FORM 1

COMMONWEALTH OF AUSTRALIA

608226

PATENTS ACT 1952

APPLICATION FOR A STANDARD PATENT

I\We,

SONY CORPORATION

of   6-7-35 KITASHINAGAWA
          SHINAGAWA-KU
          TOKYO 141
          JAPAN

hereby apply for the grant of a standard patent for an
invention entitled:

MODE PROCESSING CIRCUIT

which is described in the accompanying complete specification

Details of basic application(s):

Number of basic application	Name of Convention country in which basic application was filed	Date of basic application
135349/1986	JP	11 JUN 86
137996/1986	JP	13 JUN 86

My/our address for service is care of CLEMENT HACK & CO., Patent
Attorneys, 601 St. Kilda Road, Melbourne 3004, Victoria,
Australia.

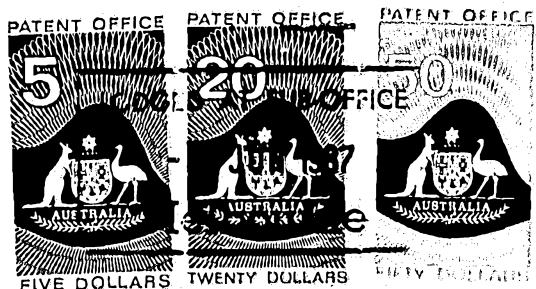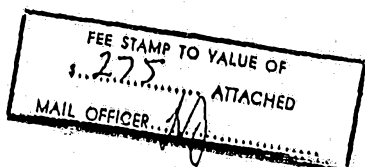DATED this 09th day of June   1987

SONY CORPORATION

APPLICATION ACCEPTED AND AMENDMENTS
ALLOWED ....11 - 1 - 91.........................

TO: The Commissioner of Patents.

CLEMENT HACK & CO.

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AUSTRALIA

Patents Act 1952

DECLARATION IN SUPPORT OF A CONVENTION OR NON-CONVENTION
APPLICATION FOR A PATENT OR PATENT OF ADDITION

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plicant(s)

In support of the application made by___SONY CORPORATION____

tle

for a patent for an invention entitled_MODE PROCESSING CIRCUIT

me(s) and
dress(es)
person(s)
king
claration

I/We, Shoji Wakayama of c/o SONY CORPORATION, 7-35,
Kitashinagawa 6-chome, Shiagawa-ku, Tokyo, Japan

do solemnly and sincerely declare as follows:-

1. I am/we are the applicant(s) for the patent, or
    am/are authorised by the abovementioned applicant
    to make this declaration on its behalf.

2. The basic application(s) as defined by Section 141
    of the Act was/were made in the following country
    or countries on the following date(s) by the
    following applicant(s) namely:-

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te and name
Applicant(s)
r the or
ch basic
plication

in___Japan_____on___June 11,_____19 86___
by___SONY CORPORATION
in___Japan_____on___June 13,_____19 86___
by___SONY CORPORATION

3. The said basic application(s) was/were the first
    application(s) made in a Convention country in respect
    of the invention the subject of the application.

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ch actual
ventor
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is part

4. The actual inventor(s) of the said invention is/are
    KEIICHIRO SHIMADA, YURIKO KISHITAKA, TORU MIURA, KOJI IWAMOTO,
    KENICHI ITO, RYO ITO and KATSUMI MATSUNO of all c/o SONY
    CORPORATION, 7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo,
    Japan

5. The facts upon which the applicant(s) is/are entitled
    to make this application are as follows:-
    The applicant is the assignee of the actual inventors.

DECLARED at_Tokyo, Japan__this 2nd_ day of___June_____19 87_

SONY CORPORATION

Shoji Wakayama
General Manager, Patents Div.

This form may be completed and filed after the filing of a patent
application but the form must not be signed until after it has been
completely filled in as indicated by the marginal notes. The
place and date of signing must be filled in. Company stamps or
seals should not be used.

No legalisation is necessary

(57) Claim

1.   A method for changing the operation mode of an
multi-operation mode electronic apparatus during a
period in which the operation mode is transferring from
a present operation mode to a final operation mode,
comprising the steps of:

      a)   receiving an input command signal;

      b)   judging whether said input command signal
is valid or not in view of the operation mode
corresponding to previously received, valid command
signals;

      c)   redetermining the final operation mode in
accordance with said valid input command signal;

      d)   determining a sequence of mode changes
from the present operation mode to the final
operation mode; and

      e)   executing said sequence of mode changes
until said present operation mode is equal to said
final operation mode.

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Form 10

COMPLETE SPECIFICATION

(ORIGINAL)

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Related Art:

TO BE COMPLETED BY APPLICANT

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Australia.

Complete Specification for the invention entitled:
MODE PROCESSING CIRCUIT

The following statement is a full description of this invention including the best method of performing it known to me:-

MODE PROCESSING CIRCUIT

BACKGROUND OF THE INVENTION .

Field of the Invention

The present invention relates to a mode processing
5   circuit for a multiple operation mode electronic
apparatus such as a video tape recorder, a tape deck, a
video disc player, a compact disc player and so on.

Description of the Prior Art

Various operation modes, such as a playback mode, a
10   rewind mode and the like are available in a known video
tape recorder (hereinafter simply referred to as a VTR).
To change these operation modes, it is necessary to
switch the VTR or to move its brake and pinch roller
into and out of engagement.

15   If a plunger is used to switch the mechanism, the
change of the operation mode can be made substantially
in a moment. The employment of the plunger, however,
causes a large current to flow upon its actuation.
Also, in the normal operation mode, a current must flow
20   continuously, requiring a large power supply circuit
which consumes a large amount of power.

It is therefore proposed to employ a motor instead
of the plunger. When a motor is used together with a
gear mechanism, although it is small in size, the
25   necessary driving power to switch the mechanism is
generated. Further, the employment of the motor can
reduce the power consumption and allow the power supply
circuit to be small in size. However, when a motor is
used to switch the mechanism, the transition (switching)
30   of its mode takes a lot of time. For example, it takes
about 2 seconds for the VTR to change from the stop mode
(STOP) to the playback mode (PB); it takes about 1.5
seconds for the VTR to change from the playback mode

(PB) to the stop mode (STOP); and it takes about 1.8
seconds for the VTR to change from the stop mode (STOP)
to the recording mode (REC).

Accordingly, when a user intends to press a second
operation key after a first operation key has been
depressed, the user must not press the second operation
key until the VTR finishes changing to the mode
commanded by the first key.

This is very inconvenient for the user, so it is
proposed to stack input commands issued by pressing the
operation keys.

Let it now be assumed that as, for example,
illustrated in Fig. 1, the VTR is placed in the stop
mode before time point t_1 and that a record'ng key is
pressed at time point t_1. Then, the mode of the VTR
(mechanism) begins to change from the stop mode to the
recording mode at time point t_1.

If a stop key, for example, is pressed at time
point t_2 during this transition period, this stop key is
valid for the recording mode which is the mode after the
mode is changed, so that the command instructing not the
recording mode but the stop mode after the mode
transition, is stacked in the mode stack.

When the mode transition of the VTR is ended at
time point t_3, the VTR is placed in the recording mode
(REC). At that time, the stop mode command stacked in
the mode stack at time point t_2 is read out and the
processing of this command is executed.

Accordingly, the VTR begins the transfer to the
stop mode at time point t_3 and is placed in tha stop
mode at time point t_4. Even though a pause key is
pressed at time point t_5 in the stop mode, the pause
mode (PAUSE) is useless for the stop mode. Hence, the
command issued by pressing the pause key is not
executed.

As described above, according to this mode stack
system, it becomes possible to remove the cumbersome
requirement that the user must not press the next
operation key until the mode transition of the VTR is
ended (even if the next key is pressed, this will be
neglected). However, the above mentioned mode stack
system has the following defect.

If the stop key is pressed at time point t_2 and the
pause key is then pressed at time point t_a as, for
example, shown in Fig. 2, since this pause key is valid
for the recording mode, which is the mode after the mode
transition (if the pause key is depressed in the
recording mode, the VTR is placed in the recording pause
mode (REC PAUSE)), and the mode stacked in the mode
stack is changed again from the stop mode to the
recording pause mode.

Accordingly, the mode of the VTR is moved to the
recording pause mode at time point t_3 and the VTR is
placed in the recording pause mode at time point t_4.

Although the stop key and the pause key are pressed
in the same sequential order as that of Fig.   the VTR
is placed in an operation mode different from that in
Fig. 1 in this case because of the timing of the
depression of the pause key vis-a-vis the actual mode
shifting of the VTR.

In other words, if a plurality of valid operation
keys are depressed during the mode transition period,
the mode stacked in the mode stack is renewed to the
mode suggested by the operation key that was last
pressed by the user and the modes commanded by the
previously-pressed operation keys are all neglected.
Accordingly, the operation mode of the VTR becomes
different depending on the timing at which the user
presses the operation keys (depending on whether the VTR

mode was in the process of being changed or was already
changed when the keys were pressed).

To overcome the above mentioned shortcomings, an
improved mode stack system is proposed, in which the
5   mode stack is arranged to have a plurality of stages to
sequentially stack the input modes and to execute the
modes sequentially.

This mode stack system having a plurality of
stages, however, must remove useless or invalid modes
10   stacked in the mode stack by optimizing the mode
stacked. This makes a program of a mode control
microcomputer complicated and takes a lot of time for
such removal. This defect becomes serious particularly
when 8-bit mode data is processed by a CPU (central
15   processing unit) which is capable of providing only a
4-bit comparing command. Further, an area for the mode
stack must be provided in a RAM.

OBJECTS AND SUMMARY OF THE INVENTION
Accordingly, it is a general object of this
20   invention to provide an improved mode processing circuit
for a multi-operation mode electronic apparatus, such as
a VTR.

According to the present invention there is provided a method for changing the operation mode of a multi-operation mode electronic apparatus during a period in which the operation mode is transferring from a present operation mode to a final operation mode, comprising the steps of:

a) receiving an input command signal;

b) judging whether said input command signal is valid or not in view of the operation mode corresponding to previously received, valid command signals;

c) redetermining the final operation mode in accordance with said valid input command signal;

d) determining a sequence of mode changes from the present operation mode to the final operation mode; and,

e) executing said sequence of mode changes until said present operation mode is equal to said final operation mode.

The features and advantages of the present invention will become apparent from the following detailed description of the preferred embodiments that are to be read in conjunction with the accompanying drawings, throughout which like reference numerals identify like elements and parts.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a mode transition diagram used to explain a known mode stack system for a video tape recorder;

Fig. 2 is another mode transition diagram used to explain the same known mode stack system for a video tape recorder;

Fig. 3 is a block diagram of an embodiment of a mode processing circuit according to the present_____

invention, illustrating hardware relating to the mode
transition operation of a video tape recorder;

Fig. 4 is a mode transition diagram used to explain
the present invention;

5   Fig. 5 is a flow chart used to explain the mode
transition operation in association with the mode
transition diagram of Fig. 4;

Fig. 6 is a table used to explain an algorithm of
the mode transition and the change of data stacked in a

10   mode stack;

Fig. 7 is a diagram used to explain the mode stack
of the invention;

Figs. 8, 9, 10 and 11 are respectively diagrams
used to explain the mode transition operation and the

15   mode stack of the invention;

Fig. 12 is a mode transition table used to explain
another embodiment of the mode processing circuit for a
multi-operation mode electronic apparatus according to
the present invention;

20   Fig. 13 is a transition vector table used to
explain the operation of the present invention;

Fig. 14 is a mode transition diagram used to
explain the operation of the present invention; and

Fig. 15 is a flow chart used to explain the

25   operation of the present invention.

        DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the present invention will hereinafter be
described in detail with reference to the drawings.

Fig. 3 illustrates hardware relating to the mode

30   transition operation of the VTR according to the present
invention.

Referring to Fig. 3, there is shown a mechanism
(VTR) control section 1 which includes a loading motor
11 for loading or unloading a tape on or from the VTR, a

control motor 12 for controlling the mode of the VTR and a servo circuit 13 for controlling a drum and a capstan of the VTR.

A mode controller 2 is formed of a microcomputer whose output is supplied to the control section 1 to place the VTR in each operation mode. At the same time, a signal indicative of the state (mode) of the VTR is supplied from the control section 1 to the mode controller 2.

Key input means 3 is provided with a plurality of operation keys (not shown). A receiving circuit 4 is adapted to receive a signal inputted by the operation key of a remote controller (not shown) when the VTR is operated by the remote controller. The key input signals from the key input means 3 and the receiving circuit 4 are both supplied to the mode controller 2. Mode indicating means 5 visually indicates to the user, e.g. by an LCD display, the mode in which the VTR is placed, on the basis of the output signal from the mode controller 2.

The mode stack is provided within a RAM (random access memory) of the microcomputer which forms the mode controller 2.

When the operation key of the key inputting means 3 or the operation key of the remote controller (not shown) is pressed, its command is processed by the mode controller 2 and the processed result or data is supplied to the control section 1, so that the control section 1 is operated so as to place the VTR in a predetermined operation mode. At the same time, the corresponding mode of the VTR is visually indicated by the mode indicating means 5. ·

Fig. 4 illustrates, by way of example, how the VTR mode and data stacked in the mode stack are changed with

the command inputted when the operation key is pressed at a certain time point.

In the description below, "present mode" and "final mode" are respectively defined as follows: the "present mode" indicates the mode of the VTR at that certain time point and also indicates, during the mode transition period of the VTR, the next mode to which the VTR is to be placed; and the "final mode" indicates the mode stored last in the mode controller 2 at that certain time point. The final mode becomes the same as the present mode when no mode data is stacked in the mode stack at all. Validity of the operation key pressed is judged depending upon whether the operation key pressed is valid for the final mode or not. The mode indicating means 5 visually indicates the final mode.

In the illustrated example of Fig. 4, since the VTR is placed in the stop mode before time point t_1, the present mode is the stop mode. At the same time, no mode is stacked in the mode stack and the final mode and the visual indication thereof are the stop mode.

When the recording key is pressed at time point t_1, this recording mode is valid for the final mode (stop mode), so that "REC" (recording mode) is stacked in the first stage of the mode stack. However, since the VTR has not yet started changing its operation mode, the VTR immediately starts changing its mode from the stop mode to the recording mode, and "REC" is indicated by the mode indicating means 5. Further, the "REC" mode command stacked in the mode stack is removed.

If the stop key is pressed at time point t_2 while the VTR is changing its mode, the stop mode is valid for the final mode (recording mode), so that "STOP" (stop mode) is stacked in the first stage of the mode stack and the final mode and the visual indication thereof are made the stop mode. However, the VTR itself is changing

its operation mode into the recording mode (present mode) which was designated by the key input at time point t_1.

When the pause key is pressed at time point t_3, while the VTR is in the mode transition period, the pause mode is invalid for the final mode (stop mode), so that this key input is neglected, leaving the mode stack, the final mode and the visual indication unchanged.

When the rewind key is pressed at time point t_4, while the VTR is in the mode transition period, the rewind mode is valid for the final mode (stop mode), so that "REW" (rewind mode) is stacked in the second stage of the mode stack and the final mode and the visual indication thereof are made the rewind mode. However, the VTR itself is still in the process of changing its operation mode into the recording mode (present mode) which was designated by the key input at time point t_1.

When the stop key is pressed at time point t_5 while the VTR is in the mode transition period, the stop mode is valid for the final mode (rewind mode), so that "STOP" (stop mode) is stacked in the third stage of the mode stack. At that time, since the same "STOP" (stop mode) is also stacked in the first stage of the mode stack, "STOP" and "REW" stacked respectively in the first and second stages of the mode stack are removed and "STOP" stacked in the third stage of the mode stack is transferred to the first stage of the mode stack. This processing is an example of what may be called "optimization". In that case, the final mode and the visual indication thereof are made stop mode.

When the playback key is pressed at time point t_6, while the VTR is in the mode transition period, the playback mode is valid for the final mode (stop mode), so that "PB" (playback mode) is stacked in the second

stage of the mode stack and the final mode and the
visual indication thereof are made the playback mode.

When the fast forward key is pressed continuously
from the time point t_7 while the VTR is in the mode
transition period, the fast forward mode is valid for
the final mode (playback mode). At the same time, upon
the playback mode, the fast forward key is pressed in
the cue mode, so that "CUE" (cue mode) is stacked in the
third stage of the mode stack and the final mode and the
visual indication thereof are made the cue mode.

At time point t_8, when the VTR finishes changing
its operation mode into the recording mode designated by
the key input at time point t_1, the mode stack is
checked. In this case, since "STOP" is stacked in the
first stage of the mode stack, this "STOP" is set to the
present mode and the VTR therefore starts changing its
operation mode to the stop mode at time point t_9 ($\stackrel{\sim}{=} t_8$).
When it is confirmed that the operation mode of the VTR
is to be changed to the stop mode, "PB" stacked in the
second stage of the mode stack is transferred to the
first stage thereof and "CUE" stacked in the third stage
of the mode stack is transferred to the second stage
thereof, making the third stage of the mode stack empty.

When the VTR has finished changing its operation
mode to the stop mode at time point t_{10}, the mode stack
is checked. In this case, since "PB" is stacked in the
first stage of the mod stack, this "PB" is set to the
present mode, so that the VTR starts changing its
operation mode to the playback mode at time point t_{11}
($\stackrel{\sim}{=} t_{10}$). After it is confirmed that the operation mode
of the VTR was changed to the playback mode, "CUE"
stacked in the second stage of the mode stack is
transferred to the first stage thereof, thus making the
second stage of the mode stack empty.

When the VTR has finished changing its mode to the playback mode at time point t_{12}, the mode stack is checked. Since "CUE" is stacked in the first stage of the mode stack, this "CUE" is set to the present mode, so that the VTR starts changing its operation mode into the cue mode at time point t_{13} ($\approx t_{12}$). After it is confirmed that the operation mode of the VTR was changed to the cue mode, the mode stack is made empty. In this way, the VTR is placed in the cue mode after time point t_{13}.

While the operation mode of the VTR and mode data stacked in the mode stack are charged as described above, this will be also explained with reference to a general algorithm which is represented in the form of a flow chart in Fig. 5.

This algorithm is exemplified in the flow chart (Fig. 5) of the program that the microcomputer forming the mode controller 2 (Fig. 3) executes.

The presence or absence of the command (key input) inputted by the operation key is checked, as represented at decisional step 21 in Fig. 5. If the command exists, the processing of the microcomputer (mode controller 2) goes from step 21 to decisional step 22. Then, it is checked, as represented at decisional step 22, whether or not the key input of which the presence was confirmed at step 21 is valid for the final mode. The validity of the key input relative to the final mode is checked on the basis of a mode transition look-up table which forms, for example, Fig. 6. Such a look-up table can be stored within a ROM (read only memory) which forms the mode controller 2 (Fig. 3). This mode transition look-up table of Fig. 6 reads as follows.

If the recording key ("REC") is pressed when the final mode is, for example, the playback ("PB") mode, it is judged that this recording key is invalid for the

final mode, however, if the pause key is pressed
instead, it is judged that this pause key is valid for
the final mode and the final mode is renewed to "PB
PAUSE" (playback pause mode).

5   If the key input is judged to be valid as
represented at decisional step 22, the processing of the
microcomputer goes from step 22 to step 23. As
represented at step 23, the final mode and the visual
indication thereof are renewed at time point t_4 shown,
10   for example, in Fig. 4 and in Fig. 7 (reference letters
A to E throughout Figs. 7 to 11 respectively designate
operation modes) in accordance with the mode transition
look-up table of Fig. 6. Then, the operation mode
renewed is stacked in the mode stack.

15   The processing of the microcomputer goes from step
23 to the next decisional step 31. It is checked, as
represented at decisional step 31, whether or not a mode
which is the same as the renewed final mode is stacked
in the mode stack. If not, the processing of the
20   microcomputer goes from step 31 to decis··· ·l step 33.

If on the other hand the same mo··   ·d in
the mc·· stack, as for example show·. ·· me · ··· t_5 in
Fig. 4 and as illustrated in Fig. 8, ·h· ··   ··· g of
the microcomputer goes fr·m step 31 to the ·ext step ·
25   As represented at step 32, the modes, beginning from the
mode (B mode in the second stage) which is the same as
the final mode renewed in the mode stack up to the mode
(D mode) just one stage before the final stage of the
mode stack, are removed as unnecessary modes and the
30   final mode renewed is shifted to the prior stage of the
mode stack. This processing forms a part of
"optimization".

Then, the processing of ·   goes from
step 32 (or step 31) to deci·   ·ra it is
35   checked whether or not a mode .   ·· changed

directly to the final mode is stacked in the mode stack,
thereby omitting unnecessary intermediate modes. If
not, the processing of the microcomputer goes from step
33 to decisional step 41. If on the other hand such a

5   mode is stacked in the mode stack, the processing of the
microcomputer goes from step 33 to step 34. At step 34,
as shown in Fig. 9, the modes between the mode (B mode),
which can be changed to the final mode, and the final
mode (E mode) are removed and the final mode (E mode) is

10   shifted to the stage of the mode stack subsequent to the
mode which can be changed to the final mode (B mode).
This processing also forms a part of "optimization".

The processing of the microcomputer goes from step
34 (or step 33) to the next decisional step 41. Also,

15   if the absence of a key input is determined, as
represented at decisional step 21, or if the key input
is invalid for the final mode, as represented at
decisional step 22, the processing of the microcomputer
goes directly from step 21 or 22 to the decisional step

20   41.

At decisional step 41 the microcomputer checks
whether the VTR is now changing its operation mode or
has finished its mode changing. If the VTR is changing
its operation mode, the processing of the microcomputer

25   goes from step 41 to the next decisional step 42 where
the microcomputer checks whether a mode which is the
same as the present mode exists in the mode stack or
not. If not, the processing of the microcomputer goes
from step 42 to decisional step 44. If the same mode

30   exists in the mode stack as represented at decisional
step 42, as shown, for example, in Fig. 10, the
processing of the microcomputer goes from step 42 to
step 43. As represented at step 43, the modes from the
mode (A mode) of the first stage to the mode (C mode)

35   which is the same as the mode which is under transition,

are removed and the next mode (D mode) is shifted
forward (to the first stage of the mode stack). This
processing also forms a part of "optimization".

Subsequently, the processing of the microcomputer
goes from step 43 (or step 42) to the next decisional
step 44 where it is checked whether or not there is a
mode in the mode stack to which the present mode of the
VTR in its transition period can be directly shifted, as
for example, shown in Fig. 11 (mode A can be shifted to
mode D). If not, the processing of the microcomputer
returns from step 44 to the decisional step 21. If such
a mode exists in the mode stack the processing goes from
step 44 to step 45.

At step 45 the modes from the mode in the first
stage to the mode (C mode) which is located just before
the transferrable mode are removed and the succeeding
mode (D mode) is shifted forward in the mode stack, so
that "optimization" is carried out. Then, the
processing of the microcomputer goes back to step 21.

If it is determined, as represented at decisional
step 41, that the VTR has already finished changing its
operation mode, the processing of the microcomputer goes
from step 41 to decisional step 51. It is then checked,
as represented at decisional step 51, whether or not any
mode command remains stacked in the mode stack. If no
mode is stacked in the mode stack, the processing of the
microcomputer goes back from step 51 to step 21. If, on
the other hand, one or more modes remain stacked in the
mode stack, the processing of the microcomputer goes
from step 51 to step 52 where the present mode of the
VTR begins to change into the mode of the first stage in
the mode stack. If it is confirmed that the change of
the operation mode of the VTR is started, the mode of
the first stage in the mode stack is removed and the
next mode is shifted forward. Subsequently, the

processing of the microcomputer goes back from step 52
to step 21.

Therefore, according to the above described
processing routine, the operation mode of the VTR is
5   changed as, for example, shown in Fig. 4.

Alternatively, the presence or absence of the key
input can be checked by executing the condition
determining command instead of using the mode transition
look-up table, as represented at decisional step 21.

10   Furthermore, the present invention is not limited
to a VTR (mechanism) but can similarly be applied to
various other kinds of multi-operation mode electronic
apparatus, such as, a tape deck, a video disc player or
a compact disc (CD) player and the like which require a
15   lot of time to change their operation modes.

Another embodiment of the mode processing circuit
according to the present invention will now be
described. This embodiment is similar to that shown in
Fig. 3 but in this embodiment, a mode transition look-up
20   table and a mode transition vector look-up table shown,
for example, in Figs. 12 and 13 are provided within a
ROM (read only memory) which forms the mode controller 2
(Fig. 3).

When the operation key of the inputting means 3 or
25   the operation key of the remote controller (not shown)
is pressed, the input data or command is similarly
supplied to the mode controller 2, in which it is
processed. The processed result or data therefrom is
then supplied to the control section 1, whereby the
30   control section 1 is so operated as to place, for
example, the VTR in the predetermined operation mode and
the operation mode in which the VTR is just placed is
visually indicated by the mode indicating means 5
similar to the first embodiment.

Fig. 14 illustrates an example in which the operation mode of the VTR is changed with the command inputted by the operation key using this second embodiment.

5   In the description below, "present mode" and "final mode" are respectively defined as follows: the "present mode" indicates the mode in which the VTR is now placed at a certain time point and also indicates the next operation mode of the VTR during the mode transition
10   period; and the "final mode" indicates the mode stored last in the mode controller 2 at that time point. The validity of the operation key pressed is determined depending upon whether the operation key pressed is valid for the final mode or not. The mode indicating
15   means 5 visually indicates the final mode.

The areas in which the present mode and the final mode are stored are formed within the RAM of the microcomputer forming the mode controller 2.

In this embodiment, since the VTR is placed in the
20   stop mode before time point t_1, the present mode at time point t_1 is the stop mode. Also, the final mode and the visual indication thereof are the stop mode.

When the reproducing key is pressed at time point t_1 in Fig. 14, the mode transition table in Fig. 12 is
25   looked up by the microcomputer. This mode transition look-up table in Fig. 12 indicates whether or not, when the operation key is depressed, the key input is valid for the final mode at that time point or if the key input is valid for the final mode, to which mode the
30   mode is to be transferred. Since the final mode is the stop mode at time point t_1 and the key input is the playback mode, it will be clear from the mode transition look-up table of Fig. 12 that the operation mode of the VTR should be "PB" (playback mode).

Accordingly, the final mode and the visual
indication thereof are made the playback mode from time
point t_1. Further, the VTR (mechanism) starts changing
its operation mode from the stop mode into the playback
5   mode and the present mode is made the playback mode.

When the stop key is pressed at time point t_2 while
the VTR is in the mode transition period as shown in
Fig. 14, the mode transition look-up table of Fig. 12 is
looked up. Since this mode transition look-up table of
10   Fig. 12 indicates that the mode should be shifted to the
stop mode, the final mode and the visual indication
thereof are made the stop mode. However, during this
period, the VTR itself continues changing its operation
mode to the playback mode (present mode) which was
15   designated by the key input at time point t_1.

Further, when the recording key is pressed at time
point t_3 during this mode transition period of the VTR,
the same mode transition table (Fig. 12) is looked up.
This mode transition look-up table of Fig. 12 indicates
20   that the mode should be shifted to the recording mode.
Thus, the final mode and the visual indication thereof
are made the recording mode. However, during this
period, the VTR itself continues changing its operation
mode into the playback mode which was designated by the
25   key input at time point t_1.

When at time point t_4 the operation mode of the VTR
has finally changed into the playback mode, the mode
transition vector table forming Fig. 13 is looked up.
This mode transition vector look-up table of Fig. 13
30   indicates whether or not at that time the VTR should
further change its operation mode and the mode into
which the VTR should change its operation mode. At that
time (at time point t_4 in Fig. 14), since the present
mode is the playback mode and the final mode is the
35   recording mode, the mode transition vector look-up table

of Fig. 13 indicates that the mode of the VTR should be "PB PAUSE" (playback pause mode). Accordingly, the VTR starts changing its operation mode to the playback pause mode from time point t_4 and the present mode is changed into the playback pause mode, too.

When the mode transition to the playback pause mode is ended at time point t_5, the same mode transition vector table of Fig. 13 is looked up. At time point t_5 in Fig. 14, since the present mode is "PB pause" (playback pause mode) and the final mode is "REC" (recording mode), it will be clear from the mode transition vector look-up table of Fig. 13 that the mode should be "REC PAUSE" (recording pause mode) next. Accordingly, the VTR starts changing its operation mode into the recording pause mode at time point t_5 and the present mode is made the recording pause mode, too.

When the mode transition of the VTR to the recording pause mode is ended at time point t_6 in Fig. 14, the mode transition vector table of Fig. 13 is looked up again. At time point t_6 in Fig. 14, since the present mode is the recording pause mode and the final mode is the recording mode, the mode transition vector look-up table of Fig. 13 indicates that the next mode should be the recording mode. Accordingly, the VTR starts changing its operation mode into the recording mode at time point t_6, and the present mode is made the recording mode, too.

When the mode transition to the recording mode is ended at time point t_7, the mode transition vector table of Fig. 13 is looked up. At time point t_7 in Fig. 14, since the present mode and the final mode are both the recording mode and equal to each other, the operation mode of the VTR is not changed any more. Accordingly, the VTR remains placed in the recording mode after time point t_7.

While the operation mode of the VTR is changed as described above, this mode changing operation of the VTR will be similarly explained by a general algorithm which is represented in a flow chart forming Fig. 15.

In other words, this algorithm forms the flow chart (Fig. 15) of a program that the microcomputer forming the mode controller 2 (Fig. 3) executes.

Firstly, the presence or absence of a command inputted by pressing an operation key is checked as represented at decisional step 121. If the presence of the command is confirmed at step 121, the processing of the microcomputer (mode controller 2) goes from step 121 to the next decisional step 122. It is checked as represented at decisional step 122 by the mode transition look-up table of Fig. 12 whether or not the key input (command) whose existence was checked at step 121 is valid for the final mode.

If it is judged as represented at decisional step 122 that the key input is valid for the final mode, the processing of the microcomputer goes from step 122 to step 123, in which the final mode and the mode visual indication thereof are renewed in accordance with the mode transition look-up table of Fig. 12, as represented at time point t_1 in Fig. 14. Then, the processing of the microcomputer goes from step 123 to the next decisional step 131.

Also, if the absence of the key input is confirmed as represented at decisional step 121 or it is judged as represented at decisional step 122 that the key input is invalid for the final mode, the processing of the microcomputer goes directly from steps 121 and 122 to the next decisional step 131.

It is checked, as represented at decisional step 131, whether the mode of the VTR is still shifting or it has already finished. If the mode of the VTR is

shifting, the processing of the microcomputer goes back from step 131 to step 121.

Accordingly, the steps 121 to 123 and the step 131 are repeatedly executed during the period from the time point t_1 to the time point t_4.

If on the other hand it is judged, as represented at decisional step 131, that the mode transition of the VTR is already ended, the processing of the microcomputer goes from step 131 to the next decisional step 132. There, it is checked whether or not the present mode is equal to the final mode. If they are not equal to each other, the processing of the microcomputer goes from step 132 to step 133. As represented at step 133, the operation mode to which the mode of the VTR should be newly shifted is determined with reference to the mode transition vector look-up table of Fig. 13, whereby the present mode is renewed to the new operation mode determined.

Then, the processing of the microcomputer goes from step 133 to step 134. The VTR starts changing its operation mode to the present mode, which was renewed as represented at step 133, as represented at step 134, and the processing of the microcomputer goes back from step 134 to step 121.

Consequently, the steps 131 to 134 are executed at time points t_4, t_5 and t_6 in the mode transition diagram forming Fig. 14, respectively.

If it is judged, as represented at decisional step 132, that the present mode and the final mode are equal to each other, the processing of the microcomputer goes back from step 132 to step 121.

Accordingly, this processing of the microcomputer is executed at time point t_7.

According to the processing routine in Fig. 15 as described above, the operation mode of the VTR is

changed as, for example, shown in the mode transition
diagram of Fig. 14.

It will be appreciated that the presence or absence
of the command inputted by the operation key can be
5   checked by using a condition judging command instead of
using the above mentioned mode transition look-up table,
as represented at decisional step 122 in Fig. 15.

The present invention is not limited to a VTR as
mentioned above but can be applied to various kinds of
10   multi-operation mode electronic apparatus such as a tape
deck, a video disc player, a CD (compact disc) player
and the like which take a lot of time to change their
operation modes.

According to the present invention, since the
15   transition mode to which the mode of the multi-operation
mode electronic apparatus should be transferred is
stacked in the mode stack and is optimized, the
operation mode of the multi-operation mode electronic
apparatus can be changed to the desired operation mode
20   in the shortest period of time at the time point at
which the operation key is pressed.

If the key input is valid, the reception of the key
input and the visual indication of the operation mode
can be immediately executed and the transition of the
25   operation mode of the multi-operation mode electronic
apparatus can be carried out in the shortest period of
time, so that the user never feels that the multi-
operation mode electronic apparatus is taking a great
deal of time to change its operation mode and thus, the
30   apparent time required by such a mode transition can be
removed. Further, the operation mode can be changed to
the same final operation mode by pressing the operation
key at any timing.

Furthermore, according to the present invention, as
35   set forth above, even if any number of operation keys

are pressed, since the operation mode to which the mode
of the multi-operation mode electronic apparatus should
be shifted can be made optimum in accordance with the
mode transition vector look-up table, the operation mode
5   can be changed to the desired mode in the minimum number
of mode transitions at the time point at which the
operation key is pressed.

In addition, since the optimization is not
required, the processing program to be executed by the
10   mode controller 2 can be simplified and the execution of
the program does not take a lot of time. Also, the mode
stack area becomes unnecessary.

The above description is given for the preferred
embodiments of the invention but it will be apparent
15   that many modifications and variations could be effected
by one skilled in the art without departing from the
spirit or scope of the novel concepts of the invention,
so that the scope of the invention should be determined
by the appended claims only.

THE CLAIMS DEFININING THE INVENTION ARE AS FOLLOWS:

1.   A method for changing the operation mode of an
multi-operation mode electronic apparatus during a
period in which the operation mode is transferring from
a present operation mode to a final operation mode,
comprising the steps of:

       a)   receiving an input command signal;

       b)   judging whether said input command signal
is valid or not in view of the operation mode
corresponding to previously received, valid command
signals;

       c)   redetermining the final operation mode in
accordance with said valid input command signal;

       d)   determining a sequence of mode changes
from the present operation mode to the final
operation mode; and

       e)   executing said sequence of mode changes
until said present operation mode is equal to said
final operation mode.

2.   A method according to claim 1 wherein said
step of receiving comprises storing in an electronic
memory device a plurality of said input command signals
and said step of determining comprises the step of
optimizing said input command signals according to
predetermined criteria.

3.   A method according to claim 1 wherein said
steps of determining and executing are performed by
electronically accessing a transition vector look-up
table stored in an electronic memory device.

4.   A method for changing the operation mode of an
multi-operation mode electronic apparatus as recited in

claim 1 wherein the step of judging the validity of the input
command signal comprises determining that the following input
commands are invalid with respect to the following
corresponding final modes:

5

FINAL MODE	INPUT COMMAND
STOP	STOP
FAST FWD.	FAST FWD., PAUSE, REC.
REW.	REW., PAUSE, REC.
PLAYBACK	FAST FWD., REW., PB, REC.
PB PAUSE	FAST FWD., REW.
RECORD	FAST FWD., REW., PB, REC.
REC. PAUSE	FAST FWD., REW., PB, REC.

10

5.   A method for changing the operation mode of a multi-
operation mode electronic apparatus substantially as herein
described with reference to and as illustrated in Figures 3 to
15 of the accompanying drawings.

15

Dated this 3rd day of January, 1991.

SONY CORPORATION
By its Patent Attorneys:

GRIFFITH HACK & CO.
Fellows Institute of Patent
Attorneys of Australia

20

FIG. 1

TIME POINT	KEY INPUT	MODE	MODE STACK
		STOP	
t_1	REC		(VACANT)
t_2	STOP		
			STOP MODE
t_3			
		REC	
			(VACANT)
t_4			
t_5	PAUSE	STOP	

TIME →

FIG. 2

TIME POINT	KEY INPUT	MODE	MODE STACK
		STOP	
t₁	REC		(VACANT)
t₂	STOP		STOP MODE
tₐ	PAUSE		REC PAUSE MODE
t₃		REC	
t₄			(VACANT)
		REC PAUSE	
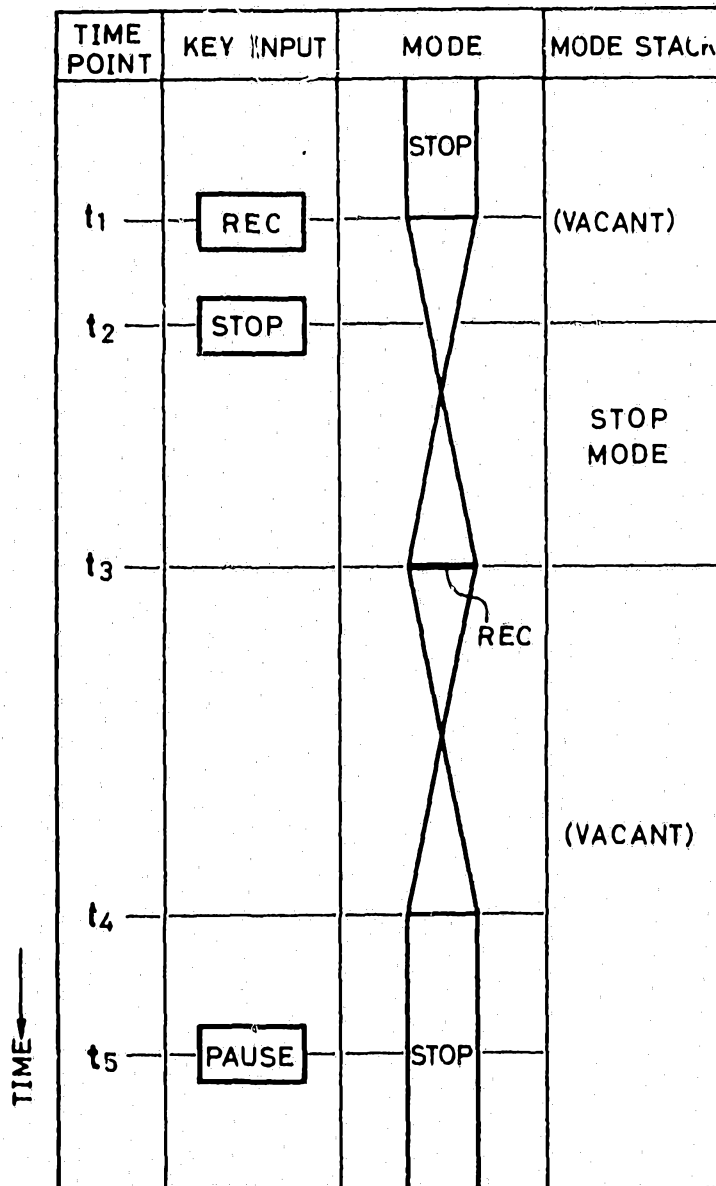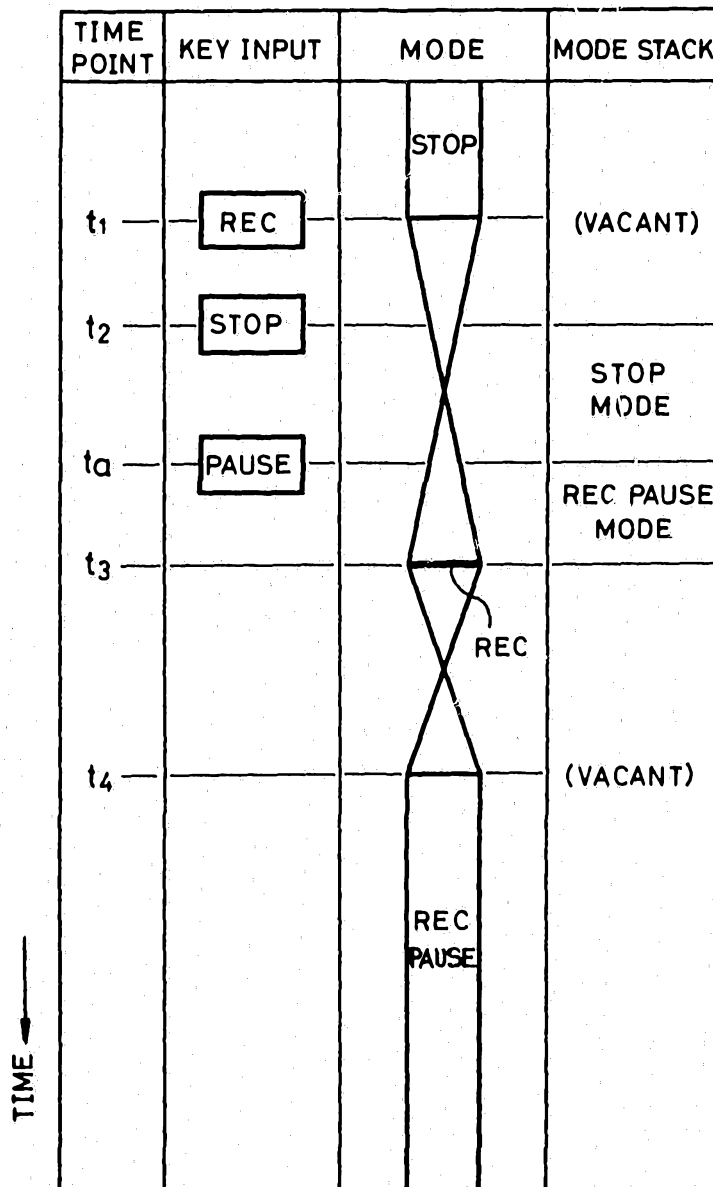
TIME ⟶

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FIG. 3
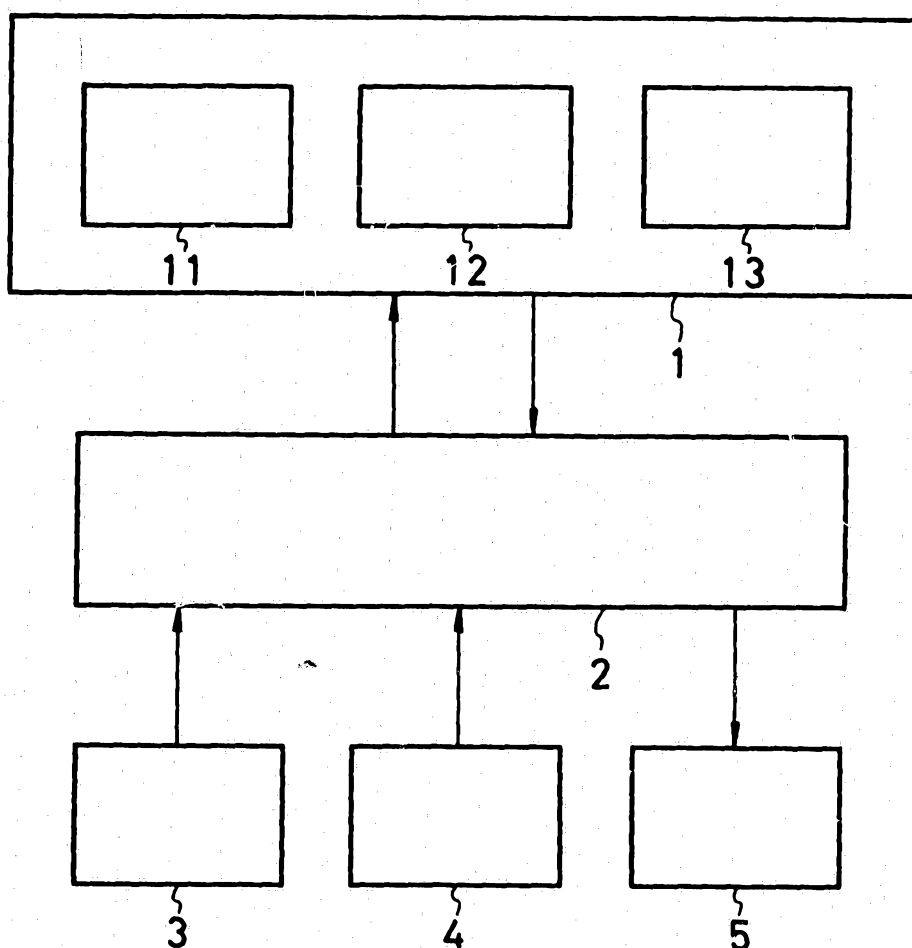
FIG. 4

TIME POINT	KEY INPUT	PRESENT MODE	MODE STACK 1ST STAGE	2ND STAGE	3RD STAGE	4TH STAGE	FINAL MODE & INDICATION
		STOP	VACANT	VACANT	VACANT	VACANT	STOP
t1	REC		REC				REC
		STOP	REC →				
		REC					REC
t2	STOP						
		REC	STOP				STOP
t3	PAUSE						
		REC	STOP				STOP
t4	REW						
		REC	STOP	REW			REW
t5	STOP						
		REC	STOP	REW	STOP		STOP
		REC	STOP				STOP
t6	PB						
		REC	STOP	PB			PB
t7	FF						
		REC	STOP	PB	CUE		CUE
t8							
t9			STOP	PB	CUE		CUE
t10							
t11			PB	CUE			CUE
t12							
t13			CUE				CUE
	FF						

TIME →

FIG. 5

Start

NO — Key input received ? — YES — 21

NO — Key input valid? — YES — 22

Renew final mode — 23

NO — The same mode ? — YES — 31

Optimize — 32

NO — Mode transition allowed ? — YES — 33

Optimize — 34

Mode transition ended? — YES — NO — 41

NO — The same mode ? — YES — 42

Optimize — 43

NO — Mode transition allowed ? — YES — 44

Optimize — 45

NO — Mode stacked? — YES — 51

Start mode transition — 52

FIG. 6

KEY INPUT / FINAL MODE	STOP	PB	REC	PAUSE
STOP	(INVALID)	PB	REC	(INVALID)
PB	STOP	(INVALID)	(INVALID)	PB PAUSE
PB PAUSE	STOP	PB	(INVALID)	PB
REC	STOP	(INVALID)	(INVALID)	REC PAUSE
REC PAUSE	STOP	(INVALID)	(INVALID)	REC

FIG. 7

FIG. 8

	MODE STACK				FINAL MODE
1ST STAGE	2	3	4	5	
A	B	C	D	B	B
↓					↓
A	B				B

FIG. 9

	MODE STACK				FINAL MODE
1ST STAGE	2	3	4	5	
A	B	C	D	E	E
↓	↓				↓
A	B	E			E

FIG. 10

PRESENT MODE

MODE STACK

1ST STAGE	2	3	4	5
A	B	C	D	

D				

FIG. 11

PRESENT MODE

MODE STACK

1ST STAGE	2	3	4	5
B	C	D	E	

D	E			

FIG. 12
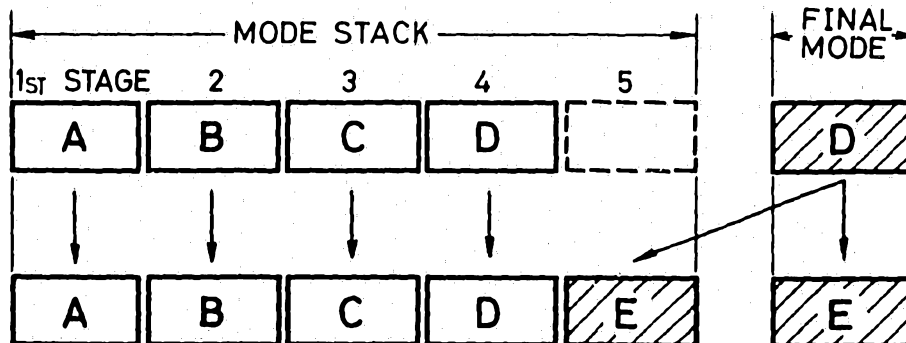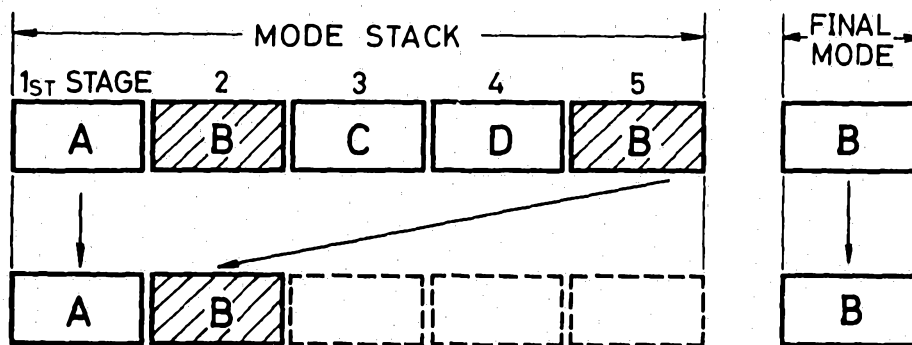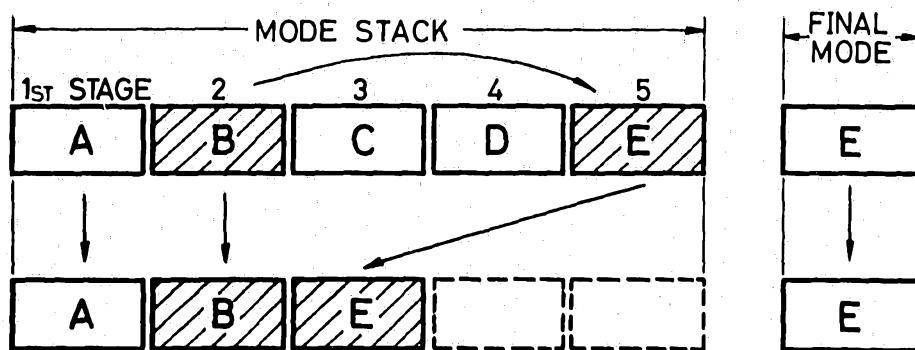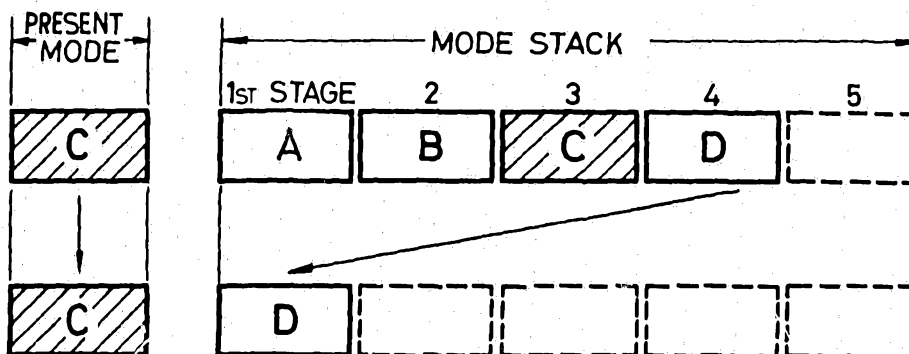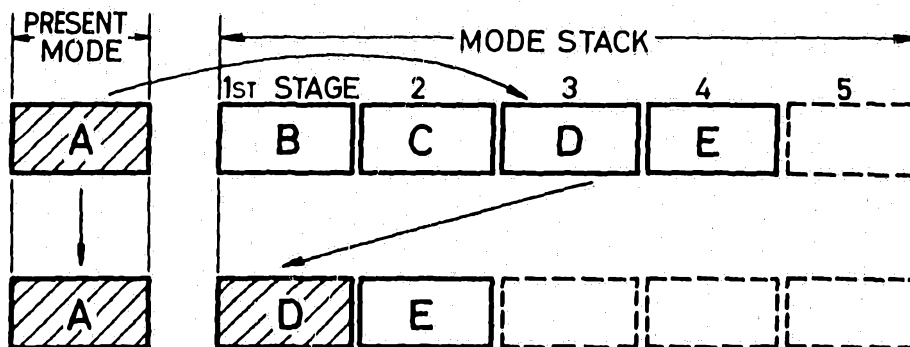
KEY INPUT / FINAL MODE	STOP	FF	REW	PB	PAUSE	REC
STOP	(INVALID)	FF	REW	PB	(INVALID)	REC
FF	STOP	(INVALID)	REW	PB	(INVALID)	(INVALID)
REW	STOP	FF	(INVALID)	PB	(INVALID)	(INVALID)
PB	STOP	(INVALID)	(INVALID)	(INVALID)	PB PAUSE	(INVALID)
PB PAUSE	STOP	(INVALID)	(INVALID)	PB	PB	REC PAUSE
REC	STOP	(INVALID)	(INVALID)	(INVALID)	REC PAUSE	(INVALID)
REC PAUSE	STOP	(INVALID)	(INVALID)	(INVALID)	REC	(INVALID)

FIG. 13

PRESENT MODE / FINAL MODE	STOP	FF	REW	PB	PB PAUSE	REC	REC PAUSE
STOP	——	STOP → FF	STOP → REW	STOP → PB	STOP → PB	STOP → REC	STOP → REC
FF	FF → STOP	——	FF → REW	FF → PB	FF → PB	FF → STOP	FF → STOP
REW	REW → STOP	REW → FF	——	REW → PB	REW → PB	REW → STOP	REW → STOP
PB	PB → STOP	PB → FF	PB → STOP	——	PB → PB PAUSE	PB → PB PAUSE	PB → PB PAUSE
PB PAUSE	PB PAUSE → STOP	PB PAUSE → STOP	PB PAUSE → STOP	PB PAUSE → PB	——	PB PAUSE → REC PAUSE	PB PAUSE → REC PAUSE
REC	REC → STOP	REC → STOP	REC → STOP	REC → STOP	REC → STOP	——	REC → REC PAUSE
REC PAUSE	REC PAUSE → STOP	REC PAUSE → STOP	REC PAUSE → STOP	REC PAUSE → STOP	REC PAUSE → STOP	REC PAUSE → REC	——

FIG. 14

TIME POINT	KEY INPUT	MODE TRANSITION	PRESENT MODE	FINAL MODE & INDICATION
			STOP	STOP
t₁	P B	STOP ⟶ PB	PB	PB
t₂	STOP	STOP ⟶ PB	PB	STOP
t₃	REC	STOP ⟶ PB	PB	REC
t₄		(TRANSITION ENDED) PB ⟶ PB PAUSE	PB PAUSE	REC
t₅		(TRANSITION ENDED) PB PAUSE ⟶ REC PAUSE	REC PAUSE	REC
t₆		(TRANSITION ENDED) REC PAUSE ⟶ REC	REC	REC
t₇		(TRANSITION ENDED)	REC	REC

FIG. 15

```
        ( Start )
            |
            v
     /  Key input  \      NO
    <   received?   >------->
     \             /
          YES    121
            |
            v
     /  Key input  \      NO
    <    valid?     >------->
     \             /
          YES    122
            |
     +---------------+
     |  Renew final  |
     |     mode      | ~123
     +---------------+
            |
            v
     /    Mode      \      NO
    <  transition    >------->
     \   ended?     /
          YES    131
            |
            v
     /   Present    \     YES
    < mode and final >------->
     \  mode equal? /
          NO     132
            |
     +---------------+
     |  See transition|
     | vector  table  | ~133
     +---------------+
            |
     +---------------+
     |  Start mode   |
     |  transition   | ~134
     +---------------+
```