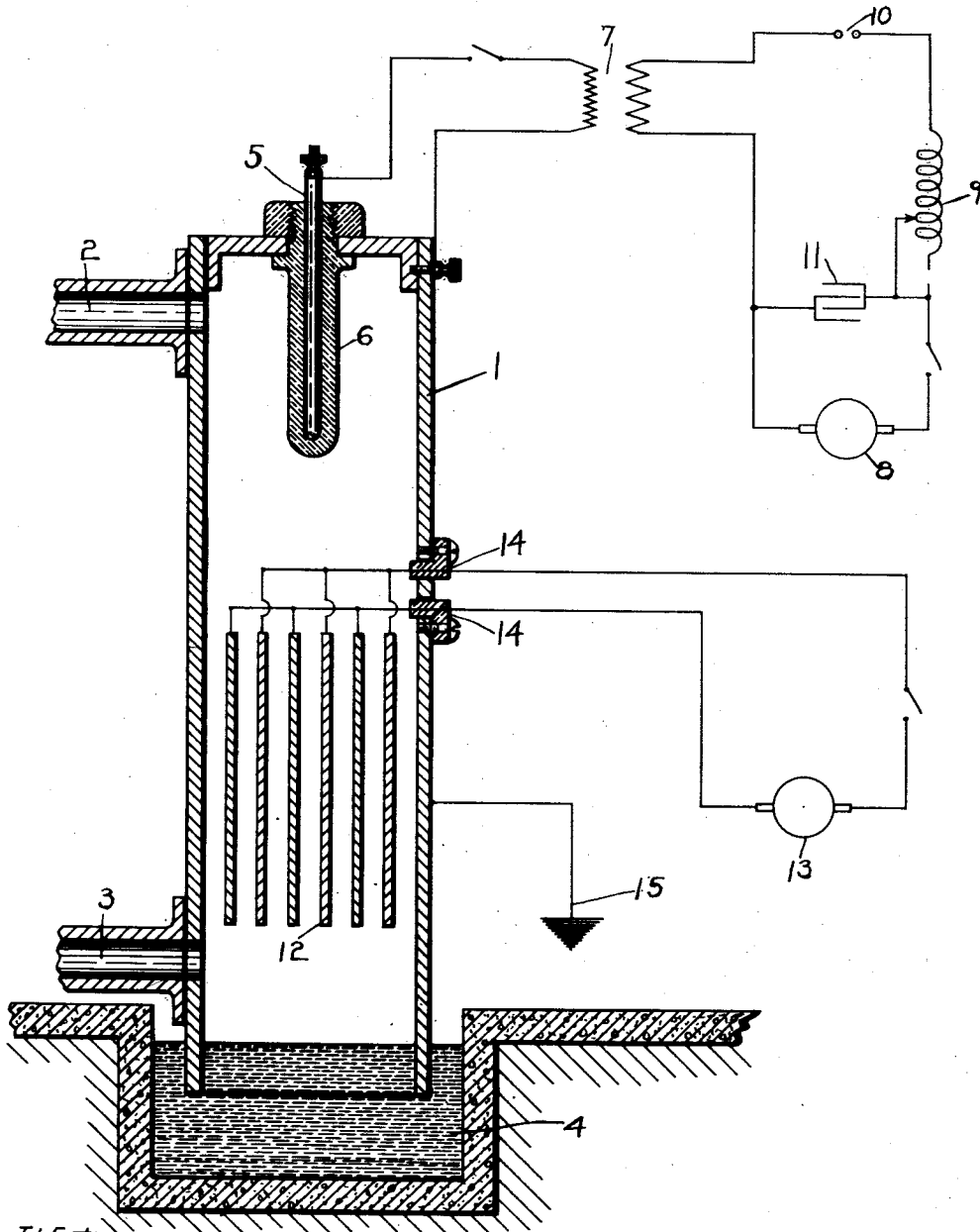


H. F. SMITH.
GAS PURIFICATION.
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1,358,031.

Patented Nov. 9, 1920.



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GAS PURIFICATION.

1,358,031.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, HARRY F. SMITH, a citizen of the United States of America, residing at Lexington, Richland county, Ohio, have invented certain new and useful Improvements in Gas Purification, of which the following is a full, clear, and exact description.

This invention relates to gas purification and more particularly to the use of electrical means for insuring the removal of vapors and like impurities from gases, such, for instance, as the tar vapor which is found in producer gas. The object of the invention is to provide an effective electrical method of removing such impurities from gas, which is sufficiently simple and easy of operation to permit of its practical use.

Many attempts have heretofore been made to utilize electrical discharges in the treatment of gases for the purpose of removing impurities therefrom. And some success has been attained in the removal of tar from producer or coal gas and in the elimination of noxious smelter fumes. The method employed in these attempts may be divided into two principal classes:—

First—Those in which the gas is subjected to brush discharge from high potential electrodes so arranged that the discharges are always of the same polarity. These discharges, of course, may be the result of either direct current or of an alternating current which has been so rectified that the alternations are unidirectional. In such treatments of gas, it is customary to provide electrodes of considerable length parallel to the direction of flow of the gas, and the particles of impurities are first electrified by brush discharge from the electrodes and then caused to so move under the influence of the electrical field as to be precipitated on one or both of the electrodes employed.

Second—Those in which the particles of impurities are subjected to a brush discharge produced by a current of alternating polarity, whereby the particles are shaken up and caused to agglomerate and thus increase in size to make easy their removal from the gas. This method is of course useful only where impurities exist in the form of a vapor or liquid, and has been used with some success in the removal of tar particles from producer gas.

My invention differs radically from the methods heretofore pursued, and in carrying it into effect, the impure gas is subjected to an ionizing electrical discharge and then after ionization has taken place, to a low potential electrical field, which causes precipitation of the particles electrified by the ionizing discharge.

Assuming that the particles of tar, dust or other impurities to be removed do not carry any electrical charge, I pass the impure gas into one end of a treating chamber where it flows between high frequency electrodes of such difference of potential as to cause brush discharge therebetween to which the gas is subjected. This brush discharge imparts an electrical charge to the individual particles of impurities. There will be no deposition of the impurities upon the discharging electrodes, since the reversals of direction of the high frequency discharge will be so rapid as to prevent actual translation of the particles toward either electrode, the force tending to move them toward one electrode on one oscillation being neutralized or counteracted by the force tending to move them toward the other electrode on the next oscillation, which will be, of course, in the opposite direction. Also there will be no agglomeration of the particles of impurity, the reversals of direction in the discharge being so extremely rapid that no transverse translation of the particles will result. In other words, the reversals of direction will be so very rapid that no appreciable change in the relative position of the particles will take place. The impurities having been electrically charged in this manner, pass with the current of gas to another part of the treating chamber, where they are subjected to the influence of a direct current field. This field should be of such low potential as to prevent any discharge, even when the electrodes are comparatively close together, but should be of sufficient intensity to insure ready migration toward the electrodes of the electrified particles in the gas. Under the influence of this direct current field, the electrified particles are carried into contact with the electrodes thereof, where they are precipitated and give up their electrical charges. It is to be understood that my invention is not limited to the use of a direct current precipitating field as, although I prefer such a

field, a unidirectional current field would function about as well.

In carrying this invention into effect, many varying kinds of apparatus may be employed, but I prefer to use that type illustrated in the accompanying drawing, which I have found thoroughly effective, as well as practical, and extremely simple of construction and maintenance.

In the drawing, 1 is a treating chamber composed of metal or some other conducting material having an inlet 2 in one end and an outlet 3 in the other end thereof. One end of this treating chamber is open and extends into a tank 4, containing liquid which covers the open end and acts as a seal therefor.

Extending through the end of the treating chamber adjacent the inlet 2, is an electrode 5, which is completely surrounded by insulating material 6. This electrode is connected to one end of the secondary coil of a transformer 7, the other end of this coil being connected to the treating chamber itself, or grounded in any desired manner.

Any desired means of attaching the connecting wires to the electrode 5 and treating chamber 1 may be employed, the means shown being purely conventional. The treating chamber is also grounded, as shown at 15. Connected to the primary of the transformer 7 is any desired form of apparatus for generating high frequency alternating currents. As illustrated, this apparatus consists of a dynamo 8, having one pole thereof attached directly to one end of the primary coil of the transformer, and having the other pole attached to the opposite end of the primary coil through a variable inductance 9 and a spark gap 10.

Inserted in the above circuit is a condenser 11. It is evident that operation of the dynamo 8 will cause the building up of a charge in the circuit connected therewith until such time as the intensity is sufficient to cause a spark to pass across gap 10. As soon as this occurs, oscillating discharges of extremely high frequency will be set up, which will act through the secondary coil of the transformer and the circuit connected therewith, to build up on the electrode 5 an alternating potential of equally high frequency and very high potential, the potential depending upon the ratio of the coils of the transformer. The transformer forming

part of this source of high frequency apparatus is illustrated in the drawing as purely conventional in form. As is well known, however, the ordinary iron cored transformer is completely inadequate for dealing with very high frequency oscillations. And in practice I use a transformer similar to that devised by Tesla for producing high frequency, high potential alternations, the so called Tesla coil. However, any other transformer responsive to high fre-

quency oscillations may be used, such, for instance, as some of those used in wireless telegraphy.

Inserted in the treating chamber 1, between electrode 5 and the outlet 3, is a series of metal plates 12, which are connected with a source of direct current 13, alternate plates being connected to opposite poles of the current source 13. By means of this arrangement, a charge may be impressed on the plates to set up therebetween an electrical field, it being evident from the arrangement illustrated, that adjacent plates will bear charges of different polarity. It is a matter of indifference which plates bear positive and which negative charges. Of course, plates 12 must be insulated from the treating chamber 1, the manner in which this is done being immaterial. Also the connections between the plates 12 and the source of direct current 13 must be completely insulated from the treating chamber 1. This may be done in any desired manner; for instance, in the manner illustrated, in which the connections are passed through plugs of insulating material 14, which are inserted through the wall of the chamber 1.

Operation of the apparatus is as follows:—The impure gas which it is desired to purify is introduced into the treating chamber through inlet 2. At the same time a high frequency alternating current is generated in the circuit connected with the primary of the transformer 7. There will thus be built up on the electrode 5 a very high potential of rapidly changing polarity. Because of this electrode being insulated, no direct discharge can take place between it and the wall of the treating chamber 1. However, a very high potential of rapidly changing polarity, the polarity reversing with the reversals on the electrode 5, will be induced on the outside of the insulation, and, since the treating chamber is grounded, a brush discharge will be set up between the insulation and the wall of the treating chamber. And, of course, the reversals of direction of this discharge will be as rapid as the oscillations set up in the apparatus producing the high frequency alternating current. This brush discharge ionizes the particles of impurity in the gas as they pass between the two electrodes. The gas thus ionized then passes between the plates 12, where it is subjected to the direct current field existing therebetween. This direct current field is of insufficient intensity to cause any discharge between the plates 12, even though they are placed quite close to each other, but is of sufficient intensity to cause ready migration of the ionized particles to the plates, where their electrical charges are neutralized and the particles themselves precipitated. The impurities thus precipitated to the plates 12 may be easily removed

in any desired manner. The apparatus shown is especially adapted for the removal of tar from producer gas. The tar precipitated being liquid, runs down off of the plates 12 into the tank 4 from which it may be readily withdrawn.

It is of course obvious that my invention is by no means limited to the above described apparatus, although that is the best form known to me at present. High potential, high frequency, alternating current as the ionizing expedient is comparatively easy of handling and subjects the user to little of the danger present where ordinary high potential currents are involved. Further, by the use of a low potential electrical field for precipitation, the collecting electrodes can be placed relatively close together without any danger of sparking over. And the removing of deposits from these electrodes is rendered quite easy and safe, since a current of low and correspondingly safe potential can be used at this point. Also, the difficulties involved in maintaining a suitable insulation on the high potential apparatus used for brush discharge is greatly simplified, because of the electrodes being short and the precipitation of extensive deposits of foreign material on the ionizing or high potential electrodes being avoided.

Any desired apparatus for producing brush discharge in the treating chamber may be employed in place of that described above. For instance, in place of the high frequency current employed, ordinary high potential alternating current, either oscillating in character or rectified so as to be unidirectional, may be used, as in the apparatus shown in my copending application Serial Number 184,457, filed August 4, 1917. Or, if desired, ionizing discharges may be obtained by the use of a direct current. It is only necessary in carrying out my methods, that a brush or ionizing discharge be obtained, regardless of the form of apparatus used. The ionizing discharge, however, should be of such character that there will be no deposit of impurities on the electrodes producing it. When alternating current is used, there is ordinarily no danger of such deposition, for as set forth above, the reversals of direction are of such frequency that the particles are not carried to either electrode. In the case of unidirectional or direct discharge, however, care must be taken to prevent particles of impurities being subjected to the influence of the high potential field a sufficient length of time to permit of their traveling to the electrodes and being deposited thereon.

My method is especially useful in the removal of tar from producer gas, and has been found very effective where so used. It is, however, not limited in its applicability,

being obviously capable of general application.

What I claim as new and desire to secure by Letters Patent is:—

1. The method of removing impurities from a gas, which consists in subjecting the gas to an electrical discharge and then passing the gas through an electrostatic precipitating field.

2. The method of removing impurities from gases which consists in imparting an electrical charge to the impurities and then passing the gas through a separate electrostatic field of constant polarity.

3. The method of removing impurities from gases which consists in imparting an electrical charge to the impurities and then passing the impurity containing gas between charged electrodes of low potential.

4. The method of removing impurities from gases which consists in subjecting the gas to an ionizing electrical discharge and then passing it through a low potential electrical field.

5. The method of removing impurities from gases which consists in subjecting the gas to a high potential brush discharge and then passing it through a direct current field of low potential.

6. The method of removing impurities from gases which consists in subjecting the gas to a high potential, high frequency, brush discharge and then passing it through a direct current field of sufficient intensity to cause migration to the electrodes thereof of the electrified particles in the gas.

7. The method of removing impurities from a gas, which consists in subjecting the gas to an induced electrical discharge, and then passing the gas through an electrostatic field.

8. The method of removing impurities from gases which consists in subjecting the impurity containing gas to a high frequency, induced brush discharge and then passing the gas and contained impurities through an electrostatic field.

9. The method of removing impurities from a gas which consists in subjecting the gas to an induced high frequency electrical discharge, and then passing the gas through an electrostatic field.

10. In an electrical purifying apparatus, a treating chamber having an inlet and an outlet therein, a completely insulated electrode extending thereinto adjacent the inlet, a source of high potential alternating current having one pole connected to the treating chamber and the other to the electrode, a plurality of electrodes within the treating chamber adjacent the outlet thereof, and a source of constant polarity potential connected to said electrodes.

11. An electrical gas purifying apparatus

comprising a treating chamber having an inlet and an outlet, an electrode therein connected to a source of high frequency, high potential, alternating current, whereby an ionizing brush discharge may be produced adjacent the inlet; and other electrodes therein adjacent the outlet and connected to a source of constant polarity potential, whereby an electrical field may be produced therebetween.

12. An electrical purifying apparatus comprising the combination with a treating chamber having an inlet and an outlet; of a completely insulated electrode therein intermediate the inlet and outlet, a source of high frequency alternating potential connected

with the said electrode; a series of electrodes in the chamber intermediate the insulated electrode and the outlet; and means connected with said electrodes for setting up therearound an electrostatic field.

13. A gas purifying apparatus comprising a treating chamber having an inlet and an outlet therein, a completely insulated electrode therein adjacent the inlet, a source of high potential connected to said electrode, a series of electrodes in the treating chamber and insulated therefrom, and a source of constant polarity low potential connected therewith.

In testimony whereof I affix my signature.
HARRY F. SMITH.