E.O. Book

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-46
Relating to Exemptions under Section 27156
of the Vehicle Code

TANNER ELECTRONIC SYSTEMS TECHNOLOGY, INC.
"TEST ELECTRONIC IGNITION"
"HURST/AIRHEART SCR ELECTRONIC IGNITION, PN 41-12127"
"RAC ELECTRONIC IGNITION, MODEL NO. 796"
"ROCKET RACING PRODUCTS, MODEL NO. 7710"
"SCR IMPULSE IGNITION"
"GOLDSPARK ELECTRONIC IGNITION"

Pursuant to the authority vested in the Air Resources Board by Section 27156 of the Vehicle Code; and

Pursuant to the authority vested in the undersigned by Section 39023 of the Health and Safety Code;

IT IS ORDERED AND RESOLVED: That the installation of silicon controlled rectifier operated breaker-points isolators manufactured by Tanner Electronic Systems Technology, Inc. (T.E.S.T., Inc.) and marketed as indicated below have been found to not reduce the effectiveness of required motor vehicle pollution control devices and, therefore, are exempt from the prohibitions of Section 27156 of the Vehicle Code for 1974 and older model-year vehicles equipped with the standard Kettering-type ignition system consisting of an ignition coil, breaker points, condenser and powered by a 6 or 12 volt battery with a negative ground. This system is applicable to Kettering-type systems retrofitted with Carter or Dana 1966-70 NOx devices with electronic speed sensors. This system is not applicable to such non-standard systems as: capacitive discharge, transistorized, breakerless, or the "leading" ignition of a Mazda rotary engine.

The following is a list of each device manufactured by T.E.S.T., Inc. and marketed as indicated; each device consists of a sealed case containing the electronic components (two resistors, one silicon controlled rectifier, one diode, and one capacitor) and four wire leads from the case that are connected to the ignition coil terminals, distributor coil lead, and engine ground.

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"SCR IMPULSE IGNITION"
"GOLDSPARK ELECTRONIC IGNITION"

EXECUTIVE ORDER D-46

TEST Electronic Ignition	Tanner Electronic Systems Technology, Inc. 19428 Londelius Street Northridge, Ca. 91324
Hurst/Airheart SCR Electronic Ignition, PN 41-12127	Hurst/Airheart Products, Inc. 20235 Bahama Street Chatsworth, Ca. 91311
RAC Electronic Ignition Model No. 796	Rite Autotronics Corporation 3485 S. La Cienega Blvd. Los Angeles, Ca. 90016
Rocket Racing Products, Model No. 7710	Rocket Racing Products 9935 Beverly Blvd. Pico Rivera, Ca. 90660
SCR Impulse Ignition	Cannon Industries, Inc. 9073 Washington Blvd. Culver City, Ca. 90230
Goldspark Electronic Ignition	Mr. Gasket Company 4566 Spring Road Cleveland, Ohio 44131

This Executive Order is valid provided that installation instructions for this device will not recommend tuning the vehicle to specifications different than those listed by the vehicle manufacturer.

Changes made to the design or operating conditions of the device as originally submitted to the Air Resources Board for evaluation that adversely affect the performance of the vehicle's pollution control devices shall invalidate this Executive Order.

Marketing of this device using an identification other than that shown in this Executive Order or marketing of this device for an application other than those listed in this Executive Order shall be prohibited unless prior approval is obtained from the Air Resources Board.

This Executive Order does not constitute any opinion as to the effect that the use of this device may have on any warranty either expressed or implied by the vehicle manufacturer.

TANNER ELECTRONIC SYSTEMS TECHNOLOGY, INC.
"TEST ELECTRONIC IGNITION"
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"GOLDSPARK ELECTRONIC IGNITION" EXECUTIVE ORDER D-46

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF ANY CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF THE TANNER ELECTRONIC SYSTEMS TECHNOLOGY, INC., "TEST ELECTRONIC IGNITION", "HURST/AIRHEART SCR ELECTRONIC IGNITION, PN 41-12127", "RAC ELECTRONIC IGNITION, MODEL NO. 796", "ROCKET RACING PRODUCTS, MODEL NO. 7710", "SCR IMPULSE IGNITION", OR "GOLDSPARK ELECTRONIC IGNITION" DEVICES.

No claim of any kind, such as "Approved by Air Resources Board" may be made with respect to the action taken herein in any advertising or other oral or written communication.

Section 17500 of the Business and Professions Code makes unlawful, untrue or misleading advertising, and Section 17534 makes violation punishable as a misdemeanor.

Sections 39130 and 39184 of the Health and Safety Code provide as follows:

> "39130. No person shall install, sell, offer for sale, or advertise, or, except in an application to the board for certification of a device, represent, any device as a motor vehicle pollution control device unless that device has been certified by the board. No person shall sell, offer for sale, advertise, or represent any motor vehicle pollution control device as a certified device which, in fact, is not a certified device. Any violation of this section is a misdemeanor."
>
> "39184. (a) No person shall install, sell, offer for sale, or advertise, or, except in an application to the board for accreditation of a device, represent, any device as a motor vehicle pollution control device for use on any used motor vehicle unless that device has been accredited by the board. No person shall sell, offer for sale, advertise, or represent any motor vehicle pollution control device as an accredited device which, in fact, is not an accredited device. Any violation of this subdivision is a misdemeanor."

TANNER ELECTRONIC SYSTEMS TECHNOLOGY, INC.
"TEST ELECTRONIC IGNITION"
"HURST/AIRHEART SCR ELECTRONIC IGNITION, PN 41-12127"
"RAC ELECTRONIC IGNITION, MODEL NO. 796"
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Any apparent violation of the conditions of this Executive Order will be submitted to the Attorney General of California for such action as he deems advisable.

Executed at Sacramento, California, this 2 day of ~~November~~ December, 1974.

WILLIAM SIMMONS
Executive Officer

State of California
AIR RESOURCES BOARD

November 20, 1974

Staff Report

Evaluation of the Tanner Electronic Systems Technology, Incorporated's "TEST Electronic Ignition", "Hurst/Air-Heart SCR Electronic Ignition, PN 41-12127", "RAC Electronic Ignition, Model No. 796", "Rocket Racing Products, Model No. 7710", "SCR Impulse Ignition", and "Goldspark Electronic Ignition" for Exemption from the Prohibitions of Section 27156 of the California Motor Vehicle Code

I. Introduction

Tanner Electronic Systems Technology (T.E.S.T.), Inc., of 19428 Londelius Street, Northridge, California 91324 has applied for an exemption from the prohibitions of Section 27156 of the California Motor Vehicle Code for the "TEST Electronic Ignition" device. In addition, T.E.S.T., Inc. has applied for exemptions for the following devices manufactured by them under private label:

Hurst/Airheart SCR Electronic Ignition, PN 41-12127	Hurst/Airheart Products, Inc. 20235 Bahama Street Chatsworth, CA 91311
RAC Electronic Ignition Model No. 796	Rite Autotronics Corporation 3485 S. La Cienega Blvd. Los Angeles, CA 90016
Rocket Racing Products, Model No. 7710	Rocket Racing Products 9935 Beverly Blvd. Pico Rivera, CA 90660
SCR Impulse Ignition	Cannon Industries, Inc. 9073 Washington Blvd. Culver City, CA 90230
Goldspark Electronic Ignition	Mr. Gasket Company 4566 Spring Road Cleveland, OH 44131

According to the applicant, the private label devices are electronically identical to the "TEST Electronic Ignition" and differ only in packaging and labeling (See Exhibit III). Section 27156 prohibits the sale, advertising, or installation of any device or mechanism which reduces the effectiveness of the required motor vehicle emissions control system. The applicant is requesting the exemption be granted for 1974 and older-model vehicles equipped with the standard Kettering-type ignition system consisting of an ignition coil, breaker points, condenser and powered by a 6 or 12 volt battery with a negative ground. This system is not applicable to such non-standard systems as: capacitive discharge, transistorized, breakerless, or the "leading" ignition of Mazda rotary engines.

II. Device Description and Function

The "TEST Electronic Ignition" is composed of a sealed case containing the electronic components (two resistors, one silicon controlled rectifier, one diode, and one capacitor) and four wire leads from the case to be connected to the ignition coil terminals, distributor coil lead, and engine ground. The case is mounted in a convenient location in the engine compartment with coil and distributor leads as short as possible (refer to Exhibit I-Installation instructions). If the SCR should fail by shorting (applicant claims this is the most likely failure mode) the ignition system will continue to operate as a normal Kettering system (Refer to Exhibit II-U.S. Patent 3,741,184 and Device Specification).

When the points close, the current flows through the diode and two resistors as well as the SCR (see circuit diagram Exhibit II, page 5). The points' opening initiates the collapse of the primary coil's magnetic field and the capacitor's charging. When the capacitor reaches its maximum charge and begins to discharge back into the primary coil, the reverse current flow switches the SCR to its blocking state and the points are then removed from the circuit electronically. When the points close again, the capacitor discharges and the SCR switches back to its conducting mode and the cycle repeats. This action allows the energy previously lost in continued point arcing to be made available to the system for increased coil-capacitor ringing.

According to the applicant, the "TEST Ignition System" will increase point life, spark plug life, and increase available firing voltage.

III. Device Evaluation

The applicant did not submit any emission data showing the effects of the device on the OEM emission control system. In order to evaluate the device, the electrical output characteristics of an ignition system with and without the device were compared.

The tests were conducted on the Air Resources Board's ignition system simulator which consists of a Sun distributor tester, Tektronix oscilloscope, Sun ignition analyzer, and associated auxiliaries.

The ARB evaluation consisted of measuring the spark advance, spark duration , available secondary voltage, secondary voltage rise time, and actuation RPM of the NOx retrofit device vacuum controlling valve.

The test configurations are as follows:

Baseline I : Simulator with Carter CER NOx retrofit device

Device I : Simulator, Carter CER Kit, and Hurst/Airheart SCR Electronic Ignition

Baseline II : Simulator with Dana Retronox electonic speed sensor

Device II : Simulator, Dana Retronox, and TEST Electronic Ignition

Table I

Centrifugal Spark Advance in Crankshaft Degrees

RPM	Baseline I	Device I	Baseline II	Device II
600	0.0	0.0	0.0	0.0
1000	3.0	3.0	3.0	3.0
1500	19.0	19.0	19.0	19.0
2000	21.0	21.0	21.0	21.0
2500	24.0	24.0	24.0	24.0
3000	25.0	25.0	25.0	25.0

Spark Duration in Microseconds

RPM	Baseline I	Device I	Baseline II	Device II
600	2200	2000	2400	1900
2000	1700	1600	1800	1600

Secondary Voltage Rise Time in Microseconds

RPM	Baseline I	Device I	Baseline II	Device II
600	30	35	30	30
2000	30	35	30	30

NOx Retrofit Device Valve Actuation Points in RPM

Configuration	Valve Opens	Valve Closes
Baseline I	1180	1000
Device I	1180	1000
Baseline II	2000	1800
Device II	2000	1800

Table I shows the results of the test. The installation of the devices did not significantly change the output characteristics of the OEM ignition system.

Conclusion and Recommendation

Based on the ARB test results, the installation of the "TEST Electronic Ignition" or any of the other five identical devices listed in the Introduction would not adversely affect the performance or operation of the OEM emission control system. The staff recommends that Tanner Electronic Systems Technology, Inc. be issued an exemption from the prohibitions of Section 27156 of the Vehicle Code for its "TEST Electronic Ignition" and the other five devices manufactured by them and listed with their marketing firms in the Introduction for the following:

Any 1974 and older model-year vehicles equipped with the standard Kettering-type ignition system consisting of an ignition coil, breaker points, condenser and powered by a 6 or 12 volt battery with a negative ground. This system is not applicable to such non-standard systems as: capacitive discharge, transistorized, breakerless, or the "leading" ignition of a Mazda rotary engine. This system is applicable to Kettering-type systems retrofitted with Carter or Dana 1966-70 NOx devices with electronic speed sensors.

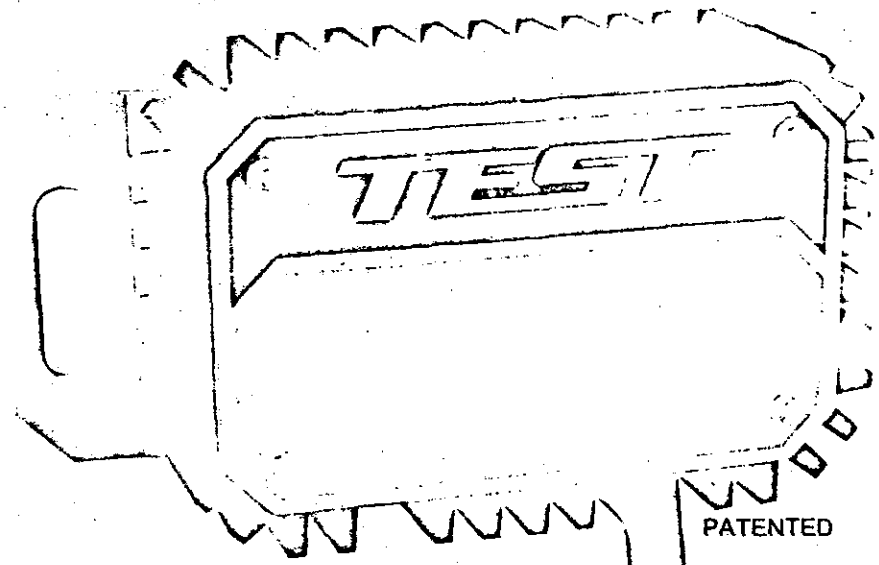
MAINTENANCE AND TROUBLE SHOOTING

The Electronic Ignition System requires no periodic maintenance. If the unit should fail, its unique fail-safe design will automatically revert the circuitry back to the conventional ignition system. No indication of this fail-safe mode is visible. To determine if your system is functioning properly, stop the engine, disconnect the Red wire from the coil and hold it away from ground. Attempt to restart the engine. If it runs, then the Electronic Ignition System is in the fail-safe mode and should be replaced.

TEST™
Incorporated
NORTHRIDGE, CALIFORNIA

TEST

ELECTRONIC IGNITION



5 YEAR WARRANTY

GENERAL INSTALLATION INSTRUCTIONS

GENERAL DESCRIPTION

YOUR NEW ELECTRONIC IGNITION SYSTEM

- Increases ignition breaker point life
- Increases spark plug life
- Increases time between tune-ups
- Improves gasoline mileage
- Features fail-safe design
- Improves starting especially in damp weather
- Improves ignition efficiency especially under heavy load and at high RPM.

FEATURES

APPLICATION

The Electronic Ignition System attaches in minutes to any engine with a conventional (Kettering) type ignition, 6 or 12 volt negative ground. Works on engines with any number of cylinders.

WATERPROOF

The Electronic Ignition System is a sealed waterproof unit connected directly to the ignition's primary or low voltage circuit.

SAFETY

The Electronic Ignition System contains no moving parts and produces no sparks or arcs in operation. It is connected only to the primary ignition circuit thus presents no additional shock hazard. Its fail-safe design provides for automatic switching back to the conventional ignition system in case of failure of the system. This feature provides engine power under all conditions.

TECHNICAL

The Electronic Ignition System is a new approach to improving the performance of an engines ignition system. Using the time proven reliable components of the conventional, Kettering design ignition system a space-age solid state device is added which switches the heavy current during the critical point closing and opening periods. This minimizes point deterioration and burning which is the major reason for the need of frequent tune-ups. Additional circuitry increases primary circuit ringing while the spark plug is firing, thus increasing the power delivered to the plug. The result is a hotter spark which burns off harmful deposits before they reduce plug life. The design features a fail-safe mode, which instantly and automatically reverts back to a conventional ignition, in case of system malfunction.

INSTALLATION

The Electronic Ignition System should be mounted in the engine room as close as possible to the distributor and coil. Do not mount directly on the engine as direct engine heat may damage the unit. Refer to Figure 1.

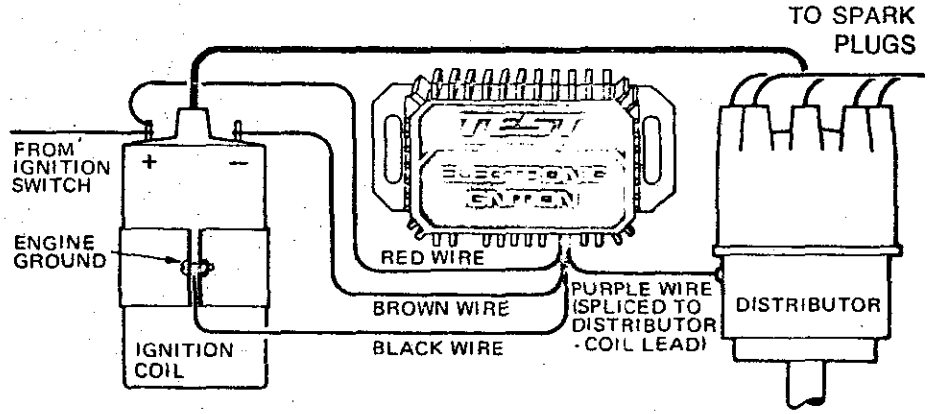
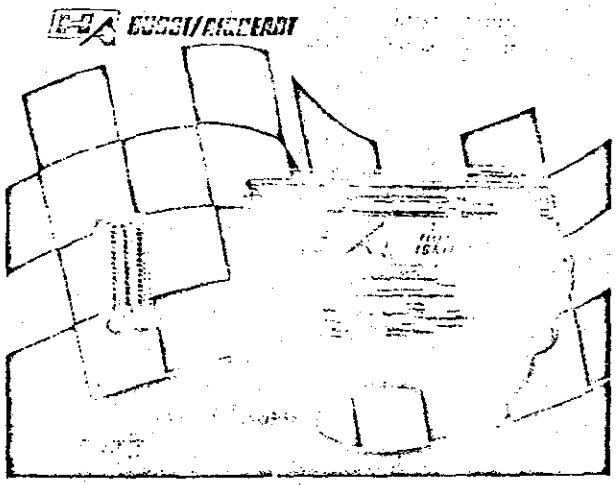


Figure 1—WIRING DIAGRAM

1. Mount electronic ignition securely in place. Select the location so the leads may be cut as short as possible. Note: long leads may increase the effect of existing sources of radio interference.
2. Connect the Black lead to either the ignition coil mounting bracket or a good engine ground.
3. Add the Red lead to the coils (+) terminal.
4. Remove the distributor lead from the coils (—) terminal and splice it to the units purple wire. Tape connection securely with electrical tape.
5. Connect the Brown wire to the coils (—) terminal.
6. For maximum point life, the standard ignition condenser in the distributor may be disconnected or removed and discarded. The Electronic Ignition System will provide full arc suppression under all conditions; including the fail-safe mode. Note: if condenser is disconnected be sure to tape and secure its pigtail lead.

HURST/AIRHEART PRODUCTS, INC.
20235 Bahama St., Chatsworth, Calif. 91311 • 213 · 882-6600

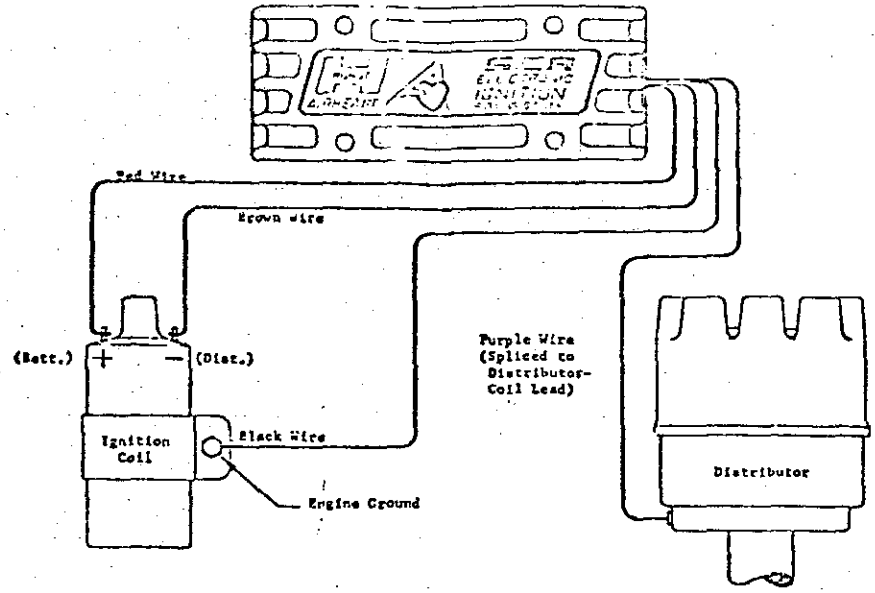


YOUR NEW HURST/AIRHEART ELECTRONIC IGNITION PROVIDES:

- ★ Easier and quicker starts
- ★ Increased point and plug life
- ★ Increased time between tune-ups
- ★ Improved ignition efficiency (especially under heavy load and at high RPM's)
- ★ Better gas mileage (due to maintaining "tuned" condition longer and increasing point and plug life)
- ★ Increased power to plugs
- ★ Waterproof design (completely sealed unit)
- ★ Failsafe design (automatically switches back to conventional ignition system if a failure should occur)

How your new HURST/AIRHEART ELECTRONIC IGNITION works:

The Hurst/Airheart SCR Electronic Ignition uses the reliable, proven components of your conventional ignition and adds a solid state module to perform the switching of heavy current during the periods of opening and closing the points, thus minimizing point deterioration and burning, and increasing point life. While each spark plug is firing, additional c rcuitry provides increased primary circuit ringing, increasing the power delivered to the plug. This results in a hotter spark to burn up harmful deposits before they damage plugs, increasing plug life.



THIS UNIT GUARANTEED FOR 5 YEARS.
Keep your sales slip as proof of date of purchase.

INSTALLATION:

The Hurst/Airheart SCR Electronic Ignition quickly attaches to any engine with a conventional 6 or 12 volt negative ground type ignition. (not for use with dual ignition or magnetos).

1. Mount Hurst/Airheart SCR Electronic Ignition securely to fender well, firewall or other convenient location as close to the distributor as practical. Long leads may increase the effect of existing sources of radio interference.
2. Connect the Black lead (ground) to a good engine ground such as the ignition coil mounting bracket.
3. Connect (add) the Red lead to the coil's battery (+) terminal.
4. Remove the distributor lead from the coil's distributor (–) terminal and splice it to the Purple wire. Tape splice well with electrical tape.
5. Connect Brown wire to the coil's distributor (–) terminal.
6. Disconnect or remove the standard ignition condenser in the distributor. If condenser is disconnected and not removed, be sure to tape and secure its pigtail lead. Removal of the standard condenser (or its disconnection) is not necessary for the electronic ignition's operation; however it is recommended to maximize point life. The Electronic Ignition will provide full arc suppression under all conditions, even in the fail-safe m

EXHIBIT-I

October 11, 1974

The device is not suitable for other than standard Kettering Ignition systems such as capacitive discharge systems (CD), Transistorized systems, Breakerless systems, the "Leading" Ignition of Mazda engines or similar arrangements that deviate from the basic Kettering configuration.

Revise Step 6 of the installation instructions to read: Disconnect or remove the standard ignition condenser in the distributor. The Electronic Ignition will provide full arc suppression under all conditions, including the fail-safe mode.

Note: If Condenser is disconnected be sure to tape and secure its pigtail lead.

Revised October 16, 1974

T.E.S.T. INC.

Bruno A. Rist
Vice President/Engineering

State of California
AIR RESOURCES BOARD

SPECIFICATIONS - IGNITION SYSTEM

I. Product Description

Manufacturer T.E.S.T. INC. Name & Model No. SCR TEST Electronic Ignition

Address 19428 Londelius St., Telephone (213) 349-2403

Northridge, California Mounting Position any

Type of Ignition

Kettering _____ Capacitive Discharge ____ Electronic _____

Other SCR

II. Input Requirement

System input voltage and current (volts and amps - RPM curve)

Same as stock

III. OUTPUT Characteristics

A. Primary System

1. System output voltage and current (volts and amps - RPM curve)

Same as stock

B. Secondary System

1. Available output secondary voltage (specify RPM or submit voltage- rpm curve)

Same as stock

2. Secondary voltage rise time Same as stock

3. Secondary output energy (at input voltage) Increased degree of output depends on many variables such as spark plugs and is not specified by the manufacturer.

4. Spark duration (specify engine RPM) and spark gap) Increased degree of spark duration depends on many variables and is not specified by the manufacturer.

IV. Design details

Storage capacitor capacitance (uf) and stored voltage Not applicable

C-D unit inductance (uH) Not applicable

Pulse triggering source Not applicable

Type of transformer in C-D and turn ratio Not applicable

Transient voltage protection (open circuits and voltage surges)
Inherent in SCR and diode by avalanche phenomenon

Close point time limit Same as stock

Maximum point current and ground circuit resistance
Same as stock

Oscillator frequency Not applicable

Number and type of power transistor Not applicable

Ballast resistors required? Yes X No ___

Resistor Type ___ Resistor Size (ohms) Stock OEM

Switch back to stock system? Yes X No ___

Describe methods Automatic-Details in attached data.

Moisture and Vibration Protection Potted

Operating Temperature Range -45° to plus 212°F

Humidity Range Not affected by humidity existing under the hood due to potting.

V. Modifications from O.E.M.

Ignition timing modified? Yes _____ No X

State modifications from O.E.M. Ignition System Characteristics None

Engine Setting Changes? Yes _____ No X

Describe Changes None

Specify any other changes from O.E.M. None

VI. Device information

Please attach circuit diagram, O.E.M. and device spark advance curves and photograph of spark line produced by device.

Description of operating principle Attached

United States Patent [19]

Tanner et al.

[11] **3,741,184**

[45] **June 26, 1973**

[54] **ELECTRO-MECHANICAL SWITCHING SYSTEM**

[75] Inventors: **James L. Tanner**, Reseda; **Bruno A. Rist**, Northridge, both of Calif.

[73] Assignee: **Tanner Electronic Systems Technology Inc.**, Northridge, Calif.

[22] Filed: **Nov. 8, 1971**

[21] Appl. No.: **196,438**

[52] **U.S. Cl.** ..... **123/148 E**, 123/148 R

[51] **Int. Cl.** **F02p 1/00**

[58] **Field of Search** ..... 123/148 E

[56] **References Cited**

UNITED STATES PATENTS

3,306,274 2/1967 Motto et al. ..... 123/148 E

FOREIGN PATENTS OR APPLICATIONS

984,137 2/1965 Great Britain ..... 123/148 E

24,805 4/1966 Japan ..... 123/148 E

OTHER PUBLICATIONS

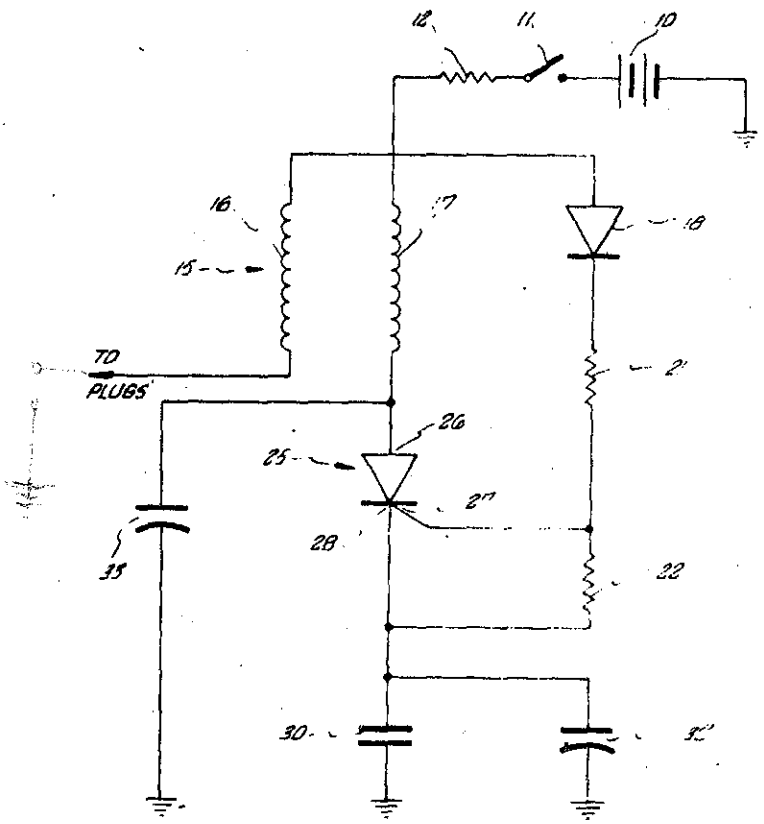
Westinghouse SCR Handbook, 4/64, pages 104–116, Robert Murray.

Primary Examiner—Laurence M. Goodridge
Assistant Examiner—Ronald B. Cox
Attorney—Richard Morganstern

[57] **ABSTRACT**

An electronic switching system having particular utility in ignition systems for internal combustion engines is disclosed. A silicon controlled rectifier in series with the inductor coil and breaker points is utilized to isolate the breaker points from the ignition coil and to carry out the make and break functions. Should the SCR fail as by shorting, the ignition system will continue to operate as a conventional ignition system.

5 Claims, 1 Drawing Figure



PATENTED JUN 26 1973

3,741,184

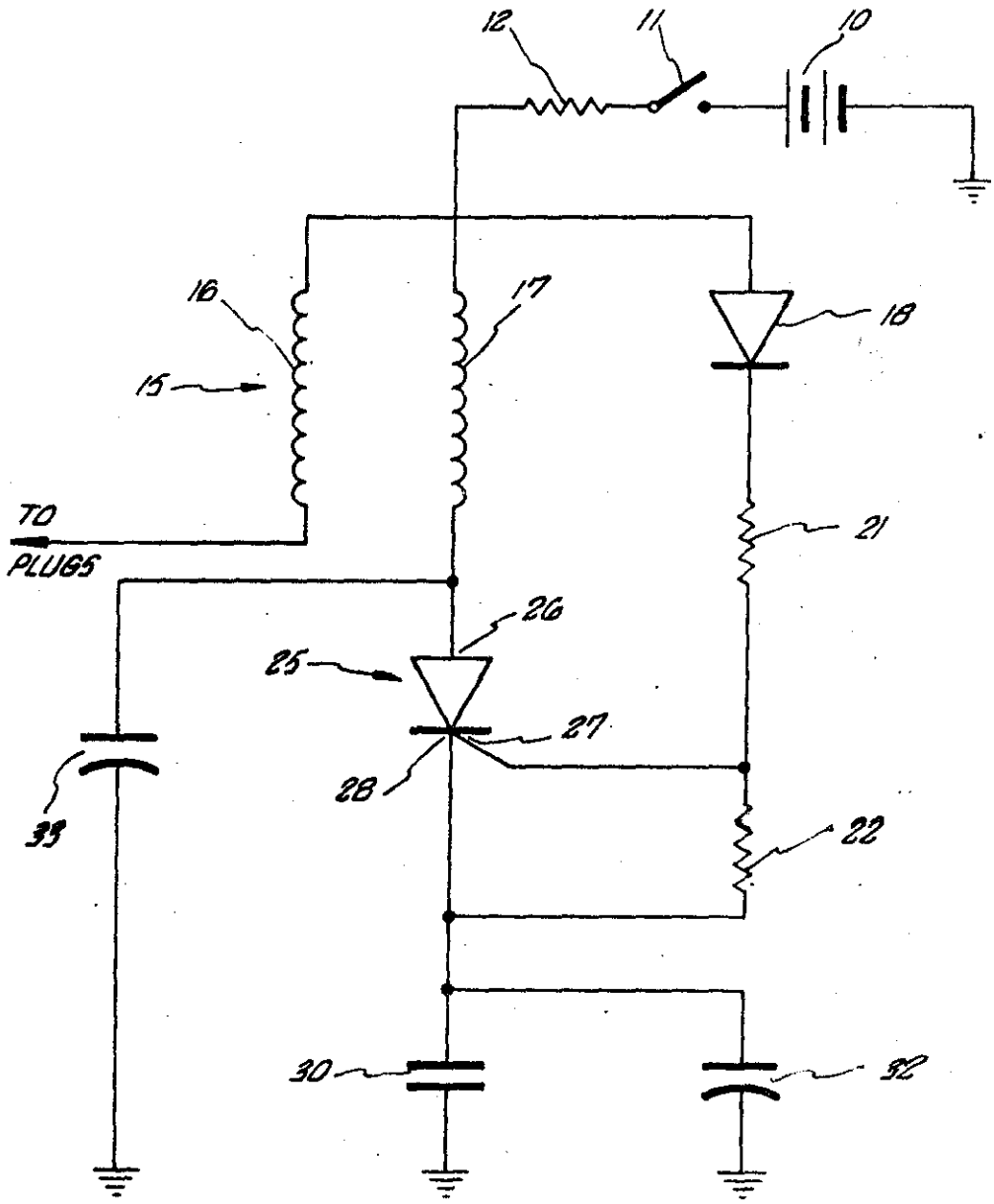


FIG. 1

ELECTRO-MECHANICAL SWITCHING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to a solid state assisted switching system in which a switch makes and breaks a ringing inductive load and, more particularly, to a new and useful ignition system for internal combustion engines and the like.

2. Description of the Prior Art

The standard ignition system of the automotive industry utilizes an ignition coil which has a primary winding and a secondary winding. The ignition coil secondary winding is connected via a suitable distribution means to the engine's spark plugs. The ignition coil primary winding is connected in series with a source of DC power, typically the automobile battery, and a set of breaker contacts. The breaker contacts open and close in synchronism with the motor in accordance with a pretermined sequence typically controlled by a mechanical means such as a breaker cam.

In such an ignition system the spark energy for the plugs is supplied by the DC battery which is stored and subsequently released by the ignition coil, at an appropriate voltage level, to jump the spark gap. In operation, closure of the points causes current to flow in the primary of the ignition coil and results in the build up of a magnetic field. Opening of the points causes the sudden collapse of the field which results in a high induced voltage in the secondary winding of the ignition coil. A capacitor is typically connected across the points to limit the rate of the field collapse to limit arcing of the contacts to an acceptable level. Frequently a ballast resistor is connected in series with the configuration thus described to limit the saturation current of the ignition coil primary.

The basic ignition system above described has proven extremely useful and has remained substantially unchanged in form and function for many years. Among its advantages are its extreme simplicity of design, reliability and economy.

The basic ignition system, however, has several important disadvantages. For example, substantial voltages appearing across the breaker contacts result in oxidation, erosion, and pitting of the contacts. The contacts thus require frequent maintenance and replacement to enable continued efficient performance of the ignition circuit. Arcing of the points also reduces available spark energy because it acts as a load on the tuned circuit formed by the ignition coil primary and the capacitor connected across the points. The dissipation of available energy, while important at all engine speeds becomes most significant at higher engine RMP's. This is so since at high engine speeds the contacts are closed for only a relatively short time period. Current build up through the ignition coil primary does not normally reach full saturation value before the points are opened. Thus, the available output voltage is reduced from its optimum value. Any further dissipation of energy as by arcing of the points further reduces available spark energy.

Numerous and varied attempts have been made to eliminate the deficiencies of the standard ignition system. In one approach transistor switching circuits are employed with the points carrying only control or bias current. Some systems do away with the breaker points completely and use magnetic or optical pick-ups and

pulse amplifiers to control the output transistor. These systems, however, require the transistor switch to be operated at high voltage and current levels. Transistors capable of meeting such criteria are extremely expensive and require elaborate compensation techniques such as special coils, diode protection, etc.

Another, alternate, approach is exemplified by the so-called "capacitor discharge ignition systems." In this type of system, the battery voltage is typically stepped up to several hundred volts by a DC to DC converted and stored in a capacitor. The capacitor is discharged into the primary of the ignition coil, at the appropriate time, by an electronic switch. The capacitor energy is thus converted to a high voltage pulse in the secondary winding of the ignition coil. In this approach too, the points typically carry only control current. Capacitive discharge systems suffer from the disadvantage that they are generally extremely complex and costly. Further, a common disadvantage of most known alternate electronic schemes is that upon failure of any component the entire ignition system fails.

SUMMARY OF THE INVENTION

An electronic switching system is disclosed having particular utility in ignition systems for internal combustion engines. The system obviates many of the deficiencies of the prior art systems while remaining uncomplicated and economical.

In accordance with a preferred embodiment of the present invention a silicon controlled rectifier is utilized to isolate the breaker points from the ignition coil and to carry out the make and break functions. The anode and cathode of the silicon controlled rectifier are connected in series with the DC power source, primary coil and breaker points of a standard ignition system and located between the primary of the ignition coil and the points.

Means are provided for turning the SCR "on" responsive to the closing of the points. With the SCR conducting and the points closed the ignition coil primary current is carried by both the SCR and the points. Means are provided for turning the SCR "off" responsive to the opening of the points. The fly-back voltage generated by the ignition coil primary is thus sustained by the SCR and not by the points. Arcing of the points and the resultant energy dissipation and spark plug wear is minimized. Substantial additional energy is made available for application to the plugs which results in faster starts, more complete combustion of the fuel, lower gas consumption and a reduction in emitted pollutants.

As another unique feature of the present invention should the SCR fail, the ignition system will continue to operate as a conventional ignition system. The system circuitry results in a decrease in the wear characteristics of the points and an increase in the energy available for application to the plugs.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a circuit diagram of a preferred form ofthe invention as incorporated in an ignition system for an internal combustion engine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a circuit schematic of a preferred form of the invention as incor-

porated for use in an ignition system for internal combustion engines or the like. A DC battery 10 is positioned in series electrical configuration with an ignition switch 11, a ballast resistor 12, primary winding 17 of a transformer 15 and a make-break switch (breaker points) 30.

The secondary 16 of transformer 15 supplies current at high voltage to the spark plugs of the internal combustion engine in a manner well known in the art. A capacitor 32 is connected across the breaker points 30 as is also known in the art. The configuration thus described comprises the standard automotive ignition system.

In accordance with the present invention, a silicon controlled rectifier or similar switching device 25 is connected with its anode and cathode terminals 26 and 28 respectively between the primary of the transformer and the breaker points. From the other end of the primary winding 17 a diode 18 and resistor 21 are connected to the gate terminal 27 of the SCR. An optional resistor 22 is connected between the gate and the cathode of SCR 25. Resistor 22 reduces the sensitivity of the gate to voltage spikes in a manner well known in the art. A capacitor 33 is connected between the SCR anode and ground, as shown.

The system thus described operates as follows:

With the ignition switch closed, and the breaker points initially open, closure of the breaker points 30 allows gate current to flow from the battery 10 through diode 18 and resistor 21. The gate current turns "on 27 the SCR after a small turn on delay corresponding to the time required to spread conduction and regeneration through the solid-state device's junctions. Initially points 30 "see" only the SCR gate current and whatever charge may be contained in capacitor 32 at the instant of point closure.

With the SCR 25 conducting and the points 30 closed, ignition coil primary current is carried by both the SCR and points up to the limit set by the ballast resistor 12 and the winding resistance of the ignition coil. The time period just described is referred to as dwell time. The current flowing through primary coil 17 stores energy therein. This energy is subsequently dissipated through secondary winding 15 upon opening of the breaker points 30 in a manner to be hereinafter described.

To initiate a spark the points 30 are opened causing a collapse of the magnetic field in the coil 17. Immediately after opening of the points 30 the SCR remains conducting since the ignition coil will not allow an instantaneous change of current flow. Capacitors 32 and 33 are thus charged until the magnetic field in the coil is depleted. In a typical embodiment capacitor 32 and 33 may be charged to approximately 300 to 350 volts.

After the capacitors reach their maximum charge, current will flow from capacitor 33 back into the coil 17. This reverses current flow through the SCR and returns it to a blocking state. Capacitor 32, however, will retain its charge and prevent gate turn on by keeping diode 18 in the gate circuit reverse biased. Capacitor 33 and the ignition coil thereafter function as an isolated tuned circuit. This results in dissipation of the stored energy in an oscillatory manner and induces a high voltage into the secondary winding 16. This voltage is routed in the standard manner by distribution means, not shown, to the appropriate spark plug.

It will be apparent that the points 30 are disconnected or isolated from the high fly-back coil voltages after the initial quarter cycle of the inductive-capacitive ringing circuit. This is so since after SCR 25 is turned off it will revert to its forward blocking state and isolate the high inductor voltages from the points 30.

In this manner the high fly-back voltages do not cause significant dissipation of stored ignition coil energy via arcing across the points, as is experienced in standard ignition systems. A significantly higher percentage of the available energy thus finds its way to the spark plugs. The breaker points tend to last an appreciably longer time!

The system of the present invention has a further advantage in that a unique fail-safe feature is provided. This fail-safe feature stems from the typical failure mode of an SCR. It is known that should an SCR be subjected to either excessive current or temperature levels the SCR exhibits a tendency to short between its anode and cathode terminals rather than open. Should the SCR 25, as incorporated in the present system, experience such a failure mode the ignition system as a whole would still continue to operate since the remaining components would function as a standard ignition system.

Although the preferred embodiment of the present invention has been described in connection with an ignition system for use in an internal combustion engine it is not so limited. The principles above taught may be applied whenever a switch is required to make and break a ringing inductive load. The system of the present invention, it will be appreciated, is characterized by extreme simplicity and low cost of fabrication as well as by unique fail-safe characteristics and improved performance.

We claim:

1. In a spark ignition system including a DC source, an energy storing ignition coil and a make-break switch connected in series, the improvement which comprises:

a silicon controlled rectifier having anode, cathode and gate terminals, said anode and cathode terminals being connected in series configuration between the ignition coil and the make-break switch;

means responsive to the closing of the switch for applying a gate signal to said gate terminal to render said rectifier conductive, enabling current flow through the ignition coil to store energy therein; and

means responsive to the opening of the make-break switch for rendering said rectifier non-conductive, whereby the make-break switch will be isolated from the ignition coil thereby minimizing arcing across the switch and increase the efficiency of the ignition system.

2. The system of claim 1 wherein said gate signal applying means comprises:

a diode connected between the DC source-ignition coil junction and said gate terminal and poled to conduct gate current from the battery to said silicon controlled rectifier gate terminal responsive to the closing of the make-break switch.

3. The system of claim 2 wherein the make-break switch has a first terminal connected to said cathode terminal and a second terminal connected to a reference potential point, said means for rendering said rectifier non-conductive comprises:

a first capacitor connected between said cathode terminal and the reference potential point; and

a second capacitor connected between said anode terminal and the reference potential point whereby said first and second capacitors will be charged subsequent to the opening of the make-break switch and thereafter back bias said silicon controlled rectifier to render it non-conductive, the ignition coil and said second capacitor functioning as an isolated tuned circuit after the silicon controlled rectifier is turned off.

4. In a system which includes a DC source of power, an energy storing inductor means and a periodically opening and closing make-break switch in series electrical configuration, the combination comprising:

a silicon controlled rectifier having anode, cathode and gate terminals, said rectifier anode and cathode terminals being connected in series electrical configuration between said inductor means and said make-break switch;

means for turning said silicon controlled rectifier on responsive to the closing of said make-break switch whereby energy from said source will be stored in said inductor; and

means for turning said silicon controlled rectifier off responsive to the opening of said make-break switch, whereby the make-break switch is electrically isolated from said inductor to prevent arcing across said switch.

5. An electronic ignition system for internal combustion engines, said system comprising:

a DC battery;

an ignition coil having primary and secondary windings;

a silicon controlled rectifier having anode, cathode, and gate terminals;

a pair of breaker points, said battery, ignition coil primary winding, anode and cathode terminals, and breaker points being connected in series electrical configuration with said anode and cathode terminals being connected between said primary winding and said breaker points, the breaker point remote from said cathode terminal being connected to a point of reference potential;

a first capacitor connected between said anode terminal and said reference point;

a second capacitor connected between said cathode terminal and said reference potential point; and

a diode connected between the primary winding terminal remote from said anode terminal and said gate terminal.

* * * * *

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November 14, 1974

Mr. G. C. Hass, Chief
Division of Vehicle Emission Control
Air Resources Board Laboratory
9528 Telstar Avenue
El Monte, Calif. 91731

Dear Mr. Hass:

TEST Incorporated hereby certifies that the Electronic Ignition systems manufactured under private label for Hurst/Airheart Products, Inc., 20235 Bahama Street, Chatsworth, California 91311 (Hurst/Airheart SCR Electronic Ignition, PN 41-12127); Rite Autotronics Corporation, 3485 South La Cienega Blvd., Los Angeles, California 90016 (RAC Electronic Ignition, Model No. 796); Rocket Racing Products, 9935 Beverly Blvd., Pico Rivera, California 90660 (Model No. 7710); Cannon Industries, Inc., 9073 Washington Blvd., Culver City, California 90230 (SCR Impulse Ignition); and Mr. Gasket Company, 4566 Spring Road, Cleveland, Ohio 44131 (Goldspark Electronic Ignition), are electrically identical to the TEST Electronic Ignition manufactured under Patent No. 3,741,184.

Very truly yours,

T.E.S.T. INC.

Bruno A. Rist,
Vice President/Engineering

BAR/mt