereby resetting these elements to prepare for the next vending operation.

When the vend condition is not satisfied and when the vend start signal Se is not applied from terminal T_4, upon depression of the clear button, the change will be paid if one vend has been made and coins will be returned if no vend has been made.

The signal from terminal T_4 and the output from the vend start signal holding flip-flop 56 are applied to the inputs of a NOR gate circuit 84 which produces a signal "1" when the signal from terminal T_4 is "0" and the vend start signal holding flip-flop 56 has not been set. The signal "1" is applied to one input of a AND gate circuit 85. The other inputs of this AND gate circuit 85 are connected to receive the outputs of the delay flip-flop 58 and the timer 54, and the inverted output from the article sending out signal holding flip-flop 68.

When the clear push button is depressed and when the clear signal holding flip-flop 74 is set, the set output thereof is applied to the delay flip-flop 58 via OR gate circuit 57 thus setting the same. The set output from the delay flip-flop 58 is applied to the timer 54 via OR gate circuit 53, thereby starting the timer.

For this reason, when the clear push button has been depressed and the timer 54 has completed its operation but when the article sending out flip-flop 68 has not been set, the AND gate circuit 85 is enabled to apply a signal "1" to one input of each of the AND gate circuits 79 and 80 via OR gate circuit 78. As above described, to the other inputs of the AND gate circuits 80 and 79 are respectively applied the output and the inverted output of the vend memory flip-flop 70 so that when this flip-flop 70 has not been set, the AND gate circuit 79 is enabled so as to apply a signal "1" to the coin return command circuit 81. However, when the vend memory flip-flop 70 has been set, the AND gate circuit 80 is enabled thus applying a signal "1" to the change payout command circuit 75 via OR gate circuit 74.

When coins are inserted during the vending operation of the automatic vending machine, there is a disadvantage that the counts of the counters 29, 30 and 31 vary. For this reason, the vending start signal Se applied to terminal T_4, the output from the vend start signal holding flip-flop 56, the output from the clear signal holding flip-flop 74 and the output from the article send out signal holding flip-flop 68 are applied to the coin insertion prohibit circuit 42 through OR gate circuit 86, line 87 and OR gate circuit 41 so as to prohibit the insertion of the coin so long as at least one of said signals is "1" by actuating the coin insertion prohibit circuit 42.

The coin collection command circuit 71, the change payout command circuit 75, and the coin return command circuit 81 are constructed to respectively hold signal "1" during the coin collecting operation, the change payout operation and the coin returning operation respectively, so that the outputs of these circuits 71, 75 and 81 are applied to the coin insertion prohibit circuit 42 through OR gate circuits 88, 40 and 41 respectively so as to actuate the coin insertion prohibit circuit 42 during the change payout operation or the coin returning operation or the coin collecting operation for prohibiting the insertion of the coin.

The coin collecting operation, coin returning operation and the change payout operation will now be described in detail.

Coin Collecting Operation

The coin collecting operation is executed by subtracting the vend set price R_{SP} from the count R_A of the 10 yen coin counter 29. Where it is impossible to subtract the vend set price R_{SP} from the count R_A of the 10 yen coin counter 29 a transfer is made from the 50 yen coin counter 30 or the 100 yen coin counter 31 to the 10 yen coin counter 29.

When the coin collection command circuit 71 stores signal "1", this signal is applied to comparator 89 via line 880. Signals representing the vend set price R_{SP} from the series register 46 and the count R_A of the 10 yen coin counter 29 are applied to the comparator 89 so that the set price R_{SP} and the count RA of the 10 yen coin counter 29 are compared with each other.

Where the count R_A of the 10 yen coin counter 29 is equal to or larger than the set price R_{SP} ($R_A \geqslant R_{SP}$) it is possible to subtract R_{SP} from R_A. This subtraction is performed in the following manner. The comparator 89 applies a signal "1" to line 90. This signal is applied to one input of the gate circuit 91 as a gate signal. The other input of the gate circuit 91 is connected to receive a pulse signal representing the vend set price R_{SP} from the series register 46.

Accordingly, when signal "1" is applied to line 90, the gate circuit 91 is enabled to apply the pulse signal representing the vend set price R_{SP} to the subtract command terminal of the 10 yen coin counter 29 via line 92 thus setting the same into the subtraction mode. At the same time, this pulse signal is applied to the count input terminal of the 10 yen coin counter 29 through OR gate circuits 93 and 26.

In this manner, the vend set price R_{SP} is subtracted from the counter R_A of the 10 yen coin counter 29. However, during the operation of the comparator 90, if the count

R_A of the 10 yen coin counter 29 is smaller than the vend set price $R_{ST}(R_A<R_{SP})$ it would be impossible to subtract R_{SP} from R_A. Under these circumstances a portion of the count R_B of the 50 yen coin counter 30 or the counter R_C of the 100 yen coin counter 31 is transferred to the content R_A of the 10 yen coin counter 29 so as to establish a relation $R_A \geqslant R_{SP}$. Thereafter R_{SP} is subtracted from R_A. This transfer operation is performed as follows.

While the comparator 89 indicates that $R_A<R_{SP}$, a signal "1" is applied via line 94, to one input of an AND gate circuit 95. The other input of the AND gate circuit 95 is supplied with the inverted output from comparator 96 which produces a "1" output when the count R_B of the 50 yen coin counter 30 is zero ($R_B=0$). Accordingly, the AND gate circuit 95 is enabled when the count R_B of the 50 yen coin counter 30 is not equal to zero, thus applying signal "1" to 50 yen→10 yen transfer command circuit 97. This circuit 97 operates to command a transfer operation for subtracting 50 from the count R_B of the 50 yen coin counter 30 and for addint 50 to the count R_A of the 10 yen counter 29. More particularly, when supplied with signal "1" from the AND gate circuit 95 the 50 yen 10 yen transfer command circuit 97 produces one pulse on line 98 which is applied to the subtraction command terminal of the 50 yen coin counter 30 and to the count input terminal thereof via OR gate circuits 99 and 27 thus subtracting 50 from the counting R_B. At the same time, the 50 yen→10 yen transfer command circuit 97 produces five pulses on line 100 which are applied to the addition command terminal of the 10 yen coin counter 29 and to the count input terminal of the 10 yen coin counter 29 via OR gate circuits 93 and 26, thus adding 50 to the count R_A.

When the transfer from the 50 yen coin counter 30 to the 10 yen coin counter 29 has been completed by the 50 yen→10 yen transfer command circuit 97, a signal "1" is applied to the comparator 89 from the transfer command circuit via line 101 and a OR gate circuit 102 to initiate another comparison of the count R_A of the 10 yen coin counter 29 and the vend set price R_{SP}.

In this manner, the transfer from the 50 yen coin counter 30 to the 10 yen coin counter 29 is continued until the count R_A of the 10 yen coin counter 29 becomes equal to or larger than the vend set price $R_{SP}(R_A \geqslant R_{SP})$. However, when the count R_B of the 50 yen coin counter 30 becomes zero, the output from the comparator 96 becomes "1" thus disenabling the AND gate circuit 95 with the result that the 50 yen→10 yen transfer command circuit 97 becomes inoperative. Then, the transfer is made from the 100 yen counter 31.

When the count of the 50 yen coin counter 30 is zero the comparator 96 produces a signal "1" which is applied to one input of a AND gate circuit 103. To the other inputs of this AND gate circuit 103 are applied a signal on line 94 which shows that the count R_A of the 10 yen coin counter 29 is smaller than the vend set price R_{SP}, and an inverted output of the comparator 104 which produces "1" when the count R_C of the 100 yen coin counter 31 is zero.

Thus the AND gate circuit 103 is enabled when the signal on line 94 is "1" and $R_B=0$, $R_C \neq 0$ to apply signal "1" to the 100 yen→50 yen transfer command circuit 105. This signal "1" is also applied to a 100 yen coin receiving solenoid controller 106 thus receiving one 100 yen coin that has been held. The 100 yen coin receiving solenoid controller 106 comprises a flip-flop 1063 having a set input connected to receive the output from the AND gate circuit 103 via a AND gate circuit 1061 and a OR gate circuit 1062, a timer T106 which is operated when the flip-flop 1063 is set, a flip-flop 1068 having a set input connected to receive the output of the timer T106 via AND gate circuits 1064 and 1065 and an OR gate circuit 1069 for resetting the flip-flop 1063, the inputs of the OR gate circuit 1069 being connected to the outputs of AND gate circuits 1065 and 1067. The set output of the flip-flop 1068 is used to operate a 100 yen coin receiving solenoid coil (escrow cash box solenoid coil) CB for receiving 100 yen coins that have been inserted and held.

The output from the flip-flop 1068 is applied to the other input of AND gate circuit 1067 while the inverted output of the flip-flop 1068 is applied to the other inputs of the AND gate circuits 1065 and 1061. One input of an AND gate circuit 10610 is connected to the output of an AND gate circuit 1066. The output of the flip-flop 1063 is applied to the other input of a AND gate circuit 1064 and the inverted output is applied to the other input of an AND gate circuit 1066.

Consequently, the signal "1" from the AND gate circuit 103 is applied to the flip-flop 1063 via the AND gate circuit 1061 and the OR gate circuit 1062 because the signal applied to the other input of the AND gate circuit 1061 is "1" and the set output of the flip-flop 1063 operates the timer T106. After the delay time of the timer T106, the AND gate circuit 1064 is enabled to supply its output to flip-flop 1068 through the AND gate 1065 thus setting the flip-flop 1068. Accordingly, the 100 yen coin receiving solenoid coil CB is energized to receive one 100 yen coin. Furthermore, the output from the AND gate circuit 1065 resets the flip-flop 1063 via the OR gate circuit 1068. At this time, the AND gate circuit 1066 is enabled and its "1" output is applied to one input of the AND gate circuit 10610. Since the "1" output from the flip-flop 1068 is applied to the other input of the AND gate circuit 10610, the output thereof sets again the flip-flop 1063 via the OR gate circuit 1062.

In the same manner as above described, the output of the flip-flop 1063 enables the AND gate circuit 1064 after the delay time of the timer T106. At this time, however, since the flip-flop 1068 is set, the AND gate circuit 1067 is enabled and its "1" output resets the flip-flop 1068 whereby the 100 yen coin receiving solenoid coil CB is deenergized thus completing one receiving operation. In this manner, the solenoid coil is energized for a time sufficient to receive one 100 yen coin. For reception of subsequent coins, the solenoid coil is again energized after a time sufficient to permit the second and following 100 yen coins in the escrow to fall into the 100 yen coin receiving solenoid coil.

The 100 yen→50 yen transfer command circuit 105 operates to transfer 100 from the count R_C of the 100 yen coin counter 31 to the count R_B of the 50 yen coin counter 30. To do this, the 100 yen→50 yen transfer command circuit 105 produces one pulse on line 101 and applies this pulse to the 100 yen coin counter 31 via OR gate circuit 28 thus subtracting 100 from the count R_C. At the same time, it produces two pulses on line 108 which are applied to the 50 yen coin counter 30 via OR gate circuit 99 and 27 for adding 100 to the counts R_B of the counter 30.

When the transfer of 100 yen from lhe 100 yen coin counter 31 to the 50 yen coin counter 30 under the control of the 100 yen→50 yen transfer command circuit 105 is completed, the transfer command circuit 105 produces a signal "1" on line 109 which is applied to one input of an AND gate circuit 110.

To the other input of the AND gate circuit 110 is applied a signal "1" which is produced when one 100 yen coin is received from the escrow solenoid coil 106 so that when receipt of the 100 yen coin is confirmed, the AND gate circuit 110 is enabled, thus applying signal "1" to the comparator 89 via an OR gate circuit 102 whereby the count R_A of the 10 yen coin counter 29 is again compared with the vend set price R_{SP}. At this time, however, since the count R_B of the 50 yen coin counter 30 is not zero, the AND gate circuit 95 is enabled thereby transferring 50 yen from the 50 yen coin counter 30 to the 10 yen coin counter 29 by the action of the 50 yen→10 yen transfer command circuit 97.

In this manner, the transfer from the 100 yen coin counter 31 to the 50 yen coin counter 30 and the transfer from the 50 yen coin counter to the 10 yen coin counter 29 are repeated until the count R_A of the 10 yen coin counter 29 becomes equal to or larger than the vend set price R_{CP}, that is $R_A \geqslant R_{SP}$.

When the relation $R_A \geqslant R_{SP}$ is established the comparator 89 produces a signal "1" on line 90 so that the vend set price R_{SP} is subtracted from the counter R_A of the 10 yen coin counter 29 as described above.

The signal "1" on line 90 is also applied to the series register 46 and the coin collection command circuit 71 to reset the same thus finishing the coin collection operation.

Completion of the coin collection operation concludes one vending operation thus preparing for the next vending operation or the clear operation.

Unless the clear push button is depressed, said vending and coin collection operations are repeatedly performed each time the vend condition is satisfied.

Each time a vending operation is completed, the output of the OR gate circuit 86 becomes "0" and hence the output of the OR gate circuit 41 also becomes "0" thereby stopping the operation of the coin insertion prohibiting device 42. For this reason, it is possible to insert coins whenever a vending operation is completed.

With reference to Figure 4, the coin returning operation when signal "1" is stored in the coin returning command circuit 81 and the change payout operation when signal "1" is stored in the change payout command circuit 75 will be described.

Coin Returning Operation

When the purchaser has inserted coins but stopped purchase for one reason or other and consequently depressed the clear push button, signal "1" is stored in the coin returning command circuit 81. (Figure 3).

The signal "1" from the coin returning command circuit 81 is applied to the escrow flip-flop 113 (Figure 4) via line 111 and an OR gate circuit 112 thus resetting flip-flop 113.

When the escrow flip-flop circuit 113 is set, its set output "1" is applied to the escrow solenoid coil 114 whereby the solenoid coil 114 is energized to return all 100 yen coins held in escrow.

The signal "1" from the coin returning command circuit 81 is applied to the 10 yen coin counter 29, the 50 yen coin counter 30 and the 100 yen coin counter 31 via an OR gate circuit 115 thus changing these counters to subtracting modes. Furthermore, this signal "1" is applied to a flip-flop 118 (Figure 4) via a line 116 and an

OR gate circuit 117 to reset the same. The set output of the flip-flop 118 is applied to a timer 119 which has the same construction as the aforementioned timers 54 and 63. Thus, it has a delay time t_3 and its output builds to "1" level when a delay time t_3 has elapsed from the receipt of signal "1".

An AND gate circuit 122 is provided having inputs connected to receive the output from the flip-flop 118, the inverted output signal of the timer 119, and the output of a NOR gate circuit 120. The output of the NOR gate circuit 120 is "0" only when a timer 121 (to be described hereinafter) is operating. At this time, however, since the timer 121 is not operating the output of the NOR gate circuit 120 is "1". Thus the AND gate circuit 122 is enabled during the operation of the timer 119 thus applying a signal "1" to one input of an AND gate circuit 123.

Since the other input of the AND gate circuit 123 is connected to the output from the escrow flip-flop 113, the AND gate circuit 123 is enabled so as to apply a signal "1" to a 100 yen coin counter count down command circuit 124 which applies pulses of the number equal to the number of 100 yen coins returned by the energization of the escrow solenoid coil 114 to the count input terminal of the 100 yen coin counter 31 (Figure 3) via line 125 and the OR gate circuit 28.

Thus, the 100 yen coin counter 31 is decremented by the signal on line 125 until the count R_C of this counter becomes zero.

The delay time t_3 of timer 119 assures sufficient operating time necessary for the return of the 100 yen coins by the escrow solenoid coil.

When the delay time t_3 of the timer 119 has elapsed the AND gate circuit 126, to which are applied the outputs of the flip-flop 118, timer 119 and the NOR gate circuit 120, is enabled thus applying signal "1" to one input of an AND gate circuit 127.

Since the set output "1" of the escrow flip-flop 113 is applied to the other input of the AND gate circuit 127, this AND gate circuit is enabled to apply a signal "1" to the reset terminal of the flip-flop 118 through line 128 and a OR gate circuit 131 thus resetting the flip-flop 118. At the same time, the signal "1" on line 128 is applied to the reset terminal of the escrow flip-flop 113 thus resetting the same. The set output "1" of the flip-flop 130 is applied to a timer 121 which is identical to the timer 119 and has a delay time t_2. When supplied with signal "1" the timer 121 operates and after the lapse of the delay time t_2, its output changes to "1". Consequently, the output of the NOR gate circuit 120, which is connected to the outputs of the flip-flop 130 and the timer 121, is "0" while the timer 121 is operating.

When the delay time t_2 of timer 121 has elapsed, the output of the timer 121 becomes "1" so that the AND gate circuit 132, which is supplied with the outputs of the flip-flop 130 and timer 121, is enabled and its output "1" is applied to the reset terminal of the flip-flop 130 thus resetting the same. Then the output of the timer 121 becomes "0" and the NOR gate circuit 120 produces signal "1".

As a consequence, the AND gate circuit 133, supplied with the output of the NOR gate circuit 120 and the inverted output signal of the flip-flop 118, is enabled thereby applying signal "1" to one input of an AND gate circuit 134. The other input thereof is connected to receive the inverted output signal of the escrow flip-flop 113. At this time, since the escrow flip-flop circuit 113 has been reset the AND gate circuit 134 is enabled to apply signal "1" to one input of an AND gate circuit 135 having the other input applied with the inverted output signal of a comparator 136 which produces signal "1" when the count R_B of the 50 yen coin counter 30 is zero.

Consequently, when $R_b=0$, the AND gate circuit 135 is enabled to apply signal "1" to the set terminal of a flip-flop 138 via OR gate circuit 137. The output of the flip-flop 138 is applied to one input of an AND gate circuit 140 via an OR gate circuit 139 and the other input of the AND gate circuit 140 is connected to receive the output of the AND gate circuit 134. Accordingly, when the flip-flop 138 is set, the AND gate circuit 140 is enabled to apply signal "1" to the set terminal of the flip-flop 118 via an OR gate circuit 117 whereby this flip-flop is set to operate the timer 119. The output "1" from the AND gate circuit 140 is also applied to a counter 1410.

The purpose of counter 1410 is to produce a command signal when no coin is paid out owing to the fact that a paid out coin is caught by a coin payout actuator as will be described hereinafter. The output of the flip-flop 138 is applied to a coin payout motor M_{01} via a AND gate circuit 1380 having the other input connected to receive the inverted signal of set output of a flip-flop 217 adapted to operate a motor M_{02} to be described later whereby motor M_{01} is rotated when motor M_{02} is not rotated.

When the coin payout motor M_{01} rotates, the coin payout actuator (not shown) is rotated for paying out coins from the 10 yen coin main tube (A tube) or the 50 yen coin main tube (B tube) or the 10 yen or 50 yen coin auxiliary tube (C tube) shown in Figure 1. If an A tube transfer solenoid coil 141 and a B tube transfer solenoind coil 142 (to be described later) are not energized, the coins are paid out from the 50 yen coin main tube (B tube).

A coin payout actuator interlocked with the coin payout motor M_{01} is provided with a carrier switch 143 for the motor M_{01} so that when the actuator is rotated by the coin payout motor M_{01} the carrier switch 143 is turned on whereas when the coin payout actuator completes one revolution to terminate payout of the coins the switch 143 is turned off.

The operation of the carrier switch 143 for the motor M_{01} is detected by a detector 144 and its output "1" is applied to one input of an AND gate circuit 146 via an OR gate circuit 145. The other input of the AND gate circuit 146 is connected to receive the output of an AND gate circuit 147 via a AND gate circuit 148, and to the inputs of the AND gate circuit 147 are applied the outputs of the OR gate circuit 120, the flip-flop 118 and timer 119 so that the AND gate circuit 147 is enabled when the timer 119 operates. The other input of the AND gate circuit 148 is connected to receive the inverted output signal of the escrow flip-flop circuit 113 so that the AND gate circuit 148 is enabled when the flip-flop 113 is reset.

Accordingly, the AND gate circuit 146 is enabled when the carrier switch 143 for motor M_{01} is turned off while the timer 119 is operating to apply signal "1" to the reset terminal of the flip-flop 138 via an OR gate circuit 149 whereby the flip-flop 138 is reset and the coin payout motor M_{01} is stopped.

A coin payout detector 150 for detecting paid out coins is provided at the coin payout opening (see also Figure 1) and when the fact that the coin paid out by the operation of the coin payout motor M_{01} has passed through the coin payout opening is confirmed, the detector 150 applies a signal "1" to one input of an AND gate circuit 151. The other input thereof is connected to receive the output of the AND gate circuit 148 which is enabled when the timer 119 is operating and when the escrow flip-flop 113 is reset.

As a consequence, the AND gate circuit 151 is enabled to apply signal "1" to a flip-flop 152 for holding the coin payout confirmation signal thereby setting the flip-flop 152. When this flip-flop 152 is set, its set output "1" is applied to one input of an AND gate circuit 201 via an OR gate circuit 200. To the other input of the AND gate circuit 201 is applied the output signal "1" of an AND gate circuit 161 which is enabled when the delay time of the timer 119 terminates so that the AND gate circuit 201 is enabled when the timer 119 completes its operation to apply signal "1" to the reset terminal of a lock signal holding flip-flop 165 thus resetting the same. The output signal "1" from the OR gate circuit 200 is also applied to one input of an AND gate circuit 203 via an OR gate circuit 202.

In the same manner as above described, since the other input of the AND gate circuit 203 is supplied with the outputs of the AND gate circuit 161, the AND gate circuit 203 is enabled when the time delay operation of the timer 119 concludes so as to apply its output signal "1" to counter 1410 via an OR gate circuit 204 thus resetting the counter 1410.

The building up of the set output of the coin payout confirmation signal holding flip-flop 152 is detected by a build up detector 153 which applies signal "1" to one input of an AND gate circuit 154. The other input of this AND gate circuit 154 is supplied with the output signal "1" of AND gate circuit 148 which is enabled while the timer 119 is operating. Under these conditions the AND gate circuit 154 is enabled to apply its output signal "1" to one input of an AND gate circuit 155 with its other input connected to receive the inverted output signal of the comparator 136 which produces signal "1" when the counter R_B of the 50 yen coin counter 30 becomes zero. At this time, since the vending machine is operating in the coin returning mode, $R_B \neq 0$ when a 50 yen coin has been inserted so that the AND gate circuit 155 is enabled to apply signal "1" to the 50 yen coin counter count down command circuit 156.

Upon receipt of the signal "1", this command circuit 156 applies one pulse to the 50 yen coin counter 30 thus subtracting 50 from the count R_B of the 50 yen coin counter 30 (the subtraction line is not shown).

The output of the AND gate circuit 155 is also applied to one input of a AND gate circuit 157 and the other input thereof is connected to receive the inverted output signal of the comparator 158 which produces an output "1" when the count R_{BN} of the stored 50 yen coin counter 33 reduces to zero. Under these conditions, the AND gate circuit 157 is enabled to apply its output signal "1" to a 50 yen coin counter count down command circuit 159.

This command circuit 159 has a construction identical to that of the command circuit 156 so that when signal "1" is applied, the command circuit 159 applies one pulse to the stored 50 yen coin counter 33 so as to subtract 1 (one) from the count R_{BN} thereof (the subtraction signal line is not shown).

In this manner, one 50 yen coin is paid out, 50 is subtracted from the count R_B of the 50 yen coin counter 30 and one is subtracted from the count R_{BN} of the stored 50 yen coin counter 33. However, since the operating time t_3 of the timer 119 is selected to be longer than the time necessary to perform these operations when these operations are executed normally, they terminate within the operating time t_3 of the timer 119.

When the operating time t_3 has elapsed, the AND gate circuit 160, which is connected to the outputs of the NOR gate circuit 120, flip-flop 118 and the timer 119, is enabled. The output signal "1" from the AND gate circuit 160 is applied to one input of an AND gate circuit 161. Then this AND gate circuit 161 is enabled because its input is supplied with the inverted signal of output of the escrow flip-flop 113 so that signal "1" is applied to the reset terminal of the coin payout confirmation signal holding flip-flop 152 thus resetting the same. At the same time, the output signal "1" from the AND gate circuit 161 is applied to the reset terminal of flip-flop 118 via the OR gate circuit 131, thus resetting the flip-flop 118. This signal "1" is also applied to the set terminal of the flip-flop 130 via the OR gate circuit 129 whereby the flip-flop 130 is set. Then the operation of the timer 121 is started again.

When the operation time t_2 of the timer 121 has elapsed, the AND gate circuit 133 is enabled again so that its output sets the flip-flop 138 via AND gate circuits 134 and 135 and OR gate circuit 137 whereby one 50 yen coin is paid out by the operation similar to that described above. This payout operating of the 50 yen coins is continued until the count R_B of the 50 yen coin counter 30 reduces to zero.

If the coin payout motor M_{01} is rotated under a condition of $R_B \neq 0$, and yet the carrier switch 143 for the motor M_{01} is not open this means that a coin has been caught by the coin payout actuator. This problem is solved in the following manner. The output of the AND gate circuit 162 whose inputs are connected to receive the outputs of the 10 yen coin carrier switch and of the flip-flop 138, is applied to one input of an AND gate circuit 164 via an OR gate circuit 163, and the other input of the AND gate circuit 164 is supplied with the output of the AND gate circuit 134.

Consequently, when the coin payout motor M_{01} has been rotated but the carrier switch 143 for the motor M_{01} does not open during the operating time of timer 119 and when the operating time t_2 of the timer 121 has elapsed, the AND gate circuit 134 is enabled again. Furthermore, when the carrier switch 143 for motor M_{01} is in the closed state when the flip-flop 138 is set the AND gate circuit 164 is enabled to apply signal "1" to the lock signal holding flip-flop 166 thus setting the same. The set output "1" from the flip-flop 166 is applied to a reverse command circuit 167 which commands operation of the motors M_{01} and M_{02}. At this time the coin payout motor M_{01} is reversed.

The output of the flip-flop 138 is applied to one input of the AND gate circuit 140 via the OR gate circuit 139 and the other input of the AND gate circuit 140 is connected to the output of the AND gate circuit 134 so that the AND gate circuit 140 is enabled to apply an output signal "1" to counter 1410 to increase the count by one. The output signal "1" of the AND gate circuit 1410 is also applied to the set terminal of flip-flop 118 via the OR gate circuit 117. Thus the flip-flop 118 is set to start the operation of the timer 119. Since the counter 1410 has been incremented by 1 count in the preceding normal rotation, the contents of the counter 1410 becomes 2 by the increment of 1 count due to this reverse rotation.

As the timing operation of the timer 119 terminates, the AND gate circuit 161 is enabled so that the flip-flop 138 is reset by the output of the AND gate circuit 164 via the OR gate circuit 149. Consequently the timer 121 is started and when this timer completes its operation the flip-flop circuit 138 is set via AND gate circuits 133, 134 and 135 and the OR gate circuit 137, thus rotating the coin payout motor M_{01} in the forward direction.

Accordingly, a coin is paid out and, when the coin payout detector 150 detects such payout, a confirmation signal "1" is applied therefrom via AND gate circuit 151 to the set terminal of a coin payout confirmation signal holding flip-flop 152 thus setting the same. The set output "1" from this flip-flop 152 is applied to the reset terminal of the counter 1410 via OR gate circuits 200 and 202, AND gate circuit 203 and OR gate circuit 204, thus resetting the counter. The set output "1" from the flip-flop 152 is also applied via OR gate circuit 200 and AND gate circuit 201 to the reset terminal of the lock signal holding flip-flop 165 thus resetting the same. Thereafter, 50 yen coins are paid out normally in the same manner as described above.

However, when the coin payout confirmation signal holding flip-flop 152 is not set because any coin has not been paid out in spite of the reverse and forward rotation of the coin payout motor M_{01}, when the operation of the timer 119 terminates during the last forward rotation of the motor, then the timer is started and when its operation terminates, the count of the counter 1410 becomes 3. Since this counter is constructed to produce a signal "1" when its count reaches 3, this signal will be applied to one input of AND gate circuit 169 via OR gate circuit 168.

Since the outputs of the OR gate circuit 120, the timer 119 and the flip-flop 118 are applied to the inputs of an AND gate circuit 170, the AND circuit 170 is enabled when the timing operation of the timer 119 terminates and applies its output to one input of a AND gate circuit 171, the other inputs of which are the inverted output signal of the escrow flip-flop 113 and the inverted output signal of the coin payout confirmation signal holding flip-flop 152. The AND gate circuit 171 is enabled when the payout of the coin is not confirmed at the time of termination of the operation of the timer 119 thereby applying signal "1" to one input of an AND gate circuit 172.

The other input of the AND gate circuit 172 is connected to the inverted output signal "1" of the comparator 136 which produces an output "1" when $R_B=0$ so that the AND gate circuit 172 is enabled when RB=0. The "1" output from the AND gate circuit 172 is applied to one input of the AND gate circuit 169.

Consequently, AND gate circuit 169 is enabled when the count of the counter 1410 becomes 3 and when no 50 yen coin is paid out during the timing operation of the timer 119. The output signal "1" from the AND gate circuit 169 is applied to the set terminal of the flip-flop 173 thus setting the same. This output signal "1" is also applied to the 50 yen→10 yen transfer command circuit 175 via an OR gate circuit 174.

The 50 yen→10 yen transfer command circuit 175 applies, to the 50 yen coin counter 30, pulse signals of number corresponding to the count R_B thereof via line 176 and the OR gate circuit 27 thus reducing the count R_B to zero. Further, the 50 yen→10 yen transfer command circuit 175 applies, to the 10 yen coin counter 29, pulse signals of number corresponding to the count R_B of the 50 yen coin counter 30 via line 177 and the OR gate circuit 26 thus changing the count R_A of the 10 yen coin counter 29 to R_A+R_B.

In this manner, the count R_B of the 50 yen coin counter 30 is transferred to the count R_A of the 10 yen coin counter 29 thus reducing the count R_B to zero. At the same time, the output "1" of the counter 1410 is applied via OR gate circuit 200 and AND gate circuit 201, to the reset terminal of the lock signal holding flip-flop 165 thereby resetting the same. At the same time, the output from the OR gate circuit 200 is applied to the reset terminal of counter 1410 via OR gate circuit 202, AND gate circuit 203 and OR gate circuit 204 thus resetting the counter 1410.

When the number of 50 yen coins paid out becomes equal to the number of 50 yen coins inserted or when the count R_B is transferred to count R_A by the operation of the 50 yen→10 yen transfer command circuit 175, the count R_B is reduced to zero, the AND gate circuit 179 is enabled since the inputs thereof are connected to the outputs of the AND gate circuit 134 and the comparator 136, and the inverted output signal of the comparator 178 which produces signal "1" when $R_A=0$. Thereafter, payout of the 10 yen coins is commenced.

The output signal "1" of the AND gate circuit 179 is applied to one input of an AND gate circuit 180 and the output of an AND gate circuit 181 and the inverted output signal of an AND gate circuit 182 are applied to the other inputs of the AND gate circuits 180.

Although the operation of the AND gate circuits 181 and 182 will be described later in connection with the change payout operation it is now assumed that their outputs are "0". Accordingly, the AND gate circuit 180 is enabled to apply signal "1" to the set terminal of the flip-flop 184 thus setting the same.

The set output "1" of the flip-flop 184 is applied to an A tube transfer solenoid coil 141 via an AND gate circuit 1840 whose inputs are supplied with the output of flip-flop circuit 184 and an inverted output signal from the flip-flop circuit 199. The purpose of the A tube transfer solenoid soil 141 is to perform switching between the 50 yen coin main tube (B tube) and the 10 yen coin main tube (A tube) and when it is energized it transfers payout from the 50 yen coin main tube (B tube) to the 10 yen coin main tube (A tube) by operating the coin payout motor M_{01}.

The output signal "1" of the AND gate circuit 179 is also applied to one input of the AND gate circuit 185 and the other input thereof is supplied with the inverted output signal ("0") of the AND gate circuit 181 so that the AND gate circuit 185 is enabled whereby a signal "1" is applied to the set terminal of the flip-flop 138 via the OR gate circuit 137 whereby the flip-flop circuit 138 is set. Then its set output "1" is applied to the coin payout motor M_{01} so that the motor is rotated to payout 10 yen coins from the 10 yen coin main tube (A tube) in the same manner as the payout of the 50 yen coins.

More particularly, the carrier switch 143 for the coin payout motor M_{01} becomes open and when this open state is detected by the detector 144, the detector 144 applies signal "1" to the reset terminal of the flip-flop 138 via OR gate circuit 145 and AND gate circuit 146 whereby the flip-flop 138 is reset to stop the coin payout motor M_{01}. Accordingly, one 10 yen coin is paid out.

The coin payout confirmation signal from the coin payout detector 150 is applied to the set terminal of the coin payout confirmation signal holding flip-flop 152 via AND gate circuit 151, so that the flip-flop 152 is set and the building up of its set output is detected by the build up detector 153 and its output "1" is applied to one input of an AND gate circuit 186 via the AND gate circuit 154.

The other inputs of the AND gate circuit 186 are supplied with the output (R_{BN}=0) of the comparator 158 and the inverted output signal (R_A=0) of the comparator 178 so that the AND gate circuit 186 is enabled when R_{BN}=0 and $R_A \neq 0$ so as to apply its output "1" to the 10 yen coin counter count down command circuit 187 whereby 10 is subtracted from the count R_A of the 10 yen coin counter 29. The output of the AND gate circuit 186 is applied to one input of an AND gate circuit 189. The other input of the AND gate circuit 189 is supplied with the inverted output signal of a comparator 190 which produces signal "1" when the count R_{AN} of the stored 10 yen coin counter 32 becomes zero. At this time, since $R_{AN} \neq 0$, the AND gate circuit 189 is enabled to apply its output signal "1" to the 10 yen coin counter count down command circuit 191 whereby one is subtracted from the count R_{AN} of the stored 10 yen coin counter 32.

As a consequence, the payout operation of one 10 yen coin is completed. The payout operation of the 10 yen coins is continued until the count R_A of the 10 yen coin counter 29 is reduced to zero and the output from the comparator 178 becomes "1".

In this manner 100 yen, 50 yen and 10 yen coins of the same number as the inserted 100 yen, 50 yen and 10 yen coins are returned. If a 10 yen coin becomes caught in the actuator during the payout operation of the 10 yen coins so that the carrier switch 143 cannot open, the reverse command circuit 167 is operated in the same manner as described above to reverse the coin payout motor M_{01}. If even after three operations, forward, reverse and forward, are performed it is impossible to confirm the payout of a 10 yen coin, a signal "1" indicating a fault is applied to a stop device 194 in the following manner.

More particularly, when the count of the counter 1410 becomes 3 its output "1" is applied to one input of AND gate circuit 192. One of the other inputs of this AND gate circuit 192 is supplied with the output of an AND gate circuit 1930 having inputs connected to receive the output of AND gate circuit 171 which is enabled when the operation of the timer 119 terminates, a signal indicating that $R_A \neq 0$ comprising the inverted output of the comparator 178, and a signal from the comparator indicating that R_B=0. Since the third input of the AND gate circuit 192 is supplied with a signal indicating that the A tube has been selected as the payout tube (this signal being equal to the output of the AND gate circuit 180) the AND gate circuit 192 is enabled, thereby applying signal "1" to the stop device 194 via OR gate circuit 193. Application of the signal "1" to the stop device indicates a fault so that the vending operation of the automatic vending machine is stopped.

During the return operation, only the 10 yen coin main tube (A tube) and the 50 yen coin main tube (B tube) are operated. The auxiliary tubes (C and D tubes) are not used.

Change Payout Operation.

The change payout operation will now be described. Assuming that an article has been purchased, that the coin collection operation has been completed, that the clear button has been depressed and that signal "1" has been stored in the change payout command circuit 75, the change corresponding to the counts R_A, R_B and R_C in the 10 yen coin counter 29, the 50 yen coin counter 30 and the 100 yen coin counter 31 respectively is payed out.

Payout of the change starts with the 100 yen coins. Since all 100 yen coins which are still held after completion of the coin collection operation should be paid out as the change, the 100 yen coins that have been held are paid out in the same manner as in the coin returning operation described above.

More particularly, signal "1" on line 196 from the change payout command circuit 75 (Figure 3) and a signal on lines 90 (Figure 3) and 18 representing the completion of the coin collecting operation are applied to the inputs of AND gate circuit 1750 (Figure 4).

The AND gate circuit 1750 is enabled simultaneously with the completion of the coin collecting operation to apply signal "1" to the set terminal of the escrow flip-flop 113 thus setting the same. The set output of the escrow flip-flop 113 is applied to the escrow solenoid coil 114 for returning all 100 yen coins that are being held.

The signal "1" from the change payout command circuit 75 turns the 10 yen, 50 yen and 100 yen coin counters 29, 30 and 31 (Figure 3) to the count down mode via OR gate circuit 115. At the same, this signal "1" is applied via a line 116 and OR gate circuit 117 (Figure 4) to the set terminal of the flip-flop 118 thus setting the same. As a consequence, the timer 119 is started.

When the timer 119 starts, the AND gate circuit 122 is enabled thereby applying signal "1" to the 100 yen coin counter count down command circuit 124 via the AND gate circuit 123. As a consequence, the count R_C of the 100 yen coin counter 31 is reduced to zero. The payout operation of the 100 yen coins is then completed. Next, the payout operation for the 50 yen and 100 yen coins are performed.

As an example, the case wherein the C tube is used as the auxiliary tube for 50 yen coins will be considered. In this case, the C tube transfer signal applied to terminal T_9 is "1".

The payout of the 50 yen coins is made in preference from the main tube (B tube) and when the count R_{BN} of the stored 50 yen coin counter 33 is not equal to zero the same operation as the aforementioned coin returning operation is performed in the following manner.

When the 100 yen coins are paid out by the energization of the escrow solenoid coil 179 and when the operation time t_3 of the timer 119 has elapsed, signal "1" is applied via AND gate circuits 126 and 127 and line 128 to the reset terminal of the escrow flip-flop 113 thus resetting the same. At the same time the signal on line 128 is applied to the reset terminal of the flip-flop 118, via the OR gate circuit 131. This signal is also applied to the set terminal of the flip-flop 130, thus setting the same. When the flip-flop 130 is set, the operation of the timer 121 is started. When the operation time t_2 of the timer 121 has elapsed, the AND gate circuit 133 is enabled to apply signal "1" to the set terminal of the flip-flop 138 via AND gate circuits 134 and 135 and OR gate circuit 137.

When the flip-flop is set, the coin payout motor M_{01} is started. The output "1" of the flip-flop 138 is applied to the counter 1410 via OR gate circuit 139 and AND gate circuit 140, changing its count to one. The output "1" of AND gate circuit 140 is also applied to the set terminal of the flip-flop 118 via the OR gate circuit 117 and this flip-flop is set for starting the timer 119.

By the rotation of the coin payout motor M_{01} the 50 yen coins are paid out and the carrier switch 143 for the motor M_{01} is ON-OFF controlled and when the off state of the switch is detected by the detector 144, the signal "1" produced thereby is applied to the flip-flop 138 via OR gate circuit 145, AND gate circuit 146 and OR gate circuit 149. Thus, the flip-flop 138 is reset to stop the coin payout motor.

When the coin payout detector 150 confirms that the coin has been paid out, signal "1" is applied to the flip-flop 152 via an AND gate circuit 151 to set the same.

The build up of the set output of the flip-flop 150 is detected by the build up detector 153 and its output signal "1" is applied to the 50 yen coin counter count down command circuit 156 via AND gate circuits 154 and 155, whereby 50 is subtracted from the count R_B of the 50 yen coin counter 30. The output of the AND gate circuit 155 functions to subtract one from the count R_{BN} of the stored 50 yen coin counter 159.

The operation described above continued until the count R_B of the 50 yen coin counter 30 reduces to zero and the payout operation of the 50 yen coins terminals when R_B=0.

During the payout operation of the 50 yen coins, if a coin is caught by the coin payout actuator the AND gate circuit 162 will be enabled to apply signal "1" to the flip-flop 166 via OR gate circuit 163 and AND gate circuit 164 for setting it. Accordingly, the coin payout motor M_{01} is rotated in the reverse direction and then in the forward direction.

When the coins are paid out by the forward, reverse and forward rotations of the coin payout motor M_{01}, the set output of the flip-flop 152 is applied to the reset terminal of the counter 1410 via OR gate circuits 200 and 202, AND gate circuit 203 and OR gate circuit 204 to clear the content of the counter 1401. In this manner, 50 yen coins are paid out in the same manner as above described but if the coins are not paid out so that the count of the counter 1410 becomes 3, signal "1" is produced by the counter 1410 and this signal is applied to the 50 yen→10 yen transfer command circuit 175 via OR gate circuit 168, AND gate circuit 169 and OR gate circuit 174 whereby the content R_B of the 50 yen coins counter 30 is changed to zero and the count R_A of the 10 yen coin counter 29 is changed to R_A+R_B.

It is assumed now that the count R_{BN} of the stored 50 yen coin counter 30 is zero.

The siganl "1" stored in the change payout command circuit 75 (Figure 3) is applied via the line 196 to the flip-flop 197 (Figure 4) so that this flip-flop is set, and its set output "1" is applied to one input of AND gate circuit 198. To the other inputs of this AND gate circuit 198 are applied the output from the AND gate circuit 135 which is enabled when the operation of the timer 121 terminates, the C tube transfer signal (in this case "1") from terminal T_9, the output of the comparator 158 which shows that R_{BN}=0, and the inverted output signal of the C tube vacant signal holding flip-flop 19. Accordingly, the AND gate circuit 198 is enabled when R_{BN}=0, when the C tube is not vacant and when the operation of the timer 121 terminates to apply signal "1" to the flip-flop 199 via OR gate circuit 183 thus setting the flip-flop 199.

The set output of the flip-flop 199 is applied to the C tube transfer solenoid coil 142 through the AND gate circuit 1990, which has its other input supplied with the inverted output signal of the flip-flop circuit 184, thus switching coin payout to the C tube.

When the timing operation of the timer 121 terminates, the AND gate circuit 133 is enabled to apply signal "1" to the set input of the flip-flop 138 via AND gate circuits 134 and 135 and OR gate circuit 137. Then, the coin payout motor M_{01} is rotated to payout 50 yen coins from the C tube.

This payout operation is performed in the same manner as described above and each time one 50 yen coin is paid out 50 is subtracted from the count R_B of the 50 yen coin counter 30 and one is subtracted from the count R_{BN} of the stored 50 yen coin counter 33.

In this manner, 50 yen coins are continuously paid out from C tube until R_B becomes zero. Suppose now that no 50 yen coin was paid out from C tube by the rotation of the coin payout motor M_{01} under the condition that $R_B \neq 0$.

Under these conditions, if a paid out coin were not caught, the output of the flip-flop 197, the output of the comparator 158 indicating that $R_{BN}=0$ and the inverted output signal of the lock signal holding flip-flop 165 are applied to the inputs of AND gate circuit 205 to enable the same so that signal "1" is applied to one input of the AND gate circuit 169 via OR gate circuit 168. To the other input of the AND gate circuit 169 is applied the output of the AND gate circuit 172 which shows that a coin was not paid out at the end of the operation of the timer 119 even under a condition of $R_B \neq 0$.

Accordingly, the AND gate circuit 169 is enabled at the end of the operation of the timer 119 for applying signal "1" to the flip-flop 173 so as to set the same. At the same time, the signal "1" is also applied to the 50 yen→10 yen transfer command circuit 175 via OR gate circuit 174 to change the count R_B of the 50 yen coin counter 30 to zero and to transfer this value to the count R_A of the 10 yen coin counter 29.

The output signal "1" from the AND gate circuit 169 is applied to the reset terminal of the counter 1410 via OR gate circuit 204 to clear the counter 1410. At the same time, this signal "1" is applied to the reset terminal of the flip-flop 197 via OR gate circuit 206 to reset the same.

At this time, since the output of the flip-flop 197, the output of the comparator 158 showing that $R_{BN}=0$, the signal on terminal T9 showing that the C tube is used as the 50 yen coin tube and a signal from OR gate circuit 208 showing that the lock signal holding flip-flop 165 is not set, are applied to the AND gate circuit 207, this AND gate circuit 207 is enabled to apply signal "1" to one input of an AND gate circuit 209. The other input of the AND gate circuit 209 is supplied with the inverted output signal of the flip-flop 19 for holding the C tube vacant signal.

Since it was assumed that the flip-flop 19 has not been set, the AND gate circuit 209 is enabled to apply signal "1" to the set terminal of the C tube vacant flip-flop 19 via OR gate circuit 210 thus setting the flip-flop 19.

When 50 yen coins are paid out while the C tube vacant signal flip-flop 19 is set, the AND gate circuit 198 will not be enabled and then the C tube transfer solenoid coil 142 will not also be energized, as the coin payout motor M_{01} is rotated due to the setting of the flip-flop 138, 50 yen coins are paid out from the B tube.

During the payout operation of the 50 yen coins from the B tube, if the lock signal holding flip-flop 165 were not set under the condition of $R_B \neq 0$, and the coin payout confirmation signal holding flip-flop 152 were not set at the end of the operation of the timer 119, the AND gate circuit 169 would be enabled whereby the flip-flop 173 would be set in the same manner as above described to operate the 50 yen→10 yen transfer command circuit 175 to change count R_B to count R_A.

Under these circumstances although the AND gate circuit 207 is enabled since at this time the C tube vacant flip-flop 19 has been set, the AND gate circuit 211 is enabled because its inputs are supplied with the outputs of the AND gate circuit 207 and the flip-flop 19. As a consequence, signal "1" is applied to the reset terminal of the C tube vacant signal holding flip-flop 19 via OR gate circuit 212 thus resetting the flip-flop 19.

Suppose now that, at the time of starting the payout of the 50 yen coins, $R_B \neq 0$ and $R_{BN}=0$ and that flip-flop 173 has been set, then the AND gate circuit 213 is enabled because its inputs are supplied with the output of the AND gate circuit 123, the inverted output signal ($R_B=0$) of the comparator 136, and the output ($R_{BN}=0$) of the comparator 158. The output signal "1" of the AND gate circuit 213 is applied to the reset terminal of the flip-flop 173 via an OR gate circuit 300 thus resetting the flip-flop 173. At the same time, the output signal "1" from the AND gate circuit 213 is applied to the 50 yen→10 yen transfer command circuit 175 to change the count R_B to count R_A and to change the count R_B to zero.

In this manner, when the count R_B of the 50 yen coin counter 30 is reduced to zero the payout operation of 50 yen coins is completed and then payout of the 10 yen coins is performed.

Suppose now that $R_B=0$ and $R_A \neq 0$, when the AND gate circuit 179 is enabled by the application of the output of the AND gate circuit 134, the output ($R_B=0$) of the comparator 136 and the inverted signal of output ($R_A \neq 0$) of the comparator 178, the payout of the 10 yen coins is commenced.

The output signal "1" of the AND gate circuit 179 is applied to the set terminal of the flip-flop 184 via AND gate circuit 180 thus setting the flip-flop whereby the A tube transfer solenoid coil 141 is energized to select the A tube as the coin payout tube. Also the output signal "1" of the AND gate circuit 179 is applied to the set terminal of the flip-flop 138 via AND gate circuit 185 and OR gate circuit 137 so as to set the flip-flop 138 to rotate the coin payout motor M_{01}. Consequently, 10 yen coins are paid out from A tube in the same manner as the payout operation of the 10 yen coins during the return operation described above.

Suppose now that the count R_{AN} of the stored 10 yen coin counter 32 is zero. In this case, the output of the flip-flop 197, the output ($R_{AN}=0$) of the comparator 190, and the inverse (a signal showing that the D tube is not separated) of the output signal from the D tube separation signal holding flip-flop 20 are applied to the inputs of the AND gate circuit 214 so that it is enabled to apply signal "1" to one input of AND gate circuit 181. To the other input of the AND gate circuit 181 is applied via OR gate circuit 215 the signal from terminal T_9 showing that C tube is selected as the 50 yen coin tube. Consequently, the AND gate circuit 181 is enabled to apply signal "1" to an AND gate circuit 216. Since the output of the AND gate circuit 179 is supplied to one input of the AND gate circuit 216, the AND gate circuit 216 is enabled at the end of the operation of the timer 121 to apply signal "1" to the set terminal of flip-flop circuit 217 thus setting the same. The set output of the flip-flop 217 is applied to the coin payout motor M_{02} to start the same. The purpose of the coin payout motor M_{02} is to payout 10 yen coins from the 10 yen coin auxiliary tube (D tube).

When the carrier switch 195 is opened and closed by the coin payout motor M_{02}, the opening of this switch is detected by the detector 218 and its output signal "1" is applied to the reset terminal of the flip-flop 217 via OR gate circuit 145, AND gate circuit 146 and OR gate circuit 219 to reset the flip-flop 217 thus stopping motor M_{02}.

By the operation described above one 10 yen coin is paid out and when the coin payout detector 150 detects such payout, a signal "1" is applied to the set terminal of the coin payout confirmation signal holding flip-flop 152 via AND gate circuit 151 thus setting the flip-flop 152.

The build up of the set output from the flip-flop 152 is detected by the build up detector 153 and its output signal "1" is applied to the 10 yen coin counter count down command circuit 187 via AND gate circuits 154 and 186 thereby subtracting 10 from RA, and the output from the AND gate circuit 186 is applied to the stored 10 yen coin counter count down command circuit 191 to subtract one from its count R_{AN}.

During the 10 yen coin payout operation from the D tube, notwithstanding the rotation of the coin payout motor M_{02}, when the coin payout detector 150 does not confirm the coin payout and when the lock signal holding flip-flop 165 is not set, AND gate circuit 220 is enabled because its inputs are supplied with the output of the AND gate circuit 1930, the output of the OR gate circuit 208, and a signal showing that D tube has been selected as the coin payout tube (that is the output signal from AND gate circuit 216) so that signal "1" is applied to the reset input of the counter 1410 via OR gate circuit 204 for clearing the content of the counter 1410. At the same time, the signal "1" from the AND gate circuit 220 is applied to the reset terminal of flip-flop 197 via OR gate circuit 206 thus resetting the flip-flop circuit 197.

When the flip-flop 197 is reset, the AND gate circuit 214 is disenabled so that the AND gate circuit 180 is enabled when the AND gate circuit 179 is enabled. As a result, the flip-flop 184 is set to energize the A tube transfer solenoid coil 141 thereby selecting A tube as the coin payout tube. In the same manner as above described the remaining change is paid out from tube A by the rotation of the coin payout motor M_{01} and the change payout operation is completed when the count R_A becomes zero.

Although in the foregoing description, the C tube was used as a 50 yen coin auxiliary tube, in an automatic vending machine which vends articles requiring a large number of 10 yen coins as change it is possible to use the C tube as a 10 yen coin auxiliary tube. In this case, the signal applied to terminal T_9 is "0".

Consequently, during the payout operation of the 50 yen coins, if $R_{BN}\neq 0$, the AND gate circuit 135 would be enabled to set the flip-flop 138 via OR gate circuit 137 whereby the coin payout motor M_{01} is rotated to payout 50 yen coins from B tube, in the same manner as described above. But if $R_{BN}=0$, the AND gate circuit 173 is enabled to apply signal "1" to the 50 yen→10 yen transfer command circuit 175 via OR gate circuit 174 to transfer the count R_B to R_A.

During payout of 10 yen coins, if $R_{AN}\neq 0$, the output "1" of the AND gate circuit 179 is applied to the flip-flop 184 via AND gate circuit 180. Consequently, the flip-flop 184 is set to energize the A tube transfer solenoid coil 141 thus paying out 10 yen coins from the A tube. Where $R_{AN}=0$ and the C tube vacant signal holding flip-flop 19 is not set, AND gate circuit 221 will be enabled since its inputs are supplied with the output of the flip-flop 197, the output (R_{AN}=0) of the comparator 190, and the inverted signal from terminal T_9, thus applying signal "1" to one input of the AND gate circuit 182. To the other input thereof is applied the output of the C tube vacant signal holding flip-flop 19 via OR gate circuit 222. Accordingly, the AND gate circuit 182 is enabled to apply signal "1" to one input of an AND gate circuit 223.

Since the inverted output signal of the AND gate circuit 181 and the output of the AND gate circuit 179 are applied to the other inputs of the AND gate circuit 223, this AND gate circuit 179 is enabled and its output changes to "1". This "1" output is applied to the set terminal of flip-flop 199 via OR gate circuit 183. Consequently, the flip-flop 199 is set to energize the C tube transfer solenoid coil 142 for transferring the payout operation to the C tube.

Consequently, as the coin payout motor M_{01} rotates, 10 yen coins are paid out from C tube. Suppose now that regardless of the rotation of the coin payout motor M_{01} the detector 150 does not detect the payout of the coin so that the coin payout confirmation signal holding flip-flop 152 is not set.

Under these conditions, since the inputs of the AND gate circuit 224 are supplied with the output of the lock signal holding flip-flop 165 via OR gate circuit 208, the output of the AND gate circuit 1930 and a signal showing that the C tube has been selected as the coin payout tube, the AND gate circuit 224 is enabled to apply signal "1" to the reset terminal of counter 1410 via OR gate circuit 204 thus resetting the counter 1410. At the same time, the signal "1" from the AND gate circuit 224 is applied to the reset terminal of the flip-flop 197 via OR gate circuit 206 thus resetting the flip-flop 197.

When the flip-flop 197 is reset, the AND gate circuit 221 is disenabled so that the output from AND gate circuit 223 becomes "0". At this time, however, the AND gate circuit 180 is enabled to apply signal "1" to the set terminal of the flip-flop 184 to set the same. As a consequence, the A tube transfer solenoid coil 141 is energized to payout the change from the A tube.

Assume now that the C tube vacant signal holding flip-flop 19 is set and that the D tube separation signal holding flip-flop 20 is reset.

Under these conditions, since the outputs of the AND gate circuit 214 and the OR gate circuit 215 are applied to the input of the AND gate circuit 181, this AND gate circuit 181 is enabled to apply signal "1" to the set terminal of the flip-flop 217 via AND gate circuit 216. Consequently, the coin payout motor M_{02} is energized to payout 10 yen coins from D tube.

In this case too, if payout of the coin is not confirmed regardless of the rotation of the motor M_{02}, the AND gate circuit 220 is enabled so that payout is switched to the A tube and the remaining change is paid out from A tube.

When the D tube separation signal holding flip-flop 20 is set and the C tube vacant detection signal holding flip-flop 19 is reset, the AND gate circuit 182, whose inputs are supplied with the outputs of the AND gate circuit 221 and the OR gate circuit 222, is enabled to switch payout to the C tube thereby paying out 10 yen coins from the C tube. At this time too, when the C tube becomes empty, the AND gate circuit 224 is enabled so that payout is switched to the A tube and the remaining change is paid out from A tube.

The output from the AND gate circuit 255 whose inputs are supplied with the inverted output signal of the D tube separation signal holding flip-flop 20 and the output of the carrier switch 195 for the motor M_{02}, and the output of the carrier switch 143 for the motor M_{01} are applied to one of the two inputs of the AND gate circuit 227 via OR gate circuit 226. The other input of the AND gate circuit 227 is supplied with the inverted output signal of the lock signal holding flip-flop 165.

Since the output of the AND gate circuit 227 is applied to one input of the AND gate circuit 203 via OR gate circuit 202, this AND gate circuit will be enabled when the outputs from carrier switches 143 and 195 do not decrease even though the lock signal holding flip-flop 165 is not set at the end of the operation of the timer 119 so as to apply signal "1" to the reset terminal of the counter 1410 via OR gate circuit 204, whereby the counter 1410 is cleared.

The output of the OR gate circuit 228, the inputs of which are supplied with the output of the flip-flop 166 and the inverted output signal of the carrier switch 143, is applied to one input of the AND gate circuit 229, the other input of which is supplied with the output of the flip-flop 138. The inputs of the AND gate circuit 230 are supplied with the outputs of AND gate circuit 229 and 161 of which the latter indicates the end of the operation of the timer 119.

Consequently, at the end of the operation of the timer 119, the output of the carrier switch 143 is "0" so that the flip-flop 166 is set and when the flip-flop 138 is not set, the AND gate circuit 230 is enabled to apply signal "1" to the stop circuit 194 via the OR gate circuit 194 thus stopping the operation of the vending machine.

The output of the OR gate circuit 231 whose inputs are supplied with the output of the carrier switch 195 and the output of the flip-flop 166, and the output of the carrier switch 143 are applied to the inputs of an AND gate circuit 232 which is thereby enabled to apply its output to one input of AND gate circuit 233. Similar to the AND gate circuit 230, the other input of the AND gate circuit 233 is supplied with the output of the AND gate circuit 161 so that the AND gate circuit 233 is enabled when the flip-flop circuit 166 is set because the output of the carrier switch 195 is "0" at the end of the operation of the timer 119 and when the output of the carrier switch 143 is "1" because the coin payout motor M_{01} has become inoperative. Then, signal "1" is applied to the set terminal of the D tube separation signal flip-flop 20 whereby the flip-flop 20 is set to inhibit payout of the coins from D tube.

WHAT WE CLAIM IS:—

1. A method of controlling an automatic vending machine, comprising directing coins inserted into said vending machine to main coin storage means, maintaining a count of the number of coins in the main coin storage means by adding the number of coins directed thereto and subtracting the number of the coins paid out therefrom, manually inserting coins of a predetermined denomination into auxiliary coin storing means, paying out coins from said main coin storing means until the count of the number of coins therein reaches a predetermined value and then transferring payout from said main coin storing means to said auxiliary coin storing means and transferring payout from said auxiliary coin storing means back to said main coin storing means if coins are not paid out from said auxiliary coin storing means as a result of an operation thereof.

2. A control system of an automatic vending machine comprising main coin storing means, coins stored therein being automatically supplemented by coins inserted into said vending machine, a counter circuit for adding the number of coins supplemented and for subtracting the number of coins paid out from said main coin storing means, auxiliary coin storing means for storing coins of a predetermined denomination which are placed therein manually, means for paying out coins from said main coin storing means until the count of said counter circuit reaches a predetermined value, means for transferring payout from said main coin storing means to said auxiliary coin storing means when the count of said counter circuit reaches said predetermined value, detection means for detecting whether a coin is paid out from said auxiliary coin storing means as a result of each operation thereof and means responsive to the detection means for transferring payout from said auxiliary coin storing means to said main coin storing means when coins are not paid out from said auxiliary coin storing means in response to actuation thereof.

3. A control system constructed, arranged and adapted to operate substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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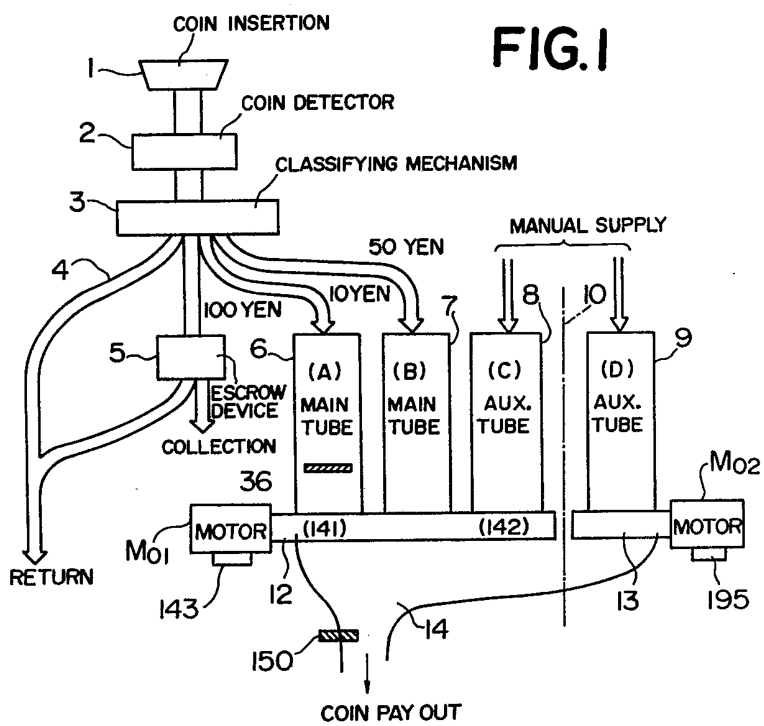
FIG. 1

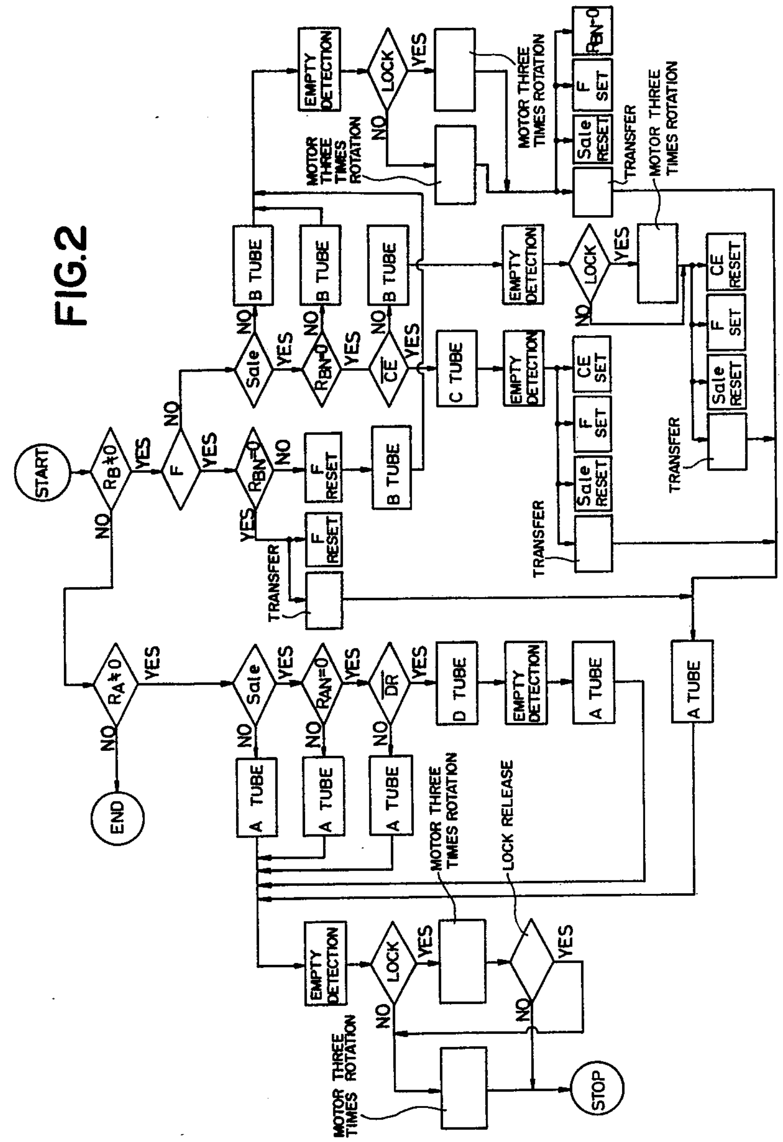

COIN INSERTION
1
COIN DETECTOR
2
CLASSIFYING MECHANISM
3
4
MANUAL SUPPLY
50 YEN
10YEN
100 YEN
7
8
10
9
5
6
(A)
MAIN
TUBE
(B)
MAIN
TUBE
(C)
AUX.
TUBE
(D)
AUX.
TUBE
ESCROW
DEVICE
COLLECTION
36
M_{02}
MOTOR
(141)
(142)
MOTOR
M_{01}
RETURN
143
12
13
195
14
150
COIN PAY OUT

1566202 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

FIG.2



1566202 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

FIG.3

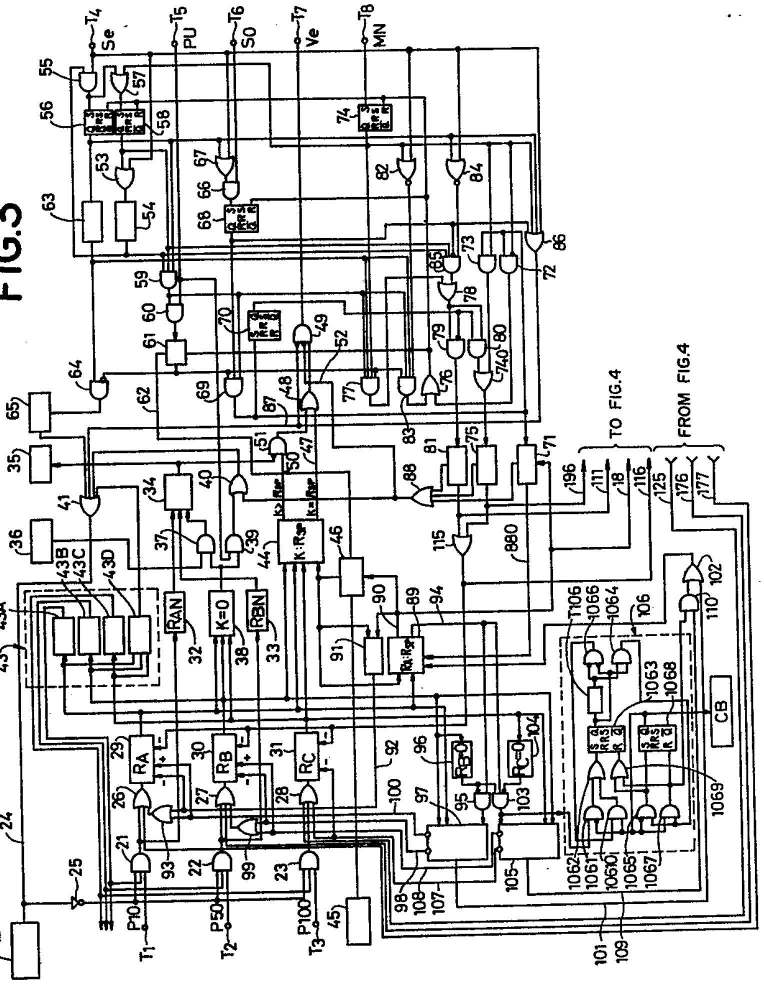


FIG.4