

- [72] Inventors **Ralph L. Slitti, Jr.**
Detroit;
Donald G. Noble, Royal Oak; William F.
Shunn, Fraser, Mich.
- [21] Appl. No. **737,478**
- [22] Filed **June 17, 1968**
- [45] Patented **Jan. 5, 1971**
- [73] Assignee **Holley Carburetor Company**
Warren, Mich.
a corporation of Michigan

[54] **STRUCTURE FOR AND METHOD OF
 ELECTRONIC SIGNAL SWITCHING**
5 Claims, 8 Drawing Figs.

- [52] U.S. Cl. **123/146.5,**
123/148
- [51] Int. Cl. **F02p 7/00**
- [50] Field of Search.
123/146.5A, 148AC, 148E; 315/209, 209T

[56] **References Cited**

UNITED STATES PATENTS

- | | | | |
|-----------|---------|---------------------|----------|
| 3,152,281 | 10/1964 | Robbins | 315/201 |
| 3,161,803 | 12/1964 | Knittweis | 315/209 |
| 3,277,340 | 10/1966 | Jukes et al. | 315/214 |
| 3,288,125 | 11/1966 | Guyton et al. | 123/148E |
| 3,331,986 | 12/1967 | Hardin et al. | 317/200 |
| 3,361,123 | 1/1968 | Kasama et al. | 123/148E |
| 3,424,142 | 1/1969 | Nilssen et al. | 123/148E |

Primary Examiner—Laurence M. Goodridge
 Attorney—Walter Potoroka, Sr.

ABSTRACT: The structure for electronic signal switching disclosed includes trigger signal producing structure, including a transformer having primary and secondary windings and

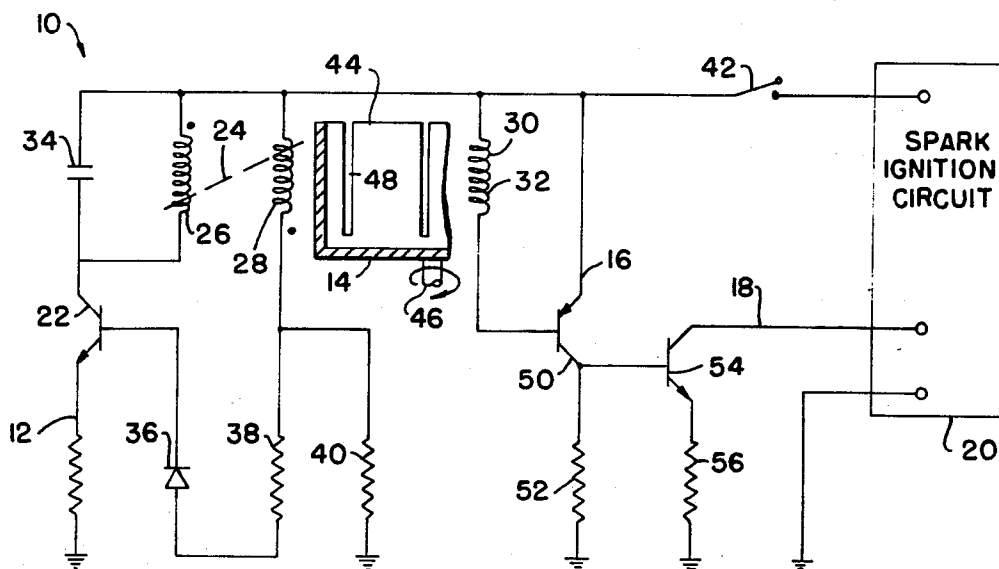
means for controlled shielding of the secondary winding from the primary winding to produce coupling of the transformer windings only when a trigger signal is desired.

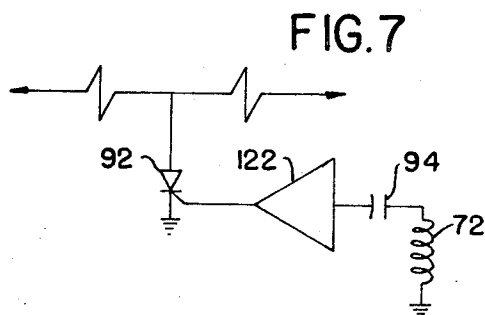
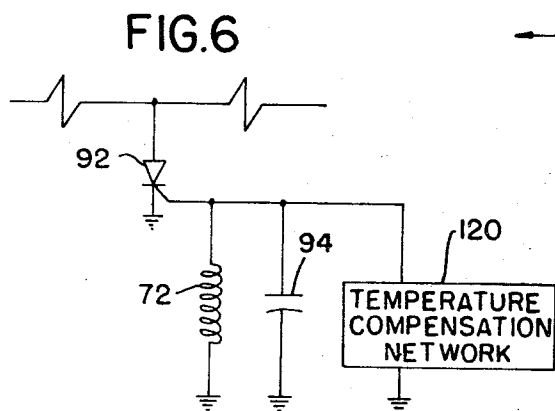
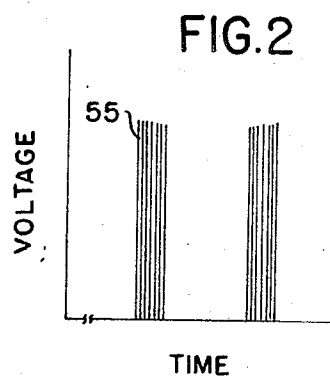
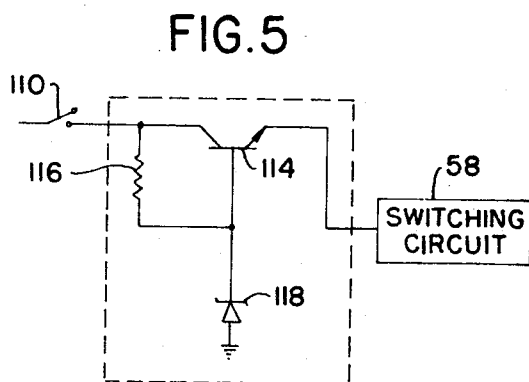
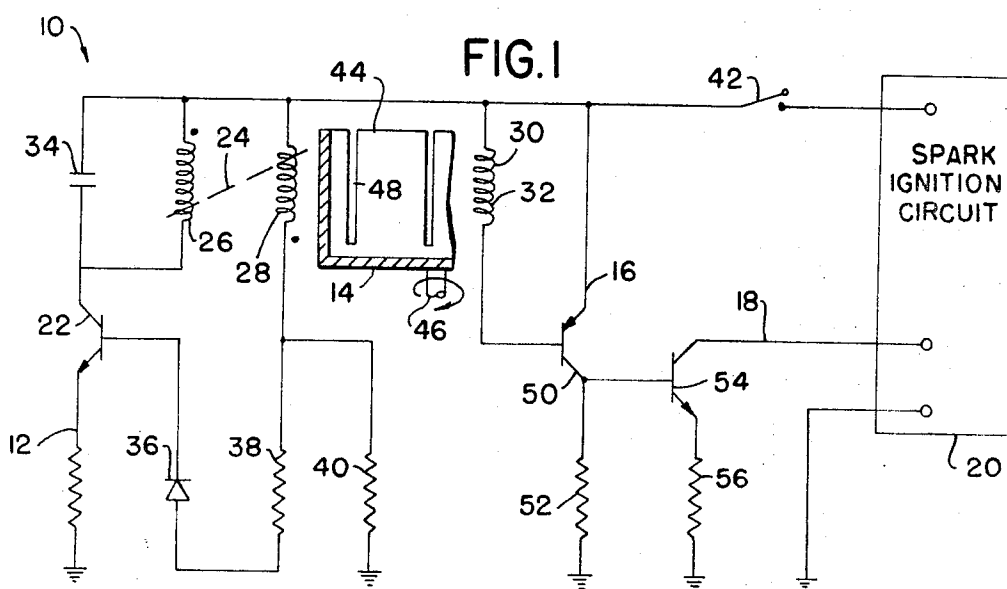
In one modification of the invention the trigger signal producing structure is included in signal switching structure substituted for the usual breaker points in a vehicle spark ignition circuit and the shielding between the primary and secondary windings of the transformer is accomplished by a slotted rotating rail or cup positioned in the vehicle distributor cap and rotated in accordance with engine speed. In this embodiment of the invention a blocking oscillator provides a continuous electric signal to the primary winding of the transformer which is a bifilar wound coil, the secondary winding of the transformer energizes a semiconductor sensing unit, which in turn energizes a switching semiconductor connected to make or break the vehicle ignition circuit in the manner of the usual breaker points.

In a second embodiment of the invention the switching circuit is a darlington amplifier, an integrating circuit receives the output of the blocking oscillator to turn the amplifier on, and a silicon controlled rectifier is connected to short the integrating circuit and turn the amplifier off when the secondary winding of the transformer is not shielded from the primary winding thereof. The amplifier in this embodiment is connected to conduct current through a load, such as an amplifier in an ignition circuit.

Both embodiments of the invention may be compensated for voltage variations and temperature by known voltage regulating circuits and commercially known compensating circuits. The second embodiment of the invention may be implemented by commercially procurable voltage and temperature compensated integrated semiconductor circuits.

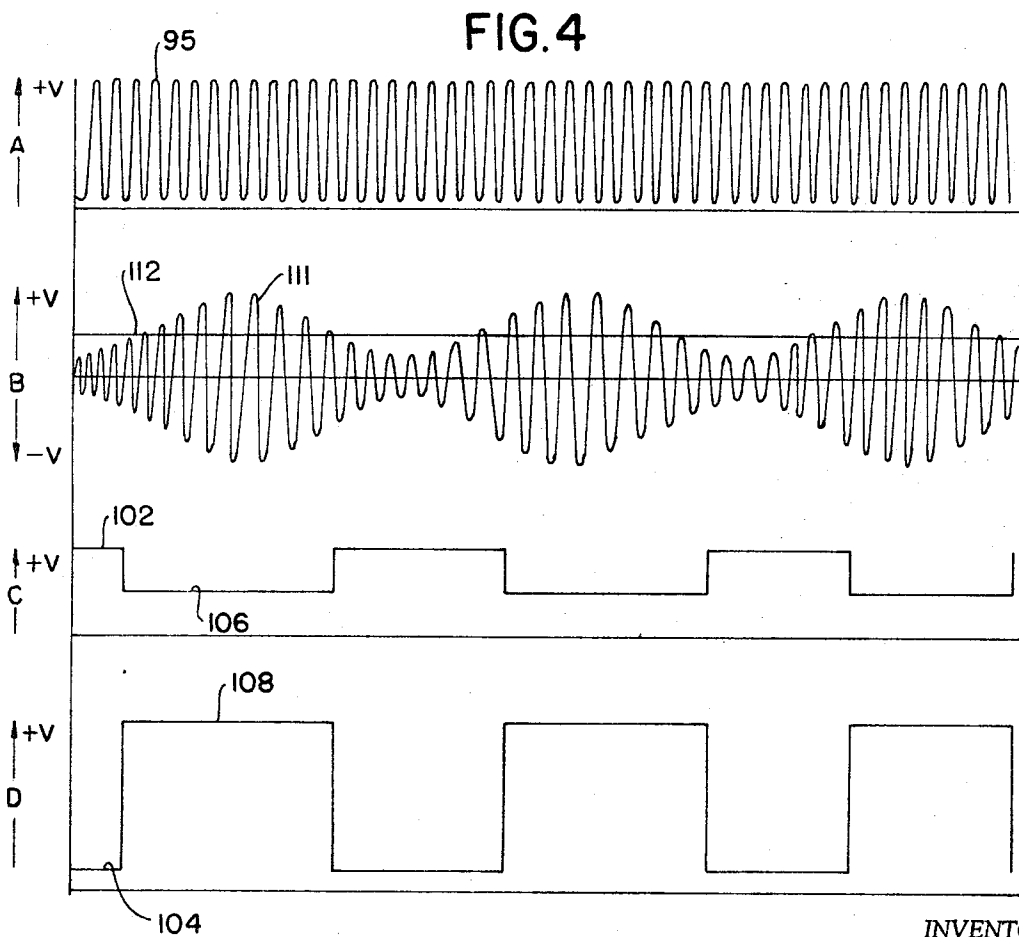
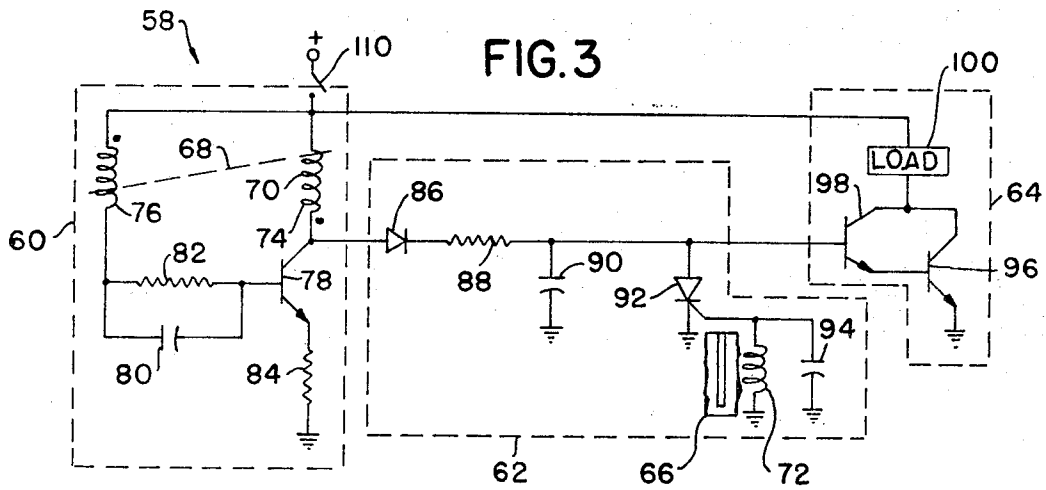
The method of producing electronic signal switching comprises producing trigger pulses by means of controlled shielding of an energized transformer primary winding from the transformer secondary winding and providing switching in accordance with energizing of the transformer secondary winding.





INVENTORS
RALPH L. SLITTI, JR
DONALD G. NOBLE
WILLIAM F. SHUNN

BY *Whittemore, Hulbert & Belknap* ATTORNEYS



INVENTORS
RALPH L. SLITTI, JR.
DONALD G. NOBLE
WILLIAM F. SHUNN

BY *Whittemore, Hall*
& Belknap
ATTORNEYS

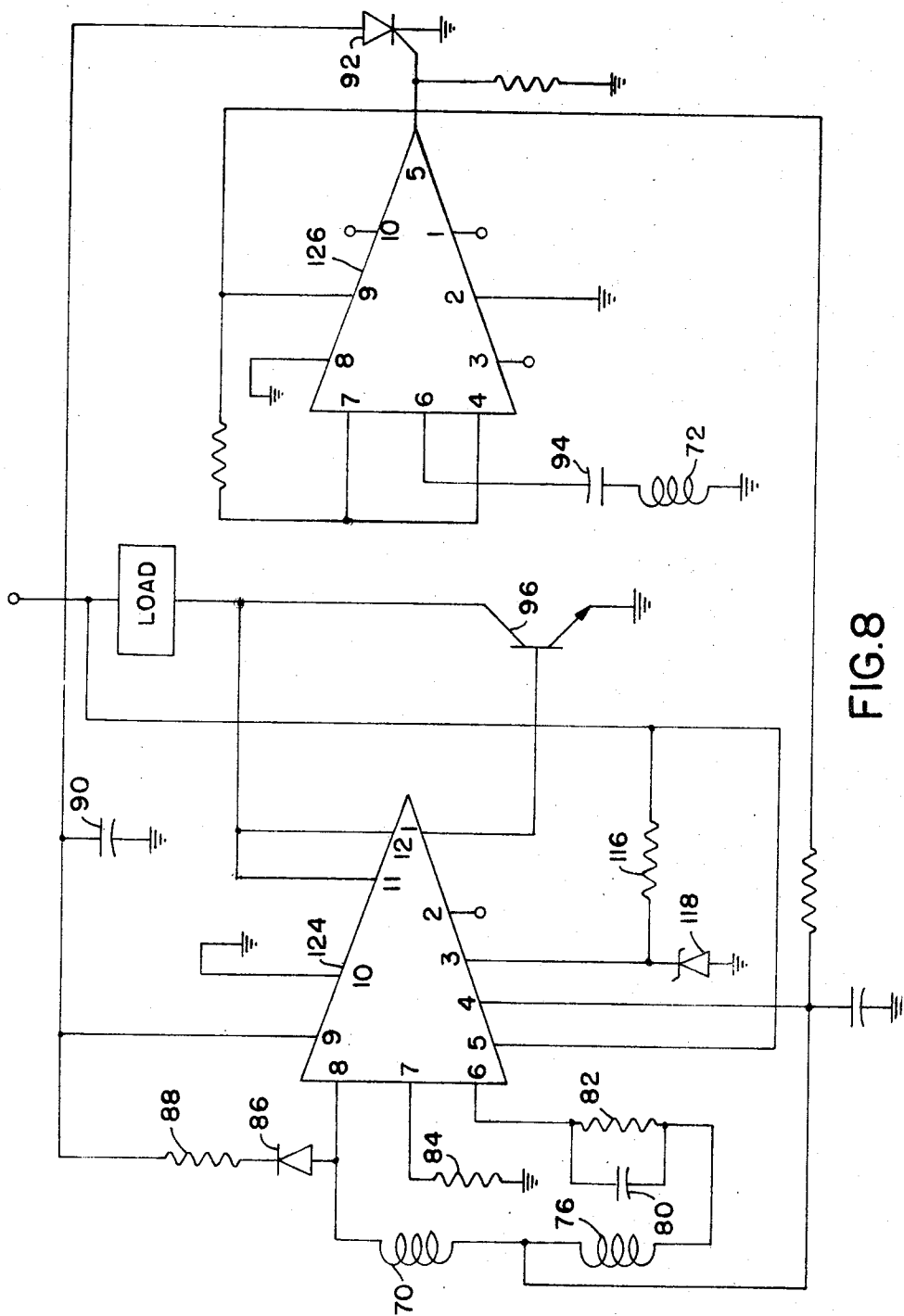


FIG. 8

INVENTORS
 RAPLH L. SLITTI, JR.
 DONALD G. NOBLE
 WILLIAM F. SHUNN

BY *Whittemore, Hulbert & Belknap*
 ATTORNEYS

STRUCTURE FOR AND METHOD OF ELECTRONIC SIGNAL SWITCHING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to electronic signal switching methods and means and refers more specifically to structure for providing timed signals, including a movable slotted rail positioned between transformer primary and secondary windings in a circuit wherein the primary winding is in a blocking oscillator and the secondary winding of the transformer is connected to energize a sensing or control circuit operable to actuate an electronic switch on being energized and the method of operation of such structure.

2. Description of the Prior Art

In the past electronic signal switching, as for example in vehicle spark ignition circuits, has been most usually accomplished by mechanical breaker points. Alternatively and more recently pulse generators, variable reluctance units and light sensing devices have been used to provide trigger pulses actuating switching circuits to provide electronic switching. Such prior electronic signal switching means and the method of operation thereof has not been satisfactory in that the structure therefor has either been complicated or expensive or has been unreliable or inefficient in operation.

SUMMARY OF THE INVENTION

Therefore, in accordance with the invention, electronic signal switching structure is provided, including a blocking oscillator for providing a continuous alternating electrical signal, a transformer having primary and secondary windings positioned adjacent each other, the primary winding of which is connected to receive the continuous electrical signal from the oscillator, sensing or control structure, including the secondary winding of the transformer operable to sense coupling of the primary and secondary windings of the transformer, a switching circuit controlled by the sensing or control circuit and means for controlled shielding of the secondary transformer winding from the primary winding. The circuit provided may include voltage regulating structure and temperature compensating means.

The method of the invention comprises periodically sensing the signal produced in the secondary winding of the transformer on coupling of the transformer windings in the sensing or control circuit and actuating the switching means in accordance with the sensed signal and the producing of the sensed signal by controlled shielding of the secondary winding of the transformer from the primary winding thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partly schematic, partly diagrammatic representation of electronic signal switching structure for performing the method of the invention.

FIG. 2 is a chart useful in describing the operation of the structure of FIG. 1.

FIG. 3 is a partly schematic, partly block diagram of a modification of the electronic signal switching structure of the invention.

FIGS. 4A, B, C and D are charts of electric signals in the structure of FIG. 3 useful in the description of the operation of the structure of FIG. 3.

FIG. 5 is a partly schematic, partly block diagram of voltage regulating means for the structure illustrated in FIG. 3.

FIG. 6 is a partly schematic, partly block diagram of temperature compensating means for the structure illustrated in FIG. 3.

FIG. 7 is a partly schematic, partly block diagram of a modification of the temperature compensating means for the structure illustrated in FIG. 3.

FIG. 8 is a partly schematic, partly block diagram of a second modification of the electronic signal switching structure of the invention similar to FIG. 3, wherein commercial in-

tegrated circuits have been substituted for elements of the circuit of FIG. 3 and the voltage and compensating circuits of FIGS. 5 and 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1, the electronic signal switching structure 10 includes an oscillator 12, mechanical shutter 14, sensing structure 16 and switching structure 18. The circuit 10, as illustrated, is connected to a spark ignition circuit 20 and functions in the manner of the usual breaker points in the spark ignition circuit 20 to provide either a conducting path through the switching structure 18 or an apparent open circuit at the switching structure 18.

In more detail, the oscillator 12 is a blocking oscillator, including the transistor semiconductor 22, the bifilar wound primary winding 24, including portions 26 and 28 of the transformer 30 having secondary winding 32, capacitor 34, diode 36 and resistors 38 and 40 connected as shown to provide a continuous sinusoidal electric signal in the portion 28 of primary winding 24 of transformer 30 on closing of the switch 42 to supply power thereto from the usual vehicle battery through the spark ignition circuit 20.

Mechanical shutter 14 includes the cup-shaped cylindrical slotted rail 44 which may be positioned in the distributor cap of the vehicle, including the spark ignition circuit 20 and which is rotated by convenient means in the manner of the usual distributor rotor in accordance with the speed of the vehicle through the shaft 46. The slotted rail 44 is positioned between the primary and secondary windings of the transformer 30, one of which is located outside the rail and the other of which is located inside the cylindrical rail. The rail thus shields the secondary winding 32 from the primary winding 24, except when a slot 48 is aligned with the primary and secondary windings 24 and 32, at which time the secondary winding 32 is coupled to the primary winding 24 to provide an alternating electrical signal output from the secondary winding 32.

The control or sensing structure 16 includes the secondary winding 32 of the transformer 30, the transistor semiconductor 50 and resistor 52, again connected as shown in FIG. 1. On energizing the secondary winding 32 of transformer 30, the transistor 50 is biased into conduction to place a bias on the switching transistor semiconductor 54 across the resistor 52.

The switching structure 18 which includes the switching transistor 54 and the resistance 56 presents an open circuit to the spark ignition circuit 20 when the transistor 54 is not conducting due to no coupling of the transformer secondary winding 32 to the primary winding 24 and consequent nonconduction of the sensing transistor 50. The circuit from the spark ignition circuit 20 through transistor 54 and resistor 56 is essentially a ground connection when the transistor 54 is conducting due to energizing of the sensing structure 16.

Thus, in overall operation, when the switch 42 is closed to apply power to the electronic signal switching structure 10 through the spark ignition circuit 20, the blocking oscillator 12 is caused to oscillate to provide a continuous alternating electrical signal in the portions 26 and 28 of the bifilar wound primary winding 24 of the transformer 30. The cup-shaped slotted rail 44 is rotated on shaft 46 to move slots 48 into alignment between windings 24 and 32 of the transformer 30, one of which is inside the cup-shaped rail 44 and the other of which is outside of the rail. Alignment of a slot with the transformer primary and secondary windings provides coupling of the secondary winding 32 to the primary winding 24. The signal thus produced in the secondary winding 32 turns the sensing transistor 50 on to draw current through the resistor 52 and bias the transistor 54 into a conducting state. The transistor 54 thus is turned on to provide a low resistance path through transistor 54 and resistor 56 to ground alternately with an apparent open circuit when the transformer secondary winding 32 is not coupled to the transformer primary winding 24.

The frequency of the oscillator 12 may be, for example, 100,000 hertz which is considerably higher than the rotational speed of the mechanical shutter 14. Thus, the secondary winding 32 of the transistor 50 is energized by a succession of closely spaced pulses 55, as shown in FIG. 2, each time a slot 48 is aligned between the secondary and primary windings of the transformer 30. Due to the circuit constants in the sensing structure and switching structure which cannot respond to the high frequency of the oscillator 12, switching is accomplished only in accordance with the movement of the slots 48 into alignment with the transformer windings, as desired. It is speculated that with proper oscillator frequency, slot dimensions and circuit constants that switching could be accomplished at the frequency of the oscillator during alignment of the slots with the transformer windings to provide a shower of sparks in the ignition circuit 20 during each alignment, if desired.

In the modified circuit 58 of FIG. 3, a blocking oscillator 60 of a slightly different configuration is used in conjunction with a sensing or control circuit 62, a switching circuit 64 and a mechanical shutter 66.

Again the blocking oscillator is provided with a bifilar wound primary winding 68, having portions 74 and 76, of a transformer 70, including the secondary winding 72. The blocking oscillator further includes the transistor semiconductor 78, capacitor 80 and resistors 82 and 84. The portion 76 of the transformer primary winding 68, the resistor 82 and capacitor 80 are a frequency determining network for the oscillator 60, while resistor 84 provides bias for the transistor semiconductor 78. The portion 74 of the transformer primary winding 68 provides an output signal to the control circuit 62.

The control circuit 62 includes the diode 86, resistor 88 and capacitor 90 connected in an integrating circuit to provide an integrated output signal on the capacitor 90 from the alternating, uniform electric signal 95, as shown in FIG. 4A at the collector of the transistor 78.

In the control circuit 62 the coupling of the primary winding 68 and the secondary winding 72 of the transformer 70 is accomplished on movement of the slotted rail 66 which may be a linearly movable straight slotted rail positioned between the windings 68 and 72 or may be a cup-shaped rail positioned between the windings and rotated in accordance with engine speed, as before. Coupling of the secondary winding 72 to the primary winding 68 of the transformer 70 by, for example, a rotating slotted rail 66, will produce a signal 111, such as shown at B in FIG. 4, which is sufficient to fire the silicon controlled rectifier 92 at a predetermined voltage 112 built up on the integrating capacitor 94. Firing of the silicon controlled rectifier 92 will cause discharge of capacitor 90 therethrough to alter the bias on the switching circuit 64 to open the switching circuit 64.

The switching circuit 64, as shown in FIG. 3, includes the transistor semiconductors 96 and 98 connected in a darlington amplifier circuit in series with the load 100, as shown. When the signal on capacitor 90 is of a predetermined value as at 102 in FIG. 4C, the darlington amplifier of the switching structure 64 will conduct to provide current flow through the load 100 at low voltage drop across the amplifier circuit 64, as shown at 104 in FIG. 4D. When the capacitor 90 is discharged, voltage across the silicon controlled rectifier 92 will be as shown at 106 in FIG. 4C and the voltage across the darlington amplifier will be as shown at 108 in FIG. 4D.

Thus, in overall operation of the circuit of FIG. 3, the blocking oscillator 60 is caused to operate when the power from a power source (not shown) is applied to the primary winding 68 of transformer 70 on closing of switch 110. The oscillator 60 provides a signal, as shown in FIG. 4A. The constant amplitude frequency alternating signal of FIG. 4A is passed through the diode 86 and integrated by resistor 88 in conjunction with the capacitor 90 to provide a signal at voltage 102 on the capacitor 90 sufficient to bias the darlington amplifier in the switching circuit 64, on, whereby conduction of current through the load 100 which may be an amplifier in an ignition circuit is permitted.

When the rail 66 is positioned to couple the secondary winding 72 of the transformer 70 to the primary winding 68 thereof and the coupling reaches a level, as indicated by the line 112 in FIG. 4B, the signal of the capacitor 94 will be such as to cause firing of the silicon controlled rectifier 92. Firing of the silicon controlled rectifier 92 will cause discharge of the capacitor 90 through the rectifier 92 to reduce the bias on the darlington amplifier portion of the switching circuit 64 to cause the amplifier to act as an open circuit whereby the current flow through the load 100 is caused to cease. The voltage bias on the darlington amplifier portion of the switching circuit 64 is, as shown in FIG. 4C, while the voltage across the amplifier will be, as shown in FIG. 4D.

The circuit illustrated in FIG. 5 may be connected to the circuit of FIG. 3 to provide voltage regulation. In FIG. 5 the circuit of FIG. 3 is indicated in block form. The voltage regulating circuit of FIG. 5 includes the transistor semiconductor 114, resistor 116 and zener diode 118 connected as shown. In operation, the zener diode will fire at a predetermined voltage and will maintain the predetermined voltage regardless of variations of the input power to maintain a predetermined bias on the transistor 114 and consequently a regulated voltage supply to the electronic signal switching circuit 58.

Should temperature variations cause inconsistent operation of the electronic signal switching circuit 58, temperature compensation may be provided, as illustrated in FIG. 6. As shown in FIG. 6, a thermistor network may be connected in parallel with the capacitor 94 and secondary winding 72 of the transformer 70 illustrated in FIG. 3.

Since it is difficult to provide efficient temperature compensation with transistor networks due to the different firing characteristics of different silicon controlled rectifiers 92, commercial temperature compensating networks 122 may be used in conjunction with the capacitor 94 and transformer winding 72 connected in series, as shown in FIG. 7. Such temperature compensating networks are commercially available, as for example from Radio Corporation of America, New York City, N. Y.

In this regard, through the use of temperature compensated integrated circuits which are again commercially available from the Radio Corporation of America, temperature is controllable within specified limits. Further, commercial integrated circuits may be used to replace all but two of the circuit components of FIG. 3, as particularly shown in FIG. 8; wherein like components have been given like reference numerals. Since integrated circuits in themselves are not new, they will not be considered in detail herein.

The exact circuit 124 in FIG. 8 is a Radio Corporation of America type CA 3018 linear integrated circuit, while circuit 126 is a type CA 3035 linear integrated circuit of the same company. The operation of the circuit of FIG. 8 is analogous to the operation of the voltage and temperature stabilized version of the circuit of FIG. 3.

While one embodiment of the present invention and modifications thereof have been considered in detail, it will be understood that other embodiments and modifications are contemplated. It is the intention to include all embodiments and modifications as are defined by the appended claims within the scope of the invention.

We claim:

1. Structure for producing a timed trigger signal comprising a source of continuous alternating electrical signals including a blocking oscillator transistor having emitter, base and collector electrodes, a resistor connected between the emitter electrode and ground, a diode, a resistor and a first part of a transformer primary winding connected between the base of the blocking oscillator transistor and a source of electrical energy, a capacitor and a second part of the primary winding of the transformer connected in parallel with each other and between the collector of the blocking oscillator transistor and the source of electrical energy in a blocking oscillator circuit, switching means operable to change an electric signal through a load comprising a switching transistor connected in series with the load between a source of electrical energy and

ground, a control circuit for switching the switching means on being energized comprising a control circuit transistor having emitter, base and collector electrodes with the emitter-collector circuit of the control circuit transistor connected between the source of electrical energy and ground and with the secondary winding of the transformer connected between the base electrode of the control circuit transistor and the source of electrical energy, means for controlled shielding of the secondary winding of the transformer from the primary winding of the transformer to control energizing of the control circuit including a rotary cylindrical member having longitudinally extending slots therein spaced angularly therearound positioned between the primary winding and secondary winding of the transformer and means for driving the rotary cylindrical member at the speed of an engine having the structure for producing a timed trigger signal as a spark ignition circuit in combination therewith.

2. Structure as set forth in claim 1, wherein the primary winding of the transformer including the first part and second part thereof is bifilar wound.

3. Structure for producing a timed trigger signal comprising a source of continuous alternating electrical signals including a blocking oscillator transistor having emitter, base and collector electrodes, a resistor connected between the emitter electrode and ground, a first part of a bifilar wound transformer primary winding connected between the collector electrode and a source of electrical energy, and a resistor and capacitor in parallel connected in series with a second part of the bifilar wound transformer primary winding between the base of the blocking oscillator transistor and the source of electrical energy in a blocking oscillator circuit, an integrating circuit including a resistor and capacitor connected in series with each other and connected between the collector electrode of the blocking oscillating transistor and ground, switching means operable to change an electrical signal through a load on switching including a first darlington transistor having emitter, base and collector electrodes, the base electrode of which is connected between the resistor and capacitor of the integrating circuit, the collector electrode of

which is connected to a source of electrical energy through the load, a second darlington transistor having emitter, base and collector electrodes, the base electrode of the second darlington transistor being connected to the emitter electrode of the first darlington transistor, the emitter electrode of the second darlington transistor being connected to ground, the collector electrode of the second darlington transistor being connected to the collector electrode of the first darlington transistor and through the load to the source of electrical energy connected in a darlington amplifier circuit and a control circuit for switching the switching means on being energized including a controlled rectifier having primary electrodes and a control electrode with the primary electrodes connected in parallel with the capacitor of the integrating circuit and a capacitor and the secondary winding of the transformer connected in parallel with each other and in series between the control electrode of the silicon controlled rectifier and ground, a rotary cylindrical member including longitudinal slots therein spaced angularly therearound positioned between the primary and secondary windings of the transformer for shielding the secondary winding of the transformer from the primary winding of the transformer to control energizing of the control circuit and means for driving the rotary cylindrical member at the speed of an engine having the structure for producing a timed trigger signal as a spark ignition circuit in combination therewith.

4. Structure as set forth in claim 3 and further including voltage regulating means for the structure for producing a timed trigger signal comprising a voltage regulating transistor having emitter, base and collector electrodes with the emitter and base electrodes being connected in series with the source of electrical energy, a zener diode connected between the base of the voltage regulating transistor and ground and a resistor connected between the emitter and base of the voltage regulating transistor.

5. Structure as set forth in claim 3 and further including temperature compensating means connected in the control circuit.

45

50

55

60

65

70

75