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(54) CONTROL CIRCUIT FOR OPTICAL PROJECTION SYSTEMS

(71) We, EASTMAN KODAK COMPANY, a Company organised under the Laws of the State of New Jersey, United States of America of 343 State Street, Rochester, New York 14650, United States of America 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 circuit for change-over projection with both forward and reverse magazine travel between two optical slide projection systems.

In change-over systems for projectors there are two basic approaches for change-over depending upon construction of the apparatus. A first construction comprises a special change-over projector combining in one housing, among other components, two projector lamps, two projection lenses, two magazines, and means for directing the images at a common screen. The other type utilizes two projectors of conventional construction, which are directed at a common screen and whose projector lamps and slide change mechanism are alternatively operated with the magazine transport by means of a control device which in most cases is provided as a remote control device.

In accordance with the present invention there is provided a control circuit for alternately changing operation between two optical slide projection systems, each including forward and reverse magazine transport devices, slide changing means, and means for turning the projection lamp on or off, said control circuit comprising a first circuit operable with forward magazine operations for effecting change-over between the lamps and then magazine transport in the projector whose lamp has been turned off and a second circuit operable with reverse magazine operation for effecting change-over between the lamps after magazine transport in the projector whose lamp is off.

The control circuit may include a bistable

circuit actuable by a forward transport actuator for providing a first signal which initiates the change-over cycle. The control circuit provides second and third signal to AND-gate circuits for providing a signal for initiating the forward magazine transport upon simultaneous occurrence of the second and third signals. Second AND-gate circuits are provided with simultaneous signals from the bistable circuit and from actuation of the reverse transport actuator for providing an output signal to the reverse magazine transport. The output signal from the second AND-gate circuit is fed back to the input of the bistable circuit and is interrupted at the end of reverse magazine travel. The interruption effects the change-over cycle at the end of reverse magazine transport.

In the detailed description of the preferred embodiment of the invention presented herein, reference is made to the accompanying drawing which shows circuitry in logic diagram form for providing change-over projection between two projectors with both forward and reverse projector magazine travel.

Slide projector systems are well known in the art, therefore, only the circuit diagram in which those components of the controlled circuit which are necessary to give an understanding of the operation of the present invention are shown and described.

The construction of the change-over arrangement according to the present invention is described with reference to one illustrative embodiment comprising two projectors which are shown in block form and numerically designated as 1 and 2. The projectors include projection lamps 11 and 21 respectively, magazine transports 12 and 22 respectively for forward magazine transport, magazine transports 13 and 23 respectively for reverse magazine transport. Magazine transport will be utilized herein to include the transport of a slide to a film gate, the placing of the slide in position for viewing, and the removal of the slide in preparation to

transport another slide to be placed in the film gate.

A control circuit 3 according to one specific embodiment of the invention is provided, which may be housed in a separate unit and connected to each of the projectors 1 and 2 by a multi-core cable. The control circuit 3 comprises a forward transport button 4, a reverse transport button 5, and the logic circuit elements as described below which serve to affect a change-over between the on-off condition between the two projection lamps 11 and 21, which will be referred to as the change-over cycle between the projectors, as well as forward or reverse magazine transport. The description of the operation of the control circuit 3 will be presented in terms of computer logic. In such presentation the logic elements of the control circuit 3 are said to have inputs and outputs of a logical '1' (one or '0' (zero) state. The logical '0' often refers to a state very close to ground and conversely the logical '1' represents a state at some potential significantly higher than ground. However, this arrangement is purely arbitrary.

The logic network which makes up the control circuit 3 includes a bistable circuit 31 which may be conventional form having a toggled input 2 and output Q and $\bar{Q}$. The vinculum or bar over Q appears as an indication that the logic level at that symbol is the opposite, or the complement of the logic where the symbol is unaccompanied by the vinculum. The control circuit 3 includes a second bistable circuit 33 having inputs designated as S (set) and C (clear), are received by way of the closure of the forward or reverse transport buttons 4 or 5, resistors 41 and 51 providing defined input levels to the bistable circuit 33, when transport actuators 4 and 5 are in the 'open' condition. The bistable circuit 33 also has

outputs Q and $\bar{Q}$, however, the $\bar{Q}$ is not used. A change-over circuit 32 receives the

outputs Q and $\bar{Q}$ from the bistable circuit 31 at its inputs S and C, and provides out-

puts Q and $\bar{Q}$ and F. The output Q of the bistable circuit 33 and the output F of the changeover circuit 32 provide inputs to an AND-gate 45. The output of AND-gate 45 provides one of the inputs to AND-gates 43 and 44 while the other inputs to the AND-gates 43 and 44 are provided from the out-

puts Q and $\bar{Q}$ of the bistable circuit 31. The logic elements thus described furnish the change-over apparatus with sufficient signals such that upon closure of the forward transport button 4 the projectors 1 and 2 are

alternately operated with forward magazine transport. 60

The logic elements of the control 3 which provide for reverse magazine transport between the projectors 1 and 2 include the bistable circuit 31 and a second pair of AND-gates numerically designated as 53 and 54. The AND-gates 53 and 54 each receive

one of their inputs from the Q and $\bar{Q}$ outputs of the bistable circuit 31 and their other input from a potential source, +V, by way of the closure of the reverse transport button 5. The outputs of the AND-gates 53 and 54 are coupled respectively to the inputs of the magazine transport 13 and 23 for reverse movement and also have their outputs coupled through switches S_1 and S_2 to the toggled input T of the bistable circuit 31 through feed back diodes 55 and 56 respectively. 70

The input to the bistable circuit 31 which initiates forward magazine transport occurs upon closure of the forward transport button 4 by means of a pulse generator 42 such as may be well known in the art which provides a pulse having finite rise time, width amplitude. 75

The projection lamps 11 and 21 are alternately turned off and on in conjunction with the operation of the control circuit 3. The duration of the on-off or darkening-lighting phase may be adjusted by a variable resistor 34 connected in the change-over circuit 32. 80

As will be described more fully later, when the lamp of one projector is being turned on for projection, the magazine transport of the other projector is being operated for placing a slide in readiness for change-over. Therefore, when the projectors are set for forward magazine travel, it must be ensured that slide transport by either magazine transport 12 or 22 does not take place before the projection lamp of the respective projector is completely darkened so that slide replacement will not become visible on the viewing screen (not shown). In order to ensure that this condition is fulfilled, the output F of the change-over circuit 32 occurs after the end of the change-over cycle i.e., it is delayed from the occurrence of the negative going trailing edge of the pulse generated by pulse circuit 42. To avoid the opposite problem when the projectors are set for reverse travel, reverse travel should start with the projector whose lamp is dark so that slide transport may be completed before the lamp is turned on. In order to ensure that this condition is fulfilled, reverse magazine travel occurs upon energization of one of the AND-gates 53 or 54, and at the end of the reverse magazine movement a switch either S_1 or S_2 , depending upon which projector is to be operated is opened whereby the feed-

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back path through the diode 55 or 56 is interrupted. The interruption of the feed back path to the toggled input T of the bistable circuit 31 produces a change in state of the bistable circuit 31 thereby changing the state of the change-over circuit 32 and consequently the light of the previously darkened projector lamp is turned on.

The operation of the slide change-over control system will be described hereinafter

in its two modes of operation i.e. forward and reverse magazine travel.

For purposes of description of the operation of the apparatus assume first that a slide from the projector 1 is being projected i.e., that the projector lamp 11 is on and that the projector lamp 21 is off (dark). In this condition the logic states of the outputs of the elements of the logic network of the control circuit 3 are as follows:

Bistable circuit 31	Change-over circuit 32	Bistable circuit 33	AND-gates
$Q \bar{Q}$	$Q \bar{Q} F$	$Q \bar{Q}$	43 44 53 54
0 1	0 1 1	1 0	0 1 0 0

It may also be seen from the logic outputs above that the AND-gate 44 is conductive and the output thereof has driven the magazine transport 22 for forward movement to its stop and a slide has been placed in the film gate (not shown). If the operator now wishes to change-over to the projector 2, the forward transport button 4 is closed, causing the pulse generator 42 to generate a rectangular pulse which is applied to the S input of the bistable circuit 33 and to the T input of the bistable circuit 31. At the end of the rectangular pulse, i.e. when the trailing edge of the rectangular pulse, has passed, the bistable circuit 31 changes state such that a '1' appears at the Q output and a '0' appears

at the $\bar{Q}$ output. The Q ('1') and $\bar{Q}$ ('0') outputs of the bistable circuit 31 are input to the S and C inputs of the change-over circuit 32 which accordingly changes the state of the output of the change-over circuit 32 such that the Q output becomes '1' and

the $\bar{Q}$ becomes '0'. Consequently the projection lamp 21 is turned on and the projection lamp 11 is turned off. The magazine transport 22 for forward movement having been previously moved to its project position has placed a slide (not shown) in a position to be projected by projection lamp 21 when it comes on. The output of the bistable circuit 33 being in a '1' state continues to stay in the '1' state upon the passing the rectangular pulse and the F output of the change-over circuit 32 which is produced after the appropriate delay, accordingly energizes the AND-gate 45 providing a '1' state at its output and at the input of the AND-gates 43 and 44. The Q output of the bistable circuit 31 being in a '1' state provides a second '1' state input to the AND-gate 43 and consequently a '1' state appears at the output of the AND-gate 43. Thus the magazine transport 12 for forward movement is energized and consequently the magazine

transport 12 moves to its project position in readiness for the subsequent change-over.

For purposes of explanation during reverse magazine travel it will be assumed that a slide in projector 2 is being projected and that the projector lamp 21 is accordingly lit while the projector lamp 11 is dark. In this phase of operation the state of the system is as last described above. If the operator now desires to repeat the projection of the preceding slide in projector 1, he depresses the reverse transport button 5 which causes, on the one hand, a '1' signal to appear at the C input of the bistable circuit 33 and a '0' signal at the output Q as the bistable circuit 33 changes state. At the same time a '1' signal appears at one of the inputs of the AND-gates 53 and 54. The other input to the AND-gates 53 and 54 is received from the outputs Q

and $\bar{Q}$ of the bistable circuit 31 which renders the AND-gate 53 conductive. Accordingly the magazine transport 13 for reverse movement is energized and moves the magazine to its project position. The '1' output from the AND-gate 53 is fed back to the toggled input T of the bistable circuit 31 via the diode 55. To avoid giving a '1' signal at the S input of the bistable circuit 33 and opening AND-gate 45 at an incorrect time, diode 57 is provided. When the magazine transport 13 for reverse movement reaches the end of its travel the switch S_2 is actuated to open the line between the AND-gate 53 and the toggled input T whereby the feed back input is terminated. Therefore, the bistable circuit 31 changes its operative state to provide a '0' output at Q and a '1' output

at $\bar{Q}$. The change in state of the bistable circuit 31 produces a change in state of the change-over circuit 32 whereby the Q output becomes '0' and the $\bar{Q}$ output becomes '1'. The lamp 11 is accordingly lit and the lamp 21 is turned off. The output F of the change-

over circuit 32 is provided to the AND-gate 45 after the aforementioned delay. However, the other input to the AND-gate 45, the Q output of the bistable circuit 33, is now at a '0' state and the AND-gate 45 is turned off. The AND-gates 43 and 44 which provide signals for the magazine transports 12 and 22 for forward movement are therefore de-energized.

10 The control circuit described hereinabove is particularly adapted for use in a change-over arrangement including two projectors and a remote control unit. However, the inventive idea can without difficulty also be realized in a special change-over projector.

WHAT WE CLAIM IS:—

1. A control circuit for alternately changing operation between two optical slide projection systems, each including forward and reverse magazine transport devices, slide changing means, and means for turning the projection lamp on or off, said control circuit comprising a first circuit operable with forward magazine operation of effecting change-over between the lamps and then magazine transport in the projector whose lamp has been turned off, and a second circuit operable with reverse magazine operation for effecting change-over between the lamps after magazine transport in the projector whose lamp is off.

2. A control circuit according to Claim 1, wherein the first circuit comprises a first AND-gate circuit which receives a first input signal from the output of a first bistable circuit rendered conductive by operation of a forward control actuator and a second input signal from the output of a lamp change-over circuit, the second input signal being produced by the change-over circuit after the change-over cycle has been completed.

3. A control circuit according to Claim 2 wherein the second circuit is rendered operative upon actuation of a reverse control actuator, wherein the change-over circuit is supplied through a second bistable circuit with a signal for change-over operation after completion of the reverse magazine trans-

port, and wherein the first input signal of the first AND-gate circuit is cut off by the output of the first bistable circuit, the output having been put into the non-conductive state by the reverse control actuator.

4. A control circuit according to Claim 3, wherein the alternate selection of the lamps is effected by the second bistable circuit energizing the change-over circuit and wherein four further AND-gate circuits provide outputs for triggering magazine transport devices within the optical slide projection systems.

5. A control circuit according to Claim 4, wherein the forward triggering outputs are provided by two of said four further AND-gate circuits each having a first input connected with one or other of the outputs of the second bistable circuit and their second inputs both being connected with the output of the first AND-gate circuit.

6. A control circuit according to Claim 5, wherein the reverse triggering outputs are provided by the other two of said four further AND-gate circuits each having a first input connected with one or other of the outputs of the second bistable circuit and their second inputs both being connected to the reverse control actuator.

7. A control circuit according to Claim 6, wherein the reverse triggering outputs are fed back through diodes to the input of the second bistable circuit and including means for interrupting the diode inputs.

8. A control circuit according to Claim 7 wherein the means for interrupting the diode inputs comprises switch means actuable by the reverse magazine transport.

9. A control circuit according to Claim 1, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

10. A control circuit according to any one of the preceding claims in combination with a pair of optical slide projection systems.

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- over circuit 32 is provided to the AND-gate 45 after the aforementioned delay. However, the other input to the AND-gate 45, the Q output of the bistable circuit 33, is now at a '0' state and the AND-gate 45 is turned off. The AND-gates 43 and 44 which provide signals for the magazine transports 12 and 22 for forward movement are therefore de-energized.
- 10 The control circuit described hereinabove is particularly adapted for use in a change-over arrangement including two projectors and a remote control unit. However, the inventive idea can without difficulty also be realized in a special change-over projector.

WHAT WE CLAIM IS:—

1. A control circuit for alternately changing operation between two optical slide projection systems, each including forward and reverse magazine transport devices, slide changing means, and means for turning the projection lamp on or off, said control circuit comprising a first circuit operable with forward magazine operation of effecting change-over between the lamps and then magazine transport in the projector whose lamp has been turned off, and a second circuit operable with reverse magazine operation for effecting change-over between the lamps after magazine transport in the projector whose lamp is off.
2. A control circuit according to Claim 1, wherein the first circuit comprises a first AND-gate circuit which receives a first input signal from the output of a first bistable circuit rendered conductive by operation of a forward control actuator and a second input signal from the output of a lamp change-over circuit, the second input signal being produced by the change-over circuit after the change-over cycle has been completed.
3. A control circuit according to Claim 2 wherein the second circuit is rendered operative upon actuation of a reverse control actuator, wherein the change-over circuit is supplied through a second bistable circuit with a signal for change-over operation after completion of the reverse magazine transport, and wherein the first input signal of the first AND-gate circuit is cut off by the output of the first bistable circuit, the output having been put into the non-conductive state by the reverse control actuator.
4. A control circuit according to Claim 3, wherein the alternate selection of the lamps is effected by the second bistable circuit energizing the change-over circuit and wherein four further AND-gate circuits provide outputs for triggering magazine transport devices within the optical slide projection systems.
5. A control circuit according to Claim 4, wherein the forward triggering outputs are provided by two of said four further AND-gate circuits each having a first input connected with one or other of the outputs of the second bistable circuit and their second inputs both being connected with the output of the first AND-gate circuit.
6. A control circuit according to Claim 5, wherein the reverse triggering outputs are provided by the other two of said four further AND-gate circuits each having a first input connected with one or other of the outputs of the second bistable circuit and their second inputs both being connected to the reverse control actuator.
7. A control circuit according to Claim 6, wherein the reverse triggering outputs are fed back through diodes to the input of the second bistable circuit and including means for interrupting the diode inputs.
8. A control circuit according to Claim 7 wherein the means for interrupting the diode inputs comprises switch means actuable by the reverse magazine transport.
9. A control circuit according to Claim 1, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.
10. A control circuit according to any one of the preceding claims in combination with a pair of optical slide projection systems.

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