July 12, 1955 H. A. WINTERMUTE 2,712,859

CENTRIFUGAL GAS CLEANING DEVICE

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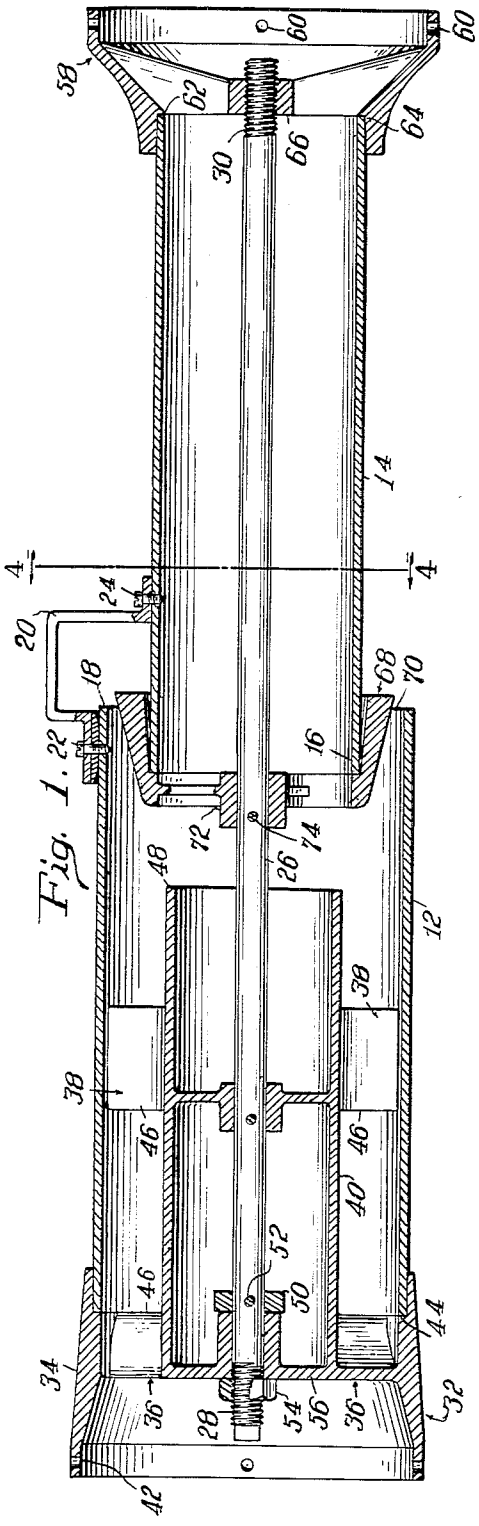


Fig. 1.

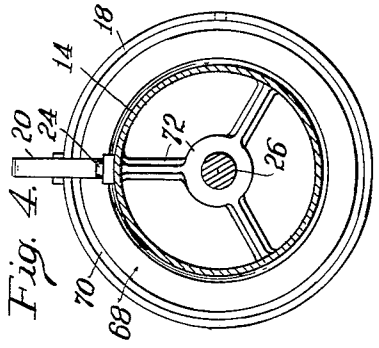


Fig. 4.

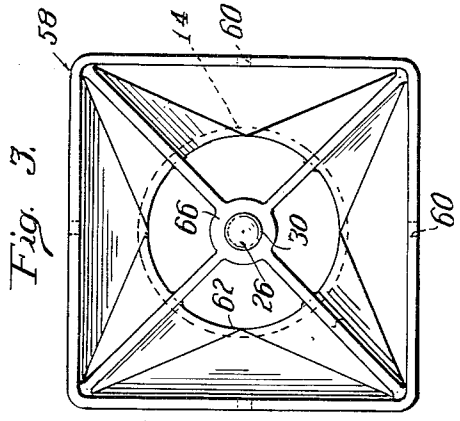


Fig. 3.

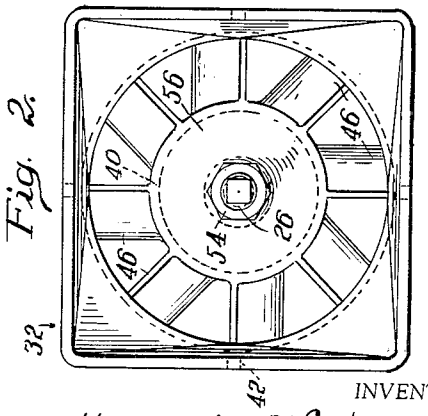


Fig. 2.

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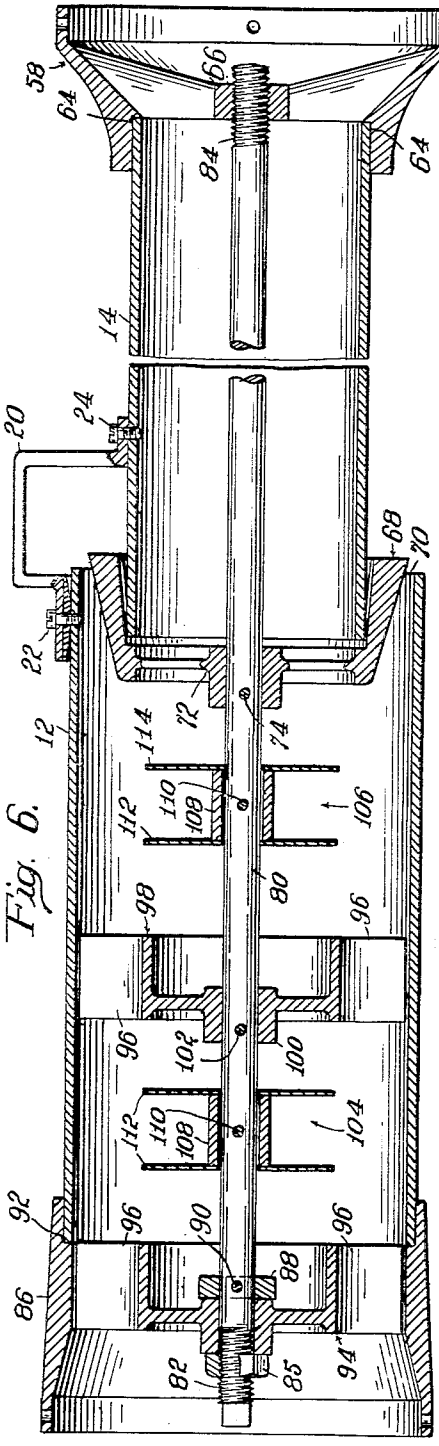


Fig. 6.

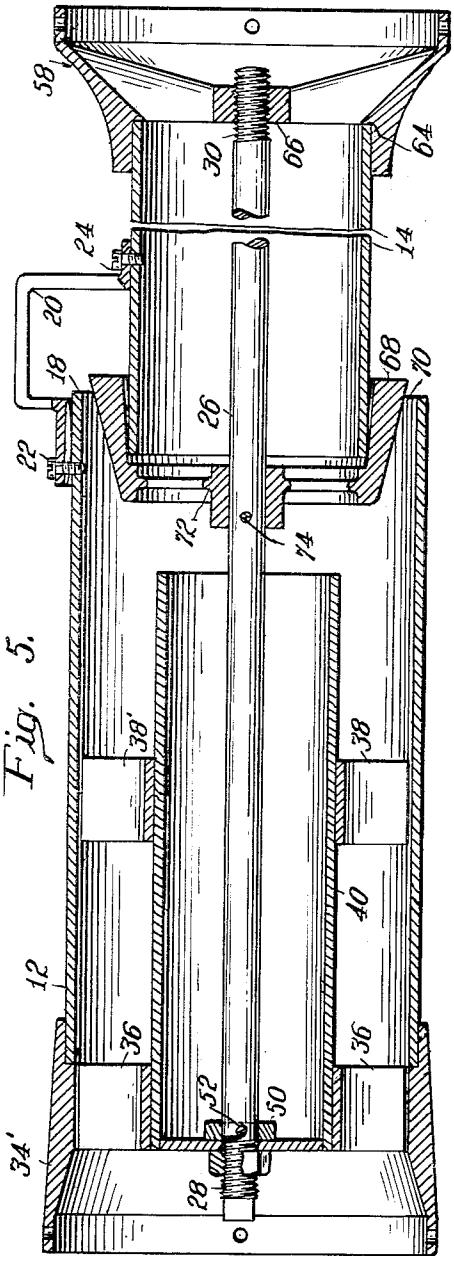


Fig. 5.

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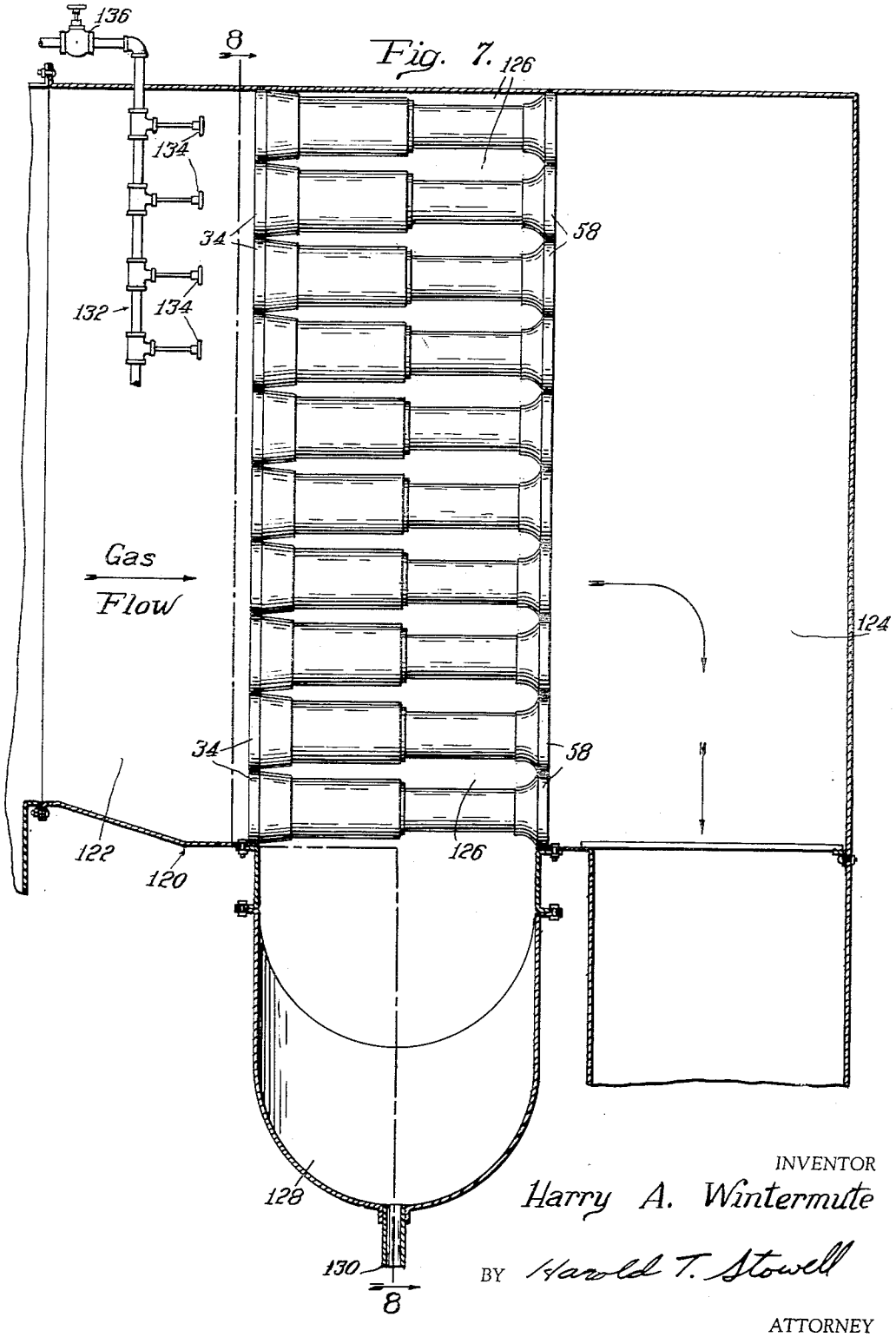
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CENTRIFUGAL GAS CLEANING DEVICE

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Fig. 7.



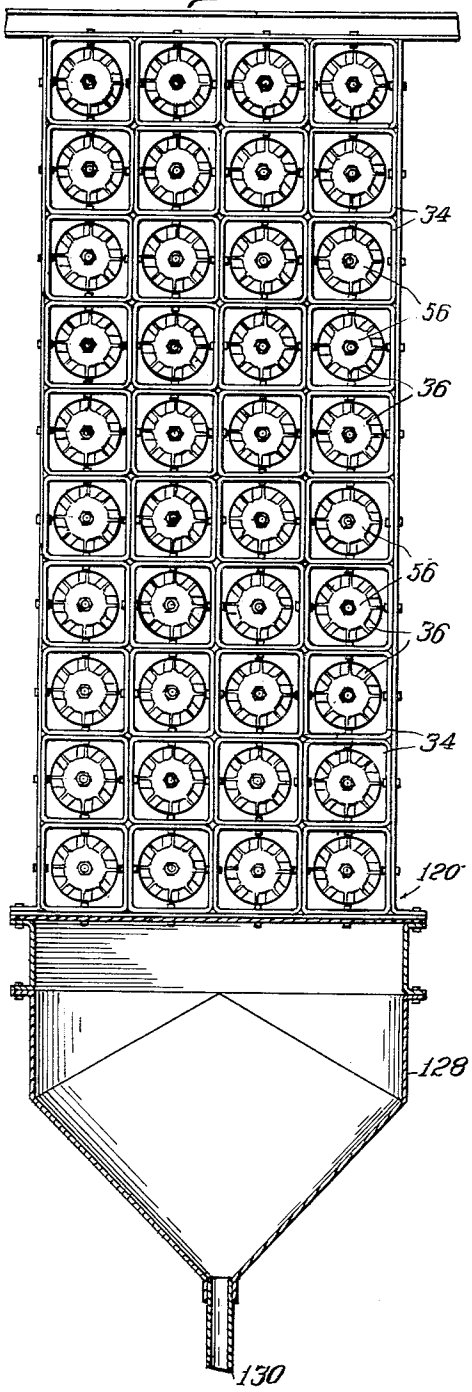
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Fig. 8.



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CENTRIFUGAL GAS CLEANING DEVICE

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Application April 30, 1952, Serial No. 285,694

2 Claims. (Cl. 183—80)

This invention relates to a centrifugal gas cleaning apparatus wherein gas bearing suspended material, such as dust and ash particles, fine droplets of liquid or the like, is passed through a tubular member wherein it is given a swirling motion to cause the suspended material to become concentrated in a layer of the gas adjacent the inner wall of the tubular member.

The gas layer containing the high concentration of suspended material is separated from the remainder of the gas stream by a skimming device and the cleaned gas stream then passes out of the cleaning device. The gas and suspended material that is skimmed off may be subjected to further separatory action if desired.

An object of the invention is to provide a centrifugal gas cleaning apparatus that has no moving parts and is highly efficient in removing suspended particles from a stream of gas.

Another object is to provide such a device that directs the flow of gas therethrough in a manner to provide maximum separatory forces with a minimum of pressure drop.

A further object of the invention is to provide a gas cleaning apparatus that is simple as to its parts and readily assembled and disassembled for cleaning and repair.

Another object of the invention is to provide such a device that is readily adjustable through a wide range of operating conditions.

These and other objects and advantages will be apparent from the following description of the centrifugal separator of the invention which generally comprises a tubular conduit member providing a gas swirling chamber, the conduit member having an open gas inlet end and an open gas outlet end, a discharge tube having an open gas inlet end and an open gas outlet end and projecting coaxially into the outlet end of the tubular conduit member to provide a restricted annular skimming orifice between the inlet end of the discharge tube and the outlet end of the tubular conduit member, gas flow restricting means in the tubular conduit member between the inlet end thereof and the inlet end of the discharge tube defining an annular passage for the flow of gas between said restricting means and the tubular conduit member and a radial passage for the flow of gas from said annular passage into the inlet end of the discharge tube, a first set of annularly arranged swirling vanes in the annular passage adjacent the gas inlet end of the tubular conduit member, and at least one further set of annularly arranged swirling vanes in said annular passage intermediate the first set of swirling vanes and the gas inlet end of the discharge tube.

The invention will be more particularly described with reference to the illustrative embodiments thereof shown in the accompanying drawings in which:

Fig. 1 is an enlarged axial sectional view of one form of gas cleaning unit in accordance with the principles of the invention;

Fig. 2 is a plan view of the forward end of the gas cleaner shown in Fig. 1;

Fig. 3 is a plan view of the rearward end of the gas cleaner shown in Fig. 1;

Fig. 4 is a sectional view taken along the plane of the line 4—4 of the cleaner shown in Fig. 1;

Fig. 5 is an enlarged axial sectional view of another form of gas cleaning unit of the invention;

Fig. 6 is an enlarged axial sectional view of still another form of gas cleaning unit;

Fig. 7 is a vertical longitudinal sectional view of a gas cleaning apparatus including a plurality of gas cleaning units of the invention; and

Fig. 8 is a sectional view taken on the plane of line 8—8 of Fig. 7.

With reference to the drawings, and in particular to Figs. 1 through 4, the gas cleaning unit shown comprises two tubular members 12 and 14 each of uniform diameter throughout its length. Tubular member 12 is the gas treating chamber and tubular member 14 the clean gas collecting flue and discharge tube. The discharge tube 14 is positioned coaxially with respect to the gas treating tube with its inlet end 16 projecting a short distance inwardly of the gas outlet end 18 of tube 12.

A bracket 20 formed of a narrow strip of metal is secured to the tubular members 12 and 14 by screws 22 and 24 to provide proper centering of the tubes and to give support to the assembly. A plurality, for example, three, of these brackets may be spaced about the periphery of the tubular assembly for added strength.

Extending longitudinally through the center of the tube assembly is a tie rod 26 having threaded portions 28 and 30 at the forward and rearward ends respectively.

The forward portion of tie rod 26 carries the gas treating assembly 32 which generally comprises a headpiece 34, a pair of identical swirling vane sets 36 and 38, and a gas flow control plug 40.

The headpiece 34, as more clearly shown in Fig. 2 of the drawings, has a substantially square forward end provided with opening 42 through which bolts may be inserted to secure the gas cleaning units together as to be more fully described hereinafter. The rearward portion of the headpiece is circular in cross-section and is adapted to slip snugly over the forward end of tube 12. An internal shoulder 44 provides a seat for the peripheral end of the tube 12. The vane sets 36 and 38 include generally radially extending vanes 46 which are inclined to the axis of the gas cleaner to impart a whirling or helical motion to gas that passes between the vanes. Both sets of vanes are inclined in the same direction.

The gas control plug 40 extends from the vane set 36 rearwardly of vane set 38 providing a substantially constant area throughout the length of the treating chamber which prevents the expansion of the gas being treated whereby it would lose a substantial portion of its helical motion, while the rearward edge 48 of the plug establishes a point where the gas is given a sharp bend prior to its leaving the treating chamber.

A collar 50 is positioned on tie rod 26 by a drift pin 52 that passes through matching holes in the rod and the collar. The collar 50 limits the forward movement of rod 26 when the nut 54 is screwed onto the shaft and against the hub 56 of the headpiece.

A tailpiece 58, as more clearly shown in Fig. 3 of the drawings, is substantially square in shape and the outer peripheral edges are provided with openings 60 whereby the rearward ends of the cleaning units may be secured together. A circular opening 62 centrally positioned in the tailpiece is adapted to slip snugly over the rearward end of the gas discharge tube. An internal shoulder 64 provides a seat for the peripheral end of the discharge tube. A threaded hub and spider unit 66 connects the tailpiece to the threaded portion 30 of tie rod 26.

A conical venturi skirt **68** is provided on the outside of the discharge tube **14** and this skirt flares outwardly toward the discharge end of tube **12**. Between the outer edge of the skirt **68** and the discharge end of tube **12** is provided a restricted annular orifice **70**. The skirt **68** is provided with a hub and spider **72**, which is positioned on the rod **26** by a drift pin **74** that passes through matching holes in the rod and the hub.

From the foregoing description it will be seen that the single tie rod **26** which extends the length of the gas cleaning unit supports and provides an adjustable control of the head and tail pieces, the vane sets, gas control plug and the venturi skirt. This arrangement permits removal of all of the internal parts of the cleaner by merely unscrewing tie rod **26** from hub **66** and nut **54**, thereby providing easy replacement and cleaning of the internal parts of the structure.

In operation, gas to be cleaned, for example, boiler flue gases carrying suspended fly ash, is passed through the tube assembly from left to right as seen in Fig. 1 under a pressure differential existing between the headpiece of treating tube **12** and the tailpiece of discharge tube **14**. As the gas passes between the vanes of the first vane set **36**, a helical motion is imparted thereto. The centrifugal force thereby produced tends to throw the suspended particles outwardly toward the inner wall of tube **12** separating the gas stream into two homogeneous layers.

As the whirling gas passes through the zone between vane sets **36** and **38**, it continues to whirl with only slight reduction in speed as the gas is prevented from expanding any appreciable amount by flow control plug **40** which also directs the gas through the second vane set **38**.

In passing through the second vane set **38** additional helical motion is imparted thereto. After passing the second vane set the suspended material is concentrated in a very thin layer adjacent the wall of tube **12**. Momentum carries a thin layer of gas containing most of the suspended material through the opening **70**. Owing to the restricted nature of opening **70** and the end of flow control plug **40** most of the gas stream is turned inwardly to flow out of the discharge tube **14** as clean gas. This turning movement throws out of the exhaust gases a final though small increment of suspended material and provides for a sharp line of separation between the suspended particles and the primary flow of gas.

Referring to Fig. 5, another form of gas cleaning unit in accordance with the invention is shown. This unit differs from that shown in Figs. 1 to 3 primarily in the manner in which the gas treating assembly is constructed and supported. Because of the similarity of the units, parts in the unit of Fig. 5 that correspond to parts in the unit of Figs. 1 to 4 are designated by the same reference numerals with prime characters, while like parts have the same reference numerals.

In Fig. 5 the cleaning unit includes the treating tube **12** providing a centrifugal separation zone, the main discharge tube **14**, and conical skirt **68** forming with the tube **12** an annular skimming orifice **70**. Extending longitudinally through the center of the tube assembly is the tie rod **26** which supports and ties together the headpiece **34'** and tailpiece **58** and positions the venturi skirt, vane sets **36'** and **38'** and flow control plug **40'**.

It is seen that in this form of the invention headpiece **34'**, vane set **38'** and flow control plug **40'** are constructed as separate members whereby the individual members may be independently replaced.

Further with the vane set **38'** being constructed as a unit separate from flow control plug **40'**, the position of the vane set **38'** with respect to the venturi skirt **68** and vane set **36'** may be readily adjusted for varying operating conditions since vane set **38'** may be axially positioned along the flow control plug **40'**.

Operation of the unit of Fig. 5 is essentially the same as the hereinbefore described operation of the unit of Fig. 1.

Referring to Fig. 6 of the drawings, another form of gas cleaning unit in accordance with the invention is shown. Like parts in units of Figs. 1 to 4 are designated with the same reference numerals.

In Fig. 6, the cleaning unit includes the treating tube **12** providing a centrifugal separation zone, the main discharge tube **14**, and conical skirt **68** forming with tube **12** an annular skimming orifice **70**.

Extending longitudinally through the center of the tube assembly is a tie rod **80** having threaded end portions **82** and **84**. The threaded end **84** is adapted to be screwed into the threaded hub and spider **66** of tailpiece **58** while threaded position **82** is adapted to receive nut **85** and thus position the hub of headpiece **86** against collar **88**. The collar **88** being positioned on tie rod **80** by a drift pin **90** that passes through matching holes in the rod and the collar.

The headpiece **86** has a substantially square forward end while the rearward portion is circular in cross-section and adapted to slip snugly over the forward end of conduit **12**. An internal shoulder **92** provides a seat for the peripheral end of conduit **12** when the hub is positioned on rod **80** and against collar **88**.

Between the hub and the outer wall of the headpiece is a vane set **94** having generally radially extending vanes **96** which are inclined to the axis of the gas cleaner to impart a whirling or helical motion to gas that passes between the vanes. An identical vane set **98** having radially extending vanes **96** and hub **100** is positioned adjacent vane set **94** on rod **80** by a drift pin **102** that passes through matching holes in the rod and the hub.

Also positioned on rod **80** intermediate vane sets **94** and **98** and vane set **98** and venturi skirt **68** are identical flow control members **104** and **106**. Each flow control member has a hub portion **108**, which is positioned on rod **80** by drift pins **110**, and flow control vanes **112** extending radially therefrom. The vanes **112** prevent undue expansion of the gas being treated whereby it would lose a substantial portion of its helical motion. The rearward edge **114** of the last vane prior to the venturi skirt **68** establishes a point where the gas is given a sharp bend prior to its leaving the treating conduit.

The operation of the unit of Fig. 6 is essentially the same as the hereinbefore described operation of the unit of Fig. 1.

A plurality of gas cleaning units such as have been described hereinbefore are employed in a gas cleaning apparatus as shown in Figs. 7 and 8. Referring to these figures, **120** represents a casing having a gas inlet opening **122** and a gas outlet opening **124**.

Gas to be cleaned flows through the apparatus in the direction of the arrows of Fig. 7. The head and tail pieces are shown at **34** and **58** and these pieces define a dust compartment **126** communicating with a dust hopper **128** at the bottom of the casing. The dust hopper has an outlet **130**. This arrangement of head and tail pieces causes the main stream of gas to divide and flow through the several gas cleaning units in the manner described hereinbefore.

A small amount of gas together with the dust separated in each unit passes from the annular dust skimming openings **70** of the units into the dust chamber or compartment **126**. The dust falls into hopper **128** from which it is removed through the outlet **130**. The dust compartment and hopper may be vented, for example, through the discharge opening **130** if necessary to control back pressure on the annular openings **70** of the gas cleaning units.

A washing device as shown in Fig. 7 may be included in the apparatus. A header pipe **132** runs parallel to each vertical row of cleaning units on the upstream side thereof. Nozzles **134** direct a spray washing liquid into the cleaning units. The washing operation may be per-

formed as desired by opening and closing a main valve **136**. Typically the spray nozzles **134** are operated continuously to provide continuous films of flushing liquid along the inner surface of the gas cleaning units. The liquid films trap the particles removed from the gas to provide high efficiency of collection. When such a flushing operation is performed, very little gas is required for scavenging purposes as the flushing liquid performs this operation.

From the foregoing description it will be seen that the present invention provides a gas cleaning device and apparatus embodying in an unique way the principle of centrifugal separation. In the gas treating units shown and described herein, the flow of gas through the units is so directed as to insure maximum efficiency of centrifugal action with a minimum of pressure drop. Moreover, the units as hereinbefore pointed out are easily fabricated, assembled and disassembled. The invention provides a gas cleaning device that satisfies the aims and objects of the invention.

In the light of this disclosure, one skilled in the art will perceive that a variety of engineering and design changes can be made in the form of the apparatus without departing from the spirit of the invention. For example, the venturi skirt shown in the drawings which provides a restricted skimming orifice may be eliminated under certain conditions as when the annular space between tubes **12** and **14** is sufficiently small to eliminate the need for the skirt.

This application is a continuation-in-part of my application Serial No. 255,168 filed November 7, 1951, now United States Patent 2,667,942.

I claim:

1. A centrifugal gas cleaning device comprising a tubular conduit member providing a gas swirling chamber, said conduit member having an open gas inlet end and an open gas outlet end, a discharge tube having an open gas inlet end and open gas outlet end and projecting coaxially into the outlet end of the tubular conduit member, means providing a restricted annular skimming orifice between said tubular conduit member and said discharge tube, said means providing the restricted orifice including a conical venturi skirt on the outside surface of the discharge tube substantially within the outlet end of the tubular conduit member, a rod member extending longitudinally through

said tubular conduit member and said discharge tube, a head piece rotatable mounted on said rod member and shouldering against the gas inlet end of conduit member and a tail piece threadedly mounted on said rod member and shouldering against the gas outlet end of the discharge tube whereby the restricted annular skimming orifice between said tubular conduit member and said discharge tube may be varied by rotating said rod member, gas flow restricting means carried by said rod member in the tubular conduit member between the inlet end thereof and the inlet end of the discharge tube defining an annular passage for the flow of gas through the tubular conduit member and a radial passage for the flow of gas from said annular passage into the gas inlet end of the discharge tube, a first set of annularly arranged swirling vanes carried by said rod member in said annular passage adjacent the gas inlet end of the tubular conduit member, and at least one further set of annularly arranged swirling vanes carried by said rod member in said annular passage intermediate the first set of swirling vanes and the gas inlet end of the discharge tube.

2. A centrifugal gas cleaning device as defined in claim 1 wherein the gas flow restricting means comprises a first disc-like gas restricting member positioned in the space between said first and second set of vanes, and a second disc-like gas restricting member positioned in the space between said second set of vanes and the inlet end of said discharge tube.

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