Sept. 10, 1957 T. E. PYNOR 2,805,895

VACUUM ASH HANDLING SYSTEM

Filed July 8, 1954 2 Sheets-Sheet 1

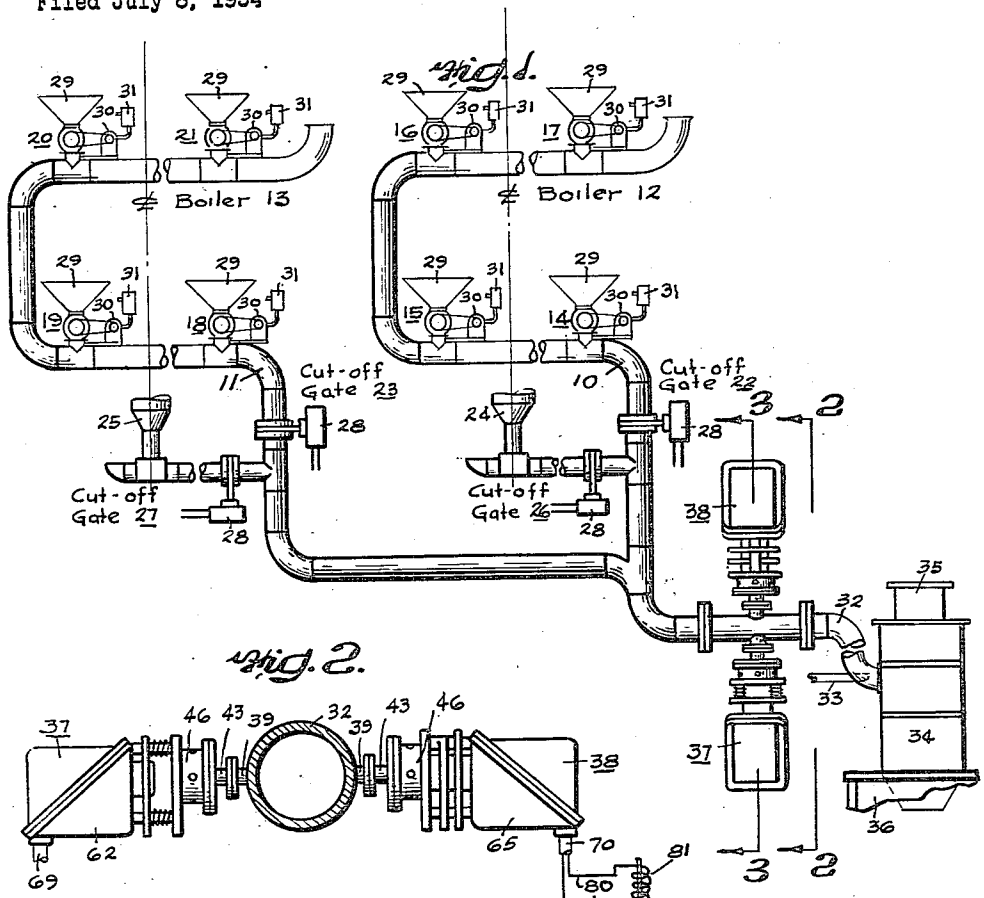
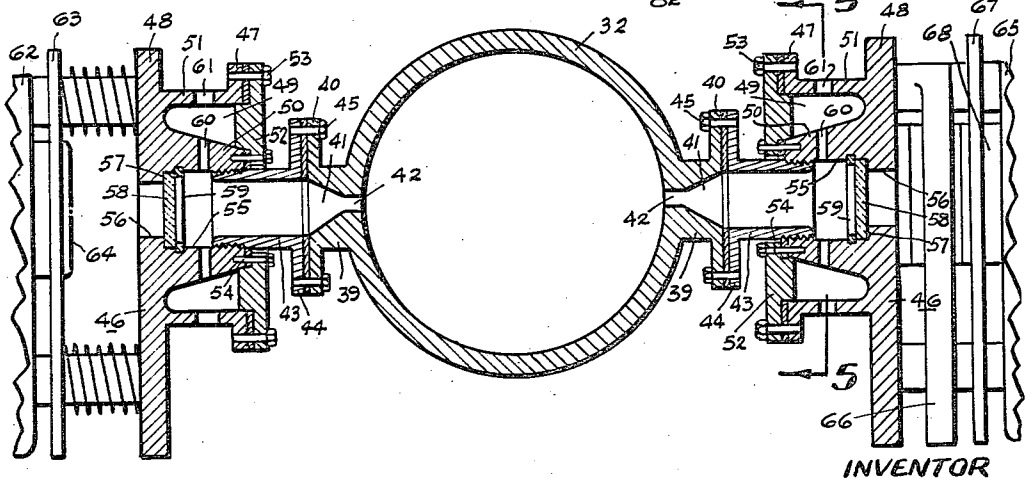


Fig. 1.

Fig. 2.



Fig. 3.



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Fig. 4.

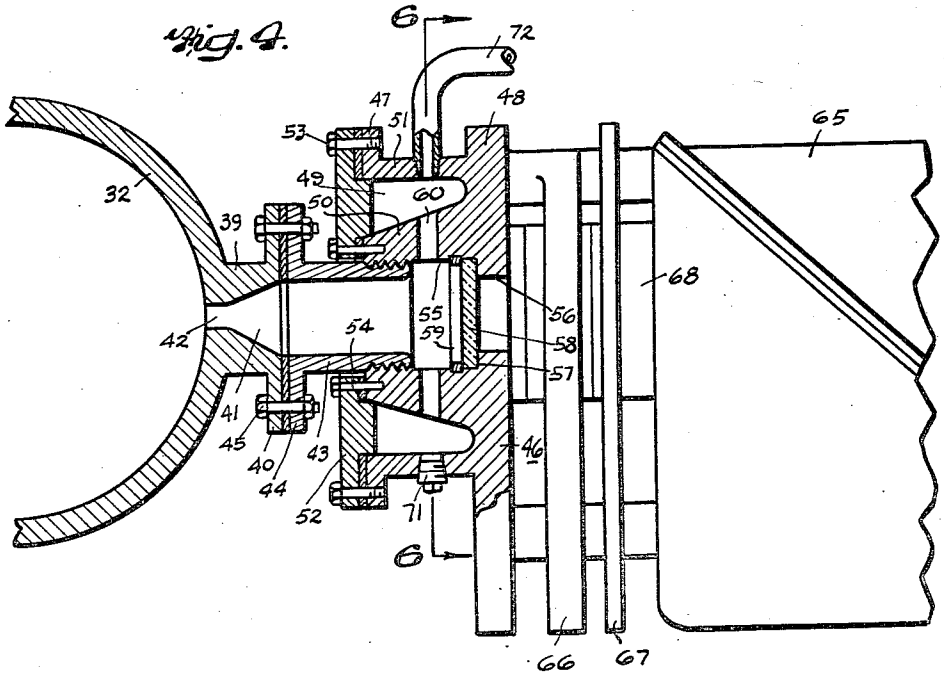


Fig. 5.

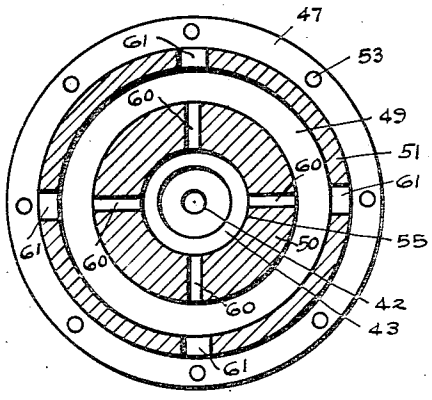
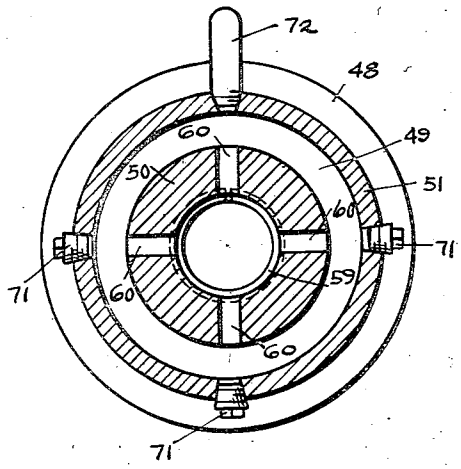


Fig. 6.



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VACUUM ASH HANDLING SYSTEM

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Application July 8, 1954, Serial No. 442,107

19 Claims. (Cl. 302—27)

The present invention relates to ash handling systems, and particularly to ash handling systems for power plants and other large boiler installations, where the problem of ash removal and disposal in large quantities, continuously from a plurality of ash producing units, is an important one.

In power plants of the coal burning type, and likewise in heating plants which utilize coal or other combustible material as fuel, the production of ash from the various units is substantially continuous and varies in quantity depending upon the load imposed upon the power or heating plant, as the case may be.

In such plants, it is customary to have a plurality of boiler or other ash producing uits, which may be operated or shut down in varying numbers, as required, to meet the varying load conditions. By utilizing a number of smaller units, rather than one large unit, greater flexibility may be obtained in carrying the load most economically. However, with an increasing number of boiler or other combustion and ash producing units, the problem of ash removal becomes greater in proportion. The greater the number of units, the greater the problem, both as to quantity of ash removed and attendance required to effect removal of the ash in such a manner as not to interfere with proper combustion.

With modern power plants, and to a certain extent with heating plants, automatic operation is desirable for the reason that varying load conditions may be met best by means responsive to variations in load conditions, and also for economy in operation and certainty of control beyond anything possible with direct control by operators. Likewise, it is desirable to provide ash handling equipment for removing the ash accumulation substantially continuously and in accordance with the production of the ash, which in turn, as hereinbefore indicated, depends upon the varying load conditions imposed upon the plant. In addition, it is desirable in large boiler installations, to provide for the control of all units from a centralized location, such as a panel conveniently located within the plant, not only to indicate the condition of operation of the system, but also to provide a record of any irregularity in the operation.

In coping with the ash handling problems presented by modern power plants and other large boiler installations, the type of ash handling system which includes a conduit system for ash removal by vacuum has been employed to advantage. Reference may be had to the pending application of William D. Hughes, Serial No. 169,492, filed June 21, 1950, now Patent No. 2,706,136 April 12, 1955, for a detailed description of one such ash handling system, which involves not only the problem of maintaining the vacuum in the conduit system while feeding material therethrough, but additionally the problem of sequential control of a conduit system involving a plurality of feeding units for each boiler. Briefly, the vacuum is created in the conduit system by a steam jet under electrical control, and the electrical system is controlled by a vacuum switch also connected with the vacuum system, together with feeder units which serve to maintain the conduit closed while at the same time feeding the ash directly into the conduit system from each boiler or other ash producing unit. Between the vacuum switch and the feeder units is an electrical control system embodying a number of electrical control and timing relays, together with electrical circuits providing for both individual and joint control of all boiler units both automatically and manually, as well as indicating and recording elements as required for continuous operation of the plant.

The type of ash handling system just described is subject to the disadvantage that frequently false indications of operating conditions occur, adversely affecting the efficiency of the ash handling system by prematurely terminating operation of one feeder unit and commencing operation of the next. An important factor which tends to cause false indications is that fly ash may be fed into the conduit system by one feeder unit, bottom ash by the next and soot by another, or fly ash, bottom ash or soot may be fed each at a different time by the same feeder unit into the conduit system. These materials have physical characteristics which distinguish them each from the others and affect the system's ability to sustain a vacuum. For example, the lighter the material discharged by a feeder unit into the conduit system, the more rapidly the vacuum in the conduit system decays, as a consequence of which the vacuum in the conduit system may drop to a minimum not because a feeder unit is empty but because the system is unable to prevent excessively rapid decay of the vacuum in the conduit system when the material discharged by the feeder unit into the conduit system is too light in weight.

Another factor which tends to cause false indications is that for each different material to be handled the ideal adjustment of the vacuum switch is different. However, there is only one vacuum switch and only one selected adjustment thereof is possible. This selected adjustment of necessity is a compromise adjustment made not to meet the demands of a selected material to be handled, but to meet as nearly as possible the demands of all the materials to be handled.

Still another factor which tends to cause false indication is that a vacuum switch is responsive only to substantial changes in vacuum, and therefore changes in the vacuum in the conduit system must be in the order of one-half inch or more of mercury before the vacuum switch will respond.

The ash handling system described hereinabove is subject to the further disadvantage that any indication of material flow in the conduit system is dependent upon indication of vacuum in the conduit system. This dependence is undesirable because the physical characteristics of the material being handled may be such that the vacuum in the conduit system remains substantially unchanged whether or not there is a flow of material, as a consequence of which there may be a flow of material without any indication thereof. Still another disadvantage is that initial installation of a vacuum switch is comparatively complicated because such a switch must be piped to the conduit system. Furthermore, a vacuum switch requires very careful adjustment in order to respond to the best of its ability to changes in vacuum in the conduit system.

It is, therefore, a primary object of this invention to provide improved means for controlling the operation of an ash handling system of the type including a conduit for ash removal by vacuum wholly automatically from various points in the conduit in predetermined sequence, or manually, selectively from various points in the conduit in any sequence.

Another object of this invention is to provide such an ash handling system with improved control means which is responsive to the degree to which the conveying me-

dium is laden with ash, irrespective of vacuum, as a consequence of which there is eliminated any compromise adjustment of the control means due to varying physical characteristics of the several materials to be handled.

And another object of this invention is to provide such an ash handling system with improved control means including photoelectric cell and light source means, which is substantially more responsive to changes in the degree to which the conveying medium is laden with ash than a vacuum switch is to changes in vacuum in the conduit.

Still another object of this invention is to provide such an ash handling system with more reliable means for indicating the flow of material in the conduit, such means being more reliable by reason of being independent of vacuum in the conduit.

And still other objects of this invention are to provide such an ash handling system with control means which is comparatively simple to install and easy to adjust, which affords increased protection against drawing hot gases through the system.

The invention will be further understood from the following description when considered in connection with the accompanying drawings, in which a present preferred ash handling system and control means therefor are shown for a multiple unit boiler plant of the type used for steam driven power plants and the like, and its scope is defined by the appended claims.

In the drawings:

Figure 1 is a schematic diagram showing an ash handling conduit system and feeder and control means arranged in accordance with the present invention;

Figure 2 is an enlarged vertical section taken on line 2—2 of Figure 1;

Figures 3 and 4 are fragmentary vertical sections taken on line 3—3 of Figure 1 respectively showing different arrangements of the parts; and

Figures 5 and 6 are vertical sections taken respectively on lines 5—5 of Figure 3 and line 6—6 of Figure 4.

Referring to Figure 1, a branched closed conduit system is shown for ash removal from two boiler units of a power plant. The system includes a number of main conduit branches of which only branches 10 and 11 are shown. The latter respectively serve boilers 12 and 13 indicated generally by the center lines shown in the figure. The main conduit branches 10 and 11 are each supplied with ash through feeder units, the main conduit branch 10 being provided with rotary feeder valves or gates 14, 15, 16 and 17, and the main conduit branch 11 being provided with rotary feeder valves or gates 18, 19, 20 and 21.

It will be noted that the main conduit branches 10 and 11 are additionally provided respectively with cut-off gates 22 and 23, and stack hoppers 24 and 25 are connected respectively with the main conduit branches 10 and 11 through cut-off gates 26 and 27, all of which gates are arranged to be electrically operated through solenoid elements, indicated at 28, connected electrically with the remainder of the system.

The rotary feeder gates are each provided with a hopper 29 and are each driven by an electric motor 30 through a suitable belt drive as indicated. Any suitable feeder unit may be used, but it may be assumed that each feeder unit is of the rotary-vane type for carrying the ash from the hoppers into the conduit system when operated by the motor means. Each motor 30 is provided with a control unit, as indicated at 31, connected electrically with the remainder of the system.

It will be noted that the ash conveying main conduit branches 10 and 11 are joined with a common conduit section 32, in which is located a steam jet 33 directed to produce a vacuum on the system when supplied with steam, the supply of steam being controlled by a steam valve (not shown) connected electrically with the remainder of the system. The common conduit section 32 is connected with a relatively large ash receiver and separator unit 34, into which it discharges the ashes and other products of combustion drawn from the main conduit branches 10 and 11. The ash-free air is discharged through the open top outlet conduit 35, while the ashes are removed from a suitable ash hopper, as indicated at 36, at the bottom of the separator unit. The handling of the ashes beyond this point does not concern the present invention.

In construction and operation the ash handling system of the present invention generally is similar to that disclosed in the pending application of William D. Hughes, to which reference may be had for details of construction and operation not set forth herein. Of course, the disclosure of only two main conduit branches in the system of the present invention is merely for the purpose of illustration. It will be understood that the number of such branches may be reduced to one or increased to three, as disclosed in the aforementioned pending application, or even more. The system of the present invention and that of the aforementioned pending application do differ essentially in that the electrical means which controls the latter system is arranged to respond to the operation of a vacuum switch, whereas that which controls the system of the present invention is arranged to respond instead, to the operation of light source and photoelectric cell means now to be described.

The light source and photoelectric cell means includes a light source unit 37 and a photoelectric cell unit 38 connected into the system for control purposes, extending outwardly preferably horizontally respectively from opposite sides of the conduit section 32. The light source and photoelectric cell units are carried by the conduit section 32, which is common to the main conduit branches 10 and 11. For connecting the light source and photoelectric cell units into the common conduit section 32, diametrically opposed portions of the wall of the conduit are provided respectively with a pair of axially aligned integral bosses 39—39 which project outwardly therefrom in opposite directions. The bosses 39—39 are provided each with an external flange 40 and a central bore having a tapered outer portion, as indicated at 41, and a constricted inner portion which communicates with the interior of the conduit section 32, as indicated at 42.

The bosses 39—39 carry respectively a pair of sleeves 43—43 each of which is provided with an external flange 44 and external threads respectively at opposite ends thereof. For mounting the sleeves 43—43, the flanges 44—44 are conventionally bolted respectively to the flanges 40—40 of the bosses 39—39, as indicated at 45, and when the sleeves 43—43 are thus mounted they communicate respectively with the central bores which extend through the bosses 39—39.

The sleeves 43—43 carry respectively a pair of fittings 46—46 each of which is provided with parallel external flanges 47 and 48 respectively at opposite ends and a deep annular groove 49 in one face disposed in concentric relation to a central bore, there being thus formed a pair of axially extending concentric annular walls 50 and 51, the wall 50 defining the central bore and the walls 50 and 51 defining the groove 49.

The fittings 46—46 carry a pair of centrally apertured plates 52—52. For mounting the plates 52—52, the same are conventionally bolted respectively to the wall 50 of the fitting 46, as indicated at 53, and to the wall 51 of the fitting 46, as indicated at 54, and when the plates 52—52 are thus mounted the grooves 49—49 of the fittings 46—46 are closed so as to form annular chambers. The central bores through the fittings 46—46 are each provided with a portion 55 which is proximate the plate 52 and a reduced bore portion 56 which is proximate the flange 48 of the fitting 46, an annular shoulder 57 being formed where the diameter of the bore changes. A lens 58 is fitted into the bore portion 55 and is seated against

the shoulder 57, being conventionally secured against removal as by a split ring 59.

For mounting the assemblies each comprising a fitting 46, a plate 52 and a lens 58, the annular walls 50—50 of the fittings 46—46 are provided with internal threads through the medium of which the aforementioned assemblies are secured respectively upon the sleeves 43—43. The annular walls 50—50 of the fittings 46—46 are additionally provided each with a group of four circumferentially equally spaced radially extending openings 60 which place the annular chamber 49 in communication with the bore portion 55 of the central bore through the fitting 46, and the annular walls 51—51 of the fittings 46—46 are provided each with a group of four circumferentially equally spaced radially extending openings 61 which place the annular chamber 49 in communication with atmosphere. It will be noted that the openings 60 in the annular walls 50 are axially alined respectively with the openings 61 in the annular walls 51. The light source unit 37 and the photoelectric cell unit 38 project outwardly respectively from the fittings 46—46. The light source unit 37 is provided with a casing 62, a lense board 63 and a lens 64, while the photoelectric cell unit 38 is provided with a casing 65 and a shutter 66, a lense board 67 and a lens 68.

The light source unit 37 is suitably connected through leads in a conduit 69 with a source of electricity, while the photoelectric cell unit is connected electrically through leads in a conduit 70 with the remainder of the electrical system. The light source and photoelectric cell units per se may be of any conventional construction, and, therefore, a further detailed description thereof is believed to be unnecessary except to point out that the photocell unit is operative when influenced by light to produce an electric current, which may be amplified as desired, sufficient to energize an electrically operated sequential control relay or other device for controlling the operation of the ash conveying system or any desired part thereof. Preferably, the terminal leads 80—80 of the photocell unit 38 are electrically connected to a relay 81 for controlling the operation of a switch 82 the contacts 83 and 84 of which are normally closed when the amount of ash being conveyed through the discharge conduit is reduced to substantially zero or a predeterminedly established minimum, whereupon the electrical control circuit is rendered effective to operate the conveying system as required.

The light source unit 37 projects a beam of light across the interior of the conduit section 32, the light beam passing through the lenses 64—58—58—68 to the photoelectric cell unit 38. The intensity of the light beam at the photoelectric cell unit 38 depends in part upon the intensity of the light beam at its source and in part upon the light passing capacity of the lenses 58—58. The latter are made preferably of clear glass, but, of course, in the operation of the ash handling system some ash will settle upon the inner faces thereof, reducing their light passing capacity and correspondingly reducing the intensity of the light beam projected as aforementioned. When the ash handling system is under vacuum, excessive reduction in the light passing capacity of the lenses 58—58 is avoided through the medium of openings 60 and 61 and the annular chambers 49—49 of the fittings 46—46. Air from atmosphere is drawn through the openings 61 into the annular chambers 49—49, from the chambers 49—49 through the openings 60 into the bore portions 55—55 of the fittings 46—46, and from the latter through the sleeves 43—43 and the bosses 39—39 into the interior of the conduit section 32. The inrushing ash-free air streaming across the faces of the lenses 58—58 insures against excessive accumulations of ash on their inner faces and in the passages communicating with the interior of the conduit 32. In the event that the ash handling system operates under positive instead of negative pressure, excessive reduction in the light passing capacity of the lenses 58—58 is avoided by plugging, in each of the fittings 49—49, all but one of the openings 61, as indicated at 71, and supplying ash-free air (or another gaseous agent) under suitably higher pressure than that prevailing in the conduit to the annular chambers 49—49 through conduits 72—72 connected respectively into the unplugged openings 61—61.

The intensity of the light beam when it reaches the photoelectric cell unit 38 additionally depends upon the degree to which the conveying medium in the conduit section 32 is laden with ash, it being understood that the conveying medium may be air from atmosphere or some other gaseous agent and that the term "ash" is used herein and in the appended claims broadly to designate not only finely divided solid products of combustion variously known as dust, fly ash, precipitator ash, soot, bottom ash and the like, but additionally any other air-conveyable material which resists the penetration of light. The greater the volume and accordingly the light-obscuring density of the ash present in the conveying medium, the more the intensity of the light beam is reduced until the light beam is totally obscured and fails to penetrate to the photoelectric cell 38.

Normally the condition of the lenses 58—58 is such that approximately 60 per cent of the light projected by the unit 37 is obscured, irrespective of ash in the conduit section 32. However, the amount of obscurity may vary between 100 percent and the aforementioned 60 percent, depending upon the degree to which the conveying medium is laden with ash. The photoelectric cell unit 38 is arranged to respond to a highly selective amount of obscurity ranging between the aforementioned total and minimum obscurities. As a hopper 29 is emptied, the amount of ash in the conveying medium is decreased with resulting decrease in the degree of obscurity to passage of light to the photoelectric cell unit 38. When the degree of obscurity has dropped to a predeterminedly established value, the effective intensity of the light projected to the photoelectric cell unit 38 is translated by said unit into an electrical current capable of rendering effective the electrical circuit for controlling the operation of the ash conveying system. When the flow of ash through the discharge conduit is reduced to a predetermined minimum, as when a given hopper is emptied of its complement of ash to be discharged into the conduit, the photoelectric cell will be activated to electrically indicate this prevailing condition upon a suitable indicator included in the electrical control circuit. The electrical control means is so arranged and operative that upon the continuance of the aforementioned indication for a predetermined period of time, the ash removing operation will be shifted to another hopper through the medium of an electrically operated sequence contactor suitably included in the electrical control circuit.

While any suitable electrical control circuit may be employed for effecting any desired sequential discharge of ash from the several hoppers 29 by selective operation as desired of the rotary feeder gates of the several hoppers and of the cut-off gates respectively included in the several branches of the conduit system, it will be understood that the electrical circuit, which is triggered and controlled by the photoelectric cell unit, hereinbefore described, preferably includes an electrically operated time delay relay which is immediately associated with and operated by the photo-cell unit for effecting the operation in turn of a sequence contactor of the several gates of the conduit system through which ash may be discharged into the conveying medium. The electrical system also includes electrically operated cam timers and control relays for opening and closing the supply valve (not shown) for the steam which is discharged by the steam jet 33 to induce the necessary vacuum in the ash-conveying conduit system, it being the general practice to time the operation of the steam supply valve so that it

is alternately open for 50 seconds and closed for 50 seconds.

As has been previously indicated, the time-delay relay which is interposed in the electrical circuit between the photoelectric cell unit and the sequence contractor is timed to operate the sequence contactor and step it from one contact to a next succeeding one thereof only upon elapse of 15 seconds following complete evacuation of ash from the conveying system. Should the conveying medium in the region of the photo-cell unit contain ash in an amount sufficient to effectively reduce the intensity of the light from the light source to a point where the light at the photo-cell unit is not enough to energize the photo-cell unit, then the time-delay relay remains ineffective to advance the sequence contactor for establishing the electrical circuit necessary to effect discharge of ash from the next ash-discharging station of the system. Also, should a given station fail to effect complete discharge of its ash within the first 35 seconds of the 50 second on period of vacuum in the ash-conveying line, thereby leaving less than 15 seconds of such on period for complete evacuation of ash from the line, the time-delay relay operates to hold the sequence contactor in position to further effect discharge of ash from the given station immediately following expiration of the 10 second off period and resumption of the 50 second on period of operation of the vacuum-producing steam jet. This cycle of operation is repeated so that the several ash-collecting hoppers respectively completely discharge their complements of collected ash into the ash-conveying line sequentially in accordance with the operation of the sequence contactor. It will be understood, of course, that for proper sequential operation and discharge of the several ash-collecting units of the system, the electrical control circuit will include such auxiliary time-delay and control relays and other electrically operated devices as may be necessary, in connection with which reference is made to the aforesaid Patent 2,705,136, for disclosure of an illustrative electrical circuit which is triggered by a vacuum switch instead of by the photo-sensitive means of the present invention.

The utilization of the photo-sensitive means of the present invention in the ash-conveying system of the character above described for triggering and controlling the operation thereof provides important advantages over use of the conventional vacuum-switch. As will be apparent, vacuum-switch control of the conveying system is sensitive to variations in the degree of vacuum present in the ash-conveying line and when it is considered that a given hopper in the system may discharge alternately fly ash and bottom ash it will be appreciated that substantial fluctuations may occur in the amount of vacuum in the line due entirely to different densities of the material conveyed therethrough. Of course, the vacuum-switch is initially operatively adjusted to effect sequential operation of the several hoppers of the system operating at a predetermined average degree of vacuum best suited for conveying material of quite different densities. This adjustment at best is but a compromise, because the switch adjustment ideal for handling fly-ash, for example, is not ideal for handling bottom ash, and such compromised adjustment of the vacuum switch for any particular ash-conveying system gives rise to false indications of the amount of material present in the line and frequently results in discharge of ash from a hopper prematurely in advance of one not already completely emptied of ash.

Should the vacuum switch be set for selective operation at a relatively low degree of vacuum, as for handling exceedingly light weight material, it may and does frequently happen that upon complete discharge of such material from a given hopper of the system, the resulting vacuum differential is insufficient to effect operation of the vacuum switch in consequence of which there is no sequential advance from said given hopper to another hopper and the system thus remains practically inoperative even though the vacuum in the line has dropped to a minimum.

In contradistinction to the above, the photosensitive means of the present invention insures sequential operatoin of the several hoppers of the system regardless of fluctuations in the degree of vacuum prevailing in the system, and is much more sensitive to minute variations in the light-obscuring density of the material present in the conveying medium than is the vacuum switch to correspondingly minute fluctuations in the degree of vacuum necessary for conveying the material through the conduit.

Even though, as above pointed out, the lens obscurity to light of the photosensitive means may be such as to permit only 40 percent of the light from the light source to project onto the photocell, the remaining effective light is more than sufficient to activate the photo-cell for any desired operating conditions. In actual practice, the photocell is adjusted for energization of its electrically connected timer-relay to effect sequential operation in turn of the sequence contactor when a predetermined amount of light traverses the conduit and is directed upon the photocell. The light effective for this purpose is within the 40 percent range available. Any intensity of this available light may be utilized as the minimum below which the photocell remains unenergized and above which it becomes energized to trigger the electrical control circuit for the system, and may be selected as the zero value which corresponds to the absence of any ash in the conveying medium, any change in such intensity being in accordance with and measure of the volume of the light-obscuring ash in the line. Consequently, the presence or absence of ash in the conveying conduit in the immediate region of the photosensitive means renders the latter effective to trigger and control the electrical control circuit of the system independently of any vacuum fluctuations in the ash-conveying line.

In addition to the timer and control relays and other devices normally included in the electrical circuit which is controlled by the photosensitive means of the present invention, there may be included also in such circuit means for electrically indicating and recording the condition of the system during operation thereof. The indicating means may be an instrument mounted upon the instrument panel of the system for visually indicating the volume or light-obscuring density of the ash or other material present in the conveying medium, the instrument being suitably calibrated for varying degrees of obscurity from zero up.

The condition of the discharge system at each boiler outlet may be recorded automatically by suitable stylus recorders also mounted on the instrument panel, the number of these recorders corresponding to the number of automatically operated feeder gates. Any conventional types of indicating and recording means may be employed and inasmuch as they constitute no part of the present invention, no description thereof is deemed to be necessary.

It will be understood, of course, that the present invention is susceptible of various changes and modifications which may be made from time to time without departing from the general principles or real spirit of the invention and it is accordingly intended to claim the same broadly, as well as specifically, as indicated in the appended claims.

What is claimed as new and useful is:

1. An ash handling system for ash producing means comprising conduit means, valved means operatively interposed between said ash producing means and said conduit for controlling the discharge of ash from said ash producing means into said conduit at a plurality of different points, electrically operated means for periodically applying a vacuum to said conduit for drawing therethrough an ash conveying medium, and photosensitive means on the downstream side of all of said different points of discharge into said conduit means and responsive to a predetermined intensity of light projected across

the path of said conveying medium for initiating the actuation of said valved means in sequence.

2. An ash handling system for a plurality of ash producing units comprising an ash conveying conduit, electrically operated ash feeder means connected with said conduit at each of said ash producing units for feeding ash to said conduit from each of said units, electrically operated means for periodically applying a vacuum to said conduit for drawing therethrough an ash conveying medium, and electrical control means including a light source unit for projecting a beam of light across the path of the conveying medium at a point on the downstream side of all of said ash feeder means, and a photoelectric cell unit for receiving said light beam and responsive to a predetermined intensity thereof for effecting sequential operation of said feeder means.

3. An ash handling system as defined in claim 2, wherein the electrically operated ash feeder means are further sequentially controlled by electrical timing relay means providing a predetermined time of operation for each of the feeder means, and wherein said timing relay means is controlled by an additional relay means in turn controlled by the light source and photoelectric cell units, whereby when the intensity of the light beam at the photoelectric cell unit increases to a predetermined point in response to reduction in the degree to which the conveying medium is laden with ash, the operation of the system is advanced.

4. An ash handling system for a plurality of ash producing units comprising an ash conveying conduit having a branch for each ash producing unit, electrically operated ash feeder means connected with each conduit branch and the associated ash producing unit for feeding ash to said ash conveying conduit, electrically operated means for periodically applying a vacuum to said conduit for drawing therethrough an ash conveying medium, and electrical control means including a light source unit for projecting a beam of light across the path of the conveying medium, and a photoelectric cell unit for receiving said light beam and responsive to a predetermined intensity thereof for effecting sequential operation of said feeder means, said light source and photoelectric cell units being associated with a section of said conduit into which the several conduit branches aforesaid commonly discharge.

5. An ash handling system as defined in claim 4, wherein the ash feeder means are sequentially responsive through electrically operated timing relays one for each ash producing unit, and wherein the timing relays are selectively controlled by said light source and photoelectric cell units.

6. An ash handling system for a plurality of ash producing units comprising an ash conveying conduit having a branch for each ash producing unit, electrically operated means for periodically applying a vacuum to said conduit to effect ash withdrawal thereto, a plurality of electrically operated ash feeding devices for each ash producing unit connected with a branch of said conduit, electrically operated gate means for selectively placing each conduit branch in operation, and photosensitive means responsive to the degree of light-obscurity of the ash present in the ash conveying conduits for controlling the operation of the system, and means providing sequential control of the ash feeding devices of the system.

7. An ash handling system for ash producing means comprising conduit means, valve means operatively interposed between said ash producing means and said conduit for controlling the discharge of ash from said ash producing means into said conduit at a plurality of different points, means for applying a vacuum to said conduit, means for progressively actuating the valve means including a photosensitive device on the downstream side of all of said different points of discharge into said conduit means and responsive to the light-obscuring density of the ash in the conduit.

8. An ash handling system for ash producing means comprising conduit means, valved means operatively interposed between said ash producing means and said conduit for controlling the discharge of ash from said ash producing means into said conduit at a plurality of different points, means for applying a vacuum to said conduit, valve control means, and automatically actuated electrical control means including a device on the downstream side of all of said different points of discharge into said conduit means and which is sensitive to light penetrating the ash present in the conveying medium for energizing successively the valved means aforesaid.

9. In an ash handling system, a conduit for a gaseous ash conveying medium, means for feeding said conduit with ash to be conveyed through said conduit by said gaseous medium, and electrical control means for said ash feeding means including photosensitive means responsive to the degree to which said gaseous medium is laden with ash, said photosensitive means including a member through which light may pass and which is disposed in sealing relation to a passage for light formed in the wall of said conduit, a photoelectric cell, means for projecting a beam of light across the interior of said conduit and through said sealing member to said photoelectric cell, and means for directing an ash-free gaseous medium across the inner face of said sealing member to insure against the excessive accumulation of ash thereon.

10. In an ash handling system, a conduit for a gaseous ash conveying medium, means for feeding said conduit with ash to be conveyed through said conduit by said gaseous medium, and electrical control means for said ash feeding means including photosensitive means responsive to the degree to which said gaseous medium is laden with ash, said photosensitive means including a pair of members through which light may pass and which are disposed in sealing relation respectively to a pair of passages for light formed in the wall of said conduit, a photoelectric cell, and means for projecting a beam of light through one of said sealing members, across the interior of said conduit and through the other of said members to said photoelectric cell, and means for directing an ash free gaseous medium across the inner faces of said sealing members for insuring against the excessive accumulation of ash thereon.

11. In an ash handling system, a conduit for a gaseous ash conveying medium, means for feeding said conduit with ash to be conveyed through said conduit by said gaseous medium, and electrical control means for said ash feeding means including photosensitive means responsive to the degree to which said gaseous medium is laden with ash, said photosensitive means including means having formed therein a pair of elongated passages for light extending laterally outwardly respectively on opposite sides of said conduit and communicating with the interior thereof, a pair of members through which light may pass disposed in sealing relation respectively to the outer ends of said passages, a photoelectric cell, means for projecting a beam of light through one of said sealing members, across the interior of said conduit and through the other of said sealing members to said photoelectric cell, and means for directing an ash-free gaseous medium across the inner faces of said sealing members and through said passages for insuring against the excessive accumulation of ash on said faces or in said passages.

12. In an ash handling system, a conduit under vacuum for drawing therethrough an ash conveying medium, means for feeding said conduit with ash, and electrical control means for said ash feeding means including photosensitive means responsive to the degree to which said conveying medium is laden with ash, said photosensitive means including a pair of transparent members disposed in sealing relation respectively to a pair of passages for light formed in the wall of said conduit, a photoelectric cell, and means for projecting a beam of light through one of said transparent sealing members, across the in-

terior of said conduit and through the other of said sealing members to said photoelectric cell, and means associated with said transparent sealing members through which, when said conduit is under vacuum, air from atmosphere is drawn across the inner faces of said transparent sealing members for insuring against the excessive accumulation of ash thereon.

13. In an ash handling system, a conduit under positive pressure for forcing therethrough an ash conveying medium, means for feeding said conduit with ash, and electrical control means for said ash feeding means including photosensitive means responsive to the degree to which said conveying medium is laden with ash, said photosensitive means including a pair of transparent members disposed in sealing relation respectively to a pair of passages for light formed in the wall of said conduit, a photoelectric cell, and means for projecting a beam of light through one of said transparent sealing members, across the interior of said conduit and through the other of said sealing members to said photoelectric cell, and means associated with said transparent sealing members through which, when said conduit is under said positive pressure, a gaseous medium under suitably higher pressure is directed across the inner faces of said transparent sealing members for insuring against the excessive accumulation of ash thereon.

14. In an ash handling system, a conduit under vacuum for drawing therethrough an ash conveying medium, means for feeding said conduit with ash, and electrical control means for said ash feeding means including photosensitive means responsive to the degree to which said conveying medium is laden with ash, said photosensitive means including means having formed therein a pair of elongated passages for light, said passages extending laterally outwardly respectively on opposite sides of said conduit and communicating with the interior thereof, a pair of transparent members disposed in sealing relation respectively to the outer ends of said passages, a photoelectric cell unit carried by one of said sealed means, a light source unit carried by the other of said sealed means for projecting a beam of light through one of said transparent sealing members, across the interior of said conduit and through the other of said transparent sealing members to said photoelectric cell, said sealed means being provided each with a plurality of openings through which, when said conduit is under vacuum, air from atmosphere is drawn across the inner faces of said transparent sealing members for insuring against the excessive accumulation of ash thereon.

15. A material handling system comprising conduit means, valved means for controlling the delivery of material into said conduit at a plurality of different points, means for producing in said conduit movement of a material conveying medium, and photosensitive means responsive to a predetermined intensity of light projected across the path of said conveying medium at a point on the downstream side of all of said different points of discharge into said conduit means for initiating the actuation of said valved means in sequence.

16. An ash handling system for a plurality of ash producing units comprising an ash conveying conduit, electrically operated ash feeder means connected with said conduit at each of said ash producing units for feeding ash to said conduit from each of said units, electrically operated means for periodically producing flow through said conduit of an ash conveying medium, and electrical control means including a light source unit for projecting a beam of light across the path of the conveying medium at a point on the downstream side of all of said ash feeder means, and a photoelectric cell unit for receiving said light beam and responsive to a predetermined intensity thereof for effecting sequential operation of said feeder means.

17. An ash handling system for ash producing means comprising conduit means, valve means operatively interposed between said ash producing means and said conduit for controlling the discharge of ash from said ash producing means into said conduit at a plurality of different points, means for creating an air flow through said conduit for conveying ash therethrough, means for progressively actuating the valve means including a photosensitive device on the downstream side of all of said different points of discharge into said conduit means and responsive to the light-obscuring density of the ash in the conduit.

18. A material handling system comprising conduit means, valved means for controlling the delivery of said material into said conduit at a plurality of different points, means for effecting flow of a gaseous medium through said conduit for conveying said material therethrough, valve control means, and automatically actuated electrical control means including a device on the downstream side of all of said different points of discharge into said conduit means and which is sensitive to light penetrating the material present in the conveying medium for energizing successively the valved means aforesaid.

19. In a material handling system, a conduit for a gaseous conveying medium, means for feeding said conduit with material to be conveyed through said conduit by said gaseous medium, and electrical control means for said material feeding means including photosensitive means responsive to the degree to which said gaseous medium is laden with material, said photosensitive means including a member through which light may pass and which is disposed in sealing relation to a passage for light formed in the wall of said conduit, a photoelectric cell, means for projecting a beam of light across the interior of said conduit and through said sealing member to said photoelectric cell, and means for directing a material-free gaseous medium across the inner face of said sealing member to insure against the excessive accumulation of material thereon.

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