

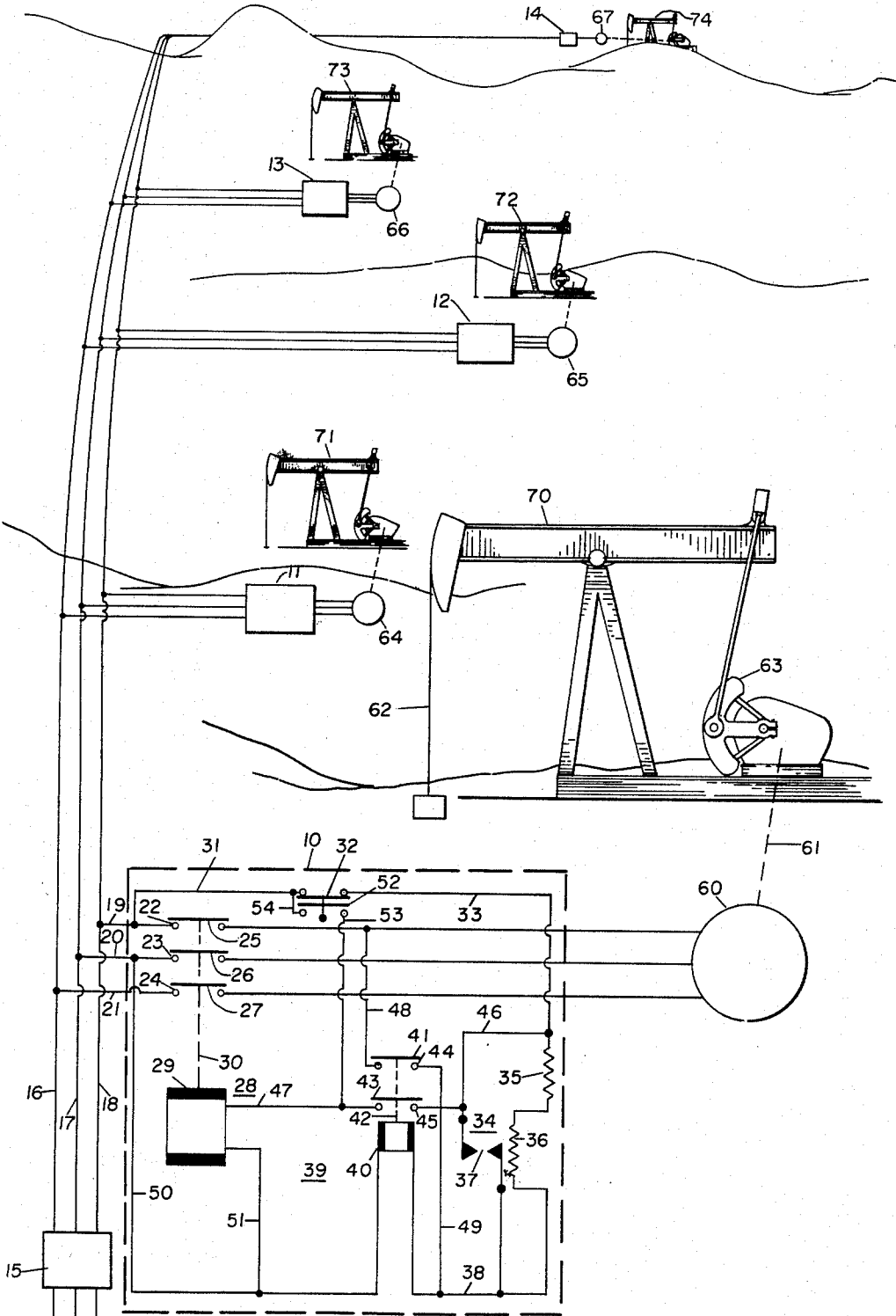
June 22, 1965

C. W. REED

3,191,114

TIME DELAY MOTOR STARTING SYSTEM

Filed Sept. 26, 1962



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3,191,114

TIME DELAY MOTOR STARTING SYSTEM
Charles W. Reed, Taft, Calif., assignor to Socony Mobil
Oil Company, Inc., a corporation of New York
Filed Sept. 26, 1962, Ser. No. 226,278
2 Claims. (Cl. 318-472)

This invention relates to the sequential and automatic starting of a plurality of well pump motors in an oil field and more particularly to a control system for starting a well pump motor at a predetermined time delay after power has been applied to the system.

In the operation of present day oil fields having a plurality of wells operated by electric pump motors, control systems are employed automatically and sequentially to start the wells after they have been shut down, for example, from power failure. The sequential starting operations prevent the power transformers utilized from being burned out by an excessive load due to starting currents which may occur if the wells were all started at the same time.

Difficulties have been encountered, however, in applying the sequential starting operation to the larger pumps for the following reason. The control systems for starting the motors sequentially and automatically include circuits having delay devices for delaying the application of power to the starting units. The starting units necessary for the larger pumps require a large amount of current for actuation which in some cases is more than the available delay devices can handle. This excessive or large amount of current will cause the delay devices to burn out when applied thereto.

In accordance with the present invention, a time delay starting system coupled to power supply means is provided which protects the delay device utilized from the large current required by the pump motor starting unit. The system includes a first relay control means for applying starting and running power to the motor. A time delay circuit is provided having a normally open first switch means which is closed after a predetermined time delay following application of current to said time delay means. The time delay circuit has input and output ends coupled to the first switch means and a current rating less than that of the first relay control means. An energizing circuit is coupled to the power supply means and to the input end of the delay circuit. A shunting circuit is provided having a second switch means. The shunting circuit has a first end coupled to the energizing circuit at a point between the power supply means and the time delay circuit and a second end coupled to the first relay control means. A second relay control means of current rating within the current limits of said delay circuit is provided for applying energizing current to the first relay control means to start the motor. This second means is coupled to the output end of the time delay circuit and is responsive to current passing from the energizing circuit by way of the first switch means when closed for closing the second switch means to complete the shunting circuit to the first relay control means, thereby shunting out the time delay circuit before applying energizing current to the first relay control means.

For a more complete understanding of the present invention and for further objects and advantages thereof, reference may now be had to the following description taken in conjunction with the accompanying drawing. This drawing illustrates an oil field having a plurality of pumps each of which has an automatic control system for starting its associated well at a predetermined time delay after power is applied to the system.

Control circuits 10-14 are provided respectively for the motors 60 and 64-67 of pumps 70-74. Power supply

means 15, which may be a transformer, supplies power to the various control circuits and pumps by way of power lines 16-18. The control circuits function such that the well pumps are started in sequence with a sufficient time period between the start of each pump so as to avoid overloading the power transformer.

To carry out this operation, each control circuit has associated therewith a starting circuit which includes a time delay device 34, as illustrated in the control circuit 10, for delaying the starting operation of each pump. Each of the time delay devices can be arranged with a different delay time. As an example, the delay difference can be anywhere from 5 to 30 seconds.

A starting or power relay 28 is provided to apply starting and running power to the motor 60 after the time delay. If the motor 60 is a large motor, for example 25 horsepower or more, a large starting relay 28 is required. This relay draws a large amount of current upon actuation. To protect the delay device 34 from the large current requirements of relay 28, a shunting circuit is provided which includes conductors 46 and 47. A small relay 39 is provided in series with the delay device 34 and is actuated after the delaying operation of device 34 to complete the shunting circuit to shunt the delay device 34 and to apply energizing current to the power relay 28. The relay 39 can be actuated without adversely affecting the delay device 34 since it draws only a small amount of current, the value of which is below the maximum limit that the delay device 34 can safely handle. With the arrangement illustrated the delay device 34 performs its delaying function and then is shunted out before the relay 28 is actuated, thereby protecting the delay device 34 from the large current requirements of relay 28.

There now will be described more specifically the manner in which the circuit 10 operates. The power transformer 15 normally supplies 440 volts to the motor 60 by way of power lines 16-18, conductors 19-21, and relay control terminals 22-24 which are normally closed by switches 25-27 coupled to starting relay 28 by way of linkage represented by dotted line 30.

If the motor 60 has been shut down for some reason, the starting relay 28 is actuated, after a predetermined time delay, to start the motor 60. The time delay is determined by the delay device 34 which preferably is a thermal-delay device. Initially, power is applied or current flows through the delay device 34 to the relay 39. This flow of current is by way of conductors 19 and 31, closed switch 32, conductor 33, line-dropping resistor 35, and through heating element or resistor 36 of delay device 34. From resistor 36, current flows to conductor 20 by way of conductor 38, coil 40 of relay 39 and conductor 50. During this time, the voltage applied to the coil 40 of the relay 39 is not sufficient to actuate the relay.

As current flows through the element or resistor 36, its temperature increases. When a predetermined temperature is reached, the bimetallic elements comprising the switch contacts 37 close to shunt the line-dropping resistor 35 and the heating element or resistor 36 whereby sufficient current is applied to the coil 40 to actuate the relay 39. When the coil 40 of the relay 39 is energized, the switches 41 and 43, which are coupled to the coil 40 by way of linkage represented by the dotted line 42, are actuated to contact respectively terminals 44 and 45. When this occurs, the shunting circuit including conductors 46 and 47 is completed across closed switch 43 thereby allowing energizing current to be applied to the coil 29 of relay 28. The circuit from the coil 29 to conductor 20 may be traced by way of conductors 51 and 50. When the coil 29 of relay 28 is energized, the switches 25-27 are actuated to contact terminals 22-24.

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Thus 440 volts are applied to the motor 60 to operate the pump 70 by way of connection 61. With the arrangement provided, the delay device 34 thus performs its delaying operation and then is shunted out before the relay 28 is actuated.

Means are also provided for maintaining the relay 39 in its actuated condition upon the completion of the shunting circuit. This comprises a circuit which includes conductor 48 coupled from conductor 19 to one of the terminals 44 and also conductor 49 coupled from the other of the terminals 44 to the conductor 38. Thus, when relay 28 is actuated, energizing current is applied to the coil 40 of relay 39 by way of conductors 19 and 48, closed switch 41, and conductor 49.

The other pumps 71-74 may be started in a like manner. If a power failure should occur, the pumps will be stopped; but upon resumption of power, the pumps will again be brought into operation sequentially in the manner described.

In event it is desired manually to start the well for one reason or another, for example, to reposition the sucker rod 62 or to reposition the counter balance 63, switch 52 can be closed, thereby opening switch 32. This completes a circuit to the relay 28 by way of conductor 54, closed switch 52, and conductor 53 which circuit shunts the time delay device 34 to allow 440 volts to be applied to the starting relay 28.

In one embodiment, the coil 29 of the starting relay 28, when actuated, draws about 5.75 amperes and the coil 40 of the relay 39, when actuated, draws about .75 amperes. The contact rating of the delay device 34 is of the order of 1 ampere at 220 volts.

While the invention has been described in connection with one embodiment thereof, it will now be understood that modifications will suggest themselves to those skilled in the art, and it is intended to cover such modifications as fall within the scope of the appended claims.

What is claimed is:

1. A motor control system coupled to power supply means for starting an electric motor comprising:

a first relay control means for applying starting and running power to said motor,

a time delay circuit having a normally open first switch means which is closed after a predetermined time delay following application of current to said time delay means,

said time delay circuit having input and output ends coupled to said first switch means,

the current rating of said time delay circuit being less than that of said first relay control means,

an energizing circuit coupled to said power supply means and to said input end of said time delay circuit,

a shunting circuit including a second switch means, said shunting circuit having a first end coupled to said energizing circuit at a point between said power supply means and said time delay circuit and a second end coupled to said first control means,

a second relay control means of current rating within the current limits of said delay circuit for closing said second switch means independently of said first relay control means,

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said second relay control means being coupled to said output end of said time delay circuit and responsive to current passing from said energizing circuit by way of said first switch means when closed for closing said second switch means to complete said shunting circuit to said first relay control means to shunt said time delay circuit and to apply energizing current to said first relay control means.

2. In a system for starting sequentially a plurality of electric pump motors in an oil field wherein a control system coupled to power supply means is provided for each of said pump motors for starting its associated motor at a predetermined time delay after power is applied thereto, a motor control system comprising:

a time delay circuit having a normally open first switch means which is closed after a predetermined time delay following application of current to said time delay means,

said time delay circuit having input and output ends coupled to said first switch means,

an energizing circuit coupled to said power supply means and to said input end of said time delay circuit,

a starting relay having a control winding for applying starting and running power to its associated motor, the current rating of said time delay circuit being less than that of said control winding of said starting relay,

a shunting circuit including a second switch means, said shunting circuit having a first end coupled to said energizing circuit at a point between said power supply means and said time delay circuit and a second end coupled to said control winding,

a second relay having a control winding of current rating within the current limits of said time delay circuit coupled to said output end of said time delay circuit and responsive to current passing from said energizing circuit by way of said first switch means when closed for closing said second switch means to complete said shunting circuit to shunt said time delay circuit and to apply energizing current to said starting relay,

an operating circuit coupled to said motor and to said control winding of said second relay for applying energizing current thereto when running power is applied to said motor, and

means actuated by said second relay for completing said operating circuit to said second relay at the same time that said shunting circuit is completed.

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ORIS L. RADER, *Primary Examiner.*