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Williams et al.

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[54] **ENGINE TEST METHOD AND APPARATUS**

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[51] **Int. Cl.** **G01m 15/00**

[58] **Field of Search** .... 73/116, 119 A, 117.3; 123/32 EA

[56] **References Cited**

UNITED STATES PATENTS

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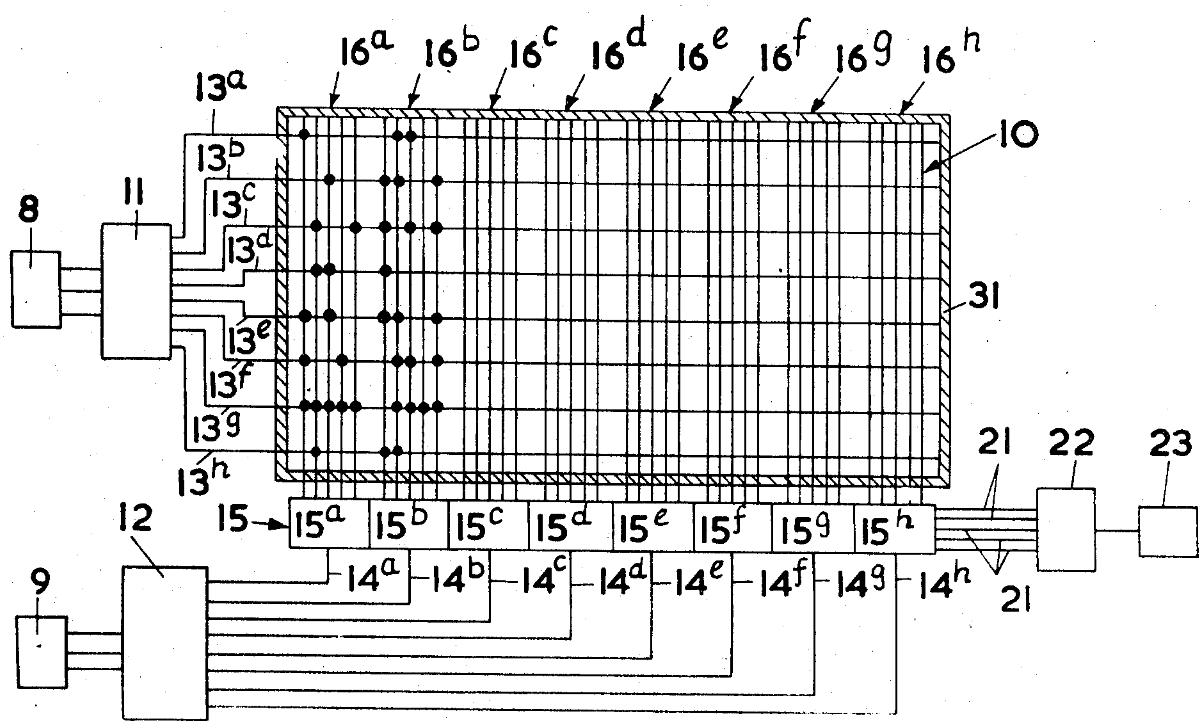
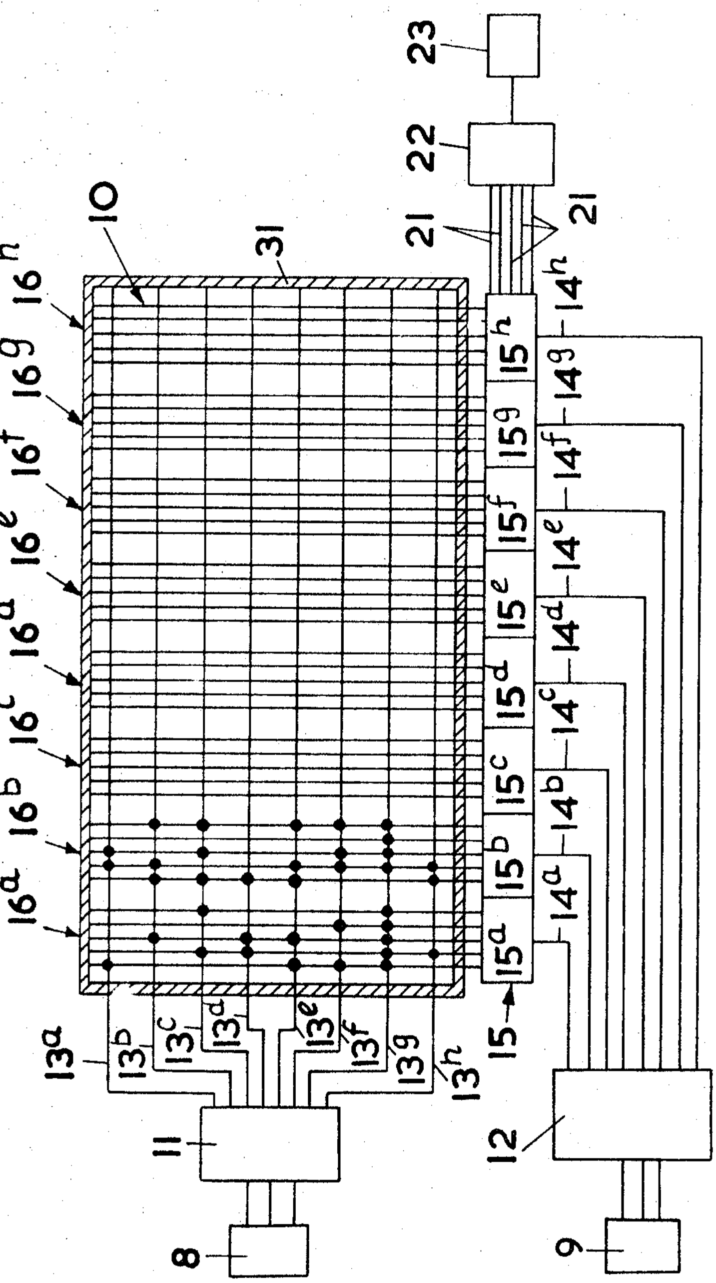
[57] **ABSTRACT**

An engine is tested by deriving a first digital signal representative of a first engine parameter and a second digital signal representative of a second engine parameter. These signals provide inputs to a semi-conductor matrix which produces a digital output signal determined by the values of the input signals, the output signal being used to control an engine characteristic. The selections within the matrix are chosen for each combination of input signal so that for each combination of input signals, the output signal exercises the required control of the engine characteristic.

2 Claims, 1 Drawing Figure

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16^a
16^b
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ENGINE TEST METHOD AND APPARATUS

This invention relates to engine control systems of the kind in which any two of three engine parameters, namely engine speed, manifold pressure (which can of course be a negative pressure) and throttle angle are used to provide two signals, the signals providing inputs to a diode or other suitable semi-conductor matrix, the matrix being designed to give an output determined by both input signals and this output being used to control an engine characteristic. The invention is particularly concerned with control systems for engines used in road vehicles and in most cases the engine characteristics controlled by the system is the injection of fuel to the engine, although, where the engine has a spark ignition system, the ignition timing or a combination of the timing and fuel injection could be controlled.

The object of the invention is to provide a convenient method of testing an engine which facilitates the manufacture of a control system of the kind specified.

The invention further resides in a method of testing an engine comprising deriving a first digital signal representative of a first engine parameter and a second digital signal representative of a second engine parameter, each of said signals providing an input to a semiconductor matrix which produces a digital output signal determined by the values of the input signals, said output signal being used to control an engine characteristic, and selecting the connections within the matrix for each combination of input signals so that, for each combination of the first and second digital signals, said output signal exercises the required control of said engine characteristic.

Preferably, said matrix is a diode matrix in which the diodes are detachable so that the positions of the diodes within the matrix can be altered so as to vary the connections within the matrix.

The invention further resides in apparatus for performing the method.

The accompanying drawing is a diagrammatic illustration of a device for use in the manufacture of a fuel injection control system according to one example of the invention.

Referring to the drawing, there is provided a transducer **8** which produces an electrical signal representing the throttle angle of the engine with which the system is employed. The electrical signal from the transducer **8** is in the form of a **3** bit binary word which is fed to control means **11** which serves to energise one of **8** input lines **13*a*** to **13*h***, the input lines **13*a*** to **13*h*** forming part of a diode matrix unit **10**, the construction of which will be described later. The unit **10** further includes **8** sets of input lines **16*a*** to **16*h***, each of the lines **13*a*** to **13*h*** crossing each of the sets of lines **16*a*** to **16*h***. Although in the example shown there are **8** input lines **13** and **8** sets of lines **16**, it will be appreciated that the number of lines can be more or less than this figure. Moreover, although in the example shown each set of lines **16** contains **5** lines, they can be more or less lines in each set **16**.

There is further provided a second transducer **9** which produces an electrical signal representing engine speed, the signal being in the form of a **3** bit binary word which is fed to control means **12**, which energises one of a set of lines **14*a*** to **14*h***. The lines **14*a*** to **14*h*** are connected to a switching device **15** having **8** sets of switches **15*a*** to **15*h*** respectively. The arrangement is such that when a signal appears on the line **14*a***, the

switches **15*a*** connect the lines **16*a*** to **5** output lines **21** coupled to a decoder **22**, the output from which is fed to injection means **23** controlling the quantity of fuel supplied to the engine.

The lines **16** and **13** are interconnected by diodes in a manner to be described. In the drawing, the connections between the first two sets of lines **16*a*** and **16*b*** and the lines **13** are shown, each dot representing a diode connection. Suppose that the value of throttle angle is such that the line **13*a*** is energised, and the engine speed is such that the line **14*a*** is energised, then the switches **15*a*** connect the lines **16*a*** to the decoder **22**, and the decoder **22** will receive a signal of the form 10,000, where 1 represents the diode connection between the line **13*a*** and the first of the set of lines **16*a***. If the parameters now change in such a manner that the line **13*g*** and the line **14*b*** are energised, then the decoder **22** will receive a signal 01,111. Thus, it will be appreciated that the unit **10** produces an output dependent on the two input signals controlled by the decoders, and controls the fuel in accordance with the connections within the unit **10**.

The unit **10** includes a base plate in the form of a peg board **31** above which the lines **13** and **16** are supported by pegs (not shown). The lines **13** extend in a first plane above the board **31**, the lines **16** extend in a second plane above the board **31** and at right angles to the lines **13**. Each of the lines **13** crosses each of the lines **16** but is spaced from the lines **16**. The design of the unit **10** is such that any line **13** can be connected to any line **16** by one of a number of semi-conductor diodes each of which can be detachably engaged between a line **13** and a line **16** to electrically connect the lines. In the drawing, which illustrates the device in use, a number of diodes are shown connected between the lines **13** and the first two groups of lines **16**, the diode connections being indicated by the dots previously referred to. During the manufacture of an engine control system, the engine speed and the throttle angle of the engine are set at predetermined values such that the line **13*a*** is energised and the line **14*a*** is energised, energisation of the line **14*a*** serving to couple the lines **16*a*** to the output lines **21**. The line **13*a*** is connected to the lines **16*a*** by **1** or more diodes which may be chosen arbitrarily, or with some prior knowledge of the engine characteristic, and as shown the output lines **21** will receive a signal 10,000. The signal on the output lines **21** serves through the decoder **22** and the injection means **23** to govern the amount of fuel supplied to the engine for the predetermined throttle setting and engine speed, and the performance of the engine under these circumstances is inspected. The nature of the inspection depends on the intention of the designer, and by way of example the intention could be to maximise engine performance, or to minimise exhaust pollution.

When the engine characteristic has been inspected, the designer then attempts to improve the situation by varying the diode connections. It will of course be appreciated that the connections chosen may not provide the required results, and the next step may, merely by way of example, be to insert another diode at the connection of the line **13*a*** to the line **16*a*** so that the lines **21** receive a signal 11,000. This process continues until the optimum engine condition is reached. The engine speed is then kept constant, but the throttle angle changed so that the line **13*b*** is energised instead of the line **13*a***. The diode connections between the line **13*b*** and the lines **16a** are then varied in the same way to give the best possible result. This procedure continues with all the sites in the matrix, the term "site" being used to indicate the position at which a line **13** can be connected by up to **5** diodes to a set of lines **16.**

It will of course be appreciated that once the required diode positions have been found in the manner described, then diode matrix units can be manufactured on a production basis for use in engine control systems.

The arrangement described above, whereby the diode connections are all found empirically, is somewhat time consuming if the designer has no idea of the most likely diode connections at any given site. In practice, the designer may well be aware of the approximate connections which will be needed, and so not every possible combination of diodes at every site has to be attempted, so that the overall length of time taken to select the diode connections is less than appears. However, in some circumstances the designer may not have any advance information whatsoever, and in such a case it is possible to reduce the time taken to select the diode positions in the following manner. The engine speed and the throttle angle are varied as before so that the site where the line **13a** crosses the line **16a** is inspected. However, the lines **21** are disconnected from the switches **15,** and are connected instead through **5** manually operable switches respectively to a power source. Closing of one of the **5** manually operable switches feeds a signal **1** to the decoder **22,** and in this way the decoder **22** can be fed with a digital signal which simulates the insertion of diodes into the unit **10.** It is far quicker for an operator to manipulate the switches than to insert the diodes in the matrix unit, and when the manipulation of the switches is completed to give the best possible result, then the diodes are inserted at the appropriate site on the unit **10** in accordance with the positions of the switches, so that if the first three switches are closed and the last two are open, diodes are inserted to connect the line **13a** to the first three of the lines **16a,** but not to the last two of the lines **16a.** This action is repeated for each site, and considerably reduces the time necessary for establishing the diode positions. It is necessary after finding the diode positions with the switches to insert the diodes in the unit itself and then to repeat the tests, in case some of the diodes need to be moved. During the repeat test, by virtue of the prevailing dynamic conditions when the engine is used in conjunction with the unit **10** the switches can again be used instead of the diodes, as long as the diode connections are all present, and the lines **21** are coupled to the switches **15** or to the manually operable switches at any given instant.

We claim:

1. A method of testing an engine comprising deriving a first set of digital signals representative of a range of values of a first engine parameter and a second set of digital signals representative of a range of values of a second engine parameter, feeding one signal from the first set representing one value of the first engine parameter and one signal from the second set representing one value of the second engine parameter to a semiconductor matrix which produces a digital output signal determined by the values of the signals fed to the semi-conductor matrix, said output signal being used to control an engine characteristic, and selecting the connections within the matrix for said combination of one of the first set of digital signals and one of the second set of digital signals so that, said output signal exercises the required control of said engine characteristics, and then repeating said process for each possible combination of signals from the first set and the second set.

2. Apparatus for testing an engine comprising in combination a first transducer for deriving a first digital signal having one of a plurality of values representing a range of values of a first engine parameter, a second transducer for deriving a second digital signal having one of a plurality of values representative of a range of values of a second engine parameter, a diode matrix to which the signals from said transducers are applied, said diode matrix incorporating detachable diodes so that the positions of the diodes within the matrix can be altered so as to vary the connections within the matrix, and engine control means operable by the output from the diode matrix to control said engine characteristic.

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