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CONTROL APPARATUS

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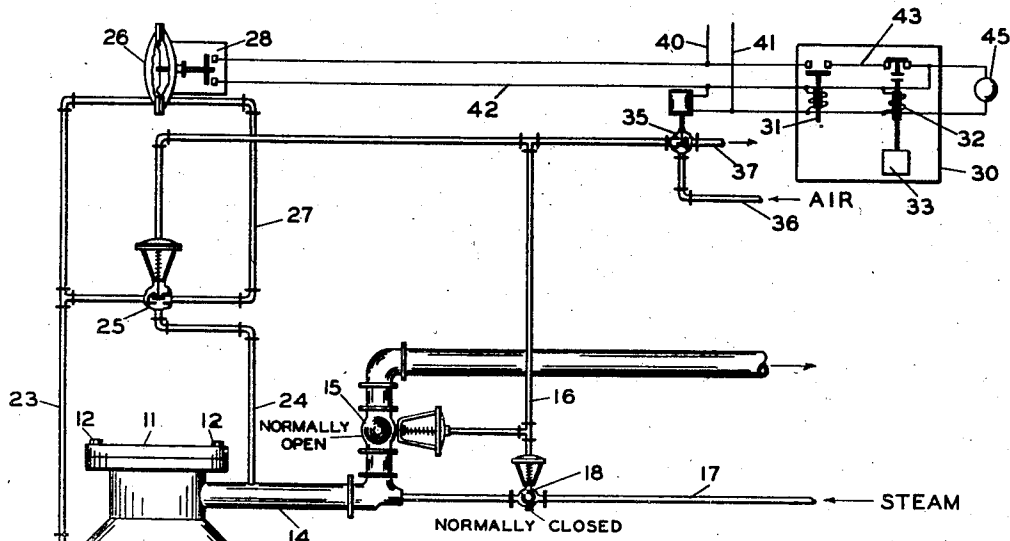


FIG. 1

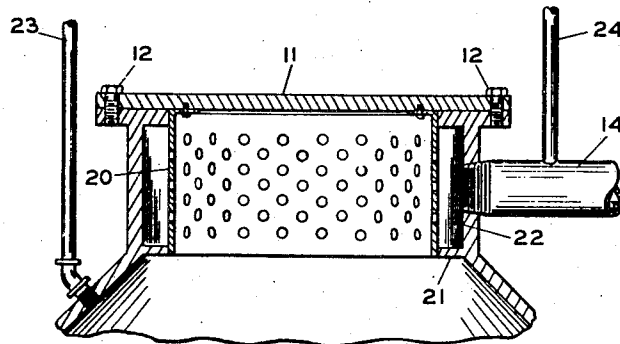


FIG. 2

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CONTROL APPARATUS

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6 Claims. (Cl. 210-152)

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This invention relates to automatic control in the operation of processing apparatus wherein it is desirable to prevent solid or semi-solid material from entering a conduit or a pipe line or a reaction vessel whose content is normally restricted to fluid media. The invention has been developed in conjunction with the control of the operation of a pulp-digester, in the manufacture of paper, and will hence be here illustrated and described as applied thereto; although it will be apparent that its utility is not restricted to any particular apparatus.

In the manufacture of wood pulp it is customary to charge a closed vessel known as a digester with a quantity of wood chips and suitable chemicals and then to set up a reaction by the admission of steam or other heating agent. In the course of this process, certain gases are given off; and it is usual to vent these from the top of the digester in a manner to maintain predetermined pressure values within the digester. Due to the chemical characteristics of the solution or liquor within the digester there is a tendency toward foaming, with the result that under certain conditions some of the solution may be drawn off with the gas, carrying with it masses of solid or semi-solid material, thus not only depleting the content of the digester but introducing conditions which may be responsible for clogging or otherwise interfering with the proper functioning of auxiliary apparatus.

Automatic control of the venting of gases is not new; and it is customary to equip digesters with instrumentalities which will regulate a valve in the vent pipe in accordance with predetermined pressure settings. Such devices, however, take no cognizance of the condition of the fluid being vented, and will as readily vent the digesting liquor as the gaseous products of the reaction. An effective means of discriminating between liquid and gaseous phases in the effluent is fully described and set forth in my co-pending application for U. S. Letters Patent, Serial No. 443,895, filed May 21, 1942, now Patent Number 2,411,986, dated December 3, 1946. Because there is likely to exist in pulp digesters a certain degree of turbulence, causing masses of partially digested wood pulp to be thrown up into the effluent line, it is customary to provide a strainer or screen, by which the passage of this material into the pip-

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ing system is prevented, and none but fluid materials allowed to pass. Under certain conditions of operation, there may accumulate upon the screen such a quantity of pulp or chips or mixtures of the same, as to obstruct the flow there-through of the normal effluent, thus seriously interfering with the proper operation of the digester.

It is an object of this present invention to provide means whereby a strainer in the path of fluid flow in an apparatus may be cleansed of obstructing material without interfering with the operation of the apparatus.

It is a further object to provide means whereby the cleansing operation may be rendered wholly automatic, not normally requiring the superposition of manual control.

The invention also comprises means responsive to a pressure differential on opposite sides of the strainer for controlling the application of a purging fluid to the strainer.

A further object is to control the duration of the flow of purging liquid.

The invention also provides for interrupting the normal flow of fluid from the apparatus during the application of purging liquid to the screen.

A more specific object comprises superimposing upon such automatic regulating devices as may normally characterize a digester system, a control system whereby, upon the development of an abnormal pressure drop across the strainer or screen due to clogging thereof by solid or semi-solid matter accumulated thereon, there will be actuated instrumentalities to introduce a purging cycle, wherein the normal venting of effluent from the digester will be temporarily halted, and a jet of steam or other suitable purging fluid admitted in a manner to flush the strainer of obstructing matter, and, after the lapse of a predetermined interval of time, normal operation will be restored, unless obstruction of the strainer still exists, in which case the purging cycle will again be initiated.

Other features and advantages of the invention will be hereinafter described and claimed.

In the drawings:

Fig. 1 is a diagrammatic representation of a pulp digester, showing the invention applied to the purging of an internal screen.

Fig. 2 is a sectional view of the upper part of

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the digester shown in Fig. 1 and showing certain details of construction thereof.

Referring now to the drawings, the numeral 10 designates a pulp-digester into which mixture of wood chips and suitable chemicals may be charged through an opening in the top, which is afterwards sealed by a cover plate 11 secured in place by means of bolts 12. A conduit 13 provides for the admission of steam to the lower part of the digester. A conduit 14 connected near the top of the digester provides for the venting of products of the internal reaction to the atmosphere, or to a receptacle not shown in the drawings whereby certain valuable constituents of said products may be salvaged. The venting of said products is regulated by a diaphragm valve 15 inserted in the conduit 14 and subject to actuation by air admitted to its operating element through a conduit 16. Said valve 15 is shown as of the "direct-acting" type, its action being such that it normally stands open, and increase of pressure in the conduit 16 tends to move its internal parts to a closed position. A pipe 17 provides for the admission of steam or other suitable flushing agent to the conduit 14, whereby the same may be admitted to the upper part of the digester to impinge upon internal parts presently to be set forth. A diaphragm valve 18 of the reverse-acting type is inserted in the pipe 17, and has its operating element placed in communication with the conduit 16, whereby air pressure within said conduit will cause said valve to be opened.

The interior construction of the upper portion of the pulp digester 10 will be better understood by reference to Fig. 2. Secured to the inner surface of the cover plate 11 is a cylindrical strainer or screen 20 formed of perforated metal or the like, said screen projecting downwards into the upper part of the digester and being surrounded by an inwardly directed flange member 21 attached to the inner surface of the digester, whereby there is formed about the screen 20 an annular chamber 22 communicating directly with the vent pipe 14 and with the interior of the digester only through the perforations in the screen 20. The perforations in the screen 20 are so dimensioned and spaced as to prevent the passage of chips or other solid or semi-solid masses, while at the same time allowing egress of fluid effluent from the space within the digester to the annular chamber 22, and thence to the vent pipe 14. Under normal operating conditions the total area represented by the perforations in the screen 20 will be sufficient to allow free passage of effluent from the digester 10 to the vent pipe 14 with a negligible pressure differential across the screen; but upon said perforations becoming obstructed by chips or other solid or semi-solid matter, the consequent reduction in effective cross-section area of opening will cause a pressure differential to be developed; and it is this differential which it is proposed to utilize for the purpose of actuating control apparatus whereby to purge or flush the screen of undesirable obstruction.

Connected to the body of the digester 10, and in free communication with the interior thereof, is a conduit 23; and a similar conduit 24 is connected to the vent pipe 14, whereby to be subjected to the pressure existing within said pipe. Referring again to Fig. 1, a pneumatically operated three-way valve 25 and a pressure-differential-responsive electrical contactor 26 are provided, and are interconnected in the following manner: The conduit 23 is connected to one side of

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the contactor 26, and the other side of said contactor is connected by means of a conduit 27 to the three-way valve 25. The valve 25 is also connected to the conduits 23 and 24 in such a manner that when no pressure is present in the operating element of said valve the conduits 24 and 27 will be in mutual communication, and both cut off from the conduit 23. When air pressure is applied to the operating element of the valve 25, the position of its interior parts will be so changed that conduits 23 and 27 will be placed in mutual communication and both cut off from conduit 24. The operating element of the valve 25 is connected to the conduit 16, whereby, when pressure is applied to said conduit all three of the valves 15, 18 and 25 will be operated in unison. The contactor 26 is provided with contact elements 28 adapted to be interconnected when the pressure in the side of the contactor connected to the conduit 23 exceeds by a predetermined amount that in the side of the contactor connected to the conduit 27, and to be separated when the pressure in the conduit 23 is not in excess of that in the conduit 27 by said predetermined amount.

An electrical relay member 30 comprises two elements 31 and 32 having the following characteristics: the element 31 is provided with normally open contacts, adapted to be closed substantially instantaneously upon the application of a suitable electrical potential to its actuating coil. The element 32 is provided with normally closed contacts, and also with a timing element 33, whereby, upon energization of its actuating coil, there will be initiated a delay interval as established by said timing element, after which interval the normally closed contacts of said relay will be opened.

Devices incorporating the principle of the relay member 30 are well-known to those versed in the art of electrical control; and an example of a relay thus adapted to the purposes of the invention is found in Patent No. 2,175,864, granted to C. L. Anderson, October 10, 1939.

A three-way solenoid-actuated valve 35 is connected in the conduit 16 in such a manner that, when the actuating coil of said valve is energized, air pressure from a source 36 will be applied to the conduit 16, and when said coil is de-energized, the conduit 16 will be placed in communication with the atmosphere through a vent 37, and cut off from the supply 36.

The electrical elements of the control system are interconnected in the following manner: A suitable source of electrical energy is represented by two conductors 40 and 41. The conductor 40 is connected to one side of the contact element 28 in the contactor 26, and also to one side of the normally open contacts of the relay element 31. The conductor 41 is connected to one side of each of the actuating coils of the relay elements 31 and 32, and also to one side of the actuating coil of the solenoid operated valve 35. A conductor 42 provides interconnection between one side of the normally closed contacts of the relay element 32, the free terminals of the actuating coils of relay elements 31 and 32 and solenoid valve 35, and also of contact element 28. The free terminals of the contacts of relay elements 31 and 32 are interconnected by means of a conductor 43.

The functioning of the apparatus involving the principles of the invention is as follows: Assuming all connections to be made as hereinbefore described, and the digester to be operat-

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ing normally, without any material degree of obstruction in the screen 20, whereby to build up a pressure gradient across the same, there will be substantially no pressure differential in the contactor 26, and the contacts 28 of the same will stand in an open position. The contacts of the relay 31 being opened, there will be no complete circuit in the electrical network of the apparatus, and the relay 31 will remain de-energized, as well as the relay 32 and the solenoid valve 35. The conduit 16, and the actuating elements of the three pneumatically operated valves connected thereto, will thus be placed in communication with the atmosphere through the vent 37 and isolated from the air supply 36. Consequently, the valve 25 will stand with conduits 24 and 27 in mutual communication, and both cut off from the conduit 23. Valve 15 will stand in its open position, allowing free venting of the effluent from the digester, and valve 18 will stand in a closed position, preventing steam in the conduit 17 from entering the pipe 14. Since the pressures in conduits 23 and 27 are substantially of a common value said pressures applied to the contactor 26 will produce no differential action, and the contacts 28 will remain opened.

It may now be assumed that, in the course of operation of the digester, the screen 20, performing its normal function of excluding solid and semi-solid material from the vent pipe 14, has become clogged with chips and the like to an extent that the effective area of the openings through said screen is materially reduced, thereby causing the pressure in the annular chamber 22 to become materially less than that within the interior of the digester. The pressure gradient across the screen 20 will appear as a differential between the pressures in the conduits 23 and 24; and since the latter of said conduits is directly in communication through the valve 25 with conduit 27, said pressure differential will be applied to the contactor 26. When the excess of pressure in the conduit 23 over that in conduit 27 attains a value corresponding to the setting of the contactor 26, its contacts will be closed. There will thus be provided a path between conductors 40 and 42, whereby current may flow between conductors 40 and 41 through the windings of relays 31 and 32 and the actuating coil of valve 35 in parallel, thereby energizing all three of said windings. Energization of the winding of the valve 35 will cause conduit 16 to be cut off from connection with the vent 37 and placed in communication with the air supply 36, whereby pressure will be applied to the actuating elements of valve 25, 15, and 18. Operation of the valve 25 will cause conduits 23 and 27 to be placed in communication with each other and cut off from conduit 24. Thus, the two sides of contactor 26 will both be subjected to pressure existing in the conduit 23, whereby, there no longer being any differential between the two sides of the pressure-sensitive element of said contactor, the contacts 28 will be opened. Relay 31 being energized, however, there will be provided through its contacts and the normally closed contacts of relay 32 an alternative path, whereby the windings of said relays, as well as that of the valve 35, will remain energized after the opening of contacts 28. Air pressure applied to the operating element of the valve 15 will cause it to be closed, thus stopping the venting of effluent from the digester through the pipe 14, and allowing the pressures in the interior of the digester and in the annular space 22 surround-

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ing the screen 20 to become equalized. Pressure applied to the operating element of the valve 18 will cause said valve to be opened and a jet of steam from the conduit 17 admitted to the pipe 14, and thereby to the chamber 22, thus building up a pressure in the space 22 exterior to the screen 20, and introducing a purging cycle, in which any obstructing material which may have accumulated on the inner surface, or within the openings, of said screen is blown back into the digester.

The purge, during which steam is admitted to the digester from the conduit 17 will continue so long as the valve 35 remains energized; which will be until the electric circuit to the actuating winding of said valve is interrupted by opening of the normally closed contacts of relay 32. The duration of the purging cycle will thus represent the interval established by timing element 33 of the relay 32, which introduces a predetermined delay between the energization of said relay and the opening of its normally closed contacts. This time interval would normally be made adjustable by means incorporated in the relay mechanism, and not forming a part of the present invention. Such means are fully described and set forth in the aforesaid Anderson Patent No. 2,175,864. Upon opening of the contacts of the relay 32, the supply of current to the winding of the valve 35 will be interrupted, and the interior parts of said valve will revert to their normal condition in which conduit 16 is cut off from the supply 36 and vented to the atmosphere. Under this condition the valve 18 will move to a closed position, terminating the supply of steam from the conduit 17 to the interior of the digester; and the valve 15 will be opened, allowing normal venting of the effluent again to be established. Valve 25 will revert to its normal condition, whereby the differential pressure across the screen 20 within the digester is applied to the contactor 26.

If the purging cycle has been effective in clearing the screen 20 of obstructing material, the pressure gradient across said screen will have disappeared or fallen to a value below the setting of the contactor 26, so that its contacts 28 will remain open, with the result that normal operation of the digester will be continued. In the event that the purging action has not been continued for a sufficiently long time, or if for any other reason the screen has not been effectively cleared, a pressure gradient will again be built up across said screen, actuating the contactor 26, and causing the cycle as hereinbefore described to be repeated. If the cycle should continue to repeat indefinitely it will be apparent to the operator in charge that there has developed an undesirable condition requiring special attention and the possible superposition of manual control or other non-automatic influences until normal action is re-established.

If desired, there may be connected, in parallel with the relays 31, 32 and solenoid valve 35, an electric bell or light 45 for providing a signal at any desired point to apprise an attendant that the purging apparatus is in operation.

The apparatus embodying the principle of the present invention may be used in conjunction with, or independently of, the liquid-gas-phase control described and set forth in my co-pending application Serial No. 443,895, filed May 21, 1942, now Patent Number 2,411,986 above referred to; and the extent to which valves and other control instrumentalities may be made common to both elements of the installation will be obvious to

those skilled in the art of automatic control in the manufacture of wood pulp and in kindred processes.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

I claim:

1. Apparatus for removing obstructing material from a strainer mounted in a container for a flowing fluid, said apparatus comprising differential pressure responsive means having conduit means for connection to said container on opposite sides of said strainer to respond to the pressure differential thereacross, valve means for controlling the flow of a purging fluid through said strainer, timed relay means connected to said pressure responsive means for operation in response to the attainment of a predetermined pressure differential across said strainer, connections between said relay means and said valve means and controlled by said relay means for actuating said valve means to establish said flow of purging fluid for a predetermined interval, together with further valve means operable to connect opposite sides of said pressure responsive means to the pressure on only one side of said strainer, and connections controlled by said relay means for effecting actuation of said further valve means coincidentally with said first valve means to connect said opposite sides of said pressure responsive means to said pressure on only one side of said strainer during said interval.

2. Apparatus for removing obstructing material from a strainer mounted in a container for a flowing fluid, said apparatus comprising differential pressure responsive means having conduit means for connection to said container on opposite sides of said strainer to respond to the pressure differential thereacross, valve means for interrupting the flow of said fluid, other valve means for controlling the flow of a purging fluid through said strainer, relay means connected to said pressure responsive means for operation in response to the attainment of a predetermined pressure differential across said strainer, connections between said relay means and both said valve means and controlled by said relay means for actuating said valve means to interrupt the flow of the first mentioned fluid and establish flow of said purging fluid, a third valve means, and connections controlled by said relay means for effecting actuation of said third valve means coincidentally with the other valve means for applying to opposite sides of said pressure responsive means the pressure on only one side of said strainer.

3. Apparatus for removing obstructing material from a strainer mounted in a container for a flowing fluid, said apparatus comprising normally closed valve means for controlling the flow through said screen of a purging fluid different from the first mentioned fluid, control means for said valve means comprising a differential-fluid-pressure responsive element, conduit means for connecting opposite sides of said element to said container on opposite sides of said strainer for subjecting said element to corresponding fluid pressures, electrical switch means mechanically connected to said fluid-pressure responsive element for operation in response to the attainment of a predetermined pressure differential across

said strainer, means for operating said valve means, and electrical connections controlled by said switch means for controlling said operating means for opening said valve means to admit purging fluid to said screen pursuant to attainment of said pressure differential.

4. In combination with a processing vessel having a vent pipe for the escape of fluid therefrom and a strainer in said vessel adjacent said vent pipe to separate entrained matter from said fluid, a valve in said vent pipe normally opened and adapted to be closed to prevent the outflow of said fluid, means for supplying steam to said strainer for purging the latter of accumulated suspended matter, a valve normally closed and controlling the admission of said steam to said strainer, a fluid-pressure responsive element, conduit means for connecting opposite sides of said element to said vessel on opposite sides of said strainer for subjecting said element to corresponding fluid pressures, electrical switch means mechanically connected to said fluid pressure responsive element for operation in response to attainment of a predetermined pressure differential across said strainer, means for operating said valves in opposite senses, and electrical connections controlled by said switch means for controlling said valve operating means to close the first-mentioned valve and open the second mentioned valve in response to attainment of said pressure differential.

5. In combination with a processing vessel having a vent pipe for the escape of fluid therefrom and a strainer in said vessel adjacent said vent pipe to separate entrained matter from said fluid, a valve in said vent pipe normally opened and adapted to be closed to prevent the outflow of said fluid, a normally closed valve operable for admitting to said vent pipe a different fluid to pass through said strainer in a sense opposite to normal flow therethrough, whereby to clear the same of accumulated suspended matter, a fluid-pressure responsive element, conduit means for connecting opposite sides of said element to said vessel on opposite sides of said strainer for subjecting said element to corresponding fluid pressures, electrical switch means mechanically connected to said fluid-pressure responsive element for operation in response to attainment of a predetermined pressure differential across said strainer, a third valve connected to the pressure applying means for said pressure-responsive element and operable to establish communication between opposite sides of said element, and connections between said switch means and all of said valves for operating the latter in response to attainment of said pressure differential.

6. In combination with a processing vessel having a vent pipe for the escape of fluid therefrom and a strainer in said vessel adjacent said vent pipe to separate entrained matter from said fluid, a valve in said vent pipe normally opened and adapted to be closed to prevent the outflow of said fluid, means for supplying steam to said strainer for purging the latter of accumulated suspended matter, a valve normally closed and controlling the admission of said steam to said strainer, a fluid-pressure responsive element, conduit means for connecting opposite sides of said element to said vessel on opposite sides of said strainer for subjecting said element to corresponding fluid pressures, electrical switch means mechanically connected to said fluid-pressure responsive element for operation in response to attainment of a predetermined pressure differential

across said strainer, means for operating said valves substantially simultaneously in opposite senses, a source of electric power, and connections from said source controlled by said switch means for controlling said valve operating means to close the first-mentioned valve and open the second mentioned valve in response to attainment of said pressure differential.

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