Nov. 5, 1968 G. MAKUH 3,409,824

AUTOMOTIVE IGNITION ANALYZER HAVING LARGE SCREEN PICTURE TUBE

Filed April 18, 1966 4 Sheets-Sheet 1

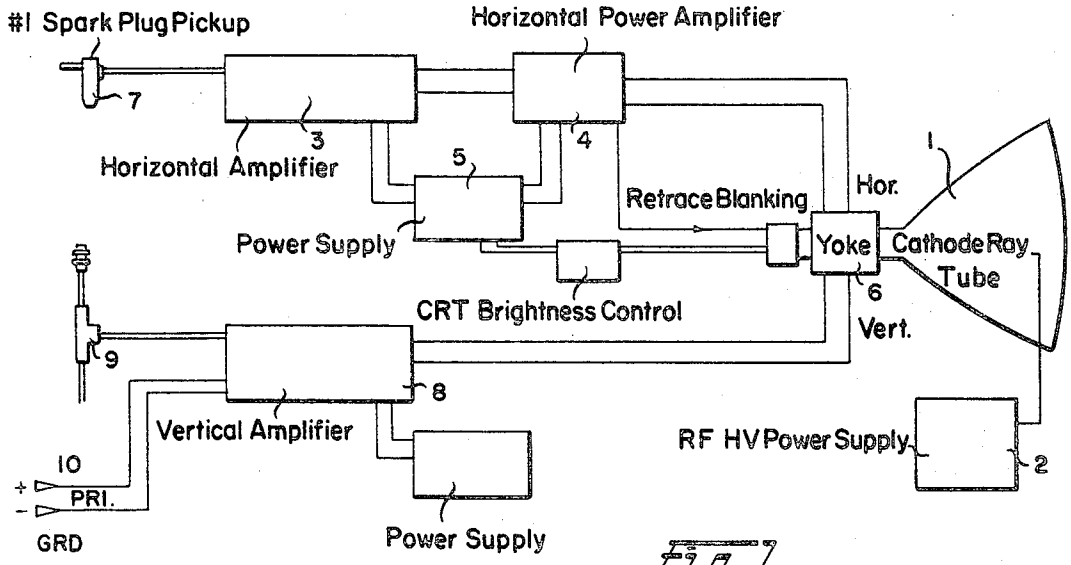


Fig. 1

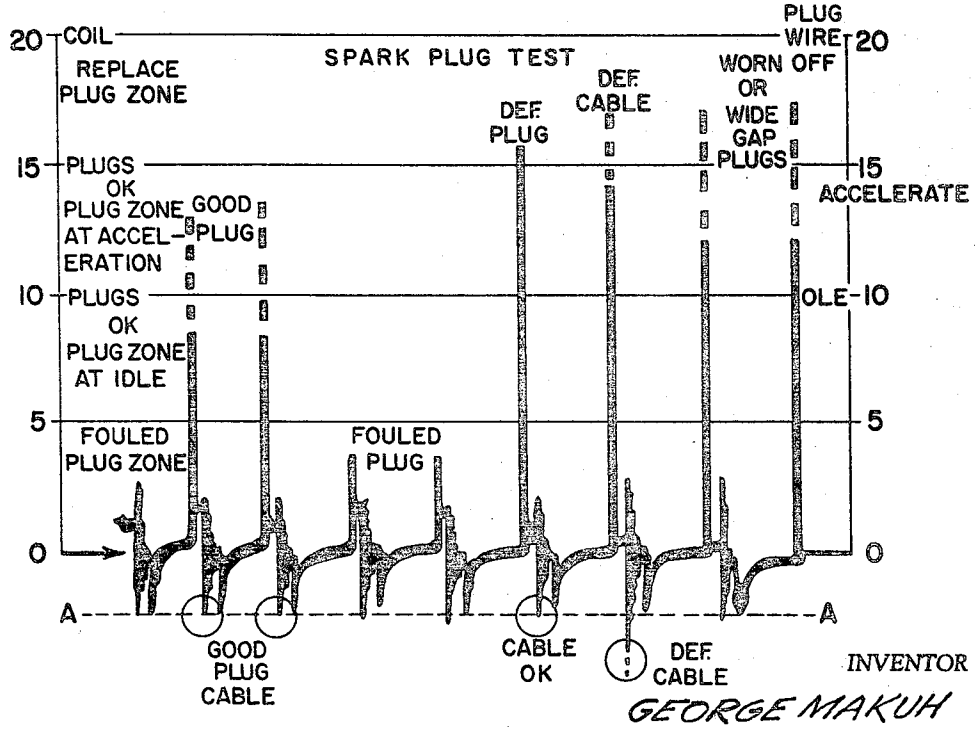


Fig. 6

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AUTOMOTIVE IGNITION ANALYZER HAVING LARGE SCREEN PICTURE TUBE

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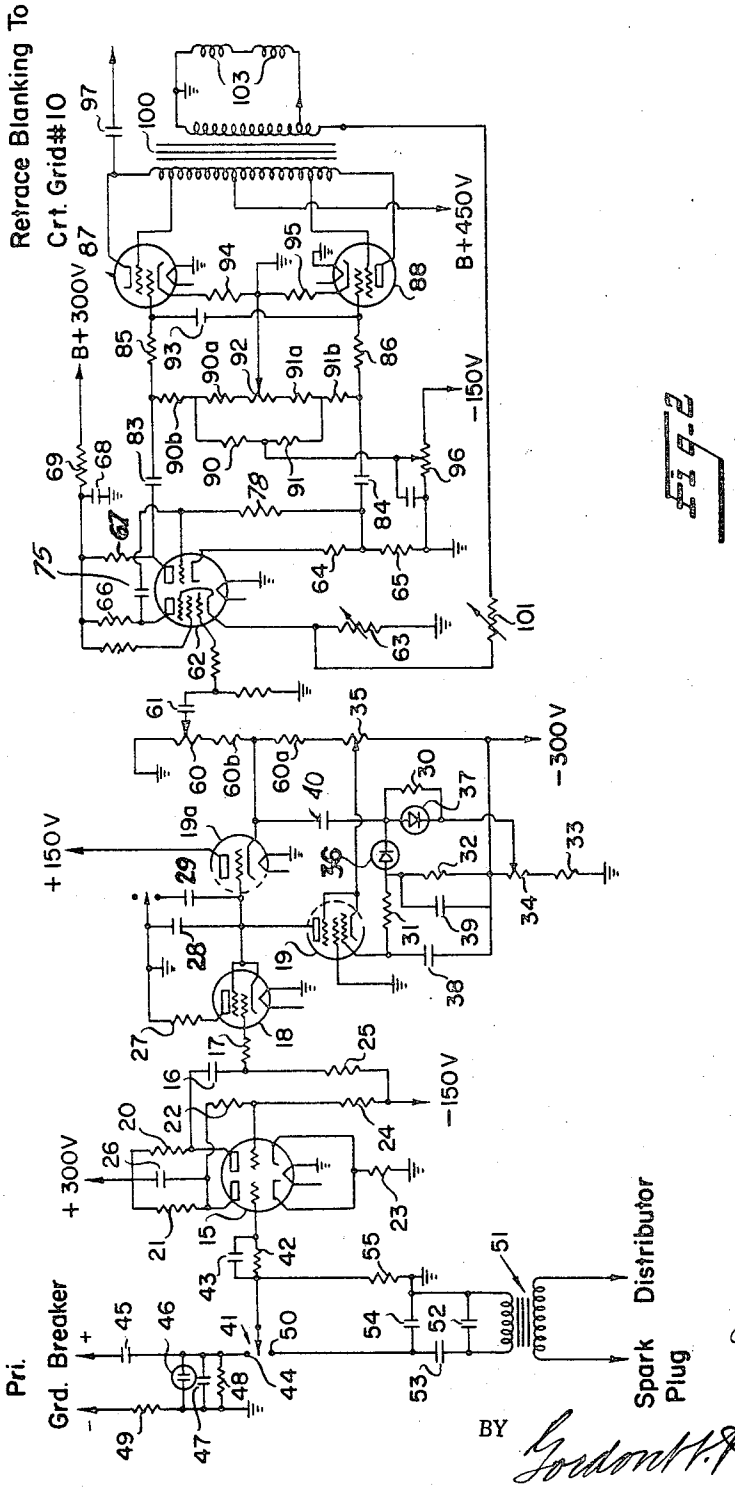


FIG. 2

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Nov. 5, 1968 G. MAKUH 3,409,824

AUTOMOTIVE IGNITION ANALYZER HAVING LARGE SCREEN PICTURE TUBE

Filed April 18, 1966 4 Sheets-Sheet 3

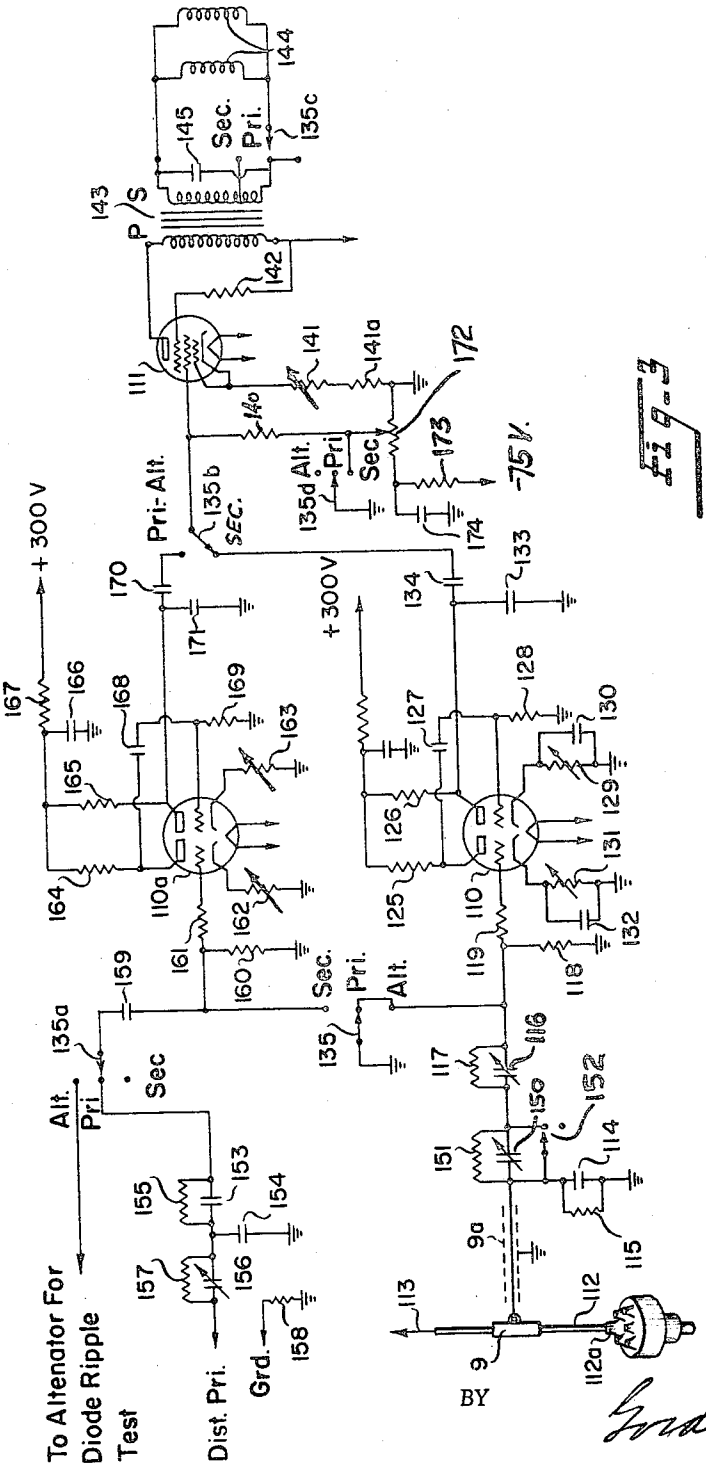


Fig. 4

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AUTOMOTIVE IGNITION ANALYZER HAVING LARGE SCREEN PICTURE TUBE

Filed April 18, 1966 4 Sheets-Sheet 4

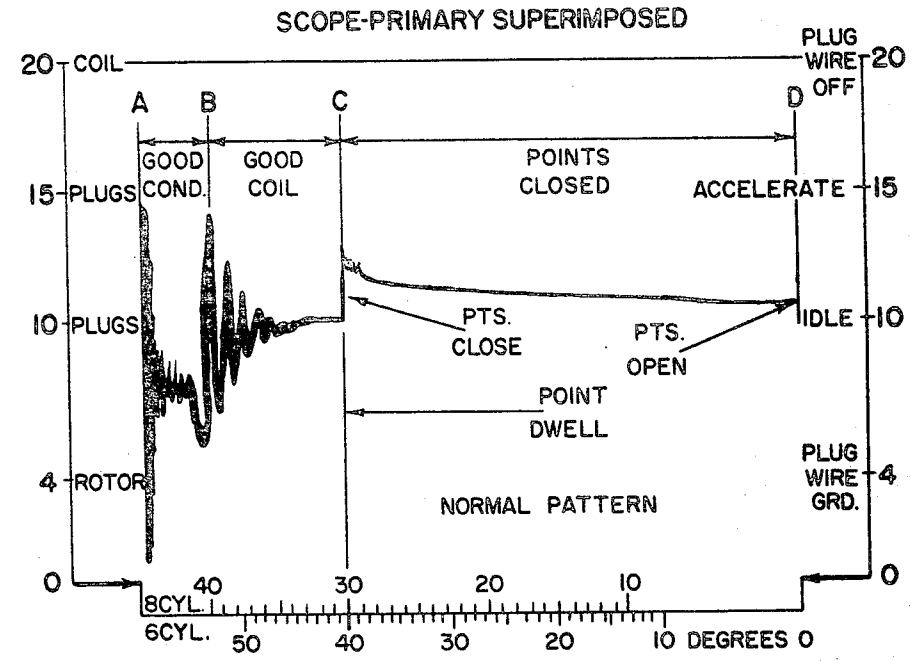


Fig. 4

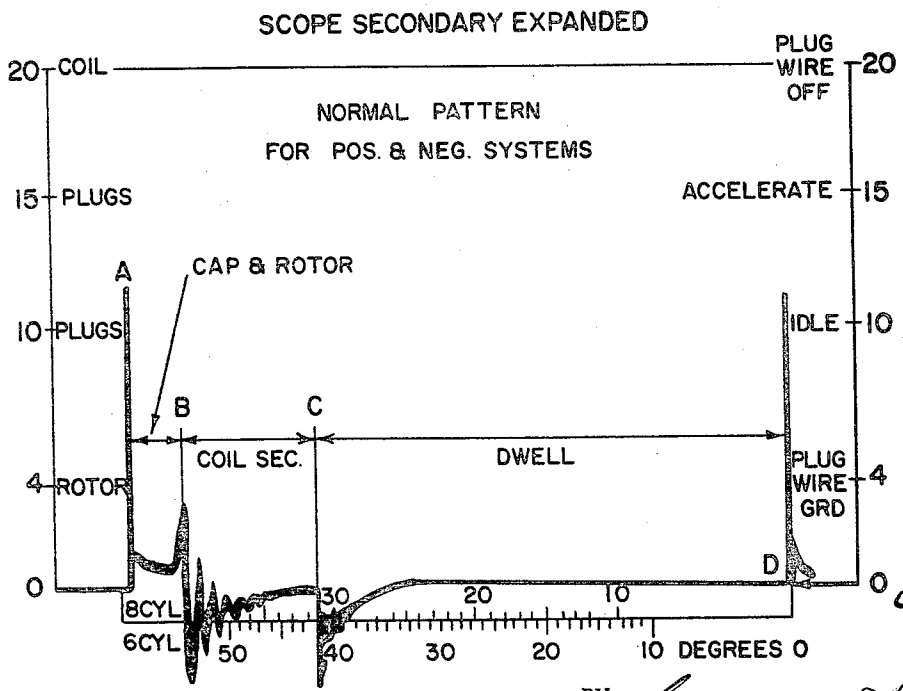


Fig. 5

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United States Patent Office 3,409,824
Patented Nov. 5, 1968

3,409,824

AUTOMOTIVE IGNITION ANALYZER HAVING LARGE SCREEN PICTURE TUBE

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Filed Apr. 18, 1966, Ser. No. 543,191
14 Claims. (Cl. 324—15)

The present invention relates to ignition testing devices for internal combustion engines, and is more particularly concerned with an electronic ignition analyzer for automotive engines.

Many forms of apparatus are known in the art for testing ignition systems of automobiles. Such apparatus generally measure and graphically represent the characteristics of the system. More particularly such devices, commonly sample the primary or circuit-breaker voltage and the secondary or sparking voltage of the ignition system. These voltages are applied to an electrostatic cathode ray oscilloscope which provides a visual representation thereof on the screen of the cathode ray tube. By comparing the visual patterns formed with known patterns the operator can immediately analyze and diagnose ignition faults.

Prior art ignition analyzers have invariably utilized oscilloscopes having electrostatic cathode ray tubes. Such tubes are reliable, can be readily made to provide a linear representation of applied voltages, and operate over a range of ignition frequencies. However, such cathode ray tubes have the disadvantage that they are small, the commonly used tubes having a picture diameter of five to eight inches. Although such tubes are suitable for many purposes, it is desirable to have a large size picture tube in order to provide a more detailed analysis of the wave form of ignition system voltages, and particularly where several people are involved or demonstrations are made to large groups, it is desirable to have a picture tube which forms a picture sufficiently large for all to see even at some distance. Large size electrostatic cathode ray tubes are known, but their cost is prohibitive for most uses.

It is an object of the invention to provide an ignition analyzer utilizing a magnetic deflection type cathode ray tube. It is a further object to provide such an analyzer wherein the cathode ray tube has a large screen and provides a large image. It is an additional object to provide an oscilloscope having such a picture tube which is relatively free from distortion, and wherein the visual representation is substantially linear to the signal voltage applied. It is still an additional object to provide an analyzer of the type described wherein the cost of the large picture tube is not prohibitively high. The accomplishment of the foregoing and additional objects will become more fully apparent hereinafter.

According to the invention, an automotive ignition analyzer is provided having means for sampling ignition voltages at both the primary and secondary of the ignition coil and also alternator output system ripple. The signals are suitably amplified and applied to a large screen television tube suitably powered. Filtering or wave shaping circuits are incorporated in the signal amplifier to compensate for non-linearities introduced into the circuit by the coils of the magnetic deflection yoke mounted on the neck of the tube, as well as non-linearities present in the tube itself. The analyzer is provided with a sweep circuit of suitable frequency and having a power amplifier of suitable power capabilities to adequately sweep a simmultaneous representation of the individual firing of all of the spark plugs, and which additionally has sufficient power capability to sweep the field sufficiently so that patterns formed by the firing of only several spark plugs may be alternately spread out over the entire field of the picture tube. As a result a true linear pattern of the spark

plug discharges as well as the primary coil voltages is projected on the picture tube in such dimensions that it may readily be seen even by persons standing a considerable distance from the tube. The filter or shaping circuit is also so designed that the vertical representation of applied voltage is substantially linear even at high sparking voltage frequencies. Additionally, patterns representative of the operation of alternator systems having a three phase diode rectifier system may be analyzed to determine open or shorted diode condition or three phase winding defects.

The invention in its preferred embodiment is illustrated by the accompanying drawings in which:

FIG. 1 is a schematic block diagram of the ignition analyzer of the invention.

FIG. 2 is a schematic circuit diagram of the horizontal sweep signal generator and the horizontal sweep signal amplifier.

FIG. 3 is a schematic circuit diagram of the vertical amplifier.

FIG. 4 is a schematic view illustrating the pattern obtained of the superimposed primary ignition discharge.

FIG. 5 illustrates the normal expanded pattern obtained from an impulse of a secondary spark discharge, and

FIG. 6 is a parade pattern obtained of the secondary while using only the impulse from the first spark plug to actuate each sweep.

Reference is now made to the accompanying drawings for a better understanding of the invention, wherein all the parts are numbered and wherein the same numbers are used to refer to corresponding parts throughout.

In the description which follows, the values for the components are not given where the circuits are conventional and suitable values are known or may be readily determined by those skilled in the art. However, where component values are critical and are not conventional, representative values will be given.

Referring to FIG. 1, the apparatus is illustrated in block diagram and comprises a magnetic deflection type cathode ray tube **1** such as a common television picture tube (23EYP4). High voltage is applied to the tube by a radio frequency high voltage power supply **2**. The horizontal sweep signal is provided by means of a horizontal signal generator **3** incorporating a voltage amplifier and a horizontal power amplifier **4**. A low voltage power supply **5** powers the horizontal signal generator **3**, the horizontal power amplifier **4**, and the picture tube **1**. The signal output from the horizontal power amplifier is fed to the horizontal coils of a deflection yoke **6** mounted on the neck of the cathode ray tube **1**. The horizontal signal generator may be actuated by any spark plug for a parade pattern display providing one horizontal sweep pulse for each rotation of distributor or by the distributor primary or secondary output circuit which provides one horizontal sweep pulse for each plug firing cycle for superimposed display. Vertical deflection is provided by means of a vertical amplifier **8** having its output connected to the vertical coils of the deflection yoke **6**. The input of the vertical amplifier **8** is selectively connected to the high tension output of the ignition coil by means of a capacity coupler or pickup **9**, or connected to the distributor primary terminal **10**.

The deflection yoke should preferably be of the type commonly termed a "cosine yoke," that is, a yoke wherein the horizontal and vertical coils are wound so that their thickness increases as the cosine of the angle from vertical or horizontal subtended by the coil windings. This arrangement prevents the type of picture distortion commonly known as the "pin cushion effect."

Referring to FIG. 2, the horizontal sweep signal generator comprises a pulse amplifier **15**, which may be a 12AX7 vacuum tube, connected through a coupling con-

denser **16** and resistor **17** to a Thyratron (2D21) **18** which generates a saw-tooth signal. The signal is applied to a 6DX8 width control tube **19** and **19***a* for controlling the width of the sweep. The output from the width control tube is then applied to the grid circuit of the power amplifier stage.

The pulse amplifier is provided with associated components for supplying proper power requirements including resistors **20**, **21**, **22**, **23**, **24**, and **25**, and capacitor **26**. The Thyratron **18** is provided with resistor **27** and condensers **28** and **29**. The width control tube **19** and **19***a* is provided with resistors **30**, **31**, **32**, and **33** and variable resistors **34** and **35**. Diodes **36** and **37**, and capacitors **38**, **39** and **40** complete the circuit components associated with the width control tube.

The circuitry for selectively connecting the horizontal sweep signal generator to the primary or secondary comprises a selector switch **41** having the selector terminal connected to the input of the pulse amplifier **15** through coupling means comprising a resistance **42** and capacitor **43**. One terminal **44** of the switch **41** is connected to the primary breaker of the distributor by means of a coupling condenser **45**. Associated circuitry comprises a diode **46**, a neon lamp **47**, and a resistor **48** connected to the ground terminal of the primary of the coil through a resistor **49**. The second terminal **50** of the switch **41** is connected to a coupling means which is in turn connected to any spark plug, generally the first spark plug in firing order, and comprises a coupling transformer **51**, capacitors **52**, **53**, and **54**, and a resistor **55**. When the switch **41** is connected to the primary by the circuit shown, the impulse amplifier is triggered by a signal produced when each spark plug is fired. Consequently, the pattern produced on the picture tube is a superimposed series of curves, one curve produced by the firing of each spark plug placed over the preceding cycle. When the switch **41** is placed in the other position and connected to the terminal **50**, only the firing of the one spark plug actuates a horizontal sweep signal, and, consequently, the pattern produced on the picture will provide a parade pattern of all the individual spark plug firing cycles.

Also shown in FIG. 2 is the horizontal sweep signal power amplifier. The basic circuit shown is that commonly known as the Ultra-linear or the Williamson type. Other high power linear power amplifiers available in the art may be used, including amplifiers utilizing solid state components such as semi-conductors. The prime requirements are that the output signal must be highly linear with respect to the input signal and, further, that the power output capability must be sufficient to cause a very wide excursion scanning beam. The beam excursion must be sufficiently great so that when the apparatus is so adjusted that all the spark plug firing cycles are visibly represented on the picture tube screen in a parade pattern, it must be possible to expand the pattern to display one or more firing cycles over the entire screen area. It has been found that the amplifier shown which has an output capability of about 25 peak watts at low pulse frequencies is sufficient to provide the necessary beam excursion magnitude.

The output from the pulse amplifier **15** is applied through a potentiometer **60**, associated resistors **60***a* and **60***b*, and coupling condenser **61** to the power amplifier 4. The amplifier comprises a pentode-triode vacuum tube **62** (6AN8) serving as a dual voltage amplifier tube. The associated circuitry comprises cathode resistors **63**, **64** and **65** and plate series resistors **66** and **67**. The associated plate filter circuitry comprises capacitor **68**, and series resistor **69**. The output from the pentode section tube **62** is applied through coupling condenser **75** to the grid of the triode section of tube **62**, which serves as a paraphase voltage amplifier and phase inverter. Associated circuitry therewith are grid bias resistor **78**, cathode resistors **64** and **65**, and plate voltage dropping resistor **67**.

The output of the tube **62** is applied through coupling condensers **83** and **84** and grid resistors **85** and **86** to a pair of power amplifier tubes **87** and **88**, which may be chosen from such types as 6CA7, 807, EL–34, etc. Associated circuitry with the power amplifier tubes are grid bias resistors **90**, **90***a*, **90***b* and **91**, **91***a*, **91***b* a balancing potentiometer **92**, grid capacitor **93** and cathode bias resistors **94** and **95**. A negative grid bias voltage is applied through potentiometer **96**. A portion of the output signal is applied through a coupling condenser **97** to the grid of the cathode ray tube for actuating retrace beam blanking. The output from the power amplifier tubes **87** and **88** is applied to an output transformer **100**, which may be any suitable high-fidelity output transformer designed for the Williamson or Ultra-linear circuits, as for example A–8072 (Chicago), TO–300 (Acrasound), or A–420 (Dynaco). A portion of the output signal of the transformer **100** is applied through a resistance **101** to the cathode of the first section of the voltage amplifier tube **62**, the signal functioning as negative feed-back to cancel or minimize harmonic distortion. The major portion of the signal from the output transformer **100** is applied to the horizontal coils **103** of the yoke mounted on the neck of the cathode ray tube **1**. Suitable filament and plate current for the amplifier is supplied from a standard power supply **5** comprising a suitable transformer, a rectifier tube such as a 5R4 or a 5V4, or silicon diodes, filter condensers, a filter choke, and resistor.

Referring to FIG. 3, a schematic diagram of the vertical amplifier is shown comprising twin-triode voltage amplifier tubes **110** and **110***a* and a pentode power amplifier tube **111**. The vertical amplifier is the most critical part of the ignition analyzer of the present invention. This is a result of the fact that ignition sparking comprises damped waves of rather high frequencies. When an electrostatic cathode ray deflection tube is utilized in an ignition analyzer, an ordinary amplifier may be used which has good linearity, the pattern shown on the screen of the tube being representative of the spark impulses applied to the amplifier input. However, it has been found that when the output of such a linear amplifier is applied to the coils of the deflection yoke of a magnetic cathode ray deflection tube, the signal is so distorted by the magnetic coils as well as associated circuitry that the pattern produced on the tube is completely unrepresentative of the spark signal applied to the amplifier. According to the invention, it has been unexpectedly discovered, that if proper tube operating characteristics and wave-shaping filters are incorporated into the circuit of the vertical amplifier to provide selective frequency amplification of the proper wave form and magnitude, to compensate for any distortion introduced by the deflection yoke, the result is that the pattern formed on the picture tube is representative of the spark signal applied to the amplifier.

Because of the criticality of the values of the components, a set of values for a particular amplifier which may be utilized with a particular picture tube (23EYP4) will be set out. However, it is to be understood that when other amplifiers or other picture tubes are used, the required values may be somewhat different. In each case, the values may be properly modified by one skilled in the art until a representative pattern is produced.

A signal for actuating the vertical amplifier is obtained by means of a capacity pickup **9** having one end **112** adapted to be inserted into the distributor cap center terminal socket, and the other end **113** is connected to the high tension terminal of the ignition coil. The signal from the pickup **9** is applied through a shielded lead **9***a* to the intermediate point of a capacitance divider comprising a capacitor **114** having a value in the range of about .0005–.003 mf., a suitable value being .001 mf. This capacitor is by-passed by a resistor **115** of 3.9 megohms. A variable capacitor **116** of about 1.5–80 mmf.

by-passed by a resistor **117** of 2.2 megohms completes the divider. The capacitor **116** is variable to provide calibration of the signal. This arrangement provides calibration in the range of 15 kv. To provide 30 kv. calibration, a second variable capacitor **150** of a range similar to that of the capacitor **116** and a resistor **151** are switched into the circuit by means of a switch **152**. The outer terminals of the capacitor **116** and resistor **117** are connected to a voltage divider network comprising a resistor **118** of 330K ohms, and a resistor **119** of 10K ohms. The outer end of the resistor **119** is connected to the grid of the first triode of the twin-triode tube **110**. Plate current is applied to the plates of the tube **110** through conventional dropping resistors **125** and **126**. The plate of the first triode is coupled to the grid of the second triode through a capacitance-resistance network comprising a coupling condenser **127** having a suitable value in the range of about .01–0.5 mf., and preferably .02 mf., and a resistor **128** having a value in the range of 470K ohms–1.5 megohms, and preferably 1 megohm. Both of the cathodes of the tube **110** are provided with low frequency bypass filters, one comprising a variable resistor **129** of 4K ohms maximum, and a capacitor **130** of .005 mf., and a second filter comprising a variable resistor **131** of 8K ohms maximum and a capacitor **132** of .0005–.003 mf., and preferably .001 mf.

The output signal from the plate of the second triode is applied to an intermediate point of another capacitance divider comprising a capacitor **133** of about .0005–.003 mf., and preferably .001 mf. and a second capacitor **134** of about .01–.05 mf., and preferably .02 mf. The signal passing through the capacitor **134** is applied to one terminal of a switch section **135***b* which is so connected as to choose alternatively signals from the voltage amplifier tube excited by the spark plug secondary signal or from the voltage amplifier tube excited by the primary signal. The center terminal of the switch is connected to the control grid of the power amplifier tube **111**.

In the preferred embodiment, a separate twin-triode voltage amplifier tube **110***a* is used to amplify the signal from the alternator for diode ripple testing and from the primary of the ignition coil. The values of the fixed components are substantially the same as the corresponding components associated with the secondary amplifier tube **110**. The only difference is that the variable components are adapted to be set at such values as to compensate for the lower signal input of the primary and alternator current. The circuit comprises a capacitance divider made up of a capacitor **153** of about .005–.003 mf. and preferably .0004 mf. and a capacitor **154** of about .01–.05 mf., and preferably .047 mf. A resistance **155** of about 6.2 megohm bypasses the capacitor **153**. An input variable capacitor **156** having a range of 8–15 mmf. is bypassed by a resistor **157** of about 47K ohms. The capacitor **156** and resistor **157** are connected to the distributor primary. A resistor **158** of about 510 ohms may be advantageously utilized in the ground return circuit. The wave shaping filter comprising the capacitors **153**, **154**, and **156** and resistors **155** and **157** is connected to a switch **135***a*, which alternatively selects connection to the alternator for a diode ripple test, through a coupling capacitor **159** and through a grid bias divider comprising a resistor **160** of about 330K ohms and a resistor **161** of about 10K ohms to the grid of the first triode section of the tube **110***a*. The cathodes of the tube are provided with a variable grid bias resistor **162** of about 10K ohms and a variable grid bias resistor **163** of about 3K ohms. It has been found that for proper operation the resistor **162** is advantageously set at about 6.5K, and resistor **163** is advantageously set at a value of about 500 ohms. In contrast, the resistor **131** of the tube **110** of the secondary amplifier, is advantageously adjusted to 8K ohms and the resistor **129** adjusted to 4K ohms. The associated plate circuitry of the tube **110***a* comprises plate voltage dropping resistors **164** and **165** of about 47K ohms, a capacitor **166** of about 20 mf., a resistor **167** of about 3K ohms, a capacitor **168** of about .02 mf. and a resistor **169** of about 1 megohm. The output from the second plate of the tube **110***a* is applied to a capacitance divider comprising a capacitor **170** of about .01–.05 and preferably .02 mf., and a capacitor **171** of about .0005–.003 and preferably .001 mf. This capacitor divider completes the wave shaping filter for the circuitry associated with the tube **110***a*. A switch section **135***b*, associated with switch **135** and **135***a* selectively switches either the primary amplifier or secondary amplifier to the control grid of the power amplifier tube **111**.

The components associated with the power output tube **111** are conventional and include a grid bias resistor **140**, cathode bias resistors **141** and **141***a*, and a screen grid voltage dropping resistor **142**. An additional bias regulator may be introduced when the secondary signal is being sampled by means of a switch **135***d* and comprises a variable resistor **172**, a fixed resistor **173** connected to a negative bias voltage source, and a capacitor **174**. The output signal from the output tube **111** is applied to the primary of an output transformer **143** (Merit #2815), the secondary of which is connected to the vertical yoke deflection coils **144**, the secondary being bypassed by a capacitor **145**. A switch **135***c* may selectively connect the vertical yoke to selective taps on the secondary coil of the transformer **143** to reduce the signal strength when the secondary current of the ignition coil is being sampled.

In adjusting the values of the critical components of the vertical amplifier for proper operation, the following should be observed. The cathode variable resistors **129** and **131** should be adjusted for proper gain and wave form. The values of the capacitors **130** and **132** are selected for minimum low frequency response and maximum sparking signal gain. The calibration trimmer capacitor **116** is adjusted for proper height of the high voltage vertical lines. The value of capacitor **114** is chosen for proper loading of the pickup **9**. The values of the capacitors **127** and **133** are selected for correct response and wave shape of the spark line and size of the high voltage spikes. Diminishing the value of the capacitor **127** drops the height of the spark line. The capacitor **133** is used to provide solid vertical high voltage spike lines, in the absence of which capacitor the lines contain bright flashes or dots.

FIGS. 4–6 illustrate various patterns which may be obtained by means of the ignition analyzer of the invention. The patterns themselves are well known in the art and need not be discussed in detail. The present invention provides the advantage that the patterns may be spread out on a large picture tube such as a 17″ to 23″ television picture tube, so that the patterns are of greater size and greater brilliancy, and may be readily seen even in bright light. Moreover, because the patterns are magnified, greater detail in the individual curves may be observed.

FIG. 4 illustrates a normal superimposed pattern obtained by connecting the primary of the ignition coil to the vertical amplifier, actuating the horizontal sweep by the ignition impulse of each spark plug. The result shown in the figure is a superimposed pattern of the firing of all plug cycles.

FIG. 5 shows a curve of a normal superimposed secondary pattern.

FIG. 6 shows a curve obtained with the sweep signal actuated by any single spark plug firing. Here individual patterns for all the plugs are shown simultaneously or in parade. The particular patterns shown illustrate both normal and abnormal condition caused by defects in plugs, cables or distributor.

The present invention has several advantages over ignition analyzers of the prior art utilizing electrostatic cathode ray tubes. First, all the various patterns which can be obtained by means of an electrostatic tube can also be

obtained by means of the television picture tubes utilized by the invention. The use of a television picture tube permits a greatly enlarged screen and thus a greatly enlarged pattern for easier viewing and for study in greater detail. The trace is brighter and consequently it is not necessary to place enclosures such as a hood or shade around the tube when it is used in a bright room, which measures are often necessary when an electrostatic tube is used. Further, since television picture tubes are produced in large quantities, a large picture tube can be obtained at modest cost. Further, because of the selected shaping filters utilized in the vertical amplifier, discharges of high sparking voltage frequencies may be recorded which are accurate pictures of the original spark discharge signal, even when utilized with deflection yokes.

Although the invention has been described in a single embodiment utilizing thermionic vacuum tubes for the various functions such as saw-tooth signal generation and amplification, it is of course to be understood that these devices may be replaced by suitable solid state devices performing the same functions, as for example diodes and transistors.

It is to be understood that the invention is not limited to the exact details of construction, operation, or exact materials or embodiments shown and described, as obvious modifications and equivalents will be apparent to one skilled in the art, and the invention is therefore to be limited only by the scope of the appended claims.

I claim:

1. An ignition analyzer for testing the ignition system of an internal combustion engine including an ignition coil having primary and secondary circuits and a plurality of spark plugs operatively connected thereto, comprising:

(A) a magnetic deflection type cathode ray tube having a deflection yoke mounted thereon comprising a horizontal deflection coil and a vertical deflection coil,

(B) means adapted to generate a sweeping signal comprising a saw-tooth generator, means for deriving a triggering impulse from an electrical lead of said engine, means for amplifying said triggering impulse and applying said amplified impulse to actuate said saw-tooth generator for producing a single sweeping signal for each triggering impulse,

(C) a power amplifier having its input connected to said sweeping signal generating means and having its output operatively connected to one of said deflection coils for causing the beam of said cathode ray tube to be swept along one set of coordinates,

(D) an electronic amplifier having its input adapted to be connected alternatively to the primary or secondary of said ignition system and having its output operatively connected to the other of said deflection coils, said amplifier having wave shaping means incorporated therein for correcting the distortion introduced by the characteristics of said deflection coils at the frequencies of oscillations caused by an ignition spark discharge, whereby the visual tracing produced on the screen of said cathode ray tube is a true representation of the signal currents applied to said amplifier.

2. An ignition analyzer according to claim 1 wherein the wave shaping means of said amplifier (D) comprises a capacitance divider having a pair of capacitors in series connection, the outer end of one capacitor being connected to ground, the outer end of the other capacitor being connected to the input of the first amplifier means of said amplifier, and the intermediate common connection to the capacitors of said capacitance divider being adapted to be connected to an ignition signal generating means.

3. An ignition analyzer according to claim 2 wherein said capacitor connected to ground has a value of about .0001–.003 mf., and said capacitor connected to the input of said first amplifier means has a value in the range of about 1.5 to 80 mmf.

4. An ignition analyzer according to claim 1 wherein said amplifier (D) comprises a plurality of amplifying means, a first capacitance divider comprising a pair of capacitors in series connection having the end of one capacitor connected to ground, the end of the other capacitor connected to the input of the first amplifier means, and the common point intermediate said capacitors adapted to be connected to the ignition signal generating means, and a second capacitance divider comprising a pair of series-connected capacitors having the outer end of one capacitor connected to ground and the outer end of the other capacitor connected to the input of said second amplifier means, and the common point intermediate said capacitors being connected to the output of said first amplifier means, the values of said capacitors being so chosen as to compensate for non-linearities introduced by the deflection coils of said yoke and picture tube, whereby a true representation of the signal voltage applied to said amplifier is provided by the trace on said picture tube.

5. An ignition analyzer according to claim 1 wherein said amplifier (D) comprises at least three amplifying means, a first capacitance divider comprising a pair of capacitors in series connection having the outer end of one capacitor connected to ground, the outer end of the other capacitor connected to the input of the first amplifying means, and the common point intermediate said capacitors adapted to be connected to the ignition signal generating means, and a second capacitance divider comprising a pair of series-connected capacitors having the outer end of one capacitor connected to ground and the outer end of the other capacitor connected to the input of said third amplifying means, and the common point intermediate said capacitors being connected to the output of said second amplifying means, the values of said capacitors being so chosen as to compensate for non-linearities introduced by the deflection coils of said yoke and said picture tube, whereby a true representation of the signal voltage applied to said amplifier is provided by the trace on said picture tube.

6. An ignition analyzer according to claim 5 wherein in said first capacitance divider said capacitor connected to ground has a value of about .0005–.003 mf., said capacitor connected to the input of said first amplifying means has a value in the range of about 1.5–80 mmf., and wherein in said second capacitance divider said capacitor connected to ground has a value of about .005–.003 mf. and said capacitor connected to the input of said third amplifying means has a value of about .01–.05 mf.

7. An ignition analyzer according to claim 5 wherein a resistance-capacitance filter is provided in the cathode circuit of each of said first and second amplifying means adapted to increase low frequency response.

8. An ignition analyzer according to claim 7 wherein the capacitor of each resistance-capacitance filter has a value of about .0005–.003 mf.

9. An ignition analyzer according to claim 8 wherein the resistance in the cathode circuit of said first amplifier means is adjusted to a value of about 8K ohms and the resistor in the cathode circuit of said second amplifying means is adjusted to a value of about 4K ohms.

10. An ignition analyzer according to claim 1 wherein the input of said electronic amplifier (D) is additionally adapted to be connected to an electrical current generating means of said ignition system.

11. An ignition analyzer according to claim 10 wherein said electrical current generating means is an alternator.

12. An ignition analyzer according to claim 10 wherein said triggering impulse is derived from a spark plug of said engine.

13. An analyzer for testing the electrical current gen-

erating means of an internal combustion engine comprising:

(A) a cathode ray tube having means for providing both horizontal and vertical deflection,

(B) means adapted to generate the sweeping signal comprising a saw-tooth generator, means for deriving a triggering impulse from the electrical ignition system of said engine, means for amplifying said triggering impulse and applying said amplified impulse to actuate said saw-tooth generator for producing a single sweeping signal for each triggering impulse,

(C) amplifier means having its input connected to said sweeping signal generating means and its output operatively connected to said means for providing deflection of the beam of said cathode ray tube along one set of coordinates,

(D) an electronic amplifier having its input adapted to be connected to the output of said electrical current generating means, and its output operatively connected to said means for providing deflection of said beam along the other set of coordinates.

14. An analyzer according to claim **13** wherein said triggering impulses are derived from one of the spark plugs of said engine.

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RUDOLPH V. ROLINEC, *Primary Examiner.*

M. J. LYNCH, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,409,824 November 5, 1968

George Makuh

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 16, "particularly such devices," should read -- particularly, such devices --. Column 5, line 17, ".01-0.5 mf" should read -- .01-.05 mf --; line 50, ".005-.003 mf" should read -- .0005-.003 mf --. Column 8, line 49, ".005-.003" should read -- .0005-.003 --.

Signed and sealed this 10th day of March 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents