

Jan. 6, 1959

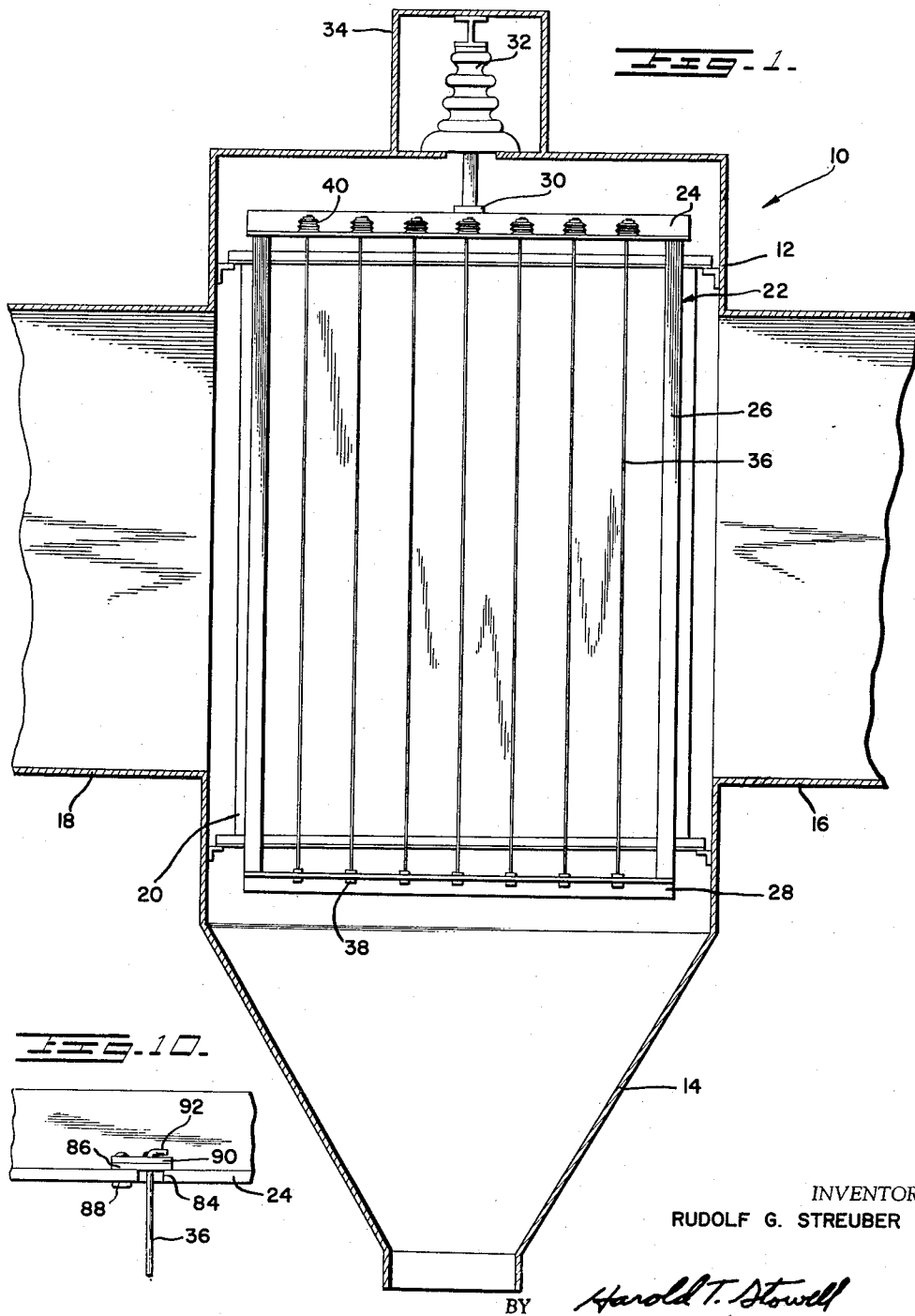
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DISCHARGE ELECTRODE TENSIONING MEANS

Filed April 23, 1956

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FIG. 2.

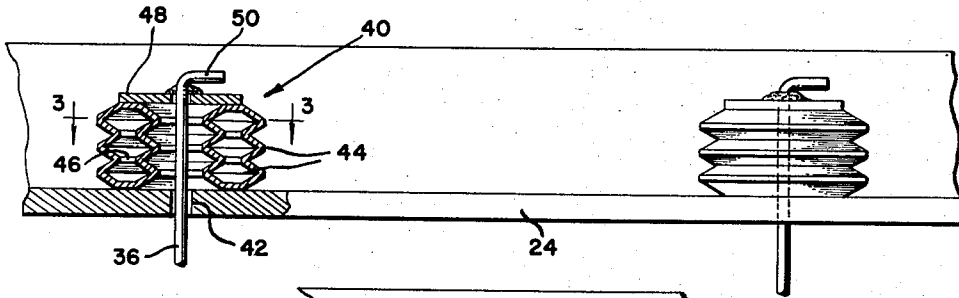


FIG. 3.

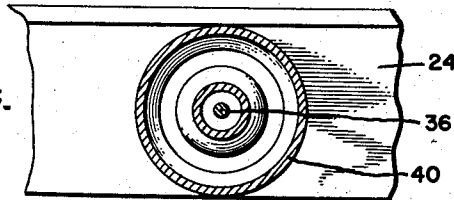


FIG. 4.

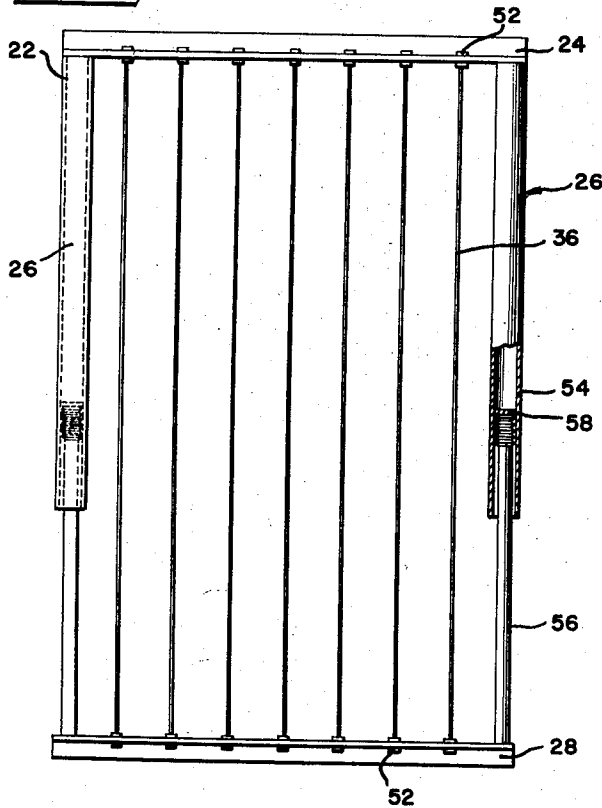
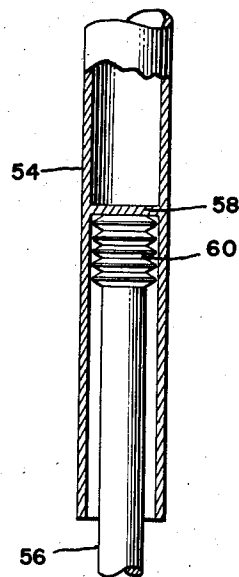


FIG. 5.



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FIG. 6.

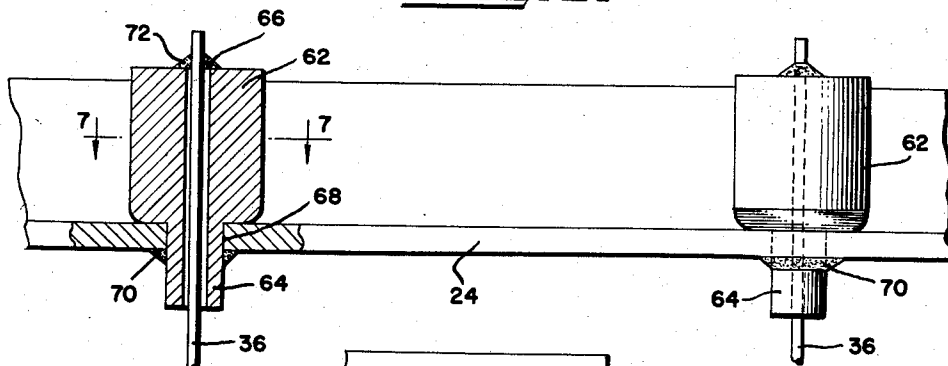


FIG. 7.

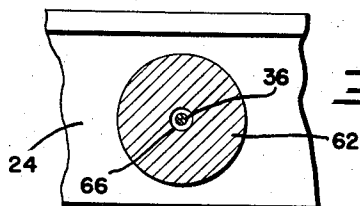


FIG. 8.

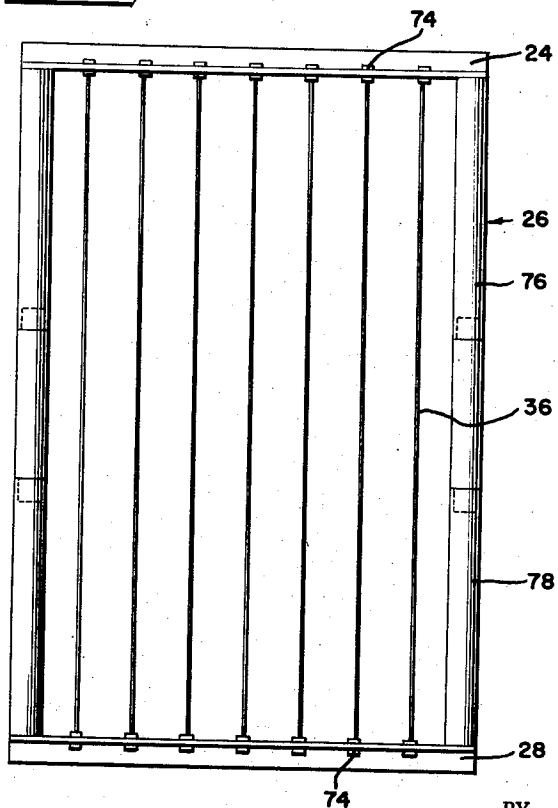
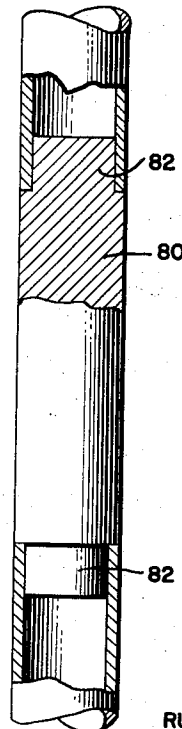


FIG. 9.



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## DISCHARGE ELECTRODE TENSIONING MEANS

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3 Claims. (Cl. 183—7)

This invention relates to electrical precipitation apparatus and more particularly and specifically to new and useful improvements in discharge electrode tensioning means for such apparatus.

In conventional precipitator constructions, it has been the practice to suspend discharge electrodes from a high tension frame by a resilient or rigid coupling of one type or another and to weight the bottom free hanging ends of the electrodes to assist in maintaining the electrodes in vertical alignment within the precipitator. Certain other conventional forms of electrode support have included a rigid rectangular frame supported vertically within a precipitator, which frame rigidly mounts the electrodes longitudinally thereof between the upper and lower ends of the frame for the purpose of maintaining the electrodes in vertical alignment.

It has been discovered however that with the use of weights on free hanging ends of electrodes a considerable degree of sway and sailing effect will be set up in the electrodes by the gases passing through the precipitator in contact with the electrodes. The undesirable results of electrode sway and sailing effect are well known in the art.

The aforescribed use of rigid mounting frames for supporting discharge electrodes within a precipitator serves to overcome swaying and sailing effects, but, at the same time, additional problems are created in the utilization of a rigid frame in retaining the electrode in a taut, tensioned condition between the extreme end members of the frame to avoid undue vibration and movement due to gas velocity which, if not avoided, will cause fatigue and breakage of the discharge wires. Certain tensioning means must be utilized in anchoring the discharge wires to the frame to avoid looseness and a slack in the electrode wires which is particularly prevalent in the precipitator apparatus utilized for cleaning high temperature gases where substantial temperature increases cause expansion of the electrodes thereby loosening them relative to their supported position in the frame.

The present invention provides new and useful tensioning means for mounting discharge electrodes in a rigid supporting frame which serve to maintain the discharge electrodes under a predetermined tension and in a taut condition at all times and through large variations in temperature within the precipitator apparatus. This improved tensioning means additionally serves to maintain discharge electrodes in such a taut condition as to avoid the sailing, swaying and misalignment of the electrodes.

An object of the present invention is to provide a new and useful tensioning means for anchoring discharge electrode wires within a rigid frame in electrical precipitation apparatus which tensioning means serves to prevent slacking of discharge wires when they are elongated due to thermal expansion.

Another object is to provide such tensioning means which will prevent breaking of discharge electrodes due

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to uneven thermal expansion between the electrodes and their supporting frame.

Another object of this invention resides in the provision of a new and improved tensioning means for mounting discharge electrodes within electrical precipitation apparatus which maintains the electrodes under controlled longitudinal tension at all times and through wide ranges of temperature variation while at the same time eliminating the use of springs and like resilient structures which lose appreciable elasticity at high temperatures, which develop fatigue reducing their compression or resilience factors over long periods of use, and substantially increase the initial cost of the installation.

It is another object of this invention to provide new and useful tensioning means for mounting discharge electrode wires in electrical precipitation apparatus wherein the tensioning means comprises an anchoring support for the ends of the electrodes which supports are constructed so as to have a linear coefficient of expansion equal to or greater than the linear coefficient of expansion of the electrode wire.

A further object of this invention is the provision of tensioning means for supporting discharge electrodes in a rigid frame within electrical precipitation apparatus wherein the ends of the electrodes are secured to the frame by tensioning members having a linear coefficient of expansion equal to or greater than the linear coefficient of expansion of the discharge wires, or, in the alternative, the frame members extending parallel to the discharge wires fixedly supported within the frame are provided with tensioning couplings intermediate their length having the same or a greater coefficient of expansion as said discharge wires.

Still a further object and advantage of this invention is the provision of new and improved tensioning means for anchoring discharge electrode wires in a rigid frame within electrical precipitator apparatus wherein the mounting means are quickly and easily assembled and removed from the structure to permit a ready insertion or removal of a discharge wire therefrom and wherein the tensioning means is of a simple and inexpensive design and manufacture which is extremely durable and long lasting over extended periods of use.

Still further objects and advantages of the present invention will become more readily apparent to one skilled in the art when the following description is read in the light of the accompanying drawings in which:

Fig. 1 is a side elevational section of a precipitator incorporating the tensioning means constituting the present invention.

Fig. 2 is an enlarged fragmentary view in partial section illustrating the tensioning elements of Fig. 1.

Fig. 3 is a horizontal section taken on line 3—3 of Fig. 2.

Fig. 4 is a side elevational view in partial section illustrating the tensioning device incorporated in the rigid frame.

Fig. 5 is an enlarged fragmentary section disclosing the tensioning device of Fig. 4.

Fig. 6 is a view similar to Fig. 2 illustrating a modified embodiment of the tensioning device construction.

Fig. 7 is a horizontal section taken on line 7—7, Fig. 6.

Fig. 8 is a view similar to Fig. 4 disclosing a modified embodiment of the tensioning device of Fig. 4.

Fig. 9 is an enlarged fragmentary sectional view of the tensioning device of Fig. 8.

Fig. 10 is a view similar to Fig. 2 illustrating another embodiment of the tensioning device.

For the purpose of illustrating the concepts of the present invention which includes generally in combination a rigid rectangular frame member supported vertically in

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a precipitator apparatus in spaced parallel relationship with collecting plate electrodes, discharge electrode wires supported vertically between the upper and lower members of the frame in equally spaced relationship transversely of the frame, an element secured to the frame having a thermal coefficient differing from the coefficient of expansion of the electrode, and the end of the discharge electrode wire rigidly secured to the expansible element, or, in the alternative, the discharge electrode wire rigidly secured at each end directly to the upper and lower transverse members of the frame, the vertical side members of the frame being divided intermediate their length into two sections, and an element having a thermal coefficient differing from the coefficient of expansion of the electrode interconnecting the two separate elements forming each vertical side member of the frame.

Referring now to Fig. 1 of the drawings there is disclosed a typical electrical gas precipitator 10 which includes a housing 12 having a hopper type discharge bottom 14 together with a gas outlet 16 on one side thereof and a gas inlet 18 on the opposite side thereof. A plurality of collecting electrode plates 20 is supported in conventional manner in spaced parallel relationship transversely of the precipitator housing in alignment intermediate the gas inlet and the gas outlet thereof.

Associated with the parallel spaced collecting plate electrodes is a plurality of rigid rectangular frames 22 which are supported vertically within the housing in parallel spaced relationship to and equidistant between adjacent spaced collecting electrode plates. The frames 22 include a top cross bar 24 of channel construction, normally tubular side bars 26 depending one from each extremity of the cross bar 24 vertically within the housing, and a bottom channel like cross bar or rail 28 supported between the lower extremities of the side bars 26. The top cross bar 24 of each frame is supported from a usual high tension frame 30 which is mounted in the upper end of the precipitator housing by a conventional insulator support 32 carried within a housing 34 on the top or upper end of the precipitator housing 12.

Associated with each of the rigid frames 22 is a plurality of discharge electrode wires 36 which are secured vertically within the frame between the upper cross bar 24 and the bottom cross rail 28 in equally spaced relationship transversely of the frame. In the embodiment disclosed the lower extended end of each electrode wire 36 is rigidly secured by a coupling or anchoring ferrule 38 to the bottom cross rail of the frame 22. The upper end of each electrode wire is secured to an expansible element 40 which in turn is secured to the top cross bar 24 of the frame 22.

Referring in particular to Figs. 2 and 3 of the drawings it is seen that the top cross bar 24 is provided with an opening 42 for receiving therethrough the upper extended end of the electrode wire 36. In this embodiment the tensioning means or expansible mounting member 40 takes the form of a metallic bellows of ring-shaped configuration consisting of a plurality of circular tubes 44 superimposed one upon the other and opening into one another through common wall openings 46. The ring like bellows construction is seated on the upper face of the top cross bar 24 concentrically about the discharge wire opening 42 therein to permit the upper extended end of the discharge wire to pass vertically through the center of the bellows. A washer member 48 is positioned over the upper extended end of the discharge electrode 36 to seat on the top of the bellows member and the electrode wire is turned over as at 50 through a 90° angle above the top of the washer member and is welded in place thereto.

By the construction defined above, the discharge wire 36 is maintained under longitudinal tension by the resilience of the bellows member acting vertically between the top bar 24 and the washer member 48. By assembling the discharge wire and the bellows at a given temperature

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relative expansion of the bellows and the wire can be computed so as to provide for a greater linear expansion of the bellows at a given temperature increase than the linear expansion of the discharge wire. By so computing the relative rates of linear expansion of the bellows and the wire, it is possible to mount the wire in the frame in a taut condition whereupon it will be maintained under linear tension at all times regardless of variations of temperature occurring within the precipitator apparatus.

By utilizing a gas at a predetermined pressure within the sealed bellows, it is possible to select a gas having a coefficient of thermal expansion greater than the linear coefficient of thermal expansion of the material from which the discharge electrode is constructed so as to insure the constant maintenance of the discharge wire under a predetermined tension through a wide range of temperature variations within the precipitator apparatus.

In Figs. 4 and 5 of the drawings there is shown a modified application of the bellows type expansion member disclosed in Figs. 2 and 3. In this modified form the electrode wires 36 are rigidly secured top and bottom by rigid ferrule or coupling members 52 in the top and bottom cross members 24 and 28 of the frame 22, said wires being secured in taut condition. The side arms 26 of the frame 22 are modified to provide an upper tubular section 54 and a lower tubular section 56 of a lesser diameter than the upper section 54. The upper tubular section 54 is provided upwardly and inwardly of its lower open end with an integral diaphragm or partition wall 58 closing the tubular arm at that point. The upper end of the lower portion 56 is telescopically received within the upper portion 54 and carries thereon a circular bellows member 60 similar in construction to the bellows member generally designated at 40 in Figs. 2 and 3 of the drawings. The bellows member 60 may be secured to the upper end of the lower portion 56 of the side arm of the frame and to the lower face of the diaphragm or partition wall 58 within the upper portion of the side arm of the frame.

By the foregoing construction a thermally expansible coupling is interposed between the upper and lower portions of each of the side arms 26 of the electrode wire supporting frame to provide for vertical expansion and contraction of the frame with variations in temperature within the precipitator housing. By securing the electrode wires in the frame under tension, it is seen that any increases in temperature will cause expansion of the bellows 60, and by providing for a greater linear expansion of the bellows per degree increase in temperature than the linear expansion of the electrode wires per degree increase in temperature the electrode wires will be constantly maintained under tension within the frame 22 thereby preventing slacking of the wires and avoiding swaying and sailing effect of the electrode wires within the frame.

In Figs. 6 and 7 of the drawings there is disclosed a modified form of the expanding tensioning element 40 which comprises a solid cylindrical plug 62 having a reduced cylindrical neck portion 64 on one end thereof. The plug is provided with a central passage 66 extending axially therethrough which passage is of a slightly greater diameter than the diameter of the electrode wire 36.

In assembling the expansible plug member 62 in the precipitation apparatus the necked portion 64 of the plug is inserted downwardly through an opening 68 in the top cross bar 24 of the frame to project for a spaced distance below the bar. The plug may be welded as at 70 to the bar to provide a rigid connection. The electrode wire 36 is inserted upwardly through the central passage 66 in the plug and is pulled up tight to place the wire under tension in which position the upper end of the wire where it projects above the plug is welded as at 72 to the top surface of the plug to interconnect

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the wire and the plug and tautly suspend or support the wire within the frame.

By providing the plug 62, in accordance with the foregoing description, of material having a linear coefficient of thermal expansion greater than the linear coefficient of thermal expansion of the wire 36 it is seen that the wire 36 will be maintained under longitudinal tension at all times through a wide range of variations of temperature within the precipitator apparatus.

In Figs. 8 and 9 of the drawings there is disclosed a modified embodiment of the frame construction 22 wherein, as in the embodiment disclosed in Figs. 4 and 5 of the drawings, the electrode wires 36 are suspended between the top and bottom cross bars of the frame between fixed couplings or ferrules 74 engaging the cross bars. Each of the side arms 26 of the frame are of tubular construction and are divided into upper and lower portions 76 and 78 respectively which terminate intermediate the length of the frame in spaced apart relationship. Interposed between the spaced ends of the upper and lower portions of the side arms of the frame is a solid cylindrical plug 80 having identical end portions 82 of reduced diameter which end portions are tightly telescopically received inwardly of the open ends of the spaced portions 76 and 78 to rigidly interconnect the same. The plug member 80 is of such a length so as to form a composite side arm member of a length capable of retaining the top and bottom cross bars of the frame in spaced relationship so as to maintain the electrode wires under longitudinal tension therebetween.

By constructing the plug inserts 80 in the side arms of the frame of a material having a coefficient of thermal expansion greater than the coefficient of thermal expansion of the electrode wires 36 it will be seen that the electrode wires will be maintained under longitudinal tension at all times intermediate the cross bars of the frame through a wide variation of temperature changes within the precipitator apparatus.

For example, assuming a steel electrode wire length of 10 feet between its points of attachment to the cross bars of the frame, a temperature increase of 300 degrees Fahrenheit will produce an elongation of the electrode wire of approximately .223 inch. If the side arms of the frame were of a one piece construction of the same material as the electrode wires the linear expansion of these members should be the same .223 inch. However, to accommodate possible variations in the expansion of the plurality of electrode wires within the frame, the provision of the cylindrical insert 80 of magnesium having a length of 4 inches will produce an expansion of the insert at the same 300° increase in temperature of .0173 inch. Thus the additional expansion of .0173 inch between the two sections of the side arm of the frame 22 which will expand .223 inch concurrently with the wire expansion insures the maintenance of the wire in a taut condition between its two points of support.

It is, of course, evident that the utilization of a 4-inch magnesium plug 62 in the embodiment disclosed in Figs. 6 and 7 will produce the same resultant effect as that described above, namely, providing for an increase of .0173 inch elongation between the points of wire support over and above the elongation of the wire and of the supporting frame.

The modified embodiment disclosed in Fig. 10 of the drawings includes in combination with the top cross bar 24 and the electrode wire 36 projecting upwardly through

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an opening 84 therein of a bi-metallic strip 86—90 secured by a bolt 88 or the like to the upper face of the cross bar adjacent the opening 84 with one end of the strip projecting across the top of the opening and having a passage therein coinciding with the opening 84 and receiving the upper end of the electrode 36 therethrough. The upper end of the electrode 36 is turned over through 90° as at 92, or provided with a ferrule to secure the electrode to the bi-metallic strip 90.

The bi-metallic strip by way of example, would include a strip of steel 90 or the like superimposed on the upper face of a strip of magnesium 86 or the like whereupon a temperature rise within the precipitator would cause a greater deflection of the magnesium strip, due to its increased coefficient of expansion, than of the steel strip in a substantially vertical direction from the top cross bar thereby placing the wire under an increased longitudinal tension.

From the foregoing description it can now be seen that new and improved means have been provided for tensionally anchoring discharge electrodes to a rigid frame within electrical precipitation apparatus to maintain the electrode wires under longitudinal tension through wide ranges of temperature variations within the precipitator apparatus. It is further evident that the linear expansion of the tensioning means supporting the electrode wires is obtained through thermal expansion of the tensioning means thereby eliminating the use of resilient elements such as springs and the like which are subject to fatigue and loss of elasticity over extended periods of use under conditions of varying temperatures.

Having thus described and explained the concepts of the present invention and the constructions thereof satisfying the objects and advantages heretofore set forth and accomplishing the new and useful results described, what is desired to be claimed is:

1. In a discharge electrode assembly for an electrical precipitator operative over a substantial temperature range comprising a rectangular frame and a plurality of parallel discharge electrodes secured between opposed lateral members of the frame, the combination with said assembly of thermal expansible bellows means, a gas sealed within said bellows means having a coefficient of thermal expansion greater than the coefficient of thermal linear expansion of the members of said assembly to maintain the discharge electrodes taut within the rectangular frame upon thermal expansion of the members of the assembly.

2. A construction as defined in claim 1 wherein said bellows means comprises metallic bellows having opposed ends connected to said electrodes and said frame respectively.

3. The combination defined in claim 1 wherein one end of said electrodes extends beyond one side of the frame, and said bellows means are seated between the extended end of said electrodes and the adjacent surface of said frame.

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