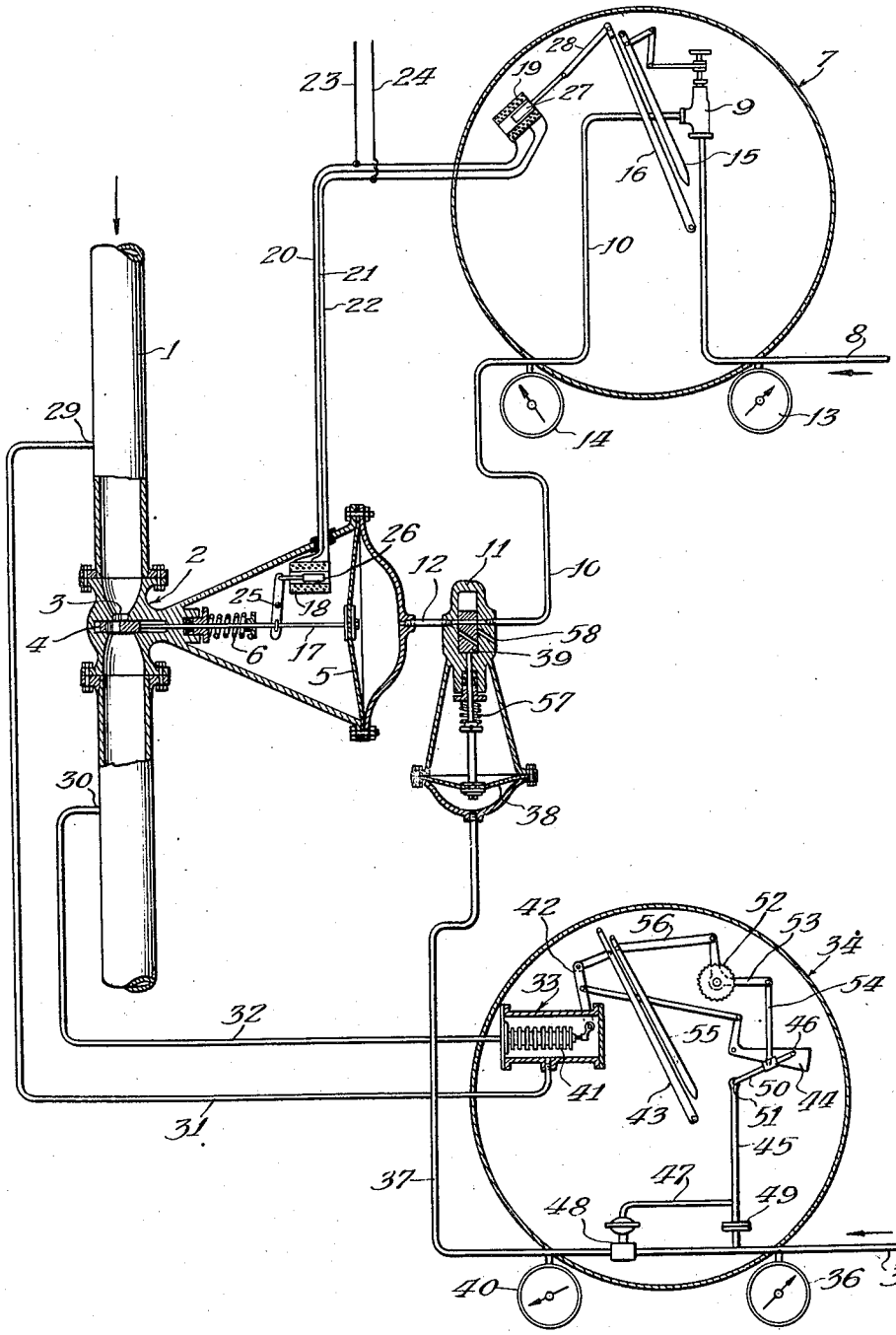
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FLOW CONTROL

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FLOW CONTROL

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This invention relates to an improved flow control method and apparatus and more particularly to a system which is especially adapted to control the flow of streams of fluid having entrained therein finely divided solid particles.

My invention may be readily adapted for use in many processes wherein it is desired to control the flow of streams of fluid carrying solid particles such as in fluidized catalyst processes for the conversion of hydrocarbon oils. For instance in the fluidized catalyst process for cracking hydrocarbon oils, it is desirable to control the quantity of catalyst being withdrawn from both the reactor and the regenerator. This is generally accomplished by means of adjustable orifices which are controlled by the differential pressure between the up-stream and down-stream sides of the fluid carrying conduit. Considerable difficulty has been encountered in the operation of these orifices due to their becoming plugged by large masses of catalyst. With the conventional arrangement, when the orifices become plugged, it is necessary to manually or by mechanical means remove the obstruction so that the process may continue.

My invention provides a means for automatically controlling the orifice size and for clearing it at the same time of any catalyst which might accumulate and close the opening. My invention also provides means for recording the orifice size as well as the differential pressure thereacross.

By employing my invention the orifice can be maintained in the desired position, but if at any time it becomes plugged, means are provided for immediately opening the orifice to its maximum size to allow any plugging material to pass through.

In order to make the features and advantages of my invention more clearly understood, reference is made to the accompanying diagrammatic drawing and the following description thereof:

The drawing illustrates one arrangement of apparatus with parts in section which may be employed for carrying out my invention.

The stream of fluid containing entrained solid particles which it is desired to control, flows through conduit 1 in which is located adjustable orifice valve 2. In the case here illustrated, this valve is provided with flanged connections for securing it to the conduit, but other suitable means may be employed. Valve 2 is provided with a square orifice 3 and a slide 4. Slide 4 is provided with a square cut hole and by adjusting its position with respect to orifice 3, the desired orifice size may be obtained. It is, of course, well within the scope of the invention to employ other types of valves with adjustable port sizes for controlling the flow of fluid through conduit 1. The slide 4 is actuated by air operated diaphragm 5 and spring 6, the spring 6 being arranged to open the orifice and the diaphragm being arranged to close it. The position of the orifice is controlled by means of air pressure applied to the diaphragm. This air pressure is controlled by means of a throttling control instrument 7, which also contains means for recording the position of the slide at all times.

Filtered air at a constant pressure is supplied through conduit 8 to throttle valve 9 within control instrument 7. The outlet of valve 9 is connected by means of conduit 10 to valve 11, the function of which will later be described. The outlet of valve 11 is connected by means of conduit 12 to the pressure chamber adjacent diaphragm 5. By adjusting valve 9, any desired pressure may be maintained on diaphragm 5 which, in turn, will determine the position of slide 4.

The air inlet pressure to controller 7 is indicated by pressure gauge 13 and the controlled pressure to diaphragm 5 is indicated by pressure gauge 14. The desired location of slide 4 is indicated by the pointer 15 in controller 7. This pointer in the case illustrated is connected by suitable linkage means to the throttling valve 9 and any adjustment of valve 9 will be indicated by pointer 15.

The actual position of slide 4 is indicated and recorded in controller 7 on a chart, not shown, by the pen carrying arm 16. This arm is connected by an inductance bridge and suitable linkage means to stem 17 of valve 2. The inductance bridge consists of inductance coils 18 and 19 disposed respectively in the housing of valve 2 and control instrument 7 connected together by means of electrical conductors 20, 21 and 22. Conductor 21 connects the middle turns of the two inductance coils together and conductors 20 and 22 connect the outer ends of the two coils. The circuit is connected to a suitable source of alternating current by means of electrical conductors 23 and 24 which are connected respectively to conductors 20 and 22.

Within coil 18 is disposed a movable plunger 26 consisting of suitable magnetic material, the position of which is controlled by the pivoted lever 25, one end of which engages a pin secured to rod 17 and the other end of which is pivotally connected to the extension of plunger 26. Another magnetic plunger 27 is disposed within coil 19 and

connected to pen arm 16 by pitman 28. When plunger 26 is moved within coil 18, plunger 27 will assume a corresponding position within coil 19 and the pen on arm 16 will record the position of slide 4.

Up-stream and down-stream respectively of valve 2, conduit 1 is provided with pressure connections 29 and 30 which are connected by means of conduits 31 and 32 respectively to an aneroid type differential pressure element 33 which is disposed within control instrument 34. Air for instrument 34 is supplied through conduit 35 and its pressure is indicated by means of gauge 36. Controlled pressure from instrument 34 is transmitted through conduit 37 to diaphragm 38 which actuates plug 39 in valve 11. This controlled pressure is indicated by means of gauge 40. The corrugated bellows 41 within manometer 33 is connected by means of pivoted lever 42 and connecting linkage to pen arm 43 and vane 44. The pen, therefore, will record the differential pressure across valve 2 and vane 44 will attain a position corresponding to said differential pressure. Conduit 35 within instrument 34 is connected to conduit 45 which supplies air to movable orifice 46 and also supplies air through conduit 47 to the diaphragm on air controlling valve 48. An orifice or other suitable pressure reducing means 49 is located in line 45 to restrict the flow of air therethrough. Orifice 46 is carried by conduit 50 which in turn is secured by pivoted connection 51 to conduit 45. The position of orifice 46 is determined by the position of knob 52 which is connected by means of bell crank 53 and pitman 54 to movable conduit 50. The position of arifice 46 is also indicated by pointer 55 which is likewise connected to bell crank 53 by pitman 56.

Valve 11 is provided with a sliding plug 39 and operates in either one or the other of two extreme positions. With no air pressure on the diaphragm, the spring 57 will maintain the plug in the position connecting conduit 12 with conduit 10 from instrument 7. When pressure is applied to diaphragm 38, plug 39 will assume a position such that conduit 12 will be connected to vent 58 thus relieving the air pressure on diaphragm 5.

In operation, my apparatus functions as follows: by adjusting valve 9, slide 4 is maintained in any desired position which is indicated and recorded on a chart, not shown, by the pen on arm 16.

Control instrument 34 is set at some predetermined pressure differential which corresponds to the normal operation of the system for the particular size orifice which has been set by instrument 7. If at some time, the orifice should become plugged due to an accumulation of solid particles, the differential pressure thereacross will be increased. This increase in differential pressure over and above normal will cause the displacement of vane 44 uncovering orifice 46, thereby allowing a discharge of air from conduits 45 and 47 at a rate higher than is supplied through restriction orifice 49. This decrease in pressure will relieve the diaphragm of valve 48 opening said valve and allowing air pressure to be transmitted to diaphragm 38 through conduit 37. The pressure applied to diaphragm 38 will cause plug 39 to assume the position which cuts off air pressure to diaphragm 5 and vents any pressure on the diaphragm to the atmosphere. When the pressure is removed from diaphragm 5, spring 6 will immediately move slide 4 to a position providing the maximum orifice size thus allowing the accumulated material to pass therethrough. When valve 2 becomes unplugged, the pressure differential thereacross will decrease and the whole system will return to normal, that is, plug 39 in valve 11 will assume a position connecting instrument 7 to diaphragm 5 and will continue to thus operate until the orifice again may become plugged.

It is well within the scope of my invention to employ electrically connected and operated instruments and control valves in place of the air or fluid pressure operated ones shown in the accompanying illustrative drawing. The invention is also not to be limited to the specific instruments shown because many other control instruments and valves may be just as readily adapted to my system of flow control.

I claim as my invention:

1. A device for regulating the flow of a stream of fluid containing finely divided solid particles, which comprises in combination a port of adjustable size disposed in the conduit through which said stream is passed, control means for maintaining said port at a predetermined constricted size, and means responsive to an increase in pressure differential across said port in excess of a predetermined amount for deactuating said control means permitting said port to become enlarged and remain sufficiently enlarged to allow accumulations of said particles to pass therethrough.

2. A device for regulating the flow through a conduit of a stream of fluid containing finely divided particles, which comprises in combination a port having adjacent thereto a slidable member for varying the effective size of said port, said port being positioned in said conduit through which said stream is passed, a control instrument, an actuating mechanism for moving said slidable member disposed in a port opening direction, said actuating mechanism being motivated in response to impulses transmitted from said control instrument to decrease the size of said port to a predetermined constricted size, and means responsive to an increase in pressure differential across said port in excess of a predetermined amount for relieving said actuating mechanism of said impulses permitting said port to become enlarged and remain enlarged to allow accumulations of said particles to pass therethrough.

3. A device for regulating the flow of a stream of fluid containing finely divided solid particles, which comprises in combination a port of adjustable size disposed in a fully open position in the conduit through which said stream is passed, a control instrument, means for decreasing the effective size of said port to a predetermined constricted size in response to impulses transmitted from said control instrument and means responsive to an increase in pressure differential across said port in excess of a predetermined amount for relieving the first-named means of said impulses to permit said port to become and remain fully opened.

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