Oct. 6, 1953 G. P. JACKSON 2,654,879

FLOW STOPPAGE DETECTOR FOR FUEL SUPPLY LINES

Filed April 17, 1950 2 Sheets-Sheet 1

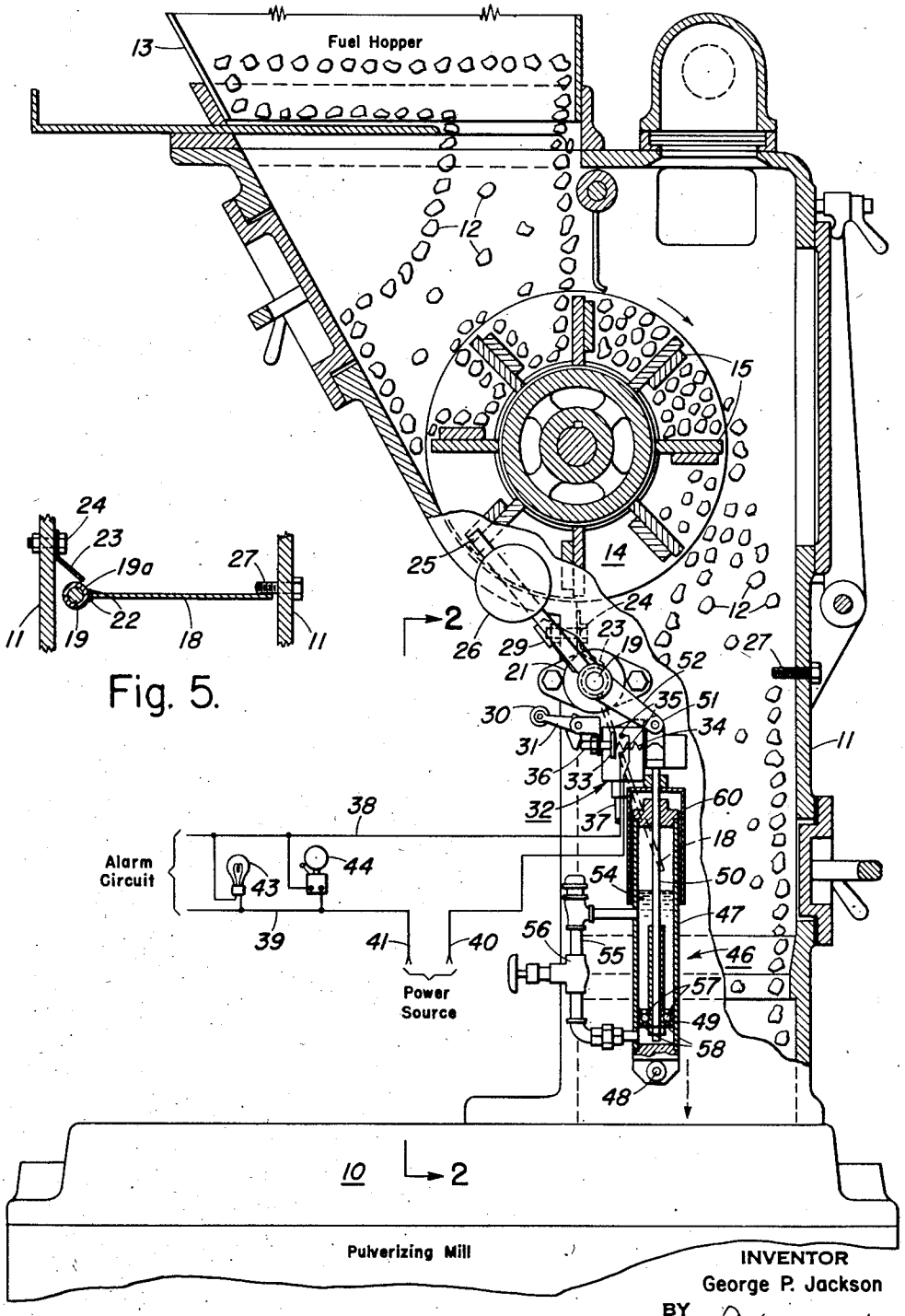


Fig. 5.

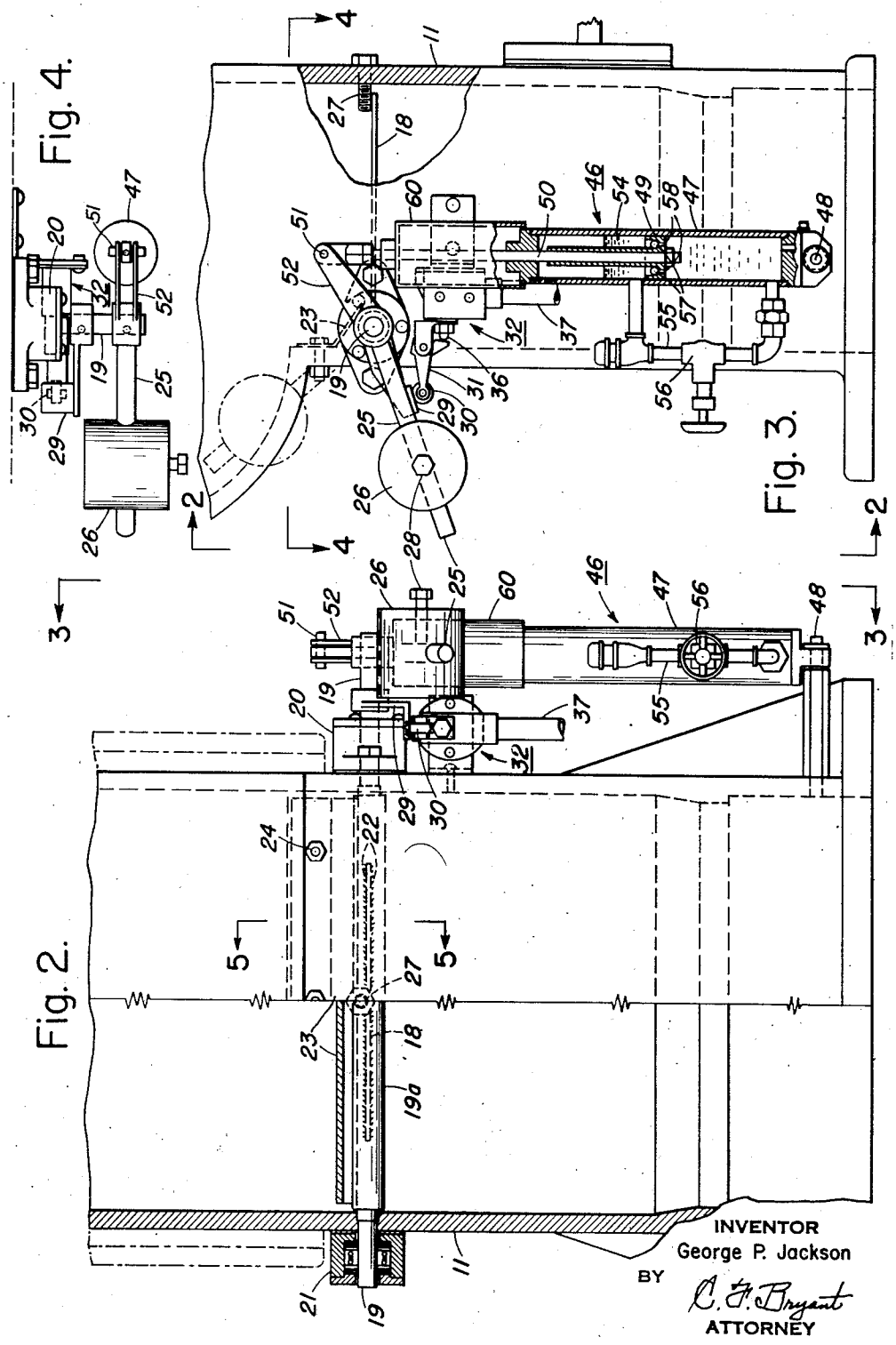
Fig. 1.

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FLOW STOPPAGE DETECTOR FOR FUEL SUPPLY LINES

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This invention relates to indicating possible stoppages in the flow of divided material and it has particular reference to improved means for activating an alarm circuit or other device: (*a*) in response to stoppage in the flow of coal or other fuel or material through supply conduits to pulverizers or other equipment into which the fuel or material is dispensed by a feeder; and (*b*) irrespective of whether said stoppage occurs in supply conduits ahead of the feeder or in the feeder itself.

One object of this invention is to simplify the construction, reduce the cost and improve the performance of "no-flow" alarm apparatus of the character stated.

Another object is to simplify the installation and improve the reliability of flow-indicator apparatus suitable for service with the coal feeders of pulverizing mills as utilized in power generating stations.

In practicing this invention I attain the foregoing and other objects by disposing within the conduit supplied by the material feeder a detector member in the form of a smooth plate that is physically contacted by said divided material as same drops through the conduit, by pivotally supporting one edge of the detector plate in hinge bearings which leave the opposite plate edge free for downward deflection by divided material moving therepast, by counterbalancing the hinge-mounted plate so that with no material flowing an upward position will be occupied thereby, by supplementing the hinge mounting with regulating cylinder means which allow rapid plate movement in the downward direction while introducing a controlled delay in return of the plate to the upward position following stoppage of material flow, by utilizing the plate movement to actuate an alarm switch or other comparable device, and by controlling from this switch an alarm circuit which remains inactive as long as the aforesaid divided material continues to flow but which is rendered active to give an appropriate alarm when the aforesaid plate returns to the upward position in response to stoppage in the material flow.

An illustrative embodiment of this invention will now be described by reference to the accompanying drawings wherein:

Fig. 1 is a representation partly in section and partly diagrammatic of a fuel feeder for a conventional pulverizing mill supplemented by flow-indicator apparatus uniquely organized in accordance with one preferred form of the invention;

Fig. 2 is a view on line 2—2 of Figs. 1 and 3,

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with the left half broken away, showing further details of the hinged mounted detector plate and of the return retarding cylinder provided therefor;

Fig. 3 is a view on line 3—3 of Fig. 2 showing the detector plate and the regulating-cylinder piston in the uppermost or "no-flow" positions instead of in the downward or active "flow" positions represented by Fig. 1;

Fig. 4 is a view taken on line 4—4 of Fig. 3 showing further details of the counterweighted hinged shaft and regulating cylinder parts; and

Fig. 5 is a partial section view taken on line 5—5 of Fig. 2 showing further details of the detector plate and its attachment to the mounting shaft.

Illustrative application

The improved "no-flow" indicator of my invention is applicable to any situation wherein divided or granular material is dispensed by feeder or otherwise into a conduit through which said material normally flows and wherein it is desired that stoppage of such normal flow will actuate an alarm circuit or the like either to warn an operator or otherwise to initiate other appropriate corrective action.

The illustrative application here shown is typical of the foregoing in that the apparatus to be benefitted comprises a pulverizing mill on whose top 10 (or on whose side in certain other constructions not shown) there is mounted an incoming conduit 11 which is supplied with coal or other fuel 12 from a hopper 13 through the medium of a conventional feeder 14 equipped with circumferentially spaced radial blades 15 that are slowly rotated (clockwise in the drawing) by any suitable means such as an electric driving motor or the like (not shown).

The inventive apparatus here disclosed and now to be described is effective to detect stoppage in the resultant normal flow of coal 12 downwardly from feeder 14 through conduit 11 and into pulverizing mill 10, and to activate an alarm circuit or other device if such stoppage persists for a predetermined time.

As the description proceeds it will become apparent that my disclosed apparatus is capable of effecting this detection irrespective of whether said stoppage occurs in supply conduits after (as conduit 11) or before (as leading to—not shown—or replacing hopper 13) the feeder 14 or in the feeder itself; also that the "star" feeder illustratively represented at 14 may be replaced by some other form of material dispenser such as one

of the "screw" type or the "table" type or the like.

The hinge mounted flow detector plate

In order to detect stoppage in said flow there is provided inside of conduit 11 a flow detector member in the form of the trip plate shown at 18 in Figs. 1, 2, 3 and 5. This plate is supported at one side (see Fig. 5) by shaft 19 mounted in bearings 20 and 21 that are disposed on opposite sides of the conduit 11 as indicated by Fig. 2. These bearings may satisfactorily be of the ball or other anti-friction type which assure free and easy rotation of shaft 19 therein.

The trip plate 18 may be secured to shaft 19 in any suitable manner as through the medium of welds 22 joining with the enlarged shaft portion 19a as indicated by Figs. 2 and 5; or the plate body may be extended for reception of clamping bolts (not shown) that pass through the shaft. With either arrangement the space between shaft 19 and its adjacent conduit wall 11 (again see Fig. 5) can be shielded from the falling fuel 12 by means of a shield or guard plate 23 held thereabove by bolts 24 as shown in Fig. 5 and other views. Figs. 2, 3 and 5 show the trip plate 18 in the horizontal position; which is in contrast to the downwardly tilted position represented by Fig. 1 in dotted outline.

One end of the mounting shaft 19 (the right in Fig. 2) projects outwardly beyond bearing 20 and has secured thereto an arm 25 by which there is carried a counterweight 26 that imparts to shaft 19 a torque tending to urge the trip plate 18 within conduit 11 upwardly into contact with a stop bolt 27. An adjuster screw 28 is provided so that the counterweight 26 may be set along the length of arm 25 in the position which in the absence of fuel flow gently urges the free end of trip plate 18 upwardly against stop 27 as indicated in Figs. 2, 3 and 5.

In this position a flatted end portion of a trip lever 29 also carried by shaft 19 (see Fig. 2) serves through roller 30 and bell crank 31 to close the contacts of an electrical switch shown generally at 32 in Figs. 1 and 3. Said switch may be of a well known "snap" type and in the simplified diagrammatic showing of Fig. 1 the contacts thereof are indicated in the form of a bridging bar 33 normally held by a compression spring 34 away from contact points 35. Such open position of the switch contacts occurs when falling fuel 12 holds the trip plate 18 in the downwardly inclined position represented by Fig. 1 wherein the weight arm 25 is upwardly inclined so that the parallel trip lever 29 is fully out of contact with switch roller 30. But upon stoppage in the flow of fuel 12 weight 26 returns trip plate 18 to the horizontal position of Figs. 2, 3 and 5 wherein the trip lever 29 pushes switch roller 30 down urging rod 36 inwardly against spring 34 to bring bridging bar 33 into engagement with contact points 35.

The controlled alarm circuit

Controlled by switch 32 is an alarm circuit illustratively shown at 38—39 as being energized by some suitable source of power here represented in the form of conductors 40—41; the electrical connections with switch 32 being carried inside of a conduit 37. As long as trip plate 18 is inclined downwardly (as in Fig. 1) by lumps of fuel 12 dropping thereagainst and therepast, the alarm circuit 38—39 can receive no energizing current from power source 40—41 since switch 32 serially included therein is held by spring 34 in the open contact position.

When however the flow of fuel 12 downwardly through conduit 11 is stopped trip plate 18 returns as aforesaid to the horizontal position of Figs. 3 and 5 wherein the trip lever 29 pushes roller 30 downwardly and thereby closes the contacts 33—35 of switch 32.

Such closure connects power source conductor 40 with alarm circuit conductor 38 and by thus energizing the alarm circuit 38-39 effects the lighting of a signal lamp 43 or the sounding of a bell 44 or warning horn, or the accomplishment of any other functions that may be desired in the particular installation. Once such alarm warns the operator he may manually shut down the mill 10 or initiate other appropriate action, or automatic means (not shown) likewise may be activated in response to the detected stoppage of fuel flow through conduit 11.

The return-delay regulating cylinder

In certain situations it might be possible to control the alarm circuit 38—39 with only the apparatus thus far described; but in this event even fuel flow stoppages of exceedingly short duration would be effective to activate the alarm circuit.

In most applications including the mill feeder here illustrated it is preferable that that the alarm circuit 38—39 be activated only in response to flow stoppages which persist for some preselected period of time such as several seconds. In order to accomplish this result use may satisfactorily be made of some form of action-delaying means such as the regulating cylinder or dash pot generally represented at 46.

In the arrangement here shown this regulating cylinder is organized to introduce a delay of controlled duration into the upward return of trip plate 18 to the horizontal position shown in Figs. 3 and 5 following stoppage in the flow of fuel 12 downwardly past the plate; but not to extend the time required for trip plate 18 to move downwardly from the horizontal position of Figs. 3 and 5 to the inclined position of Fig. 1 upon resumption in the fuel flow.

As here illustrated the regulating cylinder or dash pot 46 utilizes a cylinder sleeve 47 pivotally supported at its bottom on a stud shaft 48 and accommodating a piston 49 slidably disposed inside of the cylinder and being carried on the lower end of a piston rod 50 whose upper end is pivotally joined at 51 with a crank arm 52 also carried on the projecting end of shaft 19.

Oil or other liquid 54 fills the lower portion of cylinder sleeve 47 to a level somewhat above the position of piston 49 when the trip plate 18 is in the horizontal position of Figs. 3 and 5, and the portions of this liquid above and below the piston 49 in both extremes are interconnected through a by-pass pipe 55 having therein a flow adjusting valve 56. Included in the piston are ball valves 57 which close passages 58 therebeneath whenever the piston 49 moves upwardly but which allow free passage of fluid 54 up through those openings around the balls 57 whenever the piston 49 is moved downwardly.

This enables downward movement of the piston to proceed rapidly and without substantial retardation by the fluid 54; while upon upward movement of the piston the passages 58 are closed and the rate of motion is then slowed to the speed at which fluid from above the piston can flow through valve 56 into the space below the piston. By merely changing the setting of valve 56 there

is provided a convenient and satisfactory adjustment in the retardation of upward piston movement.

This retardation is taken advantage of in providing a desired period of delay in return of the trip plate 18 from the downwardly inclined position of Fig. 1 to the horizontal position of Figs. 3 and 5. And in the device shown such a retardation may by proper setting of valve 56 be chosen so that the upward return delay for trip plate 18 is selectable anywhere within the range from 0 to 60 seconds. As earlier indicated such retardation of the trip plate movement is effective only in the upward direction.

In the complete regulating cylinder assemblage here shown use is made of a dust cap or cover 60 carried by piston rod 50 and serving at all times to shield the top of cylinder sleeve 47 from accumulation of coal dust and the like. This dust cover moves up and down with the piston rod 50 through a range of travel which will be apparent upon contrasting the showing of Fig. 1 with the showing of Fig. 3.

Operation of complete alarm system

The manner in which the complete "no-flow" indicator system of my invention operates will have become more or less apparent from the foregoing description of the component parts included therein. As long as coal 12 or other divided material is falling upon the trip plate 18 the resultant downward inclination represented in Fig. 1 holds weight arm 25 in an upwardly inclined position wherein lever 29 is fully separated from roller 30 and spring 34 holds the contacts of switch 32 in the open position. Under this condition the alarm circuit 38—39 is de-energized by reason of being kept disconnected from power source 40—41.

If now the coal flow is stopped trip plate 18 is no longer held in the downwardly inclined position and weight 26 acting through arm 25 starts to rotate the plate upwardly towards the horizontal around mounting shaft 19. Such rotation can proceed only as fast as piston 49 can move upwardly in cylinder sleeve 47 under the pulling action of crank arm 52 also carried by shaft 19. If the flow stoppage persists for the full delay period set by adjuster valve 56 trip plate 18 will reach the horizontal position of Figs. 3 and 5 and just prior thereto arm 29 will through roller 30 effect closure of the contacts of switch 32. The accompanying connection of alarm circuit 38—39 with power source 40—41 will now indicate (as through devices 43—44) that some corrective action should be taken; or the same connection can be made directly to activate automatic means (not shown) for accomplishing the desired functions.

Upon resumption in the fuel flow through conduit 11 the falling lumps 12 thereof in contacting trip plate 18 will quickly move that plate to the downward inclined position of Fig. 1; relatively little retardation being imparted to such downward movement by the piston 49 since the cylinder fluid 54 is now free to flow upwardly through openings 58 therein without being circulated through delay valve 56. The contacts 33—35 of switch 32 now promptly return to the open position shown.

If the duration of fuel flow stoppage is less than the upward return time of trip plate 18, that plate will have moved only partly up when the renewed supply of dropping fuel 12 again strikes the plate causing it quickly to return to its downwardly inclined position without having activated the alarm circuit 45—46.

Summary

Although the new flow-indicator apparatus of this invention has been disclosed as applied to detect flow stoppage in the coal 12 which is dispensed by a rotary feeder 14 into a conduit 11 leading into a pulverizing mill 13, it will be apparent that such application is illustrative rather than restrictive and that the improved alarm system herein shown may with comparable benefit be utilized in any application wherein divided material of any kind normally flows through a conduit regardless of whether that flow is or is not controlled by a feeder and regardless of to what apparatus or device said normally flowing material is delivered.

From the foregoing it will be seen that my invention is capable of wide application and is susceptible to many uses in addition to the illustrative one here shown and described.

I claim:

1. In a system comprising a conduit through which divided material normally flows, a flow detector plate disposed within said conduit, a shaft attached to one edge of said plate and providing therefor a hinge mounting around which the plate is free to swing between a first position wherein the plate body extends into the flow path of said material and a second position wherein the plate's free end has moved along the direction of flow towards one side of said path, and a counterweight also carried by said shaft and serving to hold said plate in said first position in the absence of said divided material flow but permitting plate movement into said second position when said material passes through the conduit and physically strikes the plate, the combination of alarm means controlled by said shaft and disposed to be inactive as long as said detector plate occupies said second position but to be rendered active when the plate goes to the first position as in response to stoppage in material flow through the conduit, and fluid-cylinder means linked with said shaft and organized to retard detector plate movement from said second to said first position thereby requiring that the aforesaid stoppage in material flow persist for a predetermined time before activation of said alarm means can be effected, said fluid-cylinder means permitting detector plate movement from said first to said second position without substantial retardation.

2. In a system comprising a conduit through which divided material normally flows, a flow detector plate disposed within said conduit, a shaft attached to one edge of said plate and providing therefor a hinge mounting around which the plate is free to swing between a first position wherein the plate body extends into the flow path of said material and a second position wherein the plate's free end has moved along the direction of flow towards one side of said path, and means holding said plate in said first position in the absence of said divided material flow but permitting plate movement into said second position when said material passes through the conduit and physically strikes the plate, the combination of a cylinder having a piston linked with the aforesaid shaft and moved through the cylinder by the aforesaid detector plate movements, fluid contained by the cylinder on both sides of said piston, a by-pass circuit for shunting fluid around the piston between said two sides, valve means

in the piston permitting passage of fluid directly therethrough during detector plate movement from the first to the second position but blocking said passage during detector plate movement from the second to the first position with resultant forcing of the fluid through said by-pass circuit and accompanying retardation of said last mentioned movement, and alarm means controlled by said detector plate and disposed to be inactive as long as that plate occupies said second position but to be rendered active when the plate goes to said first position in response to stoppage in material flow through the conduit for the duration of the aforesaid retardation.

3. In a system comprising a conduit through which divided material normally flows, a flow detector plate disposed within said conduit, a shaft secured to one edge of said plate and providing therefor a hinge mounting around which the plate is free to swing between a first position wherein the plate body extends into the flow path of said material and a second position wherein the plate's free end has moved along the direction of flow towards one side of said path, the combination of a counterweight also carried by said shaft and serving to hold said plate in said first position in the absence of said divided material flow but permitting plate movement into said second position when said material passes through the conduit and physically strikes the plate, a delay-regulating cylinder containing a piston linked with said shaft and moved through the cylinder by the aforesaid movements of said detector plate, fluid contained by the cylinder on both sides of said piston, a by-pass circuit for shunting fluid around the piston between said two sides, valve means in the piston permitting passage of fluid directly therethrough during detector plate movement from the first to the second position but blocking said passage during detector plate movement from the second to the first position with resultant forcing of the fluid through said by-pass circuit, means for adjusting the flow-restricting characteristics of said by-pass circuit whereby to impart to said last mentioned movement a retardation of selectable duration, and alarm means controlled by said detector plate and disposed to be inactive as long as that plate occupies said second position but to be rendered active when the plate goes to said first position in response to stoppage in material flow through the conduit for the selected duration of said retardation.

4. Apparatus of the type described comprising in combination: a conduit for conveying divided material; a pivoted flow detector member positioned within said conduit and organized to occupy a first position during no material flow and to move into a second position during flow of said divided material through the conduit and impingement upon said member; means biasing said member to said first position; a delay-regulating cylinder containing a piston linked with said detector member and moved through the cylinder by the aforesaid movements of the detector member; fluid contained by the cylinder on both sides of said piston; a by-pass circuit for shunting fluid around the piston between said two sides; valve means in the piston permitting passage of fluid directly therethrough during detector member movement from the first to the second position but blocking said passage during detector member movement from the second to the first position with resultant forcing of the fluid through said by-pass circuit; means for adjusting the flow-restricting characteristics of said by-pass circuit whereby to impart to the last-mentioned movement a retardation of selectable duration; and alarm means controlled by said detector member and disposed to be inactive as long as that member occupies said second position but to be rendered active when the member goes to said first position in response to stoppage in material flow through the conduit for the selected duration of said retardation.

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