

**Feb. 16, 1937.**

**N. E. LINDENBLAD**

**2,070,972**

## HIGH VOLTAGE GENERATOR

Original Filed Aug. 9, 1933 4 Sheets-Sheet 1

*Fig. 1*

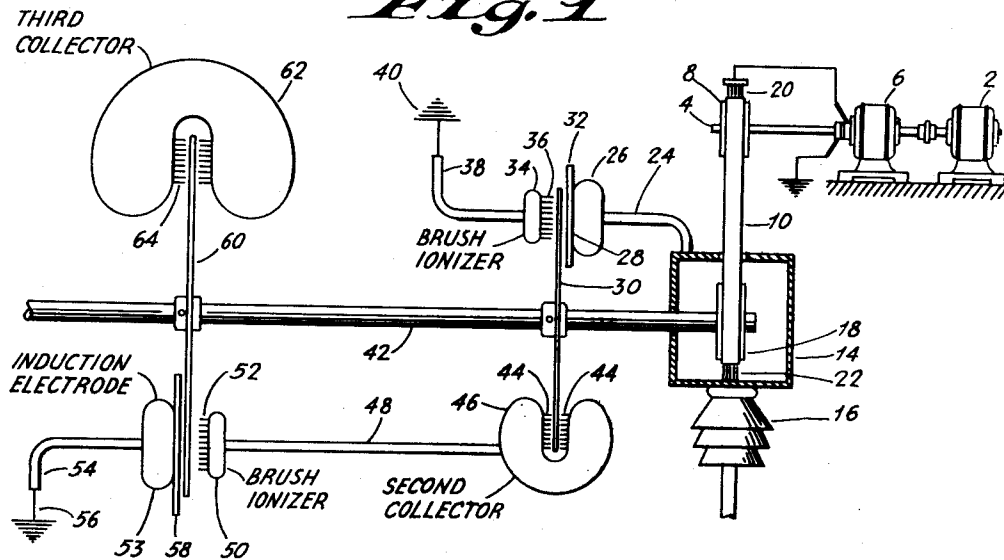


*Fig. 2*

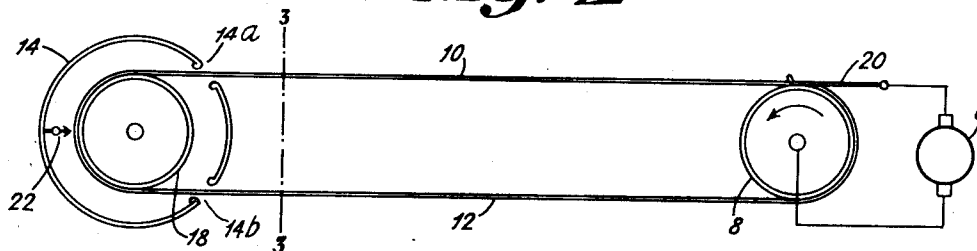


*Fig. 2a*

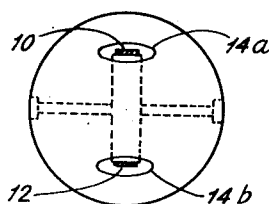


*Fig. 2b*

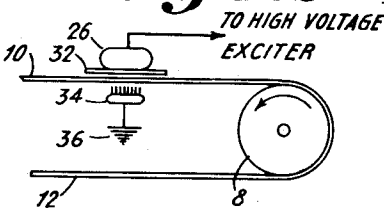
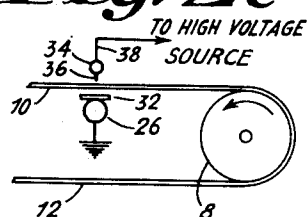


*Fig. 2c*



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*Fig. 3*

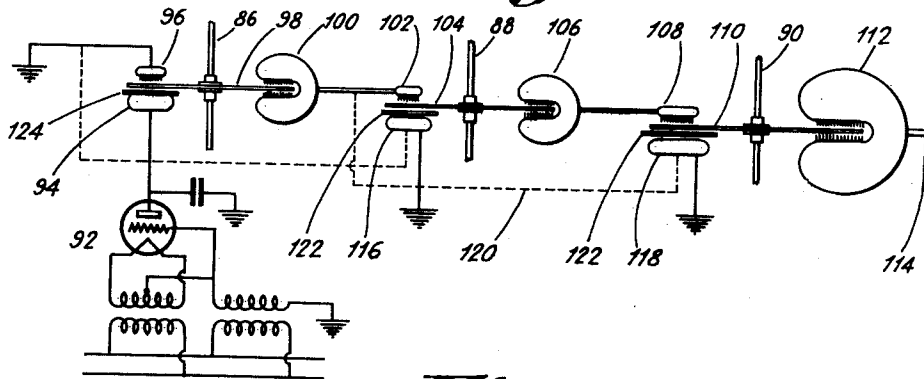


*Fig. 4*

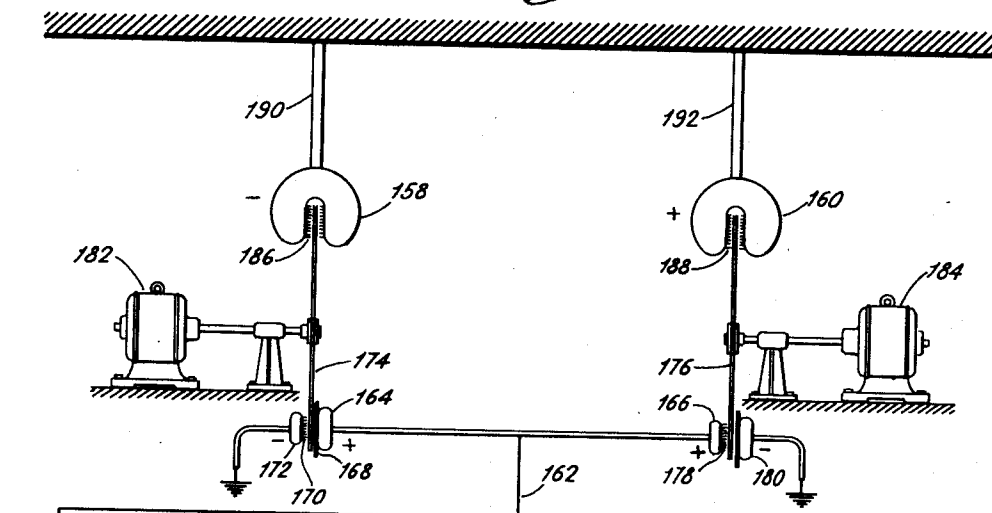
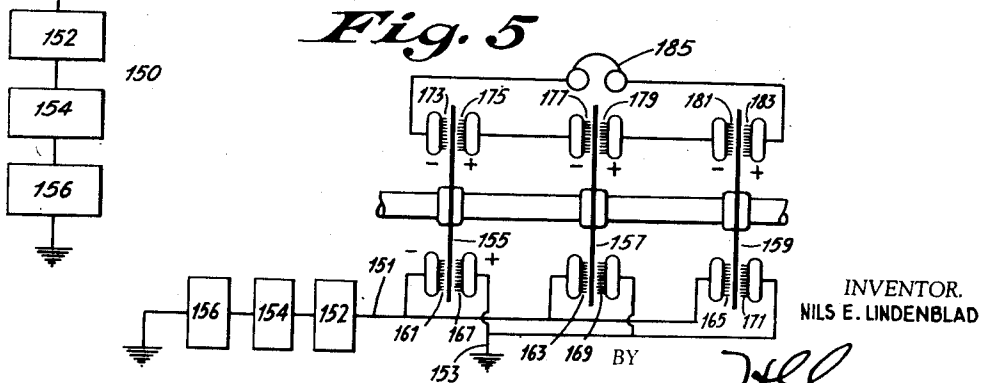


*Fig. 5*



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*Fig. 6*

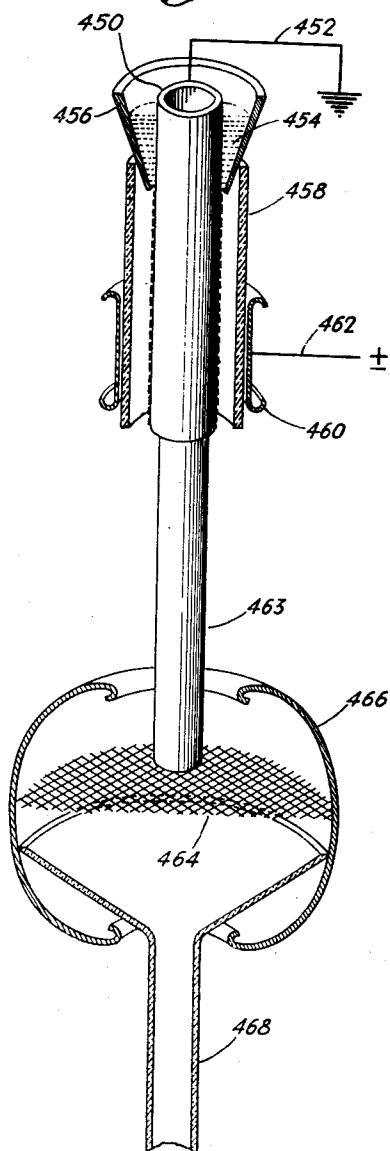
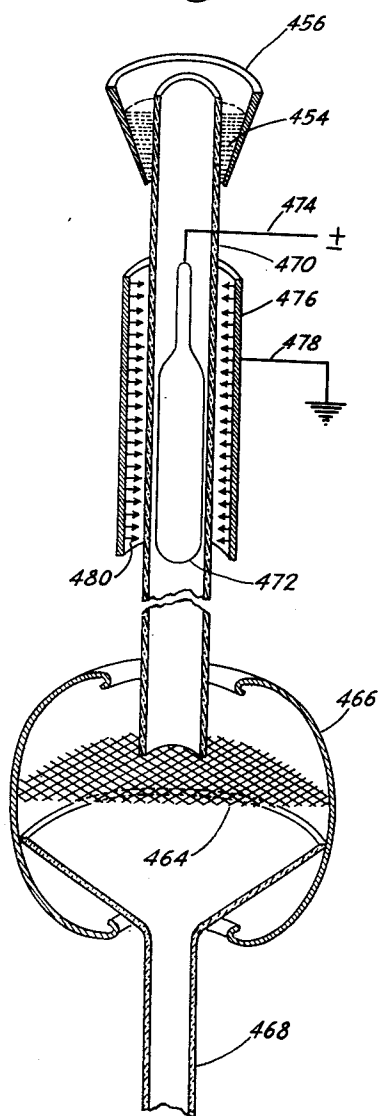


*Fig. 7*



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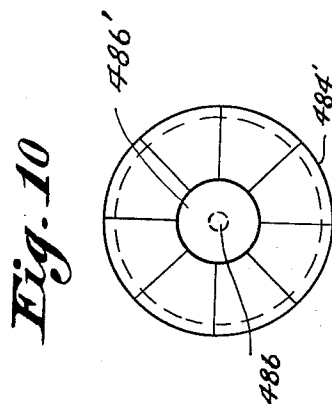
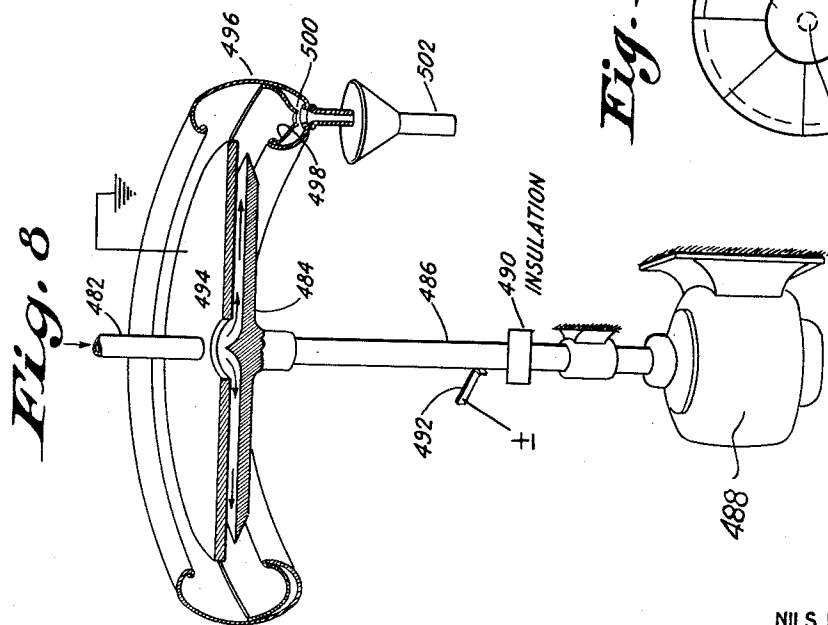
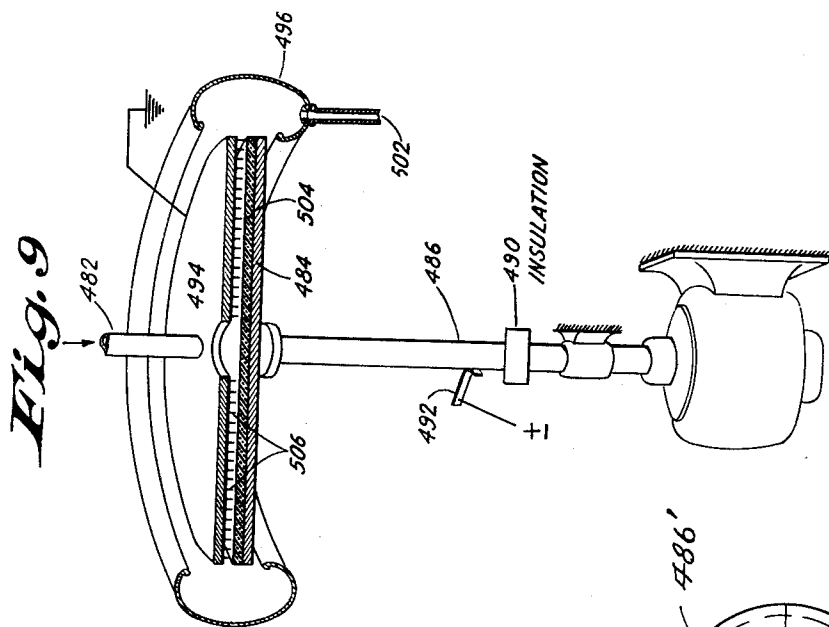
Feb. 16, 1937.

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HIGH VOLTAGE GENERATOR

Original Filed Aug. 9, 1933 4 Sheets-Sheet 4



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## UNITED STATES PATENT OFFICE

2,070,972

## HIGH VOLTAGE GENERATOR

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to Radio Corporation of America, a corporation  
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Original application August 9, 1933, Serial No.  
684,328. Divided and this application February  
1, 1935, Serial No. 4,475

16 Claims. (Cl. 171—329)

This invention relates to a method and means  
for generating extremely high potentials or volt-  
ages at high energy levels.

This is a divisional application of my copend-  
ing application, Serial No. 684,328, filed August  
9, 1933.

This divisional application is specifically di-  
rected to a rotor system wherein an induction  
principle, combined with a centrifugal force, is  
utilized to increase the voltage output.

In one way of carrying out my invention for  
the generation of high D. C. voltages, I charge  
metallic units, preferably particles of metal, by  
actual conductive contact with a D. C. source.  
Then, by moving the particles away from the  
source, the voltages of the charges thereon are  
increased, in a manner which shall be explained  
more fully hereinafter, and the charges are ulti-  
mately deposited upon a low voltage gradient-  
section of a charge-storing device or container.

In another arrangement for producing high  
voltages according to my present invention, an  
induction electrode, either grounded, or prefer-  
ably maintained at a high voltage, is insulatingly  
separated from a chargeable medium which may  
be a solid, a liquid or a gas, and, by the use of  
a point discharge electrode system connected to  
a direct current source, or preferably to ground,  
ionization or corona is caused to take place  
through and/or about the chargeable medium.  
The charged medium is then moved or carried  
to a low gradient area on a chargeable element,  
the high voltage surface of which is brought  
up to an exceedingly high voltage by the con-  
tinued deposits from the charged medium.

In a further modification of my present in-  
vention, both my "contact" and "induction"  
principles, about which more will be said later,  
are utilized.

A further and more specific object of my  
present invention is to provide systems which  
utilize my improved contact and induction prin-  
ciples for charging solid mediums such as belts  
and disks, for charging liquids such as oil and  
oil containing metallic particles in suspension  
and for charging gases.

Still further objects of my present invention  
are to provide an improved belt system for gen-  
erating high voltages; to provide an improved  
disk system for generating high voltages; to pro-  
vide improved combinations of disks alone or  
combinations of disk or disks and/or belt or  
belts, arranged in such a way as to have an  
effective output voltage much higher than the  
voltage generated by any one system; and to

provide a symmetrical network system in which  
various elements are charged in parallel but dis-  
charged in series so as to obtain a much higher  
resultant output voltage as compared to the volt-  
age applied to each element.

This invention will be more fully understood  
by referring to the accompanying drawings, in  
which

Fig. 1 illustrates diagrammatically a form of  
this invention wherein an improved belt system 10  
is cascaded with a plurality of disk arrangements  
for producing a high direct-current voltage;

Fig. 2 is a cross-sectional view of the belt  
exciter shown in Fig. 1;

Fig. 2a is a cross-sectional view of the sche-  
matic arrangement shown in Fig. 2, along the  
plane 3—3;

Fig. 2b is a detailed showing of an inductor  
electrode and belt;

Fig. 2c is a detailed showing of a charging  
electrode and belt;

Fig. 3 illustrates a cascaded disk arrangement  
having incorporated therein various features of  
this invention for producing an exceedingly high  
direct-current voltage;

Fig. 4 illustrates a simple arrangement of a  
plurality of disks according to this invention,  
wherein charging collectors associated with the  
disk are arranged to be at opposite polarity with  
a single polarity exciter. By such an arrange-  
ment double potential may be obtained in a sim-  
ple manner;

Fig. 5 is a disk arrangement for parallel volt-  
age charge and series discharge;

Fig. 6 illustrates a contact system for charg-  
ing fluids;

Fig. 7 illustrates a system similar to Fig. 6,  
which utilizes the induction principle of my in-  
vention;

Fig. 8 illustrates a system similar to Figs. 6  
and 7, wherein a centrifugal force is utilized to  
increase the voltage output;

Fig. 9 is another modification similar to Fig.  
8, except that the lower disk is provided with an  
upper surface of insulating material;

Fig. 10 is a plan view which illustrates a disc  
which is radially divided into segments.

Referring to Figure 1, a motor 2, through shaft  
4, drives a direct-current high voltage generator  
6 and pulley 8. The pulley 8 in turn drives a 50  
belt 10, 12 (see also Figures 2, 2a, 2b, and 2c)  
which at its other end rides within a collector  
14 in the form of a metallic sphere or cylinder.  
The collector is suitably insulated from ground  
by means of an insulating support 16. The pul-

ley 18 within the shell 14 may be supported in any suitable way as for example, by means of a bearing (not shown) fastened to the interior of the collector shell 14. As shown in Figure 2a, the belt 10, 12 rides into the shell by virtue of elliptical or other smoothly curved orifices 14a, 14b.

The belt 10, 12 is preferably made of varnished silk. However, for use with my present invention, it is revarnished with a suitable varnish, resinous or nitrocellulose compound, or similar substance such as an oven baking varnish and when this layer of resinous material is almost dry, a metallic powder such as aluminum dust is rubbed into the surface which does not come into contact with the metallic pulleys 8, 18. The belt is then allowed to dry and another layer or coating of varnish is applied and the belt with the sandwich of varnish layers and metallic powder is thoroughly baked. The belt is then placed upon the two pulleys 8, 18 and driven by the motor 2. At a point where the belt straightens out leaving the pulley 8, a soft metallic brush 20 is allowed to drag over the metallized surface of the belt. After a little use the top coating of the varnish is worn through sufficiently to allow actual conductive contact of the soft metallic brush 20 and the metallic particles insulatingly supported upon the belt. These metallic particles or units then form one side or effective plates of a condenser and the metallic pulley 8 the other.

Now, with the generator 6 switched into action so as to apply a moderately high voltage, say 500 volts to the brush 20, the particles or units carried by the supporting member or belt 10, 12, will be charged up as they contact with the metallic brush 20. As the belt straightens out and is moved away from the brush, the charged units (which have become charged by actual contact) because of their relative motion and increased distance between themselves and their effective other condenser plate or electrode, namely, pulley 8, will have their capacities decreased. Because of this decrease in effective capacity, the voltage on the particles will rise to several thousand volts. If there are some particles which did not happen to get charged under the brush, they will receive a charge through leakage from their contiguous charged brethren. As the particles or units move within the collector shell 14 and approach the discharge points 22 which preferably are not in direct contact with the outer surface of the belt, it will be found that the voltage on the metallic particles is sufficiently high to arc across the air gap between the metallic points 22 and the belt. This arcing is in the form of corona. The various charges deposited on the internal low-voltage gradient area of the collector shell then scamper to the outer surface of the collector shell 14 building up a large unidirectional potential thereon. The leakage throughout the length of the belt is too small to cause any drainage of the built up charge on the collector.

The charge accumulated upon the outer surface of the collector shell 14 may then be utilized in any desired way. As shown in Figure 1, I use the charge on the collector shell to excite the preferred form of my high voltage disk type of generator.

As shown in Figure 1, the charge on the outer surface of collector 14 is applied through the tubular metallic conductor 24 to a circular metallic induction electrode 26 having a surface 28 fac-

ing a portion of the insulating disk 30. The surface 28 of the induction electrode 26 may be made flat and parallel to the disk or it may be made elliptical, spherical, parabolic, hyperbolic, or may be made to curve in accordance with any law which will give small corona loss. Because of the high voltages developed on the induction electrode, and to prevent corona arc-over due to, among other things, ionization of the air between the induction electrode and the insulating disk 30, which, incidentally, may be made of any suitable high-grade insulating material, a sheet of insulating material 32 is placed between the induction electrode 26 and the disk 30.

On the opposite side of the disk 30, I place a charging electrode 34 having metallic discharge points 36. The charging electrode 34 or the brush ionization system 34, 36, is connected by means of conductor 38, which may be tubular, to ground 40. As illustrated, the charging system faces a section of the disk 30 opposite the induction electrode 26 or opposite the projected area of the induction electrode upon the disk 30.

Assuming that the generator 6 has impressed a positive charge upon the particles riding upon the belt 10, 12, the outer surface of the collector shell 14 will become charged to a high positive potential. So also the induction electrode 26 will become at a high positive potential and will tend to attract to it charges from the charging system or brush ionization system 34, 36. The discharge from the points 36, however, cannot reach the induction electrode 26 because of the interposition of the disk 30, as a result of which negative charges settle upon the section of the disk 30 between the discharge points 36 and the induction electrode 26. Because of the preferably high insulating qualities of the disk 30, the charges do not leak or distribute themselves all over the surface of the disk, but remain carried upon a particular section of the disk 30.

Rotation of the disk by means of the motor 2, belt 10, 12, pulley 18, and shaft 42 will cause the charged sections of the disk 30 to discharge on metallic points 44 carried by and located in the low voltage gradient section of a second U-shaped hollow, curved surfaced, metallic collector 46. As the disk is rotated faster and faster, new or "empty", that is, discharged sections of the disk are introduced between the induction and charging electrodes 26, 34, as a result of which more and more ions will be drawn from the points 36 and settle on the disk. Hence, greater speeds of rotation will cause greater number of charges per unit of time to be deposited on the disk giving, as a consequence, a current fed into the second collector 46 proportional to the rotative speed of the disk 30. Therefore, an appreciable amount of current may be fed into the second collector 46 which is limited, in general, only by the rotative speed of disk 30. However, inasmuch as the second collector 46 is of opposite polarity to that of the induction electrode 26, there will be a very high voltage gradient between these two bodies which will, on the smaller apparatus with small diameter disks, tend to cause undesirable loss in the form of corona. Moreover, the second electrode being negative and of opposite polarity to the induction electrode 26 will tend to produce a neutralizing action on the desired corona between the brush points 36 and the disk 30.

At this point it may be well to point out that the polarity assumed for the generator has been taken arbitrarily to impress a positive potential

upon the metallic brush 20. If desired, the brush 20 may be connected to the negative terminal of the generator 6 in which case the polarities throughout the system would be reversed.

Also, in order to avoid the high potential gradient between the induction electrode 26 and the second collector 46, the induction electrode 26 with the extra insulating sheet 32 and charging electrode 34 may be reversed in position so that the induction electrode is grounded and the charging electrode 34 is connected to shell 14. However, in this case there will not be an unlimited amount of ions produced upon the brush tips 36 since the output or charges placed upon the disk 30 will be limited by the charge delivered from the first collector shell 14. This is so since the charge on the disk can only be derived from the discharging points 36 and as their source now will drop in potential due to actual discharge at points 36, the amount of charge which can be deposited upon the disk will be limited by the charge on collector shell 14. The faster the disk is rotated, the faster will collector 14 be drained and the lower will its voltage be. In the first-mentioned connection, the faster the disk is rotated, the faster is the deposit of charge at constant voltage since there is no drainage of the source.

As an added advantage, there is, in the second case, an appreciable gain in voltage due to the movement of the charges away from the charging system and in addition, with a reversal of the electrodes 26, 34, shown in Figure 1, since the second collector 46 and the charging electrode or brush ionizer 34 are of the same polarity, there will be no exceedingly high voltage gradient between the charging electrode and the collector, as a consequence of which there will be no bad corona losses. Moreover, the neutralizing action adverted to will not take place. However, this reversal will not be necessary on a large machine where there is ample room for grounded metallic shields between the second collector and the induction electrode, as well as first collector 14.

Referring again to the arrangement as illustrated in Figure 1, the negative charge on the U-shaped, curved, second collector 46 is then conductively brought by means of tubular metallic pipe 48 to a second brush ionizer or charging electrode 50 carrying the metallic discharge points 52. On the opposite side of the charging electrode 50 is connected an induction electrode 53 similar in structure to induction electrode 26, but grounded through conductors 54, 56. Here also in the second disk system, an insulating sheet 58 is insulatingly mounted between the induction electrode and the second rotating disk 60 also of an insulating material of high tensile strength. As the disk 60 rotates, the negative charge on the second collector is deposited through the discharge points 52 thereon. Movement of the charge away from the electrode 50 causes it to increase in potential and the increased potential charge is deposited on a third collector 62 which picks up the charge by means of the metallic pick-up points 64. In connection with the third collector system the charge deposited upon the disk is limited by the amount of energy fed into the second collector 46 since the induction electrode 53 is connected to ground.

As in connection with the belt system, the disk may contain metallic particles by rubbing the same into the surfaces of the disk and then fixing them thereon by suitable insulating com-

pounds such as varnishes or any resinous compound or any nitrocellulose compound. With the metallic particles on the surfaces of the disk the various brush points such as 36, 44 and 64, may, if desired, make actual contact with the particles carried by the disks as do the metallic hairs or filaments of the metallic brush 20 riding upon the belt 10, 12.

Charging of the belt system shown in Figure 1 is not, however, limited to the contact method 10 and means which I have described. On the other hand, the induction arrangement such as used for the disks 30, 60 of Figure 1 may be applied equally as well to the belt.

In Figure 2b, the belt 10, 12 is charged up by my improved induction apparatus, induction electrode 26 being insulated from the belt by means of insulating sheet 32. The induction electrode 26 is connected as indicated to a high voltage exciter source which may be any one of the high voltage sources which shall be described more fully hereinafter, or which may be a D. C. source such as generator 6 of Figure 1. Corona discharge will take place towards the belt at the points 36 and this charged up section of the belt may then move along into the collector 14 as before. In the arrangement shown in Figure 2c, the discharge points 36 on the contrary are connected to the high voltage source and the induction electrode 26 is grounded.

It should be clear, in connection with Figure 1, that additional collector stages may be cascaded to the third system. For example, an additional disk may be placed still further to the left on shaft 42 and a brush ionizer system or an induction electrode such as 48, 50 connected to the third collector 62 to charge up the disk, a suitable induction electrode or brush ionizer being connected to the opposite side of the disk to ground, and so on. Moreover, while the system shown in Figure 1 indicates various rotating elements or disks mounted on a common shaft, this is not at all necessary since the rotating elements may be mounted independently and, if desired, rotated at the same or different speeds. In addition, it is to be clear that it is not necessary to use the belt exciter system for charging the disk system.

I have already pointed out that it is not necessary, as shown in Figure 1, to mount the disk systems on a common shaft. As illustrated in Figure 3, a plurality of shafts 86, 88, 90 driven by any suitable means (not shown) at the same or different speeds are provided. By means of an A. C. rectifier system 92, the first induction electrode 94 is charged to a negative potential causing positive ions to be drawn from the charging electrode 96 upon the rotating disk 98. These positive ions in turn jump on to the first collector 100, charging the same up to a high potential. The charge on the first collector 100 is then fed from charging electrode 102 to the second disk 104 which carries the charge over to the second collector 106, which, from what has gone on before, will be charged to a positive potential. The positive potential on the collector 106 is then fed by means of charging conductor 108 to a third disk 110 and thence to a third collector 112, the high positive voltage on which may be fed by means of a suitable conductor 114 to any suitable utilization means. It is natural that the output of one stage may be fed either to the induction electrode or to the brush ionizer of the next stage. Because of the high voltages involved, the induction electrodes 116, 118, and the

back connections 120 to previous stages may be found unnecessary as a consequence of which the insulating sheets 122 may also be dispensed with, although in connection with the first induction electrode 94, it is preferred that an insulating sheet 124 be provided, the idea being that, at the extra high potentials involved in this embodiment, there will be sufficient gradient around the brushes 102 and 108 to cause corona without the presence of an induction electrode.

As in connection with the belt, movement of the charged sections of the disk away from the induction and charging electrodes will cause, by virtue of the work done upon the disk, a rise in potential of the sections, or where the disks carry particles, a rise in potential on the charges of the particles. Consequently, the disk system also serves to increase voltage as well as, as shown in connection with, for example, the first disk system 30, 46, 34, 26 of Figure 1, current or power.

While a collector system may have regions, such as the inside of a sphere or a cylinder, where there is no voltage gradient present due to charge on the outside of the system, there is always a field outside the system which must be traversed before the inside may be reached. A charge to be transported to the sphere must therefore traverse this field. The higher the potential of the collector system becomes, due to accumulating charges, the greater will therefore the expenditure of efforts to transfer an additional charge have to be. A certain confusion in conception of this phenomena has been noticed at times. It has been noticed that the conception has at times arisen that since the gradient of the inside of a sphere is zero, it would be possible to connect a conductor from a source of moderate potential to the inside of a sphere and thus, since there is no gradient inside, the sphere could be charged up indefinitely in this way. This is of course erroneous; in fact ridiculous—but why after all is this not possible. The answer is of course that though the gradient inside is zero, this zero space is elevated to the same potential as the rest of the system and cannot be reached without going through the outside gradient of the system. Any charge in order to accomplish a journey towards the system must therefore have enough force behind it to move it forward. The work spent on a charge in this way is simply the elevation of its potential to such a value that it can join the charges already in the system. In depositing a charge it is, therefore, really not necessary that it be deposited inside the system. Due to inherent difficulties in most cases, this is however advisable. A conveying system such as a belt or a disk has sections arriving at the same rate as it has sections leaving the collector system. If for instance the collector system has the form of a pulley, the charges coming with a belt may very well be deposited directly on the outside of the same, but it would also carry charge away from the same. This example can be applied in innumerable variations.

Also, it has been pointed out that where the disks carry metallic particles substantially insulated from each other, actual metallic contact may be made with them by means of the points or soft metallic hairs carried by the brush ionization or charging electrodes. However, even with the metallic particles carried by the disks, metallic contact need not be resorted to but arc discharge may be used, the points carried by the brush ionizer of charging electrodes being suit-

ably spaced from the disk. Incidentally, the collectors are shown having points on opposite sides of the disks inasmuch as it will be found in practice that the charge, while not leaking substantially over the surface of the disk will pass sometimes to quite an extent through it since the disk is relatively thin.

When a rectifier is used to charge the belt, a more moderate voltage such as 500 volts may be applied to the charging brush although when using my induction apparatus to charge the belt, the exciting voltage should be high enough to cause ionization or corona. With a cascaded system of disks, such as shown in Figures 1 and 3, in fact with a single disk, there is no definite upper voltage limit. Large scale apparatus will produce voltages of many millions.

Figure 4 illustrates a system for obtaining opposite polarity direct current voltages on a pair of collectors by means of a pair of disk machines incorporating many features of my present invention. A particular advantage of the arrangement shown in Figure 4 resides in the fact that a single rectifier 150, consisting of three stages 152, 154, 156, although not limited thereto but may be of any number of stages, operates through the disks to impress opposite polarities on the collectors 158, 160. Thus, as shown, the output conductor 162 applies a positive potential, (although if desired a negative potential may be used) to the inductor electrode 164 and to the charging electrode 166. By virtue of the discharge points 170 on charging electrode 172, ionization or space discharge, magnified by the use of insulating sheet 168, will occur charging the disk 174 to a negative potential. However, disk 176 will be charged to a positive potential because it is easier for the charge to depart from the points 178 of the charging electrode 166 than for a charge to escape from the induction electrode 180 on to the disk 176. The disks 174, 176 are rotated by independent motors 182, 184, driven at the same speed or at different speeds as found desirable. That is, disk 174 may be rotated faster than, slower than, or at the same speed relative to disk 176. The charges on the disks are then carried over to the collectors 158, 160, and because of the charging points 186, 188 carried by the respective collectors, charged to a negative and positive potential respectively. The collectors 158, 160 are insulatingly supported from ground by means of the heavy insulating rods 190, 192. Since the collectors 158, 160 are of opposite potential, the potential difference between them is more than the potential between either collector and ground.

In Figure 5 I have illustrated an arrangement of disks which are charged up in parallel and discharged in series, as a result of which the discharge voltage becomes several times that of the voltage on a single disk. More specifically, referring to Figure 5, the leads 151, 153 are connected to a source of opposite polarity or, as illustrated, lead 153 is connected to ground and lead 151 to the cascaded rectifier system 152, 154, 156, such as illustrated in connection with Figure 4. The disks 155, 157, 159 are, assuming the voltage from the final stage of rectifier 152 to be as indicated, sprayed with negative ions on one side and positive ions on the other. That is to say, the charging points or electrodes 161, 163, 165, spray the left-hand sides of the disks with negative ions, whereas the discharge points 167, 169, 171 spray the right-hand sides of the disks with positive ions. Transfer of the charges

on the disks to the discharging electrodes 173, 175, 177, 179, 181, 183, increases, as explained before, the effective voltage and the increased voltages are effectively added in series so as to produce across the terminals 185 an enormous voltage which may be utilized for any desired purpose.

In the case of a disk which is sprayed on opposite sides with opposite polarity charges, this disk can, of course, also be prepared as a "metalized" disk. In order to be efficient at such lower voltage, the disk would have to be made thinner in order to have a larger capacity between the particles on opposite sides so that more electricity can be "bound" by lower voltage. If the disk is made thinner, it is mechanically weak and wobbly. Inasmuch as in this particular case the two halves of the "condenser" are not separated, as in the case of the belt leaving the pulley or as takes place in some of the other disk cases, the voltage between the particles on opposite sides of the disk will not increase. Despite this, however, a metal disk may be used as a mechanically strong member of the system. This metal disk should then be covered with thin varnished silk of thickness depending upon the voltage to be used. The outside surface of the silk could then be metallized. The metal disk would then be a sort of intermediate member in the capacity system formed by the disk. This idea could, of course, also be extended to cover the case of a disk with non-metallized surface. If desired, high capacity condensers could be mounted on the disc and charged as they successively pass a certain stationary contact or spark gap and to be discharged in like manner. Thus, condensers belonging to different disks could be charged in parallel and discharged in series. The virtue of mounting the condensers on a rotating system instead of having the condensers stationary and merely change their connections with a rotating commutator lies in the fact that the insulation between the parallel and the series connected system is very much easier if the condensers belong to the rotating system.

In order to obtain enough insulation for higher voltages between the parallel charging system and the series discharge system, it will be necessary to sectionalize the metal disk radially into segments fastened to an insulating disk or hub. In this way the system becomes quite close in resemblance to the idea of mounting condensers on the disk.

Referring again to such systems as shown in Figures 1 to 4, wherein systems for generating high voltages by "contact" and "induction" processes have been described, it should be clear that those systems are not limited to the use of solids, such as belts and disks as charge transfer mediums but the principles expounded thereon may readily be extended to liquids and gases. An arrangement for utilizing a contact system for charging a liquid is illustrated in Figure 6, and Figure 7 shows a somewhat similar arrangement wherein the induction principle is employed to charge up a charge transferring liquid.

Referring to Figure 6, a metallic cylindrical tube 450 is grounded through the medium of a conductor 452, which conductor may be, in the alternative, if desired, connected to a source of relatively high D. C. potential. A mixture 454 of metallic powder and some insulating medium, such as bronze powder and oil, is caused to gravitate slowly over the surface of the metallic tube 450 in any suitable way as, for example,

by the use of the drip device 456 in the form of a truncated cone.

About the longitudinal axis of the tube 450 there is placed in parallel relationship therewith in any suitable way, an insulating cylinder 458 preferably of glass and about cylinder 458 there is placed or mounted thereon a metallic cylindrical element 460 connected through conductor 462 to a suitable source of D. C. potential. In the alternative, with conductor 452 connected to a source of potential, conductor 462 should be connected to a source of potential of opposite polarity or grounded.

Consequently, as the metallic particles contained in the oil contact with tube 450, they are charged up.

The oil and metal powder mixture guided along glass tube 463 and falling upon the metallic wire screen 464 deposits its charge upon the inner surface or zero gradient surface of the metallic shell or charge holder 466. The oil and powder, after losing their charges, drop through the glass funnel 468 to be returned in any suitable way as by pumping to the container 456. The shell 466 will assume a potential opposite to the potential impressed upon conductor 462, or should the potential be impressed upon the conductor 452, the potential of the charge sphere 466 will correspond in polarity but will be of a much higher voltage than the voltage impressed upon conductor 452.

In the liquid "induction" system of Figure 7, it is preferred that the liquid 454 within the cone-shaped container 456 be merely a high quality oil. This oil is allowed to flow over the surface of the cylindrical glass tube 470 within which is contained a rounded induction electrode 472, which is preferably connected through conductor 474 to a source of high D. C. voltage, or, if desired, conductor 474 may be grounded, in which case the cylindrical metallic sleeve 476, rather than be grounded as illustrated by conductor 478, should be connected to some source of D. C. potential. As illustrated, however, the oil flowing over the surface of the glass tube 470 will be subject to corona action by virtue of the discharge points 480 conductively connected to the interior surface of the metallic cylinder 476. The charged oil will then drop onto the screen 464 and the charge will flow from the interior surface of the shell 466, which, as explained before, is of zero voltage gradient, and will spread itself over the outer surface thereof, the charge being built up to an exceedingly high value by the continued deposition of charges from the dropping oil. The excess oil may, as before, be removed by the use of a glass, funnel-like structure 468, for reuse in container 456.

In the arrangements shown in Figures 6 and 7, when exceedingly high voltages are built up upon the spheres 466, there is a tendency to prevent any further electrostatic charge from entering the sphere because of the high electrostatic field about the input orifices. To overcome this difficulty and to raise a chargeable element to still higher voltages, the arrangements shown in Figures 8 and 9 may be used to good advantage to correspond to Figures 6 and 7, in the order given.

In Figure 8, oil is fed through a tube 482 onto a metallic disk 484 rapidly rotated by a shaft 486 in turn driven by any suitable motor 488. The shaft 486, however, is insulatingly supported upon the motor shaft by the insulation block 490 so that a source of potential may be impressed upon the shaft by brush 492, which potential in turn manifests itself upon the metallic disk 484. Centrifugal force therefore will drive the oil and metal

powder mixture horizontally between the rotating disk 484 and the stationary disk 484 into the interior of shell 496, which is provided with a false bottom 498 having an outlet opening 500, through which the oil may fall into a suitable piping system 502 for passage into pipe 482. The oil metal mixture becoming charged up by conduction will in turn deposit its charge upon the interior zero potential surface of the shell 496. However, centrifugal force will overcome large electrostatic forces produced by the charge on the outer surface of the annular element 496, as a result of which higher voltages may be generated with the system shown in Figure 8, as compared to an arrangement wherein gravity, for example, illustrated in Figures 6 and 7, is relied upon as the motivating force for moving the charging medium into the chargeable element.

In the arrangement shown in Figure 9, the lower disk 484 is provided with an upper surface 504 of insulating material. The oil from pipe 482 is preferably in this case pure oil. High voltage placed upon the shaft 486 through the brush 492 will cause corona discharge at the points 506 carried by the upper metallic plate 494. The insulating material 504, however, will prevent short-circuiting of the corona discharge to the metallic plate 484. In this way still higher charges for the annular collector 496 may be obtained. The system shown in Figure 9, therefore, utilizes, for charging the liquid medium, "induction".

In the illustration shown by Figure 10, as mentioned above, in order to obtain insulation for higher voltages between the parallel charging system and the series discharge system, the metal disc 484 is needed to be divided radially into segments indicated at 484'. These segments are fastened in any suitable manner to an insulating disc or hub 486'. The hub 486' is then securely fastened for rotation to the shaft 486.

Various other changes will readily suggest themselves to those skilled in the art in carrying out the principles of my present invention. Therefore, my present invention is not to be considered limited by the various illustrations which are given merely as specific examples, but is to be given the full scope indicated in the appended claims.

I claim:

1. A high voltage generator comprising a pair of relatively movable disk surfaces, means for feeding a liquid between said surfaces, means for charging said liquid, and means for discharging said liquid after being thrown out from between said disks by centrifugal force.

2. Apparatus as claimed in claim 1, characterized by the fact that said liquid is in the form of an insulating oil and by the fact that one of said surfaces is connected to a source of potential so as to be at one potential and the other is so connected as to be at a different potential.

3. Apparatus as claimed in claim 1, characterized by the fact that the grounded disk is stationary.

4. Apparatus as claimed in claim 1, characterized by the fact that one of said disks is covered with an insulating material and subjected to a high voltage.

5. A high voltage generator comprising a pair of relatively movable metallic disk-like surfaces, means for feeding a liquid between said surfaces, means for charging said liquid, and means for discharging said liquid after being thrown out from between said disk-like surfaces by centrifugal force.

6. A high voltage generator comprising a pair of relatively movable metallized disk-like surfaces, means for feeding a liquid between said surfaces, means for charging said liquid, and means for discharging said liquid after being thrown out from between said disk-like surfaces by centrifugal force.

7. A high voltage generator comprising a pair of movable metallic disks, one of said disks being sectionalized radially into segments fastened to an insulating hub, means for feeding a liquid between said surfaces, means for charging said liquid, and means for discharging said liquid after being thrown out from between said disks by centrifugal force.

8. A high voltage generator comprising a pair of relatively movable metallic disk-like surfaces, a ring surrounding the periphery of said disk-like surfaces, means for feeding a liquid between said surfaces, means for charging said liquid, and means for discharging said liquid after being thrown out from between said disk-like surfaces by centrifugal force, so as to impinge the inner surface of said ring.

9. A high voltage generator comprising a pair of movable metallic disks, one of said disks being sectionalized radially into segments fastened to an insulating hub, a ring surrounding the periphery of said disks, means for feeding a liquid between said disks, means for charging said liquid, and means for discharging said liquid after being thrown out from between said disks by centrifugal force so as to impinge the inner surface of said ring.

10. A high-voltage generator comprising a relatively fixed surface and a movable surface, means for feeding a liquid on said movable surface, means for charging said liquid, and means for discharging said liquid after being thrown out from said movable surface by centrifugal force.

11. Apparatus as claimed in claim 10, characterized by the fact that the liquid is in the form of insulating oil, and the fact that one of said surfaces is connected to a source of potential and the other to ground.

12. Apparatus as claimed in claim 10, characterized by the fact that the relatively fixed surface is grounded.

13. Apparatus as claimed in claim 10, characterized by the fact that at least one of said surfaces is covered with an insulating material and subjected to a high voltage.

14. A high-voltage generator comprising a relatively fixed metallic surface and a movable metallic surface, means for feeding a liquid on said movable metallic surface, means for charging said liquid and means for discharging said liquid after being thrown out from said movable metallic surface by centrifugal force.

15. A high-voltage generator comprising a relatively fixed metallized surface and a movable metallized surface, means for feeding a liquid on said movable metallic surface, means for charging said liquid and means for discharging said liquid after being thrown out from said movable surface by centrifugal force.

16. A high voltage generator comprising a relatively fixed surface and a movable surface, means for feeding a liquid containing metallic powder on said movable surface, means for charging said liquid, and means for discharging said liquid after being thrown out from said movable surface by centrifugal force.

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