Nov. 4, 1947. E. J. GRACE, JR 2,430,122

VALVE LEAKAGE INDICATOR

Filed Oct. 15, 1943 2 Sheets-Sheet 1

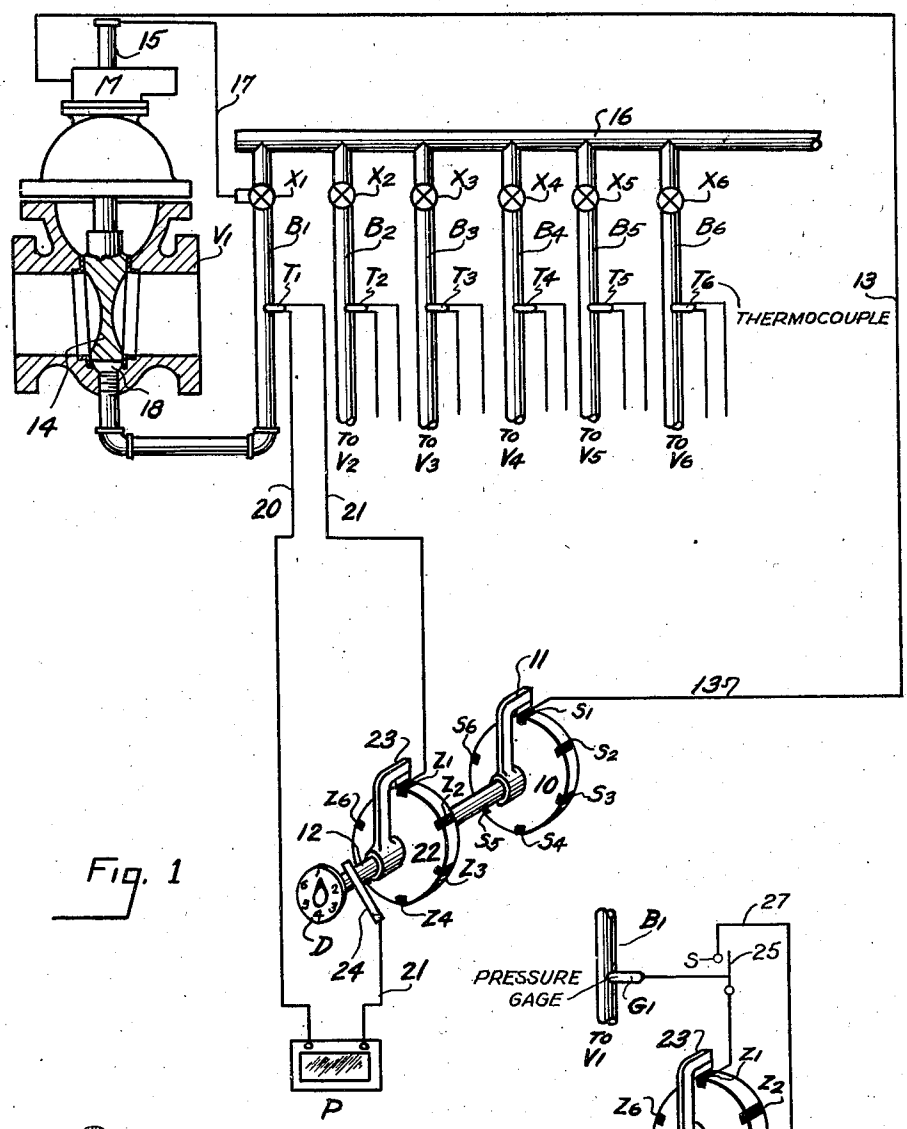


Fig. 1

Fig. 2

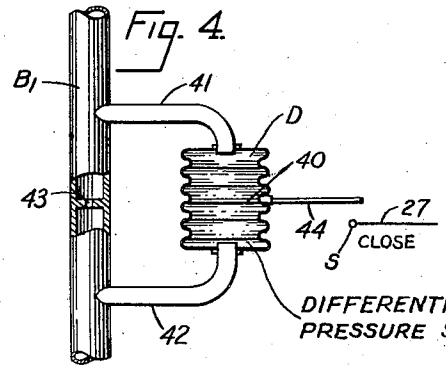


Fig. 4.

INVENTOR
EDWARD J. GRACE JR.
BY Dasser and Hardy
ATTORNEYS

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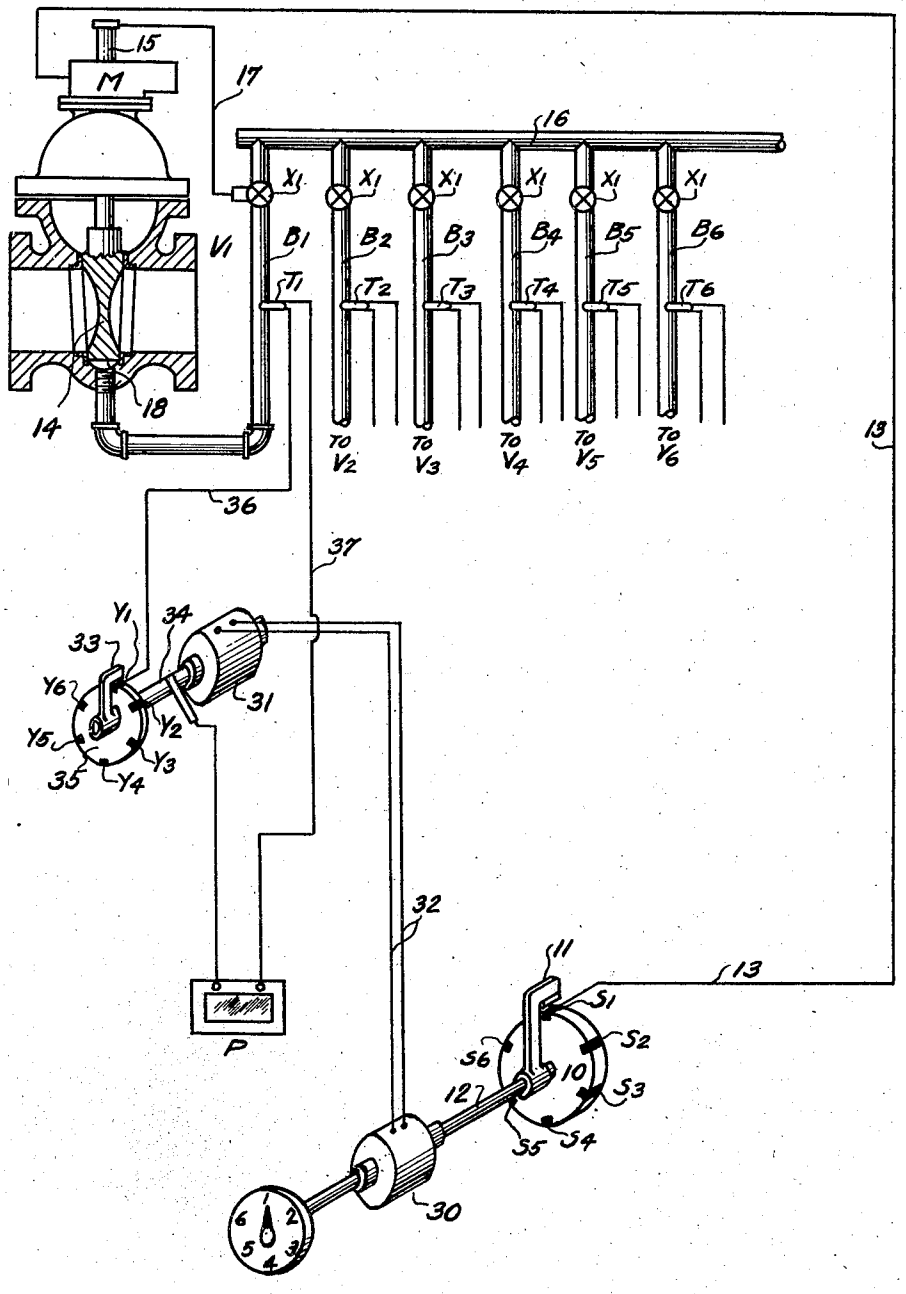


Fig. 3

INVENTOR
EDWARD J. GRACE JR.
BY
Bacon and Harding
ATTORNEYS

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VALVE LEAKAGE INDICATOR

Edward J. Grace, Jr., Chester, Pa., assignor to Sun Oil Company, Philadelphia, Pa., a corporation of New Jersey

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The present invention relates to an indicating system and is concerned particularly with apparatus for checking the operation of valves which control flow of fluids utilized in various processes.

The invention finds utility in processes which require valves to be opened or closed in timed sequence and wherein it is essential that the condition of operation of certain valves be known before one or more other valves are set into operation. It is especially adapted to such processes as the catalytic production of low boiling hydrocarbons from higher boiling hydrocarbons or gases, of high octane gasoline by cracking or treating, of toluene by cyclicizing or cracking and of butadiene by dehydrogenation.

In the catalytic treatment of hydrocarbons to obtain the desired product, the catalyst becomes contaminated by carbon deposit during the on-stream operation and loses its activity which must be restored after a period on-stream by removal of the deposit during a regeneration period. It is usually necessary or desirable to purge the catalyst after the on-stream operation as well as after the regeneration operation in order to remove from the material any fluid remaining from one or the other of the preceding operations. When the catalyst is used in in-situ operation in a converter it will be appreciated that several valves are required to regulate the supply of the various on-stream, regeneration and purge fluids to the converter and other valves required for the removal of these fluids or products from the converter. In the commercial adaptation of this particular type of catalytic operation it has been found most practical to utilize a plurality of converters in a single plant so that at least one converter is on stream at all times in order to give a continuous supply of the desired product. It follows then that a commercial plant of this type requires a great number of valves and depending upon the length of the on-stream and regeneration periods of operation, which for most processes are relatively short, it is necessary to open and close each valve many times during a twenty-four hour period of plant operation.

The various fluids used in a process must be supplied to the converter and removed therefrom in proper sequence and in order to control the great number of valve operations in a commercial plant it is the practice to regulate the operations of the valves from a central control house which is usually somewhat removed from the plant itself. To this end a time cycle con-

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trol apparatus of the type disclosed in Patent No. 2,250,453, issued to Henry J. Appel, July 29, 1941, or that disclosed in Patent No. 2,250,507, issued to Henry Thomas et al., July 29, 1941, both of which are capable of effecting the desired sequence of valve operations for any given process, are used in commercial plants. Cycle timer apparatus of either of the above types is also provided with an arrangement for testing the actual movement of the valve in order to make certain that the valve has responded to the actuation of the cycle timer. If upon testing the operation of any valve it is found that the valve has not properly responded, then the operation of the plant is temporarily shut down until the defective valve is put in proper working condition. After a valve has been actuated, the test of this valve may show that it has physically moved to closed position from the open position, but it occasionally happens that a valve does not seat properly upon closing and hence permits the intermingling of fluids by leakage through the valve. In order to overcome this it is the practice to admit an extraneous fluid, such as steam, to the valve seat or across the path of possible valve leakage in order to block the passage of the process fluid volumes on either side of the valve and thus prevent any improper mixing of the process fluids which might, with certain chemical processes, provide dangerous mixtures in the supply lines or in the converter itself. Arrangements for accomplishing this are disclosed in the aforementioned Thomas et al. patent and also in Patent No. 2,200,310, issued to C. H. Thayer et al. on May 14, 1940, but according to the teachings of these patents it is necessary that an operator inspect each valve to determine whether the valve has properly seated. After this, it is then necessary for the operator out in the plant to get in touch with the control room in order to give notice that a valve is not operating in a proper manner.

It is an object of the present invention to indicate the condition of operation of a plurality of valves at the place of control of the actuation of the valves. Another object is to indicate in timed relation and at a remote point the condition of operation of a plurality of sequentially actuated valves. Another object is to control the operation and indicate the condition of operation of a plurality of valves at a remote point. Other objects of the invention will be apparent as the description progreses, for which purpose reference may be had to the accompanying drawings, in which

Fig. 1 is generally a diagrammatic view of one embodiment of the invention with portions of the apparatus shown in section or in detail for the purpose of clarity;

Fig. 2 is a modified arrangement of a portion of the apparatus shown in Fig. 1;

Fig. 3 is a view generally similar to Fig. 1 but showing a modification thereof.

Referring to Fig. 1 the time control apparatus is by preference electrical and comprises a stationary timing disc 10 located in the control room and provided about its periphery with a plurality of segments S which are contacted in sequence and at predetermined time intervals by an energizing arm 11 secured to and rotatable with a drive shaft 12. Each of the valves to be actuated, during the process cycle, to open or closed position by the timer will be in circuit with a selected segment of disc 10 and for the purpose of clarity only the actuation of one valve will be described since the others will operate in a similar manner. As the arm 11 contacts segment S_1, power from a source (not indicated) will energize this segment and send current through line 13 to motor M of valve V_1 which, like the other valves to be actuated, is located in the plant. The valves for the purpose of this description will be of the gate type and the motor M will be arranged to raise the gate 14 of each valve to allow reactant fluid to flow therethrough or to lower the gate 14 to the valve seat and prevent flow of reactants therethrough. Consider the motor M of valve V_1 to be set to move the gate 14 from the raised or open position, then when current energizes the motor through segment S_1 the gate 14 will be moved downwardly by shaft 15 through suitable gearing within the motor. After a predetermined period of time has elapsed the gate should reach its lowermost position, as indicated, and in order to check the valve closing or to block the flow of the fluid volumes on either side of the gate 14 an extraneous fluid is supplied to the valve seat. The extraneous fluid, for example, a saturated vapor such as steam, is supplied at a known temperature, pressure and rate of flow to a fluid blocking system comprising a main 16 and valved branch steam blocking lines B each of which is in direct communication with the seat of a valve. When the gate 14 of valve V_1 is lowered shaft 15 is arranged through mechanical or other connections 17 to open a valve X_1 in blocking line B_1 when the gate reaches its lowermost position and admit fluid from main 16 to the blocking chamber 18 of the valve. Segments S_2, S_3, S_4, S_5 and S_6 will be in circuit respectively with the motors of valves V_2, V_3, V_4, V_5 and V_6 (not shown) and the fluid from the main line 16 will be admitted by blocking lines B_2, B_3, B_4, B_5 and B_6 to the seats, respectively of vavles V_2, V_3, V_4, V_5, and V_6, after each valve has been actuated to closing in a manner similar to that explained in the description of valve V_1.

The fluid from the blocking system which is admitted to the seats of the valves will be supplied to the line 16 at a desired temperature, pressure and rate of flow which is suitable to block or prevent the intermingling of any fluid volumes on either side of the valve gate 14 under normal conditions of operation and when the temperature, pressure or rate of flow of the fluid in the steam blocking system rises or falls above or below that considered proper for normal operation this condition can, according to the present invention, be used to indicate the improper

operation of the valves in the plant at a remote point, for example, in the control house.

In Fig. 1 the apparatus is arranged to indicate the condition of operation of the valves in accordance with the temperature existing in the blocking lines. Assume the temperature of the steam in the blocking lines B_1, B_2, B_3, B_4, B_5 and B_6 to be at about 300° F. when the valves are operating normally and a normal supply of fluid is being admitted to the valve seats, then any increase in temperature of the fluid in any one of these lines will mean that more than a normal volume of fluid is being sent to a valve and hence that it has not seated properly. To utilize this temperature fluctuation for indicating remotely the condition of operation of each valve, thermocouples T_1, T_2, T_3, T_4, T_5, and T_6 are inserted, respectively, in these fluid blocking lines and each is placed in circuit with an indicating device in such a manner that the temperature of the fluid obtaining in each blocking line is indicated for each valve after it has been actuated to close. To this end each thermocouple as illustrated by thermocouple T_1 in blocking line B_1 is electrically connected by lines 20 and 21 with a potentiometer P located in the control house. A switch is interposed in one of these lines and comprises a disc 22 which may be similar to timing disc 10 and provided on its periphery with a plurality of segments Z which are energized in sequence by switch arm 23, secured on shaft 12, at a predetermined time interval after the actuating segments S have been energized. The segments Z_1, Z_2, Z_3, Z_4, Z_5, and Z_6 are placed in circuit, respectively, with thermocouples T_1, T_2, T_3, T_4, T_5, and T_6 and as the switch arm 23 sequentially engages these segments the temperature existing in each of the lines B is indicated on the potentiometer P through brush arm 24. A dial D is associated with the shaft 12 and located near the potentiometer P to indicate readily to the cycle timer operator which valve operation is registering.

In Fig. 2 a portion of the apparatus of Fig. 1 is shown slightly modified to adapt it to function in carrying out the invention when the extraneous blocking medium is in the gaseous state. Consider the fluid in line B_1, for example, to be CO_2, then to indicate the condition of the gas after valve V_1 has been actuated to close, a pressure gauge or Venturi flow meter or gauge diagrammatically shown at G_1 is inserted in line B_1 and the gauge indicating arm arranged to actuate a switch 25 counter-clockwise in accordance with the decrease in pressure of the gas in line B_1 to contact switch S. The switch 25 will be placed in circuit with a signal such as light 26 through the segments B_1, etc., and brush arm 24. Current will be supplied by line 27 and when the switch 25 closes due to an abnormal decrease in pressure of the gas the light 26 will indicate the improper operation of the valve.

Fig. 3 shows a modified arrangement of synchronizing the cycle timer control of the valves with the valve condition indicating means. The segments S of timer disc 10 are placed in circuit with the motors of the valves to be actuated as shown by line 13 connecting the segment S_1 with motor M of valve V_1. After the valve gate 14 is moved downwardly by shaft 15 the extraneous fluid from main 16 is admitted to blocking line B_1 as the connection 17 operates to open valve X_1 to supply the fluid to the valve blocking chamber 18. The segments S_2, S_3, S_4, S_5 and S_6 will be arranged to actuate the motors of valves V_2, V_3, V_4, V_5 and V_6 and after each valve gate has been

lowered to its seating position fluid from the blocking lines B_2, B_3, B_4, B_5 and B_6 will be admitted in sequence to the seats of the valves, all as explained in the description of Fig. 1.

In Fig. 4 an arrangement is shown which is designed to indicate the operation of the valves in accordance with the rate of flow of fluid through the blocking lines B_1, B_2, etc. The apparatus comprises a differential pressure switch purchasable on the market and which in effect is a bellows D having a diaphragm 40 positioned centrally thereacross dividing the bellows into upper and lower chambers. The upper and lower chambers are connected respectively to the conduit B_1 through tubes 41 and 42 and an orifice plate 43 is positioned in the conduit B_1 and the connections of the tubes 41 and 42 are made with the conduit B_1 on either side of the orifice plate. A pointer arm 44 is mechanically connected with the diaphragm 40 and is actuated through movement of the diaphragm. The arrangement shown in Fig. 4 can be substituted for the members G_1 and 25 of Fig. 2 heretofore described. Normally the pointer arm 44 is maintained out of contact with switch S which is in circuit with power supply line 27. Upon abnormal or increased rate of flow through conduit B_1 the pressure exerted on the diaphragm 40 will be such as to move the pointer arm 44 into contact with the switch S and complete the circuit to the indicator light 26 of Fig. 2.

In order to indicate remotely the condition of operation of the valves in accordance with variations from the normal of the temperature, pressure or rate of flow of the extraneous fluid in the blocking lines a motor 30 which is one of a pair of self synchronizing devices is located in the control room and has its armature rotated by shaft 12 as the energizer arm 11 is rotated in contact with segments S of the timing disc 10. The second device of the pair is a motor 31 located in the plant and has its armature displaced in synchronism with shaft 12 by motor 30 through electrical connections 32. The motor 31 rotates switch arm 33 through shaft 34 sequentially over segments Y of disc 35 which are arranged to be energized a predetermined period after the segments S of the cycle timer have been energized. Each fluid responsive means will be in circuit with a segment of switch 35, as indicated by line 36 connecting thermocouple T_1 with segment Y_1 and each thermocouple will be in circuit with the potentiometer P as indicated by line 37. As in the description of Fig. 1 a dial D is associated with shaft 12 near the potentiometer P to indicate readily to the operator which valve operation is being registered on the potentiometer.

While the invention has been disclosed with specific details of construction, it is to be understood that they are not intended to limit the invention but are to be considered exemplary thereof.

What I claim and desire to protect by Letters Patent is:

1. An indicating apparatus for a plurality of valves which comprises a timing device for actuating the valves to closed position in timed sequence, a blocking fluid system including a fluid manifold and a plurality of conduits, the several conduits being in communication with the manifold and with the several valves respectively, means operable by the movement of each valve to closed position to supply blocking fluid from the manifold to the conduit communicating with such valve for passage of the fluid to the path of possible leakage of such valve, and independent fluid responsive means for each of said conduits, indicating means operable by said fluid responsive means, connections between said indicating means and each of said fluid responsive means, said timing device controlling the admission of fluid to the conduits to operate the fluid responsive means in sequence, and means between the fluid responsive means and the indicating means to make connections therebetween in order to indicate sequentially and at a remote point the condition of the closing operations of the valves.

2. An indicating apparatus for a plurality of valves which comprises a timing device for actuating the valves to closed position in timed sequence, a blocking fluid system including a fluid manifold and a plurality of conduits, the several conduits being in communication with the manifold and with the several valves respectively, means operable by the movement of each valve to closed position to supply blocking fluid from the manifold to the conduit communicating with such valve for passage of the fluid to the path of possible leakage of such valve, and independent fluid responsive means for each of said conduits, indicating means operable by said fluid responsive means, connections between said indicating means and each of said fluid responsive means, said timing device controlling the admission of fluid to the conduits to operate the fluid responsive means in sequence, and means between the fluid responsive means and the indicating means to make connections therebetween in order to indicate sequentially and at a remote point and at a predetermined time interval the condition of the closing operations of the valves.

3. An indicating apparatus for a plurality of valves which comprises a timing device for actuating the valves to closed position in timed sequence, a blocking fluid system including a fluid manifold and a plurality of conduits, the several conduits being in communication with the manifold and with the several valves respectively, means operable by the movement of each valve to closed position to supply blocking fluid from the manifold to the conduit communicating with such valve for passage of the fluid to the path of possible leakage of such valve, and independent means responsive to rates of fluid flow in each of said conduits, indicating means operable by said rate of flow means, connections between said indicating means and each of said rate of flow means, said timing device controlling the admission of fluid to the conduits to operate said rate of flow means in sequence, and means between the rate of flow means and the indicating means to make connections therebetween in order to indicate sequentially and at a remote point the conditions of the closing operations of the valves.

4. An indicating apparatus for a plurality of valves which comprises a timing device for actuating the valves to closed position in timed sequence, a blocking fluid system including a fluid manifold and a plurality of conduits, the several conduits being in communication with the manifold and with the several valves respectively, means operable by the movement of each valve to closed position to supply blocking fluid from the manifold to the conduit communicating with such valve for passage of the fluid to the path of possible leakage of such valve, and independent pressure responsive means in each of said conduits, indicating means operable by said pressure responsive means, connections between said indicating means and each of said pressure responsive

means, said timing device controlling the admission of fluid to the conduits to operate the pressure responsive means in sequence, and means between the pressure responsive means and the indicating means to make connections therebetween in order to indicate sequentially and at a remote point the conditions of the operations of the valves.

5. An indicating apparatus for a plurality of valves which comprises a timing device for actuating the valves to closed position in timed sequence, a blocking fluid system including a fluid manifold and a plurality of conduits, the several conduits being in communication with the manifold and with the several valves respectively, means operable by the movement of each valve to closed position to supply blocking fluid from the manifold to the conduit communicating with such valve for passage of the fluid to the path of possible leakage of such valve, and independent temperature responsive means in each of said conduits, indicating means operable by said temperature responsive means, connections between said indicating means and each of said temperature responsive means, said timing device controlling the admission of fluid to the conduits to operate

the temperature responsive means in sequence, and means between the temperature responsive means and the indicating means to make connections therebetween in order to indicate sequentially and at a remote point the conditions of the operations of the valves.

EDWARD J. GRACE, JR.

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