United States Patent

Taylor

[15] **3,641,257**

[45] **Feb. 8, 1972**

[54] NOISE SUPPRESSOR FOR SURVEILLANCE AND INTRUSION-DETECTING SYSTEM

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[73] Assignee: **Hughes Aircraft Company,** Culver City, Calif.

[22] Filed: **Jan. 16, 1970**

[21] Appl. No.: **3,407**

[52] **U.S. Cl.**.....**178/6.8,** 178/DIG. 1, 178/DIG. 33

[51] **Int. Cl.**.....**H04n 7/02**

[58] **Field of Search**.....178/6.8, DIG. 1, DIG. 21, DIG. 33; 250/219 WD, 219 DF; 340/259; 356/200, 237, 238

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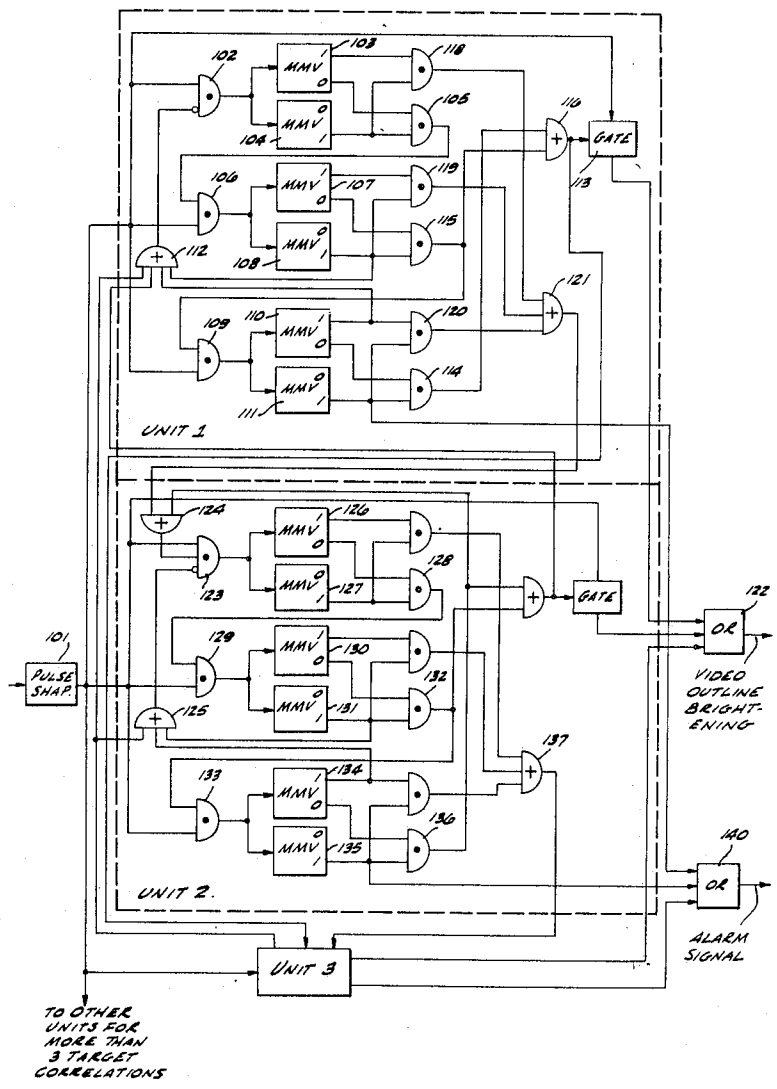
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Attorney—James K. Haskell and Walter J. Adam

[57] **ABSTRACT**

A surveillance and intrusion detection system is provided using a scanning-type sensor to monitor a field of view and transmit a video signal to a moving target indicator (MTI) the output of which is applied to an alarm system through a threshold level detector having a relatively low-threshold level for higher system sensitivity. A correlation unit minimizes false alarms which could occur from high-level noise by transmitting pulses to the alarm system only when they occur at approximately the same place in three successive scanning lines. Other units are provided for correlation of other possible moving targets in the same line. When transmitted pulses are added to the video signal from the sensor for display, the outline of a moving target is brightened.

9 Claims, 9 Drawing Figures



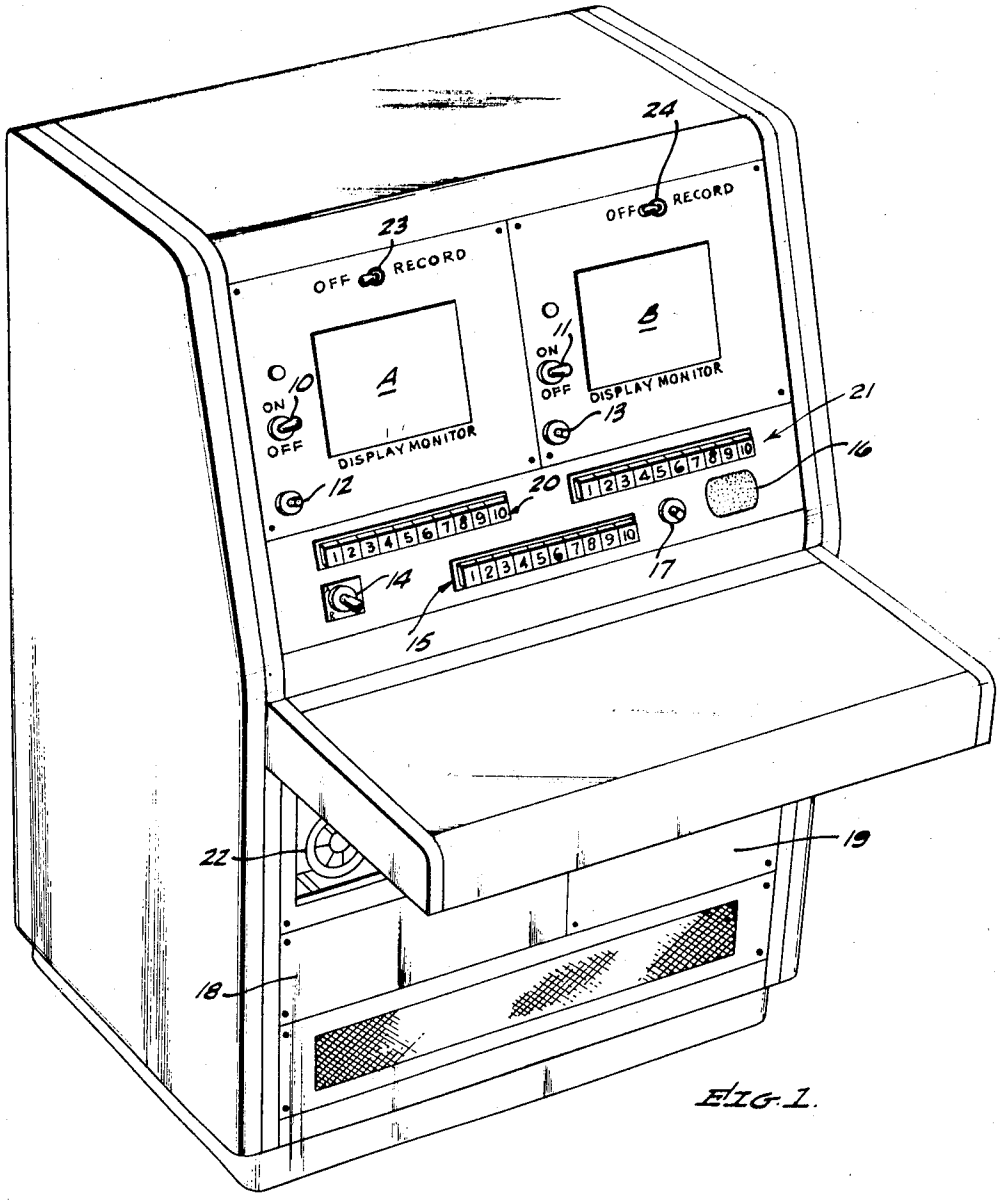


FIG. 1.

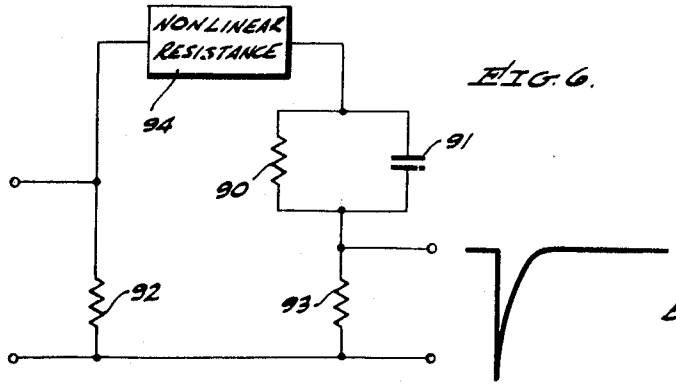


FIG. 6.

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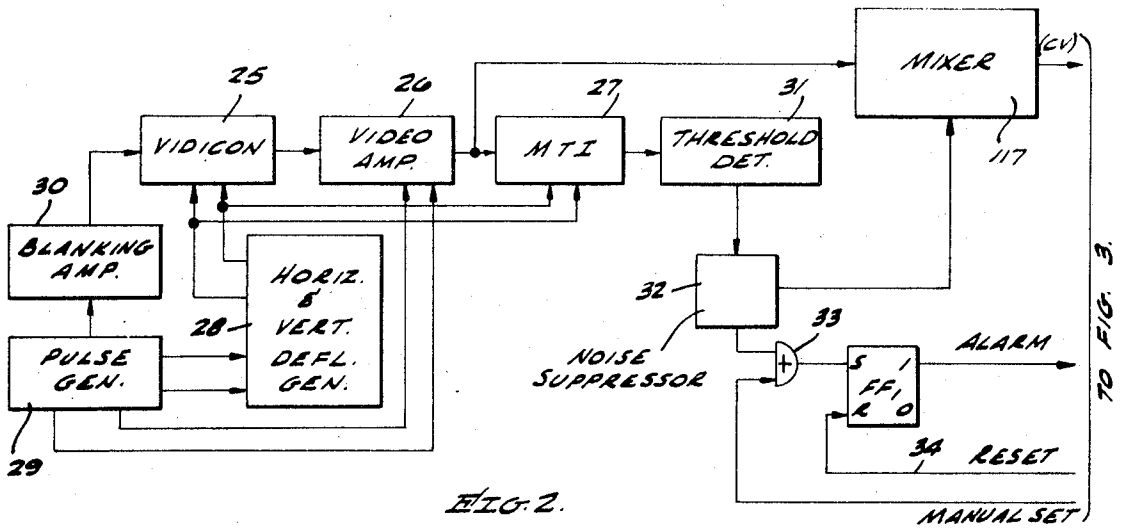

MIXER
(CV)
117
25
VIDICON
26
VIDEO AMP.
27
MTI
31
THRESHOLD DET.
30
BLANKING AMP.
HORIZ. & VERT. DEFL. GEN.
28
PULSE GEN.
29
32
NOISE SUPPRESSOR
33
S
R
FF1
1
0
ALARM
34
RESET
MANUAL SET
TO FIG. 3.

FIG. 2.

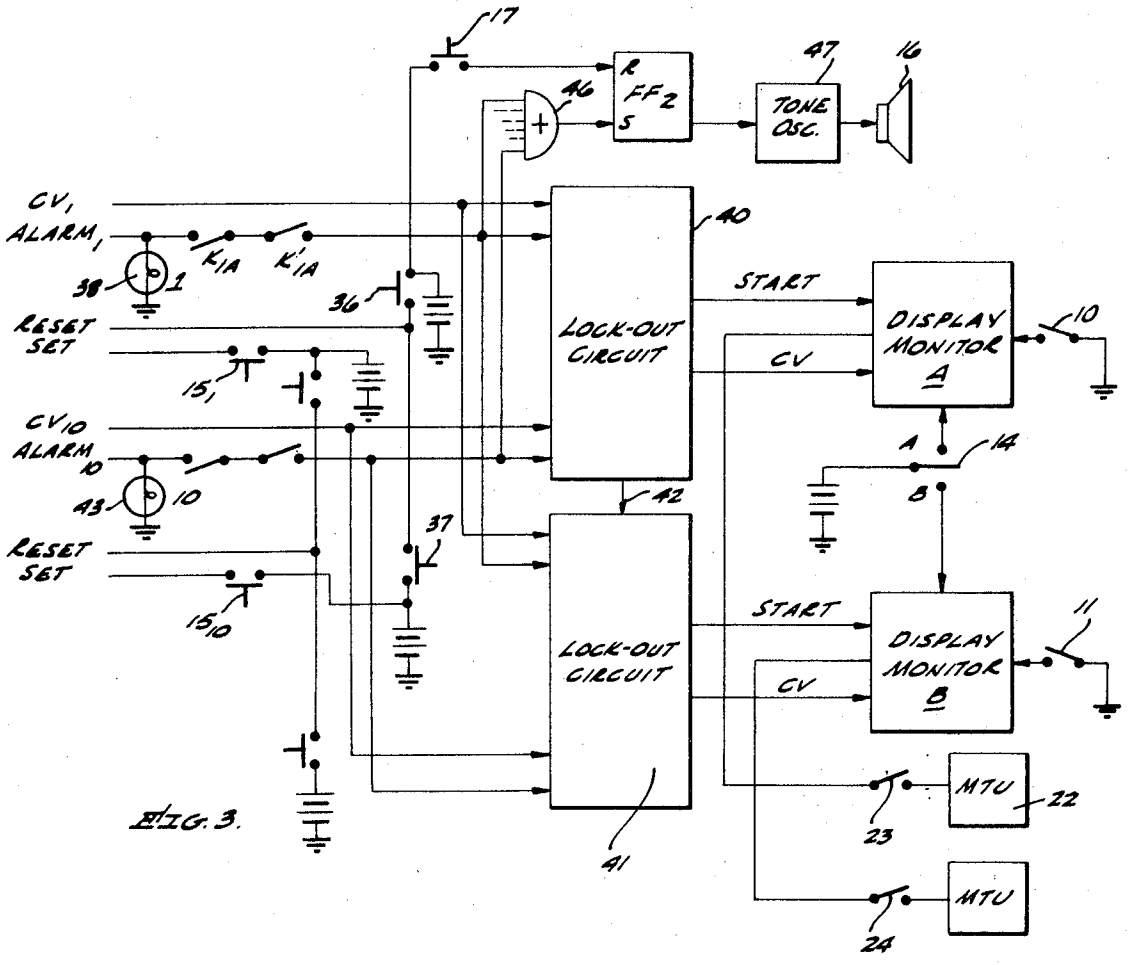

17
46
R
FF2
S
47
TONE OSC.
16
CV1
ALARM1
K1A
K'1A
38
1
36
RESET SET
15,
CV10
ALARM10
43
10
37
15,0
40
LOCK-OUT CIRCUIT
42
41
START
CV
DISPLAY MONITOR A
10
A
B
14
DISPLAY MONITOR B
11
MTU
22
23
24

FIG. 3.

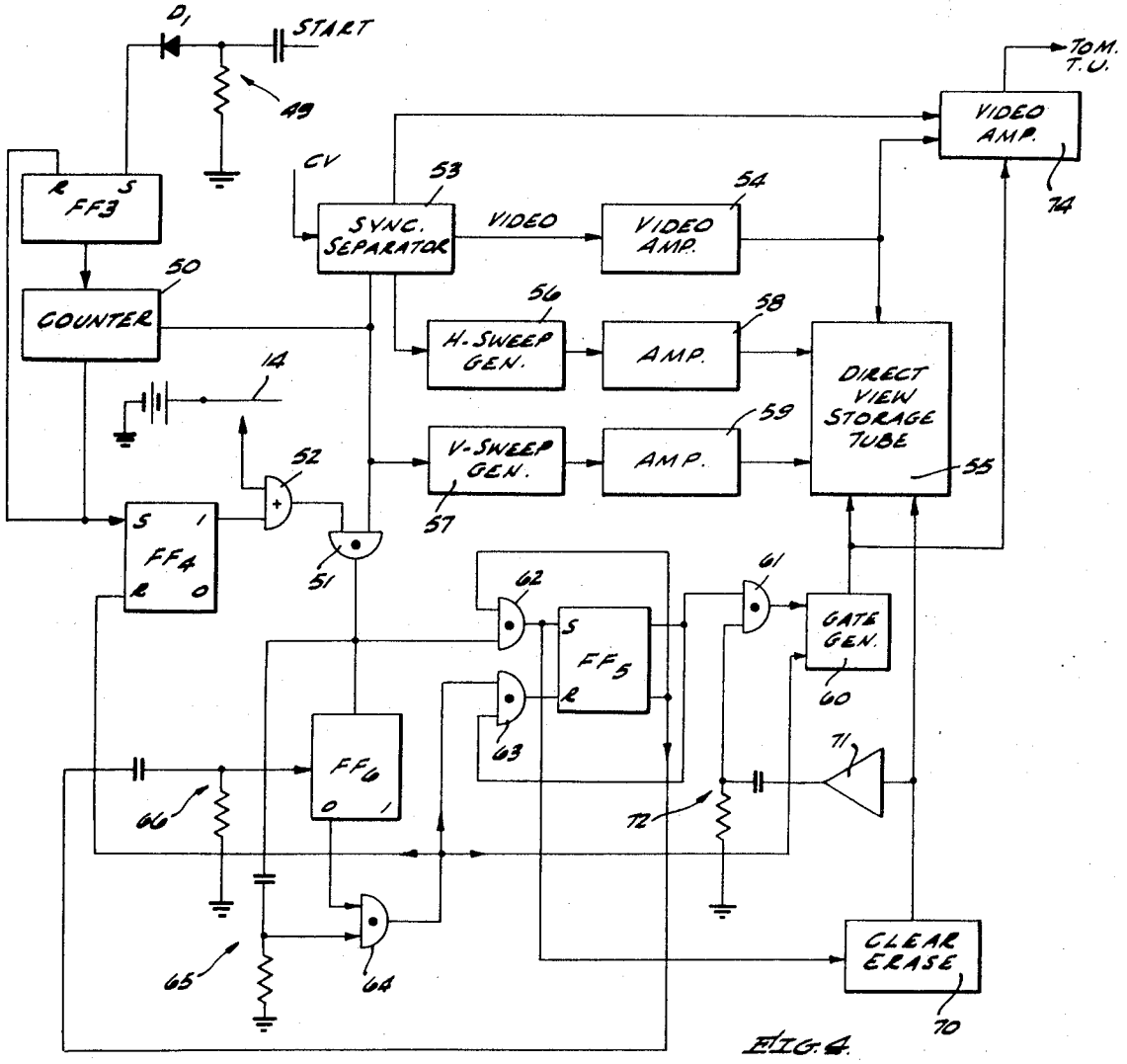

D1
START
49
CV
53
SYNC. SEPARATOR
VIDEO
54
VIDEO AMP.
TO M.T.U.
VIDEO AMP.
74
R FF3 S
50
COUNTER
56
H. SWEEP GEN.
58
AMP.
DIRECT VIEW STORAGE TUBE
55
14
52
V-SWEEP GEN.
57
59
AMP.
S 1 FF4 R 0
51
62
61
S FF5 R
GATE GEN.
60
63
FF6
0 1
66
72
71
65
64
CLEAR ERASE
70

FIG. 4.

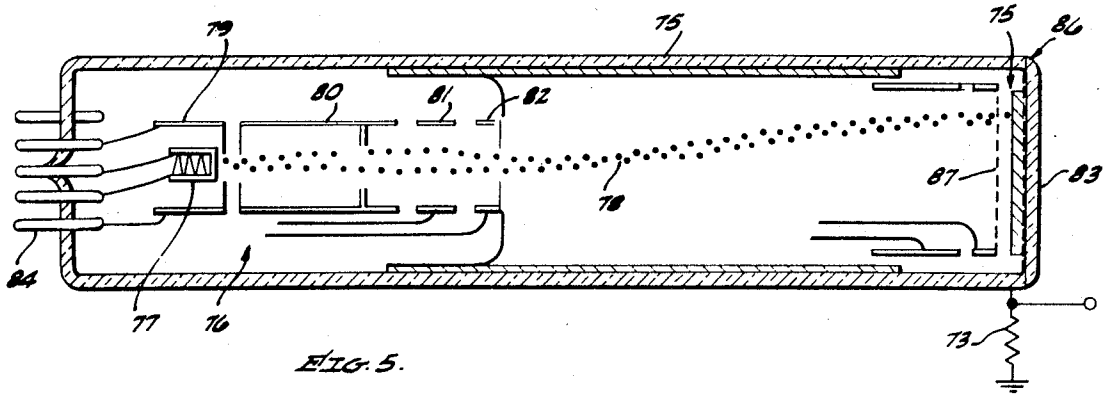

79
75
75
86
80
81
82
87
83
78
84
77
76
73

FIG. 5.

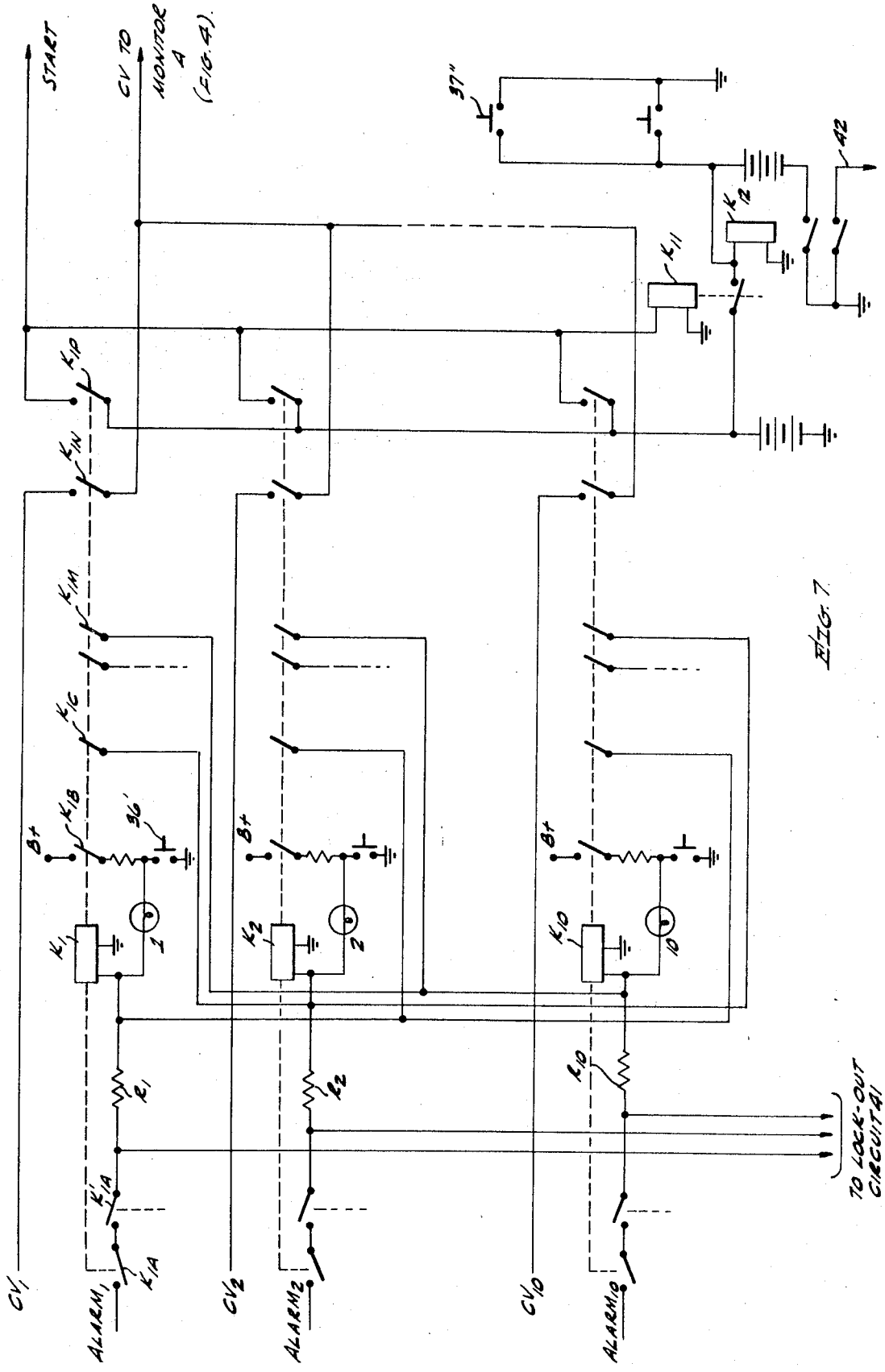

START
CV TO MONITOR A (FIG. 4)
37"
42
K12
K11
K10
K1N
K1M
K1C
K1B
36'
Br
K1
K2
K10
1
2
10
E1
E2
E10
K'1A
K1A
CV1
CV2
CV10
ALARM1
ALARM2
ALARM10
TO LOCK-OUT CIRCUIT AT

FIG. 7

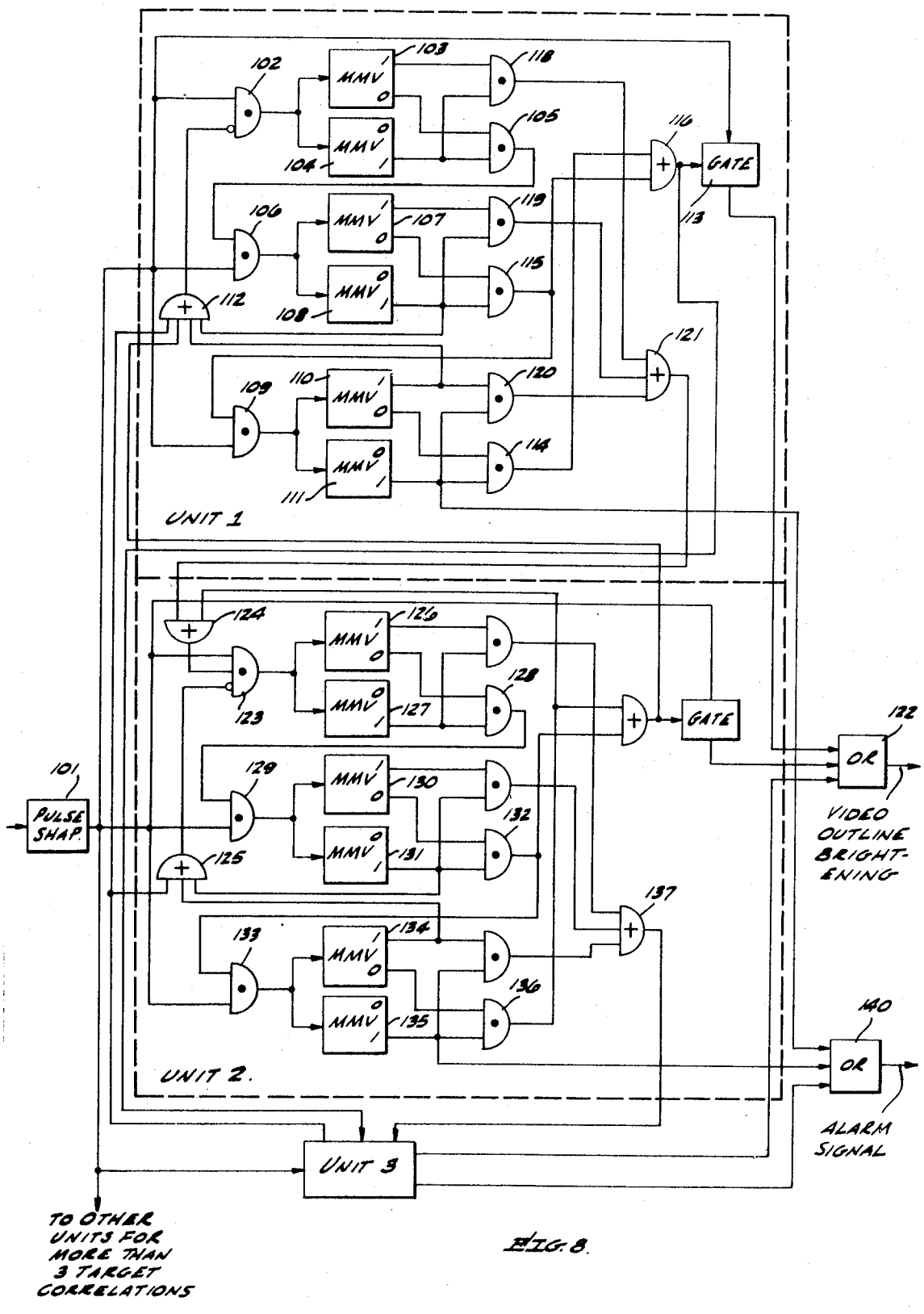
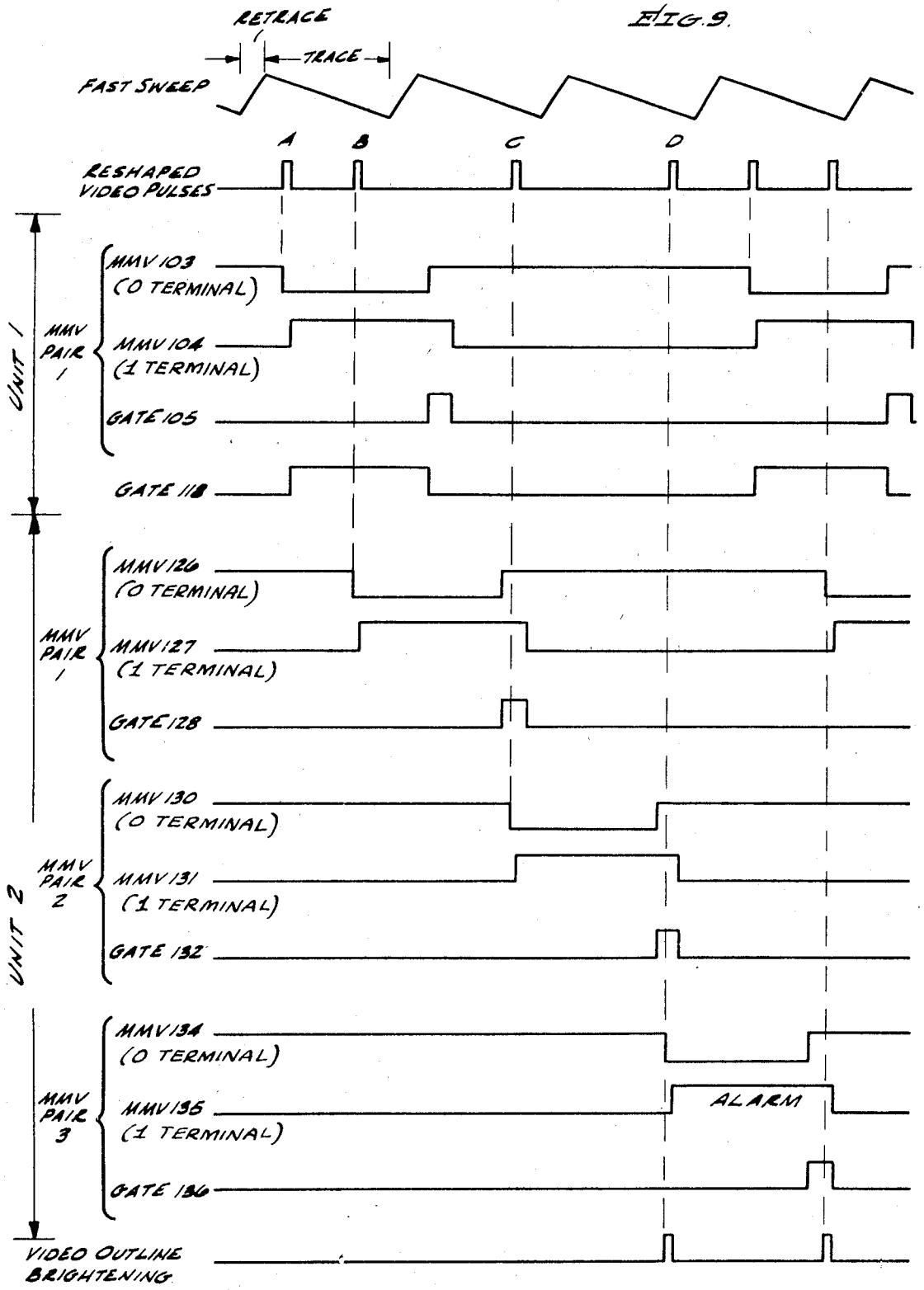

UNIT 1
UNIT 2
UNIT 3
MMV
GATE
OR
PULSE SHAP.
VIDEO OUTLINE BRIGHTENING
ALARM SIGNAL
TO OTHER UNITS FOR MORE THAN 3 TARGET CORRELATIONS

FIG. 8.

FIG. 9.


RETRACE
TRACE
FAST SWEEP
A
B
C
D
RESHAPED VIDEO PULSES
UNIT 1
MMV PAIR 1
MMV 103 (0 TERMINAL)
MMV 104 (1 TERMINAL)
GATE 105
GATE 118
MMV PAIR 1
MMV 126 (0 TERMINAL)
MMV 127 (1 TERMINAL)
GATE 128
UNIT 2
MMV PAIR 2
MMV 130 (0 TERMINAL)
MMV 131 (1 TERMINAL)
GATE 132
MMV PAIR 3
MMV 134 (0 TERMINAL)
MMV 135 (1 TERMINAL)
ALARM
GATE 136
VIDEO OUTLINE BRIGHTENING

NOISE SUPPRESSOR FOR SURVEILLANCE AND INTRUSION-DETECTING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to security systems, and more particularly to apparatus for minimizing false alarms which could occur from random noise in security systems having a moving target indication device for alarm generation.

In security systems using scanned electro-optical techniques as the media of analysis, automatic visual surveillance and intrusion detection may be provided by the use of a scanning-type sensor and a moving target indicator operating on the output signal from the sensor. To reduce the number of false alarms due to noise in the output signal from the sensor, a threshold device may be employed to effectively inhibit the transmission of an alarm signal until the output signal reaches an amplitude above the expected level of noise. However, if the level of the threshold detector is increased to eliminate all expected noise from the output signal, sensitivity of the system to moving targets is greatly reduced. What is required is apparatus for extracting a true moving target indication from statistically distributed random noise without degrading sensitivity of the system.

An object of the present invention is to provide a system for minimizing false alarms which could occur from random noise in a moving target indication system using a scanning-type sensor.

Another object is to compare more than one line of video information as provided by a moving target indication system using a scanning-type sensor to confirm the presence of a moving target only when a moving target indication recurs at approximately the same place in a predetermined number of consecutive scanning lines.

Yet another object is to provide automatic correlation analysis on a line-by-line basis of moving target indications in a video signal of a scanning type sensor such that only moving targets of a size sufficient to span several successive scanning lines will produce a valid intrusion system.

Still another object is to provide apparatus for enhancing the outline of an intruder in a pictorial display of a scene being monitored by a surveillance unit having a moving target indicator while at the same time suppressing from the moving target indication false indications which could occur from random noise without decreasing sensitivity of the system to moving targets.

SUMMARY OF THE INVENTION

In accordance with the present invention, a scanning-type sensor monitors a field of view and transmits a video signal to a moving target indicator (MTI) for producing a moving target signal. Low-level noise in the moving target signal is eliminated without unduly degrading sensitivity by a device having a low threshold level. Means at the output of the threshold device minimizes false alarms which could occur from random high-level noise by automatically correlating the moving target signal of a predetermined number of successive scanning lines, and generating target-indicating pulses for moving target signals which occur at approximately the same location of the successive scanning lines being correlated. The correlation means includes a gate signal generator responsive to a moving target signal in a given scanning line for use in searching for the occurrence of a moving target signal in the next scanning line. The width of the gate signal is sufficient to span a target signal in the next line for a target moving at a predetermined maximum velocity. To thus track more than one moving target in each line, several correlation means are provided with control such that a second one is inhibited from functioning until the first is engaged in tracking a moving target, and a third is similarly inhibited until the second is engaged in tracking a moving target. Additional correlation means may be similarly provided. The target-indicating pulses generated by the correlation means are added to the video signal from the scanning-type sensor for display of the scene being monitored with intensified outlines of moving targets to enhance visual detection of moving targets. The target-indicating pulses are also used to initiate an audio alarm, a visual alarm, or both an audio and a visual alarm.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a console for a control station of a security system embodying the present invention.

FIG. 2 illustrates diagrammatically one of a plurality of surveillance units at remote locations from a control station having the console of FIG. 1.

FIG. 3 illustrates diagrammatically an exemplary implementation of the security control station console of FIG. 1.

FIG. 4 illustrates diagrammatically one of two display monitors of the console illustrated in FIG. 1.

FIG. 5 illustrates schematically a moving target indicating tube for the surveillance unit of FIG. 2.

FIG. 6 illustrates an equivalent circuit of the moving target indicating tube of FIG. 5.

FIG. 7 illustrates an exemplary implementation of a lockout circuit of FIG. 3.

FIG. 8 illustrates an exemplary implementation of a system for preventing random noise from generating an alarm signal in a surveillance unit shown in FIG. 2.

FIG. 9 shows a typical operating sequence diagram for the system of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

CONTROL STATION CONSOLE

The surveillance and intrusion detection system of the present invention comprises a control station display console illustrated in FIG. 1 connected by transmission links, such as transmission lines, to a plurality of surveillance units at remote locations. One surveillance unit is shown in FIG. 2; all other surveillance units are identical to the one illustrated.

In accordance with the present invention automatic surveillance and intrusion detection for a plurality of surveillance sites from a single security control station is accomplished by utilizing a repetitively scanned transducer with information storage and processing capability. Photon transducers including conventional vidicons, image intensifier orthicons and secondary electron conduction (SEC) vidicons are preferred devices since they are capable of providing high-resolution pictorial information over a wide range of indoor-outdoor security site environmental conditions.

Scan rates are not limiting factors and depend upon each unique security problem. For example, scanning rates may be determined by transmission link considerations for bandwidth compression, low light ambient environmental conditions requiring longer scanned photon exposure per resolution element, depth of field and area of surveillance site and intruder size with consideration to minimum and maximum motion detection rates.

Repetitively scanned microwave, infrared and laser techniques may also be employed with equal effectiveness relative to the particular security problem and environmental conditions. All that is required is that surveillance scene pictorial data be repetitively scanned from the transducer converting each image to equivalent electrical data which is stored and processed on an element by element basis, and then compared with sequential data directly from the transducer to determine "change information" indicative of a moving object. However, as an illustrative implementation of the present invention in its broadest aspects, a television camera is employed.

Signals representing intrusions are transmitted by the various surveillance units through the transmission lines to a video distribution system illustrated in FIG. 3 at the security control station console illustrated in FIG. 1. The console includes two display monitors A and B. Each comprises a 10-inch storage tube such as a Tonotron (direct view) tube manufactured by Hughes Aircraft Company, model H-1033AP4.

The storage tubes may receive conventional television video signals to store and display a complete frame for up to 5 minutes without deterioration following an alarm signal. If required, the viewing time may be extended to 10 or more minutes. The storage tube produces a very bright display of several hundred foot lamberts permitting ease of viewing in well-lit rooms.

It should be noted that until an alarm signal is generated to cause a frame of data to be stored, the storage tubes are blank. Thereafter, a stored picture may be erased completely in a fraction of a second to permit new frames to be displayed almost instantly, on a frame by frame basis if desired.

The console includes on-off switches **10** and **11** to provide power separately to the display monitors A and B. Separate manual erase pushbuttons **12** and **13** are provided to allow the operator to manually clear either of the display monitors A and B.

A single-pole, double-throw switch **14**, which is normally off in the center position, is provided to override the normal function of a selected display monitor by allowing vertical synchronizing pulses of a composite video signal received from an outlying surveillance unit to clear the storage tube of the selected display monitor on a frame by frame basis, thereby permitting the operator to continuously view the location of the surveillance unit through a television camera once the surveillance unit has detected a moving target.

A plurality of illuminated pushbuttons **15** are provided, one for each surveillance unit. When a given surveillance unit detects a moving target, an alarm signal is transmitted to the console to sound an audio alarm through a speaker **16** and energize a lamp for a corresponding one of the illuminated pushbuttons **15**. A pushbutton **17** is provided to allow the operator to silence the speaker **16** until another alarm is received from a different surveillance unit, or an alarm is received from the same surveillance unit once it has been reset by pushing the corresponding illuminated pushbutton.

A pair of lockout circuits are provided in racks **18** and **19**, together with necessary power supplies for all of the circuits of the display console to route the composite video signal being transmitted by the surveillance unit which first transmits an alarm signal to the display monitor A. The lockout circuit which accomplishes that is in the rack **18**. Once that lockout circuit has routed a composite video signal to the display monitor A, it enables the lockout circuit in the rack **19** to route to the display monitor B the composite video signal transmitted by the second surveillance unit to detect a moving target and transmit an alarm signal.

Each lockout circuit has associated with it a plurality of illuminated pushbuttons designated in groups by the reference numerals **20** and **21**. The group of pushbuttons **20** indicate which surveillance unit has been routed to the display monitor A by having the lockout circuit in the rack **18** energize a lamp associated with the appropriate one of the pushbuttons **20**. To reset the alarm condition as established by that surveillance unit, the operator need merely push the illuminated pushbutton. The group of pushbuttons **21** similarly indicate which surveillance unit has been connected to the display monitor B by the lockout circuit in the rack **19** and allows the operator to reset the alarm condition.

Once the alarm condition of a surveillance unit connected to the display monitor A has been reset, the lockout circuit in the rack **18** will respond to the next alarm signal from any surveillance unit to connect that unit to the display monitor A since the lockout circuit is enabled to perform its function as soon as the illuminated pushbutton of the group **20** has been pushed. Similarly, the lockout circuit in the rack **19** is enabled to perform its function as soon as the illuminated pushbutton of the group **21** has been pushed, but only if one of the pushbuttons in the group **20** remains lit. Thus, if the eliminated pushbutton in each of the two groups **20** and **21** are momentarily pushed to reset the alarm condition of surveillance units associated therewith, the lockout circuit in the rack **19** will be disabled until the lockout circuit associated with the rack **18** has received an alarm signal and has routed the composite video signal from the surveillance unit transmitting the alarm signal to the display monitor A.

A magnetic tape recording unit **22** is associated with the display monitor A to allow the operator to record a video signal being displayed in the monitor A upon setting a single-pole, single-throw switch **23** in the record position. A similar magnetic tape unit is associated with the monitor B to record a video signal being displayed in the monitor B through a single-pole switch **24** in the record position.

It should be appreciated that with only two monitors in the console of the security control station, only two alarm conditions can be accommodated. The first alarm condition will cause the predetermined one of the subsequent frames of a composite video signal from a television camera to be displayed on the monitor A. The second alarm condition from another surveillance unit will cause a predetermined one of the subsequent full frames to be stored and displayed in the monitor B. If a third alarm condition occurs from still another surveillance unit before the alarm condition in either of the first two has been reset by pushing the appropriate one of the illuminated pushbuttons in the groups **20** and **21**, a third one of the pushbuttons **15** will be illuminated. Once the operator has detected the third alarm condition by noting the third pushbutton being illuminated in the group **15**, he may view the location of the third surveillance unit by resetting the second alarm condition to enable the lockout circuits in the racks **19** to function as though the third alarm condition were the second. Alternatively, both of the first two alarm conditions may be reset. Thereafter, if a moving target is still being detected in either one of the first two surveillance units, the lockout circuits will automatically route composite video signals from that unit to the monitor B. If a moving target is not being detected, but the operator nevertheless wishes to view that location, or any other location, a false alarm condition can be established for the associated surveillance unit by momentarily pushing the associated one of the groups of pushbuttons **15**. Thus, with two monitors and the ability to set and reset alarm conditions, the operator of the console has considerable flexibility.

In most security systems having 10 or more locations, an intrusion at more than two locations at one time is not to be expected. Therefore, two monitors will normally be sufficient to allow the operator to continue to view one or two locations at which a moving target has been detected. An alarm condition at a third surveillance unit would be unusual. Three or more alarm conditions existing at substantially the same time would be indicative of an invasion, rather than an intrusion, and would require the operator to sound a general alarm rather than follow procedures established for just one or two alarm conditions. However, if a particular installation of a security system should warrant the operator monitoring three or more alarm conditions simultaneously, additional display monitors may be provided, each with a lockout circuit connected in cascade in a manner similar to the cascade connection of the lockout circuit for the display monitor B to the lockout circuit for the display monitor A.

ON-SITE SURVEILLANCE UNIT

Each surveillance unit comprises a television camera tube shown in FIG. 2 to be a vidicon **25** coupled by a video amplifier **26** to a composite video (CV) line of a cable, or some other suitable transmission link, and to a moving target indicator (MTI) **27**. Both the vidicon **25** and the MTI **27** are synchronized by a horizontal and vertical deflection generator

28 which is driven by a basic pulse generator 29. In accordance with standard television, the pulse generator 29 also drives a blanking amplifier 30. In that manner the vidicon 25 and video amplifier 26 provide a composite video signal in accordance with standard television practice, such as with 525 lines of video data transmitted in two fields each having 262.5 lines between vertical synchronizing pulses.

The composite video signal transmitted to the security control station is routed to one of the two display monitors A and B as described hereinbefore with reference to FIG. 1, but not until the MTI 27 causes a threshold detector 31 to trigger a monostable multivibrator in a noise suppressor 32 to be described with reference to FIGS. 8 and 9. The output pulse of the multivibrator will set a flip-flop FF_1 through an OR-gate 33 to transmit an alarm signal to the security control station console until it is reset (through a line 34 connected to the console) when the appropriate one of the group of pushbuttons 20 and 21 is momentarily pushed The one to be pushed is of course indicated by an energized lamp. For example, the surveillance unit illustrated in FIG. 2 may be assigned location number 1 and so connected to the lockout circuits of the console shown in FIG. 1 that when an alarm signal sets the flip-flop FF_1, the pushbutton number 1 of the group 15 is illuminated. When the lockout circuits route the CV signal from that surveillance unit number 1 to, for example, the monitor A, the pushbutton number 1 of the group 20 will be illuminated. Therefore, to reset the alarm condition of the surveillance unit number 1, the operator will know that he must push the button number 1 of the group 20. If the CV signal had been routed to the monitor B, the pushbutton number 1 of the group 21 would have been illuminated. The switches of the two pushbuttons associated with that surveillance unit and the respective monitors A and B are shown in FIG. 3 as pushbuttons 36 and 37. Regardless of which monitor receives the CV signal, the corresponding pushbutton of the group 15 is energized for illumination. The lamp which illuminates the pushbutton number 1 of the group 15 is shown in FIG. 3 as lamp 38.

The MTI 27 may be a tube of the type developed by Hughes Aircraft Company and described in U.S. Pat. No. 3,432,717 titled MOVING TARGET VISUAL INDICATOR TUBE by L. S. Yaggi, but modified to eliminate the visual indication function and provide an output signal across a resistor connected to a transparent conductive coating on the face thereof to provide a signal corresponding to each line scanned by the vidicon 25. That signal does not exceed a predetermined level detected by the threshold detector 31 until the CV signal of a given line of a given full frame differs from the same line of the immediately preceding full frame.

The MTI tube is a small low-voltage device similar in size to a vidicon tube. Briefly, the operation of the MTI tube is as follows. A video signal is stored on a semiconductor target by a beam synchronized with the vidicon 25. This target stores the video signal from one full frame and automatically compares it with the video signal of the succeeding frame. An output from the threshold detector 31 results only when the two frames do not correlate.

DATA PROCESSING AND DISTRIBUTION

Referring now to FIG. 3, display monitors A and B are connected to surveillance units, such as the surveillance unit illustrated in FIG. 2, through lockout circuits 40 and 41. Each lockout circuit has 10 composite video signal inputs from each of 10 different surveillance units and only one composite video output connected to an associated one of the display monitors A and B. Each of the lockout circuits also has 10 alarm input terminals, one for each of the surveillance units. The lockout circuit 41 has as an additional input through a connection 42 from the lockout circuit 40 to disconnect operating potential (ground) from the lockout circuit 41 until the lockout circuit 40 has connected a CV signal to the monitor A in response to an alarm signal on the alarm input terminal associated with the CV signal. For example, if an alarm signal is received from the surveillance unit number 1 to energize the lamp 38 and thereby illuminate the pushbutton number 1 of the group 15 (FIG. 1), the lockout circuit 40 will connect the CV signal from the surveillance unit number 1 to the display monitor A. At the same time, a lamp is energized to illuminate the pushbutton number 1 of the group 20 (FIG. 1). Thereafter, if an alarm signal is received from another surveillance unit, another lamp is energized to illuminate the corresponding one of the pushbuttons. For example, if an alarm signal is received from the unit number 10, a lamp 43 is energized to illuminate the pushbutton 10 of the group 15 and cause the lockout circuit 41 to connect the CV signal from the unit number 10 to the display monitor B. At the same time, a lamp associated with the lockout circuit 41 is energized to illuminate the pushbutton number 10 of the group 21, thereby indicating that the surveillance unit number 10 has been connected to the display monitor B.

The responding one of the lockout circuits 40 and 41 will disconnect a given alarm circuit once a CV signal has been connected to a display monitor. For example, once the lockout circuit 40 has responded to the alarm signal from the flip-flop FF_1 of surveillance unit number 1, a switch K_{1A} is opened by the lockout circuit 40 to disconnect the flip-flop FF_1 from both the lockout circuit 40 and the lockout circuit 41. Similarly, if the lockout circuit 41 responds to the alarm signal from the flip-flop FF_1 a switch K'_{1A} is opened to disconnect the alarm signal from both the lockout circuit 40 and the lockout circuit 41. However, before either of the switches K_{1A} and K'_{1A} can be opened, the alarm signal from the flip-flop FF_1 will set a flip-flop FF_2 through an OR-gate 46. Once the flip-flop FF_2 has been set, an audio alarm is provided through the speaker 16 via a tone oscillator 47 energized by the flip-flop FF_2. The speaker 16 will continue to provide an audio alarm until the flip-flop FF_2 is reset by the pushbutton switch 17.

Each of the display monitors A and B will respond to a composite video signal to store and display one full frame. That will enable the operator to determine the nature of the intrusion which caused the alarm. If unable to do so from the single frame being displayed, the operator may actuate the override switch 14. For example, assuming an alarm has succeeded in having a composite video signal transmitted to the display monitor A, and the on/off switch 10 is in the on (closed) position, the display monitor A will respond to vertical synchronizing signals of the composite video to trap for storage and display one full frame. Thereafter, by actuating the switch 14 to the "A" position, the display monitor A will respond to subsequent vertical synchronizing signals to cause successive frames to be (stored) displayed automatically in sequence. Once the switch 14 has been returned to its neutral position, the display monitor A will respond to the vertical synchronizing signals to trap for storage and display the next full frame.

As noted hereinbefore with reference to FIG. 1, the operator may selectively actuate switches 23 and 24 associated with monitors A and B to record in a magnetic tape unit the composite video signal being transmitted to the associated monitor. For example, to record the composite video signal being transmitted to the display monitor A, the switch 23 is closed to allow the magnetic tape unit 22 to record. Ganged with switch 23 is an additional switch (not shown) which actuates a clutch to engage the tape drive mechanism of the magnetic tape unit 22 while the switch 23 is closed.

The composite video signal to be recorded by a magnetic tape unit is taken from the display monitor associated therewith so that when the switch 14 is not in the override position, the magnetic tape unit records only the composite signal of the frame trapped for display. In that manner, the operator may, if he wishes, record the first frame of the composite video signal as it is received by display monitor. Then when the override switch 14 is actuated, subsequent events at the site being monitored are recorded.

DISPLAY MONITOR

When the lockout circuits **40** and **41** respond to an alarm signal to connect an associated composite video signal to a display monitor, such as display monitor A shown in FIG. **4**, a start signal is transmitted by the lockout circuit to start the sequence for capturing a full frame. That sequence is carried out by flip-flops FF_3, FF_4, FF_5 and FF_6.

The flip-flop FF_3 is set by the leading edge of the START signal via a differentiating circuit **49** and diode D_1. The true output terminal of the flip-flop FF_3 then enables a counter **50** to count vertical (field) synchronizing signals from a linear integrating sync separator **53** which separates the vertical and horizontal (raster) synchronizing pulses, sometimes referred to hereinafter as "sync pulses." When a predetermined number of fields have been counted a flip-flop FF_4 is set to enable an AND-gate **51** via an OR-gate **52**. In the meantime, CV signals are transmitted through a linear integrating sync separator **53** which separates the vertical and horizontal sync pulses. The remaining signal is transmitted through a video amplifier **54** to a direct view storage tube **55** to be stored on a full frame basis.

The horizontal and vertical sync pulses are transmitted to respective horizontal and vertical sweep generators **56** and **57**. Amplifiers **58** and **59** then drive the beam deflection system of the direct view storage tube **55**. However, a gate generator **60** holds the direct view storage tube **55** off until a pulse is received from an AND-gate **61**.

The first vertical sync pulse received by the AND-gate **51** after the flip-flop FF_4 has been set will set both of the flip-flops FF_5 and FF_6. Once the flip-flop FF_5 has been set, and AND-gate **62** is disabled so that the flip-flop FF_5 cannot receive another set pulse. At the same time, an AND-gate **63** is enabled so that the flip-flop FF_5 can be reset by a pulse from an AND-gate **64**.

The AND-gate **64** is disabled when the binary (T-type) flip-flop FF_6 is set so that the second vertical synchronizing pulse will not be transmitted via the AND-gate **51** and the AND-gate **64** to the AND-gate **63** in order to set the R-S flip-flop FF_5. The third vertical synchronizing pulse will then be transmitted by the AND-gate **64** since the flip-flop FF_6 will then be reset. It should be noted that the flip-flop FF_6 is being set by that third vertical synchronizing pulse, but since the flip-flop FF_6 will require a finite period of time to switch to the set condition, a differential network **65** will provide a sharp pulse at the leading edge of the vertical synchronizing pulse to be transmitted through the AND-gate **64** also resets the R-S flip-flop FF_4 to disable the AND-gate **51** thereby preventing further vertical synchronizing pulses from being transmitted to the flip-flops FF_5 and FF_6.

When the flip-flop FF_5 is set by the first of the three vertical synchronizing pulses, a clear-erase network **70** is triggered to clear and erase the direct view storage tube **55**. The clear-erase network **70** consists of two monostable multivibrators. The output amplitude of each monostable multivibrator is independently controlled, and the two pulses are then combined to form a composite pulse. The first portion of a composite pulse constitutes the clearing cycle. The amplitude of that first portion is equal to or slightly greater than the potential necessary to clear the direct view storage tube **55**. The remaining portion of the composite pulse then constitutes the erase signal. This type of composite pulse insures that the direct view storage tube **55** is uniformly erased over the entire viewing area in a manner known to those familiar with the Tonotron direct view storage tube.

The clear-erase pulse from the network **70** is inverted by an amplifier **71** and differentiated by a network **72** to trigger the gate generator **60** via the AND-gate **61** at the end of the clear-erase pulse. Thus in response to the first vertical synchronizing pulse the gate generator **60** will turn the direct view storage tube **55** on. The pulse generated by the AND-gate **64** in response to the third vertical synchronizing pulse will trigger the gate generator **60** off, thereby turning the direct view storage tube **55** off. The result is that a full frame comprising an odd and an even field of video data is stored. The particular frame selected for storage is controlled by the counter **50** which can be adjusted to select any frame subsequent to an alarm signal.

The advantage of selecting a full frame several frames after the alarm is that it allows an intruder coming into the view of the surveillance unit to be in full view. For example, a surveillance unit in a hall may be triggered into the alarm condition by the toe of the intruder coming into the hall through a door. By waiting a predetermined period of time to capture a full frame in the monitor, a full view of the intruder is assured. Thus, the counter **50** may be selected or adjusted for the optimum taking into consideration the location of all of the surveillance units.

To override the sequence provided by the flip-flops FF_3, FF_4, FF_5 and FF_6, the switch **14** is actuated to provide to the OR-gate **52** an enabling voltage for the gate **51**. The sequence just described for the operation of the flip-flops FF_5 and FF_6 is then repeated, with the flip-flop FF_5 directly resetting the flip-flop FF_6 via the differentiating network **66** when the flip-flop FF_5 is reset to end the next sequence. However, the very next vertical synchronizing pulse will initiate another cycle. Between cycles one field of a frame will be blocked by the gate generator **60** so that for each successive sequence of the flip-flops FF_5 and FF_6 the fields gated to the direct view storage tube **55** will be alternately odd, even, and even, odd. However, since there are 30 odd and 30 even fields transmitted per second in standard TV transmission, the view provided to the operator will be virtually flicker free. If it is desired to provide a more perfect override operation, a separate sequencing network for the gate generator **60** may be provided responsive to the override switch **14**.

In order to store in a magnetic tape unit (MTU) any full frame stored, including the first frame stored before the override switch **14** is actuated, an enabling signal from gate generator **60** unblanks an MTU video amplifier **74** permitting the pictorial information being stored to also be recorded together with horizontal and vertical synchronizing signals from the sync separator **53**. In other words, the video amplifier **74** adds the horizontal and vertical sync pulses to store in the MTU a composite video signal.

A single-ended scan converter tube (SCT) is also an equally acceptable device for implementation of stored pictorial information. An SCT such as the Hughes **H1206** can be used as the storage medium for periods of 3 to 5 minutes supplying continuous electrical output signals of the stored picture through a video amplifier to a conventional standard cathode-ray tube monitor. Actuation of the override switch **14** would simply bypass the SCT permitting the composite video to be applied directly to the TV monitor. For magnetic tape recording the electrical output signal of the SCT is applied to the MTU through the video amplifier **74** thus recording the initial frame of pictorial information. The resulting video tape is then conveniently played back through the TV monitor unit.

An illustrative embodiment of the present invention has thus far been described with a general reference to a preferred method of implementing particular components. Further details of those particular components will now be described, but it should be understood that the present invention does not depend upon such details. Other components may be substituted for some of the components, and modifications may be provided in still other components.

MTI TUBE OPERATIONS

The MTI tube of the aforesaid U.S. Pat. No. 3,432,717 modified for use in the present invention will now be described with reference to FIG. **5**. It comprises an evacuated envelope **75**. Disposed in one end of the envelope is an electron gun assembly **76** for forming an electron beam **78** of elemental cross-sectional area. The electron gun assembly **76**

comprises a heated cathode 77, a control grid 79 and beam focusing and accelerating electrodes 80, 81 and 82.

The structure thus far described is conventional in cathode-ray tubes having a deflection system (not shown in FIG. 5) for scanning a face 83 of the tube 75 with the focused beam 78, the intensity of which is modulated in accordance with an input signal applied to the control grid 79 through a pin 84 at the base of the tube 74. Other electrodes within the tube 74 are similarly connected to pins at the base of the tube in the usual manner.

Disposed adjacent to the face 83 is a target assembly comprising a continuous dielectric layer 85 deposited on a conductive plate 86. Operation of the MTI tube depends upon scanning the dielectric layer 85 through a collector grid 87 with the focused beam 78 of low-energy electrons. That results in the establishment of a stored charge pattern on the surface of the dielectric layer 85 which may be referred to as a storage target. Secondary electrons produced by impingement of the beam 78 on the dielectric layer 85 are collected by the collector electrode 87. In that manner an overall charge pattern corresponding to the intensity modulation of the beam 78 through the control grid 79 is obtained.

In the moving target visual indicator tube of the aforesaid patent No. 3,432,717 the charge pattern is developed on a first storage target provided in the form of a grid in order to control the passage of a flood of electrons from a viewing electron gun to a viewing target. Since the MTI tube employed in the present invention is not intended to provide a visual moving target indication, the viewing electron gun, the viewing target and a second storage target are omitted.

To understand the operation of the MTI tube employed in the present invention, it is helpful to first consider an elemental area of the continuous dielectric layer 85. Such an area may be approximately represented by a resistor 90 in parallel with a capacitor 91 in the equivalent circuit of FIG. 6. Resistors 92 and 93 represent the respective input impedance of the signal applied to pin 84 and output impedance of a signal derived from the output signal plate 86 (FIG. 5). A nonlinear resistance 94 represents the landing characteristics of the beam 78 on the dielectric layer 85. While the dielectric resistance 90 and capacitance 91 change with dielectric thickness, the dielectric time constant (RC) is substantially constant and determined only by the characteristics of the particular dielectric material used.

As the beam 78 scans the elemental area represented by the resistor 90 and capacitor 91, an output signal will immediately appear across the resistor 93 due to the capacitance 91. As the beam charges the capacitor 91 to a new potential determined by an input signal applied to the control grid 79, the output signal decreases. When the charging is completed, the output signal will again be substantially zero as shown by the waveform in FIG. 6. The differentiating action of the capacitor 91 and resistor 93 thus causes only new information (new voltage levels applied to the control grid 79 while scanning the elemental area represented by the resistor 90 and the capacitor 91) to appear across the output resistor 93.

Due to the low energy of the electron beam, the dielectric layer 85 (FIG. 5) is charged in the negative direction. Positive charging necessary to prevent the dielectric layer from remaining at a negative potential indefinitely once charged is achieved through the resistor 90 (FIG. 6) since the signal plate 86 (FIG. 5) is held at a positive potential with respect to the average control grip potential. The value of the resistor 90 is sufficiently high to maintain a substantial proportion of a charge on the capacitor 91 from frame to frame as the composite video signal applied to the control grid 79 modulates the beam 78 while the deflection system (not shown) causes the beam 78 to scan the face of the tube raster by raster in synchronism with operation of the vidicon 25 (FIG. 2). If there is no change in the video signal as the elemental area is scanned during the next cycle, the output signal across the resistor 93 will be very small. However, if there has been a change due to motion of a target being viewed by the vidicon 25, the output signal across the resistor 93 (a load resistor connected to the signal plate 86 of FIG. 5) will be sufficiently large to exceed a preset level of the threshold detector 31 (FIG. 2), thereby indicating a moving target is being viewed by the vidicon 25.

It should be noted that although reference to a particular moving target indicator tube in combination with a particular camera tube has been made, other camera tubes such as an orthicon may be used with the particular MTI tube, and that considered in its broadest aspects, other moving target indicators may be provided to detect a change in a video signal from any scanning-type sensor to determine the presence of a moving target. However, in each case it is preferable to have the moving target indicator contained within a secure housing for the sensor at the site of the surveillance unit so that detection of the presence of a moving target will be made at the sight of the surveillance unit. Thus the integrity of the system is maintained at a maximum while error due to noise is maintained at a minimum by transmitting only a DC alarm signal to the security control station. The DC alarm may, for example, be a zero-volt signal produced by the noise suppressor 32. At all other times, the output of the monostable multivibrator 32 may be either a positive or negative potential so that, when cables are used as transmission links, any effort to ground or cut the alarm signal cable will produce an alarm indication at the security control station.

LOCKOUT CIRCUIT OPERATION

The lockout circuit 40 shown in FIG. 3 will now be described with reference to FIG. 7 where alarm signals from surveillance units 1, 2 ... 10 are connected to relays K_1, K_2 ... K_{10} by current-limiting resistors R_1, R_2 ... R_{10}. If an alarm signal is received from the surveillance unit number 1, the relays K_1 is energized through the resistor R_1 to make contacts K_{1B} ... K_{1P} before breaking a contact K_{1A}, thereby latching the relay K_1 through contact K_{1B}. Once the relay K_1 has been energized relay contacts K_{1C} through K_{1M} will ground the input terminals to all other relays K_1 through K_{10}, thereby preventing any other relay in the lockout circuit 40 from being energized in response to an alarm signal. In that manner, the composite video signal of the surveillance unit number 1 is transmitted to monitor A through the relay contact K_{1N} while the composite video signals of other surveillance units are locked out. The relay contact K_{1P} is closed by the energized relay K_1 to energize a relay K_{11} and transmit a start signal to the flip-flop FF_3 in FIG. 4.

The single contact of the relay K_{11} energizes still another self-latching relay K_{12} which, through a second contact connects ground to the line 42, thereby enabling the lockout circuit 41 to operate by providing ground to all of its relays corresponding to relays K_1 to K_{10} of the lockout circuit 40.

When the flip-flop FF_1 in the surveillance unit number one is reset by actuating the corresponding switch 36 in response to pushing the pushbutton number 1 of the group 20 (FIG. 1), a second contact 36' (FIG. 7) ganged with the first switch 36 is closed to deenergize the relay K_1. That enables any other alarm to actuate the lockout circuit 40 except an alarm which has succeeded in having its corresponding composite video signal routed to monitor B by the lockout circuit 41 after the self-latching relay K_{12} been energized. For example, after the composite video signal from the surveillance unit number 1 has been connected to monitor A, an alarm from the surveillance unit number 2 (locked out of the lockout circuit 40 by the contact K_{10} being closed) will be transmitted to the lockout circuit 41 to energize a relay corresponding to relay K_2 of the lockout circuit 40.

It should be noted that the resistor R_2 will prevent the connection to the lockout circuit 41 via contacts K_{2A} and K'_{2A} from being grounded even though the input of the relay K_2 in the lockout circuit 40 of FIG. 7 is grounded. Once the corresponding relay K_2 of the lockout circuit 41 (not shown in detail) is energized by the alarm signal from the surveillance

unit number 2, its relay contact K'_{2A} shown in FIG. 7 is opened thereby disconnecting the alarm signal of the the surveillance unit number 2 from both lockout circuits.

The lockout circuit 41 is the same as the lockout circuit 40 shown in FIG. 7 in respect to the manner in which the relays K_1 through K_{10} and associate contacts are connected. The lockout circuit 41 also includes the relay K_{11} in order to provide a START signal to the monitor B, but it does not include a relay K_{12} unless a third lockout circuit is to be cascaded with the lockout circuit 41 to accommodate a third console.

When a given surveillance unit is reset by pushing one of the pushbuttons of the group 21 associated with display monitor B, a separate contact is closed such as the contact 37 connected to the flip-flop FF_1 in FIG. 2. Ganged with the contact of the pushbutton 37 of FIG. 3 is a contact 37' (not shown) corresponding to the contact 36' ganged with the pushbutton 36 of FIG. 3 in order that the corresponding relay of the lockout circuit 41 may be deenergized in the same manner in which the relay K_1 is deenergized by the contact 36'. However, if the flip-flop FF_1 is reset from the group of pushbuttons 21 associated with display monitor B not only must the contact of the pushbutton 37 and the associated contact 37' (not shown) be closed, but also a contact 37'' must be closed to deenergize the relay K_{12} if the relay K_{11} has been deenergized. In that manner, once the composite video signal routed to the monitor A has been cut off by resetting the alarm flip-flop associated therewith, the monitor A is no longer locked out, but any composite video signal being routed to the display monitor B will not be disturbed by having all of the relays K_1 through K_{10} of the lockout circuit 40 deenergized since the relay K_{12} is self-locking. Thus, if the composite video signal being routed to the display monitor B is cut off (by having its associated alarm flip-flop reset) before another alarm is received to energize one of the relays K_1 through K_{10} of the lockout circuit 40, the relay K_{12} is deenergized in order to lock out the entire lockout circuit 41 until the next alarm circuit has succeeded in routing its associated composite video signal to the display monitor A. In that manner the display monitor A is always preferred by the lockout circuits 40 and 41, and the display monitor B is used only when a composite video signal is being routed to the display monitor A.

RANDOM NOISE SUPPRESSION AND BRIGHTENING MOVING TARGET OUTLINE

A system for minimizing false alarms which could occur from random noise will now be described with reference to FIGS. 8 and 9. It comprises an electronic circuit in the noise suppressor 32 (FIG. 2) which may be used to extract (detect) a target signal from the statistically distributed random noise at the output of the MTI tube 27 where successive picture frames are continuously compared on a line-to-line and element-to-element basis, thereby obtaining an indication of any motion within the scene.

In such a system, in the event that one "frame" is identical with the next, every video element of every line will be identical and all video signal elements will exactly cancel in the MTI tube 27 with no net uncancelled output in the frame. When motion has occurred within a scene, those picture elements associated with the moving object will be different from one frame to the next; MTI tube cancellation will therefore be incomplete or nonexistent in those areas, and uncancelled video signals will appear at the output of the MTI tube. As noted hereinbefore, this video output may then be threshold detected and used to trigger the alarm flip-flop FF_1 (FIG. 2) which signifies that an intrusion has been made. However, a problem exists since system-generated random noise may look like uncancelled video and therefore may also trigger the alarm flip-flop. As the detection is made more sensitive by lowering the threshold level, the false alarm rate increases rapidly.

The noise suppressor 32 provides an automatic correlation analysis of each output from the threshold detector 31 by searching for a potential target at the same place for three successive scanned lines. The premise is that for objects of reasonable size (several resolution elements), in order for a signal to represent a valid intrusion, it must occur at approximately the same location for three successive scanning lines. Although this correlation approach reduces the "detection" resolution of the system by a factor of three below visual resolution of the system by a factor of three below visual resolution, it can reduce the false alarm rate by a factor of 10^6. This order of effective target-to-noise improvement in the target detector makes feasible a high-sensitivity, low false alarm rate, automatic surveillance and intrusion detection system.

The noise suppressor 32 is shown in the block diagram of FIG. 8. It a series of three units, 1, 2 and 3, each of which searches for signal correlation for three successive lines. However, unit 2 does not search until unit 1 is engaged in a search, and unit 3 does not search until both units 1 and 2 are engaged in a search. Each unit will thus search for signal correlation of a different moving target. Additional units may be added, but for a typical application three units are considered adequate to accommodate the expected number of noise impulses on a given line. For an application expected to have more noise in the video signal producing output signals from the threshold detector 31 (FIG. 2), more units will be required.

The input video signals supplied to the three units are obtained from the threshold detector 31 located at the output of the MTI tube 27. These signals represent target signals and noise impulses whose amplitudes exceed the predetermined adjustable threshold level. Before being applied to the three units, these random impulses are all reshaped into 1-microsecond pulses of fixed amplitude by a pulse shaper 101, such as a monostable multivibrator.

When a reshaped video pulse is received, it passes through a gate 102 of unit 1 and triggers a pair of monostable multivibrators (MMVs) 103 and 104. The MMV 103 triggers on the leading edge of the reshaped video pulse, and has a period slightly less than the picture line period. The MMV 104 triggers on the trailing edge of the pulse and generates a period slightly longer than the line period. Complementary outputs of the two MMVs are compared by an AND-gate 105 to produce a LOOK signal which brackets the time interval in the succeeding line at which real target video can be expected to reappear. This LOOK signal is adjusted in width by controlling the two MMV periods, and is selected to give the desired target-to-noise incidence ratio, consistent with target-tracking capability. In a typical application, this width may be set between 5 microseconds and 20 microseconds.

The LOOK signal enables a gate 106 at the input of a second pair of MMVs 107 and 108. If another reshaped video pulse occurs during the LOOK signal interval, it will pass through the enabled gate 106 and trigger the second MMV pair. This pair will then in turn generate a second LOOK signal which will enable a gate 109 to trigger a third pair of MMVs 110 and 111. If a "triple coincidence" is obtained by having a third video pulse occur within the second look gate interval, the third pair of MMVs will be triggered, signifying the presence of a real target.

When either the second or third pairs of MMVs are triggered, their outputs are combined through an OR-gate 112 to generate an INHIBIT signal to disable the gate 102 and thereby disable the first pair of MMVs 103 and 104.

An enable gate 113 enabled by the second and third pair of MMVs (via AND-gates 114 and 115, and OR-gate 116) allows reshaped video pulses (other than those triggering the first MMV pair) to be fed to a video adder 117 (FIG. 2) via an OR-gate 122 as saturated video to serve in brightening or outlining the potential target on the visual display.

AND-gates 118, 119 and 120 receive the true output signals of the respective MMVs 103, 107 and 110, and the true output signals of the respective MMVs 104, 108 and 111 to transmit through an OR-gate 121 a signal which enables unit 2 to start a search for a possible second moving target signal in the same line, but only for the period of time not being tracked by

unit 1 as shown by the timing diagram of FIG. 9. The fast-sweep signal defines the successive line or raster scanning periods, but only the reshaped video pulses are applied to the three units since the timing for tracking moving objects is provided in the three units by RC timing circuits in the multivibrators. A first pulse A triggers the first pair of multivibrators 103 and 104 to generate a look signal at the output of gate 105. A second pulse B occurs, but not during the LOOK signal from the gate 105. Therefore, the second pair of multivibrators 107 and 108 is not triggered. When the first pair of monostable multivibrators has reset, it may be triggered again by a subsequent reshaped video pulse, but only one which occurs in a period not being tracked by units 2 and 3. That blanking of unit 1 during tracking periods of units 2 and 3 is achieved by signals from units 2 and 3 similar to a signal at the output terminal of the OR-gate 116 of unit 1 to unit 3.

The output of the OR-gate 121 enables the unit 2 during a period from the trailing edge of the pulse A to the leading edge of the LOOK signal from gate 105 in order to search for a moving target except during the tracking period of the unit 1. That is accomplished by enabling a gate 123 via OR-gate 124 when the output of gate 121 is high except during periods being tracked by unit 3 and other periods defined by the output signal of an OR-gate 125 which functions in the same manner as the OR-gate 112 in unit 1. The inhibit functions of input signals to gates 102 and 123 are represented by a small circle.

If a pulse occurs while gate 124 is enabled, such as pulse B, a first pair of MMVs (126, 127) is triggered to produce a LOOK signal at the output of a gate 128 to enable a gate 129. The sequence of operation is then the same as for unit 1 in tracking a target. If a pulse occurs during the LOOK signal at the output of the gate 128, such as pulse C, a second pair of MMVs (130, 131) is triggered in unit 2 to generate a look signal at the output of a gate 137. A pulse D which occurs during that LOOK signal period, is transmitted through an enabled gate 133 to trigger a third pair of MMVs (134, 135). A LOOK signal from a gate 136 enables the gate 123 via the OR-gate 124 to cause unit 2 to continue to track the moving object. It should be noted that such a recycling signal is not required in unit 1 since its gate 102 is always enabled except during its own LOOK signal periods and those from units 2 and 3. It should also be noted that the LOOK signal moves with the object creating the reshaped video pulses provided the object does not move at a speed so great as to cause a subsequent pulse to fall outside a LOOK signal. Consequently, to ignore objects which move faster then a maximum velocity with which a person can move, such as a large stone thrown into the field of view, the width of the LOOK signals can be adjusted to just include video pulses of a moving object moving at that maximum velocity.

Once the third pair of MMVs has been triggered in any unit, an alarm signal is transmitted through an OR-gate 140 to set the flip-flop FF_1 (FIG. 2). Meantime pulses are transmitted through the OR-gate 122 as second and third pairs of MMVs are triggered in any of the three units. Then pulses are combined in the mixer 117 to enhance (brighten) the outlines of targets being tracked so that once an alarm signal is generated, and the composite video signal is routed to a display monitor, the attention of the operator will be focused on the brightened object. FIG. 9 shows the first two pulses transmitted as a video "outline" output occurring when the third pair of MMVs is triggered in the unit 2 and when the first pair of MMVs is triggered by a pulse F passing through enabled gate 123 enabled by the LOOK signal from the gate 136.

The unit 3 is similar to unit 2 in organization and operation. Therefore, it is not shown except in block form. The significant difference is that it is enabled by the output of OR-gate 137 to search for a moving object at all times once unit 2 starts tracking a moving object except when the unit 2 is tracking (in which case unit 3 is not enabled during the LOOK signal periods of unit 2) and when the unit 1 is tracking (in which case unit 3 is inhibited by the LOOK signal pulses from the unit 1).

From the foregoing it may be appreciated that a surveillance system devised with a noise suppressor as just described has many advantages over simple threshold detection of moving objects. It provides an increase in target-to-noise incidence ratio by a factor of approximately 10^6 to reduce proportionately the false alarm rate. That factor can be increased by providing additional pairs of MMVs in each unit to require 4- or 5-line correlation. Another advantage is the bounded velocity tracking feature noted hereinbefore. Still another advantage is a decrease in the resolution of a moving object such that small objects may be ignored without sacrifice in recognition and identification in the event of an alarm since the entire composite video signal is transmitted to the display monitor. That signal is enhanced in two out of every three lines or rasters scanned along the edge or edges (outline) of a moving object being scanned to attract the operators attention.

The system may be employed successfully without these advantageous features by so controlling the environment that the threshold level of the detector 31 (FIG. 2) 2) can be increased sufficiently to provide the desired signal-to-noise incidence ratio. The noise suppressor 32 may then consist of simply the pulse shaper 101 having its output continually fed to the mixer 117 (FIG. 2) to brighten the moving object. To avoid too much brightness (which may decrease recognition and identification of the moving object), a counter may be provided to transmit to the mixer only every other reshaped pulse, or two out of every three as in the illustrated embodiment. Thus, although a preferred embodiment of the present invention has been disclosed, many modifications may be made without departing from the present invention pointed out in the appended claims.

What is claimed is:

1. In a surveillance and intrusion detection system using a scanning-type sensor to monitor a field of view, the combination comprising:

moving target indicating means for producing electrical signals in response to changes in a video signal from said sensor; and

correlating means for correlating moving target indications on a scanning line basis to provide an output alarm signal indicating the presence of a moving target in said field only in response to a moving target indication in said electrical signals occurring in a predetermined number of successive lines at substantially the same place in each line.

2. Apparatus as defined by claim 1 including a low-level threshold detector coupling said moving target indicating means to said correlating means to provide low-level noise rejection.

3. In a surveillance and intrusion detection system, using a scanning-type sensor apparatus for minimizing false alarms from random noise in a moving target indication signal comprising at least one unit, each having:

an ordered plurality of gating means, each responsive, when enabled, to a received pulse in said signal for generating an output signal having its center at substantially the same place said received pulse occurred but in the next succeeding scan of said sensors;

the second of said gating means being enabled to generate an output signal in response to a pulse received during the time interval of the output signal generated by said first gating means, and the remaining said gating means enabled to generate an output signal in response to a received pulse during the time interval of the output signal generated by the next preceding one of said ordered plurality of gating means; and

means for producing an alarm indicating a target present only when the last of said ordered plurality of gating means produces an output signal.

4. Apparatus as defined in claim 3 in which said units are ordered and interconnected, a succeeding one of said ordered units being enabled to respond to pulses in said signal when said next preceding unit is engaged in sensing and correlating a series of line scan pulses, except during the time interval of the output signals from said gating means produced by any

preceding units, whereby a plurality of moving targets may be correlated during the same line scans.

5. Apparatus as defined in claim 4 wherein each of said gating means comprises:

a pair of monostable multivibrators triggered by a pulse, one multivibrator having the characteristic of returning to its stable condition in slightly less then a line-scanning period and one having the characteristic of returning to its stable condition in slightly more than a line-scanning period; and

means for generating said output signal in concurrence with a received pulse occurring while one of said multivibrators is still in its unstable condition after the other of said multivibrators has returned to its stable condition.

6. Apparatus as defined in claim 4 and further comprising video display means, video signal gating means for gating signals to said display means, and means responsive to signals of said gating means of said units for enabling said video signal gating means to translate all but the first of a cyclic sequence of said received pulses to said video display means, for addition to a video signal from said sensor being displayed, to brighten an outline of a moving target to enhance visual moving target detection.

7. An a surveillance and intrusion detection system using a scanning-type sensor to monitor a field of view, a moving target indicating means to produce pulses on a line-by-line basis for a moving target, and a low-level threshold detector for discriminating said pulses from low-level noise, apparatus for discriminating said pulses from high level noise, apparatus for discriminating said pulses from high-level noise including a unit having an ordered plurality of gating means, the number of lines being equal to the number of said gating means, each said unit comprising:

a first gating means generating an output signal, in response to a received pulse, for enabling a second gating means at substantially the same place said pulse occurred but in a next succeeding scan, said second gating means generating an output signal, in response to a received pulse, for enabling a third gating means, the remainder of said ordered plurality of gating means each generating an output signal, in response to received pulse, for enabling a next succeeding gating means at substantially the same place said pulse occurred but in a next succeeding scan, until the last of said gating means generates its output signal in response to a received pulse; and

means responsive to the output signal of the last of said ordered plurality of gating means to generate an alarm.

8. Apparatus as defined in claim 7 wherein each of said gating means comprises:

a pair of monostable multivibrators triggered by a received pulse, one multivibrator having the characteristic of returning to a stable condition in slightly less than a line-scanning period and one having the characteristic of returning to a stable condition in slightly more than the line-scanning period; and

means for generating said output signal in concurrence with a pulse received while one of said multivibrators is still in its unstable condition after the other of said multivibrators has returned to its stable condition.

9. Apparatus as defined in claim 8 and further comprising video display means, video signal gating means for gating signals to said display means, and means responsive to output signals of said gating means for enabling said video signal gating means to translate all but the first of a cyclic sequence of said received pulses to said video display means, for addition to a video signal from said sensor being displayed, to brighten an outline of a moving target to enhance visual moving target detection.

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