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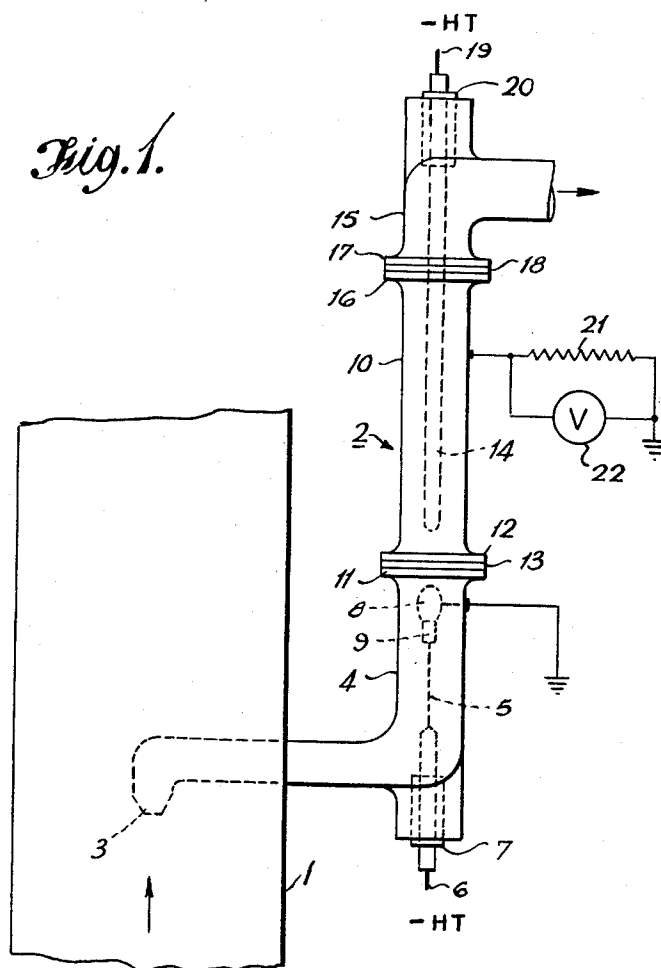
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# APPARATUS FOR SMOKE DETECTION

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# APPARATUS FOR SMOKE DETECTION

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## APPARATUS FOR SMOKE DETECTION

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8 Claims. (Cl. 73—28)

Conventional means for detecting and measuring the density of smoke in a chimney or duct employ a light beam, which after traversing the flow of smoke excites a photo-electric cell, so that the density of the smoke is related to the output of the cell.

The present invention relates to an improved arrangement which has the advantage of operating without a light beam so that errors caused by the accumulation of dust on windows in the path of the light beam are avoided.

This is achieved according to the invention by measuring the rate of transfer of electric charge by solid particles in the gas stream. In a practical embodiment a substantially constant proportion of the flow to be tested is branched off to provide a sample which is passed first through a chamber in which the solid particles are electrostatically charged without being withheld, while charged gas ions may be collected and withheld from the stream. The charged solid particles proceed with the stream in which they are carried to a second chamber where their electric charge is transferred to a surface whose rate of charging is measured. The electrically discharged solid particles are removed from said surface and can be returned to the main flow, for instance to a chimney stack, or disposed of otherwise in a suitable manner.

Any kind of electrostatic precipitator can be used, which may generally consist of a hollow cylindrical outer electrode at ground potential surrounding an axially positioned centre electrode of small diameter, such as a wire, to which high negative potential is supplied. Corona discharge around the central electrode causes charging of the solid particles of the flow in the cylinder. Some of the charged particles are readily attracted by and deposited on the surface of the outer electrode, others however are not so readily deposited or are released from this surface. With ordinary precipitating plants the length of the two electrodes allows any particles that are released to re-enter the corona region so that they can be repeatedly recharged by the inner electrode and attracted by the outer electrode until practically all the particles are deposited on the latter.

Accordingly this invention resides in apparatus for ascertaining the smoke content in a flow of gaseous fluid comprising at one point of the flow an electrode for applying an electric charge to the smoke particles, and at another point situated downstream of the first point a second electrode for collecting the charge of the particles, a means being provided to measure the total electric charge of the particles which strike the said second electrode per time unit.

For an accurate result it is necessary to prevent ions in the stream from discharging on the collecting electrode. This can be achieved by a suitably shaped trap electrode maintained at earth potential and positioned at the end of the central electrode near the outlet of the first chamber for instance. Since the ions are of higher mobility than the solid particles, the greater proportion of ions in the stream is collected either on the trap electrode or on the inner wall of the first chamber.

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More details will become apparent and the invention will be better understood from the following description referring to the accompanying drawings; in which:

Fig. 1 shows diagrammatically and by way of example an arrangement in accordance with the invention; and Fig. 2 shows a modification.

Referring to Fig. 1 a chimney 1 contains a stream of fluid the smoke density of which is to be tested. A small fraction only of this flow is sucked through a test section generally indicated at 2 and having a nozzle 3 projecting into the said flow for instance by a fan (not shown). The test section comprises a first chamber formed by a short straight tube 4 surrounding a central wire electrode 5 to which a high negative potential is applied through a conductor 6 sealed by an insulator 7 in the wall of an elbow portion of the tube 4. The upper end of the wire 5 is suspended from a trap electrode 8 with the intermediary of an insulator 9. The trap electrode 8 and the wall of the chamber or tube 4 are grounded. A second chamber is formed by a straight tube 10 of greater length than the straight portion of tube 4. The ends of the tubes 4, 10 are connected together by flanges 11, 12, an insulating gasket 13 being arranged between the flanges. A central electrode 14 extending into chamber 10 and having a substantially greater diameter than the wire 5 is suspended from an elbow portion 15 which is connected to the tube 10 by means of flanges 16, 17 insulated by gasket 18. The elbow 15 leads the stream to the fan (not shown). The electrode 14 is supplied with a high negative potential via a conductor 19, said conductor and electrode 14 being sealed to and insulated from the wall of elbow 15 by a bushing 20. The wall of tube 10 is connected to ground through a load resistor 21 and a voltmeter 22 is arranged in parallel circuit relationship to the load resistor. It will be understood that this arrangement operates as before described and that the voltmeter 22 will indicate the rate of charge transfer to the wall of tube 10 as the solid particles are discharged. The voltmeter can be calibrated to read directly the total surface area of solid charged particles sampled in unit time, and therefore the smoke content.

Fig. 2 shows another embodiment of the invention. Here the diversion of a branch flow for testing outside the flue and the use of a fan for this purpose are avoided by locating the two chambers in the main flow of the gaseous fluid, the smoke content in which it is desired to ascertain. As will be seen the device containing the two electrode arrangements and denoted 2a has a streamlined outer contour to offer the least resistance to the flow in the flue. It may be supported by a bracket 23 fastened to the wall 1a of the flue and the device 2a itself may be accessible if a plate or cover P is removed from an opening at that part of the flue where the device 2a is arranged. Alternatively the brackets 23 supporting the device 2a may be mounted on the plate P so that the device is removable with the plate P.

A portion of the flue gases to be tested enters the device 2a through an opening 24 at the upper end of a tubular section 25 to flow downwards as indicated by arrow A towards a charging electrode 26, preferably of needle shape and mounted on a pear-shaped insulating body 28, of ceramic material for instance. The electrode 26 and its insulating and screening means 28 are accommodated in a first chamber, the wall 31 of which is of glass or other electrically insulating material, and is bulb shaped to provide a substantial uniform cross-sectional area along the flow path of the flue gases. The voltage applied through a conductor 29 to the electrode 28 may be -10 kv. A coarse wire mesh 27 of concave shape grounded through the section 25, which is of metal, and a connecting strip 30 is provided in this case to operate

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as the ground electrode determining the shape of the static field provided by the charging electrode 26.

The second high voltage electrode 32 is "screened" from the electrode 26 by the bulbous shape of the shielding insulator 28. The diameter of electrode 32 is considerably greater than that of electrode 26 to avoid corona effects. A suitable voltage, -5 kv. for instance, is applied to electrode 32 through a conductor ring 33 and conductor 34. The collector electrode is now formed by a cylindrical section 35 which is coaxial with the electrode 32 and is connected through a conductor 36 to a measuring circuit, not shown but equivalent to the measuring means shown in conjunction with the embodiment of Fig. 1. Advantageously this circuit also includes an amplifier.

As will be seen an outer casing 37 is provided to protect with its upper portion the glass wall 31 of the first chamber and to form with its lower portion the outer wall of the second chamber, also protecting the collecting electrode 35. The electrode 32 is mounted on an insulator 38, such as of ceramic material. This insulator rests on a spider or arms 39 which are held in position at a point where tubular sections 40, 41 forming a continuation of the chamber 37 and shaped to maintain a substantially constant flow section join together. An air gap AG is provided at the lower end of the annular space defined between the electrode 35 and the outer wall 37 so that gases from this ring space may escape into the section 40.

In many cases the draught in the flue will suffice to maintain an adequate branch flow through the device 2a, but an auxiliary means may be provided for this purpose, such as an air ejector 42. Dampers or valves 43, 44 can be provided at the nozzle end and at the entrance of the ejector. Similarly shutter means (not shown) can be arranged at the entrance and exit ends of the device 2a so as to prevent passage of flue gases and the deposition of dust in the device when no smoke tests are carried out.

Additional means can also be provided to loosen the dust which may cling to the surfaces, particularly that of the electrode 35, and such means may comprise a rapping device schematically indicated as a rod 45 projecting from the plate P to hit the cylindrical electrode 35. Advantageously the rapping device is arranged to be automatically operated, for instance when the above-mentioned shutters are opened.

Many variations are possible without departing from the invention. In a simplified embodiment, for instance, the high voltage electrode in the second chamber could be omitted and porous or multi-channel material, such as steel or metal wool, can be arranged inside the second chamber to act as collecting electrode. As the particles pass through they discharge on to the said material, and thence through a surrounding wall of electrically conducting material, which is insulated from the remainder of the ducting, to a load resistor. The arrangement of an instrument for measuring the rate of discharge may be similar to that shown in Fig. 1.

What I claim is:

1. A smoke content detecting apparatus comprising at

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one point in a flow of gaseous fluid an electrode connected to a source of high negative voltage and arranged for applying an electric charge to the smoke particles in the flow, also comprising a second electrode for collecting the charge of the particles at another point in the flow downstream of the first point, and a means to measure the total electric charge of the particles which strike the said second electrode per unit time wherein a trap electrode is provided and positioned between the first and second electrodes so as to prevent gas ions produced by said first electrode from reaching said second electrode.

2. Apparatus as claimed in claim 1, comprising first and second chambers wherein the first and second electrodes are arranged, said chambers having inlet and outlet means for directing through them a sample fraction only of the gas flow.

3. Apparatus as claimed in claim 1, comprising a load resistance connected between the second electrode and ground, further an instrument for measuring the voltage drop across the load resistance thereby providing a means for continuously measuring the rate of charge transfer to the second electrode.

4. Apparatus as claimed in claim 2, comprising two tubular sections detachably connected together in axial alignment to form the two chambers.

5. Apparatus as claimed in claim 4, comprising a connection to ground of the tubular section forming the first chamber, and a connection to the measuring means of the tubular section forming the second chamber.

6. Apparatus as claimed in claim 2, wherein the two chambers are situated within the flow of gaseous fluid and are axially aligned with each other and the said flow.

7. Apparatus as claimed in claim 2, comprising an air ejector arranged to force the sample fraction of the fluid through the first and second chambers.

8. Apparatus as claimed in claim 1, comprising a rapping device arranged for removing after their electrical discharge the collected particles from the second electrode.

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