

[54] **SECONDARY WAVEFORM ANALYZER**

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1970, abandoned.

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

[58] Field of Search **324/15, 16, 121, 16 S, 16 T,**
324/169, 170; 73/116-119

[56] **References Cited**
UNITED STATES PATENTS

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[57] **ABSTRACT**

An analyzer which detects and displays on a cathode ray tube secondary voltage waveforms of internal combustion engines and the like with no physical connections required to be made to the engine under test, the coupling being accomplished by a remote pick-up such as a directional antenna or a proximity probe. The analyzer is provided with an extraordinarily high input impedance in order to be able to detect the radiated signal, which has an extremely low current component.

9 Claims, 3 Drawing Figures

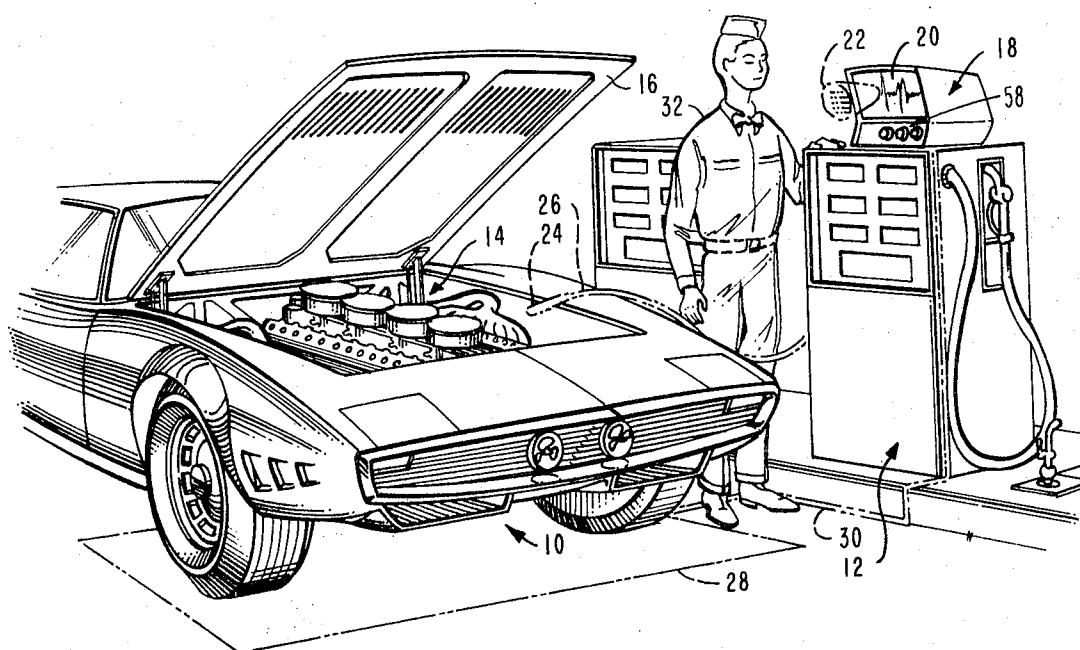
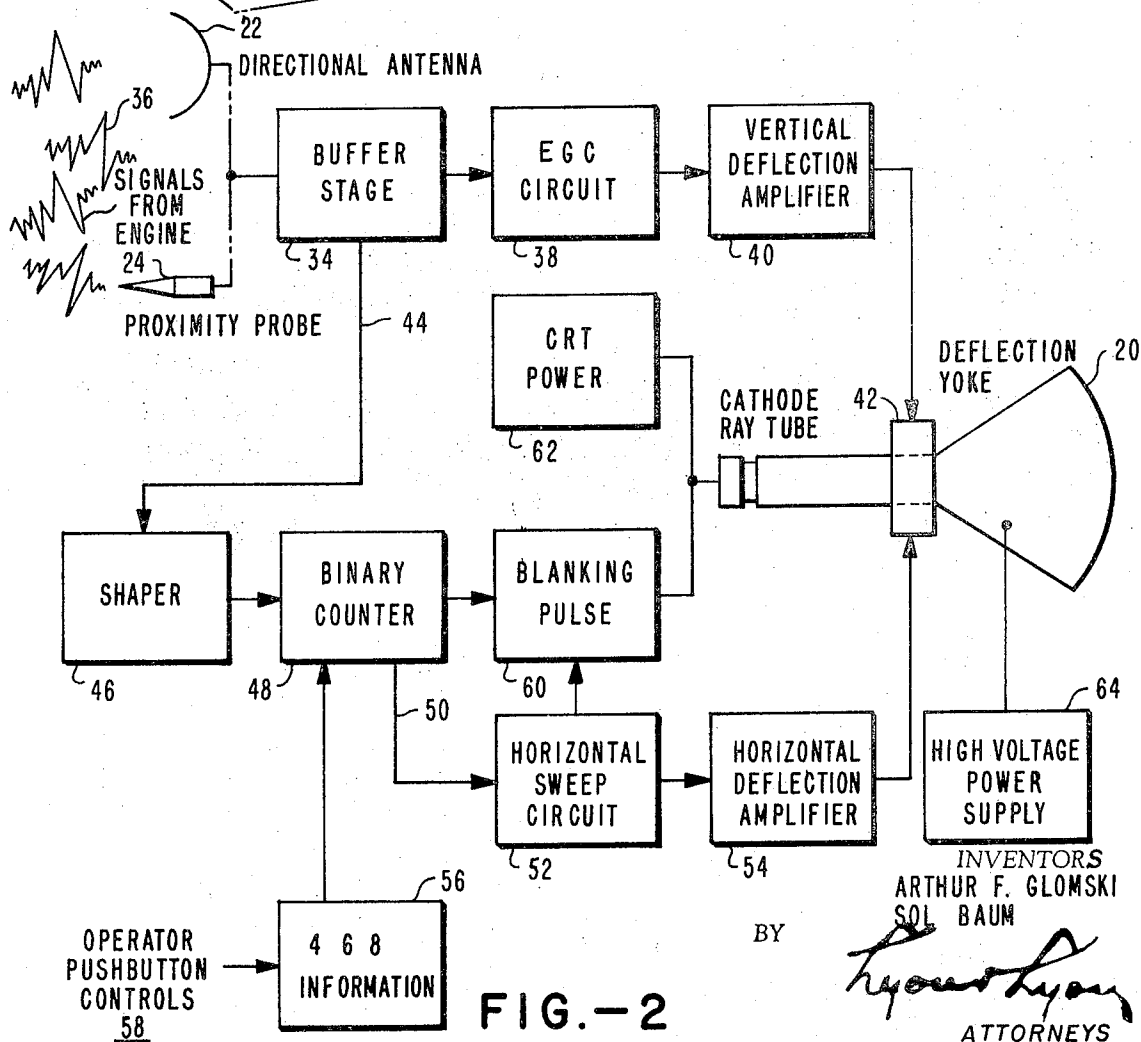
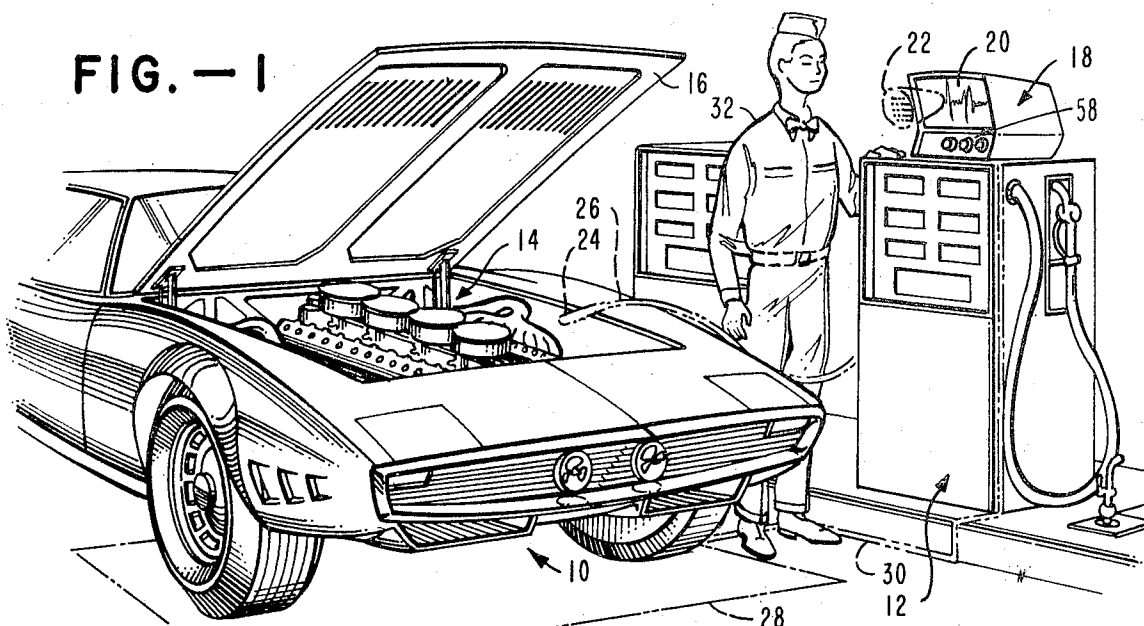


FIG. - 1



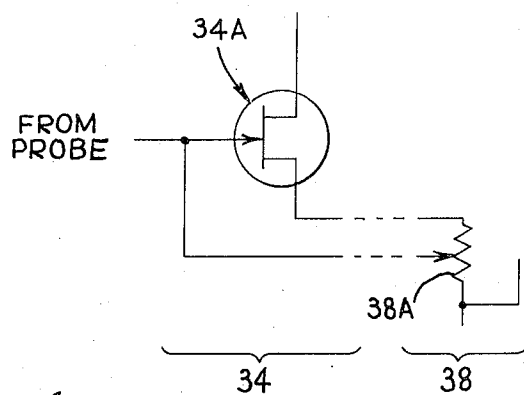


Fig. 3

SECONDARY WAVEFORM ANALYZER

This is a continuation-in-part of my co-pending application, Ser. No. 748,002, filed July 26, 1968, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to electronic ignition analysis equipment, and more specifically to the cathode-ray tube devices which provide a visual display of the significant electronic events occurring during the performance of an internal combustion engine. Such display devices are presently well-known and are in wide spread use to diagnose various engine malfunctions to the extent that engine malfunctions can be diagnosed through an electronic analysis. Such analyzers can run a large number of tests both on the primary and secondary portions of an automobile ignition system. Analyzers commonly in use require that several physical connections be made of the analyzer to the ignition system under test, and particularly to specific points in the ignition system in order to make certain checks. Such requirement necessitates that the car be temporarily out of service while these detailed analyses are made, and even though proposals have been recently made to automate the analysis procedure, it is still obvious that the car must be out of service at least for a short period.

SUMMARY OF THE INVENTION

The aforementioned difficulties are obviated in the present invention through the use of relatively conventional cathode-ray tube analyzer circuitry to which has been coupled appropriate remote sensing means such as a directional antenna or other sensitive device which can pick-up electro-magnetic or electro-static signals emanating from the ignition system in operation. The interface between the antenna and the cathode-ray tube circuitry includes an extremely high input impedance.

It is the object of the present invention to provide an analyzer which can make some of the simple electronic checks on the performance of an automobile engine or the like without placing the car unnecessarily out of service.

More specifically, it is an object of the present invention to provide an analyzer which can detect and display certain ignition system events without the necessity for physical connections to the particular engine in question.

It is a specific object and advantage of the present invention that analysis of an automobile engine ignition system may be made while the automobile is stopped at a gas pump for normal servicing.

Further objects and advantages of the present invention will become readily apparent upon reading the ensuing detailed description in conjunction with the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 discloses apparatus according to the present invention arranged for use in an automotive service station.

FIG. 2 is a diagram of the circuitry of the apparatus of FIG. 1.

FIG. 3 discloses a portion of the buffer stage of FIG. 2.

DESCRIPTION OF THE INVENTION

Turning first to FIG. 1, an automobile generally designated by the numeral 10 is shown in a typical service station situation, in which it has pulled up next to a number of gasoline pumps 12 for the usual servicing including refilling the gas tanks, checking the water and oil, and the other customary periodic checks made for internal combustion engines. The automobile 10 in this case has an internal combustion engine generally designated by the numeral 14, which is exposed by opening the hood 16. Positioned either on top of one of the gasoline pumps 12 or on a separate stand adjacent the pumps, there is an analyzer 18, which includes a cathode-ray tube 20 therein. The cathode-ray tube 20 is adapted to display a waveform depicting performance of the secondary portion of the automobile ignition system which comprises the high voltage portion thereof, and contains the information relating the firing of the spark plugs and embodies considerable information concerning conditions of engine performance.

The analyzer 18 is not physically connected to the engine 14 at all, but is electrically coupled thereto by means of one or more sensing devices. Actually the analyzer is spaced a considerable distance from the engine, and the sensing device is likewise spaced some distance away. FIG. 1 shows three such devices, although it is not contemplated that all three must be used in any one installation and other equivalent sensing devices are usable as well. The first of such devices is a directional antenna 22 positioned adjacent the analyzer 18. The antenna 22 is of highly directional nature, in order to assure that only the signals emitted by the operating engine 14 are picked up to the exclusion of any other such signals which may be coming from the general vicinity. The second form of such sensing device is a proximity detector 24 which forms a probe coupled through a cable 26 and connected to the analyzer 18. The probe 24 may be laid loosely in the engine compartment and in such manner will pick-up the secondary circuit signals effectively. A third form of pick-up is a capacitive type probe in the form of a large horizontal sheet 28, which may be permanently or temporarily installed in the driveway adjacent the pumps 12 and which may be connected through a cable 30 to the analyzer 18. With one or more of the pick-up devices mentioned, the car 10 when driven into the gas station for service may thus easily have a rather quick engine analysis conducted by the analyzer 18. The station attendant 32 needs merely to turn the analyzer 18 on and assure that the appropriate sensing device is properly positioned or directed as in the case of the antenna 22 or the proximity probe 24, whereupon he may then obtain a waveform on the cathode-ray tube 20 and thereby evaluate the performance of the engine 14.

Turning now to FIG. 2, the directional antenna 22 and the proximity probe 24 are shown coupled in the alternative to the buffer stage 34. Either antenna 22 or the probe 24, or the capacitive probe 28, mentioned with regard to FIG. 1, pick up the signals 36 and conduct them to the buffer stage 34. The buffer stage 34 comprises a broad band detector and amplifier which processes the secondary waveform and conducts it to an external gain control circuit 38. The buffer stage 34 matches the impedance of the antenna or the probe 24 and also serves to buffer the detected signal. The input 34A (FIG. 3) to the buffer stage comprises a metallic

oxide silicon field effect transistor (MOSFET) device, a junction FET or an electrometer tube, the gate electrode of which is coupled directly to the antenna. The MOSFET is the preferred device. The MOSFET 34A has a characteristic input impedance of about 109 ohms and it is this high impedance which is vital to the detection of the secondary voltage signals. Such signals are of high voltage but almost negligible current, i.e., of very low radiated power, and it has been found that provision of a lower input impedance will distort the signal. The gain control circuit 38 compensates for what may be a wide range in the level of input signals 36, by providing amplitude control over signals coming from the buffer stage to the vertical deflection amplifier 40. The external gain can merely be a potentiometer 38A coupled across the output of the MOSFET device and having the wiper coupled to the input thereof. The vertical deflection amplifier is a standard type of current feedback operational amplifier. This circuit converts the signal from the gain control circuit 38 and conducts a current to the deflection yoke and maintains linearity of the signal.

The buffer stage 34 has a second output 44, which is coupled to a shaper 46, which thereby converts the secondary waveform signal into a logic signal. That logic signal is then conducted to the binary counter 48 to drive the counter and to maintain the system in synchronous operation. The binary counter 48 generates a signal through line 50 to the horizontal sweep circuit 52, which is in turn coupled to the horizontal deflection amplifier 54 in a customary manner to maintain a desired number of waveforms displayed on the cathode-ray tube 20. The 4-6-8 information circuit 56 is coupled to the binary counter 48 and provides a coding means for determining the number of waveforms which will be displayed on the cathode-ray tube. By a number of pushbutton controls 58, the desired number of waveforms will be displayed on the cathode-ray tube independent of the information obtained from the radiating source. Thus, the accurate number of waveforms for automobiles having four, six and eight cylinders, respectively, can be fully displayed on the analyzer screen. If, however, the number four pushbutton were depressed for an eight cylinder engine, the display would successively show waveforms for the first four cylinders and the second four cylinders in an overlay manner. It is thus to be made clear that the 4-6-8 information does not exclude information, only operates to cycle the binary counter in a proper manner.

The binary counter 48 is also coupled to a blanking pulse circuit 60, and generates a trigger for the blanking pulse for every group of four, six or eight secondary waveforms permitted to pass the binary counter, depending on which pushbutton has been depressed. The blanking pulse will, therefore, occur after the last specified waveform is displayed. For example, if the eight cylinder button was depressed, the blanking signal would occur after the eighth waveform was displayed and will blank out the remainder of the display during retrace. That operation would be repeated as long as the same pushbutton remains depressed.

The horizontal sweep circuit 52 maintains the selected number of secondary waveforms on the scope symmetrically placed on the face thereof. The sweep circuit 52 may consist of a closed loop servo amplifier which would generate a sawtooth output of fixed amplitude and variable slope. By providing a fixed amplitude

signal here, you can obtain fixed horizontal sweep on the face of the cathode-ray tube no matter what the engine RPM might be, within reasonable ranges. In this manner the information displayed in real time and is not time dependent. The horizontal deflection amplifier 54 is of common circuitry which merely conducts a signal from the sweep circuit 52 to the deflection yoke 42. The CRT power supply 62 merely converts input power to the appropriate level of voltage required by the cathode-ray tube and to those voltages required by the analyzer signal processing circuitry herein above described. By the same token, the high voltage power supply 64, merely provides those necessary voltage levels for the ordinary operation of the cathode-ray tube.

It will thus be seen that much of the circuitry involved in the analyzer is fairly conventional, except for the means of adapting such circuitry to a directional antenna or proximity sensing device, and the manner of adapting those signals for use with conventional circuitry to display them on the cathode-ray tube.

While three forms of detecting means have been shown and described herein, it is obvious that other forms of electro-magnetic or electro-static detecting devices might be used following the teachings of this invention, and it is intended that the claims hereto appended cover all such changes, modifications and equivalents as are within the scope of the invention.

We claim:

1. A system for use in the analysis of internal combustion engine ignition systems or the like, comprising:

radiation detecting means for remotely detecting signals indicative of engine performance radiated by the secondary circuit of the ignition system, said detecting means in use being located near but spaced apart from and out of contact with said ignition system or said engine, said detecting means comprising a capacitive robe in the form of a fixed plate and over which a vehicle including such engine may pass for analysis;

means for converting said signals into a waveform representing the electrical performance of said secondary circuit and display means coupled to said converting means for visually displaying said waveform; and

coupling means for coupling said detecting means to said converting means.

2. A system of the type described in claim 1 wherein said coupling means comprises buffering means, amplifying means, and signal amplitude control means.

3. A system of the type described in claim 1 wherein said coupling means comprises buffering means, said buffering means having an input impedance on the order of 10^9 ohms.

4. The system set forth in claim 3 wherein said buffering means has impedance means coupled to the input thereof and comprising a metal oxide silicon field effect transistor, the gate electrode of said transistor being coupled to said detecting means.

5. A system for rapid and simple analysis of an internal combustion engine ignition system of an automotive vehicle while adjacent the fuel pumps of a service station for conventional fueling and associated services, comprising:

probe means responsive to high voltage, low power radiation from the entirety of the secondary circuit of said ignition system for providing a signal indicative of engine operating condition, said probe

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means being located near to but being spaced from and free of physical contact with said ignition system when the vehicle is adjacent said fuel pumps, said probe means being located adjacent said fuel pumps;

an analyzer device at one of said fuel pumps and having a visible cathode-ray tube for displaying a waveform depicting performance of the ignition system secondary circuit of the adjacent vehicle, said analyzer device including input buffer means connected to said probe means and having a high input impedance in the region of 10^9 ohms for preventing distortion of said signal received from said probe means despite the low power of such radiation, said input buffer means having first and second outputs;

circuit means connecting said first and second outputs to said cathode-ray tube for causing a display thereon corresponding to the operating condition of the ignition secondary circuit of the vehicle being serviced;

whereby the fuel pump attendant can evaluate such operating condition while carrying out fueling and associated routine services on the vehicle at the fuel pumps and without removing the vehicle from the fuel pump area.

6. A system of the type described in claim 5 wherein said circuit means includes:

an external control circuit and a vertical deflection amplifier connected in series from said first output to the deflection yoke of said cathode-ray tube; pulse shaper means connected to said second output

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for converting said signals to logic signals and a binary counter driven by said logic signals;

attendant controlled information circuit means responsive to the number of cylinders of the engine of the adjacent vehicle and connected to said binary counter for controlling cycling of said binary counter, said binary counter having a pair of outputs.

7. A system of the type described in claim 6 wherein said circuit means further includes:

a horizontal sweep circuit connected to one of said outputs of said binary counter and a horizontal deflection amplifier connecting an output of said horizontal sweep circuit to said cathode-ray tube;

blanking pulse circuit means connected to another output of said horizontal sweep circuit and responsive to the other of said binary counter outputs for generating a blanking pulse for each binary counter count corresponding to the number of cylinders of the adjacent vehicle engine, said blanking pulse circuit connecting to said cathode-ray tube;

said probe means comprising a directional antenna mounted at least in close adjacency to said analyzer device and directed toward the engine compartment of the vehicle adjacent said fuel pumps.

8. A system of the type described in claim 6, wherein said probe means comprises a directional antenna.

9. A system of the type described in claim 6, wherein said probe means comprises a proximity probe responsive to electromagnetic radiation to produce electrical signals when placed in proximity to said engine.

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