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(54) **Programmable time switch.**

(57) A microprocessor controlled time switch has a liquid crystal display device (13) with provision for displaying day of the week and time. Below the display a row of four keys (21 to 24) are used to select programming functions and a key (20) can be pressed at either end to increment and decrement numerical values. The keys (21 to 24) are multi-function and, above each key, the display device (13) includes a column of three legends, of which only one is ever displayed at a time. The microprocessor controls the legends (27) so that, in all phases of operation, the functions performed by the keys (21 to 24) are apparent.

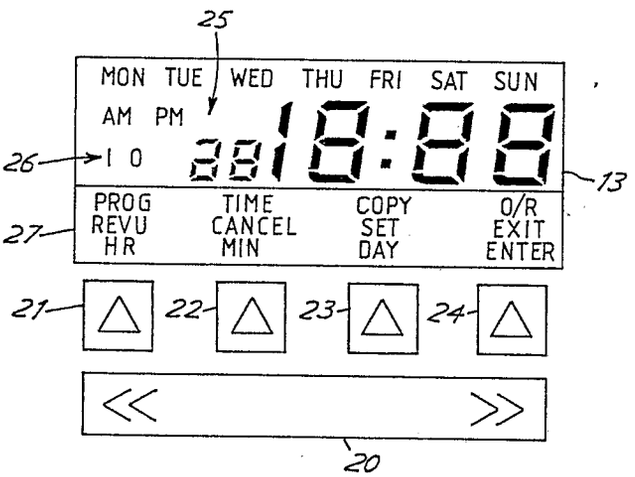

FIG. 2

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Description

PROGRAMMABLE TIME SWITCH

The present invention relates to a programmable time switch of the type based upon a microprocessor. The word 'programmable' refers to the facility whereby the user can set up the on/off time schedule or program; it does not refer to the control program in the microprocessor. Because the control functions of such a time switch are set up in software it is possible to provide complex on/off schedules, e.g. for a plurality of individually programmable channels or with a plurality of ON and OFF times for each day of the week. More specifically the invention concerns time switches as defined in the introductory part of claim 1. Such time switches are readily available, commercial articles.

The keys or buttons which have to be provided to allow such a time switch to be programmed can be numerous and confusing to use. It is known to reduce the number of keys by providing UP and DOWN keys, instead of a numeric keypad, for setting in the numerical values, such as times. It is also known to provide keys which have a plurality of different functions, according to the phase of the program obtaining at the time they are pressed. These are known as multi-function keys. Such keys are used also in watches and it is well known to place legends by the keys giving an indication of the set of functions covered by each key. This approach is hardly satisfactory for more than two functions per key and it is all too easy for the user to get confused.

It is known in VDU-based computers to provide a row of multi-function keys along the top of the keyboard, beneath the VDU and to display along the bottom of the VDU legends indicating the current function of each key. In particular this approach is disclosed in EP 0 076 328, EP 0 127 122 and US 4 303 973 in relation to complex process controllers. Such an approach is not feasible in a time switch which must necessarily be a simple and inexpensive device.

The following references are indicative of the state of the art in relation to labelling keys.

GB 1 574 449 discloses a microprocessor controller for a domestic appliance with a display device for providing information guiding the operator in using the switches of the appliance. However these switches are single-function switches with fixed labels.

GB 2 063 165 disloses a photocopier with switches which each have the sole function of stepping from option to option. The currently selected option is indicated by a lamp lit adjacent one of a set of labels adjacent the key.

GB 2 074 346 discloses a microprocessor controller for a domestic appliance with an LED or LCD display and a set of keys. The display presents a series of options of sequence and the user selects an option by pressing a key at a time that it is displayed. Each key has the sole function "select currently displayed option".

It will be understood that these devices all use single function keys.

The object of the present invention is to provide a programmable time switch which can handle complex programming with a minimum number of multi-function keys and yet be clear and unconfusing to use. For example the embodiment of the invention to be described below is designed to allow up to 21 ON and OFF times to be programmed, with facilities such as 'copy' to make programming easy and the customary override (O/R) facility, all achieved in a clear manner with only four keys in addition to the keys for setting numerical values. The latter keys are preferably just UP and DOWN keys so that the time switch has only six keys in total, excluding a special "permanent OFF" key mentioned below.

The programmable time switch according to the present invention is defined in the characterising part of claim 1.

The display device is preferably a liquid crystal display (LCD). The multi-function keys are conveniently in a row with the legends in a plurality of adjacent rows. The rows can be horizontal rows but this is not essential. The keys could be in a vertical row with the legends in adjacent vertical rows.

The invention will now be described in more detail by way of example, with reference to the accompanying drawings in which

Fig.1 is a block diagram of a time switch embodying the invention,

Fig.2 shows the display panel and control keys of the time switch, and

Figs.3, 4 and 5 are display flow charts for the operation of the time switch.

Referring to Fig.1, the time switch comprises a microprocessor 10 which is a four-bit single chip micro controller incorporating its own ROM, RAM, input/output circuits and timing circuits which are controlled by a crystal timing source 11. Such microprocessors are well known and commercially available. Inputs are received from a keyboard 12. Outputs are provided to an LCD 13 and a relay switching circuit 14 which controls an output relay 15. Power is supplied by a power supply circuit 16, run off the mains but provided with a back-up battery 17.

Fig.2 shows the front panel of the time switch comprising the LCD 13 and the keyboard 12. In Fig.2, the LCD is shown with all segments and legends displayed, a condition which never occurs in practice. The keyboard 12 consists of an UP and DOWN key 20 and four keys or buttons 21, 22, 23 and 24, referred to as key 1, key 2, key 3 and key 4. These four buttons have different functions, according to the phase of operation and the relevent function is displayed above each button on the LCD. Only one legend is displayed at a time above each button.

The top section of the LCD consists of a large 3 1/2 digit seven segment display which is used to indicate time of day and programming times. To the left of this there is a small 2 digit seven segment display 25 which shows the number of possible programming times remaining to the user. This

number decrements from a maximum of 21. Further to the left legends AM and PM indicate whether the displayed time is a.m. or p.m. and two legends 26 indicate whether an ON time or an OFF time is being programmed, and in normal operation, whether the relay is on or off. Along the top of the display are the days of the week.

Underneath this part of the display there is an array 27 of twelve legends arranged in three rows and four columns aligned above the keys 21 to 24 respectively. In operation, there is never more than one displayed legend in a column; either one legend or no legend is displayed, depending upon the existing function assignment of the corresponding key.

When the time switch is operating normally, only the first row of legends will be displayed. This means that key 1 is the PROG key used to select programming mode, key 2 is the TIME key used for setting clock time in the time switch, key 3 is the COPY key used for copying a program from day to day and key 4 is the O/R key used to provide an override function. This may either toggle the state of the relay or be an ON override only which turns the time switch on for a maximum of say two hours (unless turned off earlier by the program).

Assume that the user has pressed key 1 corresponding to PROG the display then changes to show only the middle line of legends. The four buttons now have new functions. Key 1 is REVU for selecting REVU/MODIFY functions, key 2 is CANCEL, key 3 is SET for setting in an ON time, OFF time pair, and key 4 is EXIT used to leave a program state.

The bottom row of legends consist of HR, MIN and DAY which indicate when keys 1, 2 and 3 are assigned to select hours, minutes and days respectively. The legend for key 4 is ENTER, used when a time is actually entered.

The complex but clear way in which the keys are programmed will now be explained with reference to Figs. 3, 4 and 5. In Fig.3, block 30 shows the normal display state with the top row of legends indicating the functions of the four keys. However, when there are no programmed events the display is as in block 31 with only the legend ENTER over key 4. The programming mode is selected from state 30 by pressing key 1 or by state 31 by pressing key 4. In the programming mode, the display is as in block 32, with the middle row of legends selected. It will be convenient to describe the functions of the keys from right to left. Key 4 is EXIT and pressing this key puts the program back to its top level with the display of block 30.

If key 3 SET is pressed the display changes to block 33, from which key 4 EXIT causes reversion to the previous level. Pressing any one of the keys 1 to 3, or pressing INC or DEC causes the display to change to block 34 in which key 4 is ENTER. Up until the time that key 4 is pressed, hours, minutes or day can be selected by keys 1, 2 and 3 and whichever value is selected can be adjusted using the INC and DEC key 20, as indicated by block 35. Once a desired ON time has been set up, key 4 is pressed to cause the time to be entered and the display moves on to block 36. This requires corresponding OFF time to be entered. This has to be in the same day so that the only legends are HR for key 1, MIN for key 2 and ENTER for key 4. When key 4 is now pressed, the program reverts to the first level with the display of block 32, ready for another ON/OFF time pair to be set in, if desired.

From the first programming level, block 32, key 2 is used when it is desired to cancel all stored events. However, as a safeguard, pressing key 2 does not lead to immediate cancellation. The display changes to block 36 allowing exit back to block 32 (key 4) or requiring key 2 to be pressed again to implement the cancellation which is symbolised by block 38, reverting to block 31.

If, in the first level, key 1 REVU is pressed, the display changes to block 39 from which it is possible to exit back to the first level (key 4) or modify programmed events. Key 3 shows DAY and, if this is pressed, it is possible to change the selected day by INC/DEC (block 40) and the display changes to block 41. If key 2 CANCEL is then pressed, all the selected day's events are cancelled (block 42) and the program reverts to the first level. However, if key 4 ENTER is pressed no cancellation is effected and the program reverts to block 39. In block 39, if key 2 CANCEL is pressed, the display changes to block 43 in which keys 1 and 2 allow a displayed time to be modified (44) while key 4 ENTER causes the modified time to be entered, with reversion to block 39.

Fig. 4 shows the top level display, block 30, and the possibilities existing when key 3 COPY is pressed. The system switches to the display of block 50, from which key 4 EXIT reverts to the top level display 30. Key 3 SET moves to display block 51 from which key 4 EXIT reverts to block 50. Key 3 DAY allows the base day, that is the day to be copied, to be selected by using INC/DEC block 52. The display is as in block 53 with key 4 shown as ENTER. When this key is pressed, the displayed day becomes the base day and INC/DEC, block 54, can be used to select the target day, to which the program of the base day is to be copied. The display is as in block 55 with key 4 ENTER. When this key is pressed, the copying is effected and the program reverts to block 51 for another possible copying operation.

Reverting to the first level block 50, key 1 REVU allows copied days to be reviewed. The display switches to block 56 and INC/DEC, block 57, can be used to scan through the days to be reviewed. Key 2 CANCEL will cancel copied days, block 58, but only those which have been copied from the displayed base day.

If, at the first level, block 50, key 2 CANCEL is pressed, the display switches to block 59 and a second press of key 2 CANCEL causes all copied days, irrespective of their base day, to be cancelled, block 60.

Fig.5 shows the remaining options available from the top level display 30. Key 2 TIME switches the display to block 65 in which keys 1, 2 and 3 can be used to select hours, minutes and day for alteration using INC/DEC, block 66. The correct time of day can thus be set up and, when key 4 ENTER is pressed, this time is entered and the system reverts

to the top level, display block 30.

Finally, in this state, if key 4 O/R is pressed, the output state is changed by the override function described above, block 67, and the system reverts to the top level.

It will be appreciated that the microprocessor 10 causes the LCD to display time of day when the system is in the top level. At other levels, the appropriate days and times being set, copied, reviewed, and cancelled are displayed, as is customary in digitally programmed time switches.

The details of the microprocessor program are not described. The ways in which microprocessors are programmed to respond to key signals and implement the desired functions in each operating state are extremely well known and within the ordinary skills of a competent programmer. Moreover it will be appreciated that the programming scheme outlined with reference to Figs.3, 4 and 5 is only one of the many possibilities which can be worked out for use with a restricted number of control keys. Apart from the means for adjusting numerical values (the INC/DEC key 20 in the embodiment described) there are just four keys 21 to 24. A smaller or larger number of keys could be employed but four is a convenient number because it is the smallest number of keys allowing one each to be assigned to hours, minutes and days plus a key available for controlling entry and exit operations.

More complex time switches embodying the invention can be devised, including multi-channel switches. A facility may be provided for putting the time switch in a pulse mode in which each programmed time is not an ON or OFF time but pulses the relay 15 on for a short time such as one second. The legends 26 in Fig.2 can then include a pulse mode symbol. A further button, not shown, may be provided for putting the time switch into a permanent OFF state and, on a second pressing, putting the switch back into its programmed state. This is preferably a recessed button requiring a probe to operate it. Many other modifications are possible within the scope of the invention as claimed.

Claims

1. A programmable time switch comprising a microprocessor (10) with a timing circuit (11), a switching circuit (14, 15) controlled by the microprocessor to effect switching operations at programmed times, a plurality of keys (20 - 24) for effecting the programming, and a display device (13) with a plurality of individually displayable indicia which are displayable in groups under the control of the microprocessor to display time of day or programming times, characterised in that the keys comprise a linear array of multi-function keys (21 - 24) whose function is determined by the microprocessor(10) differently in different phases of operation, in that the display device (13) further has an array of selectively displayable legends (27) adjacent the linear array of keys and aligned in sets with the keys, each set of legends denoting the various functions associated with the corresponding key, and in that the microprocessor further controls the display device to display only those of the legends as are appropriate in each phase of operation.

2. A time switch according to claim 1, characterised in that the display device (13) is a liquid crystal display.

3. A time switch according to claim 1 or 2, characterised in that the multi-function keys (21 - 24) are in a horizontal row and the legends (27)are arranged in a plurality of adjacent horizontal rows.

4. A time switch according to claim 1, 2a, 3, characterised in that there are four multi-function keys (21 - 23) of which three have associated legends indicating hours, minutes and days respectively, as well as other legends, and the fourth (24) has associated legends comprising a legend denoting when the key is available to select data entry and a legend denoting when the key is available to select exit from a programming function.

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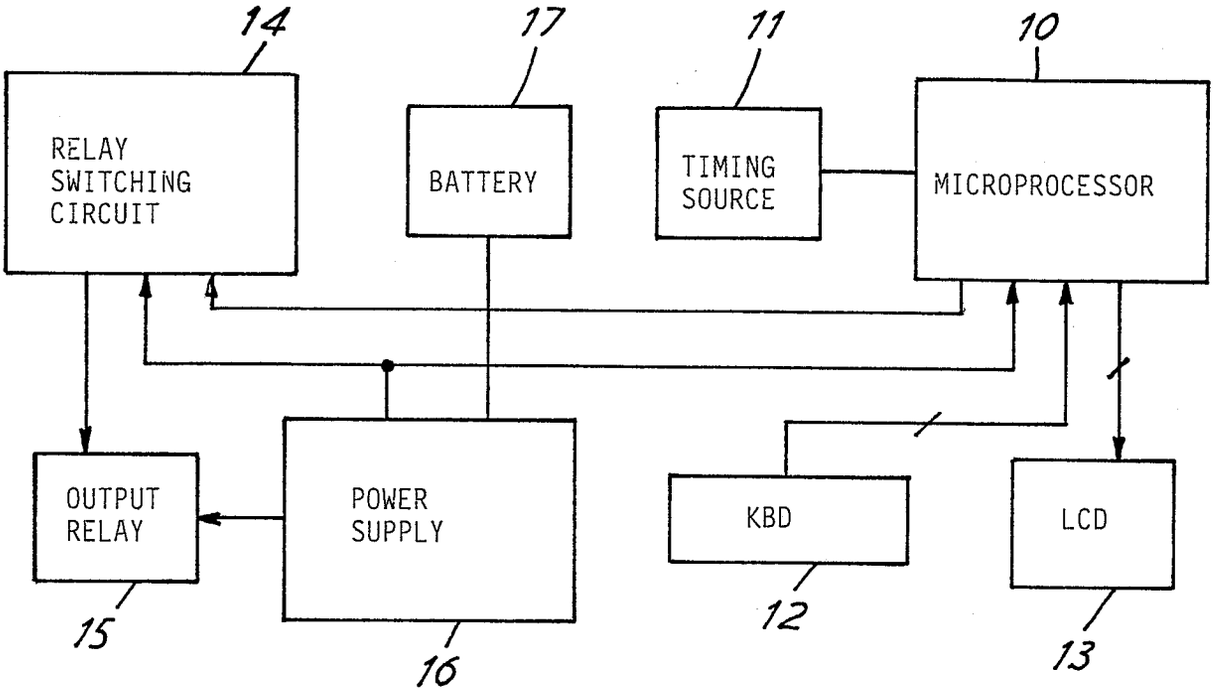

FIG. 1

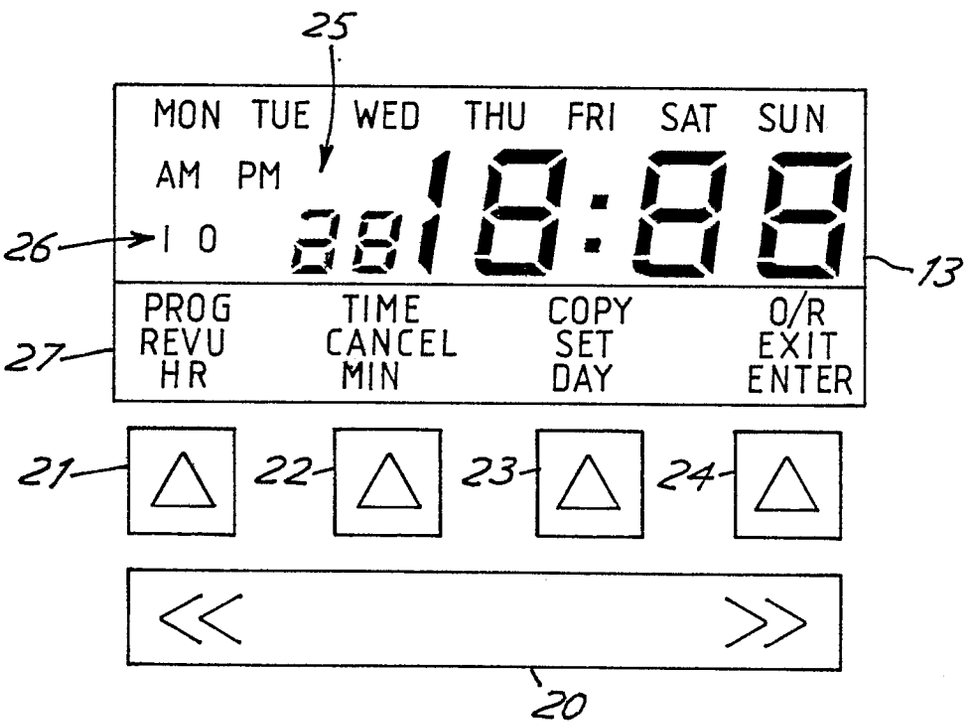

FIG. 2

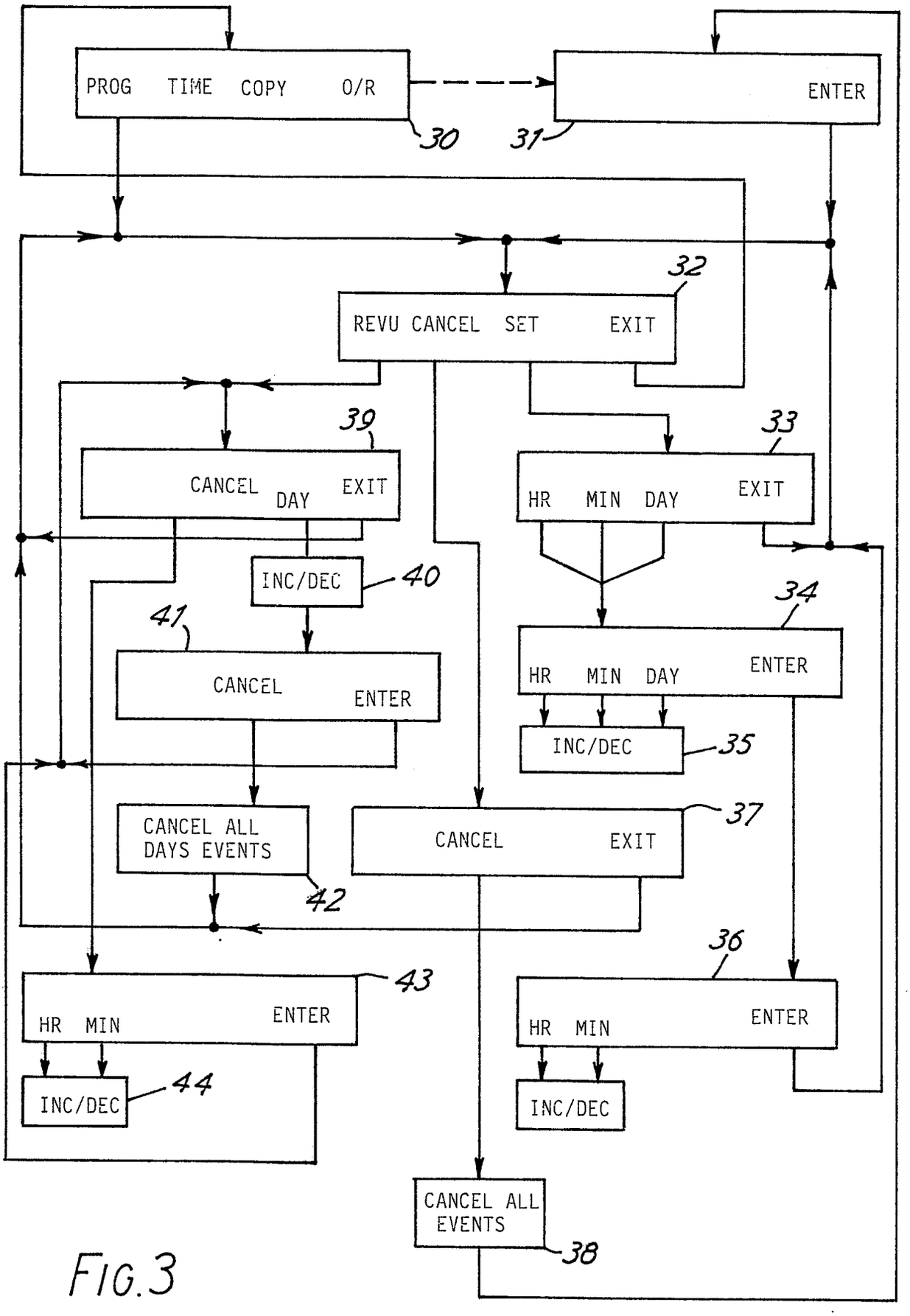
PROG TIME COPY O/R
30
ENTER
31
32
REVU CANCEL SET EXIT
39
CANCEL DAY EXIT
33
HR MIN DAY EXIT
INC/DEC
40
41
CANCEL ENTER
34
HR MIN DAY ENTER
INC/DEC
35
CANCEL ALL DAYS EVENTS
42
CANCEL EXIT
37
43
HR MIN ENTER
36
HR MIN ENTER
INC/DEC
44
INC/DEC
CANCEL ALL EVENTS
38

FIG. 3

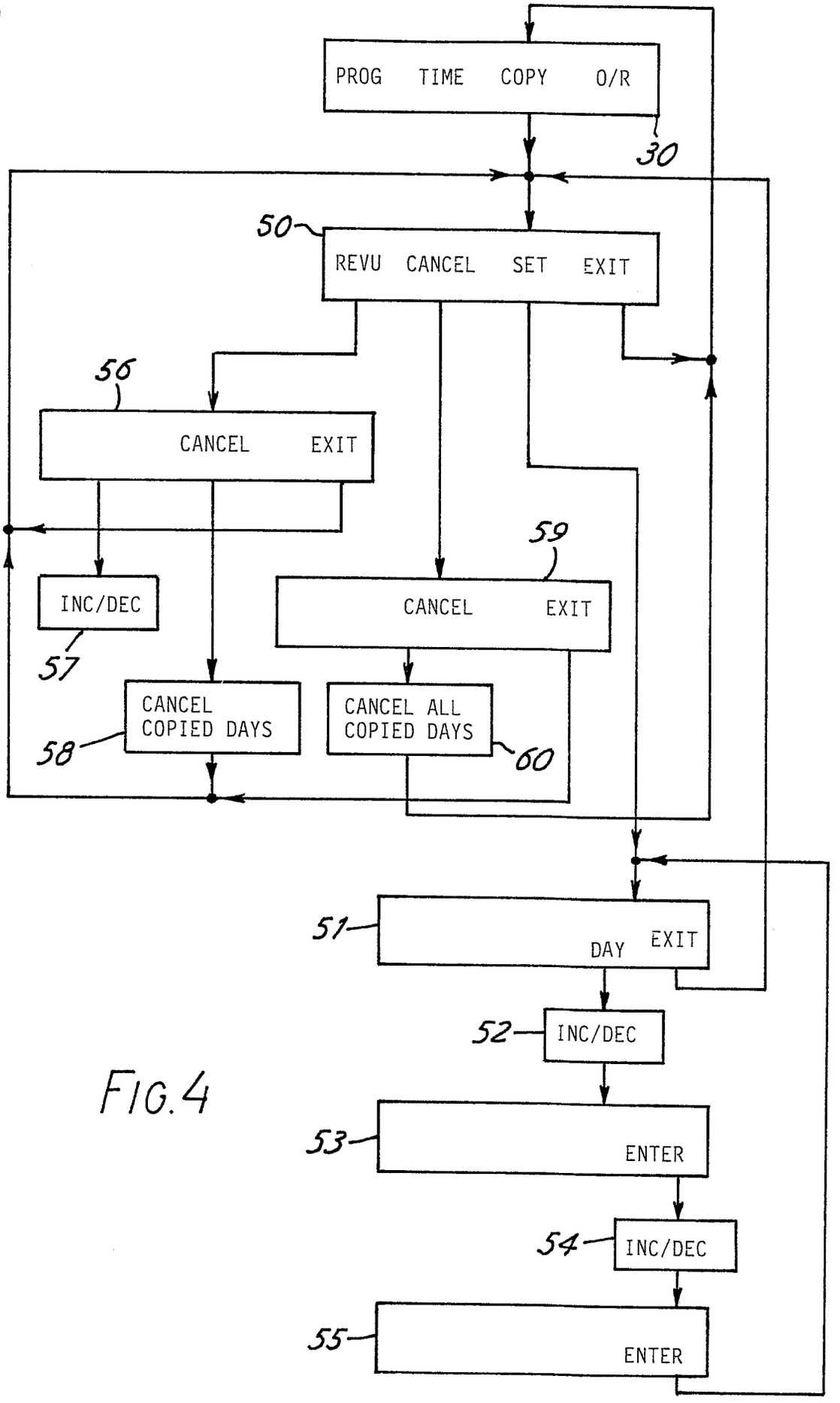
PROG TIME COPY O/R
30
50
REVU CANCEL SET EXIT
56
CANCEL EXIT
59
INC/DEC
57
CANCEL EXIT
CANCEL COPIED DAYS
58
CANCEL ALL COPIED DAYS
60
51
DAY EXIT
52
INC/DEC
53
ENTER
54
INC/DEC
55
ENTER

FIG. 4

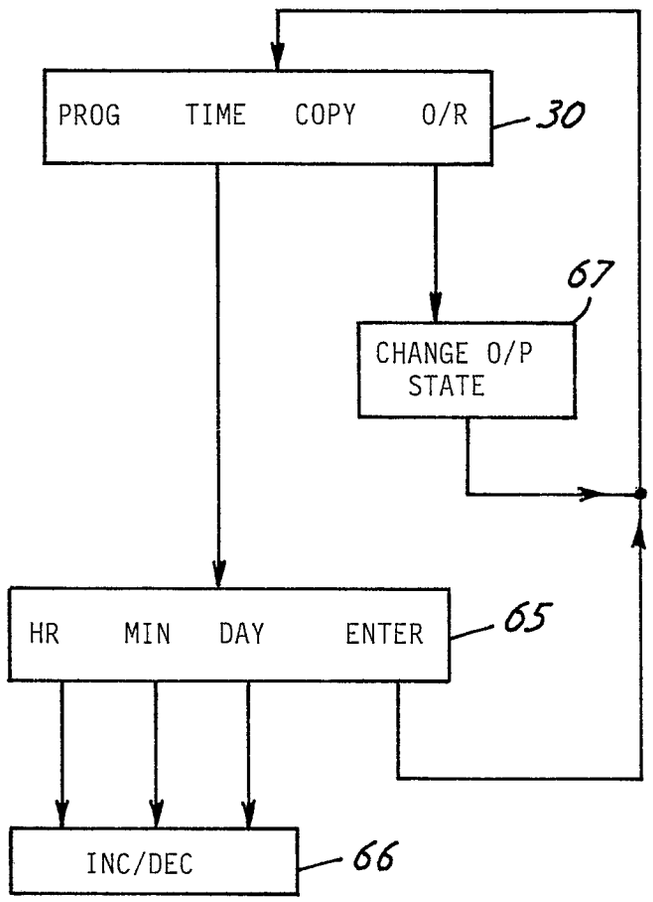
PROG
TIME
COPY
O/R
30
67
CHANGE O/P STATE
HR
MIN
DAY
ENTER
65
INC/DEC
66

FIG.5