March 12, 1929. H. E. BRIGGS 1,704,934

HEATER SYSTEM FOR OIL ENGINES

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FIG. 1

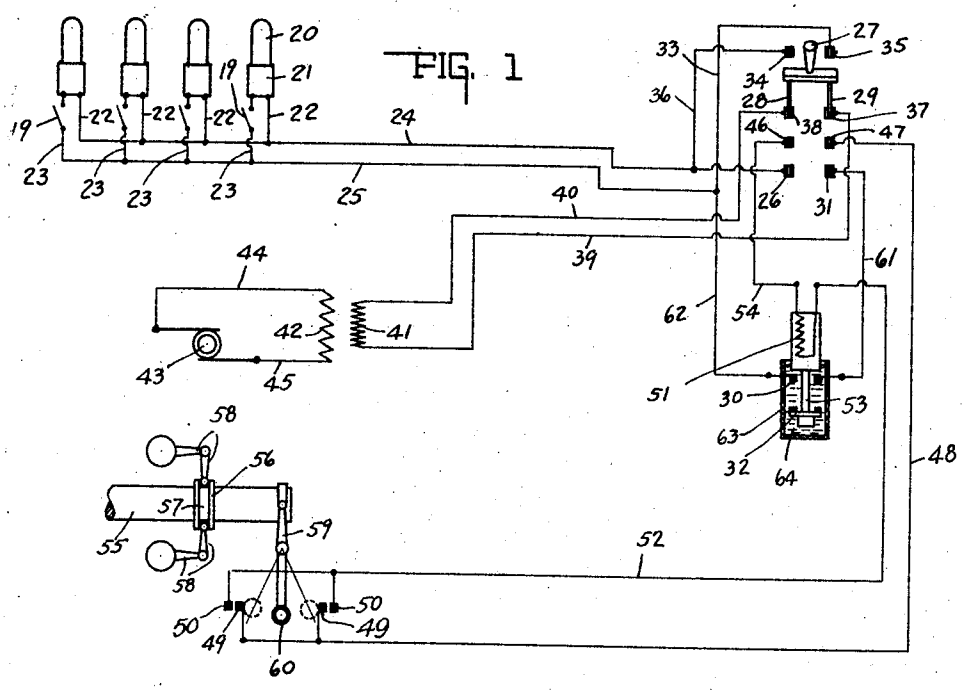
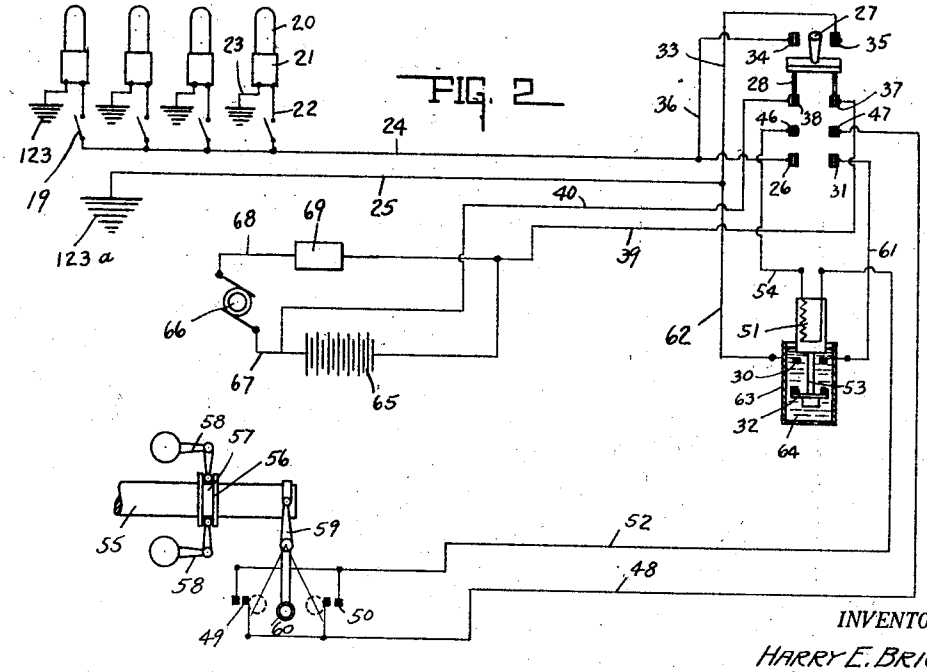


FIG. 2



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HEATER SYSTEM FOR OIL ENGINES

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FIG. 3

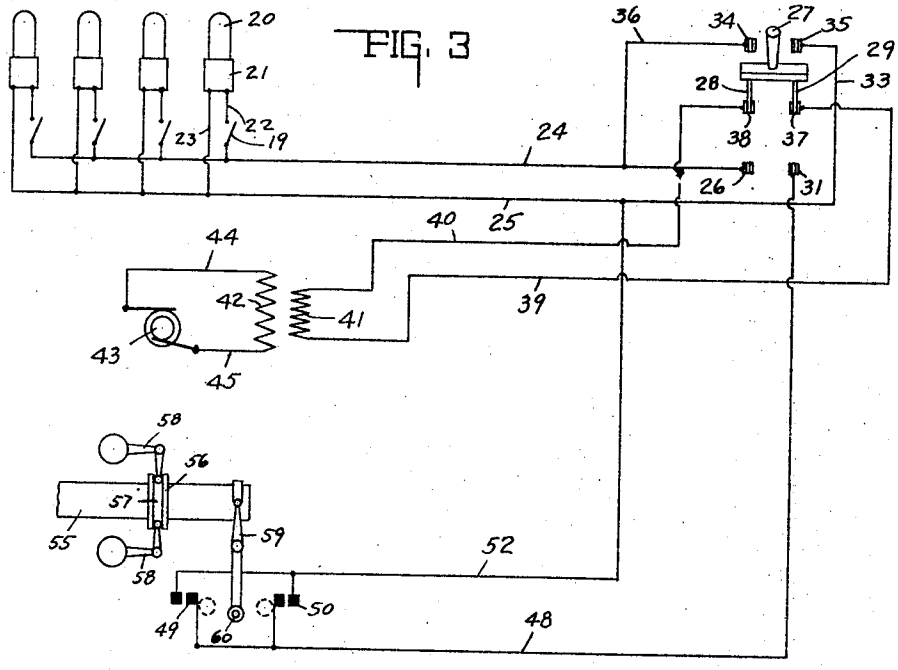
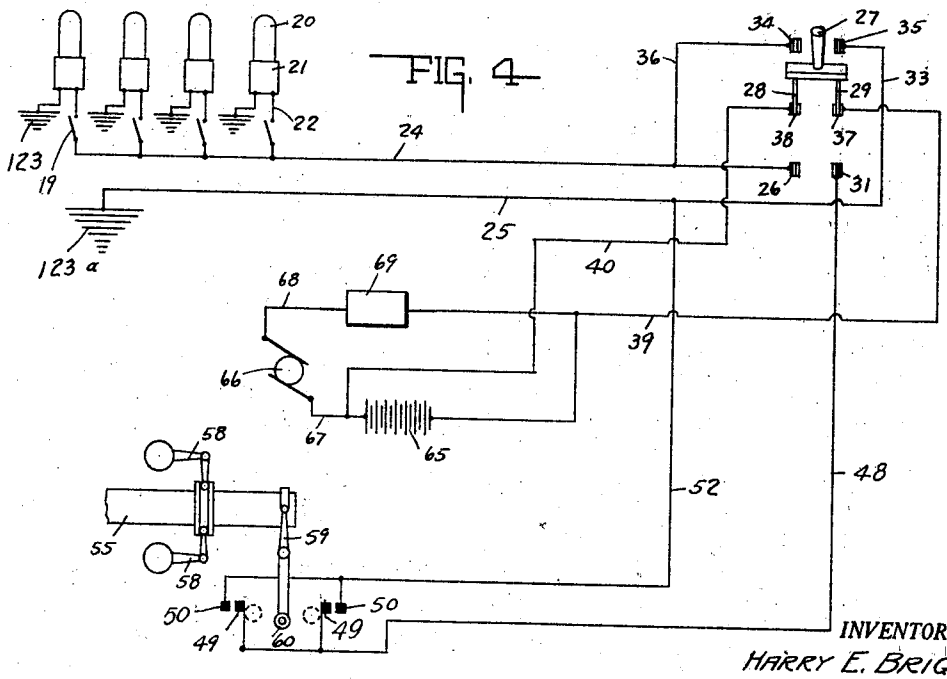


FIG. 4



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FIG. 5

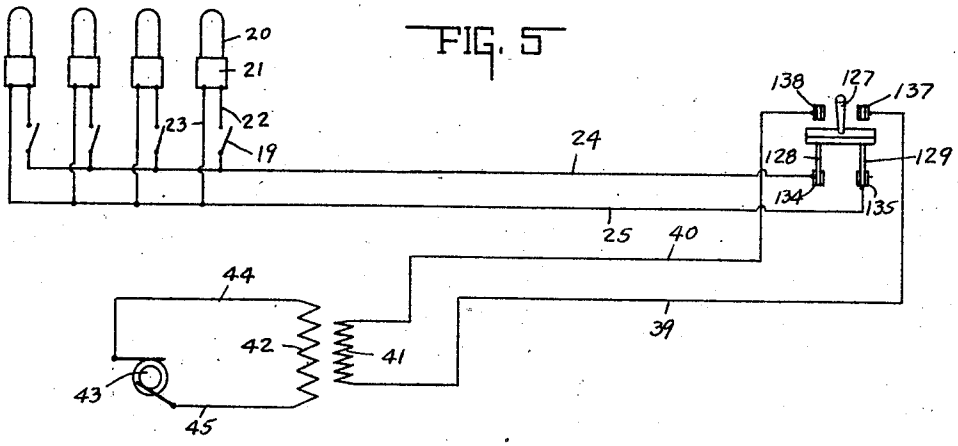


FIG. 6

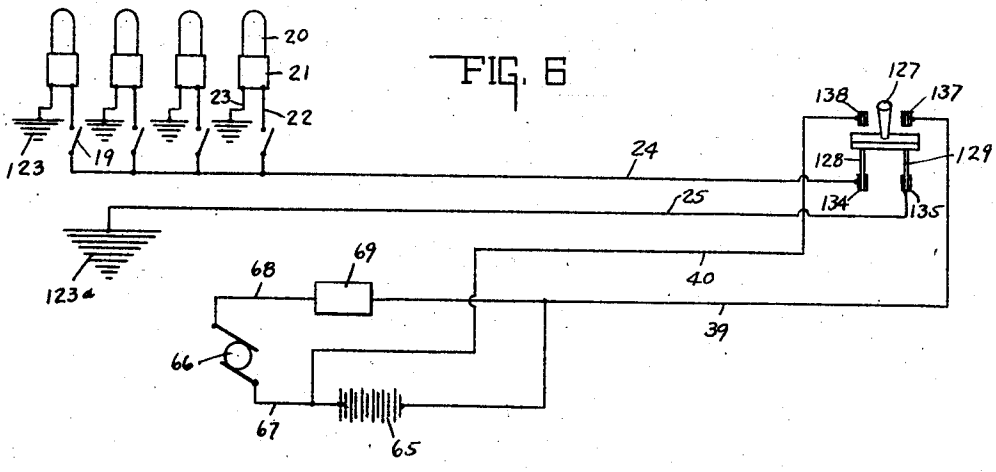


FIG. 7

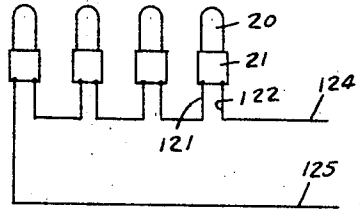
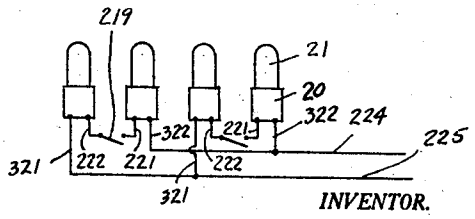


FIG. 8



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HEATER SYSTEM FOR OIL ENGINES

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FIG. 9

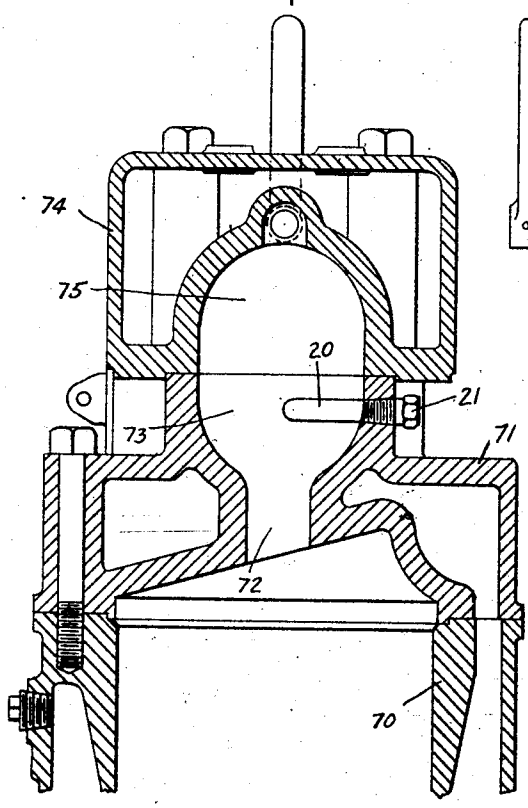


FIG. 10

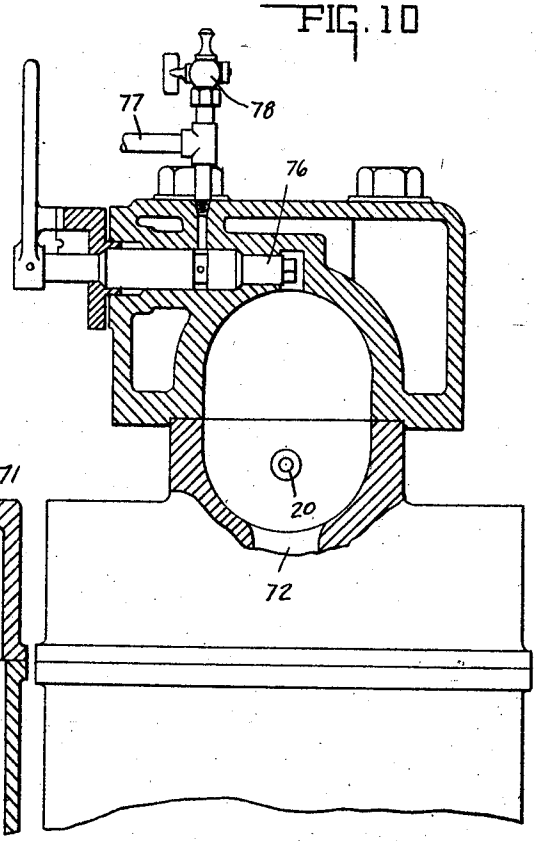


FIG. 11

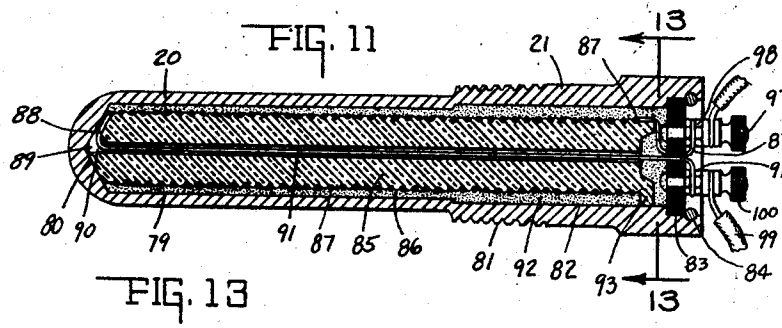


FIG. 12

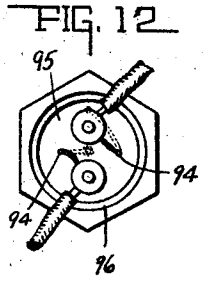
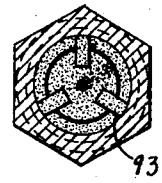


FIG. 13



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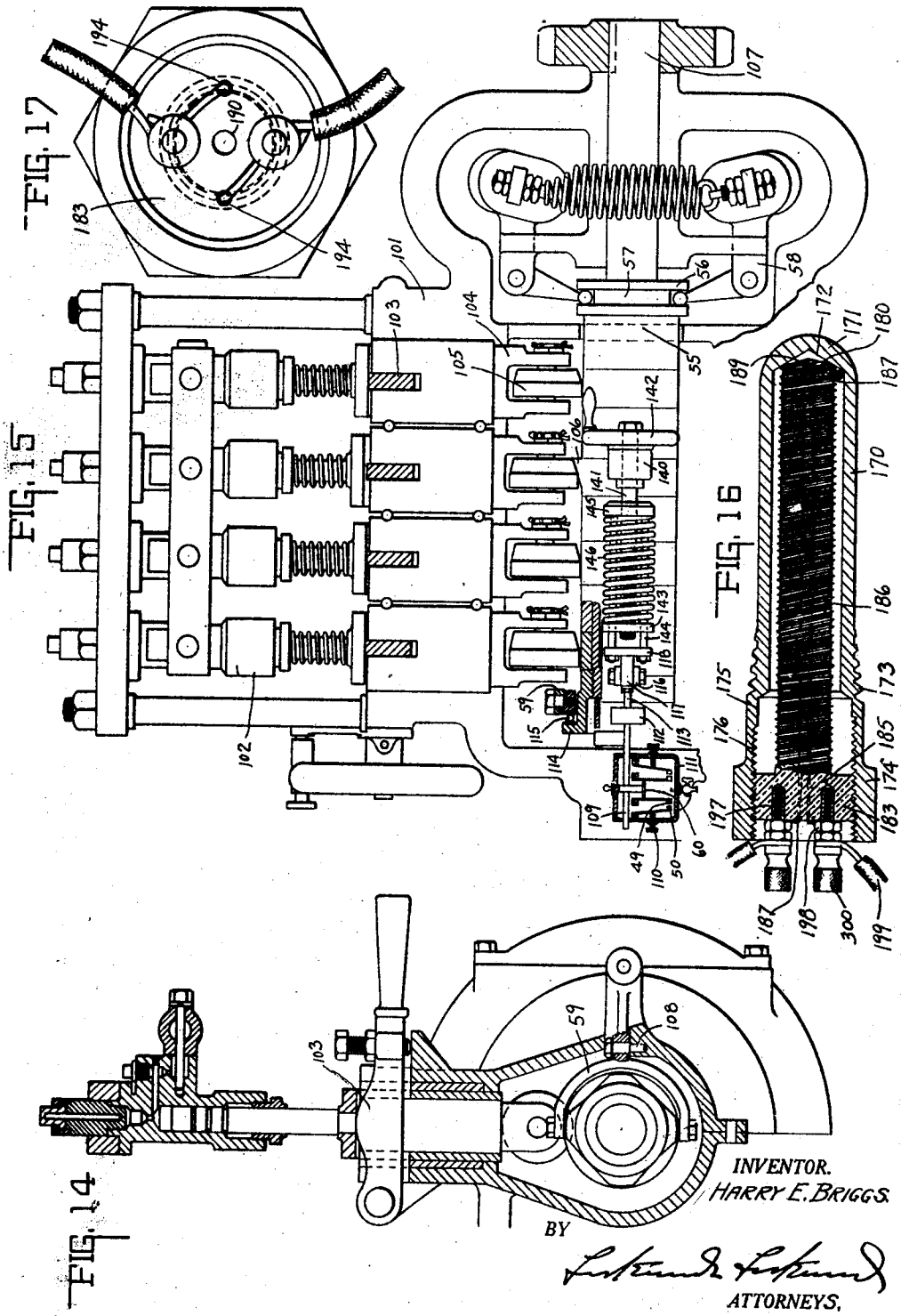
BY Lothrop & Lothrop

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March 12, 1929. H. E. BRIGGS 1,704,934

HEATER SYSTEM FOR OIL ENGINES

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Patented Mar. 12, 1929. 1,704,934

UNITED STATES PATENT OFFICE.

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HEATER SYSTEM FOR OIL ENGINES.

Application filed February 17, 1923. Serial No. 619,616.

This invention relates to internal combustion engines of the semi-Diesel type which are adapted to burn crude oils and the like.

The chief object of the invention is to provide a cylinder of an internal combustion engine of the character described with a heating plug which is heated from an external source of energy, which energy is introduced into the plug to provide heat therein and raise the plug temperature to that desired and necessary for the ignition of the combustible mixture supplied to the engine cylinder.

Another object of the invention is to provide automatically operable means, whereby the externally energized plug will be automatically energized and de-energized in the operation of the engine and by means operable by said engine.

Another important object of the invention is to associate the automatic control with the igniting plug in such a manner that the automatic control does not directly control the operation of said plug but remotely controls the same.

Another object of the invention is to construct the plug in such a manner that it may be associated with other plugs or other cylinders in the same engine, so that all the plugs can be operated at their maximum capacity with a minimum initial cost and maintenance cost.

Another object of the invention is to provide the engine with a plug or plugs, and suitably connect the same to a source of energy, which source of energy may be of three types.

The chief features of the invention consists in the means for accomplishing all of the foregoing objects.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims.

In the drawings, Fig. 1 is a diagrammatic view of a plurality of plugs connected in parallel and energized by an alternating current source of energy with the addition of an automatically operable switch for remotely controlling the connection between said plugs and said source of alternating current. Fig. 2 is a similar view of substantially the same parts, except that the alternating current source of energy is replaced by a direct current source of energy. Fig. 3 is a view similar to Fig. 1, except that the automatically operable switch directly controls the connection between the plugs and the source of alternating current. Fig. 4 is a view similar to Fig. 3, except that the alternating current source of energy is replaced by a direct source of energy. Fig. 5 is a view similar to Fig. 3, except that the automatically controlled switch is eliminated. Fig. 6 is a view similar to Fig. 5, except that the alternating current source of energy is replaced by a direct current source of energy. Fig. 7 is a diagrammatic view of a plurality of plugs similar to those shown in Figs. 1 to 6 inclusive, but herein shown connected in series instead of in parallel. Fig. 8 is a diagrammatic view of a similar number of similar plugs showing the same connected in a series-parallel relation. Fig. 9 is an enlarged transverse sectional view of a single cylinder of an internal combustion engine of the character described showing the same provided with a heating plug. Fig. 10 is a similar view, but is taken at right angles to the plane of Fig. 9. Fig. 11 is a longitudinal sectional view of one form of heating plug. Fig. 12 is an end view of the same. Fig. 13 is a transverse sectional view taken on the line 13—13 of Fig. 11 and in the direction of the arrows. Fig. 14 is the fuel pump construction of an internal combustion engine of the character described with parts in section to show other parts in detail. Fig. 15 is a side elevation of the governor and fuel pump of an internal combustion engine of the character described with parts in section and parts broken away to show other parts in detail. Fig. 16 is a longitudinal sectional view of another form of heating plug similar to that illustrated in Figs. 11, 12 and 13. Fig. 17 is an enlarged end view of the plug shown in Fig. 16.

In Fig. 1 of the drawings there is illustrated a plurality of heating elements hereinafter termed heating plugs which have a heating portion 20 and a securing portion 21. Each plug is provided with suitable electrical connections and in Figs. 1 to 6 inclusive, said plugs are shown connected in parallel by the parallel lines 22 and 23 and individually controlled by the switches 19. The lines 22 are connected together to a line 24, and the lines 23 are connected together by a line 25. The line 24 is connected to one terminal 26 of a switch having the handle 27

and blades 28 and 29. The line 25 is connected to the opposite terminal 31 through a relay switch having the switch points 30 bridged by a relay operable bar 32. A line 33 in parallel with the line 25 terminates in a switch point 35 of the double throw switch connection including the switch points 26, 31, 34 and 35. The switch point 34 is connected in parallel with the switch point 26 by means of the line 36 and to the line 24. The common points 37 and 38 of the switch are connected to the blades 29 and 28 respectively, and these points are connected by the lines 39 and 40 to the secondary winding 41 of a transformer having the primary winding 42. The primary winding 42 is connected to the source of alternating current 43 by the wires 44 and 45.

Included in the double pole switch construction is a pair of auxiliary contacts 46 and 47. The contact 47 is connected by a line 48 to a pair of parallel connected contacts 49 of a switch connection. These contacts 49 are preferably movable and are adapted to engage a pair of preferably stationary contacts 50 likewise connected in parallel which are connected to a relay 51 by means of a line 52. The relay 51 has an armature or stem 53 which carries the switch bridging bar 32 hereinbefore described. The other terminal of the relay 51 is connected by the line 54 to the other terminal 46 of the main switch construction.

A sliding shaft 55 carries a collar 56 having a groove 57 therein. Associated with the shaft 55 are the weighted centrifugal governor levers 58 which terminate adjacent the collar 56 and in the groove 57 and serve to reciprocate the shaft 55 in accordance with the speed of the engine. The shaft 55 actuates a pivoted yoke 59 which terminates in an actuating portion 60. The actuating portion 60 is adapted to engage either of the movable contacts 49 to move the same into engagement with the adjacent stationary contact 50. Thus at a relatively high speed, the lever 59 will cause one contact 49 to engage the adjacent contact 50 and close a circuit therethrough; while at a relatively low speed, the lever is adapted to cause the other contact 49 to engage the adjacent contact 50 and likewise close the circuit therethrough. Either closure completes a circuit through the lines 48 and 52, as well as 54, together with the relay 51, and thereby energize the relay. The relay elevates the armature 53 and maintains said armature in the elevated position, which corresponds to the closed circuit position of the switch, including the bridging bar 32 and the contacts 30. These are connected to the double throw main switch, and herein said contacts 30 are connected to the terminal 31 of said switch and the line 25 respectively by the lines 61 and 62. The line 62 is in parallel with the line 33, both being connected to the line 25 hereinbefore described.

When the handle 27 is positioned in the upper position so that the blades 28 and 29 engage the switch points 34 and 35, current is supplied from the alternator through the transformer to the switch points 34 and 35 and thereafter is conducted by the lines 24 and 25 to the heating plugs. The aforesaid constitutes the manual operation and is generally used in starting. After the engine has obtained its normal speed, the switch handle 27 is moved to the lowermost position so as to engage the contacts 46, 47, 26 and 31. When in this position, current is supplied to the terminal plugs from the alternator by way of the transformer only at such time as the switch points 30 are bridged by the bridging bar 32, and this can only be accomplished by the relay 51 being energized, which in turn can only be accomplished by the closing of a circuit, including one of the movable switch members 49 and the adjacent stationary member 50. The closure of either of these switches controlling the relay circuit is accomplished only when the speed of the engine has been reduced sufficiently so as to cause the lever 59 to be moved into actuating position in one direction, or when the speed of the engine has increased to such an extent that the lever has been moved sufficiently into the opposite direction. Light load conditions of an engine of the character described permit the engine to run at an excessive rate of speed, and when running under light load conditions, the heat retained in the engine is not sufficient to ignite the diminished fuel supply and thereafter poor ignition results as a general rule. But with the present construction, such poor ignition does not result, because when the light load condition occurs, the circuit through the relay 51 will be closed, which in turn closes the switch controlled by the relay to supply the heating plugs with energy from the alternator 43. Herein in order to prevent excessive arcing at the contacts 30 and bridging bar 32, the same are immersed in an oil receptacle 63 containing the usual arc-diminishing or dampening mineral oil 64.

In Fig. 2 of the drawings the lines 23 of the individually controllable plugs are shown grounded at 123 and the line 25 is shown grounded at 123^a, thereby completing the circuit from the line 23 through the ground connection to the line 25 and the circuit is thereafter substantially the same as that hereinbefore described for parts illustrated in Fig. 1, with this exception, the lines 40 and 39 in Fig. 2 are connected to a source of energy, but in this instance instead of being connected to the transformer construction indicated by the numerals 41 and 42, and the alternator 43 as shown in

Fig. 1, said lines are connected to a storage battery 65. The storage battery 65, therefore, provides a source of direct current energy and thus replaces or may be substituted for the source of alternating current 43 indicated. It is to be noted that the alternator 43 may be a high tension alternator or may be a low tension alternator, and in the latter event the transformer having the windings 41 and 42 may be eliminated. It is likewise to be noted that if a suitable source of alternating or direct current is provided at a normal voltage, to-wit, 110, 220 or 550, the lines 40 and 39 may be connected directly thereto, as in the ordinary service application.

In order to make the engine unit self-contained as well as fully automatic, as hereinbefore described, a direct current generator 66 is provided which is driven by the engine through suitable power connections and said generator is connected by the line 67 to one terminal of the battery 65 and is connected by the line 68 to the other terminal of the battery 65 through the relay 69. The reverse current relay prevents the battery from discharging through the generator at such times as the battery is not under load, but permits the generator to discharge into the battery even though the main double pole, double throw switch, or the relay operable switch, or the governor operable switch be open, thus charging the battery 65. At light loads the generator 66 will also assume part of the heating load and assist the battery 65 or carry most of the load imposed upon the circuit by closing the same through the several switches and the heating plugs. Fig. 2, therefore, illustrates a self-contained and automatically and remotely controlled construction. The arrangement of the circuit described in Fig. 2 is identical with that illustrated and described with reference to Fig. 1, and said circuits are provided with the same reference numerals.

In Fig. 3 the construction is very similar to that shown in Fig. 1, but herein the feature of remote control has been eliminated. In this form of the invention similar numerals indicate like parts. There is this change, however, the relay and relay-operable switch lines thereto and the lines 52 and 48 associated with the automatically controlled parallel switches are connected directly to the line 25 and the switch point 31 direct.

In Fig. 4 it will be noted that the construction illustrated is substantially identical with that illustrated in Fig. 2, except that the remote control relay operable switch has been eliminated and the automatically controlled switch is directly associated with the source of energy as heretofore described with reference to Fig. 3. Herein the lines 52 and 48 are connected to the lines 25 and switch point 31 in the same relation as described with reference to Fig. 3. Fig. 4 differs from Fig. 3 in the same manner that Fig. 2 differs from Fig. 1, to-wit, there is herein illustrated a source of direct current, whereas in Fig. 3 there is illustrated a source of alternating current and the remarks heretofore made with reference to the source of current illustrated in Figs. 1 and 2 apply equally to the sources of current shown in Figs. 3 and 4.

In Fig. 5 there is illustrated a still further simplified form of the invention, and in this form of the invention the automatic control is eliminated, as well as the remote control. This form of the invention is essentially manually operable, and herein there is illustrated a double pole single throw switch having the handle 127 and the switch points 138 and 137 and the switch points 134 and 135 adapted to be connected together respectively by means of the switch blades 128 and 129. In this form of the invention the line 24 is connected directly to the switch point 134 and the line 25 is connected directly to the switch point 135. The line 40 from the transformer is connected to the switch point 138 and the line 39 is connected to the switch point 137. Thus the circuit is closed from the source of energy to the heating plugs when the handle 127 is moved to close the circuit by bridging the gaps between the switch contacts 138 and 134 and 137 and 135.

In Fig. 6 the plugs therein illustrated are connected in the identical manner shown in Figs. 2 and 4 and the feeder lines 24 and 25 from said plugs are connected to the terminals 135 of the switch construction in a manner identical to that illustrated in Fig. 5 and hereinbefore described. The lines 40 and 39 are similarly connected to the switch points 138 and 137 at one end and to a source of direct current identical with that hereinbefore described with reference to Figs. 2 and 4. It will again be noted that Fig. 6 only differs from Fig. 5 in the same manner that Fig. 4 differs from Fig. 3, and Fig. 2 differs from Fig. 1. It will be noted that Figs. 1 and 2 differ from Figs. 3 and 4 by the addition of the remote control and mechanism, while Figs. 3 and 4 differ from Figs. 5 and 6 by the additional omission of the automatically operable switch, reducing the invention in Figs. 5 and 6 to a straight manually operable circuit. If desired, the same circuit shown in Figs. 5 and 6 may be modified by the substitution of a relay controlled circuit, such as shown in Figs. 1 and 2, and the relay thereof could be included in a circuit comprising the same or another source of energy and a manually operable switch substantially similar to that shown in Figs. 5 and 6, or said switch may be a single pole, single throw switch, thus breaking the re-

lay circuit in but one place instead of two places and simultaneously. When the same source of electrical energy is utilized in the foregoing suggested modified form of the invention, the relay circuit is in parallel with the main circuit, and thus manual operation, together with the remote control, can be secured. In view of the forms of the invention illustrated in Figs. 1 to 6 inclusive, the foregoing suggested modifications of the invention will be readily understood by those skilled in the art to which the invention applies and further illustration thereof is believed needless.

In Fig. 7 the plugs 20—21 are supplied by the feeder lines 124 and 125. The feeder lines 124 and 125, however, are connected to each other through the plugs 20—21. It will be remembered that the lines 24 and 25 in the construction illustrated in Figs. 1 to 6 inclusive were connected to each other through the plugs by a parallel construction including the plug terminal lines 22 and 23. Herein the plug terminal lines are designated by the numerals 122 and 121, and said lines are connected together so as to form a series connection, so that the feeder lines 124 and 125 are connected together and the plugs by a series connection. It is to be noted that the aforesaid connection may be substituted for the connections shown in Figs. 1 to 6 inclusive, and such a change from a parallel to a series connection is to be construed as an equivalent construction, the sole function of such a construction being to permit the use of suitable resistance elements in the plug proper, the detailed construction of which will be hereinafter described. It will be sometimes desirable to use a low voltage high amperage relation, and when such is the case, the parallel construction shown in Figs. 5 or 6 will be utilized. When, however, a high voltage, low amperage is available, the construction shown in Fig. 7 is the preferable connection of the plugs.

In Fig. 8 the plug feeder lines are indicated by the numerals 224 and 225, and in this instance the several plugs 20 and 21 are connected in series-parallel relation. The lines 322 to two of the plugs are connected together and to the line 224. The other terminals of the same plugs have the line 221 connected to the line 222 of an adjacent plug through a switch 219, and the other terminals of the adjacent plugs are connected by the lines 321 to the line 224. Thus, a series-parallel connection of the plugs is secured, and it may be desirable under certain conditions to utilize a series parallel connection, preferably, however, either a series connection or the parallel connection will be utilized.

In Figs. 9 and 10 there is illustrated a conventional form of engine cylinder construction and the associated parts. In said figures, 70 illustrates a cylinder block provided with a head 71 having a fuel passage 72 therein, which is enlarged to form an ignition chamber 73. A cap or cover 74 is provided with a chamber 75, and said chambers 73 and 75 form a complete ignition chamber. Extending into the chamber 73 is the heating plug, and particularly the portion 20 thereof, said plug being secured to the head 71 by means of the body portion 21. The particular construction of the plug will be hereinafter described. Positioned in the cap 74 is a fuel nozzle 76, which nozzle is adapted to discharge fuel upon the body portion 20, and as herein shown may also be adapted to discharge fuel directly on to the piston head slidably supported in the cylinder walls 70 by the fuel passing through the passage 72. The nozzle 76 is supplied with fuel from the supply line 77, which herein is shown provided with a relief valve 78. The supply line 77 is connected to a suitable fuel pump, hereinafter to be described.

In Figs. 11, 12 and 13 there is illustrated one form of the heater plug, and in said figures, the plug body is hollowed out as at 79 and a seat 80 is provided at the closed end of said portion. The body portion 21 has an externally tapered and threaded portion 81, whereby said plug is rigidly secured in the cylinder head 71, as illustrated in Fig. 9. The body portion is illustrated as cut away at 82 and at 83 and grooved at 84 adjacent to the enlarged opening 83. Extending axially through the hollowed body is an insulating core 85 which is adapted to stand up under high temperatures, particularly within the range of 500 to 1,500 degrees Fahrenheit. The commercial product known as "Lava" satisfies this condition and will approximately withstand 2,000 degrees before disintegrating. The surface 86 of the core 85, is threaded and positioned in said threads, is a wire 87, which constitutes a resistance unit. Said wire terminates adjacent the free end in a leader portion 88 positioned in a slot 89 which communicates with an axial hole 90 through the insulator body portion 85 and the axial opening 90 receives the connection 91. The space between the core carrying the resistance unit and the wall of the chambers 79—82 is herein shown filled with an insulating compound 92. The end of the core 85 opposite from the slotted end 89 is herein illustrated as provided with three projecting portions 93 which are receivable by the chamber 82 and serve to center the outer end of the core 85, whereas the other end of the core 85 is centered by reason of the conical end 80. The wire 87 and the leader 91 are brought out through holes 94, see Fig. 12, cut in an insulating plug or disk 95 seated in the enlarged portion 83 of the axial opening in the plug

body. The insulated disk or plate 95 is retained in position by means of the spring clip ring 96 seated in the groove 84. The disk 95 supports a pair of terminal posts 97 and these each are secured to one of the heating unit terminal wires 87 or 91 by means of the nut 98 while the external connector 99 is secured to said terminal post or stud 97 by means of the thumb nut 100. The construction shown in Figs. 11, 12 and 13 constitute one form of heating plug which might be employed.

Reference will now be had to Figs. 14 and 15 wherein a fuel pump construction is illustrated and the automatically operable switch construction is likewise illustrated. In said figures the framework is indicated generally by the numeral 101, and the same slidably supports the fuel valve construction indicated generally by the numeral 102. The fuel valve construction is adjusted by the supporting lever 103 and is actuated by the roller supporting yoke 104 carrying the roller 105. The roller 105 is adapted to engage the cam 106 supported upon the shaft or sleeve 55, which it will be remembered is rotatable with the main shaft 107 and slidably mounted thereon. The sliding movement, it will likewise be remembered, is imparted by the governor construction illustrated in Fig. 15 and diagrammatically illustrated in Figs. 1 to 4 inclusive. The lever 59 is herein shown as a clamp member, see Fig. 14, pivotally supported at 108, and the opposite end of the lever is connected to the actuator 60, which is herein illustrated as carried by the sliding rod 109.

The governor operable switch, it will be remembered, includes the movable contacts 49 and the stationary contacts 50, which stationary contacts 50 are connected in parallel as well as the contacts 49 which are similarly connected in parallel. The adjusting screws 110 adjust the position of the stationary contacts 50. A suitable housing 111 supports the entire switch construction, and the same may be filled with an arc-resisting and quenching fluid, such as mineral oil and the like.

The rod 109 extends into a snap switch construction indicated generally by the numeral 112 and an actuating portion 113 is associated with said snap switch construction and with the yoke lever 59 so as to transmit movement from said yoke lever 59 to the actuating member 60 with a quick make-and-break movement.

The connection between the yoke-shaped pivoted lever 59 and the actuating member 113 is as follows: The sleeve which carries the cams 106 and grooved collar 56 also carries a member 114. Said member 114 engages one side of a ball thrust bearing construction 115, which is directly connected to the yoke lever 59, as shown in Figs. 14 and 15. The pivoted yoke lever 59 terminates at 116 in a yoke portion which is suitably secured to an extension 117 of a spring supporting member 118. Associated with the extension 117 and directly connected thereto is the map switch actuating member 113 hereinbefore described. A stationary support 140 receives a threaded shaft 141 which carries upon one end a hand wheel 142 and upon the other end a spring seat member 143 which is slidably supported upon rods 144 secured at one end to the supporting member 118 hereinbefore mentioned. The other ends of said rods are secured to the spring retainer 145 and seated upon said rods between the seats 143 and 145 is a coiled spring 146. The rod 141 has a threaded connection with the spring seat 143.

From the foregoing construction it will be noted that when the hand wheel 142 is turned, the tension of the spring 146 will be increased or decreased, and with said increase or decrease in tension, there will be a corresponding movement of the pivoted lever 59, and said movement is transmitted through the ball thrust bearing 115 to the sleeve construction, and in turn to the spring controlled weighted levers 58. The resultant structure, therefore, is that the governor construction may be loaded or unloaded by means of the aforesaid third spring adjustment. For instance, it has been experimentally determined that the full load speed of the hereinbefore described engine is 250 R. P. M. and the speeds at other loads are as follows: 254 R. P. M. at ¾ load; 251 R. P. M. at ½ load and 260 R. P. M. at ¼ load and 263 R. P. M. at no load, and that at 10% overload, the R. P. M. is 247, the loading of the governor springs may be varied so as to shift the range of speeds. At the speed corresponding to no load, the position of the weighted levers is fully extended. Thus, by increasing the effect of the third spring transmitted to the cam sleeve construction herein illustrated, the governor position at no load speed can be changed, and correspondingly the fuel supplied thereto will be changed in proportion.

Under no load condition, the engine receives a smaller supply of fuel than under full load conditions, and to insure successful operation of the engine at this no load speed, the foregoing automatic construction has been associated therewith so that the heating plugs are energized to ignite the small supply of fuel furnished. Certainty of ignition at no load condition heretofore has been impossible because under no load conditions the amount of heat generated has not been sufficient to keep the piston heated to the proper temperature to ignite the fuel when the same impinges thereon. At no load with the present additions to the construction, all of the fuel will always be ignited by reason of

the heated plug construction being energized at said no load.

In starting, of course, the speed of the engine is zero and rapidly rises. Under such conditions the governor levers are in their innermost position and are not distented. The cam sleeve is in its corresponding position so as to supply the engine with a maximum amount of fuel. Since the engine is cold, the fuel discharged into the cylinders must be ignited by same external means, and this external means herein constitutes the heated plug.

It sometimes happens that one of the cylinders of the engine for some unknown reason suddenly stops firing when the engine is operating under a ¾ or full load condition. When this occurs, the speed of the engine immediately drops below the minimum rated full load speed of the governor, so that this condition is comparable to the starting condition hereinbefore described. Thereupon the plugs automatically will become energized and will insure complete ignition in all the cylinders until such time as the speed of the engine increases to full load speed, whereupon the plugs will be deenergized. It will be noted that the switch indicated generally by the numerals 49 and 50 is automatically operable by the governor construction and preferably with a quick-make-and-break movement to prevent arcing, and, therefore, since a two-position and parallel switch construction is provided, the engine will be provided with externally heated ignition means under low speeds and at excessive speeds or at all speeds other than full load speeds.

The operation of the device has been described in detail, and a general summary need only be herein given. The manually operable switch indicated in the several Figures, 1 to 4 inclusive, is closed at starting, and preferably in the upper position until the engine has been brought to speed and the load applied. Thereafter, the switch is opened and closed in the lower position which throws the heating plugs over on to an automatically controlled circuit. If desired, however, this throw-over arrangement may be eliminated and the switch be but a single throw switch, such as illustrated in Figs. 5 and 6; and when such is the case, the starting is accomplished automatically, since in Figs. 1 and 2 the governor actuated switch operates the relay to close the plug circuit; while in Figs. 3 and 4 the governor actuated switch closes the circuit directly through the heating plugs.

In Figs. 16 and 17 there is illustrated another and a modified form of the heater plug, and in said figures the plug body comprises a tubular portion 170 having a closed end 171 with a conical seat 172 therein. The tubular portion 170 at its opposite end terminates in an externally threaded and tapered portion 173, which is enlarged at 174 to form a tool-receiving portion, and herein said portion 174 is shown as hexagonal in form. The portions 173 and 174 are hollowed out at 175 and externally threaded as at 176. Extending axially through the hollowed body is an insulating core 185. This insulating body or core is adapted to stand up under high temperatures, particularly within 500 to 1000 degrees Fahrenheit. Such material is a commercial product known as "Lava" which will readily withstand a temperature of 2000 degrees. The surface 186 of the core is externally threaded, and herein the threaded portion 186 differs from the portion 86 of the previously described modification, that is, the former is a double thread. The wire 187 is positioned in one of said threads and runs from one end of the thread to the opposite end, and thereupon passes through the core by passing through the opening 189, which provides a communication from one of the threads to the other thread. The wire 187 thus passes down one thread and returns up the other thread. The end of the core 185 opposite the communication 189 is enlarged as at 183 and is threaded externally to be receivable by the threads 176 of the plug wall. Thus the core at this end is centered within the tubular heater body, and the other end of the core is centered by reason of the conical end 180 engaging the conical portion 172 of the plug body. The wire 187 is brought out through the openings 194 in the enlarged portion 183. The enlarged portion 183 supports a pair of terminal posts 197 which have a threaded engagement therewith, and said posts support the nuts 198 which are adapted to secure the terminal ends of the wire 187 to said terminal posts. The thumb nuts 300 are adapted to secure the external connectors 199 to the terminal posts. If desired, and herein the same is illustrated, the core is apertured longitudinally, as at 190, but this longitudinal opening may be omitted if desired.

It will be noted that the modified form of the heater plug shown in Figs. 16 and 17 constitutes the simplest form of the invention which may be made. It is to be understood that the metallic body portion 170 is preferably formed of a metal having peculiar properties, such as low specific heat and high resistance to conduction of heat which have been found to be desirable in a heating unit which is subjected to the high temperatures found in a crude oil engine under normal operation.

It has been found that in a multi-cylinder engine one or more cylinders do not require as much attention as others. The

switches 19 and 219 permit of considerable latitude in control that may be not only desirable but necessary at times.

Although the invention has been described in great detail in the foregoing specifications, such a detailed description is to be considered only as illustrative in character. Many modifications have been suggested in the foregoing, some of which have been illustrated as well as described, and these modifications as well as those which will readily suggest themselves to those skilled in the art to which this invention applies are all considered to be within the broad purview of the appended claims, which herein read on all figures, and particularly Figs. 2, 8, 9 and 15.

The invention claimed is:

1. The combination with a crude or fuel oil engine, of a source of electrical energy, an electrically heated igniter for said engine, an engine controlled switch, and a double throw switch for connecting said igniter directly with said source of electrical energy or through said engine controlled switch.

2. The combination with a crude or fuel oil engine, of a source of electrical energy comprising a storage battery, a generator driven by said engine and connected to the battery for charging the same, relay means controlling the battery and generator connection, an electrically heated igniter for said engine, an engine controlled switch, and a double throw switch for connecting said igniter directly with said source of electrical energy or through said engine controlled switch.

3. The combination with a crude or fuel oil engine, of an engine controlled switch, an electrically heated igniter for said engine, a switch for controlling said igniter and remotely controlled by said engine controlled switch, a source of electrical energy for said electrically heated igniter comprising a storage battery, a generator driven by said engine and connected to the battery for charging the same, and relay means controlling the battery and generator connection.

4. The combination with a crude or fuel oil engine, of a governor operable thereby, an electrically heated igniter for said engine, a switch operable by said governor, a relay controlled switch controlling said igniter, a relay controlling said relay controlled switch and controlled by said governor operable switch, a source of electrical energy comprising a storage battery, a generator driven by said engine and connected to the battery for charging the same, and a relay means controlling the battery and generator connection.

5. In a crude or fuel oil engine having a fly-ball governor operable thereby and for controlling the same, an electrically heated igniter, and a switch for controlling said igniter, the combination of a reciprocable shaft for actuating the switch, a lever actuatable by the governor construction and operatively connected to the shaft, and a loading spring for said shaft and lever.

6. A device as defined by claim 5, characterized by the addition of an adjustable arrangement for varying the loading of said spring.

In witness whereof, I have hereunto affixed my signature.

HARRY E. BRIGGS.