

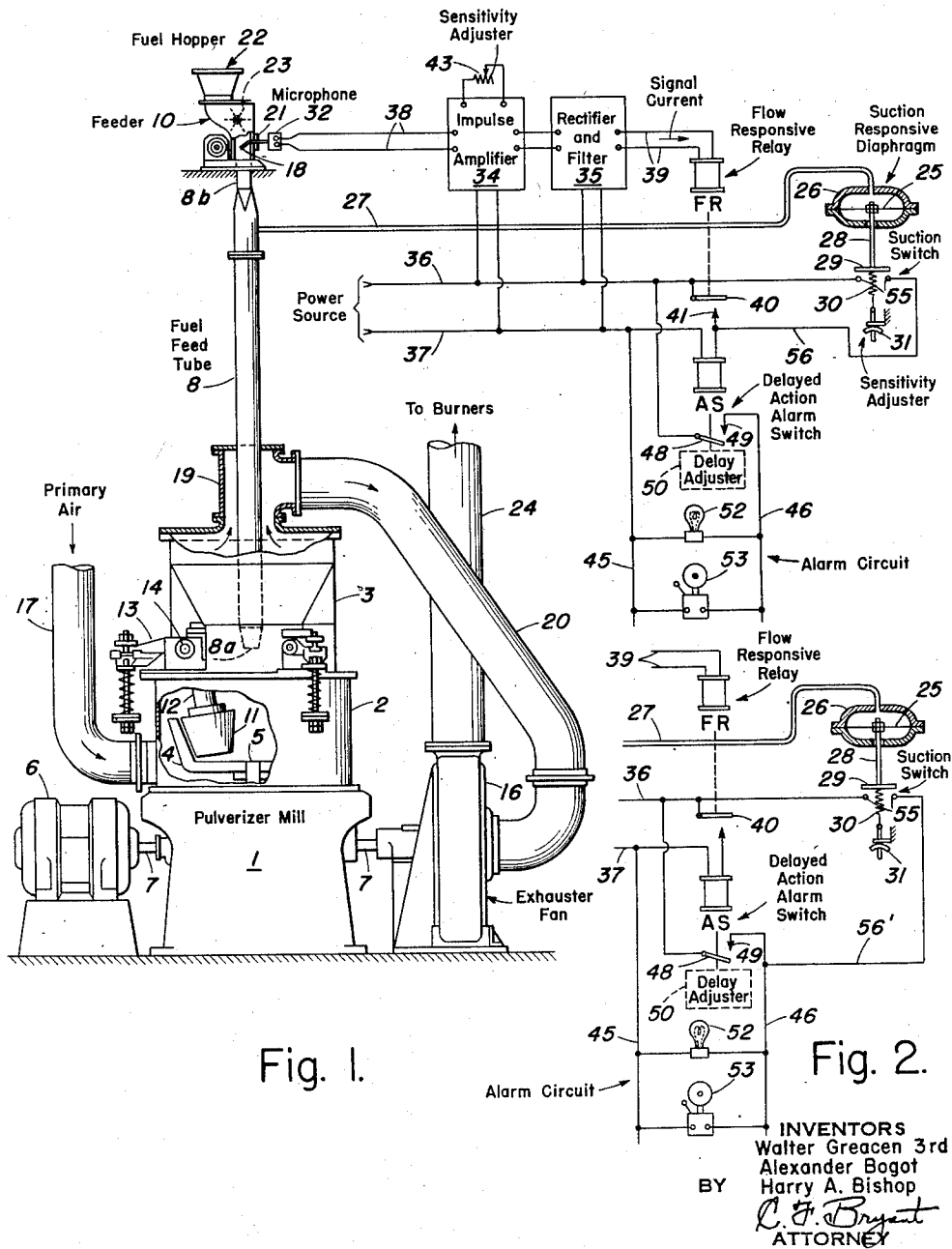
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FLOW STOPPAGE INDICATOR FOR MILL FUEL SUPPLY

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1

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FLOW STOPPAGE INDICATOR FOR MILL FUEL SUPPLY

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This invention relates to indicating possible stoppages in the flow of fuel or other material to pulverizing mills, and it has particular reference to improved means for activating alarm apparatus in response to stoppage in the flow of coal to pulverizing mills such as supply the burners of boiler furnaces in steam power plants.

Broadly stated, the object of this invention is to extend the usefulness of "no-flow" alarm devices of the character here considered.

Another object is to better the performance and raise the reliability of flow indicator apparatus suitable for service with the coal feeders of pulverizing mills of the air-swept type in the interiors of which appreciable suction normally is maintained.

An additional object is to make novel use of the aforesaid suction in detecting stoppage of coal flow through the feed tube that leads into the grinding chamber of the mill.

A further object is to supplement the new suction-actuated alarm apparatus for the feed tube by other alarm apparatus for the fuel feeder serving said tube, and thereby provide a combination system which affords benefits and safeguards not obtainable heretofore.

Still further objects and advantages will become apparent from the following description of illustrative embodiments of the invention when taken in conjunction with the accompanying drawings wherein:

Fig. 1 is a representation partly in section and partly diagrammatic of a conventional pulverizing mill and associated fuel feeder equipped with flow-indicator apparatus which incorporates the improvements of this invention; and

Fig. 2 shows how the Fig. 1 system may be modified to provide alarm circuit activation directly by the suction switch without any time delay.

The pulverizing mill to be benefited

Illustrative of the various pulverizing mills with which the improved "no-flow" alarm facilities of this invention may be used is the "bowl" type mill here shown as comprising a base 1 supporting thereabove a casing 2—3 within the lower portion 2 of which is a bowl 4 mounted on a vertical shaft 5 for rotation therewith. This vertical shaft is carried by bearings (not shown) mounted within the base 1 along with suitable gearing (likewise not shown) through which the shaft 5 is rotated by a driving motor 6, a horizontal shaft 7 being included in the driving connection.

A central feed tube 8 delivers the coal or other material to be ground downwardly from a feeder 10 through the top of upper casing 3 and thence into the interior of bowl 4. As the bowl rotates centrifugal force carries the fuel outwardly to the upturned bowl rim causing passage between it and cooperating rollers 11, of which the represented apparatus has three (only one can be seen in Fig. 1). Each of these rollers 11 freely rotates about the lower end of a shaft 12 carried by arm 13 in rocker bearings 14, and is urged towards the rim of bowl 4 by a spring 15. The resulting force exerted upon the fuel passing between the bowl rim and rollers serves to pulverize same and reduce the particle size thereof.

The mill further is provided with an exhaustor fan 16 organized to draw a current of air upwardly through the mill casings 2 and 3, and here shown as being driven by motor 6 through shaft 7. This air comes into the

2

lower part of casing 2 through an intake conduit 17 and flows upwardly between the rim of bowl 4 and the casing wall, thereby carrying the sufficiently ground fuel up through casing 3 and out top offtake 19 into suction conduit 20 and thence through fan 16 to a discharge conduit 24 which may serve the burners of a boiler furnace (not shown) in well known manner.

Within the upper mill casing 3 there is provided classifier apparatus which serves in conventional manner to separate insufficiently ground material out of the up-flowing air stream and to return that separated material back into the interior of bowl 4 for re-grinding between rollers 11 and the bowl rim. Since such classifier apparatus is well known, no attempt has been made to show same here.

During operation of a pulverizing mill such as the one here illustrated and described, the interior of suction conduit 20 is maintained under appreciable negative pressure (which in practice may be of the order of 6 inches water column) by the earlier explained action of exhaustor fan 16; and the space inside of upper mill casing 3 is by the same fan action likewise kept under a negative pressure of only slightly lesser intensity, such, for example, as of 5 inches of water column. This means that as long as the mill continues to operate in normal manner the pressure inside of casing 3 and 2 will continuously be appreciably less (such as 5 inches water column) than the atmospheric pressure outside of the mill.

Since central feed tube 8 opens at its lower end 8a directly into mill casing 3, the aforesaid negative pressure also will exist inside of said tube 8 unless clogging thereof occurs. Normally fuel passed by feeder 10 from hopper 22 through slowly rotating star wheel 23 downwardly into the top of central feed tube 8 drops freely through that tube and leaves at least some open space through which the negative pressure impressed upon the tube bottom 8a is freely communicated to the entire tube length; the represented feeder 10 (including star wheel 23 and fuel-filled hopper 22) constituting what amounts to a seal against admission of air into the feed tube top 8b.

But restrictions of this central feed 8 sometimes do occur under certain conditions; such, for example, as when the material fed therethrough into the mill is very wet or otherwise has a tendency to stick to the sides of the pipe building up to a point where the material flow may be cut off either partially or even completely.

New alarm facilities depend on mill suction

The new alarm facilities now to be described are effective to detect plugging of this central feed tube 8 anywhere along its length from the lower end 8a opening into the mill interior to the top portion 8b communicating with the fuel feeder 10.

Said facilities utilize a diaphragm 25 enclosed on one side in an air tight casing 26 the interior of which communicates with the interior of the mill feed tube 8 through tubing 27 joined with said feed tube near its top 8b. The other side of this diaphragm is exposed to the atmosphere, and from the diaphragm center there extends a rod 28 leading to a switch 29 which occupies the open position shown as long as normal mill suction acts upon the diaphragm, but which is pulled into the closed position by a spring 30 whenever the suction within casing 26 falls substantially below a given value selected by adjuster 31.

Other forms and organizations of suction-actuated switch apparatus obviously may be substituted for the illustrative devices here shown and described.

In the arrangement shown by Fig. 1 the suction switch represented at 29 controls a delayed action alarm switch AS associated with any suitable energizing source here shown in the form of conductors 36—37. The winding of switch AS is connected to receive from this source energizing current when and only when suction switch 29 closes its contacts. Hence as long as fuel is dropping through mill feed tube 8 in normal manner alarm switch AS will be deenergized, in which event its contact 48 will occupy the released position shown.

Controlled by said contact 48 is an alarm circuit 45—46.

3

Under the condition stated in preceding paragraph, this alarm circuit can receive no energizing current from power source 36—37 over the AS contact point 49, and it is therefore maintained inactive.

Said normally released contact 48 of switch AS may have a desired pick up delay imparted thereto in any suitable manner as through the medium of adjuster means represented at 50. Such means may take any one of a number of well known forms such as a dash pot, clock work, electrical storage mechanism or the like. As such devices are all conventional, detailed representation thereof has not been attempted; instead it will suffice to say that in the illustrative arrangement shown adjuster 50 may satisfactorily be chosen to provide for contact 48 a closure delay selectable anywhere within the range of from 0 to 60 seconds.

Preferably, moreover, the mechanism 50 is so arranged that contact 48 of switch AS is free to move from the closed (horizontal) to the released (open) position without substantial retardation or delay. Assuming that device 50 is set for a pickup delay of 20 seconds, this means that interruptions in suction transmission to tubing 27 for less than 20 seconds will be ineffective for causing switch AS to activate the alarm circuit 45—46. With such setting the plugging of mill feed tube 8 must cause suction switch 29 to close its contacts for more than 20 seconds before alarm switch AS can move contact 48 upwardly into engagement with point 49 and thereby connect the alarm circuit 45—46 with its power source 36—37.

Said alarm circuit may when so energized be arranged to light a signal lamp 52, or to sound a bell 53 or a warning horn, or to accomplish any other functions that may be desired in the particular installation. Once such alarm warns the operator he may manually shut down the mill or initiate other appropriate corrective actions, or automatic means (not shown) likewise may be activated in response to the detected plugging of the mill feed tube 8.

Operation of suction-responsive alarm system

The manner in which the new suction-responsive alarm system operates will have become more or less apparent from the foregoing description of the component parts included therein. As long as the mill feed tube 8 remains unobstructed the suction maintained by exhauster fan 16 within mill casing 3 is communicated through feed tube 8 and tubing 27 to chamber 26 and the upper side of diaphragm 25. Said suction pulls the diaphragm center up overcoming the tension of spring 30 and keeping the contacts of switch 29 in the open position shown. Under this condition alarm switch AS is de-energized so that contact 48 thereof keeps the alarm circuit disconnected from power source 36—37.

Coal freely falling downwardly from feeder 10 through central tube 8 into the pulverizing mill does not disturb the aforesaid communication of the mill suction to diaphragm 25, and the alarm circuit 45—46 is in consequence kept inactive under this condition of normal mill operation. But should for any reason the feed tube 8 become clogged or filled up with fuel at any point between lower end 8a and the upper-end junction with tubing 27, such clogging will cut off communication of the mill suction to diaphragm 25 and allow spring 30 to move suction switch contact 29 downwardly into engagement with cooperating points 55. This completes for alarm switch AS an energizing circuit shown as extending from power source conductor 36 through suction switch contacts 29 and 55, conductor 56 and the winding of relay AS to power source conductor 37.

The resultant energization starts pick up of AS switch contact 48 and if the feed tube plugging persists for the full delay period set by adjuster 50, contact 48 will engage point 49 and connect alarm circuit 45—46 with power source 36—37, thereby indicating (as through devices 52—53) that some corrective action should be taken. Such corrective action may consist in shutting down of the mill long enough to clear the feed tube 8 of the plugged material.

Once the feed tube 8 has been reopened, resumption of normal operation of the mill is accompanied by communication of the mill suction to diaphragm 25 which opens the contacts of suction switch 29 and thereby deenergizes alarm switch AS. Contact 48 of said switch now promptly returns to the released position shown. If the duration of the feed pipe plugging is less than the pick up time of

4

switch AS, contact 48 will have moved only partly up when suction switch 29 deenergizes the winding of switch AS; and that contact 48 of said switch then will quickly drop back to its fully released position without having activated the alarm circuit 45—46.

Cooperation with flow indicator for mill feeder

Another aspect of this invention resides in novelly utilizing the suction-alarm facilities just described in conjunction with "no-flow" alarm apparatus provided for the mill feeder 10. One form of mill alarm apparatus satisfactory for this purpose is the "microphone-amplifier" arrangement disclosed and claimed by a copending application Serial No. 158,212, filed April 26, 1950, now Patent No. 2,659,881, in the names of Alexander Bogot and Harry A. Bishop for "Detection of Stoppage in the Flow of Divided Material."

In the scheme of that copending application there is inserted through one of the walls of feeder 10's casing a flow-detector member 18 here shown in the form of a small diameter (as ¼") round stainless steel rod projected as indicated into the downward flow path of the coal released from hopper 22 by star wheel 23 into the central feed tube 8 of the pulverizing mill. The rod mounting is made cushioned or yieldable (as through employment of a sponge rubber disc 21 covering an enlarged opening in the casing wall and snugly supporting the rod at its center) in order that individual lumps of the fuel in contacting the rod 18 can set up therein vibrations which accompany the normal flow of fuel but which cease whenever that flow is stopped.

Attached to the outer projecting end of this detector rod 18 is a microphone 32 which translates into electrical impulses the aforesaid mechanical vibrations which the flowing fuel sets up in the detector. Such electrical impulses are communicated by conductors 38 to an amplifier 34 wherein they are strengthened and otherwise made suitable for accomplishing desired control functions. This amplifier may utilize electronic tubes conventionally organized (and hence not represented here) and is shown as being powered from the energizing source 36—37 earlier mentioned.

From the amplifier the strengthened impulses pass into rectifier and filter apparatus 35 which converts them into a signal current that is impressed upon the winding of a flow responsive relay FR via conductors 39. This signal current continues to persist only as long as flowing fuel from feeder star wheel 23 continues to hit detector member 18 and set up therein the aforesaid vibrations which microphone 32 converts into electrical impulses that when appropriately strengthened by amplifier 34 are applied to rectifier and filter apparatus 35.

The named relay FR energized by the resulting signal current is provided with a contact 40 which is held open by that current during the aforesaid conditions of normal fuel flow into the top 8b of mill feed tube 8. However, when that fuel flow stops and said signal current ceases to flow through the FR relay winding, contact 41 is allowed to drop into engagement with point 41. In the combination system here shown, such engagement duplicates the action of suction switch 29 in connecting the winding of alarm switch AS with energizing source 36—37; as later description herein will make more fully evident.

Relay FR is safeguarded against false signal current energization when no falling fuel hits detector member 18 and when said member is thus subjected only to the vibrations set up by the feeder 10 and the associated pulverizing mill during operation thereof; this safeguard taking the form of a sensitivity adjuster 43 for the amplifier 34. In each installation this control 43 is set by trial and error so that mill and feeder vibrations alone cannot activate flow responsive relay FR; such setting once made assuring that said relay FR will respond in desired manner only to actual flow of fuel downwardly from feeder 10 into the mill feed tube 8.

How the combination alarm system operates

From the drawing Fig. 1 it will be seen that the alarm circuit 45—46 is normally inactive and is so kept as long as the flow relay FR is held picked up (by actual passage of fuel into the top of mill feed tube 8) and the suction switch 29 is held open (by transmission of the mill suction to diaphragm 25 through feed tube 8).

Should there be a stoppage in the flow of fuel down-

wardly past detector 18 and into feed tube 8, then flow responsive relay FR will release contact 18 to energize alarm switch AS and thereby activate the alarm circuit 45—46 if the stoppage persists for a time longer than the AS pick up delay for which adjuster 50 is set. In this event an appropriate alarm will be given in the manner already explained.

Moreover, should the mill feed tube 8 become clogged with fuel or otherwise stopped up, the resultant loss of suction to diaphragm 25 will allow closure of suction switch 29 and thereby also activate the alarm circuit 45—46 if the clogging persists for a time longer than the AS pick up delay. Under this further condition an appropriate alarm likewise will be given by devices 52—53.

The advantage of this combined arrangement is that cloggings in the mill feed tube 8 at any point below the location of detector member 18 are directly indicated by suction switch 29, whereas if such switch were not provided there could be no indication of the clogging until the fuel had backed completely up to the level of detector 18. Such packing of fuel in a substantial length of this feed tube 8 is highly undesirable in that clearing of the tube when so fully packed is a major operation much more difficult to perform than when the clogging is allowed to build up through only a short length.

When so novelly used in conjunction with the microphone detector 18, the suction-switch facilities of this invention thus perform a function of practical significance and commercial importance; it being apparent that when pulverizing mills are constructed as shown in the drawing hereof it becomes physically impractical to install a microphone detector 18 close to the lower end 8a of mill feed tube 8 (as within the confines of mill casing 3 or top offtake 19). But the suction-responsive facilities here disclosed do provide for this portion of the feed tube and they thus constitute a valuable adjunct to the microphone-amplifier facilities of copending Bogot-Bishop application Serial No. 158,212.

Alternative arrangement of Fig. 2

In the organization of Fig. 1 relay AS functions to introduce a time delay between each closure of suction switch 29 and each resultant activation of alarm circuit 45—46.

In certain situations it may be desirable that such time delay be eliminated; thereby assuring a correspondingly earlier giving of an alarm in response to clogging of fuel feed tube 8. Such elimination may be accomplished by modifying the Fig. 1 circuits in the manner represented by Fig. 2; the referred to modification residing in shifting the conductor 56 connection (with suction switch 29) from the winding of alarm switch AS (Fig. 1) to the alarm circuit conductor 46 as shown at 56' in Fig. 2.

With the circuits so modified (Fig. 2), closure of suction switch 29 now directly activates alarm circuit 45—46 (without any time delay) by connecting the one alarm conductor 46 with the first power source conductor 36 over conductor 56' and suction switch contacts 29 and 55 (the other alarm conductor 45 being continuously joined with the second power source conductor 37 in both Figs. 1 and 2).

In this way (Fig. 2) response of the alarm devices 52—53 to plugging of fuel feed tube 8 can be correspondingly quickened, because the delayed action alarm switch AS is no longer utilized (as in Fig. 1) in giving alarms initiated by the suction switch 29.

What is claimed is:

1. In a system of the type described the combination of a pulverizing mill, a feed tube for conveying material to be pulverized into the interior of said mill, means for maintaining said mill interior and the discharge end of

said feed tube under suction, a feeder for dispensing said material into the inlet end of said feed tube while sealing said tube end against admission of air, a suction-responsive device connected with the inlet end portion of said feed tube for reception of the aforesaid mill suction as transmitted from the mill interior through the feed tube, a switch actuated by said suction-responsive device, and normally-inactive alarm means controlled by said switch and rendered active thereby if transmission of the mill suction to said device ceases as in response to a clogging of the feed tube.

2. The combination with a pulverizing mill of a feed tube for conveying material to be pulverized into the interior of the mill, means for maintaining said mill interior and the discharge end of said feed tube under suction, a feeder for dispensing said material into the inlet end of said feed tube while sealing said tube end against admission of air, a suction-responsive device connected with the inlet end portion of said feed tube for reception of the aforesaid mill suction as transmitted from the mill interior through the feed tube, a quick-acting switch actuated by said suction-responsive device, and a delayed-response relay controlled by said switch and disposed to occupy an inactive position as long as said suction transmission through the feed tube continues but to go to an alarm position when said transmission ceases as in response to a clogging of the feed tube.

3. In a system of the type described the combination of a pulverizing mill, a feed tube for conveying material to be pulverized into the interior of said mill, means for maintaining said mill interior and the discharge end of said feed tube under suction, a feeder for dispensing said material into the inlet end of said feed tube while sealing said tube end against admission of air, a suction-responsive device connected with the inlet end portion of said feed tube for reception of the aforesaid mill suction as transmitted from the mill interior through the feed tube, a switch actuated by said suction-responsive device, an alarm relay controlled by said switch and disposed to occupy an inactive position as long as said suction transmission through the feed tube continues but to go to an alarm position in time-delayed response to discontinuance of said transmission, and an alarm circuit activated by said relay when in said alarm position as by reason of prolonged clogging of the feed tube.

4. The combination with a pulverizing mill of a feed tube for conveying material to be pulverized into the interior of the mill, means for maintaining said mill interior and the discharge end of said feed tube under suction, a feeder for dispensing said material into the inlet end of said feed tube while sealing said tube end against admission of air, a suction-responsive device connected with the inlet end portion of said feed tube for reception of the aforesaid mill suction as transmitted from the mill interior through the feed tube, normally-inactive alarm means controlled by said suction-responsive device and rendered active thereby if said transmission of the mill suction to the device ceases as in response to a clogging of the feed tube, a detector member responsive to flow of the aforesaid material dispensed by said feeder into said feed tube, and relay means controlled by said detector member and disposed also to render the aforesaid alarm means active if the flow of said material from the feeder into the mill feed tube is discontinued.

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