Nov. 2, 1926. 1,605,648

M. W. COOKE

ART OF SEPARATING SUSPENDED MATTER FROM GASES

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Fig.1

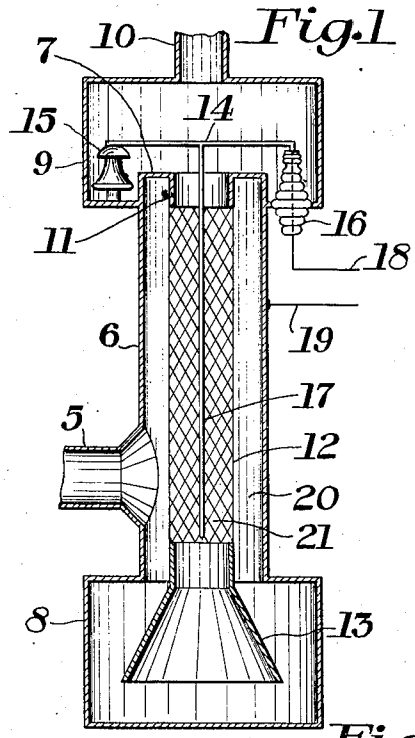


Fig.2

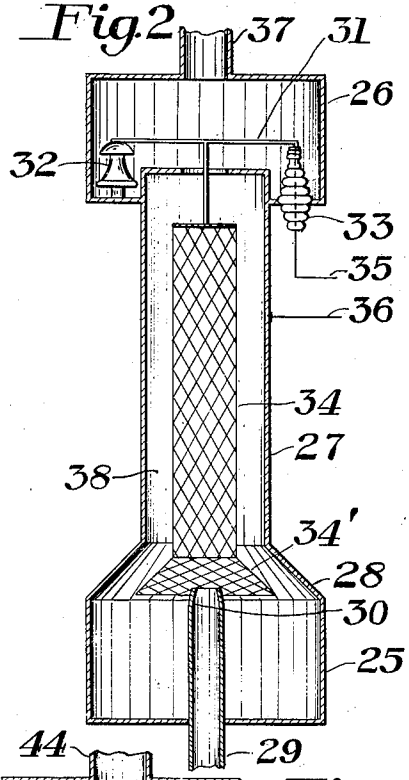


Fig.3

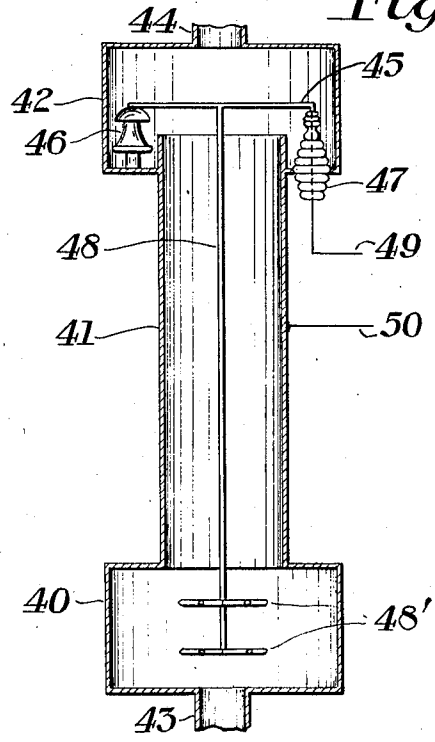
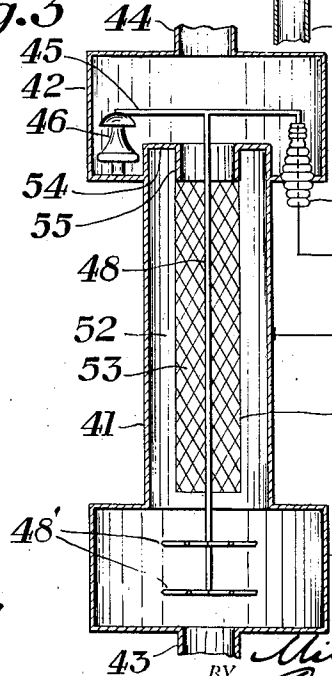


Fig.4



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Fig. 5

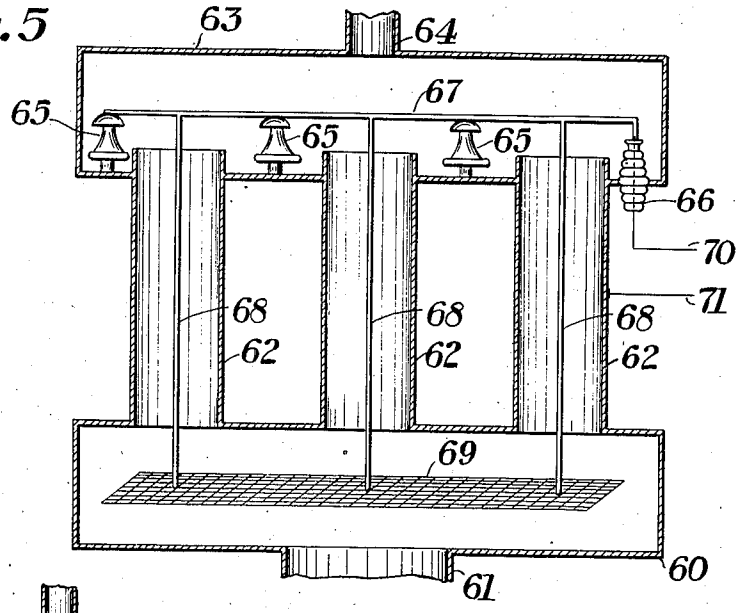


Fig. 6

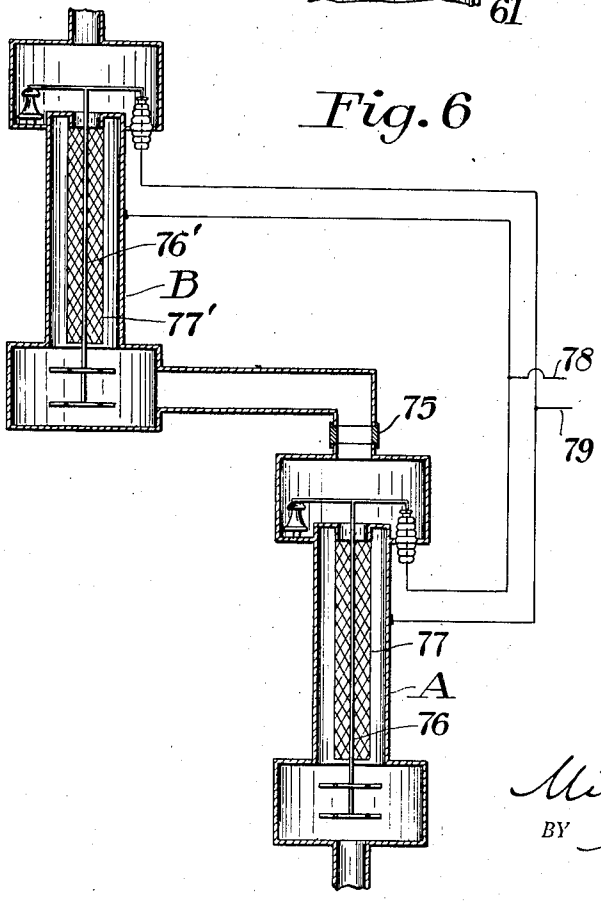
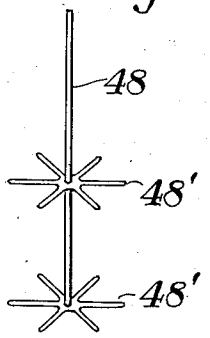


Fig. 7



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UNITED STATES PATENT OFFICE.

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ART OF SEPARATING SUSPENDED MATTER FROM GASES.

Application filed March 7, 1921. Serial No. 450,288.

This invention relates to apparatus for separating suspended particles from gases by electrical action.

In apparatus for precipitating particles from gases, it has been the practice to pass the gases to be cleaned between electrodes maintained at a sufficiently high potential by a unidirectional current to secure a highly active corona discharge about one of the electrodes, the ionizing effect of which repelled the solids toward the other receiving electrode, where they agglomerated into masses. The effect of such building up of masses of particles on one electrode tended to decrease the distance between the electrodes, and hence lower the resistance of the gap until the current would arc across, breaking down the potential between the electrodes.

Efforts have been made to prevent such action by forming the receiving electrode of a screen of coarse wire mesh and spacing it from the walls of the receptacle within which it is housed, but with which it is in electrical connection. The electrode of opposite potential is spaced from the receiving electrode in such manner as to form a zone between the screen and the casing which is neutral, the polarity of the screen and the casing being common, and to produce an active zone between the receiving electrode and the electrode of opposite polarity, which electrode is referred to as the "active" or "central" electrode because it is generally centrally positioned in the apparatus, with the receiving electrodes thereabout.

In such apparatus, the gases with the suspended particles are passed through the active zone around the central electrode, and the particles are repelled therefrom, through the screen, where they collect on the side of the screen nearest the casing or housing, in the neutral zone. The gases pass on through the active zone and out of the separator. The velocity of the gases is relatively high, and it is not insured that all of the particles will be precipitated.

It is the object of the present invention to provide means by which the gases will pass over or through one electrode before being introduced into the active zone.

A further object is to provide a separator into which the gases will pass through a neutral zone before entering the active one, thus mechanically introducing the particles at the point or in the zone where they are to be precipitated.

Other objects are to provide a separator effective for precipitating the particles which have become ionized before entering the separator, due to a process of disassociating, by which the particles are produced, or from other reasons; and to provide an arrangement of the separators in series to insure a thorough precipitation.

My invention is illustrated in the accompanying diagrammatic drawings, in which:

Fig. 1 is a vertical section of one form of separator constructed in accordance with my invention;

Fig. 2 is a similar view of a modification;

Fig. 3 is a similar view of a further modification;

Fig. 4 is a vertical section of another modification;

Fig. 5 is a view of a multiple arrangement of apparatus such as shown in Figs. 3 or 4;

Fig. 6 shows a series of devices such as illustrated in Fig. 4 arranged successively; and

Fig. 7 is a detail view showing in perspective one way in which the central electrode used in the apparatus in Figs. 3 and 4 may be made.

In Fig. 1 of the drawings, 5 is a gas supply pipe; 6, a vertical metal cylinder having an inwardly turned flange 7 at the top end thereof. The lower end of the cylinder is supported by and opens into a drum 8, while the top of the cylinder projects into a drum 9 in the top of which is a gas outlet pipe 10. Depending into the cylinder 6 from the flange 7 is an imperforate flange 11, from which is suspended a coarse wire mesh or other suitably perforated cylinder 12. The lower end of the wire cylinder is provided with an imperforate metal bell 13. The wire cylinder 12 is in electrical circuit with the cylinder 6, and forms the receiving electrode.

Suspended from a cross wire 14 supported on an insulator 15 and insulator bushing 16, is a central electrode 17. The cross wire and central electrode are connected with one pole of a unidirectional source of high voltage current by wire 18 passing through insulator bushing 16, while the cylinder 6 is grounded to the other pole, as at 19.

It will be noted that in this construction

a space 20 is provided between the cylinder 6 and the perforated or wire cylinder 12, in which space there is no electric activity, due to the fact that the polarity of the two members is the same. In the space 21 between the central electrode 17 and the wire cylinder 12, there is an active zone, due to the difference of potential between the two electrodes.

In operation, the gas with suspended particles is introduced into the neutral zone or space 20 from pipe 5. The electrodes are then energized to a potential just below the flashing point at which the current would arc across the electrodes. The particles in suspension in the gas will immediately begin to collect on the outside of electrode 12 in the neutral zone, due to the repulsive action of the ionized emanations from the central electrode. Any particles which do pass through the screen into the active zone will be immediately repelled by this action. Thus, most of the particles are conveyed mechanically by the gas to the neutral zone and then retained there by electrical action, rather than by being thrown into the neutral zone from gases passing through the active zone. As the particles agglomerate into masses on the receiving electrode, they will drop down into the drum 8.

The bell 13 tends to prevent much of the gas from passing downwardly into drum 8, and thence up inside of the screen, but if a small amount of gas does follow this path, the particles therein will be thrown out into the neutral zone by electric action. Depending imperforate flange 11 and flange 7 prevent the gas from escaping into drum 9 and out exhaust pipe 10 without passing through the active zone 21.

This form of apparatus is especially effective in treating gases in which substantially none of the particles have become ionized or charged prior to their introduction into the separator.

In the manufacture of certain gases, such as by disassociation processes, a large percentage of the particles become ionized when they are produced, and enter the separator in a "preionized" condition. In this condition, they have an affinity for the electrode which under other normal conditions, would repel them. The apparatus illustrated in the modification shown in Figs. 2 to 7, inclusive, are for precipitating particles where some of them are preionized. This condition prevails, for instance, in the production of hydrogen from natural gas by a process of disassociation, in which the particles are amorphous carbon or lamp black.

In the form of apparatus shown in Fig. 2, 25 is a bottom drum, 26 a top drum similar to drum 9, shown in Fig. 1, and 27 is a vertical cylinder. The drum 25 is preferably contracted at 28. In the bottom of drum 25 is a central gas supply pipe 29 having a contracted end 30. From a cross wire 31 supported on insulator 32 and insulating bushing 33 is suspended a central electrode 34 in the form of a cylinder of coarse mesh wire screen, preferably having a flared lower end 34' into which projects nozzle 30 of pipe 29, but which nozzle is spaced from the electrode. The central electrode is shown in elevation in Fig. 2. It is connected with one pole of a unidirectional source of high tension current through wire 35 passing through bushing 33, while the cylinder is grounded to the other pole, as at 36. The cleaned gases are exhausted at 37.

In this form of device, a neutral zone exists within the hollow cylindrical wire electrode 34, while the active zone is in the space 38 between the electrode and the shell or cylinder 27.

In operation, the fluid with the suspended particles, some of which are pre-ionized, is introduced into the neutral zone within the interior of the central electrode by pipe 29. These particles, having an affinity for this electrode, collect on the interior thereof and fall to the bottom of the drum 25. Those particles not having an affinity for the electrode are repelled by it out against the sides of cylinder 27, where they agglomerate and fall to the bottom of the drum. It has been found that as high as ninety per cent of the particles will sometimes be ionized prior to their introduction into the separator.

The electrode 34 is preferably closed or screened at the top so that the gas will all pass through the electrode. In this form of device, it will be seen that the gases are first introduced into the neutral zone and then into the active zone, and that they come into intimate contact with one electrode first.

In the construction shown in Fig. 3, 40 is a bottom drum, 41 a vertical cylinder, and 42 the top drum. Drum 40 is provided with a gas inlet pipe 43 and drum 42 is provided with a gas outlet pipe 44. A cross wire 45 is supported on insulator 46 and insulating bushing 47 on the drum 42, and from this cross wire is suspended a central electrode 48 in the form of a wire or rod. The lower end of the rod extends into the lower drum 40 and its lower end is provided with a series of laterally extending rods 48' which are radially or otherwise suitably arranged on the rod, as shown in Fig. 7.

Electrode 48 is connected with one pole of a source of high tension current, as previously described, through cross wire 45 and wire 49 extending through the insulating bushing. The other pole of the source of high tension current is grounded to the cylinder 41, as at 50.

In operation, the gases containing particles in suspension enter drum 40 through

pipe 43. They pass through the spaces between the lateral electrodes 48′, the spaces between the lateral electrodes corresponding in effect to the interior of the cylindrical screen electrode described in the preceding construction. The particles which enter the drum in an ionized condition adhere to the cletrodes where they agglomerate in a mass. The particles not having an affinity for the active electrode are repelled outwardly while the rising gas carries them up along the inside walls of cylinder 41, where, under the action of the emanations from electrode 48, they are deposited. In this construction, however, no means is provided for preventing the masses of particles from building up on the walls of the cylinder 41.

In the construction shown in Fig. 4, which is similar generally to that shown in Fig. 3, similar reference numerals indicating similar parts, a cylindrical screen or perforated receiving electrode 51, grounded on the casing, is provided so that a neutral zone 52 and an active zone 53 is provided. A neutral zone also exists in the spaces between the laterally extending electrodes 48′. Horizontal flange 54 and depending flange 55 prevent direct passage of gases from the neutral zone 52 to the drum 42.

In operation, the gases are introduced at 43. The pre-ionized particles collect on the electrodes 48′. The other particles are repelled by the electrodes outwardly, while the gases move them upwardly. Thus, they enter the neutral zone 52 where they will collect on the outside of the screen cylinder, as explained in connection with Fig. 1. Any particles that pass through the cylinder 51 will be repelled outwardly into the neutral zone. Thus, the particles are conveyed first through electrodes 48′, then into the neutral zone 52, largely by mechanical action, and then repelled or excluded from the active zone 53 by electric action. The provision of electrodes 48′ prevents the agglomeration of particles having an affinity for the central active electrode in the active zone between electrode 48 and receiving electrode 51, so that in this construction, rapid building up of agglomerated masses to reduce the space across which the current may arc is prevented.

Fig. 5 is diagrammatic and illustrates a vertical section through a separator operating on the principle described in connection with Fig. 3, showing a multiple arrangement of separating units with a common lateral electrode, which electrode is shown in perspective.

In this construction, 60 is a bottom casing; 61 a supply pipe; 62, verticle cylinders; 63, a top casing; and 64, an outlet pipe. Supported on insulators 65 in the casing 63 and on insulating bushing 66 is a transverse rod or wire 67. Depending through each of the cylinders is a central rod or wire 68 connected with cross wire 67. From the ends of wire 68 in the casing 60 is a common electrode in the form of a coarse mesh wire screen or perforated sheet 69, indicated in perspective. Wire 67 is connected with one pole of a source of unidirectional high tension current through wire 70, and the body of the apparatus is grounded on the other pole through wire 71.

The operation of the precipitator is identical with that described in connection with Fig. 3, the device being capable, however, of handling larger volumes of gas at high velocity.

In Fig. 6 I have shown a series of units of the kind shown in Fig. 4, although any of the other forms of apparatus hereinbefore described might be so arranged. In this form of apparatus, A indicates the first precipitator of the series, and B the second. B is insulated from A, as indicated at 75. The central electrode of A is indicated by 76, and of B by 76′. The receiving electrodes of A and B are indicated at 77 and 77′, respectively. It is desired that the central electrodes of A and B be of opposite polarity, and to this end, I have shown one way of doing this; 76′ and the casing of A being connected with one pole of a source of unidirectional high tension current through wire 78 and central electrode 76, and casing of B being connected to the other pole through wire 79. Thus, the polarity of corresponding parts in each unit is reversed. This arrangement insures of practically all the particles being separated, even where the gas has a high velocity, each of the units A and B operating in the manner described in connection with Fig. 4.

It will be obvious that various changes may be made in the construction and arrangement of parts without departing from the spirit of my invention. In all of the apparatus, the gases pass through spaces or openings formed in one electrode in advance of coming into the zone of activity between the two electrodes.

I claim as my invention:

1. The method of separating particles in suspension from fluid in which some of the particles are ionized prior to the separation, which consists in bringing the fluid into intimate contact with a charged electrode for which the ionized particles have an affinity to separate out the ionized particles and in a zone where the ionizing action of the electrode is negligible and involving the passage of the fluid through the charged electrode, then passing the fluid between electrodes of opposite potential where there is an intense ionizing effect to precipitate the remaining particles.

2. The method of separating particles in suspension from fluids in which some of the

particles are ionized prior to the separation, which consists in bringing the fluid into intimate contact with a charged electrode for which the ionized particles have an affinity to separate out the ionized particles, passing the fluid through said electrode into a space between two electrodes of opposite potential, one of which has openings therethrough, to repel the remaining particles through the openings and thereby maintain the space between the electrodes free of precipitated masses of particles.

3. The method of separating particles in suspension from fluids which consists in passing the fluid into contact with an active electrode whose potential is opposed to that of the conduit through which the gases are conveyed to a point where its ionizing action is negligible, then between the first electrode and one of opposite polarity, one of which surrounds the other, and then similarly subjecting the fluid to similar action by electrodes having the polarity thereof reversed relatively to the first.

4. The method of separating particles in suspension from fluids which consists in bringing the fluid containing the particles intimately into contact with one of two active electrodes whose potential is opposite that of the conduit through which the gases are conveyed in advance of the other, then passing the fluid between the electrodes of opposite polarity, then similarly passing the fluid around and between other electrodes, the polarity of which is reversed relatively to the first.

5. The method of separating particles from gases which consists in first passing the gases into a chamber in which there is a highly charged electrode about which there is a minimum ionizing action due to its distance from any electrode of opposite potential, then passing the gases into another chamber in which electrodes of opposite potential are in close proximity to produce an intense ionizing effect, with passage through one of said electrodes.

6. The method of separating particles from gases by electrical action which consists in first passing the gases into a chamber into which a highly charged spreading discharge electrode extends but about which there is no appreciable coronal discharge, whereby a large percentage of the particles, including those having an affinity for the charged electrode are collected thereon, then passing the gases between two highly charged electrodes of opposite potential about one of which there is an appreciable coronal discharge to repel the remaining particles to the electrode whose potential is opposite that of the highly charged one which first acted to remove some of the particles, including passage through one member thereof.

7. The method of removing particles from gases electrically by first attracting all preionized particles to a highly charged discharge electrode having a relatively large area with open spaces therein through which the gases may pass and in a zone where the ionizing action of the electrode is negligible, and then passing the gases and particles which have no affinity for the electrode between electrodes of opposite potential in an intensely active zone to repel the remaining particles into a neutral zone and retaining them there electrically while removing the cleaned gases from the active zone.

8. The method of removing particles from gases electrically by collecting in a neutral zone by means of an insulated highly charged electrode all particles having an affinity for the electrode, passing the gases and particles which have no affinity for the electrode between electrodes of opposite potential in an intensely active zone to repel the remaining particles into a neutral zone and retaining them there electrically while removing the cleaned gases from the active zone.

9. Apparatus for the electrical separation of particles from gases comprising a housing, a perforated electrode inside the housing in spaced relation to the walls thereof, a chamber at one end of the housing, a gas inlet in the said chamber, a spreading divided terminal on the end of said electrode within the said chamber, and a gas outlet at the other end of said housing.

10. Apparatus for the electrical separation of particles from gases comprising a housing, a chamber at one end of the housing, a perforated electrode extending longitudinally of the housing and extending into the chamber, a spreading divided terminal on the electrode within the chamber, a gas inlet in the chamber, and a gas outlet at the other end of the housing.

11. Apparatus for the electrical separation of particles from gases comprising an upright housing, a chamber of increased dimensions at the lower end of said housing, a perforated electrode suspended centrally in the housing from the upper end thereof, and extending down into said chamber, a spreading divided terminal on said electrode in the chamber, a gas outlet at the top of the housing, and a gas inlet in the chamber.

12. Apparatus for effecting the electrical separation of particles from gases comprising an upright housing having a drum of increased dimensions at each end thereof, a gas outlet in the upper drum, a pair of insulators in the upper drum at each side of the top of the housing and the gas outlet, whereby they are out of any direct current of gases in the upper drum, a perforated electrode suspended from said in-

sulators passing downwardly through said housing into the lower drum, a spreading divided terminal on said electrode in the lower drum, and a gas inlet in the lower drum.

13. Apparatus for effecting the electrical separation of particles from gases comprising a housing, a concentric cage in the housing spaced therefrom and in electrical connection therewith, comprising a perforated electrode whereby a difference of potential may be maintained between the electrode and cage, a partition at the top of the housing extending from the housing to the cage to close the space between the housing and cage, the space between the cage and housing being open at its lower end, a gas outlet above said partition, and a gas inlet below the partition.

14. Apparatus for effecting the electrical separation of particles from gases comprising a housing, a concentric perforated cage electrode in the housing spaced therefrom, a central electrode in the cage and spaced therefrom and projecting beyond one end of the cage, a spreading divided terminal on the projecting part of said electrode, means for introducing gas into the housing at the end thereof in which the spreading terminal is positioned, and a gas outlet at the other end of the housing, said cage and electrode being electrically insulated from each other.

15. Apparatus for effecting the electrical separation of particles from gases comprising a housing having an enlarged chamber at one end thereof and a gas outlet at the other end thereof, a perforated cage electrode disposed in the housing and spaced therefrom, an electrode in the cage insulated and spaced therefrom and extending therethrough, said electrode projecting into the chamber beyond the cage, a spreading divided terminal on the projecting end of said electrode, and means for introducing gases to be cleaned into the chamber.

In testimony whereof I hereunto affix my signature.

MILTON W. COOKE.