

May 17, 1955

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2,708,488

ARRANGEMENT IN EMITTING ELECTRODES

Filed Feb. 16, 1953

FIG. 1

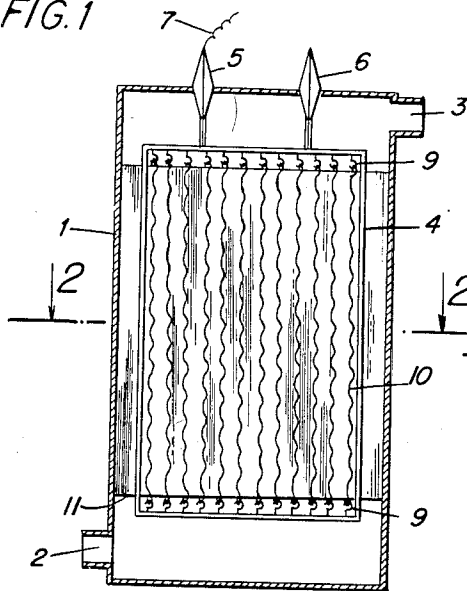


FIG. 5



FIG. 2

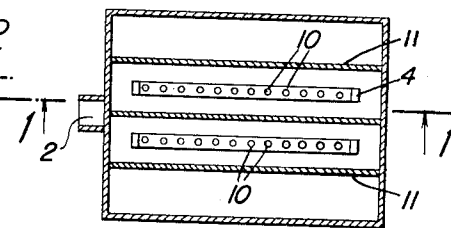


FIG. 3

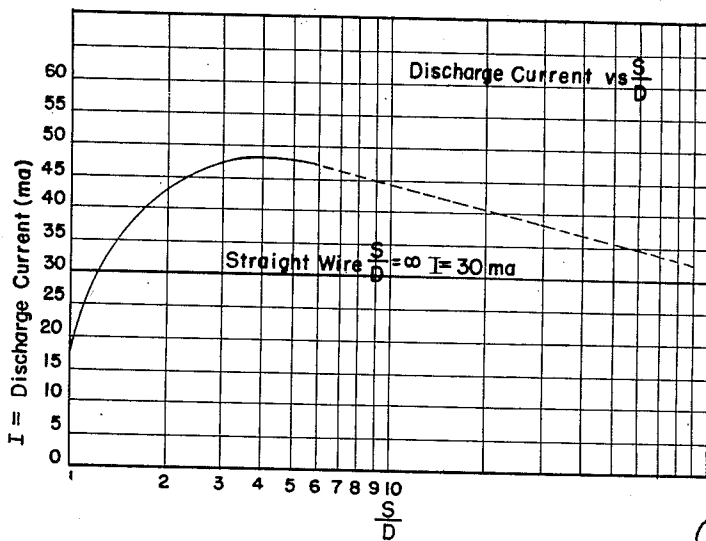
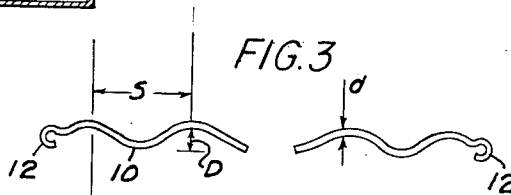


FIG. 4

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ARRANGEMENT IN EMITTING ELECTRODES

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Application February 16, 1953, Serial No. 337,131

4 Claims. (Cl. 183—7)

This application relates to electrostatic precipitators, more especially to an improved electrode for such precipitators, and to a method for making such electrode.

Conventional electrostatic precipitators comprise a series of parallel plate collecting electrodes and between each pair of collecting electrodes, a number of straight parallel wire emitting electrodes. A potential of the order of say 50,000 volts is imposed between the collecting and emitting electrodes. The high impressed voltage results in the migration of electrons at a speed sufficient to cause ionization of gas particles at the surface of the emitting electrode. This ionization is accompanied by a characteristic corona and a small current flowing between the electrodes. The foul gas to be cleaned containing solid or liquid particles, is passed between the emitting and collecting electrodes. The particles become ionized, are attracted to the collecting electrodes, and are thus removed from the gaseous stream. In general, the stronger the corona, the greater will be the ionization of dirt particles and the better the separation.

A serious problem in the construction of such precipitators has been caused by reason of the vibration of the emitting electrodes. As pointed out, these electrodes are, conventionally, long, straight wires. They are attached at their upper ends, usually by means of hooks, to a rack. Vibration causes movement of the wire at the point of its attachment to the rack, and this movement causes wear on the wire, particularly when small particles of grime or dirt become interposed between the wire and the rack. Failure of the wire results, causing shut-down of the precipitator, and expense for repair and maintenance. In general, the higher the frequency of vibration and the greater the tension in the wire, the more pronounced will be the wear. Moreover, when the frequency of vibration approaches the frequency of the pulsating direct current employed or $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ or other even part of said frequency, resonance may be set up producing increased amplitude of vibration and possible arcing between the emitting and the collecting electrodes. The risk, however, being less the smaller said part of the pulse frequency is.

It is known that the natural frequency of vibration of the electrodes may be described by the relation

$$f \sim \sqrt{\frac{F}{m}}$$

where f is the frequency of vibration, F is the tension in the wire, and m is the mass per unit length, "length" being the straight line distance from one end of the electrode to the other. Thus, the frequency of vibration is inversely proportional to the square root of the mass per unit length. By using a spirally wound electrode, one actually inserts more wire per unit length of electrode, thus increasing the mass per unit length and cutting down the natural frequency of vibration when F is constant.

In view of the desirability of reducing the natural frequency of the electrode, it might be considered that optimum construction would call for a very closely wound

spiral which would therefore have a very low frequency of vibration. Such, however, is not the case.

As pointed out above, the ionization of dirt particles is increased with increasing corona and it is therefore desired to have as strong a corona or discharge current as possible, short of arcing. I have found that when the pitch of the spiral is decreased beyond the limits set forth in the claims the discharge current between emission and collection electrodes falls off sharply, but that when a helical electrode having the dimensions set forth in the claims is employed, the total corona current is not only stronger than that obtained with a more closely wound helix, but is, in fact, stronger than with a straight wire. This is due to the fact that when the pitch is sufficiently large, the corona extends over the entire wire length, this length being longer than that for a straight wire extended between the same hooks.

This point is strikingly brought out in Fig. 4 which is a graph of discharge current versus the S/D ratio for various helical electrodes, S being the pitch and D the diameter of the helix. In making the experiments whose results are shown in Fig. 4, the voltage was kept constant at 51.4 kv. and the distance between collecting and emitting electrodes, i. e., between the collecting electrode and the outside of the helix, was maintained at $3\frac{3}{8}$ inches. The tension on the electrodes was kept at about ten pounds. The diameter of the wire in all cases was 0.1055 inch.

As is shown in Fig. 4, closely wound electrodes deliver a very poor discharge current indicating a very poor corona. This is due to the fact that, when the value of S/D becomes less and less, the electrodes begin to behave like compact electrodes of diameter D . Such electrodes will at prevailing voltages not give any corona at all. On the other hand, electrodes which range between

$$\frac{S}{D} = 2.8 \text{ and } \frac{S}{D} = 5.2$$

give a very high discharge current, considerably higher, in fact, than that obtained with even a straight wire.

A further drawback to closely wound helical electrodes is that the area in the center of the helix is substantially field free and thus provides a channel through which foul gases may escape without being treated in case of vertical gas flow.

It is clear, therefore, that to obtain the full benefit of the invention, the relation of pitch to diameter must be kept within the stated limits.

In manufacturing electrodes according to the invention, the preferred procedure is to wind the electrode in a helix of sufficiently small pitch so that the turns are substantially contiguous. The electrodes may conveniently be packed and shipped in this fashion. When it is desired to mount an electrode, one end of the closely wound helix is attached to the top of the electrode frame and the electrode is pulled out to the desired extent greatly increasing the pitch and decreasing the diameter of the helix, and is fastened to the lower part of the frame. In general, the tension of the electrode should be of the order of ten pounds.

According to the invention an emitting electrode for an electrostatic precipitator is a wire in the shape of a helix having a pitch from about 2.8 to about 5.2 preferably about 4.2, times its diameter.

Preferably, the diameter of the helix will be from about 2.5 to about 3.5, say about 3 times the square of the diameter of the wire from which it is formed, and the pitch, therefore, from about 10 to about 13 times the square of the diameter of the wire. If the stated limits are observed, it will be found that the resultant helix will give a higher corona effect and also have a low fre-

quency of vibration compared to a straight wire of similar dimensions.

In the drawings:

Fig. 1 is a vertical elevational view, partly in section, of an electrostatic precipitator having electrodes wound in a slow helix according to the invention.

Fig. 2 is a sectional plan view of the precipitator of Fig. 1, taken along the section 2—2 of Fig. 1.

Fig. 3 is an elevational view of a spirally wound electrode made according to the invention.

Fig. 4 is a graph of discharge current versus the ratio S/D for precipitators having different types of helically wound emitting electrodes, S being the pitch, and D the diameter of the helix in which the electrode is wound.

Fig. 5 shows an electrode according to the invention, as it is manufactured, and before installation in an electrostatic precipitator.

Referring now to Fig. 1, an electrostatic precipitator comprises a housing 1 which is provided with an inlet pipe 2, and an outlet pipe 3 for the gas to be cleaned. Inside the housing 1, a rectangular frame 4 is suspended from two insulators 5 and 6. Conductor 7 passes through insulator 5 and supplies a high potential to the frame 4. Hooks 9 are provided at the top and bottom of the frame 4, and between the hooks are extended a series of parallel, helically wound wire emitting electrodes 10. As shown more clearly in Fig. 2, each row of emitting electrodes is placed between two flat plate collecting electrodes 11. It will be understood that although only two rows of emitting and three collecting electrodes are shown in the drawings, in practice a greater number may be used. When a high potential is impressed between the collecting and emitting electrodes, a corona appears about the latter and a small current flows, usually from the emitting to the collecting electrodes.

It will be observed that the helical electrodes shown in Fig. 1 are attached directly to the top and bottom of frame 4. Conventional practice using straight electrodes, has been to suspend the electrodes from the frame by means of springs at the top or bottom or both or to use weights at the lower ends of the wires. Because my helical electrodes have an appreciable though slight spring quality inherent in their helical construction, these suspension springs can be eliminated, not only saving the cost of the springs, but also making it possible to have a functioning corona over the entire length of the electrode. In addition, the electrode can be made of corrosion-resistant material; whereas, springs in general cannot be made of such material and therefore must frequently be replaced in installations where corrosive gases are being treated.

In operation, foul gases enter through inlet 2. The gases flow up between the collecting and emitting electrodes where particles of entrained dirt are ionized, move toward the collecting electrodes, and are removed from the gases. The clean gas flows out through outlet pipe 3.

As shown more clearly in Fig. 3, each emitting electrode is composed of a wire wound in a slow helix having a pitch S , and a diameter D . The diameter of the wire

itself is denoted in Fig. 3 as d . The electrode is preferably made of stainless steel to prevent corrosion, but other materials may be used. Preferably the electrodes are not made of materials having pronounced spring qualities. As shown in Fig. 3, the electrode may have hooks 12 formed in its end for mounting in the precipitator. As stated above, the pitch S of the helix is from about 2.8 to about 5.2 times the diameter D , and I have found that the diameter of the helix is preferably from about 2.5 to about 3.5 times the square of the diameter d of the wire.

The present invention, therefore, provides an electrode for electrostatic precipitators having higher corona and less vibration than those conventionally used. By lowering the frequency of vibration, the invention greatly reduces wear and the danger of arcing at resonant frequencies. Moreover, electrodes according to the invention are convenient to ship and install, and can be installed without the use of auxiliary devices such as suspension springs which add to the cost and decrease the efficiency of the precipitator.

This application is a continuation-in-part of my copending application Serial No. 89,947, now abandoned.

What I claim is:

1. An electrode for use in electrostatic precipitators comprising a metal wire in the shape of an expanded helix whose pitch is from about 10 to about 13 times the square of the diameter of the wire and whose diameter is from about 2.5 to about 3.5 times the square of the diameter of the wire.

2. An electrostatic precipitator comprising a pair of substantially planar collecting electrodes and an emitting electrode arranged between said collecting electrodes, said emitting electrode comprising a metal wire in the shape of an expanded helix having a pitch from about 2.8 to about 5.2 times its diameter, whereby vibration and corona characteristics of said electrode and the efficiency of said precipitator are improved.

3. An electrostatic precipitator as claimed in claim 2, wherein the diameter of the helix is from about 2.5 to about 3.5 times the square of the diameter of the wire.

4. A method of forming and mounting an emitting electrode in an electrostatic precipitator having a pair of substantially planar collecting electrodes which comprises taking a wire wound in a helix having substantially contiguous turns, then stretching said helix axially to form an expanded helix having a pitch from about 2.8 to about 5.2 times its diameter, and securing said stretched helix at its ends so that it lies between and substantially parallel to said collecting electrodes.

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