April 14, 1942. W. H. BENNETT 2,279,586

ELECTRIC DISCHARGE SYSTEM

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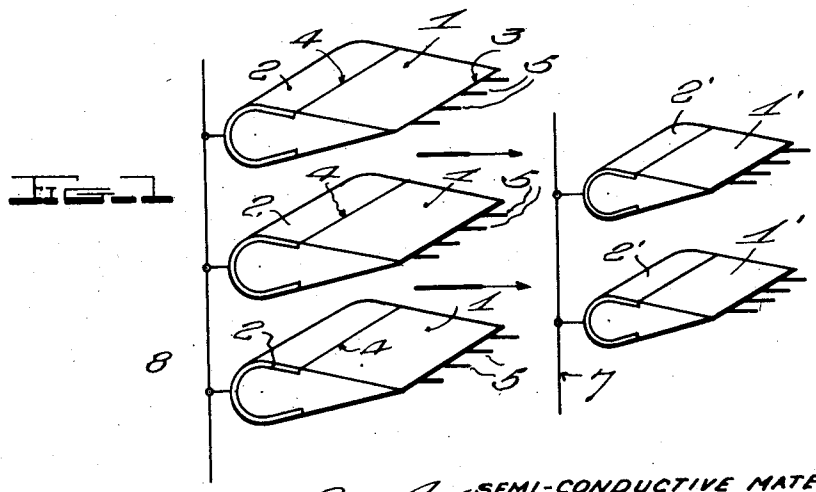

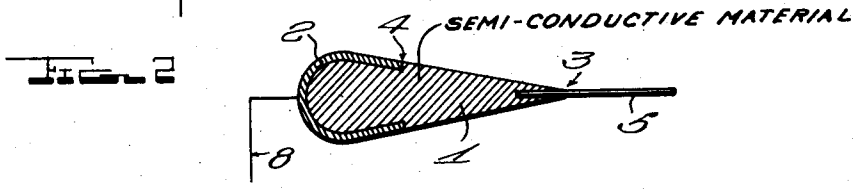

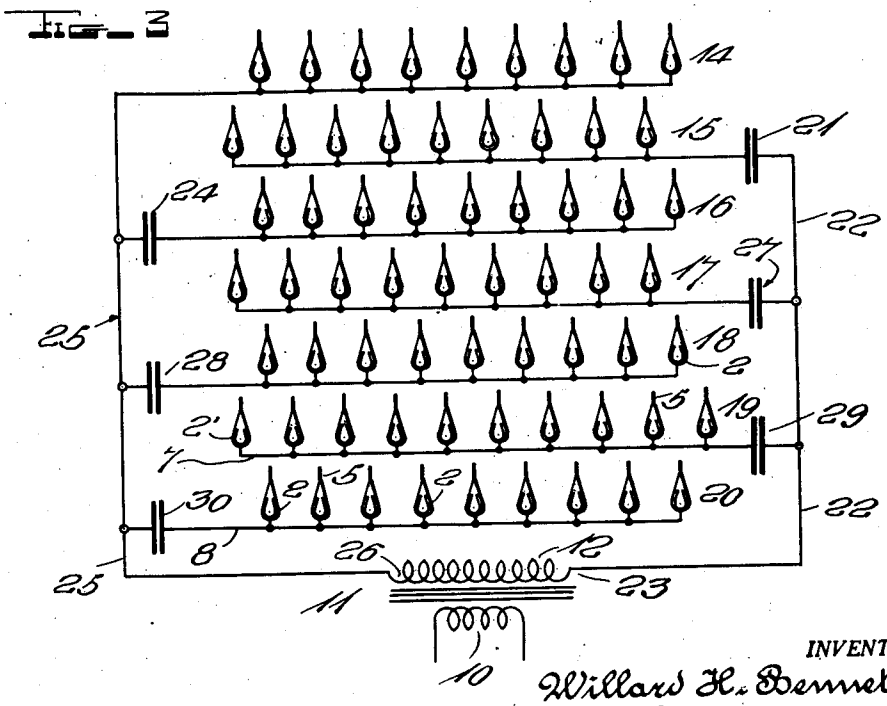

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Fig. 4

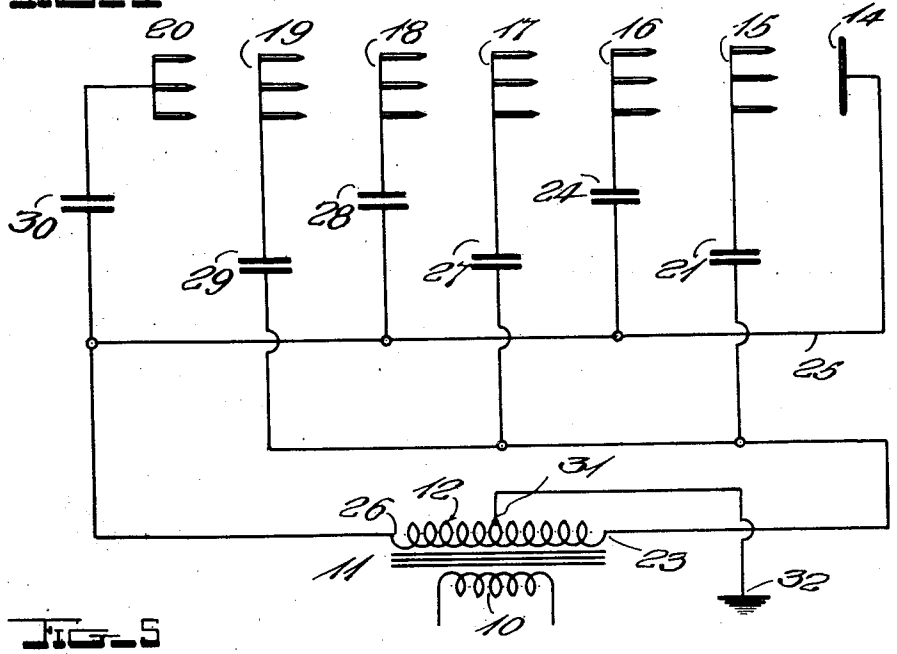

Fig. 5

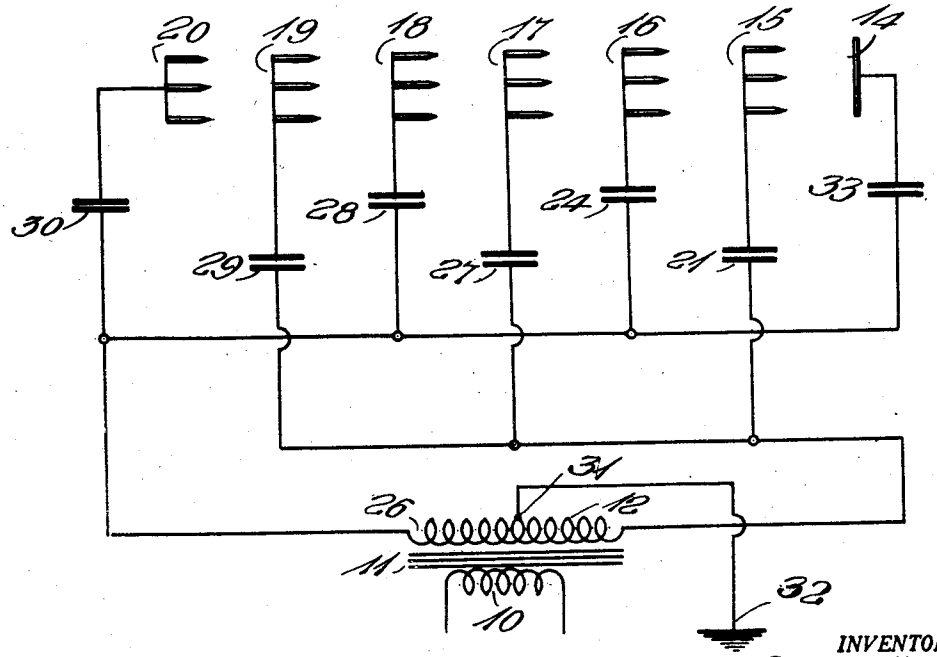

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Fig. 6

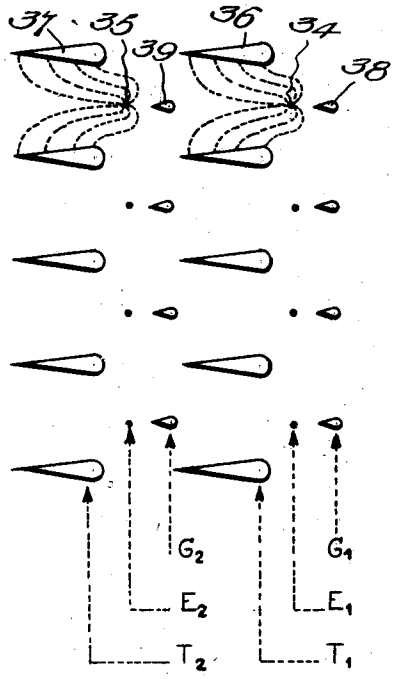
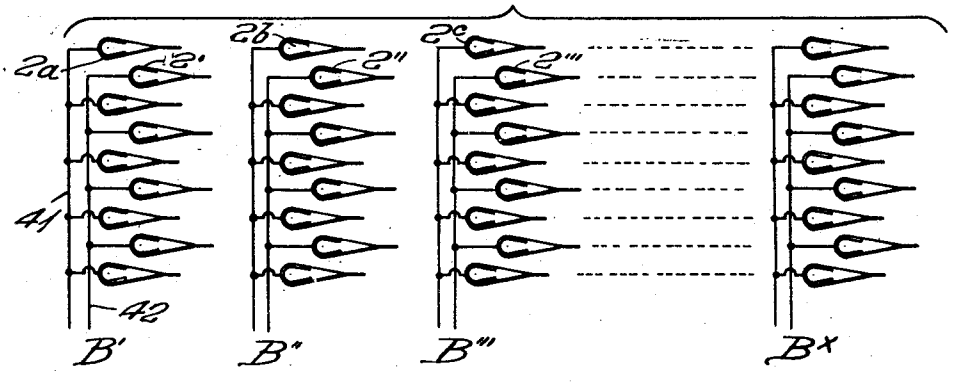


Fig. 7



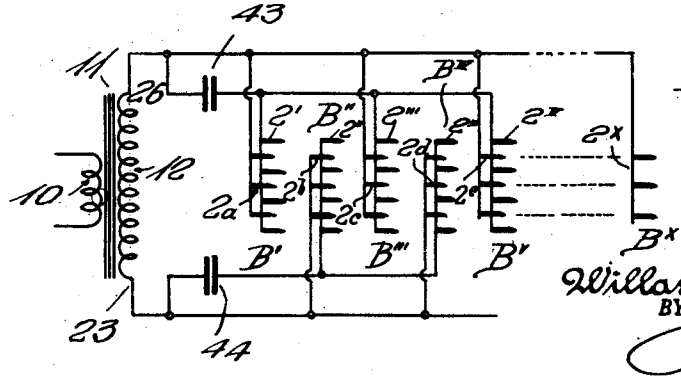


Fig. 8

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Patented Apr. 14, 1942 2,279,586

UNITED STATES PATENT OFFICE

2,279,586

ELECTRIC DISCHARGE SYSTEM

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Application February 4, 1939, Serial No. 254,724

21 Claims. (Cl. 230—69)

My invention relates broadly to fans and more particularly to arrangements of electrodes in fans of the electric discharge type.

One of the objects of my invention is to provide a cascade arrangement of electrodes for fans of the electric discharge type by which mass movement of fluid such as air may be produced with a high degree of efficiency.

Another object of my invention is to provide constructions of electrodes for fans of the electric discharge type having means for producing maximum movement of fluid such as air under control of impressed electric potentials in which the number of stages of discharge electrodes may be readily cascaded.

Still another object of my invention is to provide an arrangement of cascade electrodes for electric discharge apparatus in which the electrodes are stream-lined for reducing resistance to the flow of air or other fluid around the electrodes under control of an impressed electric potential.

A further object of my invention is to provide a construction of discharge electrode for fans in which a multiplicity of short sections of metallic wire are embedded in a semi-conductive plastic material, stream-line to offer minimum resistance to the flow of air around the electrode.

A still further object of my invention is to provide a circuit arrangement for operating a cascaded fan system in which alternately arranged banks of electrodes are connected to opposite sides of a source of alternating current for integrating pressure effects established by successive discharges of the alternate banks.

Still another object of my invention is to provide a system of electrically controlling the direction of discharge in a cascaded fan structure for increasing air deliveries and improving general fan efficiency.

Other and further objects of my invention will be understood from the specification hereinafter following by reference to the accompanying drawings in which:

Figure 1 is a perspective view of one arrangement of discharge electrode embodying my invention; Fig. 2 is a transverse sectional view taken through one of the discharge electrodes shown in Fig. 1; Fig. 3 illustrates one circuit arrangement for cascaded banks of emitters embodying my invention; Fig. 4 shows a modified circuit for a fan constructed in accordance with my invention; Fig. 5 shows a further modified form of circuit operating under the principles of my invention; Fig. 6 shows a method of increasing the delivery of air and improving the efficiency of fans constructed in accordance with my invention; Fig. 7 shows the manner in which the electrodes in the fan system of my invention may be staggered for increasing the fan delivery; and Fig. 8 is a schematic circuit arrangement of the fan system shown in Fig. 7.

My invention is directed to an arrangement of electrodes for electric discharge apparatus and circuit arrangement for cascaded banks of electrodes in which an electrically discharging element or member is molded from semi-conductive plastic material and stream-lined to a tapered edge portion in which there is embedded a multiplicity of sections of fine wire. Depending on the polarity of these electrodes, the electrodes will emit either electrons or will eject ions, and when the electrodes are negative and emit electrons, these electrons may (and probably do) immediately attach themselves to neutral molecules to form negative ions. Accordingly these electrodes are both electron and ion emitting. The sections of fine wire are spaced uniformly one from another with their ends directed toward a target electrode. Both the target electrode and the semi-conductive plastic emitting electrode are stream-lined in contour for offering minimum obstruction to the flow of fluid around the electrodes under control of the electric discharge between the exposed ends of the sections of fine wire and the target electrode. The emitting electrode and the associated target electrode may be readily cascaded for inducing a greater flow of fluid.

The emitting electrodes of each bank may be connected together and the banks alternately disposed with alternate banks connected to one side of an alternating current source through condensers. Due to the condenser blocks each bank is individually caused to approach an average potential such that it draws as much current at positive potential as it draws at negative potential, or expressed otherwise, the total sum, through each complete cycle, of negative charge received from a next preceding bank plus positive charge delivered must equal the total positive charge received from the next preceding bank plus the negative charge delivered. Due to the natural bias of this type of discharge the successive banks will shift by a D. C. potential so that successively increasing positive potential will be assumed by the banks in succession from the last target bank.

If all banks are left condenser blocked the operation is still such that equal negative and posi-

tive emission occurs on successive half cycles, but the further advantage is attained that any bank may be grounded at will without drawing any current after the initial charging current. If the capacity to ground of the fan assembly is small enough the charging current at grounding can be made so small as to not be dangerous. The velocity of drive may be increased by the use of guard members which serve to eliminate losses due to interelectrode action in successive banks. I may arrange the electrodes of each bank in staggered arrangement to form dual ranks, and have the electrodes of one bank coacting as emitters, with electrodes of an adjacent bank operating as targets. The electrodes of each bank are connected to the same side of the source of potential, the rank with leading target edges being directly connected to one side of the source of potential and the rank with retracted target edges being connected through a condenser to the same side of the source of potential. That is to say, each bank of electrodes is composed of two ranks arranged in staggered relation, the ranks alternately being effective as emitters. The field applied to the emitting edges of the electrodes is almost entirely determined by the potential of the buses of the next adjacent rank serving as targets for the emission because the other rank of that target bank is in a more remote position. The potential of those emitter ranks which are more exposed toward their target banks, is determined by that condenser potential required to make the emission on positive swing equal to the emission on negative swing. The emission of the more retracted emitting edges of each bank will always occur only on the negative swing. The principal advantages of this form of my invention are that the current is substantially the same on each half cycle; secondly, that all banks fire simultaneously; thirdly, that the charge coming up to each bank from the previous bank assists in inciting the emission for on-set of each successive half cycle; fourthly, the wind pressures produced by advanced banks assist in producing more regular discharges at the remote banks and as a result the drive produced is more regular and more susceptible to increase by decreasing interbank distances. This staggered arrangement is also advantageous in connection with electric circuits which give phase rotation of applied voltage and which, therefore, make the emission extend over a larger percentage of each half cycle.

The electrode arrangements illustrated herein are adapted particularly to use in creating movements of fluid media such as air and the embodiments to be described may, therefore, be termed "fans" or "blowers" as hereinbefore indicated. The electric discharge system disclosed, however, may be employed in a variety of ways for the accomplishment of other varied effects, for example, in the electric precipitation of particles from suspension in fluids to electrify the particles, in making chemical substitutions to provide a catalytic effect, in the field of electromechanics to produce reactive forces, and for various other purposes where a controlled electric discharge, accompanied by relative movement of the medium and the electrode structure, is required. It will be understood, therefore, that the disclosure of my invention in connection with fans of the electric discharge type, is by way of example only.

Referring to the drawings in detail, reference character 1 designates the emitting electrodes which are molded from semi-conductive material in substantially stream-lined contour. The emitting electrodes taper from a rounded rear edge portion 2 to a relatively sharp edge portion 3. The rear edge portion 2 is constituted by a longitudinally extending curved plate member which is embedded adjacent the rear edge portion of the semi-conductive material of the electrode 1 during the molding process so that the junction between the sides of the molded structure of the electrode and the rear edge portion 2 is stream-lined as at 4. The discharge elements consist of a plurality of short sections of metal wire 5, molded at spaced intervals in the tapered edge 3 of the emitting electrode 1. The sections of fine wire 5 constitute discharge points directly toward the rounded edge 2' of the coacting stream-lined target electrode 1'. A difference of potential is established between connection 7 to the rear edges 2' of target electrodes 1' and the connection 8 which leads to the rear edges 2 of electrodes 1 in cascade. The electric discharge between the points constituted by the sections of fine wire 5 and the rear edges 2' of target electrodes 1' establishes a movement of fluid from the discharge points toward the target. Where the assembly of electrodes is arranged in the atmosphere, the wind direction is established in the direction which I have indicated by arrows.

In Fig. 3 I have shown the manner in which the discharge electrodes may be arranged in a cascade system. The banks of emitting electrodes are connected as shown with the source of alternating current connected to primary winding 10 of transformer 11, having secondary winding 12 connected to the banks of emitting electrodes as illustrated. The electrodes are similar to the electrodes set forth in Figs. 1 and 2 in that each electrode includes a target 2 and emitting points 5. Each bank of emitting electrodes is staggered with respect to the adjacent bank. I have shown the separate banks at 14, 15, 16, 17, 18, 19 and 20. The banks of electrodes which serve as emitters are condenser blocked with respect to the alternating current supplied from secondary winding 12 of the transformer 11. The alternate banks are connected through their condensers to opposite ends of the secondary winding 12. That is to say, the bank of emitting electrodes 15 is connected through condenser 21 and conductor 22 with the end 23 of secondary winding 12 while the alternate bank 16 is connected through condenser 24 and conductor 25 with the opposite end 26 of secondary winding 12. Similarly, the adjacent bank 17 is connected through condenser 27 and conductor 22 with the end 23 of secondary winding 12. The next adjacent bank of emitting electrodes 18 is connected through condenser 28 and conductor 25 with the end 26 of secondary winding 12. The next adjacent bank of emitting electrodes 19 is connected through condenser 29 and conductor 22 to the end 23 of secondary winding 12. The adjacent alternate bank of emitting electrodes 20 is connected through condenser 30 and conductor 25 to the end 26 of secondary winding 12.

By reason of the condenser blocks 21, 27, 29, and 24, 28 and 30, each bank is individually caused to approach an average potential such that it draws as much current at positive potential as it draws at negative potential, or expressed otherwise, the total sum, through each complete cycle, of negative charge received from a next preceding banking plus positive charge delivered must

equal the total positive charge received from the next preceding bank plus the negative charge delivered. Due to the natural bias of this type of discharge, resulting in a potential difference between each two successive banks, successively increasing positive potential will be assumed by the banks in succession from the last target bank. If all banks are left condenser blocked as shown in Fig. 5, the operation is still such that equal negative and positive emission occurs on successive half cycles, but the further advantage is attained that any bank may be grounded at will without drawing any current after the initial charging current. If the capacity to ground of the fan assembly is small enough, the charging current at grounding can be made so small as to not be dangerous.

Fig. 4 illustrates schematically the circuit arrangement diagrammatically shown in Fig. 3, wherein the emitting electrodes are condenser blocked but in which the final bank of target electrodes represented by bank 14 are directly connected through lead 25 with the end 26 of secondary winding 12 of transformer 11. In this arrangement the center tap 31 of secondary winding 12 is connected to ground as indicated at 32.

As previously noted, all banks may be condenser blocked as indicated in Fig. 5 where the group of electrodes 14 constituting targets may be connected through condenser 33 to the end 26 of secondary winding 12 of transformer 11. Tap 31 is connected to ground 32 as in the arrangement illustrated in Fig. 4. As heretofore noted, the operation under these conditions is still such that equal negative and positive emission occurs on successive half cycles. However, any bank of electrodes may be grounded without drawing any current after the initial charging current.

In Fig. 6 I have shown a modified form of my invention by which two or more banks of fans, emitting electrodes or blowers may be cascaded and used to drive air or other fluids by the direct action of electric discharge from fine points or wires with or without ballast resistances. In this arrangement the emitting electrodes are arranged in the form of longitudinally extending emitting wires indicated at E_1 and E_2 disposed in spaced groups. The emitting electrodes E_1 and E_2 are arranged in rows designated generally at 34 and 35 stretched in a substantially vertical plane. The coacting sets of targets for the groups of emitters 34 and 35 are represented at 36 and 37 which are stream-lined in form. I have illustrated the functioning of the emitters in which electric discharge passes from emitters E_1 in row 34 toward the targets 36; and from the emitters E_2 in row 35 to the targets 37. The object of the arrangement is to obtain a velocity of drive on the air being moved which would be the sum of the effects of either of the two fans taken or used alone. Ordinarily, if only the emitters and targets were used as shown, the emitters E_1 and E_2 both at the same potential and the targets T_1 and T_2 both at the same potential, the emitters together being at a potential difference with respect to the targets sufficient to cause passage of electricity from the emitters to the targets, the passage of the ions from E_1 to T_1 as well as the passage of ions from E_2 to T_2 would both tend to produce fluid motions towards the left in the figure, but there would be a considerable passage of current from E_2 back towards T_1. This latter would serve to a very considerable extent to block the wind produced by the other two currents.

I have found that guard members such as G_1 and G_2 mounted in rows 38 and 39 behind the rows of emitters 34 and 35 operate to eliminate blocking losses because the lines of force extending from the rows of guard members 38 and 39 toward the associated targets 36 and 37 when the guard members have the same potential as the associated rows of emitters, serve to render that part of the volume electrically inactive so that ions which produce wind travel only along regions shown by the dotted lines in the figure. The guard members G_1 and G_2 are each streamlined in contour for offering minimum resistance to the flow of air or fluid around the guard members. In this way a high degree of efficiency is secured in the generation of air or fluid pressure.

In Figs. 7 and 8 I have represented the manner in which the emitters may be staggered for increasing the volume of flow of fluid or air. As illustrated in Fig. 7, the groups of electrodes are arranged in banks B', B'', B'''—B^x. The groups of electrodes are disposed in two ranks comprising each bank. The electrodes in the two ranks are staggered as represented by the overlapping relationship of the emitters. The emitters of one rank in group B' are represented at 2_a electrically interconnected through conductor 41. The emitters of the second rank in group B' are represented at 2' interconnected through conductor 42. In group B'' the first rank of emitters is designated at 2_b while the staggered interrelated rank of emitters is designated at 2''. In group B''' the emitters in one rank are indicated at 2_c while the emitters in the adjacent rank are shown at 2'''. A similar arrangement exists with respect to succeeding groups of emitters designated generally by group B^x. Emitters 2_a are influenced by the potential of emitters 2' which function in the nature of control electrodes, while the potential of emitters 2' is governed by the operation of condenser 43. It will be observed that emitters 2_a of group B' coact with the target portions of both emitters 2_b and 2'' of group B'' as an assembly, while emitters 2' of electrode assembly B' likewise coact with the target portions of emitters 2_b and 2'' of electrode assembly B''. Similarly, the emitting portions of emitter 2_b of group B'' coact with the target portions of both emitters 2_c and 2''' of group B''' conjointly. The emitting portions of emitters 2'' of group B'' coact with the target portions of emitters 2_c and 2''' of group B'''. Similar arrangements are followed for other coacting groups of electrodes.

In Fig. 8 I have illustrated the manner of applying potential to the coacting groups of electrodes. A power transformer similar to the transformer illustrated in Fig. 3 is provided with secondary winding 12 provided with terminal connections 23 and 26. Alternating current is supplied to the groups of electrode assemblies in alternate positions as shown. That is to say, group of electrodes B', B''', and B^v—B^x are connected to terminal 26 while the alternate groups of electrodes B'', and B^{iv} are connected with terminal 23 of secondary winding 12. In the groups of electrodes B', B''' and B^v, the ranks 2_a, 2_c, 2_e—2_x are directly connected to output terminal 26 while the associated ranks 2', 2''', 2^v are connected through condenser 43 to output terminal 26. Groups of electrodes B'' and B^{iv} have their ranks of emitters 2_b and 2_d connected in parallel and directly connected to output terminal 23 of the secondary winding 12 of transformer 11, while their associated ranks 2'' and 2^{iv} are connected in parallel and through con-

denser 44 to terminal 23. The field applied to the emitting edges of the electrodes is almost entirely determined by the potential of the buses of the next adjacent rank serving as the target for the emission because the staggered row of discharge members constituting the other rank of the target bank is in a more remote position. The potential of those emitter ranks which are more exposed toward their coacting target banks is determined by the potential of condensers 43 and 44 which supply the potential required to make the emission on the positive swing equal to the emission on the negative swing. The emission of the more retracted emitting edges of each bank will always occur only on the negative swing. The advantages of the staggered arrangement of emitters are that the current is substantially the same on each half cycle and all banks fire simultaneously for integrating pressure effects. Moreover, the charge impressed upon each bank from the previous bank assists in inciting the emission for on-set of each successive half cycle. The fluid or wind movement produced by advance banks assists in producing more regular discharges at the more remote banks and as a result the pressure produced is more regular and uniform and more susceptible to increase by decreasing interbank distances. The staggered arrangement is also advantageous in connection with electric circuits which give phase rotation of applied voltage and which, therefore, might make the emission extend over a larger percentage of each half cycle.

While I have shown discharge electrodes formed by wire-like members it will be understood that I may employ discharge electrodes formed from fibrous members or thread-like textile elements suitably treated or impregnated to render the fibrous members or thread-like textile elements semi-conducting.

The arrangement of electrodes set forth herein has been found highly desirable in cascade arrangements in fans for developing wind pressures by electric discharge. However, I realize that other modifications in structure and arrangements of electrodes may be made and I intend no limitations upon my invention other than may be imposed by the scope of the appended laims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In an electric discharge system, a stream-lined electric discharge electrode and a coacting stream-lined target electrode, said discharge electrode comprising a mass of semi-conductive material stream-lined in the direction of said target electrode, a multiplicity of spaced wire like members embedded in said discharge electrode with the outer ends thereof directed toward said target electrode, and a metallic support for said discharge electrode extending throughout the length thereof.

2. In an electric discharge system, a target electrode, a discharge member extending substantially parallel to said target electrode, said discharge member comprising a mass of semi-conductive material tapered to an edge portion directed toward said target electrode, and a multiplicity of wire like members molded within the tapered edge portion of said mass of semi-conductive material with the outer ends thereof extending toward said target electrode and constituting electric emitters with respect to said target electrode.

3. In an electric discharge system, a target electrode, a discharge electrode extending substantially parallel to said target electrode, said discharge member comprising a mass of semi-conductive material tapered to an edge portion directed toward said target electrode, and a multiplicity of wire like members disposed at uniformly spaced intervals within said mass of semi-conductive material with the outer ends thereof projecting from the tapered edge portion of said discharge electrode toward said target electrode.

4. A fan of the electric discharge type comprising a multiplicity of groups of discharge members, each of said discharge members being stream-lined and including a charge collecting portion and a charge emitting portion, said discharge members being arranged in a pair of ranks constituting each group with the members of one rank off-set from the members of the associated rank, and means for impressing alternating current between the discharge members of one of the ranks in one of said groups and the discharge members in a corresponding rank of an adjacent group whereby discharge alternates between the corresponding ranks of adjacent groups of electrodes according to the cyclic change of the alternating current.

5. An electric discharge system comprising members disposed in rows in staggered spaced relation one to the other, each of said members including a charge collecting portion and a charge emitting portion, and means for exciting the rows of members with alternating current in cyclic recurring order.

6. A discharge electrode comprising a semi-conductive plastic body portion, charge emitting means at one end of said semi-conductive plastic body portion and charge collecting means inserted in the opposite end of said semi-conductive plastic body portion, whereby charges impressed upon said charge collecting means at one end of said semi-conductive plastic body portion are conducted through said semi-conductive plastic body portion to the charge emitting end thereof.

7. A fan comprising a multiplicity of groups of discharge electrodes, said groups of electrodes being alternately positioned one with respect to another, each group of electrodes comprising two rows of staggered discharge members, a source of alternating current, a connection between one end of said source and one of the rows of discharge members of alternate groups of electrodes, connections between the other rows of discharge members of said last mentioned groups of electrodes through a condenser with the same side of said source of alternating current, a connection from the opposite side of the source of alternating current with one row of each of the intermediate groups of electrodes, and a connection through a condenser from the last mentioned side of said source of alternating current with the other rows of the groups of electrodes in said last mentioned intermediate groups of electrodes.

8. An electric discharge system comprising a multiplicity of groups of electric discharge electrodes, each of said groups of discharge electrodes comprising a pair of rows of discharge members with the discharge members of one row spaced from and disposed in staggered relation to the discharge members in the associated row of the same group of electrodes, whereby discharge portions of one row of electrodes project beyond the plane of the discharge portions of the associated row of discharge electrodes of each group, a charge collecting portion carried by each of said electrodes, the charge emitting portion of one row of

electrodes of one group having a potential impressed thereon coacting with the charge collecting portions of correspondingly displaced electrodes in the adjacent group of electrodes.

9. An electrical discharge system comprising in combination with a source of alternating current, rows of electrodes, each of said electrodes having an emitting portion and a target portion with the emitting portion of one row of electrodes staggered with relation to the target portions of an adjacent row of electrodes, means electrically connecting all of the target portions of the electrodes of one of said rows, a condenser disposed between said means and one side of the source of alternating current, separate means interconnecting the target portions of the other row of electrodes, and an independent condenser connected between said last mentioned means and the opposite side of said source of alternating current.

10. An electrical discharge system comprising in combination with a source of alternating current, a multiplicity of rows of discharge electrodes, each of said discharge electrodes having an emitting portion and a target portion with the alternate rows of electrodes having their emitting portions disposed in staggered relation to their target portions and coacting therewith, the alternate rows of electrodes each being connected through a condenser with opposite sides of the source of alternating current.

11. An electrical discharge system comprising in combination with a source of alternating current, a multiplicity of rows of discharge electrodes, each of said discharge electrodes having an emitting portion and a target portion with the alternate rows of electrodes having their emitting portions disposed in staggered relation to their target portions and coacting therewith, the alternate rows of electrodes each being connected through impedance devices with opposite sides of the source of alternating current.

12. An electrical discharge system comprising in combination with a source of alternating current, a transformer having a primary winding and a secondary winding, a multiplicity of rows of discharge electrodes, each of said electrodes having an emitting portion and a charge collecting portion, connections between the charge collecting portions of alternate rows of said discharge electrodes with one side of said secondary winding, connections between the collecting portions of the intermediate rows of electrodes with the other side of said secondary winding, and condensers disposed in certain selected ones of said connections.

13. An electrical discharge system comprising in combination a source of alternating current, a multiplicity of rows of discharge electrodes, each having an emitting portion and a charge collecting portion with the emitting portions of the electrodes in one row arranged in staggered relation with respect to the charge collecting portions of the electrodes in an adjacent row, connections with the respective sides of the source of alternating current and the charge collecting portions of the alternate rows of said electrodes, and condensers disposed in certain of said connections.

14. An electrical discharge system comprising in combination a source of alternating current, a multiplicity of rows of discharge electrodes, each having an emitting portion and a charge collecting portion with the emitting portions of the electrodes in one row arranged in staggered relation with respect to the charge collecting portions of the electrodes in an adjacent row, connections with the respective sides of the source of alternating current and the charge collecting portions of the alternate rows of said electrodes, and impedance devices disposed in certain of said connections.

15. In an electrical discharge system, a multiplicity of rows of emitting electrodes, a multiplicity of rows of coacting target electrodes, and control electrodes associated with said emitting electrodes and electrically charged at substantially the potential thereof for directing the discharge from said emitting electrodes, toward said target electrodes all of said electrodes having a stream-lined shape and facing in the same direction so as to offer the minimum obstruction to the flow of fluid with respect to said electrodes.

16. An electrical discharge system comprising, in combination, a source of alternating current, a multiplicity of electrodes in cascade formation; each of said electrodes having a semi-conductive body portion with charge collecting means at one edge and charge emitting means at the opposite edge thereof, whereby charges impressed upon said charge collecting means are conducted through said semi-conductive body portion to the charge emitting means; and means for energizing successive electrodes in said cascade formation from different terminals of said alternating current source including means for maintaining an average potential on each electrode such that the sum of the negative charge received at the collecting means plus the positive charge delivered at said emitting means equals the sum of the positive charge received plus the negative charge delivered, through each complete cycle of the alternating current supplied.

17. An electrical discharge system comprising, in combination, a source of alternating current, a multiplicity of electrodes in cascade formation, each electrode including a charge collecting portion and a charge emitting portion, means for connecting successive electrodes in said cascade formation to different terminals of said source of alternating current, and means operative in combination with the aforesaid means for maintaining each electrode at an average potential to equalize the emission in the positive and negative phases of the alternating current applied.

18. An electrical discharge system as set forth in claim 17 and including additional electrodes arranged adjacent the aforesaid electrodes in staggered relation thereto in said cascade formation; said additional electrodes having charge collecting portions arranged respectively in advance of the charge collecting portions of the adjacent aforesaid electrodes and constituting primary target means, and charge emitting portions retracted with respect to the charge emitting portions of the corresponding aforesaid electrodes; and means for connecting said additional electrodes successively to different terminals of said source of alternating current in correspondence with the aforesaid electrodes respectively adjacent thereto.

19. An electrical discharge system comprising a discharge electrode, a combined target and discharge electrode and a target electrode disposed in cascade cooperative relation, said combined target and discharge electrode having a terminal at the target portion thereof and a ballast resistance interposed between said ter-

minal and the discharge portion thereof; and means for energizing said electrodes by alternating current including a source of alternating current, separate connections from one terminal of said source to said discharge electrode and said target electrode, and a connection from the opposite terminal of said source to said combined target and discharge electrode at the said terminal thereof, and means disposed in at least two of said connections for supplying bias potentials for equalizing the emission from said discharge electrode and from the discharge portion of said combined target and discharge electrode in the positive and negative phases of the applied alternating current at each electrode.

20. In an electric discharge system, a discharge electrode, a target electrode extending substantially parallel to said discharge electrode, both of said electrodes having body portions of semi-conductive material stream-lined in the same direction, and a multiplicity of wire-like members embedded into the body portion of the discharge electrode with the outer ends thereof directed toward the target electrode.

21. An electric discharge system comprising a plurality of groups of discharge electrodes and a plurality of groups of coacting target electrodes, a source of alternating current, connections from opposite sides of said source of alternating current to alternate groups of said discharge electrodes and alternate groups of the target electrodes, a group of control electrodes associated with each group of discharge electrodes, and means connected to the source of alternating current for supplying a bias potential on the control electrodes to control emission from the discharge electrodes to the target electrodes.

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