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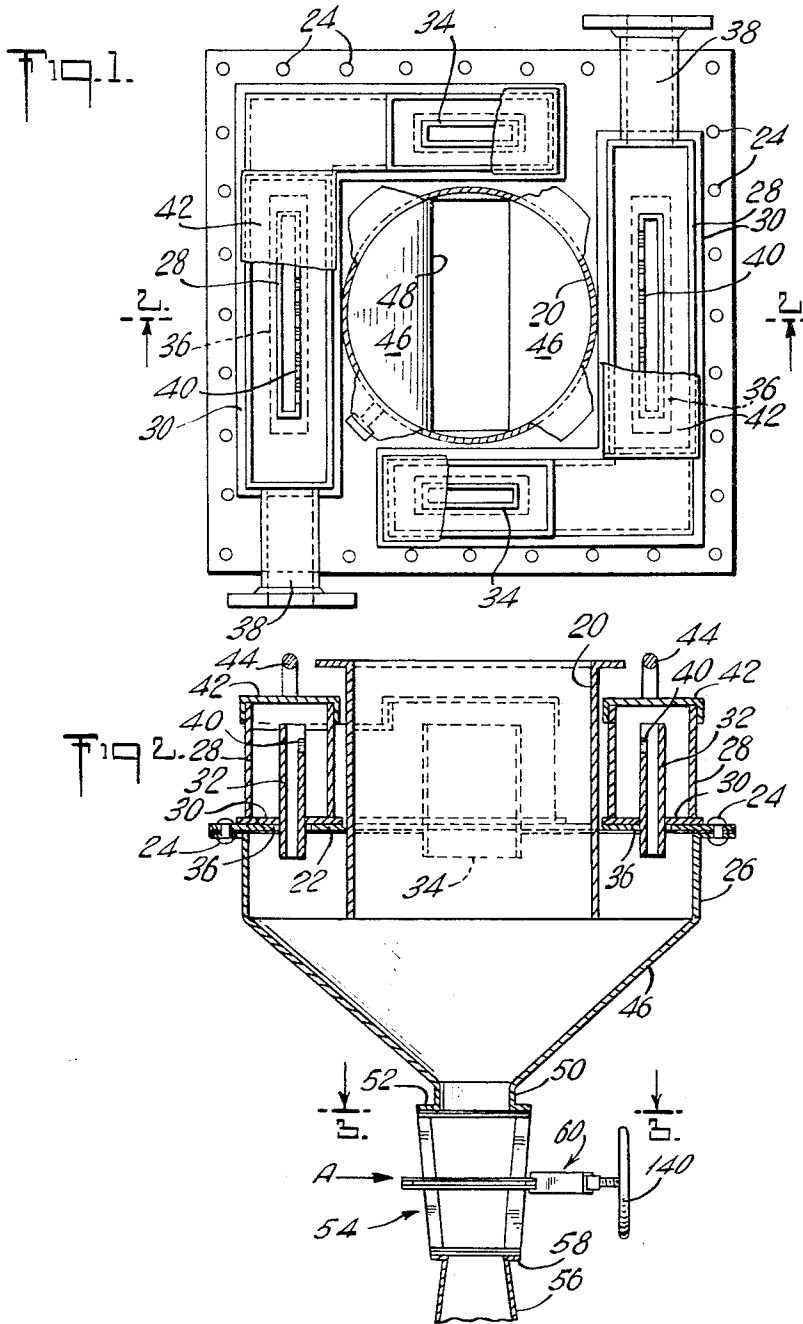
R. R. CALACETO ET AL

3,405,918

ADJUSTABLE VENTURI FOR SCRUBBERS

Filed March 3, 1967

3 Sheets-Sheet 1



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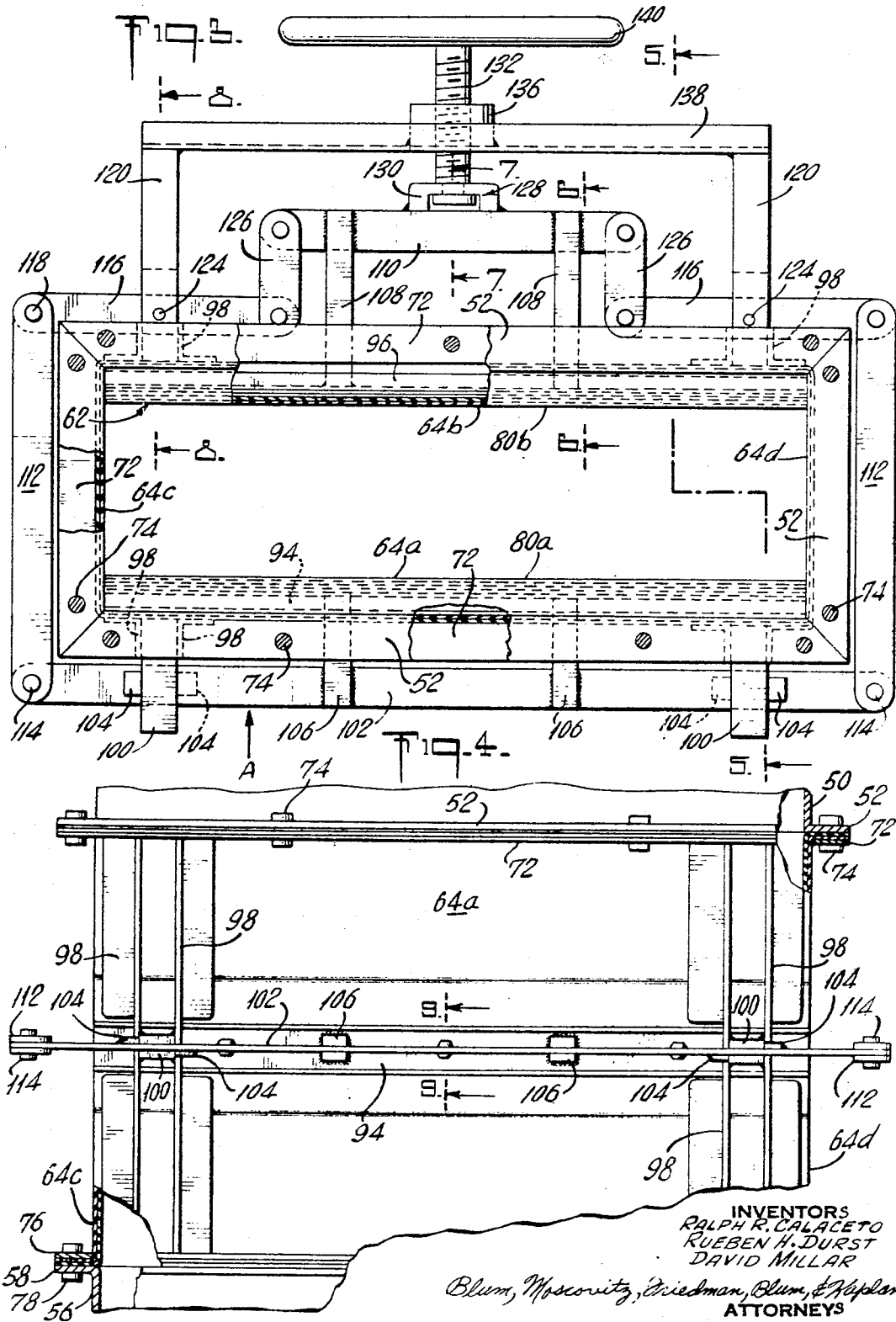
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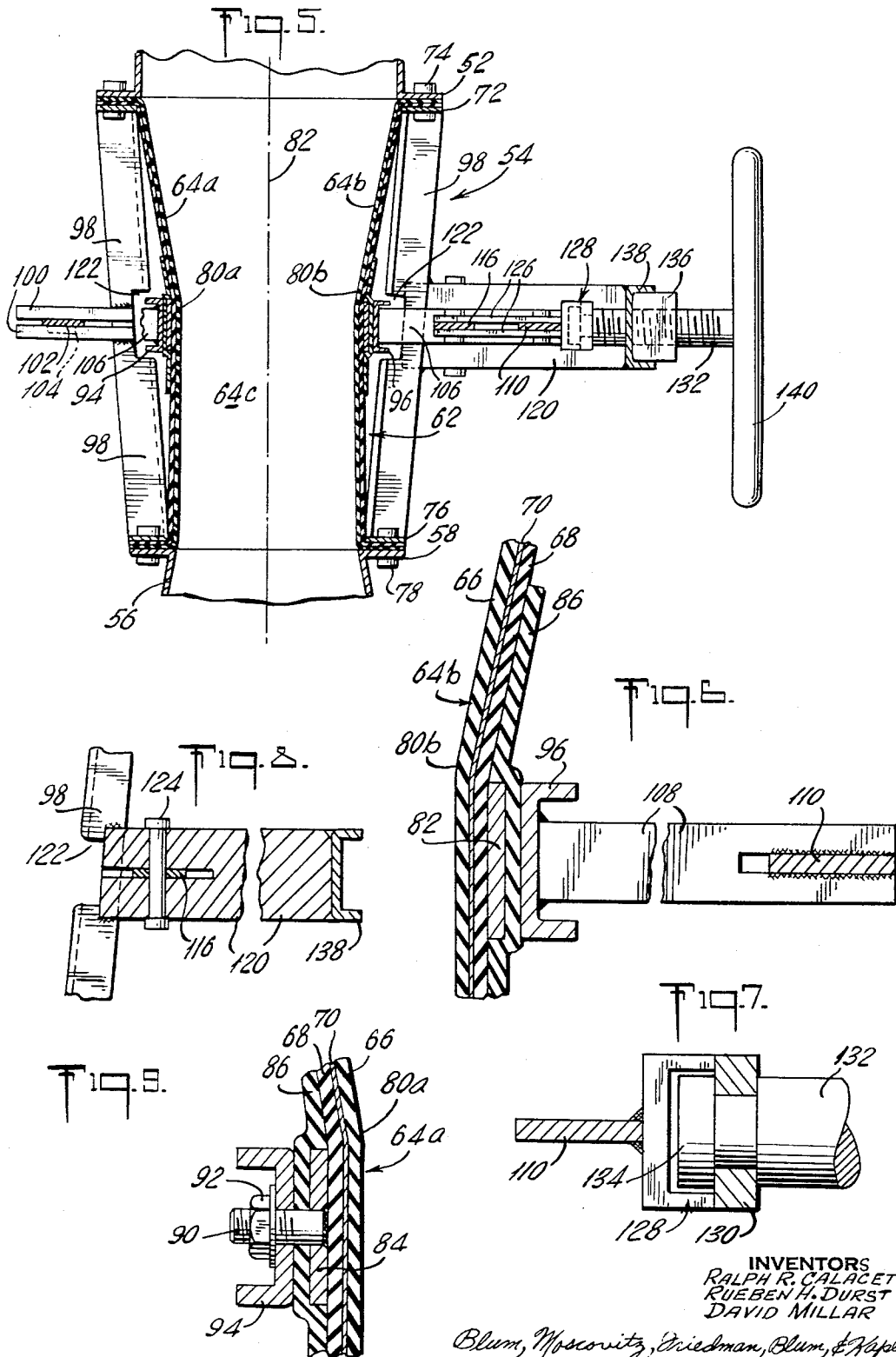
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ADJUSTABLE VENTURI FOR SCRUBBERS

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ABSTRACT OF THE DISCLOSURE

A gas scrubber having an adjustable Venturi throat which receives the gas which is to be cleaned and a liquid for cleaning the gas. The adjustable Venturi throat has a pair of inner straight parallel edges which extend perpendicularly with respect to the central axis of the Venturi and which are situated in a plane normal to the latter axis, the adjustable Venturi structure providing for equal and opposite displacement of the pair of inner edges with respect to the central axis, and these inner edges define the smallest area of the Venturi throat at any adjusted position thereof. The adjustable Venturi throat structure may take the form of a pair of stretchable sheets which are actuated by a linkage to displace the above inner parallel edges of the Venturi equally and oppositely with respect to the central axis thereof.

The adjustable Venturi throat structure is capable of being adjusted by a manually operable or power-operated adjusting means.

The present invention relates to scrubbers.

In particular, the present invention relates to that type of scrubber where a gas which is to be cleaned and a liquid which cleans the gas are both directed through the throat of a Venturi.

The throat velocities of the unscrubbed gas, when in contact with the scrubbing liquid, produces pressure drops across the throat section of the Venturi. This pressure drop is directly proportional to the efficiency of collision between the particles in flight and the water droplets created during turbulence in the throat region of the Venturi. During the handling of a given gas stream in the course of any process, the gas throughput may vary either intentionally due to production changes or as the result of the peculiar nature of the particular process which varies the volume of the gas. During a change in the gas throughput the velocity will change in proportion, and this in turn will reduce or increase the pressure drop. However, the best performance will be achieved only when the pressure drop in the Venturi is maintained at a predetermined ideal value.

It is accordingly a primary object of the present invention to provide for a scrubber an adjustable Venturi throat structure which is capable of adjusting the throat area of the Venturi to provide the best possible performance under the particular operating conditions of the scrubber.

A further object of the present invention is to provide for a scrubber an adjustable Venturi throat structure which will maintain a flow of the gas and liquid which is balanced with respect to the central axis of the Venturi.

Also, it is an object of the present invention to provide for a scrubber an adjustable Venturi throat structure which is composed of simple rugged elements which are very re-

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liable in operation and which require practically no maintenance.

Yet another object of the present invention is to provide for a scrubber an adjustable Venturi throat section which is actuated by an adjusting means which is manually operable.

Also, it is an object of the invention to provide for a scrubber an adjustable Venturi throat structure which is adjustable by way of an adjusting means which is power actuated.

In accordance with the present invention, the scrubber includes a conduit means which directs the gas which is to be cleaned and a liquid which is used for cleaning the gas along a given path, this conduit means having a tapered portion which converges in the direction of flow of the gas and liquid and which forms the inlet of a Venturi. An adjustable Venturi throat means of the invention communicates with the tapered portion of the conduit means to receive the gas and liquid therefrom and to provide for the gas and liquid an adjustable cross-sectional area through which the gas and liquid flow, an adjusting means being operatively connected with the adjustable Venturi throat means for adjusting the latter. The adjustable Venturi throat means has a central axis which extends in the direction of flow of the gas and liquid, and this adjustable Venturi throat means has at its interior a pair of elongated straight parallel edges which are equidistantly spaced from the central axis of the Venturi, extending perpendicularly thereto in a plane which is normal thereto, and it is these inner edges which are movable equally and oppositely with respect to the central axis and which determine the smallest cross-sectional area of the Venturi at any adjusted position thereof, so that in this way with the adjustable Venturi throat means of the invention a balanced flow is achieved.

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a top plan view of a scrubber which includes the structure of the invention, part of the structure being broken away in FIG. 1 to more clearly illustrate the details thereof;

FIG. 2 is a transverse sectional elevation of the structure of FIG. 1 taken along line 2-2 of FIG. 1 in the direction of the arrows;

FIG. 3 is a sectional plan view showing details of one possible embodiment of an adjustable Venturi throat means of the invention, FIG. 3 being taken along line 3-3 of FIG. 2 in the direction of the arrows;

FIG. 4 is a fragmentary elevation of the adjustable Venturi throat structure as seen in the direction of arrow A of FIGS. 2 and 3;

FIG. 5 is a fragmentary sectional elevation of the structure of FIG. 3 taken along line 5-5 of FIG. 3 in the direction of the arrows;

FIG. 6 is a fragmentary sectional elevation of part of the structure of FIG. 3 taken along line 6-6 of FIG. 3 in the direction of the arrows;

FIG. 7 is a fragmentary sectional elevation of part of the structure of FIG. 3 taken along line 7-7 of FIG. 3 in the direction of the arrows;

FIG. 8 is a fragmentary sectional elevation of part of the structure of FIG. 3 taken along line 8-8 of FIG. 3 in the direction of the arrows;

FIG. 9 is a fragmentary sectional elevation of part

of the structure of FIG. 4 taken along line 9—9 of FIG. 4 in the direction of the arrows.

The drawings illustrate the structure of the invention incorporated into that type of scrubber which is disclosed in U.S. Patent 3,145,239.

The structure of the scrubber includes a conduit means composed of an upper cylindrical conduit section 20 (FIGS. 1 and 2) through which the gas which is to be cleaned is directed downwardly. This conduit section 20 extends through and is carried by a horizontal wall 22 which is fixed, as by the rivets 24, to the top end of a conduit section 26 which is rectangular or square and which surrounds the portion of the conduit 20 which extends beneath the horizontal wall 22. The wall 22 carries at its upper surface a pair of L-shaped boxes 28 each having a bottom wall 30 resting directly on the wall 22. This bottom wall 30 carries a pair of elongated rectangular tubes 32 and 34 which extend through the bottom wall 30, in each box 28, and the wall 22 is formed with slots 36 through which lower portions of these elongated rectangular tubes 32 and 34 extend to an elevation somewhat lower than the wall 22. Supply pipes 38 communicate with the interiors of the boxes 28 at one end thereof to supply the cleaning liquid thereto, and this liquid will rise upwardly in each box 28 to flow over the top edge of one of the walls of each rectangular tube 32. Each rectangular tube 32 has a pair of opposed walls one of which has a toothed or serrated edge 40 which is lower than the top edges of the remaining walls of each tube 32, so that the liquid flows over the serrated edge 40 downwardly through the several tubes 32 in the form of sheets of liquid. The boxes 28 are provided with suitable covers 42 having handles 44 which enable the operator to remove the covers 44 whenever desired so as to be able to inspect the interior of the boxes 28.

The conduit means of the scrubber includes, in addition to the conduit sections 20 and 26, a tapered conduit section 46 which converges downwardly in the direction of flow of the gas and liquid provided by the conduit means 20, 26, 46. This tapered portion of the conduit means forms the inlet of a Venturi and at its smallest end, the tapered conduit portion 46 defines the rectangular orifice 48 visible in FIG. 1. This orifice 48 is defined by a relatively short rectangular tube 50 which, as shown in FIG. 2, terminates at its bottom end in an outwardly directed flange 52.

The adjustable Venturi throat means 54 of the invention is connected to the flange 52 and thus communicates with the conduit means 20, 26, 46 for receiving the gas and liquid therefrom, and the details of the adjustable Venturi throat means 54 are described below. The conduit means includes downstream of the adjustable Venturi throat means 54 a conduit section 56 which has an upper flange 58 connected to the downstream end of the adjustable Venturi throat means 54. This latter adjustable throat means is capable of being adjusted in the example of FIG. 2 by way of an adjusting means 60 in the form of a linkage which can be manually operated in a manner described below.

The adjustable Venturi throat means 54 is in the nature of a pinch valve in that it includes a stretchable sheet structure 62 (FIG. 5) which is of tubular configuration. This stretchable sheet structure 62 includes a pair of opposed relatively wide elongated sheets 64a and 64b and a pair of opposed elongated relatively narrow end sheets 64c and 64d (FIGS. 3 and 5), and all of these sheets are integral with each other to form the unitary stretchable tubular sheet structure 62. Each of these sheets is composed, as shown most clearly in FIGS. 6 and 9, of an inner wall 66 made of rubber sheet material which may be one quarter inch thick, for example, and which is stretchable, and an outer rubber wall 68 which may be identical with the wall 66 and which surrounds the later, these walls 66 and 68 being separated from each other by a nylon cord structure 70 so as to provide a

rugged sheet structure which at the same time is stretchable. The upper ends of the several integral sheets are outwardly flanged and situated against the lower surface of the flange 52, and the outwardly flanged upper ends of the integral sheets are engaged at their undersides by a flat rectangular ring 72 urged by bolts and nuts 74 or the like toward the flange 52 so as to clamp the upper flanged edge of the stretchable tubular structure 62 against the upper Venturi throat flange 52.

In much the same way the lower ends of the several integral sheets of the structure 62 are outwardly flanged and engage the top surface of the lower flange 58. A flat rectangular ring 76 (FIG. 5) of the same size as the flange 58 engages the upper surface of the outwardly flanged lower ends of the several sheets of the structure 62 and is urged toward the lower flange 58 by any suitable structure such as the bolt and nuts 78, so that in this way the stretchable Venturi throat structure is clamped at its lower end to the lower Venturi flange 58.

The pair of opposed sheets 64a and 64b have intermediate their upper and lower ends inner elongated straight parallel edge portions 80a and 80b, respectively, which are situated in a plane normal to the central axis 82 of the Venturi and which extend perpendicularly thereto.

By way of an adjusting means which is operatively connected with the adjustable Venturi throat means 54 these inner edges 80a and 80b are movable equally and oppositely toward and away from the central Venturi axis 82 so as to determine at any time the smallest cross-sectional area of the Venturi in the adjusted position thereof.

The adjusting means of this embodiment includes an elongated flat horizontal bar 82 extending parallel to the edge 80b and situated against the exterior surface of the wall 68 of the sheet 64b (FIG. 6), as well as an elongated flat horizontal bar 84 which is situated against the exterior surface of the wall 68 of the sheet 64a and which extends parallel to the edge 80a, as shown in FIG. 9. The bars 82 and 84 extend across the entire widths of the sheets 64b and 64a, respectively.

These bars 82 and 84 are respectively covered by outer sheet members 86 and 88, and a plurality of fastening studs 90 are welded to and extend outwardly from the bars 82 and 84 through suitable openings in the sheets 86 and 88, in the manner shown in FIG. 9. These studs 90 have nuts 92 threaded thereon and acting through suitable washers on elongated channel members 94 and 96 which respectively extend parallel to the bars 84 and 82, so that in this way these channel members are fixed to the pair of opposed sheets 64a and 64b.

Each of the longer sides of the upper flat rectangular ring 72 is fixed, as by welding, in the region of each of its ends to a pair of downwardly extending parallel angle irons 98. Each pair of these angle irons 98 has its angle irons parallel to each other and they extend downwardly to the lower flat rectangular ring 76 to which they are also welded, so that in this way the flat rings 72 and 76 are maintained spaced from each other.

Each of the two pairs of angle irons 98 which are situated adjacent the sheet 64a are fixed to a pair of horizontal link guides 100, as by being welded thereto, and one pair of these link guides 100 is illustrated in FIG. 5. As may be seen from FIG. 5 the pairs of link guides 100 are spaced slightly from each other to receive between themselves an elongated horizontal flat bar 102 which is thus slidably guided by the guides 100 while being maintained in a plane normal to the central axis of the Venturi. As may be seen from FIGS. 3 and 4, the bar 102 fixedly carries at its upper and lower surfaces slide blocks 104 which are welded to the bar 102 and which slidably engage outer side surfaces of the link guides 100. The channel member 94 is fixed, as by welding, to a pair of outwardly directed horizontal bars 106 shown in FIGS. 3 and 4, and these bars 106 are parallel to each other and to the link guides 100 while extending perpendicularly to the bar

102 to which the bars 106 are also fixed as by being welded thereto.

In such the same way the channel member 96 shown in FIG. 6 is welded to a pair of outwardly directed horizontal bars 108, and these bars 108 are welded at their outer ends to an elongated flat horizontal bar 110 which extends parallel to the bar 102 but which is shorter than the latter. As is apparent from FIG. 6 the bars 108 are slotted to receive the bar 110, and this same structure interconnects the bar 102 with the bars 106. Thus, it will be seen that in fact the bars 102 and 110 are rigidly fixed to the sheets 64a and 64b, respectively, extending parallel to the edges 80a and 80b thereof, respectively, so as to be movable in unison with these edges.

The adjusting means 60 further includes a pair of elongated parallel end links 112 having notched ends which receive the ends of the bar 102, as shown in FIG. 4, and suitable rivets 114 or the like extend through the overlapping ends of the links 112 and the bar 102 for pivotally connecting the links 112 to the bar 102 for turning movement with respect to the latter respectively about axes which are parallel to each other and to the central axis of the Venturi. At their ends which are distant from the bar 102, the links 112 are pivotally connected with a pair of levers 116. The links 112 also have suitably slotted ends receiving the outer ends of the levers 116 and pivotally connected thereto by suitable pivot pins 118 in the same way that the links 112 are pivoted to the bar 102.

The pairs of angle irons 98 which are situated adjacent the sheet 64b are welded to a pair of bars 120 which extend from between each pair of angle irons 98 outwardly away from the sheet 64b in a horizontal direction perpendicular to the central axis of the Venturi, and these bars 120, one of which is shown in FIG. 8, are situated at the same elevation as the bars 106. It is to be noted that in the region of the inner ends of the bars 120 and the link guides 100 the angle irons 98 are all notched out to form recesses 122 which form clearance spaces for the elongated channel members 94 and 96. The stationary bars 120 are horizontally slotted between their upper and lower surfaces to receive the levers 116 which are pivotally connected with the bars 120 by way of the pivot pins 124. This construction is shown most clearly in FIG. 8. At their inner ends which are distant from the pivots 118, the levers 116 are pivotally connected with a second pair of links 126 which are in turn pivotally connected at their ends distant from the levers 116 to the bar 110, in the manner shown most clearly in FIG. 3. As is shown in FIG. 5, each link 126 may include upper and lower members respectively engaging the upper and lower surfaces of the levers 116 and the bar 110 and pivotally connected to the latter.

In the particular example illustrated the adjusting means 60 is manually operable, and for this purpose the bar 110 fixedly carries at its side which is directed away from the sheet 64b a substantially U-shaped bracket 128. The wall 130 of this bracket which is spaced from the bar 110 is formed with a bore in which a reduced portion of a rotary screw or worm 132 is turnable, this screw 132 having within the bracket 128 an enlarged end 134 (FIG. 7), so that while the screw 132 can freely turn with respect to the bracket 128 it cannot move axially with respect thereto. The rotary screw 132 is threaded through a stationary nut 136 fixedly carried by a stationary channel member 138 formed with an opening through which the screw 132 freely passes and fixed at its ends to the outer ends of the stationary bars 120, so that during turning of the screw 132 it will move axially through the stationary nut 136 (FIGS. 3 and 5). At its outer end the screw 132 is fixed with a hand-wheel 140, so that the operator can conveniently turn the screw 132.

With this construction whenever the operator turns the handwheel 140 the bar 110, while remaining horizontal, and while remaining parallel to the bar 102, will move toward or away from the central axis of the Venturi in a plane normal to the latter. Through the links 126 the

bar 110 will turn the pair of levers 116 equally and oppositely about their pivots 124, respectively, so that if the bar 110 is advanced towards the axis of the Venturi the links 112 will displace the bar 102 in an opposite direction toward the axis of the Venturi, and the lengths of the lever arms of the levers 116 are equal so that with this construction the bar 102 will be advanced inwardly toward the Venturi axis to the same extent as the bar 110 while remaining parallel thereto and perpendicular to the axis of the Venturi. In the same way when the bar 110 is displaced oppositely away from the Venturi axis the bar 102 will also be displaced outwardly away from the Venturi axis to the same extent. As a result, with this construction the inner edges 80a and 80b of the Venturi throat means 54 will at all times remain parallel to each other and equidistant from the central Venturi axis 82 while extending perpendicularly thereto, and thus a balanced flow for the gas and liquid is assured.

While the embodiment of FIGS. 1-9 is described above as being manually actuated, it is clear that any suitable power unit may be operatively connected with the worm or screw 132 for rotating the latter, even from remote controls, so that in this way the embodiment of FIGS. 1-9 also may be power actuated. It is to be noted that with the embodiment of FIGS. 1-9, the suspended stretchable wall structure 62 will automatically respond to the pressure prevailing within the Venturi. At the same time the equal and opposite adjustment of the opposed sheets thereof provides a smooth gas flow pattern through the Venturi.

The adjustable throat section provided with the Venturi structure of the invention makes it possible to maintain a constant overall pressure even when the particular process requires a throughput of varying volume. It is to be noted that the controls for the adjustment of the Venturi of any of the embodiments of the invention may be automated.

What is claimed is:

1. In a scrubber, conduit means for directing along a given path a gas which is to be cleaned and a liquid for cleaning the gas, said conduit means having a tapered portion which converges in the direction of flow of the liquid and gas and which forms a Venturi inlet, adjustable Venturi throat means communicating with the tapered portion of said conduit means for forming a Venturi throat of adjustable cross-sectional area which receives the gas and liquid from said conduit means and through which the gas and liquid flow, and adjusting means operatively connected with said adjustable Venturi throat means for adjusting the latter to provide an adjusted throat area, said adjustable Venturi throat means having a central axis extending in the direction of movement of the liquid and gas and a pair of opposed elongated inner straight parallel edges situated in a plane normal to said axis with the latter passing centrally between said edges, and said adjustable Venturi throat means displacing said edges thereof equally and oppositely with respect to said axis to the smallest area of the Venturi throat at any adjusted position of said Venturi throat means and to provide a balanced flow of the liquid and gas with respect to said axis, said adjustable Venturi throat means including a pair of stretchable sheets respectively having intermediate elongated portions defining said inner parallel edges of said Venturi throat means, said adjusting means including a pair of rigid bars respectively extending parallel to said edges and engaging said sheets at said intermediate elongated portions thereof, respectively, and linkage means including a plurality of links and pivot means for each of said links operatively connected with one of said bars and means defining a rigid linkage operatively connected with the other of said bars for simultaneously displacing the latter equally and oppositely with respect to said axis in said plane normal thereto.

2. The combination of claim 1 and wherein means is connected to said linkage means for manual operation.

3. The combination of claim 1 and wherein said linkage includes a first pair of links pivotally connected to one of said bars and extending therefrom transversely to said axis past the other of said bars, a pair of levers pivotally connected to said links, respectively, at ends thereof distant from said one bar, said levers respectively being turnable about a pair of parallel axes which are parallel to said central axis and which are situated intermediate the ends of said levers, respectively, a second pair of links pivotally connected to ends of said levers distant from said first pair of links, respectively, said second pair of links being parallel to each other and extending from said levers in directions which are perpendicular to said central axis, and a third bar extending between and pivotally connected to said second pair of links and ends thereof distant from said levers, said third bar being parallel to the other bars and displaceable toward and away from said central axis to provide equal and opposite movement of said pair of bars.

4. The combination of claim 1 and wherein said con-

duit means extends vertically for providing a downward flow of the liquid and gas, said tapered portion of said conduit means being downwardly tapered and said adjustable Venturi throat means being situated beneath said tapered portion of said conduit means.

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