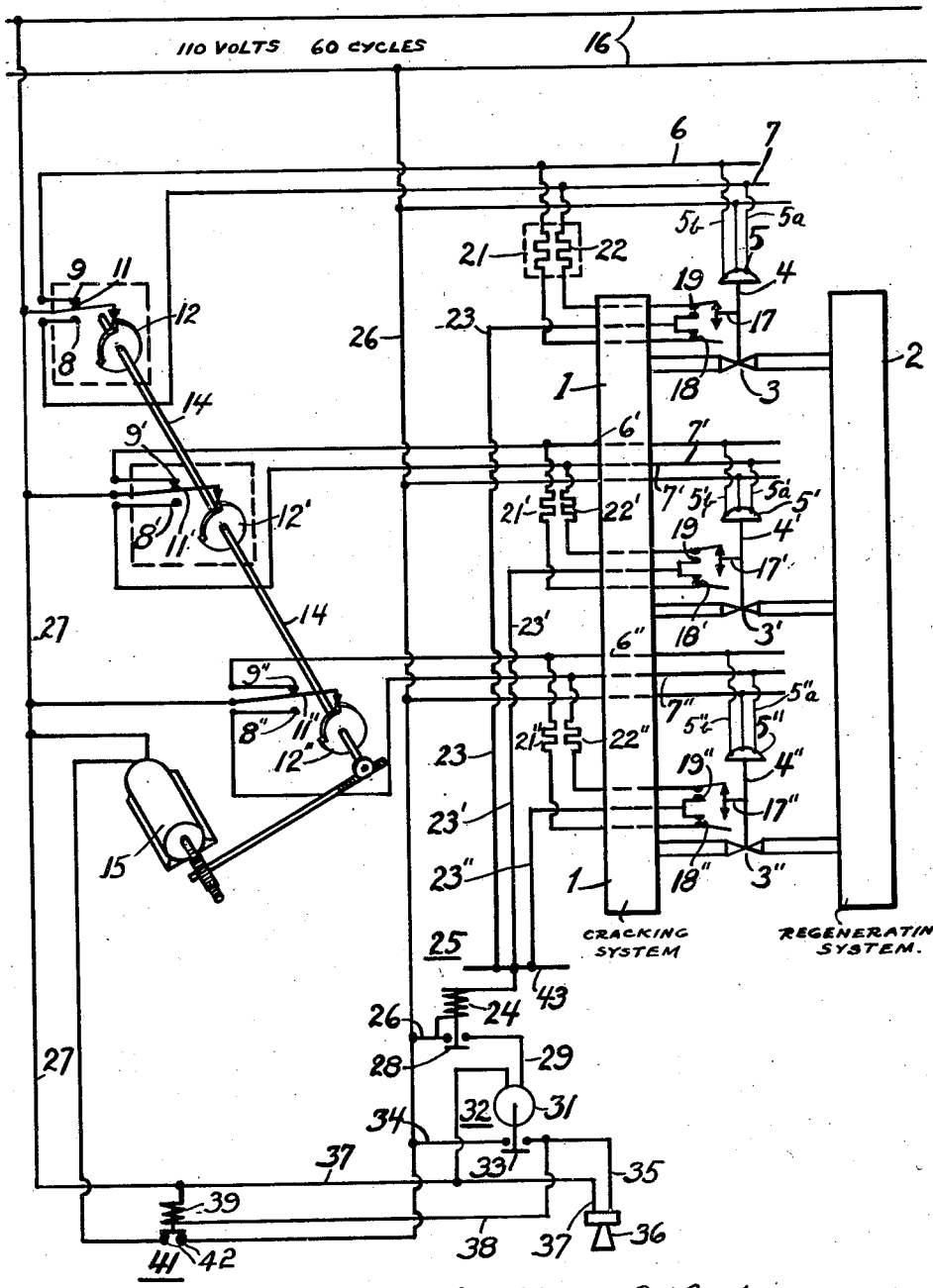
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ALARM SIGNAL SYSTEM FOR AUTOMATIC VALVES

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ALARM SIGNAL SYSTEM FOR AUTOMATIC VALVES

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This invention relates to automatic valve control mechanism with a failure warning signal; relates particularly to an automatic valve control system in petroleum cracking apparatus; and relates especially to a protective relay system for insuring a correct sequence and timing of the operation of valves for determining the cycle of process steps in the system; and delivering a warning signal in the event of incorrect operation.

In many processing systems, particularly such process systems as petroleum cracking apparatus, series of cyclic process steps are conducted in sequence; these steps being carried out successively at definite time intervals. This is particularly the case in the cracking of crude oil. In this cracking process a catalyst is used which influences the character of the cracking reaction, and directs the cracking reaction into a form which produces a maximum amount of gasoline boiling range hydrocarbons. This cracking operation, whether conducted with a fixed catalyst; or with a powdered catalyst carried along with the hydrocarbon through the cracking coil system, requires regeneration of the catalyst. In order to conduct the regeneration, the catalyst must be separated from the hydrocarbon, both the produced gasoline and the residual crude being either drained away from the catalyst or otherwise removed before the application of the regenerating step. In the cracking operation, the crude hydrocarbon oil is heated in the presence of a catalyst, which may be in powdered form, suspended in the hydrocarbon oil and carried along with the oil, or may be in the form of substantial aggregates which are set in place in the cracking chamber. In either event, means must be provided for the separation of the catalyst and hydrocarbon, which means ordinarily consist of chambers and valve control members. Since the regeneration of the catalyst is obtained by oxygen containing gases, and the hot cracked and residual hydrocarbons are combustible with oxygen, it is imperative that the regeneration means be kept segregated from hydrocarbons in the cracking coils by closed valves at all times; otherwise, combustion of valuable material or even explosions may occur.

The present invention provides a control and signal system by which the various valves are operated in the proper cyclic sequence for the separation of the powdered catalyst from the hydrocarbon materials when a powdered circulating catalyst is used; for the regeneration of the catalyst; and for the return of the catalyst to fresh cracking stock; while at the same time, the positive and complete closure or opening of all of the valves is checked and verified at all times; and in the event that any valve fails to close or open at the proper time within a limited time interval and if operation of the valves is not complete within the limited time interval, a warning signal is given, and if desired, the whole sequence of operations is suspended.

The system comprises the cracking coil members, the regeneration members, and power operated valves disposed therebetween. The valves are actuated by a clock or motor driven cam timer which opens and closes circuits to the valve operating motors; together with limit switches on the valves which open and close contacts at the valves when the valves are fully opened or fully closed; together with a relay system, a time delay resetting relay, and an alarm system, with a relay for stopping the time clock if desired.

Accordingly, the invention per se consists of a control relay system in a petroleum cracking and regenerating system in which the valves are operated cyclically; by which the actuation of the valves at proper time intervals (within a limiting time interval for the actuation operation) is checked, and an alarm signal energized if the valves fail to operate in proper sequence within a limited time.

Thus an object of the invention is to ensure the opening and closing of valves in a petroleum cracking system and to warn an operator of the failure of valves to operate within a predetermined, limited time. Other objects and details of the invention will be apparent from the following description when read in connection with the accompanying drawing, in which the single figure is a diagrammatic representation of the cracking system, together with the control valves and operating, checking and signal circuits cooperating therewith.

Referring to the figure, the cracking coil system indicated by the reference character 1 is connected to the regenerating system 2 through a group of valves 3, 3' and 3'' having valve stems 4, 4' and 4'' and valve actuating means 5, 5' and 5'' which may be electric motors or may be pressure actuated diaphragms under the control of solenoid operated supply and bleed valves. The valve motors 5, 5' and 5'' are controlled and energized by circuit leads 6, 6' and 6''; and 7, 7' and 7'' connected to contacts 8, 8' and 8''; and 9, 9' and 9'' which cooperate with contacts 11, 11' and 11'' which in turn are actuated by cams 12, 12' and 12''. The cams 12, 12' and 12'' are mounted upon a shaft 14 rotated by a clock member 15. The clock member 15 preferably is a synchronous

electric motor or clock operated from controlled-frequency power-supply mains 16. The valve stems 4, 4' and 4'' are provided with members 17, 17' and 17'' which cooperate with pairs of contacts 18, 18' and 18''; and 19, 19' and 19'' which function as limit switches. One of each of the contact pairs 18 and 19 is connected, respectively, to the mains 6 and 7 through "dropping resistors" 21 and 22. The other contacts of each of the pairs 18 and 19 are connected together to a lead 23, which in turn is connected to the coil 24 of a sensitive relay 25. The coil 24 is connected through a lead 26 to the other power supply main 16; the contacts 11, 11' and 11'' also being connected to the power supply main 16 through a lead 27. The relay 25 has contact members 28, one of which is connected to the lead 26. The other is connected through a lead 29 to the coil 31 of a resetting time delay relay 32 having contacts 33. This relay may be any convenient type of time delay relay such as an induction disc or motor type of relay, or a dash pot type of relay, or a thermal time delay relay or, in some instances, may be simply a magnetic shielded, sluggish relay with instantaneous reset.

The requirement imposed upon this relay is that it shall close the contacts 33 after a time limit slightly greater than that normally required to actuate the valve 3; which time limit of course depends to some extent upon the size of the valve 3; and the actuating power. Obviously, a small valve with an air pressure actuating diaphragm will close much more quickly than a large valve operated by an electric motor, requiring accordingly a different time delay.

The contacts 33 are connected, one by a lead wire 34 to the lead wire 26 and thence to the main power supply line 16. The other contact 33 of the relay 32 is connected by a lead 35 to an alarm signal 36, the other terminal of which together with the signal lead from the coil 31 is connected through a lead 37 to the other of the power supply leads 16. If desired, a signal lead 38 is connected to the contacts 33 and to the coil 39 of a relay 41, the contacts 42 of which are connected in the circuit of the timer motor 15. A common bus bar 43 is provided, to which a number of leads 23, 23' and 23'' connecting a plurality of other contacts 18, 18' and 18'' and 19, 19' and 19'' which are actuated by other valves 3' and 3'' for actuation of the relay 25, the time delay relay 32 and the alarm signal 36.

In the operation of the device of this invention, the cracking coil system is placed in operation in the usual manner by being brought up to cracking temperature; the catalyst regenerating system likewise is prepared for operation by being brought up to temperature and the catalyst flow is started through the cracking system. The catalyst accumulates in a hopper connected with the cracking system and, when the proper point in the operation is reached, the valve 3 together with other valves must be actuated to transfer the catalyst from the cracking system to the regenerating system. This point in the cycle is indicated by the position of the cam 12 on the shaft 14 as driven by the timer motor 15. The cam 12 shifts the contact member 11 from one position with respect to the contacts 8 and 9 to the other position with respect to the contacts 8 and 9, thereby transferring voltage from contact 8 to contact 9, thereby applying voltage to the lead conductor 6. Voltage upon the lead conductor 6 actuates the valve, as for instance, to close it. When the voltage is applied to the lead 6, it supplies power simultaneously to the contact pair 18 and through the contacts 18, the lead 23 and the bus bar 43, to the coil 24 of the sensitive relay 25; the circuit being completed through the lead 26. Energization of the coil 24 closes the contacts 28 and applies power from the lead 26 through the contact 28 and the lead 29 to the coil 31 of the time delay relay 32; the circuit being completed through the lead 37. Thus the valve 3 starts to close and simultaneously the relay 32 starts its travel towards closed position. Normally, the valve 3 closes promptly and the member 17 opens the contact pair 18, removing voltage from the lead 23 and the coil 24, thereby allowing the contacts 28 to open and remove power from the relay 32 before its travel is sufficient to close the contacts 33 and accordingly no alarm is given and the time delay relay 32 instantaneously resets itself. If, however, the valve does not close within the time interval set by the relay 32, the contacts 33 are closed and the alarm 36 energized. This alarm preferably is a loud horn, but it may also be an electric signal light, or may be a horn in the immediate neighborhood of the control valves and a telltale signal light in the headquarters office.

If the cycle is such that a delay in the closing of the valve 3 will require a longer time for the next cycle, or will require a shutting down of the plant, the timer motor driving the shaft 14 and cam 12 is stopped by the relay 41 through the application of power to the relay coil 39 from the contacts 33, this power serving to actuate the relay 32, open the contacts 42 and deenergize the timer motor 15.

In the event that the cycle continues normally with the valves operating within the time limit set, the shaft 14 continues to rotate under the drive of the timer motor 15 until the high position of the cam is reached.

When this point in the cycle is reached, the contact 11' is separated from the contact 9 and brought against the contact 8, thereby applying power to the opening motor 5, through the lead 5a and simultaneously applying power to the contact pair 19; and through the pair 19, the lead 23 and coil 24 of the relay 25 to actuate the relay, close its contacts 28 and apply power through the lead 29 to the coil 31 of the relay 32. If the opening operation is completed promptly, the contacts 19 are opened by the member 17 before the contacts 33 of relay 32 are closed and no alarm is given and the time delay relay 32 instantaneously resets itself. Alternatively, if the valve does not open promptly, the alarm is given as before described.

When the next stage in the cycle is reached, and reversal of the position of the valves is required, the continued rotation of the cams 12, 12' and 12'' completes circuits through the alternative leads which are analogously numbered to reverse the position of the valves in the manner which will be evident from the showing of circuits in the drawing.

Thus the device of the invention controls one or more valves in a cyclic opening and closing operation and checks and verifies operation of one or more valves within a predetermined time limit; and if the valves are not actuated within the time limit, actuates a signal to notify an attendant of the failure, and simultaneously halts the cycle of operations. At the same time there is a continuous check on all valves and if any valve changes position other than when changed by the cam 12, the alarm is also operated.

While there is above disclosed but a single embodiment of the invention, it is possible to produce still other embodiments without departing from the inventive concept herein disclosed, and it is, therefore, desired that only such limitations be imposed upon the appended claims as are stated therein.

The invention claimed is:

1. In combination, a valve having a valve stem, electrically operated means for moving the valve stem between two opposed limiting positions; one for closing the valve, and the other for opening the valve, normally closed switches at the said limit positions, means controlled by the valve stem for opening the respective limiting switches when the valve stem moves to the corresponding limiting position, cyclically operating switching means for closing either one of two circuits to said electrically operated means, one of said circuits causing the electrically operated means to move the valve stem to valve closing position and the other causing the said means to move the stem to valve opening position, circuit connections between the respective circuits and the respective limit switches whereby when a corresponding circuit is closed by the switching means a corresponding circuit is completed through the limit switches, signaling means and a time delay relay controlled by each of said circuits including the limit switches for operating the signaling means if the corresponding limit switch is not opened within a predetermined time after the cyclically operated switching means closes the corresponding circuit.

2. The system according to claim 1, and in combination therewith means for stopping the cyclic operation of the switching means when the time delay relay operates.

3. In a petroleum hydrocarbon cracking system, a cracking tower, a regenerating tower, and a plurality of connections therebetween, each of said connections having a valve therein for the control of the flow of crackable petroleum and cracking catalysts, each of said valves comprising in combination, a valve having a valve stem, electrically operated means for moving the valve stem between two opposed limiting positions; one for closing the valve, and the other for opening the valve, normally closed switches at the said limit positions, means controlled by the valve stem for opening the respective limiting switches when the valve stem moves to the corresponding limiting position, cyclically operating switching means for closing either one or two circuits to said electrically operated means, one of said circuits causing the electrically operated means to move the valve stem to valve closing position and the other causing the said means to move the stem to valve opening position, circuit connections between the respective circuits and the respective limit switches whereby when a corresponding circuit is closed by the switching means a corresponding circuit is completed through the limit switches, signaling means and a time delay relay controlled by each of said circuits including the limit switches for operating the signaling means if the corresponding limit switch is not opened within a predetermined time after the cyclically operated switching means closes the corresponding circuit.

4. A petroleum cracking system comprising in combination, a cracking tower, a catalyst regenerating tower, a plurality of connections therebetween for the transfer therebetween of petroleum material and cracking catalyst, each of said connections including a valve having electrically operated means and control circuits therefor for moving the valve between full open and full closed position, normally closed limit switches so coupled to said valve as to be opened thereby at the respective limit positions, cyclically operating switching means in said control circuits timed according to the cracking and regenerating cycle for electrically actuating said valves between open and closed position; circuit connections between the control circuits and the limit switches, a time delay relay connected to said limit switches and said control circuits, a signaling means actuated by said time delay relay upon failure of operation of valve and limit switch within a predetermined time after the cyclically operating means closes the valve actuating circuit.

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