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OR 3,678,512

X7048T (3)

X7006C
X7045H

Fergus

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[45] July 18, 1972

[54] **TELEMONITORING SYSTEM**

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[73] Assignee: **The United States of America as represented by the United States Atomic Energy Commission**

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[52] **U.S. Cl.** ....**340/408,** 340/151, 340/167 A, 340/206, 340/416

[51] **Int. Cl.** **G08b 26/00**

[58] **Field of Search**............340/408, 206, 151, 167 A, 152 R

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[57] **ABSTRACT**

A multistation monitoring system is interconnected by a single cable. Pulses are transmitted over the cable by a signal generator. Each station counts the pulses and upon the receipt of the appropriate pulse each station changes the pulse width according to the data to be transmitted. Provision is also made to transmit control pulses which can be used to activate controls at remote locations.

5 Claims, 7 Drawing Figures

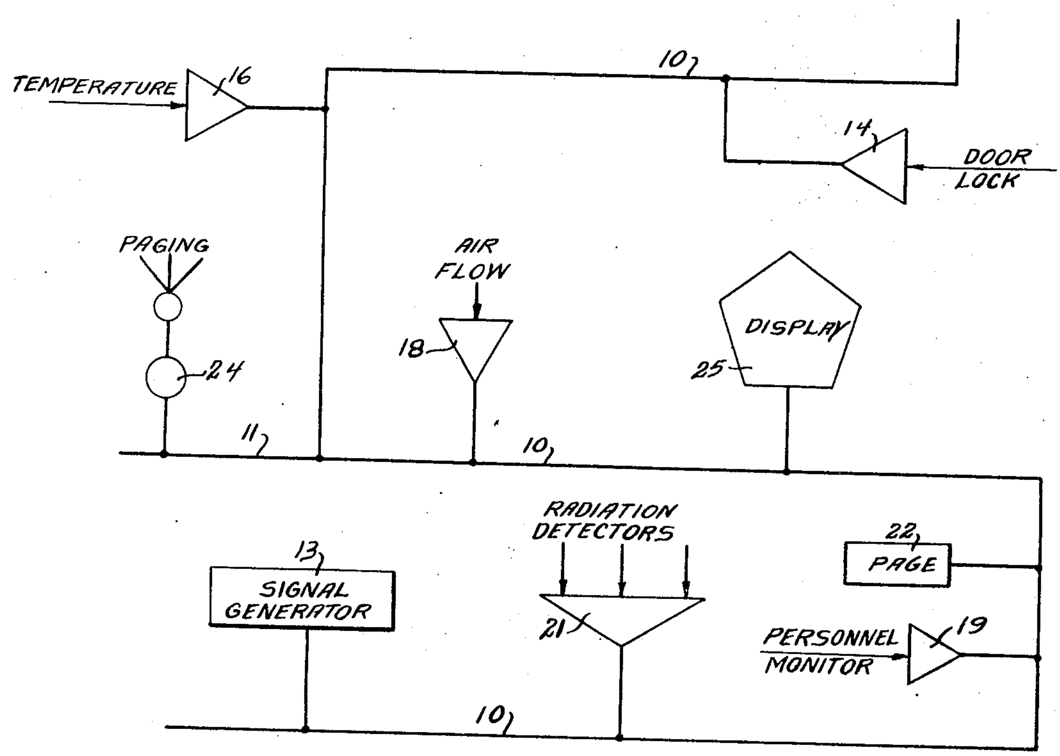

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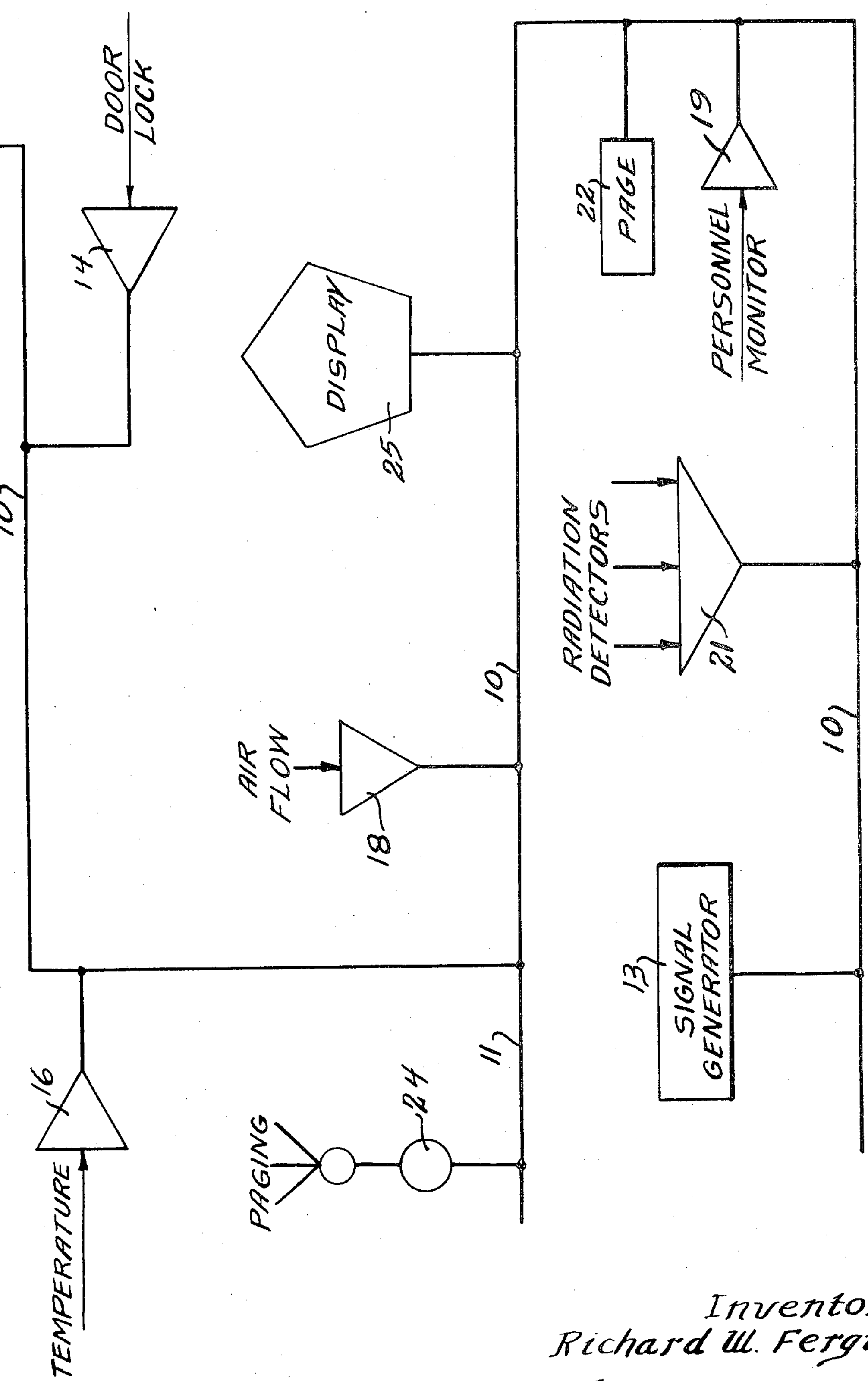
Fig-1



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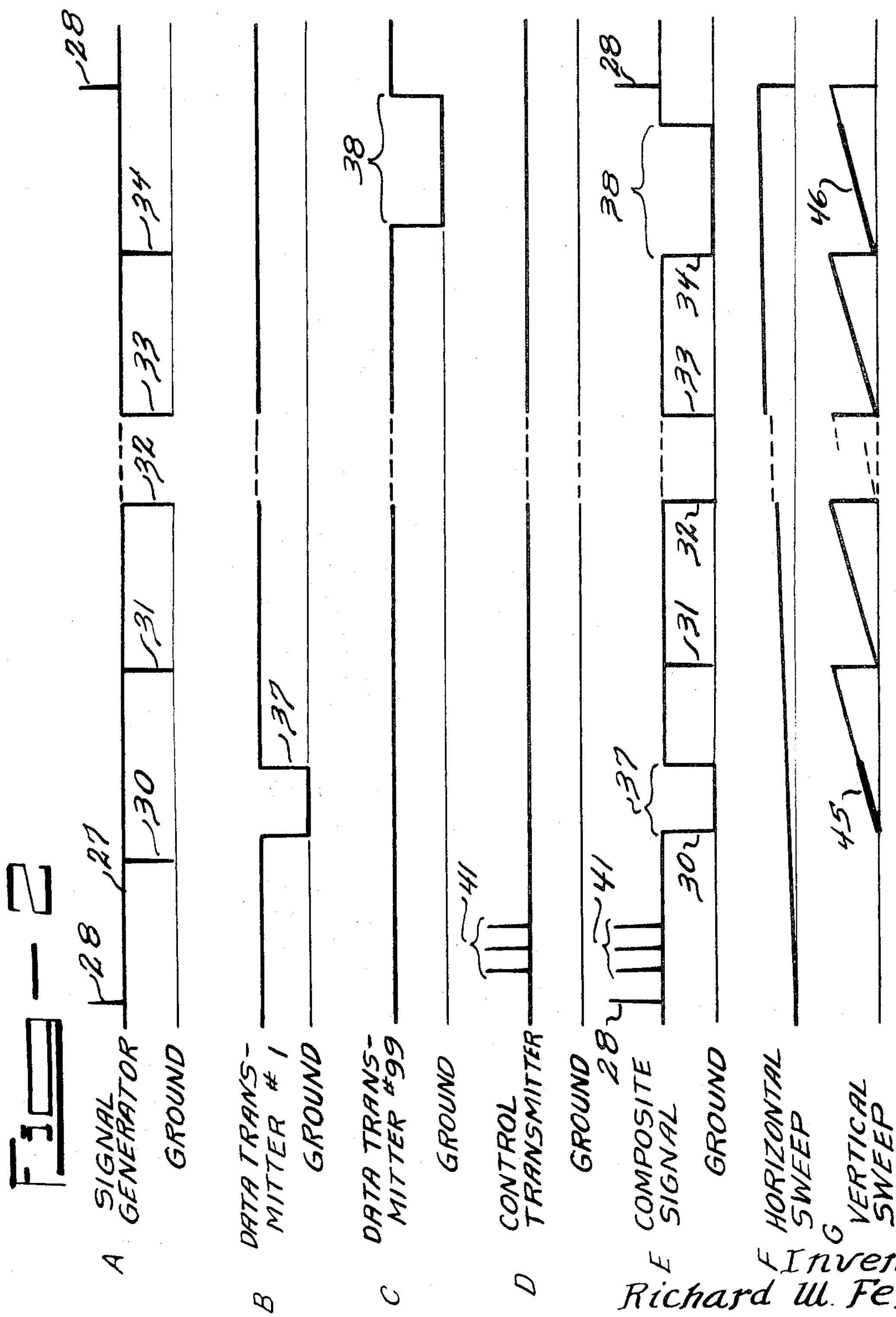

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Fig-3

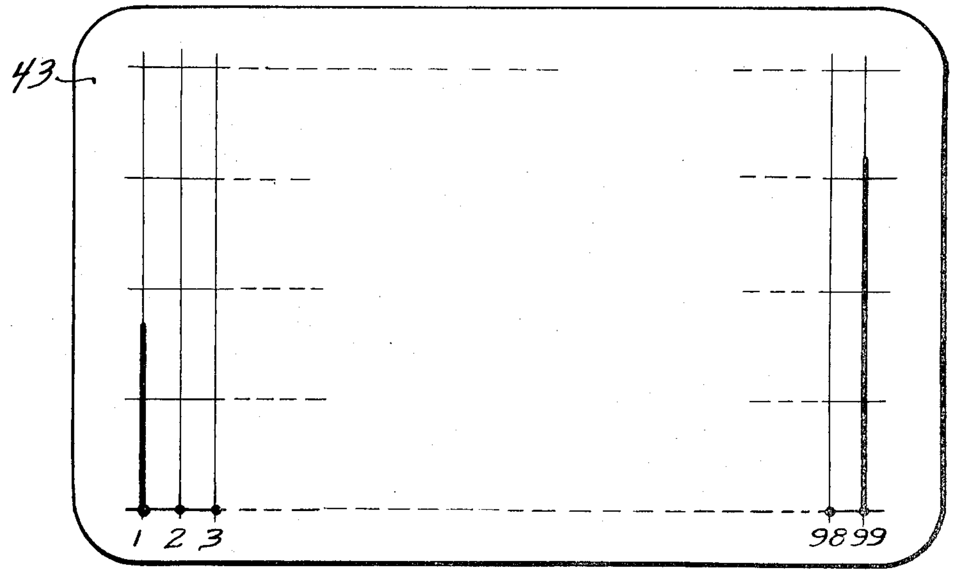
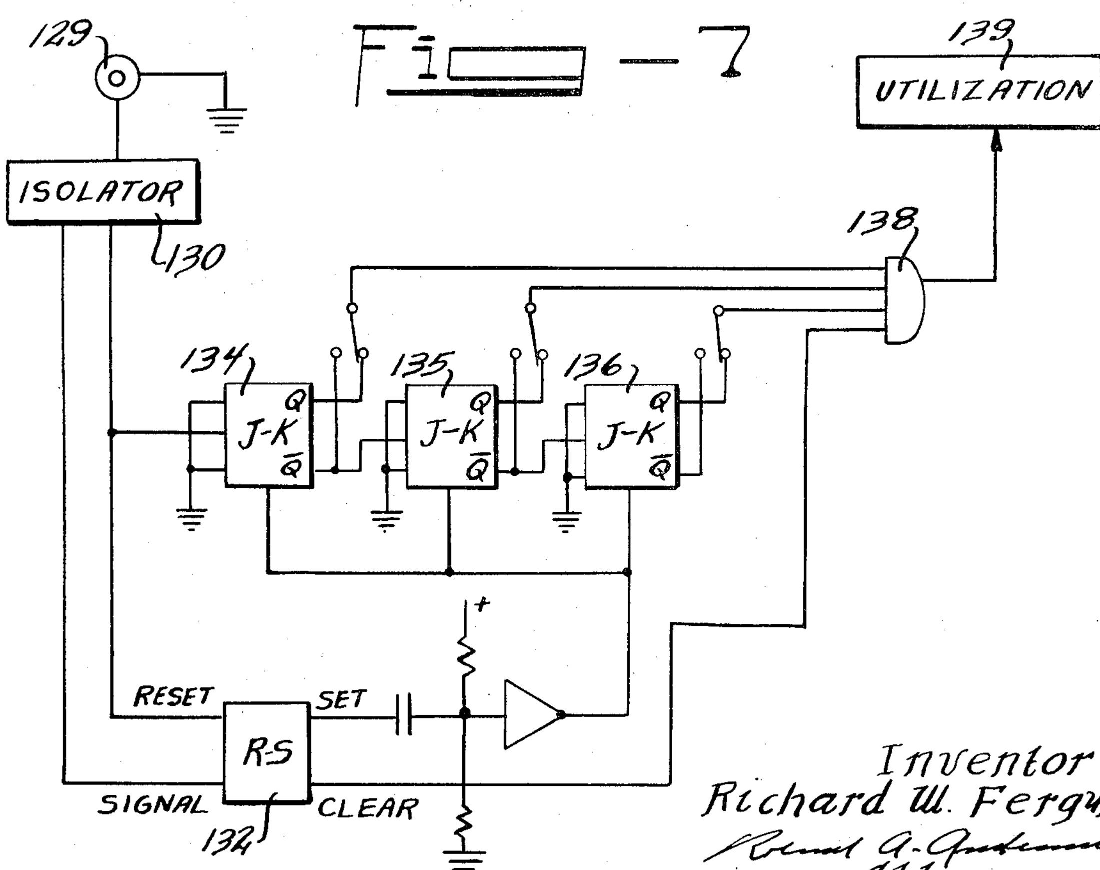


Fig-7



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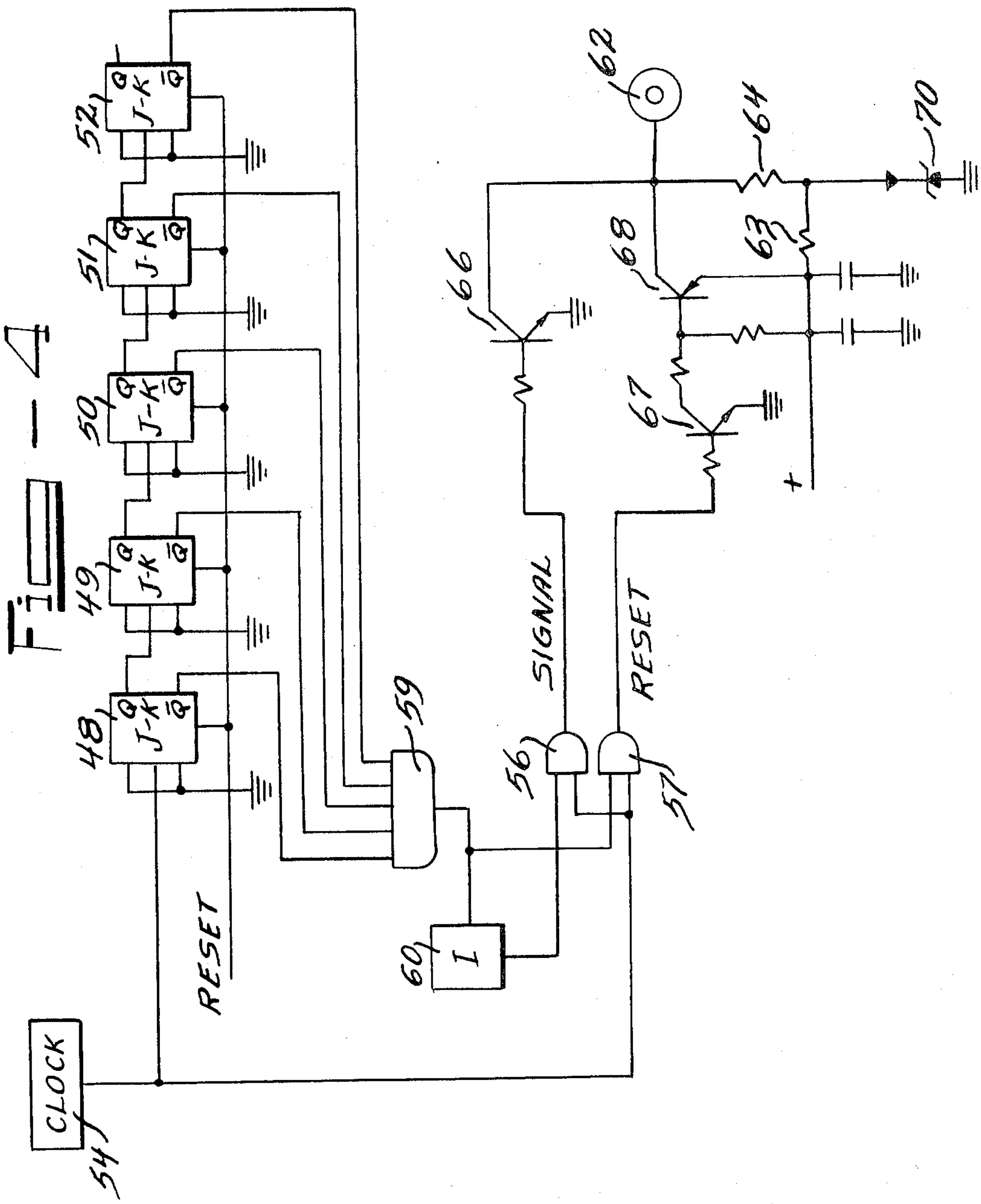

Fig-4

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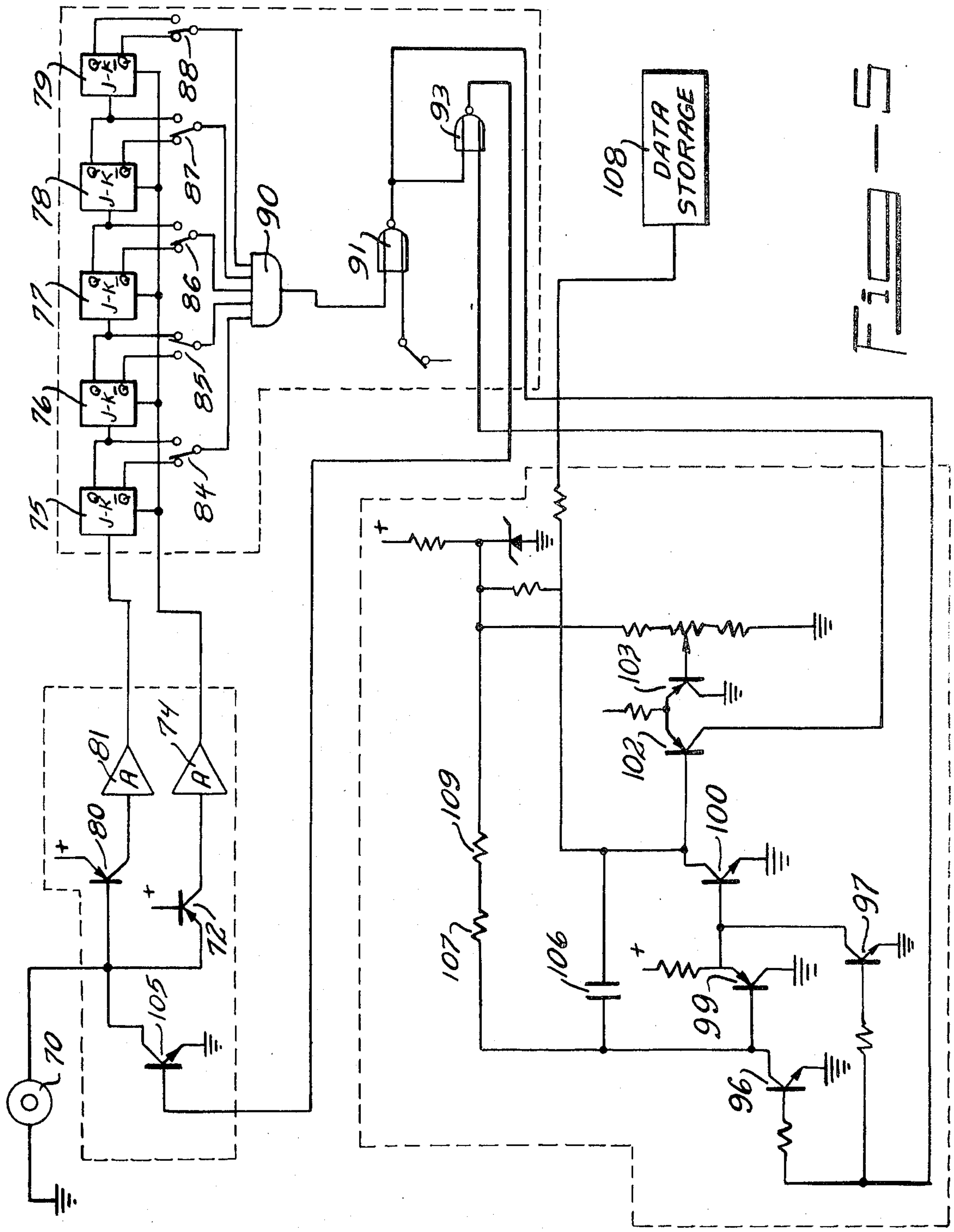

Fig-5

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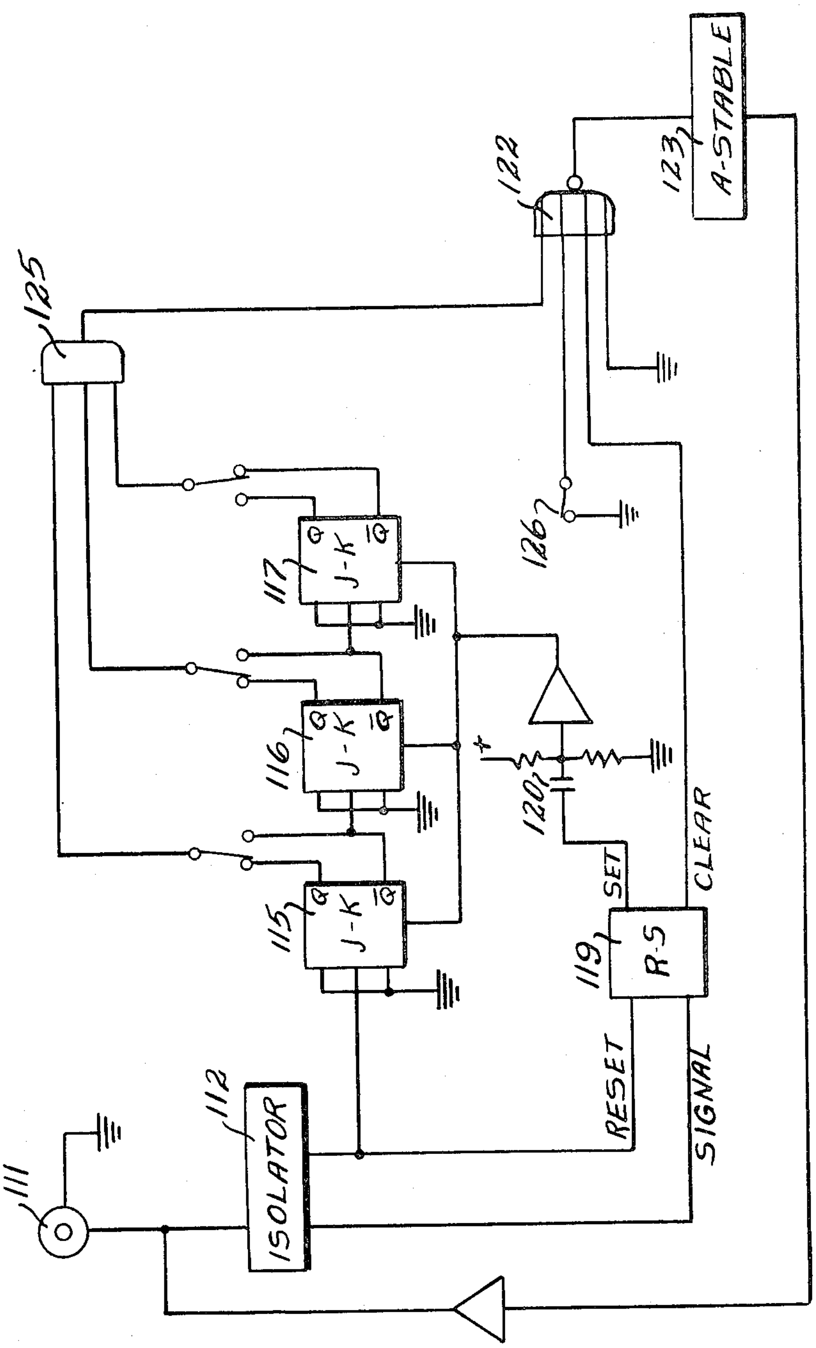
Fig—6



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TELEMONITORING SYSTEM

CONTRACTUAL ORIGIN OF THE INVENTION

The invention described herein was made in the course of, or under, a contract with the United States Atomic Energy Commission.

BACKGROUND OF THE INVENTION

As factories and laboratories become more complex, monitoring instrumentation must be expanded to meet the demands of safety, process control and security. The information which is to be monitored has been collected from various locations by different means. Personnel have been used to read meters, check machines or perform routine operations at periodic intervals. The speed and accuracy of this method is not sufficient for many applications. Electrical and electronic systems have been used but they have been complex and costly and/or have had a limited number of information channels.

For an instrumentation system to be useful, it must be versatile and capable of adapting to the changing demands of the installation. The locations of both the monitoring and readout units are often changed with building expansion. Additional monitoring functions can appear as the plant operation is modified and the monitoring system must be able to incorporate the unknown future requirements.

It is therefore an object of this invention to provide an improved monitoring system.

Another object of this invention is to provide a monitoring system in which a single wire line connects all the stations.

Another object of this invention is to provide a monitoring system in which stations can be added or removed as desired without replacement of the system.

Another object of this invention is to provide a monitoring system in which control signals can be sent over the monitoring wire line.

SUMMARY OF THE INVENTION

In practicing this invention a multistation monitoring system is provided in which a single cable connects each of the stations. A signal generator establishes a first voltage level in the cable. The signal generator acts to generate a reset pulse in the cable at a second voltage level followed by a plurality of signal pulses at a third voltage level. The first voltage level is between the second and third voltage levels and the signal pulses have a predetermined pulse width. Each station connected to the cable is responsive to a particular one of the signal pulses and acts to change the width of the signal pulse according to the data to be transmitted. Control transmitters can also be connected to the cable to actuate control receivers by adding extra reset pulses before the first signal pulse. Display units responsive to the pulse width of the signal pulses display the data from the data transmitters.

DESCRIPTION OF THE DRAWINGS

The invention is illustrated by the drawings, of which:

FIG. 1 is a block diagram of the monitoring system of this invention;

FIG. 2 shows the waveforms at various points in the system;

FIG. 3 shows the display of information;

FIG. 4 is a partial block diagram and partial schematic of the signal generator;

FIG. 5 is a partial block diagram and partial schematic of a data transmitter;

FIG. 6 is a partial block diagram and partial schematic of a control transmitter; and

FIG. 7 is a partial block diagram and partial schematic of a control receiver.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, there is shown a block diagram of the arrangement of the communications system. A cable **10** is positioned throughout a desired area to provide a communication path. A branch line **11** may also be used if required to cover the area. The cable may be a coaxial cable to give the desired frequency response or any other suitable type of cable may be used. Various elements are connected to the cable through isolators where required. The elements may be connected during initial cable installation or at a later date. Elements may be removed or replaced at any time without affecting the system.

The system includes a signal generator **13** which provides most of the required pulses and various other control receivers, control transmitters and data transmitters. For example, data transmitter **14** provides data on the status of a door lock, data transmitter **16** on the magnitude of temperature, data transmitter **18** on the magnitude of air flow, data transmitter **19** on the status of personnel and data transmitter **21** on the status of radiation detectors. A control transmitter **22** can be used to actuate a paging alarm **24**. Information from various data transmitters can be displayed on various display units connected to cable **10** and represented by display unit **25**.

Referring to FIG. **2**, there is shown the waveforms of the control and information pulses on cable **10** of FIG. **1**. In this example, the signal generator applies an intermediate voltage level **27** (waveform A, FIG. **2**) to the cable. At the beginning of each period of operation the signal generator transmits a reset pulse **28** during which the voltage on the cable is raised to a value greater than the intermediate value. The reset pulse is followed by a series of signal pulses **30** during each of which the voltage level is reduced to a value lower than the intermediate value (in this example, 0). The signal pulse is sent for each of the stations on the lines to be interrogated.

In curve A five signal pulses **30–34** are shown by way of example. Signal pulses **30–32** represent the first three remote stations to be interrogated. Signal pulses **33** and **34** represent the last stations to be interrogated, for example stations **98** and **99**. Between the signal pulses **32** and **33** there occur signal pulses **4** to **97**. Depending upon the number of stations required, the total number of stations may greatly exceed **99**. The signal generator may include the capability of developing more signal pulses than are required to allow for future expansion of the system. Extra signal pulses not required by the number of stations on the system are ignored by the remote stations on the line.

Each of the data transmitters includes a counter which is reset to zero upon receipt of the reset pulse **28**. As the signal pulses are received, they are counted and then each data transmitter is activated upon the receipt of a particular signal pulse. Thus data transmitter one would be activated upon receipt of the first signal pulse **30**, data transmitter **2** on receipt of the second signal pulse **31** and data transmitter **99** upon receipt of the 99th signal pulse **34**.

When a data transmitter is activated, it acts to prolong the signal pulse according to the data being sent. The first data transmitter lengthens the signal pulse as shown by pulse **37** waveform B and the 99th data transmitter lengthens the signal pulse as shown by pulse **38** waveform C. In this example, it is assumed that data transmitters activated by signal pulses **31**, **32** and **33** do not have data to transmit.

The pulse **37** from data transmitter one may represent a temperature at some point with the length of the pulse **37** being proportional to the temperature. Pulse **38** from data transmitter **99** may represent a radiation level with the length of pulse **38** being proportional to the magnitude of the radiation level.

Waveform D illustrates the operation of the control transmitter. When the control transmitter is activated, it develops a series of reset pulses after the reset pulse **28** and before the signal pulse **30** from the signal generator. For example, control transmitter three will generate three extra reset pulses. The control receivers count the extra reset pulses and the control receiver designated by the number of reset pulses **41** (in this example, control receiver three) will be activated upon receipt of the first signal pulse **30**.

The composite signal which will appear on the cable 10 of FIG. 1 is shown in waveform E. This waveform is the combination of the waveforms in A, B, C and D and the same reference numerals are used to identify the different portions of the waveform. It should be noted that the leading edge of the resultant signal pulses of waveform E are formed by the signal pulses 30–34 of waveform A, while the elongated portion of the signal pulses of waveform E are formed by the data transmitter as shown by 37 and 38 in waveforms B and C.

In FIG. 3, there is shown a CRT display which may form a portion of the display unit 25 of FIG. 1. The face of the CRT 43 is divided into a plurality of vertical lines (in this example, 99) with each vertical line representing a separate data transmitter. In FIG. 2 waveform F shows the horizontal sweep for the CRT. The electron beam is swept horizontally across the face 43 of the CRT once for each period between successive reset pulses. At the time of each signal pulse the vertical sweep causes the electron beam to rise vertically as shown by the vertical sweep waveform G. The Z axis of the CRT is modulated by the signal pulses appearing on cable 10 of FIG. 1 so that there is an output on the CRT only during the period of a signal pulse. Thus the first data transmitter causes the signal pulses 30, 37 to be lengthened and the CRT is bright during the portion of the vertical sweep 45. The 99th data transmitter lengthens the signal pulses 34, 38 so that the CRT is brightened during the portion of the vertical sweep 46. Signal pulses 31–33 are not lengthened so that the outputs from these data transmitters are indicated by dots on the face of CRT 43. The face of CRT 43 is suitably calibrated so that the magnitude of the data is shown.

Referring to FIG. 4, there is shown a partial block diagram and partial schematic of the signal generator. A plurality of J-K flip-flops are connected in series for toggle operation. The number of flip-flops used is determined by the number of data transmitters in the system. Flip-flops 48–52 are driven by a clock 54 which is also connected to AND gates 56 and 57. The $\bar{Q}$ outputs of each of the J-K flip-flops 48 to 52 are connected to 5 input AND gate 59. Thus, when flip-flops 48 to 52 are all in the $\bar{Q}$ state (number 0), there will be an output from AND gate 59 which will enable reset AND gate 57. This output from AND gate 59 is inverted in inverter 60 and the inverted output disables signal AND gate 56. When any one of the flip-flops 48 to 52 is not in the $\bar{Q}$ state (number other than 0), there will be a 0 output from AND gate 59 and reset AND gate 57 is disabled. The 0 output from AND gate 59 is inverted in inverter 60 and acts to enable the signal AND 56. Thus a clock pulse appears at the output of AND gate 57 when the flip-flops 48-52 indicate the number 0. A series of clock pulses appear at the output of AND gate 56 when the flip-flops 48-52 indicate a number other than 0.

A positive voltage is applied through resistors 63 and 64 to the connector 62 which is connected to cable 10 of FIG. 1. With transistors 66, 67 and 68 biased off, the voltage level at connector 62 is determined by zener diode 70. The pulse from AND gate 57 acts to bias transistors 67 and 68 to conduction, causing the voltage at connector 62 to rise, producing the reset pulse. The pulses from AND gate 56 act to bias transistor 66 to conduction, causing connector 62 to be grounded, producing the signal pulses.

Referring to FIG. 5, there is shown a partial schematic and partial block diagram of a data transmitter of the system. Connector 70 is coupled to the cable and receives the signal pulses and the reset pulses. The reset pulse is coupled through transistor 72 and amplifier 74 to the reset line of J-K flip-flops 75–79 to reset each flip-flop to $\bar{Q}$. The signal pulses are coupled to the input of J-K flip-flop 75 through transistor 80 and amplifier 81.

J-K flip-flops 75–79 are connected to form a counter. The Q and $\bar{Q}$ outputs of the flip-flops are connected to selector switches 84-88 which are set according to the number of the signal pulse which will activate the unit. In this example, switches 84 and 86–88 are set to $\bar{Q}$ and switch 85 is set to Q so that the data transmitter will be activated on the second signal pulse through AND gate 90. When the counter receives the second pulse, there will be an output from AND gate 90 which disables NOR gate 91. At all other times there will be no output from AND gate 90 and NOR gate 91 will be enabled. With NOR gate 91 enabled, transistors 96 and 97 are biased to saturation and transistors 99, 100 and 102 are biased off. With transistor 102 biased off, transistor 103 is biased on. NOR gate 93 is disabled by the output from NOR gate 91. With NOR gate 93 disabled, transistor 105 is biased off. The voltage across capacitor 106 is determined by the voltage from data storage unit 108. The voltage from data storage unit 108 is determined by the magnitude of the data which is monitored by the particular data-monitoring unit.

When the counter (J–K flip-flops 75–79) counts a predetermined number of signal pulses (2 in this example), NOR gate 91 is disabled and NOR gate 93 is enabled. With NOR gate 93 enabled, transistor 105 is biased to saturation and the cable is clamped to ground even after the signal pulse is removed from the cable. With NOR gate 91 disabled, transistors 96 and 97 are biased off and transistors 99, 100 and capacitor 106 will form a linear integrator. As the current through resistors 107 and 109 discharges capacitor 106, the bias voltage applied to transistor 102 drops until transistor 102 is biased to conduction and transistor 103 is biased off. The bias point at which this occurs is determined by the bias setting of transistor 103. The time it takes capacitor 106 to discharge to this point is determined by the voltage across capacitor 106 (the magnitude of the data received), the value of capacitor 106, and the current through resistors 107 and 109.

When transistor 102 is biased to conduction, NOR gate 93 is disabled and transistor 105 is biased off. This releases the clamping action of transistor 105 and the ground is removed from the cable. Thus the length of time the ground on the cable is maintained is determined by the magnitude of the data received from data storage 108.

In FIG. 6, there is shown the control transmitter. The control transmitter is coupled to the cable through connector 111 and the reset and signal pulses are coupled to an isolator 112 which acts to separate the signal and reset pulses. J–K flip-flops 115–117 form a counter which is set for five counts in this example. Before receiving the reset pulse, R–S flip-flop 119 is in the clear position, NOR gate 122 is disabled and A-stable multivibrator 123 is turned off. Upon receipt of the reset pulse, R–S flip-flop 119 is in the set state and J–K flip-flops 115-117 are set to $\bar{Q}$. With the disabling signal from R–S flip-flop 119 removed, NOR gate 122 turns on A-stable multivibrator 123 which develops a series of pulses. The pulses from A-stable multivibrator 123 are the same as the reset pulse and are coupled to the cable through connector 111.

The pulses from A-stable multivibrator are coupled to the J–K flip-flops 115–117 through isolator 112 and are counted. When the count reaches the desired number, an output is developed by AND gate 125 which disables NOR gate 122, turning off the A-stable multivibrator 123. Switch 126 is used to turn the control transmitter off if the control signal is not required. Upon receipt of the first signal pulse, R–S flip-flop 119 is changed to the clear position.

FIG. 7 shows the control receiver. Connector 129 is coupled to the cable and receives the signal and reset pulses which are separated by isolator 130. R–S flip-flop 132 is in the clear state after the receipt of a signal pulse. When a reset pulse is received, R–S flip-flop 132 is changed to the set state and the J–K flip-flops 134–136 are set to $\bar{Q}$. J–K flip-flops 134–136 form a counter which counts the subsequent reset pulses (those developed by the control transmitter). In this example, the counter is set for five so that, if five pulses are received, three enabling signals (one from each of flip-flops 134–136) are coupled to the four input AND gate 138. When a signal pulse is received, R–S flip-flop 132 is changed to the reset state and a fourth enabling signal is applied to AND gate 138. AND gate 138 is now enabled and an enabling signal is applied from AND gate 138 to utilization circuit 139.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A multistation monitoring system, including in combination, a main two conductor cable connecting all of the stations to be monitored, signal generator means coupled to said main cable for establishing a first voltage level between said conductors of said main cable, said signal generator means further acting to generate a reset pulse at a second voltage level followed by a plurality of signal pulses at a third voltage level and having a predetermined pulse width, said first voltage level being between said second and third voltage levels, a plurality of data-transmitting means coupled to said main cable, said data-transmitting means including data storage means, address means and data-modulating means, said data storage means being adapted to receive data supplied thereto and being responsive thereto to develop a data signal which is a function of the received data, said address means being responsive to a particular one of said plurality of signal pulses to develop an address signal, said data-modulating means being responsive to said address signal and said data signal to maintain said main cable at said third voltage level for a predetermined time after the receipt of said particular one of said plurality of signal pulses to increase said pulse width thereof according to the magnitude of said received data.

2. The multistation monitoring system of claim 1 further including, display means coupled to said main cable, said display means being responsive to said pulse width of each of said plurality of signal pulses to display the information conveyed by said pulse width.

3. The multistation monitoring system of claim 2 further including, control transmitter means coupled to said main cable, said control means being responsive to said reset pulse to develop at least one control pulse and couple the same to said main cable, control receiver means coupled to said main cable, said control receiver means being responsive to a particular number of said control pulses and the first one of said signal pulses to perform a predetermined function.

4. The multistation monitoring system of claim 3 wherein, said display means includes a cathode ray tube having a plurality of vertical lines displayed thereon with each of said vertical lines representing a particular monitoring means, the length of each of said vertical lines being representative of the magnitude of said received data from said monitoring means.

5. The multistation monitoring system of claim 3 further including, a branch cable coupled to said main cable, and at least one of said data-transmitting means, said control transmitter means, said control receiver means and said display means coupled to said branch cable.

* * * * *