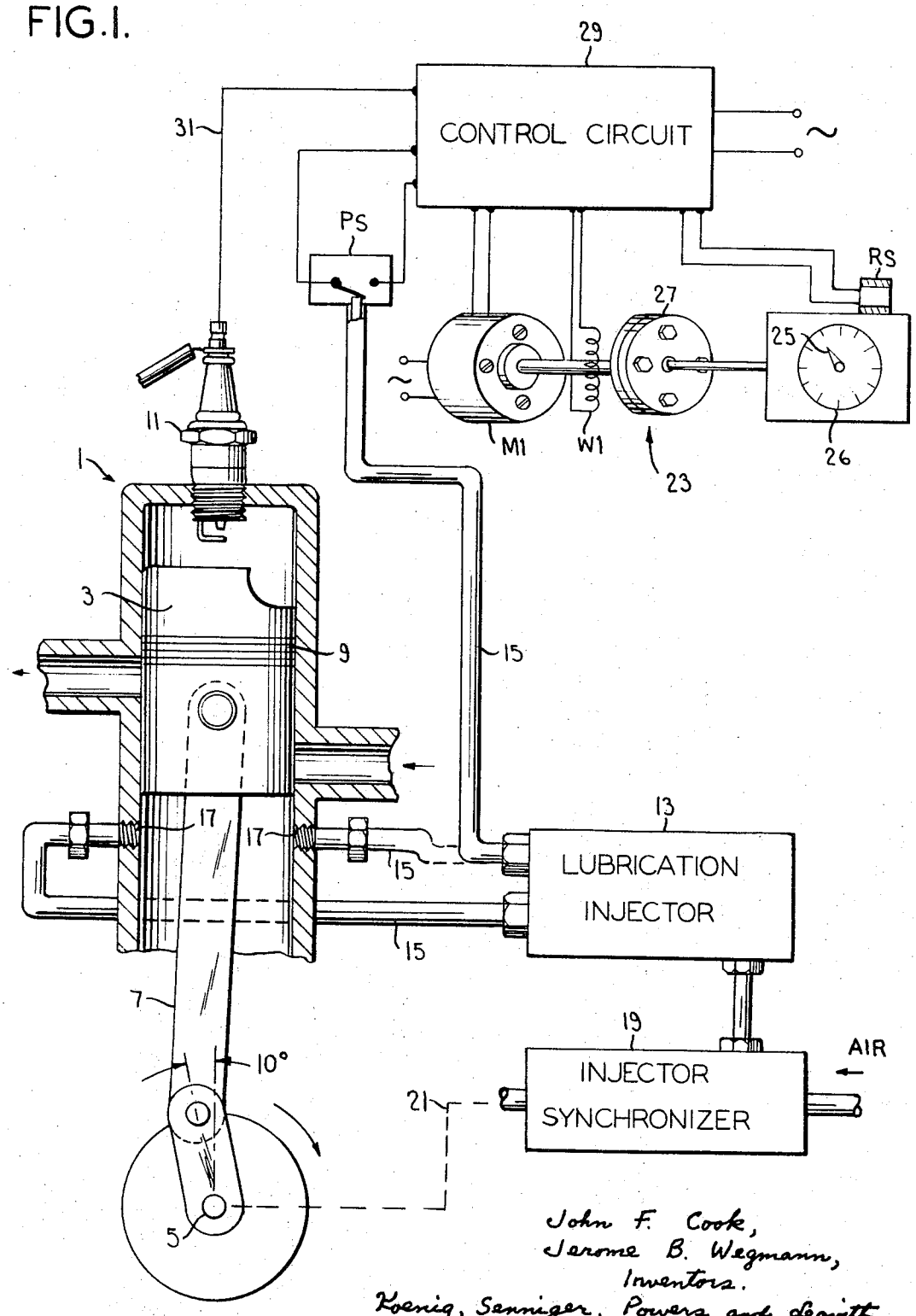
Nov. 7, 1967 J. F. COOK ET AL 3,351,156

LUBRICATION APPARATUS

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FIG. 1.



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LUBRICATION APPARATUS

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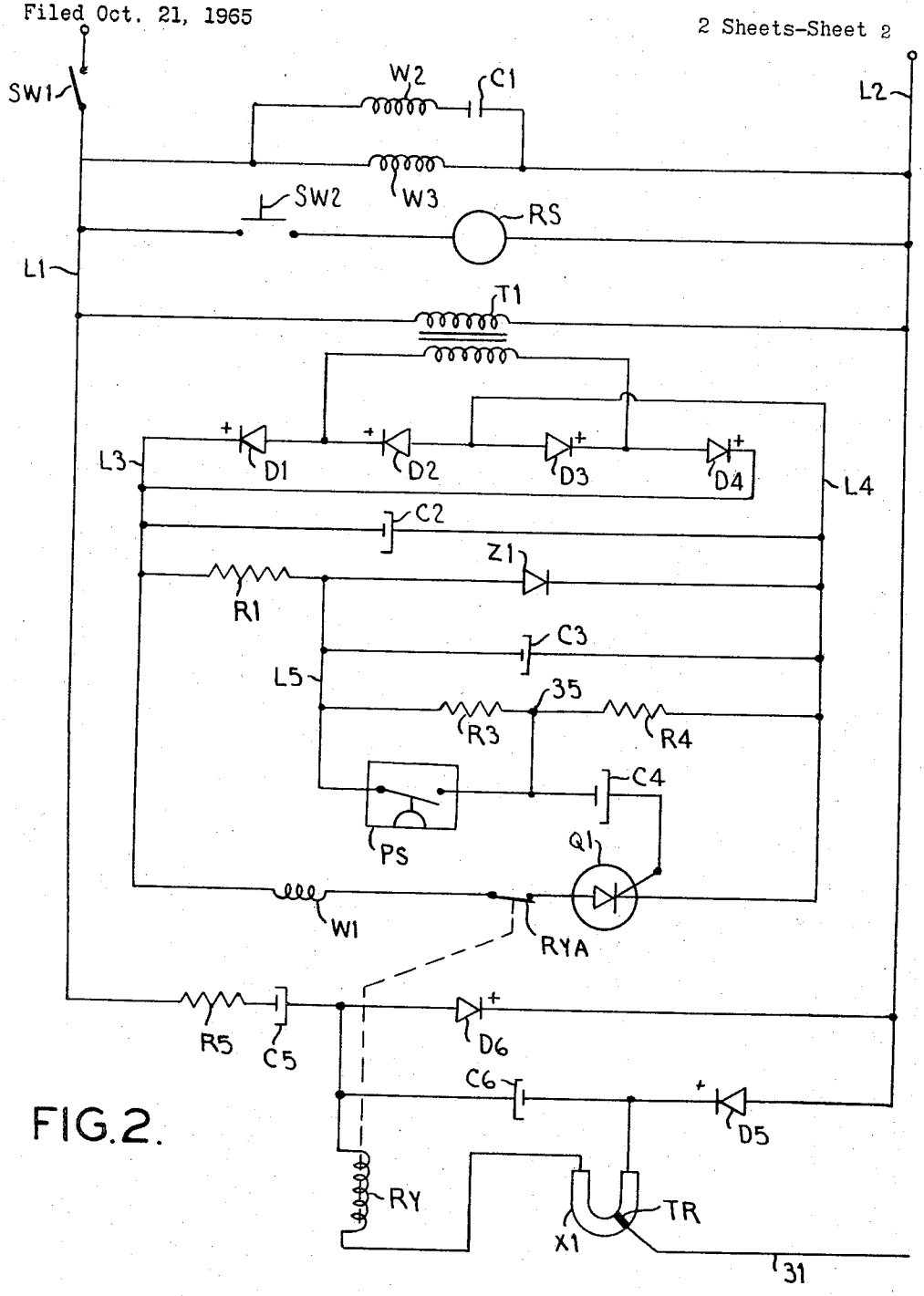


FIG. 2.

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3,351,156

LUBRICATION APPARATUS

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8 Claims. (Cl. 184—6)

This invention relates to lubrication apparatus, and more particularly to apparatus for timing injections of lubricant into the cylinder of a piston and cylinder device, such as the cylinder of an internal combustion engine.

In the copending coassigned application of Carl H. Mueller, Lutwin C. Rotter and Jerome B. Wegmann, Ser. No. 273,221, filed April 15, 1963, entitled Lubricating Apparatus, which now is U.S. Patent No. 3,232,379, there is shown a system for periodically injecting lubricant into a cylinder of an internal combustion engine, through injection ports in the wall of the cylinder, in synchronism with the passage of the piston past the ports so that the lubricant is discharged directly onto the rings of the piston for efficient lubrication with minimal fouling by carbonization. In order for such a system to operate most efficiently, it is necessary that the injection of lubricant, which occurs periodically (for example, once every fifteen seconds) be accurately synchronized with the passage of the piston past the injection ports. This requires some mode of determining whether or not the operation of the injector is so phased with respect to the operation of the piston that the injection of lubricant is occurring at such a point in the stroke of the piston that the lubricant is discharged directly onto the piston rings.

Among the several objects of this invention may be noted the provision of apparatus for accurately determining the timing of injection in relation to the passage of the piston across the injection ports, so that suitable correction may be made in the event the injector and piston are out of phase; and the provision of such apparatus adapted for use in conjunction with lubrication systems for use with engines operating at relatively high speeds. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is a diagrammatic illustration of the application of a timing system of the invention to a two-cycle internal combustion engine; and

FIG. 2 is a schematic circuit diagram of the timing control circuit.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to the drawings, there is indicated at 1 in FIG. 1 a cylinder of a typical internal combustion engine, such as two-cycle gas engine, having a piston 3 working therein. The engine crankshaft is indicated at 5. Connected between the piston and crankshaft is the usual connecting rod 7. The piston will conventionally have piston rings such as indicated at 9. A spark plug 11 is provided for igniting the powering charge as the

piston nears the top of its stroke, e.g., at 10 degrees before top dead center.

At 13 in FIG. 1 is indicated a lubricant injector which may be of the same type as indicated at 35 in said U.S. patent application Ser. No. 273,221 which now is U.S. Patent No. 3,232,379. This is adapted to deliver measured charges of lubricant through each of four lubricant lines such as indicated at 15 (corresponding to lines 37, 39, 41 and 43 shown in said copending U.S. application) to four lubricant injector ports (two of which appear in FIG. 1) each designated 17 (and which correspond to nozzles 29 shown in said copending application). Ports 17 are intermediate the ends of the stroke of the piston. At 19 in FIG. 1 is indicated a synchronizer corresponding to that shown at 33 in said copending application for periodically actuating the injector with air pressure to deliver said charges of lubricant through lines 15. Synchronizer 19 is driven by crankshaft S as indicated at 21, the phasing between the crankshaft and the synchronizer being adjustable to permit adjustment of the timing of lubricant delivery.

Injector 13 and synchronizer 19, as disclosed in said copending application, are capable of very rapidly delivering the desired measured charge at a precise point in the engine's cycle. However, to obtain satisfactory operation it is necessary to initially adjust the timing of the injections in relation to the engine's cycle so that the lubricant is discharged directly onto the piston rings. This timing must take into account any delays inherent in the operation of injector 13 after an injection ampulse is initiated by synchronizer 19.

At 23 in FIG. 1 is indicated a start-stop timer for measuring the interval elapsing between the delivery of lubricant by injector 13 and the time at which piston 3 reaches a predetermined point in its stroke, in particular the point at which spark plug 11 is fired. Timer 23 includes a continuously running motor M1, a pointer 25 which sweeps an indicating dial 26 calibrated in milliseconds, and an electromagnetically controlled coupling 27 which is actuated by energization of winding W1 to couple pointer 25 to motor M1. Preferably, coupling 27 includes both a clutch which is engaged when the pointer 25 is to be driven and a brake which automatically engages upon release of the clutch to stop pointer 25 without overrunning. Timer 23 also includes a reset solenoid RS which, when energized, returns the pointer to its initial position or zero reading.

Coupling 27 is operated by a control circuit 29 to advance pointer 25 during the interval between delivery of lubricant and the firing of spark plug 11. A pressure switch PS is provided for sensing the delivery of lubricant, one of the lines 15 being temporarily disconnected from its respective port 17 and connected to the pressure switch during the timing operation. Lead 31 is provided for connection to the insulated electrode of spark plug 11.

Referring now to FIG. 2, power for energizing control circuit 29 is obtained through a pair of leads L1 and L2 from suitable supply mains or an A.C. source (not shown). An on-off switch SW1 permits the timing apparatus to be deenergized. As illustrated, motor M1 is of a split-phase induction type having a pair of windings W2 and W3. Winding W3 is connected directly across leads L1 and L2 while winding W2 is in series with a conventional phase splitting capaictor C1. Motor M1 runs continuously when circuit 29 is energized. The in-

dicator resetting solenoid RS is connected across lines L1 and L2 by a circuit which includes a reset switch SW2.

Low voltage D.C. is provided between a pair of lines L3 and L4 by means of a power supply which includes a stepdown transformer T1, a full wave bridge rectifier constituted by diodes D1–D4, and a filter capacitor C2. The winding W1 which controls coupling 27 is connected for energization across lines L3 and L4 by a circuit which includes a set of normally closed relay contacts RYA and the anode-cathode circuit of an SCR (silicon controlled rectifier) Q1.

A regulated source of D.C. is provided, at a lower voltage than that appearing across lines L3 and L4, at a line L5 by means of a Zener diode Z1 and a dropping resistor R1. This source is further filtered by a capacitor C3. A voltage intermediate those present at lines L4 and L5 is provided at a terminal 35 by a voltage divider constituted by a pair of resistors R3 and R4. Terminal 35 is connected to the gate-electrode of SCR Q1 by a coupling capacitor C4. This terminal is also selectively shunted to the line L5 by the pressure switch PS described hereinbefore with reference to FIG. 1.

Also connected across lines L1 and L2 is a voltage doubler circuit constituted by a pair of diodes D5 and D6 and a pair of energy storage capacitors C5 and C6. A resistor R5 limits the initial flow of charging current into the doubler. The voltage doubler is operative to charge capacitor C6 to a voltage which is substantially twice the peak voltage appearing between lines L1 and L2. A relay coil RY and a gas discharge flash tube X1 are connected in series across capacitor C6. Coil RY is operative, when energized, to open the contacts RYA described previously. The trigger electrode TR of flash tube X1 is connected to the lead 31 which extends to the engine's spark plug 11.

Operation is as follows:

The closing of pressure switch PS in response to delivery of lubricant by injector 13 will send a positive pulse through capacitor C4 to the gate of SCR Q1 thereby triggering it into conduction. Due to the latching characteristics of silicon controlled rectifiers, SCR Q1 will continue to conduct even after the pulse provided by capacitor C4 is dissipated. When SCR Q1 conducts, the winding W1 is energized to engage the coupling clutch and couple the pointer 25 to the continuously running motor M1. The pointer thus begins to advance thereby representing elapsed time commencing at the delivery of lubricant.

Pointer 25 will continue to accumulate elapsed time until piston 3 reaches that predetermined point in its stroke when the spark plug 11 is fired. The high voltage pulse coupled through the lead 31 by the firing of the spark plug produces ionization in flash tube X1 which will then discharge capacitor C6 through the relay winding RY. This abrupt energization of relay RY in turn opens the contacts RYA thereby deenergizing winding W1. When winding W1 is deenergized, the coupling clutch is released and the brake is set so that pointer 25 is brought to an abrupt stop. The reading on the dial 26 at this point is then a representation of the time elapsed between the delivery of lubricant and the time at which piston 3 reached that predetermined point in its stroke at which spark plug 11 is fired.

Knowing the speed of the engine, the spark timing and the position of the piston within its stroke when the rings 9 pass the ports 17, the desired elapsed time between the delivery of lubricant and the firing of plug 11 can be readily calculated. A comparison between the reading of pointer 25 on dial 26 and this calculated elapsed time then gives sufficient information for determining whether the synchronizer 19 is properly adjusted or, if it is not, how it should be readjusted.

While in the illustrative embodiment the delivery of lubricant has been shown as being timed relative to the firing of the spark plug, it will be apparent to those skilled in the art that this timing can also be performed relative to other functions of the engine which occur at known or predictable points within the piston's cycle or stroke. Similarly, while the apparatus shown measures time from the delivery of lubricant to the occurrence of the known function, it can be seen that the timing could instead be initiated in response to the known engine function and terminated by the delivery of lubricant and that adjustment of the synchronizer could be made from this information as well as from the information obtained in the manner described in the exemplary embodiment.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A system for timing the operation of lubricating apparatus for a piston and cylinder device, which apparatus comprises an injector for periodically injecting lubricant into the cylinder through a port in the wall of the cylinder, to synchronize the injection of lubricant with the passage of the piston past said port, comprising a start-stop timer, means for starting the timer, and means for stopping the timer, one of said means being operable in response to delivery of lubricant by the injector, and the other of said means being operable in response to the piston reaching a predetermined point in its stroke.

2. Apparatus as set forth in claim 1 wherein said port is away from the top end of the stroke of said piston and said other means is triggered in response to the piston reaching a point near one end of its stroke.

3. Apparatus as set forth in claim 1 wherein said device constitutes a cylinder and piston of an internal combustion engine having a spark plug, and said other means is triggered in response to the firing of said plug which occurs at a predetermined point in the stroke of the piston.

4. A system for timing the operation of lubricating apparatus for the cylinder and piston of an internal combuston engine having a spark plug, which apparatus comprises an injector for periodically injecting lubricant into the cylinder through a port in the wall of the cylinder, to synchronize the injection of lubricant with the passage of the piston past said port, comprising a start-stop timer adapted to register elapsed time in fractions of a second; means responsive to delivery of lubricant by the injector for starting the timer, and means responsive to firing of the spark plug for stopping the timer, whereby the timer indicates the time elapsed between delivery of lubricant and the firing of the spark plug.

5. A system for timing the operation of lubricant apparatus for the cylinder and piston of an internal combustion engine having a spark plug, which apparatus comprises an injector for periodically injecting lubricant into the cylinder through a port in the wall of the cylinder, to sychronize the injection of lubricant with the passage of the piston past said port, comprising a start-stop timer adapted to register elapsed time in fractions of a second, said timer comprising a continuously operable motor, a time indicator, and an electric clutch interconnecting the motor and the indicator, means responsive to delivery of lubricant by the injector for actuating the clutch to couple the motor to the indicator, and means responsive to firing of the spark plug for deactuating the clutch to uncouple the indicator from the motor.

6. Apparatus as set forth in claim 5 wherein the means for actuating the clutch includes a silicon controlled

rectifier for energizing the clutch and a pressure switch adapted to be connected to said injector for sensing delivery of lubricant, said switch being interconnected with the rectifier to initiate conduction therein upon delivery of lubricant.

7. Apparatus as set forth in claim 6 wherein the means for deactuating the clutch comprises an energy storage capacitor, means for charging said capacitor, and a gas discharge tube for controllably discharging said capacitor, said tube being adapted to be connected to said spark plug whereby firing of said spark plug initiates conduction in said tube, the current discharged from said capacitor by conduction of said tube being applied to deactuate said clutch.

8. Apparatus as set forth in claim 7 including means for resetting said timer following a timing cycle.

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