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ELECTRICAL PRECIPITATION APPARATUS

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Fig. 1.

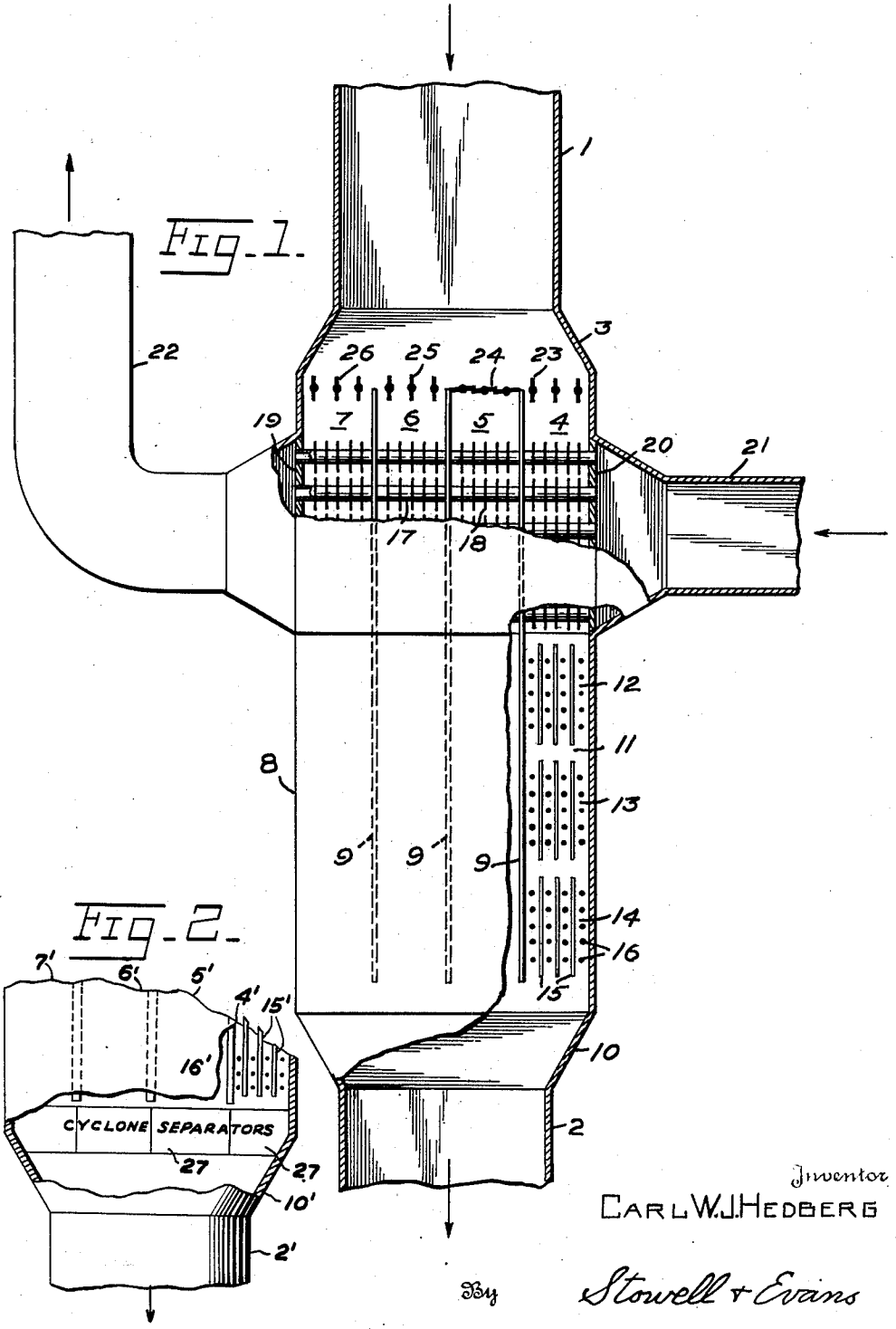


Fig. 2.

Inventor

CARL W. J. HEDBERG

By Stowell & Evans

Attorneys

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ELECTRICAL PRECIPITATION APPARATUS

Carl W. J. Hedberg, Bound Brook, N. J., assignor to Research Corporation, New York, N. Y., a corporation of New York

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9 Claims. (Cl. 183—7)

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This invention relates to electrical precipitation apparatus and more particularly to such apparatus of relatively large size employing a plurality of precipitation chambers to which gas to be cleaned is delivered from a plenum chamber.

The invention is particularly useful in controlling the loss of dust from precipitators when the electrodes are rapped for removal of the precipitate from the collecting electrodes. This problem is especially troublesome with large precipitators handling large gas volumes such as are usually employed for removal of fly ash from the combustion gases from large pulverized coal fired boilers. Ordinarily these boilers operate continuously for long periods of time and it is not possible to interrupt the gas flow through the precipitator unit employed for collection of the ash either for rapping of the electrodes or for other servicing operations.

In normal operation much of the precipitated dust falls from the electrodes naturally into the hoppers below. However, there is a residual accumulation of dust on the electrodes which necessitates that these be rapped or vibrated to loosen the residue and cause it to fall into the hopper. When this operation is carried out with normal gas flowing, there is an unusually heavy discharge of dust from the stack, the maximum density of which may reach 3 to 5 times the density of ash in the gases normally coming to the precipitator. The frequency and duration of the vibrating operation will vary over a considerable range. Frequency may be from once each ½ hour to once in 24 hours, and the duration of the vibration may run from approximately 20 seconds up to 2 minutes. While the daily loss of dust during this period may be a relatively small proportion of the total 24-hour load entering the precipitator, the contrast in stack appearance resulting from the rapping operation is objectionable in many installations.

In prior art constructions, dampers have been used either directly at the inlet or outlet of the precipitator. Since most of these precipitators are very large, it has been found impractical with this damper location to redistribute the gas flow uniformly over the other units of the precipitator when one unit is dampered off for rapping. Usually this operation results in a very great increase in gas velocities through the unit or units adjacent to that one which is being rapped with relatively little added flow to the units further removed. As a result, the very great increase in velocity through an adjacent unit causes very high loss of dust from the unit even though it is not being rapped.

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I have found that by inserting in the gas stream flowing to each precipitation chamber means providing a high pressure drop, distribution of the gas to remaining units is greatly facilitated.

It is a principal object of the invention to provide in electrical precipitation apparatus of the type referred to above, means substantially equalizing gas flow to a plurality of precipitation chambers arranged in parallel when one or more of the chambers is blanked off for electrode rapping or servicing.

A further object is to provide in an electrical precipitator for removing fly ash from furnace gases, means accomplishing the primary object of the invention while retaining the inherent advantages of heat exchange, as provided by exchangers of known design, and of precooling the hot furnace gases prior to subjecting them to electrical precipitation.

Another object is to provide electrical precipitation apparatus for cleaning furnace gases that permits rapping of the electrodes without danger of unduly high re-entrainment of precipitated fly ash.

Yet another object is to provide improved electrical precipitation equipment that is simple in design and economical to manufacture and operate, that has a long service life, and that can be operated continuously over extended periods of time without requiring periodic shutdowns.

In a characteristic embodiment, the device of the invention comprises, in an electrical precipitation apparatus, at least three electrical precipitation chambers each including spaced electrode members, a common plenum chamber from which gas to be treated is supplied to said precipitation chambers, separate gas passages leading from said plenum chamber to each of said precipitation chambers, means for selectively and separately interrupting the flow of gas between said plenum chamber and each of said precipitation chambers, and means intermediate said plenum chamber and the outlet ends of said precipitation chambers to effect a substantial pressure drop in the flow of gas therethrough.

Air preheaters as commonly supplied on steam generating units may be used advantageously as the means for effecting a substantial pressure drop in the flow of gas to the precipitation chambers.

The foregoing and other objects and advan-

tages of the invention will be in part apparent and in part pointed out in the following detailed description of a preferred embodiment of the invention as shown in the accompanying drawing wherein: Fig. 1 is a plan view of an electrical precipitation system in accordance with the invention, parts being broken away to show interior construction, and Fig. 2 is a fragmentary plan view of another form of electrical precipitation system in accordance with the invention.

Referring to the drawing, particularly to Fig. 1 thereof, the electrical precipitation equipment shown is especially suited to the removal of fly ash from furnace gases. Hot furnace gases enter the apparatus through an inlet duct 1 in the direction of the arrow at the top of the sheet and flow through the apparatus to an outlet duct 2 under draft forced from the inlet side or induced from the outlet side by suitable fans or blowers which may be assisted by stack draft. These devices, well known to the art, are not illustrated.

From the inlet duct, the stream of hot gases passes to a plenum chamber 3 and from the plenum chamber through four passageways 4, 5, 6 and 7, defined by the casing 8 and the three parallel gas impervious plates 9. After issuing from the four passageways, the streams of gas are reunited in the chamber 10 and pass out of the apparatus.

As illustrated in the passageway 4, there is provided in each of the passageways a precipitating chamber 11 having a plurality of precipitating zones 12, 13 and 14 arranged serially. Each precipitating zone is energized in conventional manner and includes the collecting plate electrodes 15 and the complementary wire or rod discharge electrodes 16. Preferably, the plates 15, the partitions 9, and the walls of the casing 8 are of metallic construction and are grounded; and the discharge electrodes 16 are insulatedly supported in parallel curtains between the collecting electrodes and are supplied with high tension current. As will be understood by persons skilled in the art to which this invention pertains, when the precipitator is energized, ionizing discharge emanates from the wires to charge particles suspended in the gas stream which are then attracted to and precipitated upon the collecting plates 15, the walls of the casing 8, and the partitions 9.

Extending transversely of the passageways 4, 5, 6 and 7 in a zone intermediate the plenum chamber 3 and the precipitation chambers 11 is a heat exchanger including the pipes 17 provided with annular fins 18 for increasing the area of heat exchange contact between the finned pipes and the stream of hot gases flowing thereover. The finned pipes 17 are supported in header plates 19 and 20 and pass through apertures in the partitions 9. Although only the top layer of finned pipes appears in the drawing, it will be understood that the layers of pipes are arranged in tiers extending vertically from top to bottom of the passageways 4, 5, 6 and 7. The specific showing of the heat exchanger is merely illustrative and it will be understood that other types of air heaters that are commercially available may be substituted for the heat exchanger shown, provided the air heater is modified to provide a number of hot gas passages corresponding to the number of precipitating chambers.

Cold air to be used as combustion air for the furnace enters the heat exchanger through the inlet pipe 21 and passes through the finned pipes 17 to the pipe 22 through which it is led to the

furnace. In passing through the heat exchanger, the cold air is heated by the combustion gases flowing over the finned pipes and returns to the furnace as sensible heat much of the heat which would otherwise be lost. The combustion gases are cooled in the process and are delivered to the precipitation chambers at a low temperature permitting the use of low heat-resistant materials in the construction of the precipitation chambers, minimizing corrosion therein and reducing the volume of gas flowing through the precipitation chambers.

The bank of finned pipes 17 provides in each of the passageways means effecting a substantial pressure drop therethrough. Specifically, the total resistance to gas flow through one of the passageways 4, 5, 6 and 7, including a portion of the heat exchanger or other resistance means, should be about two to five times the resistance of the passageway in the absence of the heat exchanger section, such resistances being measured in the range of gas velocities encountered in normal operation. The back pressure drop through the heat exchanger may range from 2" to 5" of water, for example.

At the entrance to the passageways 4, 5, 6 and 7 there are provided the dampers or louvers 23, 24, 25, and 26 that are selectively and separately operable as units by conventional means (not shown) to close or open any one or more of the passageways. Dampers 24 are shown in closed position and dampers 23, 25, and 26 are shown in open position. The dampers may be set to intermediate positions, if desired.

In the absence of the pressure drop imposed by the heat exchanger, gas flowing through the apparatus would tend to favor passageways 4 and 6 when the passageway 5 is blanked off, and the passageway 7 would carry less than its proportional load. Such a condition would tend to re-entrain precipitated dust from the precipitation chambers of passageways 4 and 6 with resultant loss in efficiency and pollution of the ambient atmosphere. However, with the heat exchanger included, the added resistance thereof distributes the main gas stream substantially uniformly to the passageways 4, 6, and 7 when passageway 5 is closed for rapping or servicing.

The difficulties encountered in the absence of the construction of the present invention are even more pronounced when one of the outer passageways 4 or 7 is closed; conversely, the advantages of utilizing the principles of the invention are even more evident. Were passageway 4 to be closed and the others left open, passageway 5 would carry an inordinate load where no resistance means is provided. On the other hand, with the heat exchanger forming a component of the apparatus, good gas distribution between passageways 5, 6, and 7 is obtained under such circumstances.

It may be pointed out that, in the exemplary construction shown in the drawing, those portions of the partitions 9 that lie on the downstream side of the heat exchanger and serve to separate the precipitation chambers 11 from each other may be omitted without losing the advantages of the invention. In such case, the remaining portions of the partitions 9 serve to direct the gas streams into the several precipitating zones 11, and, once the path of flow has been established the gas will continue to flow rectilinearly through the precipitators without diffusing to an adjacent dampered zone.

The advantages of the invention may be real-

ized where means providing a high pressure drop are placed at the outlet ends of the precipitation chambers on the upstream side of the chamber 10, for example. The resistance means may take the form of cyclone separators arranged in parallel with each other, one or more separators being in series with each precipitation channel. This construction is shown in Fig. 2 wherein parts similar to the parts of the system of Fig. 1 are indicated by similar but primed reference numerals.

Referring to Fig. 2 the precipitating passageways or chambers 4', 5', 6' and 7' are arranged in parallel and in each are positioned the usual complementary discharge electrodes 16' and collecting electrodes 15'. The gas outlet ends of the precipitation chambers communicate with the outlet chamber 19' and outlet duct 2'. Adjacent the outlet end of each of the precipitation chambers is a cyclone separator indicated diagrammatically by the numeral 27. These cyclone separators are arranged each in series with one of the precipitation chambers and in parallel with each other. The separators provide the desired resistance to gas flow through the open precipitation chambers and effect redistribution of gas flow to the open chambers when one or more of the chambers is closed for cleaning and the like.

The apparatus of the invention includes at least three precipitation channels in parallel, so that when one channel is blanked off, there are at least two channels remaining open to carry their respective and proportionate shares of the gas stream.

I claim:

1. In electrical precipitation apparatus, a plurality of electrical precipitation chambers each including spaced complementary electrode members, a common plenum chamber from which gas to be treated is supplied to said precipitation chambers, separate gas passages leading from said plenum chamber to each of said precipitation chambers, heat interchange means in each of said gas passages extending transversely of said gas passages and spaced in the direction of gas flow from said electrode members to afford a substantial resistance to the flow of gas through said passages, and means in each of said gas passages for selectively and separately interrupting the flow of gas between said plenum chamber and each of said precipitation chambers.

2. In electrical precipitation apparatus for removing fly ash from furnace gases, at least three electrical precipitation chambers each including spaced complementary electrode members, a common plenum chamber from which hot furnace gases to be treated are supplied to said precipitation chambers, separate gas passages leading from said plenum chamber to each of said precipitation chambers, heat interchange means in each of said gas passages extending transversely of said gas passages and spaced in the direction of gas flow from said electrode members to afford a substantial resistance to the flow of gas through said passages and means in each of said gas passages for selectively and separately interrupting the flow of gas between said plenum chamber and each of said precipitation chambers.

3. Apparatus for treating hot furnace gases containing fly ash to cool and clean the same comprising means providing an elongated casing, means admitting furnace gases to said casing, a plenum chamber in said casing receiving said furnace gases, spaced parallel partitions in said casing extending longitudinally from the exit end of said plenum chamber to an outlet chamber in said casing and dividing said casing into at least three passages in parallel, louver means at the entrance ends of said passages for selectively and separately interrupting the flow of gas between said plenum chamber and said passages, heat interchange means having a plurality of finned pipes extending continuously and transversely across said passages on the downstream side of said louver means, said heat interchange means providing a substantial resistance to the flow of gas through said passages, electrical precipitation means in said passages on the downstream side of said heat interchange means, and gas outlet means leading from said outlet chamber.

4. A gas treating apparatus comprising a casing, gas inlet means located at one end of said casing, gas outlet means located at the other end of said casing, said casing housing in spaced relationship in the direction of gas flow; louvre means, heat interchange means and electrical precipitator means, and dividing walls in said casing extending in the direction of gas flow and sectionalizing said louvre means, said heat interchange means and said electrical precipitator means into a plurality of parallel sections, said heat interchange means extending transversely of said passages and substantially equalizing gas flow through the operating sections by providing a substantial resistance to the flow of gas in the operating sections when gas flow is interrupted in one of the sections by the louvres.

5. Electrical precipitation apparatus comprising a plurality of electrical precipitation chambers each including spaced complementary electrode members, a common plenum chamber from which gas to be treated is supplied to said precipitation chambers, separate gas passages leading from said plenum chamber to each of said precipitation chambers, heat interchange means in each of said gas passages extending transversely of said gas passages and spaced in the direction of gas flow from said electrode members to afford a substantial resistance to the flow of gas through said passages, and means for selectively and separately interrupting the flow of gas between said plenum chamber and each of said precipitation chambers.

6. Electrical precipitation apparatus comprising at least three electrical precipitation chambers arranged for parallel flow of gas therethrough, each of said chambers having spaced complementary electrode members therein, gas inlet and gas outlet means communicating with each of said chambers, a common plenum chamber communicating with the gas inlet means of said electrical precipitation chambers, gas inlet means communicating with said plenum chamber, means selectively and independently blocking and unblocking flow of gas through each of said precipitation chambers, and fixed gas flow resistance means positioned adjacent at least one end of each of said precipitation chambers, spaced in the direction of gas flow from said electrode members and imposing substantial resistance to the flow of gas through said precipitation chambers.

7. Electrical precipitation apparatus comprising at least three electrical precipitation chambers arranged for parallel flow of gas therethrough, each of said chambers having spaced complementary electrode members therein, gas inlet and gas outlet means communicating with each of said chambers, a common plenum cham-

ber communicating with the gas inlet means of said electrical precipitation chambers, gas inlet means communicating with said plenum chamber, means selectively and independently blocking and unblocking flow of gas through each of said precipitation chambers, and heat interchange means positioned adjacent the inlet end of each of said precipitation chambers, spaced in the direction of gas flow from said electrode members and imposing substantial resistance to the flow of gas through said precipitation chambers.

8. Electrical precipitation apparatus comprising at least three electrical precipitation chambers arranged for parallel flow of gas therethrough, each of said chambers having spaced complementary electrode members therein, gas inlet and gas outlet means communicating with each of said chambers, a common plenum chamber communicating with the gas inlet means of said electrical precipitation chambers, gas inlet means communicating with said plenum chamber, means selectively and independently blocking and unblocking flow of gas through each of said precipitation chambers, cyclone separator means positioned adjacent the outlet end of each of said precipitation chambers, spaced in the direction of gas flow from said electrode members and imposing substantial resistance to the flow of gas through said precipitation chambers.

9. Electrical precipitation apparatus as defined in claim 6 wherein the resistance to gas flow through said gas flow resistance means is from about two to above five times the resistance to gas flow through said precipitation chambers.

CARL W. J. HEDBERG.

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