United States Patent

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[54] LOW IMPEDANCE REMOTE CONTROL SYSTEM FOR ENGINE ANALYZERS
10 Claims, 2 Drawing Figs.

[52] U.S. Cl. 73/116, 324/19
[51] Int. Cl. G01m 15/00
[50] Field of Search ..... 73/116, 117.3; 324/19, 16 S, 16 T; 307/100, 223

[56] References Cited
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ABSTRACT: A remote control system for use in an internal combustion engine analyzer is described. The system permits a given cylinder of the engine to be shorted as well as a particular display pattern on an oscilloscope to be selected by a switch remotely located with respect to the analyzer. A plurality of gates such as NAND gates, located at the analyzer and controlled by the remote switch selectively transfer high frequency control pulses to a cylinder shorting switch and to an oscilloscope sweep generator located at the analyzer. The remote switch enables a selected NAND gate by controlling a DC voltage level, thereby rendering the remote switch and connecting cable immune from noise.

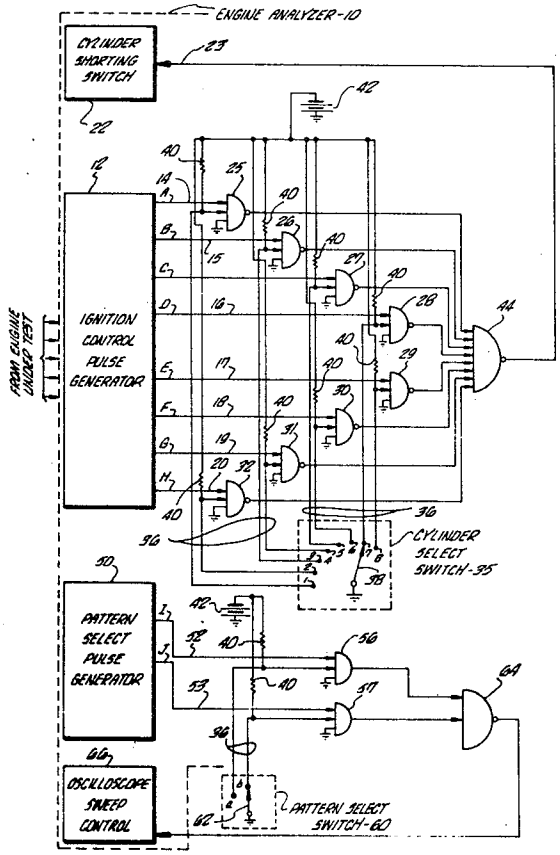
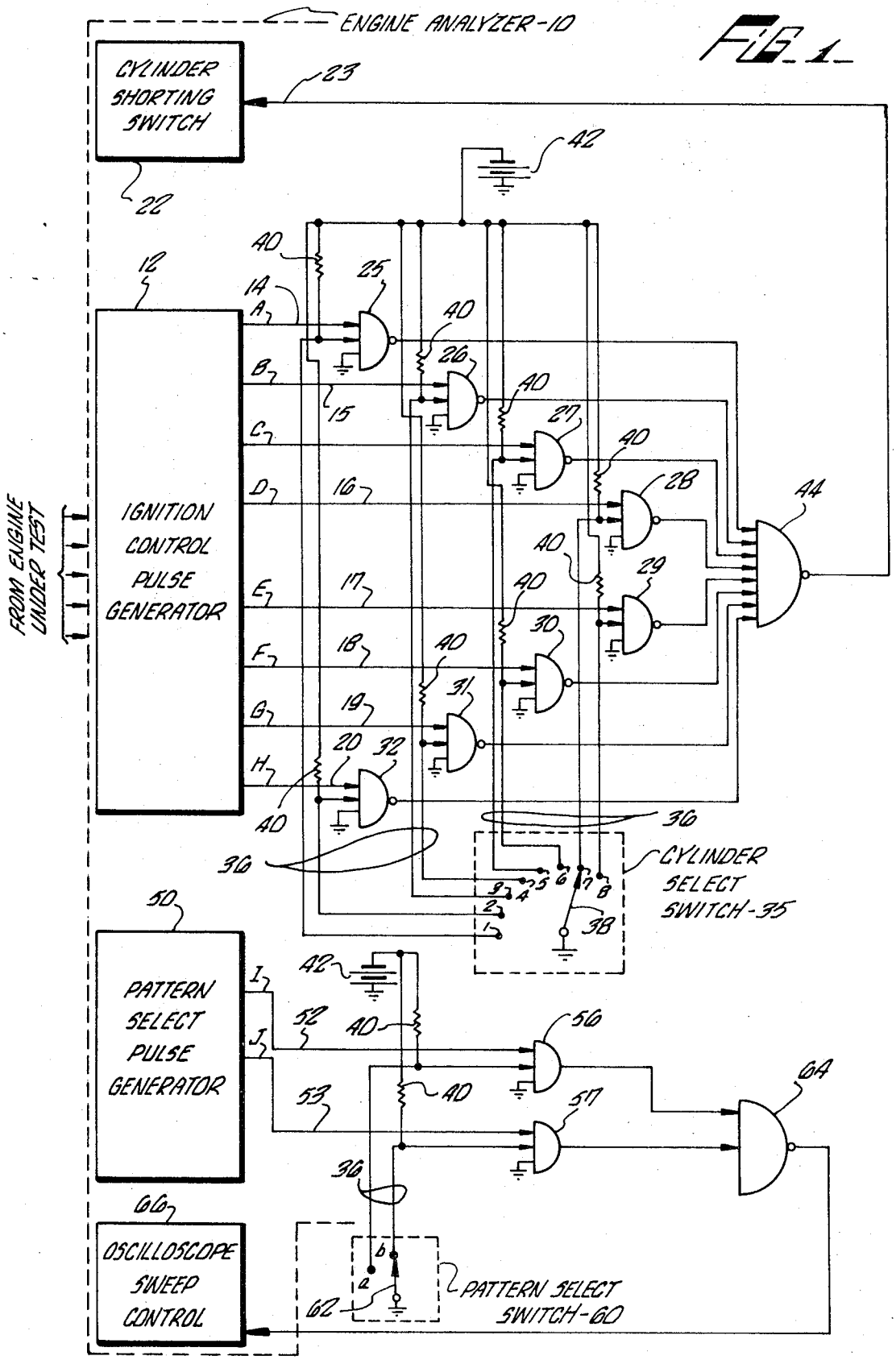


FIG. 1


ENGINE ANALYZER-10
CYLINDER SHORTING SWITCH
23
22
42
40
12
IGNITION CONTROL PULSE GENERATOR
FROM ENGINE UNDER TEST
1A
A
B
C
D
E
F
G
H
15
16
17
18
19
20
25
26
27
28
29
30
31
32
44
36
38
CYLINDER SELECT SWITCH-35
50
PATTERN SELECT PULSE GENERATOR
I
J
52
53
56
57
GA
60
OSCILLOSCOPE SWEEP CONTROL
62
PATTERN SELECT SWITCH-60

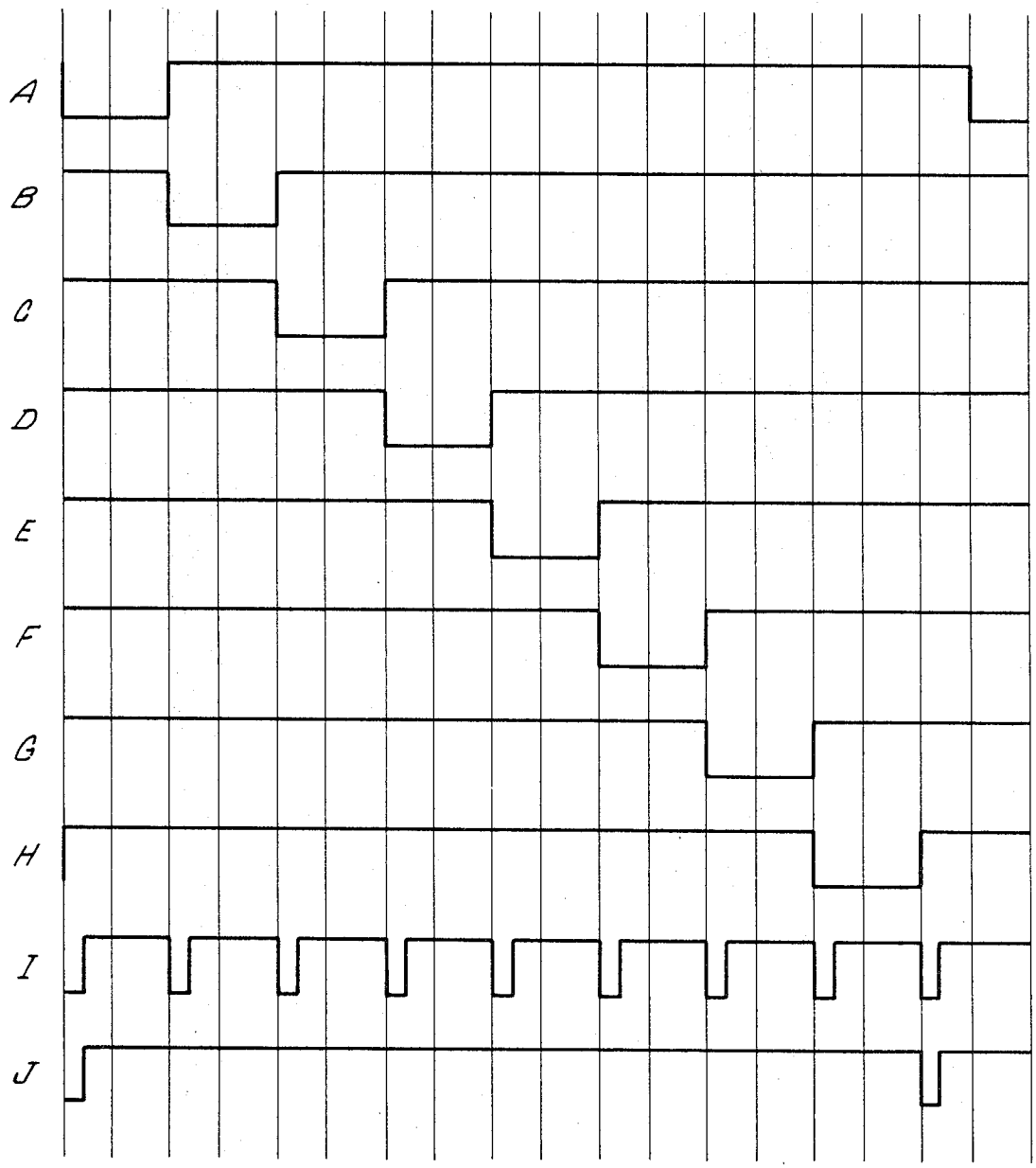


FIG. 2

LOW IMPEDANCE REMOTE CONTROL SYSTEM FOR ENGINE ANALYZERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a remote control system for selectively transferring high frequency signals between electronic components located at a central station and more particularly to such a system for use with an internal combustion engine analyzer.

2. Description of the Prior Art

A number of electronic analyzers have been proposed hereto to indicate various performance characteristics of internal combustion engines and more particularly the function of the ignition system. Such electronic analyzers have provided a measure of the relative power contribution of each cylinder of the engine by rendering any desired cylinder inoperative while the engine is running. These devices of the prior art also employ cathode ray oscilloscopes to provide a visual display of the test data in various patterns. For example, the ignition characteristics of all of the cylinders may be displayed on the oscilloscope in a superimposed pattern, a vertically stacked pattern (with the waveforms separated horizontally on the scope) and in a parade pattern (with the waveforms separated horizontally on the scope).

The prior art engine analyzers have not, however, provided any effective means for permitting a remote control of the cylinder shorting function or the pattern display selection function so that an operator may select the cylinder to be shorted and the display pattern while controlling a vehicle under dynamometer loaded conditions, for example. Conventional remote control techniques in which high frequency control pulses are switched at a remote location are unsatisfactory in engine analyzers due to inherent noise problems to which the connecting cable and the remote switch are subjected. The present invention overcomes the disadvantages of the prior art by providing a remote control system which is immune to noise.

SUMMARY OF THE INVENTION

The present invention provides an apparatus for remotely controlling the cylinder of an internal combustion engine to be shorted, as well as the particular display pattern in which the test data is displayed in an electronic engine analyzer. The engine analyzer includes a pulse generator located at a central station for producing high frequency control pulses in a plurality of output circuits thereof. A controlling means having at least one input circuit is also provided at the central station or console to control selected functions of the analyzer, such as cylinder shorting and/or type of display pattern in response to the control pulses. A gate is individually connected between each pulse generator output circuit and the input circuit of the controlling means. The gates are arranged to transfer the control pulses to the pulse utilization means in response to a first predetermined DC voltage and to inhibit the control pulses in response to a second DC voltage. A multiple conductor cable is connected at one end to each of the gates with the other end of the cable being remotely located from the central station. At least one selector switch is connected to the remote end of the cable and is arranged to apply the first voltage to at least one selected gate. Bias means are located at the central station for applying the second voltage to each of the gates in the absence of the first voltage.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a remote control system for use in an engine analyzer in accordance with a preferred embodiment of the invention; and

FIG. 2 illustrates the waveforms taken at various points in the circuit of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, an engine analyzer **10** located at a central station or console includes an ignition control pulse generator **12** provided with eight output circuits **14—20**. The output circuits of the pulse generator **12** corresponds to respective cylinders of the internal combustion engine under test. The eight output circuits **14—20** represent the cylinders of an eight cylinder engine. Four or six output circuits may be utilized when testing a four or six cylinder engine. The ignition control pulse generator provides a shorting control pulse in each output circuit which corresponds to or brackets the firing time of the associated engine cylinder. The waveforms of the shorting control pulses are illustrated by curves A-H in FIG. 2. Letters corresponding to the waveforms of FIG. 2 are cross-referenced on FIG. 1. Various circuits known to those skilled in the art may be employed to generate shorting control pulses which are synchronized with the engine operation. Circuits for providing such shorting control pulses as well as oscilloscope display pattern control pulses are described in detail in my copending application Ser. No. 792,382, filed Jan. 21, 1969, of common assignee with the present application.

The analyzer **10** also includes a cylinder shoring switch **22** provided with an input circuit **23** and arranged to suppress the cylinder ignition, for example by shorting the primary winding of the ignition coil in response to the application of the shorting control pulses to the input circuit **23**. The output circuits of the ignition control pulse generator **12** are coupled to one input circuit of NAND gates **25—32** as illustrated. The NAND gates **25—32** include a second input circuit which is connected to a remotely located manually operated cylinder select switch **35** by means of a multiple conductor cable **36**. The cylinder select switch **35** includes eight positions (**1—8**), each of which corresponds to a respective cylinder of the engine under test. A rotating arm **38** of the cylinder select switch **35** is grounded as illustrated. The cylinder select switch applies a first predetermined DC voltage, i.e. ground potential, to the second input circuit of a selected NAND gate as determined by the position of the arm **38**.

The second input circuit of each of the NAND gates **25—32** is also connected through a low impedance resistor **40** (e.g. 1,000 ohms) to a source of bias voltage **42**. The bias source, for example, may provide a second predetermined voltage of, for example, 4 volts. An OR gate **44** connects the output circuits of the NAND gates **25—32** to the input circuit **23** of the cylinder-shorting switch **22**.

Each of the NAND gates **25—32** passes the associated shorting control pulses (A-H, FIG. 2) from the first input circuit to the output circuit thereof only when the second input circuit is grounded by the remote switch **35**. Thus only one NAND gate will transfer the shorting pulse to the cylinder shorting switch **22** via the OR gate **44** as determined by the position of the rotating arm **38** of the cylinder select switch **35**. In this manner, any selected cylinder may be shorted by the operator by merely rotating the switch arm **38** of the remote switch **35** to the selected cylinder.

The engine analyzer **10** also includes a pattern select pulse generator **50** which is provided with three output circuits **52—54**. The pulse generator **50** produces three output signals in the respective circuits as illustrated by the waveforms I, J and K in FIG. 2 to control the oscilloscope display pattern. For example, the pattern control pulses I occur at each cylinder ignition and represent an oscilloscope sweep signal which is used to display the ignition waveforms in a superimposed manner. The pattern control pulses J in FIG. 2 occur only when a particular cylinder fires, i.e. the number one cylinder. These control pulses represent an oscilloscope sweep signal which brackets the ignition times of all of the cylinders and is used to display the ignition waveforms in a parade or horizontally spaced pattern on the oscilloscope screen.

The output circuits of the pattern select pulse generator **50** are connected to a first input circuit of two NAND gates **56—**

57 as illustrated. The second input circuits of the NAND gates 56—57 are connected to respective switch contacts *a* and *b* of a remotely positioned pattern select switch 60 by two additional conductors in the cable 36. The pattern select switch 60 is located adjacent the cylinder select switch 35 and includes a grounded rotating arm 62. The second input circuit of each of the gates 56—57 is also connected to the bias source 42 by means of resistors 40. The output circuit of the gates 56—57 is coupled to an oscilloscope sweep control 66 via an OR gate 64. A particular oscilloscope pattern may be selected by rotating the switch arm 62 to ground the second input circuit of one of the NAND gates 56—57.

There has been described a remote control system for an internal combustion engine analyzer which allows the operator to remotely control certain functions while operating the vehicle under test on a dynamometer, for example. Remote switch 35 and the cable 36 carry only direct current signals. This permits each of the cable conductors to be terminated in a low impedance (e.g. ground or less than 1,000 ohms) regardless of the position of the remote switch 35. The input impedance of the NAND of the NAND gates is defined by the 1,000 ohm resistor and the input impedance of the turned on gate. The termination of the cable conductors in a low impedance renders the remote control system immune form noise.

I claim:

1. In a remote control system for a multiple cylinder internal combustion engine analyzer located at a central station which includes an ignition pulse control generating means with an output circuit associated with each cylinder of the engine for providing control pulses in each output circuit and controlling means including cylinder-shorting means having and input circuit and being arranged to suppress the cylinder ignition in response to the application of control pulses to the input circuit thereof, the combination which comprises:

means for providing first and second predetermined voltages;

gating means individually connected between the output circuit of each pulse-generating means and the input circuit of the cylinder-shorting means, each of the gating means being arranged to transfer the control pulses from the respective generator output circuit to the input circuit of the cylinder-shorting means in response to a first predetermined voltage and to inhibit the control pulses in response to a second predetermined voltage;

a multiple conductor cable coupled at one end to each of the gating means, the other end of the cable being remotely located from the central station;

a selector switch connected to the remote end of each of the conductors of the cable, the selector switch and cable being arranged to apply the first predetermined voltage to a selected gating means to suppress the ignition in the respective cylinder; and

means for applying the second predetermined voltage to each of the gating means in the absence of the first predetermined voltage.

2. The combination as defined in claim 1 wherein the first and second predetermined voltages are DC voltages, and the cable includes a conductor individually connected to each gating means and each gating means includes a pair of input circuits, one of the input circuits of each gating means being connected to a respective pulse generator output circuit, the other input circuit of each gating means being connected to separate conductors of said cable for receiving the first predetermined voltage.

3. The combination as defined in claim 2 wherein the selector switch connects the other input circuit of a selected gating means to ground through the cable for transferring signal pulses through the selected gating means and wherein the means for applying the second predetermined voltage includes a source of bias voltage and a low impedance individually connected between the bias voltage and said one input circuit of each of the gating means.

4. The combination as defined in claim 2 wherein the cylinder-shorting means includes a cylinder-shorting switch having an input circuit and arranged to suppress cylinder ignition in response to the application of the control pulses to the input circuit thereof, one of the gating means being connected in series between each output circuit carrying the control pulses and the shorting switch.

5. The combination as defined in claim 4 wherein the pulse generating means further includes a plurality of additional output circuits and is arranged to produce pattern control pulses in the additional output circuits associated with preselected data display patterns, and wherein the controlling means further includes an oscilloscope sweep generator having an input circuit and being arranged to generate a sweep signal in accordance with the oscilloscope pattern control pulses supplied to the input circuit thereof, one of the gating means being connected in series between each of said additional output circuits and the input circuit of the oscilloscope sweep generator.

6. In a multiple cylinder internal combustion engine analyzing system including a central console for receiving and displaying electrical signals representative of the ignition characteristics of the individual engine cylinders on an oscilloscope, the combination which comprises:

ignition control pulse generating means at the central console, the control pulse-generating means having an output circuit associated with each cylinder of the engine and being arranged to produce shorting control pulses in each output circuit thereof which correspond to the ignition times in the associated cylinders;

a cylinder shorting switch at the central console having an input circuit and arranged to suppress the cylinder ignition in response to the application of the shorting control pulses to the input circuit thereof;

a cylinder select gate associated with each cylinder of the engine at the central console, each of the cylinder select gates having a pair of input circuits and output circuit;

means connecting the output circuit of each of the cylinder select gates to the input circuit of the cylinder shoring switch;

means connecting each output circuit of the ignition control pulse-generating means to one input circuit of the associated cylinder select gate, the cylinder select gates being arranged to couple the shorting control pulse from said one input circuit to the output circuit thereof when a first predetermined voltage is applied to the other input circuit and to inhibit the shorting control pulse when a second predetermined voltage is applied to the other input circuit;

a multiple conductor cable having a respective conductor connected at one end to a respective input circuit of each of the gates, the other end of each of the conductors being remotely located with respect to the console;

a cylinder select switch connected to the remote end of each of the conductors of the cable, the cylinder select switch being arranged to apply the first predetermined voltage to a selected conductor, whereby the ignition in a selected cylinder is suppressed; and

bias means for applying the second predetermined voltage to the other input circuit of each of the cylinder select gates in the absence of the first predetermined voltage.

7. The combination as defined in claim 6 wherein the bias means comprises a source of bias voltage and a low impedance resistor is connected between the source and the other input circuit of each of the gates.

8. The combination as defined in claim 7 including:

pattern select pulse-generating means at the central console, the pattern select pulse-generating means having a plurality of output circuits and being arranged to produce pulses in the output circuits associated with preselected display patterns;

an oscilloscope sweep generator at the central console having an input circuit and being arranged to generate a

sweep signal for the oscilloscope in accordance with the oscilloscope pattern select pulses supplied to the input circuit thereof;

a pattern select gate coupled with each output circuit of the pattern select pulse-generating means, each of the pattern select gates being located at the central console and having a pair of input circuits and an output circuit;

means connecting the output circuits of each of the pattern select gates to the input circuit of the sweep generator;

means connecting each output circuit of the pattern select pulse-generating means to one input circuit of the associated pattern select gate, the pattern select gates being arranged to couple the pattern select pulses from said one input circuit to the output circuit thereof when the first predetermined voltage is applied to the other input circuit and to inhibit the pattern select pulses when the second

predetermined voltage is applied to the other input circuit;

a pattern select switch connected to the remote end of the cable, the pattern select switch being arranged to apply the first predetermined voltage to the other input circuit of a selected pattern select switch; and

a low impedance resistance individually connected between the source of bias voltage and the other input circuit of each of the pattern select gates.

9. The combination as defined in claim **8** wherein the cylinder select switch includes a switch position corresponding to each cylinder and is arranged to connect the second input circuit of a selected gate to ground.

10. The combination as defined in claim **9** wherein each of the gates comprises a NAND gate.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,583,217 Dated June 8, 1971

Inventor(s) Peter A. Howes

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 26, "horizontally" should be "vertically".

Signed and sealed this 23rd day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents

FORM PO-1050 (10-69)

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