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[56]

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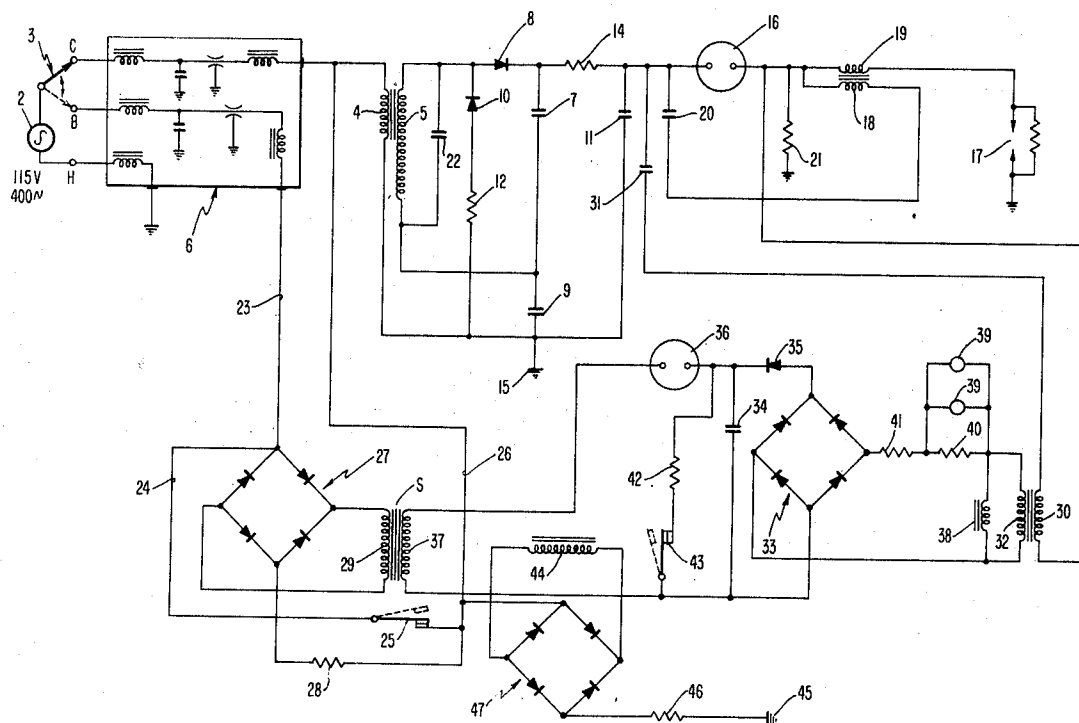
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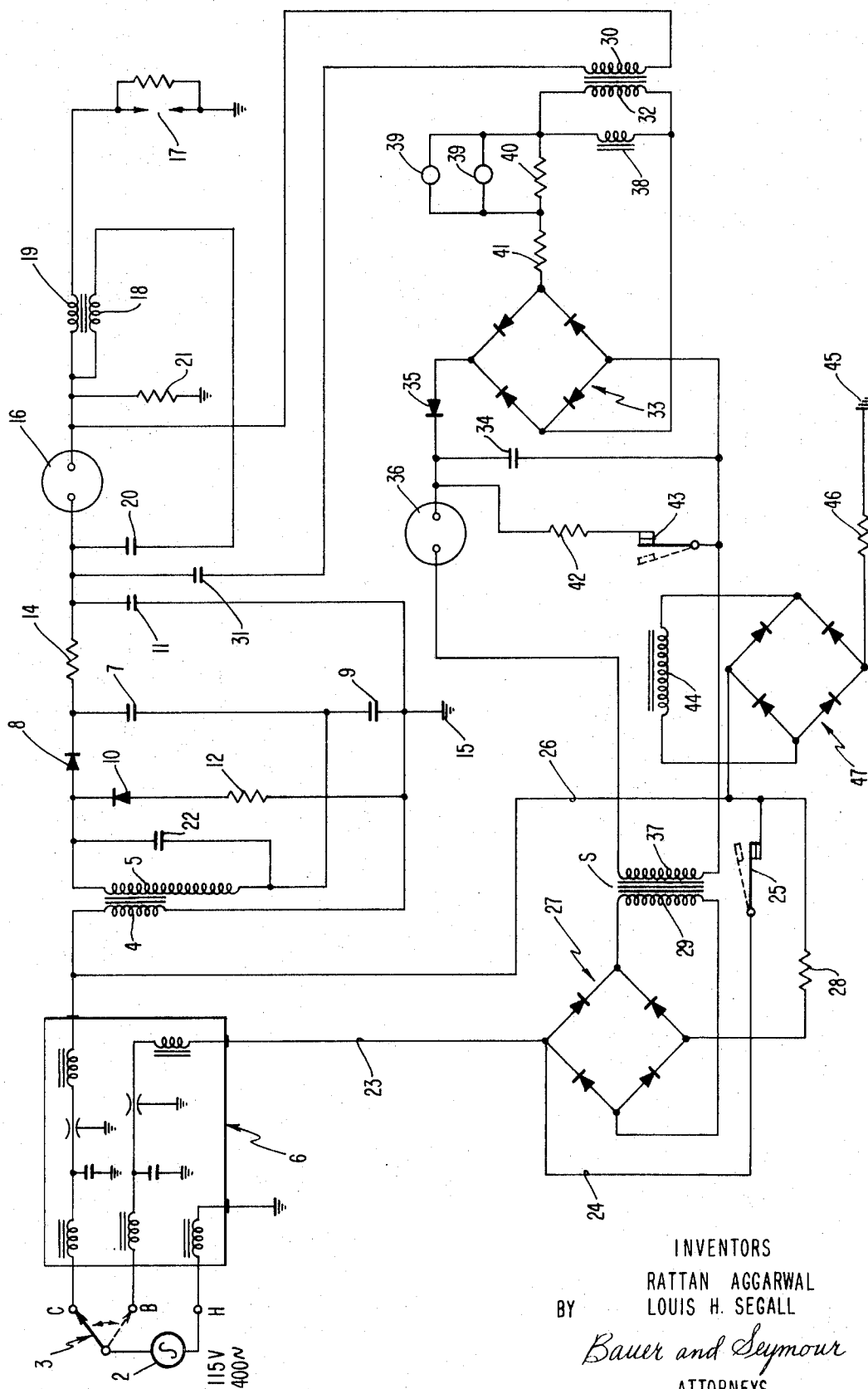
[54] CONTROL MEANS FOR PULSE GENERATING APPARATUS

19 Claims, 1 Drawing Fig.

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ABSTRACT: A condenser discharge type electrical pulse generating circuit, such as for a combustion engine ignition system, in combination with means for automatically disabling said circuit after operation for an interval within a predetermined range, the combination being such that the disabling means may be selectively bypassed and such that recycling of said means may be effected following an interruption of power input.





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CONTROL MEANS FOR PULSE GENERATING APPARATUS

This invention relates to electrical apparatus and more particularly to means for controlling the operation of electrical pulse or spark generating apparatus.

An object of the present invention is to provide novel control means for automatically disabling an electrical pulse or spark generating apparatus after a predetermined operating interval.

Another object of the invention is to provide means operable in a novel manner in response to intermittent signals or pulses to control the operation of an electrical pulse generating system or the like.

A further object is to provide apparatus of the above character wherein the control or disabling means may be by passed and hence, rendered ineffective and wherein said means may be recycled following an interruption of the power supply.

Another object of the invention is to provide a pulse generating system wherein the pulse rate is reasonably constant over a wide range of temperatures in combination with means responsive to the pulse rate for disabling the system after a predetermined interval of operation.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not intended as a definition of the limits of the invention.

The single embodiment of the invention illustrated in the drawing, by way of example, comprises an electrical pulse or spark generating circuit of known construction adapted for use as an untimed ignition system for jet or gas turbine type engines. The invention is not, however, limited to such uses or systems.

In the form shown, the ignition circuit is of the condenser discharge type which may be energized in a known manner by a suitable source 2 of alternating or interrupted electrical current. Said source may be selectively connected by means of a switch 3 across input terminals H and B or H and C and thence, to the primary winding 4 of a power input transformer having a secondary winding 5. If desired, suitable radio frequency filtering means 6, which may be in the form of any of various known constructions, is preferably, although not necessarily, interposed between the power source 2 and transformer 4, 5.

A voltage doubling type of energy storage means is connected across secondary winding 5 to be incrementally charged thereby. In the form shown, said storage means comprises a small condenser 7 connected across winding 5 through a diode or half wave rectifier 8, a second small condenser 9 connected across said winding through a reversely polarized diode or half wave rectifier 10, and a main relatively large tank condenser 11 connected across condensers 7 and 9 in series. If desired, the rectifier means 8, 10 may be protected against damage, the operating life thereof may be enhanced, and the required rating thereof may be minimized by providing either or both of the current limiting resistors 12 and 14 in the circuit, as shown.

One side of the above-described energy storage means is grounded at 15, and the high potential side thereof is connected through a control gap 16 to the ungrounded electrode of an ignition spark gap 17. The latter is diagrammatically shown as a shunted surface or low voltage type gap or igniter, but may be of any other known type.

When the spark-over or break down voltage of gap 17 exceeds that of control gap 16, suitable known means may be provided for ionizing igniter gap 17 to thus reduce its spark-over voltage. In the form shown, said means includes a high frequency setup transformer comprising primary winding 18 and secondary winding 19, the latter being interposed between gaps 16 and 17. Primary winding 18 is connected in

series with a triggering condenser 20 and a resistor 21 across tank condenser 11. Condensers 11 and 20 are thus concurrently charged to approximately the same voltage by the output of transformer 4, 5.

When the charge on condenser 20 attains the predetermined onset or breakdown voltage of control gap 16, said condenser will discharge across the gap through primary winding 18, thereby inducing a stepped-up voltage across secondary winding 19 of sufficient potential to break down and ionize igniter gap 17. The high energy charge stored on condenser 11 can then be discharged through gaps 16 and 17 in series to provide the required high energy ignition spark at gap 17 in the engine combustion chamber. To provide a more consistent sparking rate at gap 17 over a wide range of operating temperatures, a condenser 22 may be connected across secondary winding 5.

It has been found desirable, particularly in connection with jet and gas turbine type engines in aircraft, to provide for selectively operating the ignition system either continuously during engine operation or only intermittently for short intervals, such as for starting the engine. The present invention contemplates novel means for automatically disabling the pulse generating or ignition system after a short period of operation by effecting a suitable reduction in the voltage applied to the primary winding 4 without disconnecting the system from power source 2. In the form illustrated, said means embodies parallel or shunt connected branches in the power input system when source 2 is connected across terminals H and B and means responsive to the discharging of tank condenser 11 for interrupting one of said branches.

When switch 3 is in the illustrated dotted line position primary winding 4 is connected directly across source 2 from terminal B through leads 23, 24, the separable contacts of a normally closed magnetically actuated switch 25, a lead 26, winding 4 and ground to terminal H. Connected in shunt with switch 25, there are a full wave bridge rectifier 27, a resistor 28 and a winding 29 of a solenoid S. The circuit parameters are such that when the contacts of switch 25 are engaged, a major portion of the current from source 2 flows therethrough, while the flow through winding 29 in the shunt branch is insufficient to effect opening of the switch. Also, with the switch 25 closed, the full voltage of source 2 is across input winding 4, thereby effecting operation of the ignition system in the same manner as when the source voltage is applied across input terminals H and C, as described above.

When the switch 25 is open, i.e., in the dotted line position, thereby diverting the full energy of source 2 through resistor 28 and solenoid winding 29, the latter becomes effective to maintain the switch in open position. Under these conditions, the voltage drop in winding 29 and resistor 28 reduces the voltage appearing across primary winding 4 to such an extent that transformer 4, 5 is incapable of charging condensers 11 and 20 to a sufficiently high voltage to trigger control gap 16. The ignition system is thus effectively disabled when the contacts of switch 25 are open, thereby preventing sparking at ignition gap 17.

Novel control or timing means responsive to the pulse or sparking rate of the ignition system are provided for effecting the opening of the circuit at switch 25 to thereby automatically disable said system after the same has been operated for approximately a predetermined interval as measured by time or number of sparks or discharge pulses following connection at terminal B. Said timing means comprises a suitable signal pickup device capable of transmitting a series of electrical pulses to incrementally charge a capacitor. Although various known types of suitable pickup devices may be used, the one chosen for illustration, by way of example, comprises an induction transformer, the primary winding 30 of which is connected in series with a condenser 31 across control gap 16. Thus, whenever condenser 11 discharges across the control gap, a voltage pulse is applied across primary winding 30 and a voltage pulse is induced in secondary winding 32.

The currents thus intermittently generated in secondary winding 32 are rectified by a full wave bridge rectifier 33 and transmitted to a storage condenser 34 through a diode 35. A trigger gap 36 having a predetermined break-down or onset voltage is connected in series with a winding 37 across condenser 34. The latter winding forms a part of solenoid S for opening the contacts of switch 25. Thus, after a number of pulses, which may be at least approximately predetermined, have been transmitted by the signal pickup transformer 30-32, condenser 34 will attain a charge exceeding the break-down voltage of trigger gap 36 and will discharge across the gap through solenoid winding 37. This momentary discharge through winding 37 and the continuous flow of current through winding 29 from source 2 generates sufficient magnetism to effect separation of the contacts of switch 25. As previously pointed out, when said contacts have been thus separated, there is increased current flow through winding 29, and the magnetism thereby generated is sufficient by itself to hold the contacts open and thereby disable the ignition system.

For a given pulse generating or ignition system, the interval or number of pulses required to charge condenser 34 to the breakdown voltage of trigger gap 36 may be varied by means of an adjustable resistor connected in parallel with secondary winding 32. As shown, such resistor is illustrated in the form of an inductive resistance 38 with an adjustable ferrite core. A reduction of this resistance by adjustment of the core reduces the effective input signal and thereby increases the charging time of condenser 34. To attain a more constant operating interval over a wide range of temperatures, it is desirable to provide a suitable thermistor network in the charging circuit for timing condenser 34. The illustrated network comprises two thermistors 39 of known construction and a resistor 40 connected in parallel with each other and in series with a resistor 41. The thermistor network is effective to compensate for increased leakage losses in condenser 34 at the higher temperatures.

In the event the voltage across terminals H-B is removed by manually opening switch 3 while a charge remains on timing condenser 34, it is desirable to bleed this charge off not only in the interest of safety but also to insure recycling of the timing or control circuit from scratch when voltage is again applied across terminals H-B. To accomplish this, a bleed resistor 42 is connected in series with a switch, such as a normally closed reed switch 43, across condenser 34. Suitable means are provided for maintaining switch 43 open whenever voltage is applied to terminals H-B, said means in the form shown comprising a solenoid coil 44. Said coil is connected between lead 26 and ground at 45 through a resistor 46 and a full wave bridge rectifier 47 and hence, is energized to electromagnetically maintain switch 43 open when the source voltage is applied to terminals H-B. When the source voltage is removed switch 43 closes automatically and any charge remaining on condenser 34 is quickly dissipated in resistor 42.

Typical values of component parts which make up an exemplary operative system as illustrated in the drawing are as follows:

Condensers:	Micro-
7 and 9	farads
11	.05
20	1.6
22	.01
31	.003
34	.11
	.5
Resistors:	Ohms
12, 14, 40 and 42	1,000
21	600
28	1,200
41	27
46	500

Transformers:	Primary/ Secondary Turns Ratio
4, 5	300/5050
18, 19	5/17
30, 32	30/24
Windings:	Turns
29	9,000
37	3,400
38	75
44	10,000

Although only a single embodiment of the invention has been illustrated in the accompanying drawing and described in the foregoing specification, it is to be expressly understood that the invention is not limited thereto but may be embodied in specifically different circuits. For example, a variety of other known timed and untimed ignition circuits, particularly those of the condenser discharge type, may be substituted for the specific circuit illustrated, and other known types of signal pick up devices, such as capacitive and inductive type pickups associated with the discharge circuit of condenser 11, may be substituted for the direct coupling illustrated. If desired, switch 25 could be connected to open the circuit between leads 24 and 26 and to simultaneously close a normally open circuit between resistor 28 and lead 26. Various other changes may also be made, such as in the electrical values suggested herein by way of example, and in the types of rectifiers illustrated without departing from the scope of the invention, as will now be apparent to those skilled in the art.

We claim:

1. Electrical apparatus comprising a source of electrical energy, an electrical pulse generating circuit, means connecting said source to said circuit to energize the latter for generating pulses, and means powered by the energy of the pulses generated in said circuit for varying the resistance of said connecting means sufficiently to effectively reduce the energization of said circuit by said source below that required for the generation of pulses therein while current flow through the connecting means is continuous.
2. Electrical apparatus as defined in claim 1 wherein said pulse powered means comprises energy storage means and means coupling said circuit to said storage means for charging the latter.
3. Electrical apparatus as defined in claim 2 wherein said storage means comprises a capacitor adapted to be incrementally charged by pulses in said circuit.
4. Electrical apparatus as defined in claim 3 wherein said pulse powered means further comprises a control gap and a solenoid coil connected in series across said capacitor.
5. Electrical apparatus as defined in claim 4 comprising switch means in said source-to-circuit connecting means adapted to be electromagnetically actuated in response to energization of said solenoid coil by the discharge of said capacitor through said coil.
6. Electrical apparatus as defined in claim 5 comprising a solenoid coil in said source-to-circuit connecting means for holding said switch means in the position to which it is actuated by said first-named solenoid coil.
7. Electrical apparatus as defined in claim 3 comprising circuit means connected across said capacitor for dissipating the charge thereon and means connected to be energized by said source for interrupting said circuit means.
8. Electrical apparatus comprising a source of electrical energy, an electrical pulse generating circuit, means connecting said source to said circuit to apply voltage thereto of sufficient potential to generate pulses therein, and means powered by the energy of the pulses generated in said circuit to reduce the voltage applied to said circuit to a potential below that required to generate such pulses in said circuit while current flow in said connecting means is continuous.
9. Electrical apparatus as defined in claim 8 wherein said source-to-circuit connecting means comprises normally closed switch means, and including solenoid means for electromagnetically actuating said switch means.
10. Electrical apparatus as defined in claim 9 wherein said

solenoid means comprises a first winding energizable by said pulse powered means to actuate said switch means to open position.

11. Electrical apparatus as defined in claim 10 wherein said solenoid means comprises a second winding in said source-to-circuit connecting means energizable by said source to electromagnetically hold said switch means in open position.

12. Electrical apparatus as defined in claim 8 wherein said pulse generating circuit includes a capacitor adapted to be intermittently charged and discharged and wherein said pulse powered means comprises energy storage means connected to be incrementally charged by the discharges of said capacitor.

13. Electrical apparatus as defined in claim 8 wherein said source-to-circuit connecting means comprises first and second branches adapted to be connected in parallel, one of said branches including normally closed switch means.

14. Electrical apparatus as defined in claim 13 comprising means for normally holding said switch means in a first position to close said first branch, and electromagnetic means including a solenoid winding for actuating said switch means to a second position to open said first branch.

15. Electrical apparatus as defined in claim 14 wherein said second branch is permanently closed.

16. Electrical apparatus as defined in claim 14 comprising means powered by the energy of pulses in said circuit for energizing said solenoid winding to actuate said switch means to open said first branch.

17. Electrical apparatus as defined in claim 16 wherein said electromagnetic means includes a solenoid winding in said second branch, the magnetic field of which is insufficient to actuate said switch means from its first to second position but is sufficient to hold said switch means in said second position.

18. Electrical apparatus as defined in claim 17 wherein said pulse powered means comprises energy storage means connected to be charged by energy supplied from said circuit and means for controlling the discharge of said energy storage means through said first-named solenoid winding.

19. Electrical apparatus as defined in claim 4 comprising normally closed switch means in said source-to-circuit connecting means adapted to be opened in response to the discharge of said capacitor.

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