March 17, 1953 L. HARDY 2,631,685

CONSTRUCTION OF WATER-FLUSHED ELECTRODE FOR ELECTRICAL PRECIPITATORS

Filed Nov. 1, 1949 2 SHEETS--SHEET 1

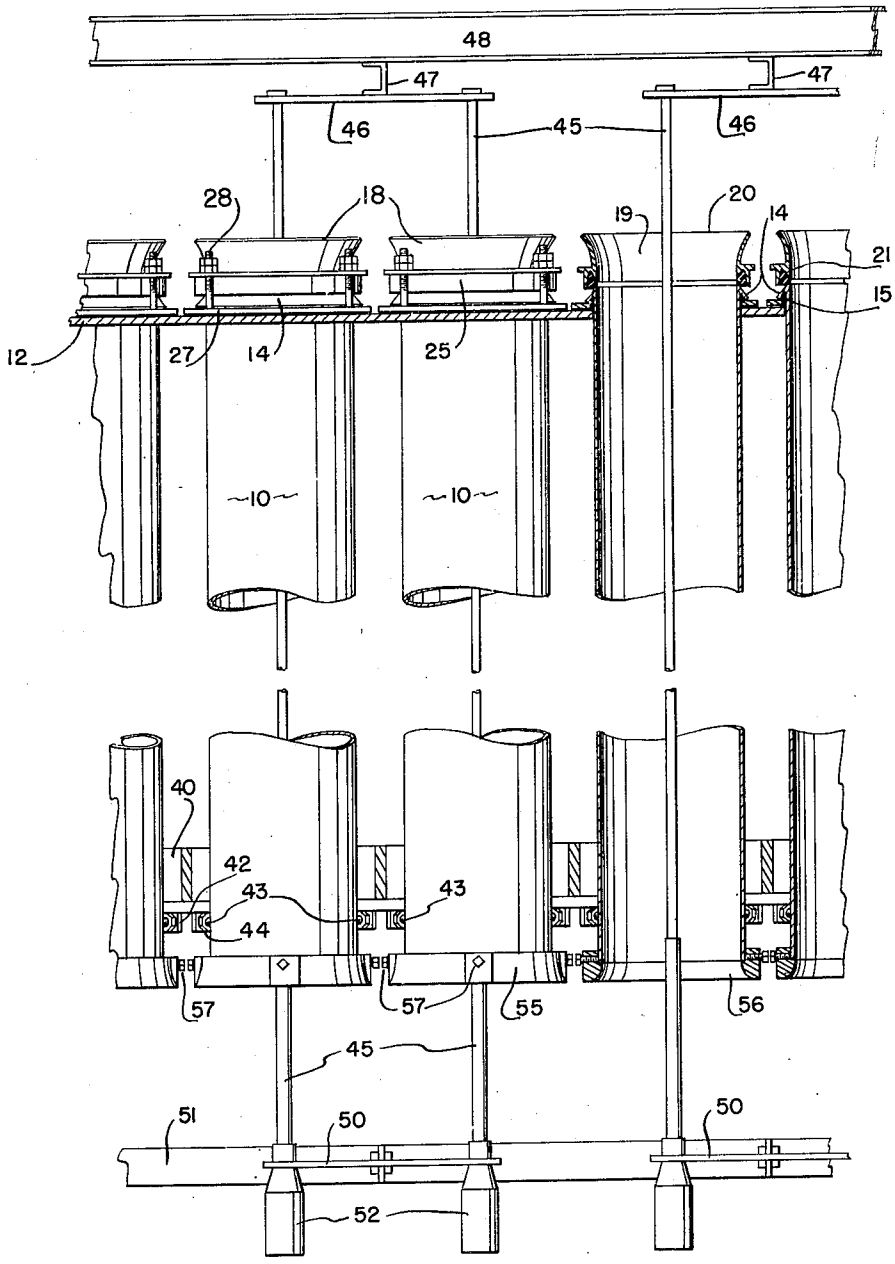


FIG. 1

LANCE HARDY, *INVENTOR.*

BY

Knight & Rodgers

ATTORNEYS

March 17, 1953 L. HARDY 2,631,685

CONSTRUCTION OF WATER-FLUSHED ELECTRODE FOR ELECTRICAL PRECIPITATORS

Filed Nov. 1, 1949 2 SHEETS—SHEET 2

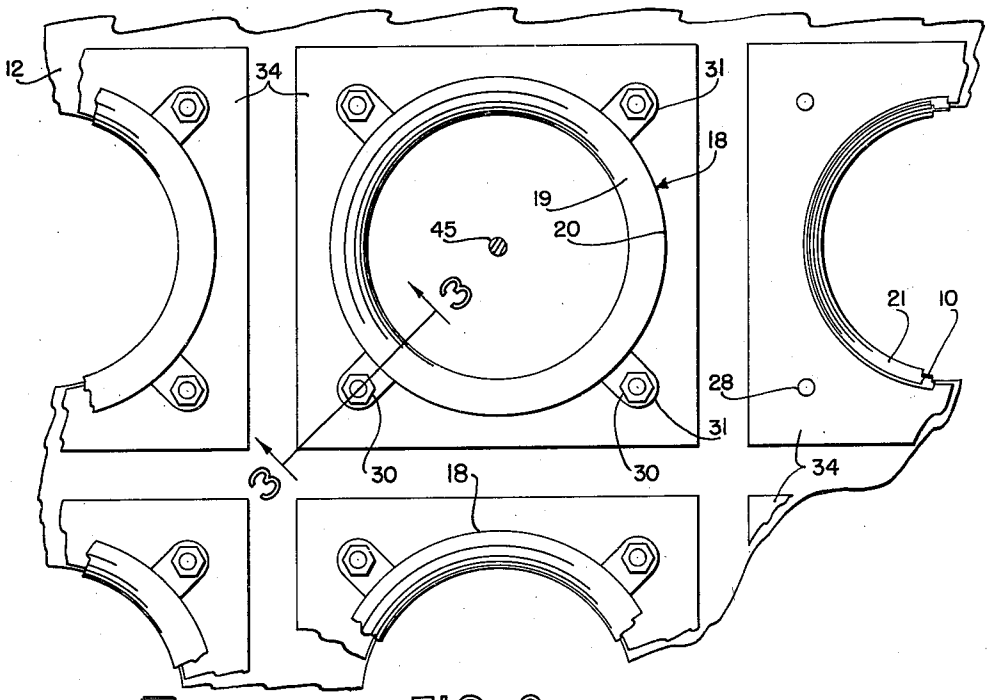


FIG. 2

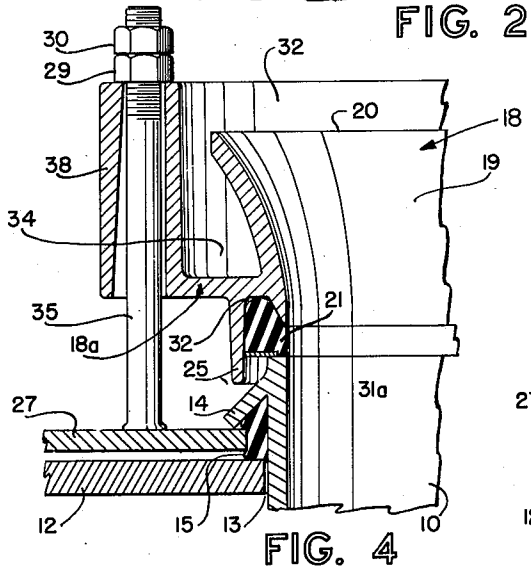


FIG. 4

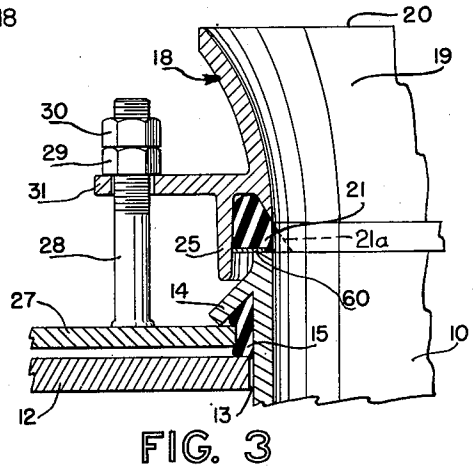


FIG. 3

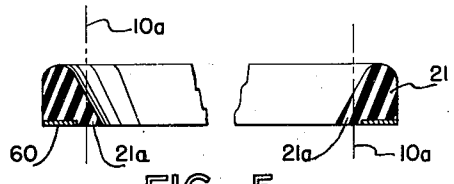


FIG. 5

LANCE HARDY, *INVENTOR.*

BY Knight & Rodgers

ATTORNEYS

Patented Mar. 17, 1953 2,631,685

UNITED STATES PATENT OFFICE

2,631,685

CONSTRUCTION OF WATER-FLUSHED ELECTRODE FOR ELECTRICAL PRECIPITATORS

Lance Hardy, South Gate, Calif., assignor to Western Precipitation Corporation, Los Angeles, Calif., a corporation of California

Application November 1, 1949, Serial No. 124,820

8 Claims. (Cl. 183—7)

1

The present invention relates generally to the art of electrical precipitation and apparatus for use in the separation of suspended materials from gases; and it relates more particularly to collecting electrodes, and a method of constructing such electrodes, in which a thin film of liquid, for example water, is passed over the surface of the collecting electrode upon which the collected material is precipitated.

In its broad aspects, the invention is concerned with liquid-flushed collecting electrodes which provide an extended surface upon which the suspended material is precipitated. Usually and typically these collecting electrodes take the form of vertical pipes or tubes of which the inner surface is the vertically extending collecting surface. The gas is passed vertically through the collecting electrode pipes, and an opposing electrode, maintained at a relatively high potential, extends centrally within each pipe. The spacing between these two electrodes is maintained as uniform as possible.

It has been common practice to place a number of collecting electrodes of this character within a housing or shell which also supports a horizontally extending header plate from which the collecting electrodes are supported. Water or any other suitable liquid is supplied to the upper ends of the collecting electrodes and a thin film is formed inside the electrodes that flows down their collecting surfaces.

Ordinarily, both the upper and the lower ends of the tubular electrodes are provided with terminal sections of larger diameter than the central collecting portion in order that the liquid film may be formed and broken at locations at which the electric field is reduced in strength. This enlargement of the end of the tubular elements is designed to prevent arcing between the electrodes and favors maintaining continuity of the liquid film.

An early example of this general type of precipitator is shown in Crowder et al. Patent No. 1,968,334 issued July 31, 1934. In this patent the header plate has a liquid-tight connection with the housing and with the several tubes so that a pond of liquid may be maintained on the header plate to supply liquid to the upper ends of a plurality of collecting electrode tubes. The upper terminal sections of the collecting electrode tubes themselves are flared outwardly and their top edges form weirs over which the liquid flows from the pond. In this construction it is necessary not only to level each combined electrode and weir with respect to the pond surface but each weir must be placed as closely as possible at exactly the same elevation in order to equalize flow of liquid into each electrode. Where the terminal weir section is formed integrally with the main collecting portion of the electrode, the movement of the weir to level it with respect to the pond moves the remainder of the electrode, and vice versa.

2

As a matter of practice, it has been found extremely difficult and time-consuming, and therefore expensive, to obtain equal flow of liquid in all electrodes of a group supplied from a common pond when the weir is integral with the collecting portion of the electrode. All tubes must be individually leveled and raised or lowered, as required, and in many cases the displacement of the collecting electrode portion incurred in leveling the weir necessitates readjustment of the high tension discharge electrode system. When it is understood that the number of pipes to be leveled may run as high as one to two hundred in a single installation, the enormous amount of work involved in leveling weirs of this type will be appreciated, and how even a small labor saving per unit becomes a substantial amount in the aggregate.

Even after the tubes are satisfactorily leveled at the time of installation, this condition may not continue to exist for any great length of time. There are many factors which operate to cause one or more of the weirs to shift out of level. As a result, operation is impaired; and often it is necessary to shut down and re-level a substantial number of the tubes.

Various designs have been made for the purpose of reducing the amount of work involved in this operation, examples of which are found in Viets Patent 2,397,302 issued March 26, 1946, and the patent to Schmidt et al. 2,412,912 issued December 17, 1946. These patents disclose constructions in which a separate weir ring is provided surrounding the flared upper end of each collecting electrode, the weir rings being individually adjustable and movable with respect to their electrodes so that they may be raised or lowered or tilted without causing the electrodes to shift in position. Constructions of this type have the serious objection of being very expensive because of the relatively large amount of accurate machine work necessary in order to fit the weir rings to the electrode pipes. The fit between the pipe and its weir ring must be relatively tight in order to prevent leakage of liquid at undesired points and to eliminate any interruption in the surfaces which might break the

continuity of the liquid film. On the other hand, if the tolerances are too close, then the range of movement of the weir ring relative to the electrode is so restricted that it loses much or all of its value as a separately adjustable member.

As a further modification of a construction involving a separately adjustable weir, there is disclosed and claimed in the co-pending application of Walter Malcolm Schmidt on "A Collecting Electrode Construction for an Electrical Precipitator," Ser. No. 124,789 filed November 1, 1949, a weir surrounded by wall means providing a space which can hold a body of liquid that overflows the weir.

Hence it becomes a general object of my invention to provide an electrode construction for a liquid film precipitator in which the weir member can be leveled and elevated with a minimum of time and effort and without moving the main portion of the electrode.

It is also a primary object of my invention to provide a collecting electrode construction in which the amount of machine work involved is reduced to a minimum, and especially machine work on mutually engaging metal surfaces so that expensive manufacturing operations and questions of close tolerances are both eliminated.

It is a further object of my invention to provide a construction for a liquid-flushed electrode in which the surface over which the film flows is free from any interruptions or discontinuities which would cauce a break in the continuity of the liquid film, especially in the zone of transition from the collecting surface of the electrode to the surface of the weir member where the film is formed.

These and other objects of my invention have been accomplished by providing, at the upper end of an electrode, a separate weir member with a resilient gasket between the electrode and weir members to form a liquid tight joint therebetween. Either because of its initial shape or because of pressure applied to it during leveling, the gasket projects slightly beyond the surfaces of the collecting portion of the electrode assembly and the weir member; but the projecting portion of the gasket is removable in order to form a smooth surface over which the liquid film flows and which is continuous with the wetted surfaces of the weir member and the electrode portion of the electrode.

I have found that an improved liquid-flushed surface for the electrode assembly may be formed by first placing this deformable gasket between the stationary tube and the movable weir member. Next the weir member is leveled and in the process the gasket is compressed, forcing a portion of it to project outwardly beyond the wetted surface of the weir member and the collecting surface. This projecting portion of the gasket is finally removed in a suitable manner, as by grinding, to produce a surface on the gasket which is continuous with the downstream surface of the weir immediately above and the collecting surface of the electrode immediately below. The result is the production of a substantially smooth, continuous surface over which the liquid film flows without any break or discontinuity.

How the above objects and advantages of my invention, as well as others not specifically referred to herein, are attained will be more readily understood by reference to the following description and the annexed drawings, on which:

Fig. 1 is a fragmentary view taken inside a precipitator housing showing in elevation and vertical section several tubular collecting electrode assemblies constructed according to my invention, portions of the apparatus being broken away for better illustration;

Fig. 2 is an enlarged fragmentary plan view showing a single collecting electrode assembly of Fig. 1 in plan with portions of adjoining electrode assemblies;

Fig. 3 is a further enlarged fragmentary vertical section through the upper end of the collecting electrode assembly, as on line 3—3 of Fig. 2;

Fig. 4 is a fragmentary vertical section similar to Fig. 3 illustrating a variational construction of the weir member; and

Fig. 5 is a fragmentary vertical section through the deformable gasket showing its preferred initial shape in cross section.

A plurality of tubular collecting electrodes 10 are shown as extending vertically through and supported by header plate 12, it being understood that these electrodes are ordinarily mounted within an enclosing precipitator housing or shell provided with gas inlet and gas outlet means at opposite sides of the header plate. Header plate 12 is supported upon the housing by any suitable means and subdivides the housing in such a manner that the portion of the housing interior below header plate 12 forms in effect an inlet chamber which distributes the gas to the bottom ends of tubular electrodes 10. The gas rises within the electrodes into the space above header plate 12 and leaves the housing through the gas outlet means. Details of the housing and its gas inlet and outlet means are not illustrated in detail because they make many various forms and are well known in the art; but reference may be made to the above-mentioned Patent No. 1,963,334 for disclosure of one type of housing.

Each collecting electrode 10 comprises a pipe or tube of suitable length and diameter, the diameter being substantially constant. The axes of pipes 10 are all vertical, or substantially so. The upper end of the tube extends for a short distance above header plate 12, as shown in greater detail in Fig. 3, and is provided with a surrounding flange 14 by which the electrode is suspended. The electrode receiving opening 13 in header 12 is of slightly larger diameter than the electrode, and resilient gasket 15 is interposed between electrode flange 14 and the upper surface of the header plate to provide a fluid tight seal between the electrode and the header plate. The weight of the tube resting upon the gasket forces it into intimate contact with both the header plate and the electrode; and it is preferable to incline flange 14 downwardly in order to confine the gasket and improve this contact.

Flange 14 may be formed integrally with tube 10 or welded to tube 10 in the shop, in which cases the electrode with gasket 15 in place is lowered through opening 13. If the head room above plate 12 does not permit this manner of assembly, tube 10 without flange 14 may be inserted through opening 13 from below. After this the gasket is put in place and flange 14 put on top of the gasket and field welded to the outside of the electrode.

The inside surface of each tubular electrode 10 is the collecting surface of the electrode and it can be seen from the drawings that this inner surface is of extended area. It is a comparatively smooth, continuous surface in order that the liquid film formed thereover, as will be further

described, may be maintained as a continuous film.

It is to be understood that my invention is not necessarily limited to a tubular electrode; but I show and describe it in conjunction with such structure as liquid-flushed electrodes are most usually tubular. If the collecting surface is flat, as provided by a plate, or otherwise shaped, then it will be self-evident to persons skilled in the art from the following description how my invention can be altered in its details to conform to collecting surfaces of other than cylindrical configuration.

On the upper end of each electrode 10 is a weir member 18. The weir member has an inner wall 19 which is flared outwardly at its upper end and at its lower end is substantially the inside diameter of electrode 10 so that the collecting surface of the electrode and the inner surface of the weir member over which the liquid film flows are in substantially vertical alignment, as illustrated particularly in Fig. 3. The top edge 20 of the weir member is suitably finished, as by grinding, so that it lies in a single plane. This edge 20 forms a weir over which liquid flows from outside the weir member to form the film flowing down the collecting surface of electrode 10. The film-covered inner surface of wall 19 is referred to herein as the downstream surface of the weir member.

For the purpose of supplying liquid to the weirs, a pond is maintained on and above header plate 12 to a depth sufficient to overflow the weirs. This pond is a common source of supply for all the electrodes.

Resilient gasket 21 is interposed between weir member 18 and the upper end of electrode 10 in order to form a liquid-tight joint between these two members. The gasket is deformable, and preferably resilient, so that the weir member can be moved relative to the electrode in order to permit leveling weir 20 to bring the plane of the weir into a horizontal position. In order to adequately confine gasket 21 under compressive forces and force it to project into the electrode when it is deformed, in the manner described above, it is desirable to provide the weir member with a gasket-receiving recess formed between the lower portion of wall member 19 and an external flange or wall 25. The walls of this recess are preferably downwardly diverging, as illustrated in Fig. 3.

Adjustment of the position of the weir is accomplished by fastening means which holds weir member 18 in place on the electrode. This fastening means comprises plate 27 surrounding the electrode and bearing against the under edge of electrode flange 14. The central opening in plate 27 is sufficiently large to receive gasket 15 between the plate and the electrode wall so that the plate forms a means for confining the gasket against outward movement as a result of the weight imposed upon it by flange 14. Plate 27 has fastened to it a plurality of upwardly extending bolts 28 each provided with a nut 29 and a lock nut 30 at its upper end. Each bolt 28 passes upwardly through a suitable opening in a lug 31 extending outwardly from weir member 18.

My invention is not necessarily limited to the type of weir member 18 described above, but may be used with other kinds including weirs of known types. An example of another kind of weir member is shown in Fig. 4 where the weir 20 is surrounded by an annularly spaced wall 32 which is preferably an integral part of the weir member

18a. This provides an annular reservoir space at 34 which holds a supply of liquid that overflows the weir. In this way each weir has its individual pond or supply source; hence each weir may be leveled without reference to the elevation of the other weirs. To fasten weir member 18a in place bolts 35 are provided passing through lugs 33 at spaced intervals around the outer wall 32. Otherwise this form of weir member 18a is constructed and installed as described in connection with Figs. 1–3. This type of weir member is described in greater detail and claimed in the copending application of Walter Malcolm Schmidt mentioned above. Reference may be made to said application for additional details of construction, as for example means for supplying liquid to each separate pond.

When the electrodes are placed in position, they are aligned vertically by any suitable means engaging them at or near their lower ends. As an example of such means, there is shown in Fig. 1 an open rectangular grid consisting of bars 40 extending at right angles to each other and passing between successive electrodes 10. At the intersections of bars 40, are mounted short, vertically extending plates 42 which have threaded bores to receive adjusting screws 43. Screws 43 are provided with lock nuts 44 to hold them in adjusted position. By means of this arrangement, which is shown in greater detail in Viets Patent No. 2,397,302, the lower end of each collecting electrode can be moved into and held in the desired position to make the electrode vertical. There is sufficient flexibility in the supporting connection between header plate 12 and flange 14 to permit movement of the electrode for this purpose.

After the collecting electrodes are in place, the discharge electrodes 45 are installed. These may be wires of relatively small diameter or twisted rods with peripheral portions of relatively small radius to facilitate corona discharge therefrom when the discharge electrode is maintained at a sufficiently high potential relative to the collecting electrode. Discharge electrodes 45 are positioned axially of the collecting electrodes and are supported from their upper ends by suitable frame members 46 and 47 attached to cross beam 48 which is suitably supported, by means not shown, to insulate it from the housing. At their lower ends, electrodes 45 are engaged by spacers 50 attached to frame member 51 in order to hold the discharge electrodes in proper alignment with respect to the collecting electrodes. If desired, a weight 52 may be attached to the lower end of each discharge electrode to tension the electrode.

Since it is desired that the liquid film be broken, as well as established, at a point where the electric field is of reduced strength, the lower end of each collecting electrode may be provided with a removable ring 55. The ring is preferably recessed on its inner surface by the thickness of the wall of tube 10 in order to receive the lower end of tube 10, as shown in the right hand side of Fig. 1, and the bottom portion of the ring is then flared outwardly at 56 so that the inside diameter of the lower end 56 is of substantially greater diameter than the diameter of the major portion of the electrode. By virtue of the recess in the ring, the inner surface of the ring forms a flush joint with the inner collecting surface of the electrode pipe and there is thus provided a substantially smooth, continuous surface over which the liquid film flows. The liquid then drops off ring 55 at the lower end, which is the point of

greatest diameter. Each ring has a plurality of set screws 57 by which it is fastened to electrode tube 10.

An alternative construction is possible if flange 14 is field welded to electrode 10 as described above. The lower end of each tube 10 can be flared or "belled" by spinning or the like. Ring 55 can then be eliminated as the flared part of the tube carries the water film sufficiently far away from the central high tension electrode.

After a collecting electrode 10 has been placed in position, gasket 21 is placed on its upper end as shown at the right hand side of Fig. 2. Then the weir member is placed in position with the upper ends of bolts 28 extending above lugs 31 to receive nuts 29. The gasket is preferably originally shaped as shown in Fig. 5 so that a small portion of it now projects beyond the inner surfaces of members 10 and 19. This portion is an annulus of triangular cross section as indicated at 21*a* in Fig. 5, and lies inside the lines 10*a* which indicate the positon of the inner cylindrical surface of electrode 10. As nuts 29 are tightened, the first action is to bring plates 27 snugly against flange 14. If any nut 29 is further tightened on a bolt, the weir member and collecting electrode are drawn together at the side when the nut is being tightened. This movement of the weir member relative to the electrode compresses or deforms gasket 21. As a result of this compression, a portion of it is ordinarily forced outwardly through the narrow gap between the inner surface of the weir member and the collecting surface of the electrode. This is in addition to the portion which originally projects beyond the collecting surface of electrode 10 because of the shape of the unstressed gasket, and can be done even though the original gasket does not project beyond the collecting surface. Any one or more of nuts 29 may be tightened to improve the liquid tight character of the seal provided by gasket 21 and to bring weir 20 into a truly horizontal position. This adjusting movement of weir 20 takes place without any movement of electrode 10 so that the vertical positioning of the tube is not altered by adjusting the weir. When the weir is in a horizontal position, liquid in the pond around the weir overflows the weir at a uniform rate at all points and a continuous liquid film of substantially uniform thickness is established and maintained around the entire circumference of wall 19. This film then flows smoothly over the inner downstream surface of the wall member 19. Each weir is leveled independently of every other weir.

When the weir member has been brought into a level position, some portion of the gasket as that indicated by the dotted lines at 21*a* in Fig. 3, projects outwardly beyond the collecting surface and the inner surface of wall 19. This projecting portion from the gasket is removed in any suitable way, as for example by a portable power driven grinding wheel. When finished off in this manner, the final shape of the gasket is as shown in solid lines in Fig. 3, providing on the gasket an inner cylindrical surface, which is smooth and flush with the surface of the weir and electrode members 19 and 10 immedately above and below it. Portions of the weir member and tube above and below the gasket may also be ground away to get a better surface for the water film. Thus the inner gasket surface and the inner surface of the weir member form a smooth substantially continuous surface with the inner collecting surface of electrode 10 and the water film is enabled to flow down onto the collecting surface without any break or interruption in it.

From the above description, it will be appreciated that gasket 21 may be altered in cross section from that shown. In general, it should have a substantial vertical dimension in order to permit the weir member to have a desirable range of movement, either bodily or angularly, with respect to the electrode below it. Although not essential, it is preferable that it have a portion of tapering cross-section to project beyond the electrode as described. This readily adapts the gaskets to the normal variations in a given diameter of tube or weir member and eliminates the need for precise dimensions, thus eliminating precision machining. Alternatively, the inner surface of the gasket may be at lines 10*a* of Fig. 5 so that all the projecting portion of the gasket is created by compression of the gasket.

Since the tubes used for collecting electrodes 10 are not always uniform in diameter, although of the same nominal size, because of minor variations in dimensions inherent in manufacture, it is desirable that flange 25 be large enough to accommodate the full range of sizes of tube 10. This condition may produce an annular gap between flange 25 and the upper end of tube 10, which gap is covered by annular metal plate 60. This plate may be a separate member or it may be incorporated in gasket 21 (Figs. 3 and 5) by securing the metal plate to the elastic portion of the gasket. Plate 60 prevents the deformable gasket from being forced outside of the electrode when the weir is leveled and instead causes it to project into the electrode so that it may be subsequently removed as just described.

In view of the foregoing, it will be understood that various changes in the design and arrangement of parts of my improved electrode assembly may be made by persons skilled in the art without departing from the spirit and scope of my invention. Consequently, it is to be understood that the foregoing description is considered as illustrative of, rather than restrictive upon, the appended claims.

I claim:

1. A collecting electrode assembly for a liquid-flushed electrical precipitator, comprising: an electrode member providing a vertically extending collecting surface of extended area; a weir member providing a liquid weir above the electrode member and having a surface for forming a liquid film that flows over said collecting surface, the film forming surface of the weir member at its lower edge being spaced above and in substantial alignment with the collecting surface; a resilient gasket between the electrode member and the weir member forming a liquid-tight joint therebetween, a surface of the gasket extending substantially vertically between and in alignment with the lower edge of the film forming surface of the weir member and the collecting surface; and fastening means to fasten the weir member onto the electrode member.

2. A collecting electrode assembly for a liquid-flushed electrical precipitator, comprising: an electrode member providing a vertically extending collecting surface of extended area; a weir member providing a liquid weir above the electrode member and having a surface for forming a liquid film that flows over said collecting surface, the film forming surface of the weir member at its lower edge being spaced above and in substantial alignment with the collecting surface; a re-

silient gasket between the electrode member and the weir member forming a liquid-tight joint therebetween, the gasket having a portion originally projecting beyond the collecting surface and removable to form a smooth surface continuous with the film forming surface of the weir member and said collecting surface of the electrode; and fastening means to hold the gasket and weir member on the electrode member.

3. A collecting electrode construction for a liquid-flushed electrical precipitator, comprising: an electrode member providing a vertically extending collecting surface of extended area; a weir member spaced from the electrode member and providing a liquid weir at the upper end of the electrode member for forming a liquid film that flows over said collecting surface, and having a recess with downwardly diverging walls around the lower part of the weir member; a resilient gasket in said recess and in contact also with the upper end of the electrode member to form a liquid-tight joint therebetween, the gasket and the weir forming a smooth substantially continuous surface with the collecting surface of the electrode member; and fastening means to hold the gasket and weir member on the electrode member.

4. A collecting electrode construction for a liquid-flushed electrical precipitator, comprising: an electrode member providing a vertically extending collecting surface of extended area; a weir member providing a liquid weir at the upper end of the electrode member for forming a liquid film that flows over said collecting surface, and having a recess with downwardly diverging walls around the lower part of the weir member; a resilient gasket in said recess and in contact also with the upper end of the electrode member to form a liquid-tight joint therebetween; means cooperating with the end of the electrode member to confine the gasket in the recess at a gap between the weir member and the collecting surface; and fastening means to level the weir independently of the electrode member.

5. A collecting electrode construction for a liquid-flushed electrical precipitator, comprising: a generally horizontal header plate having a plurality of openings; a plurality of vertically extending tubular electrode members passing one through each opening in the header plate and supported thereby, each electrode member having a vertically extending collecting surface of extended area; a separate weir member supported on the upper end of each electrode member and providing a liquid weir for the electrode member; a deformable gasket at the upper end of each electrode member forming a liquid-tight joint with the associated weir member, a surface of the gasket cooperating with the downstream surface of the weir member and the collecting surface of the electrode to form a substantially smooth, continuous surface over which liquid flows from the weir; and tension means connected to each electrode member and to the associated weir member for leveling the weir independently of the tubular electrode.

6. The method of constructing a continuous, liquid-flushed surface in an electrical precipitator that includes: placing a deformable gasket between an electrode member having a collecting surface and a weir member positioned above the electrode member having a downstream wetted surface, in a position to leave a portion of the gasket projecting through a space between the downstream surface of the weir member and the collecting surface and beyond said surfaces; deforming the gasket to level the weir member; and finally removing a portion of the gasket to form thereon a smooth surface connecting said downstream surface and said collecting surface without any substantial discontinuity.

7. The method of constructing a continuous liquid-flushed surface in an electrical precipitator that includes: placing a deformable gasket between an electrode member having a collecting surface and a weir member having a downstream wetted surface and providing a liquid weir above the electrode member; levelling the weir by compressing the gasket and forcing a portion of it to project through a space between the downstream surface of the weir member and the collecting surface and beyond said surfaces; and finally removing a portion of the gasket to form with the collecting surface and the downstream weir surface a smooth substantially continuous surface.

8. A collecting electrode assembly for a liquid-flushed electrical precipitator, comprising: an electrode member providing a vertically extending collecting surface of extended area; a weir member providing a liquid weir above the electrode member for forming a liquid film that flows over said collecting surface, the film forming surface of the weir member at its lower edge being in substantial alignment with the collecting surface; a resilient gasket between the electrode member and the weir member with a part of the gasket projecting beyond said collecting surface; and weir levelling means attached to the weir member to move the weir member toward the electrode member at selected locations to compress the gasket and level the weir without moving the electrode member; said projecting part of the gasket being removable after levelling the weir to form with the collecting surface a smooth continuous surface for a water film.

LANCE HARDY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,434,952	Johnson, Jr.	Nov. 7, 1922
1,968,334	Crowder et al.	July 31, 1934
2,016,375	Kipnis	Oct. 8, 1935
2,138,946	Trickey	Dec. 6, 1938
2,329,000	Rembert	Sept. 7, 1943
2,397,302	Viets	Mar. 26, 1946
2,412,912	Schmidt et al.	Dec. 17, 1946
2,478,818	Geiger	Aug. 9, 1949