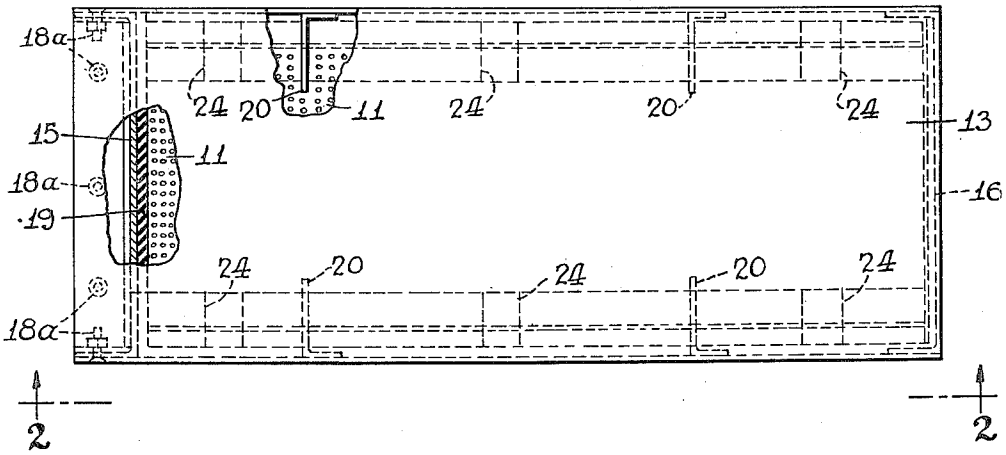
March 18, 1952 G. S. DAUPHINEE 2,589,229

ADSORBING DEVICE

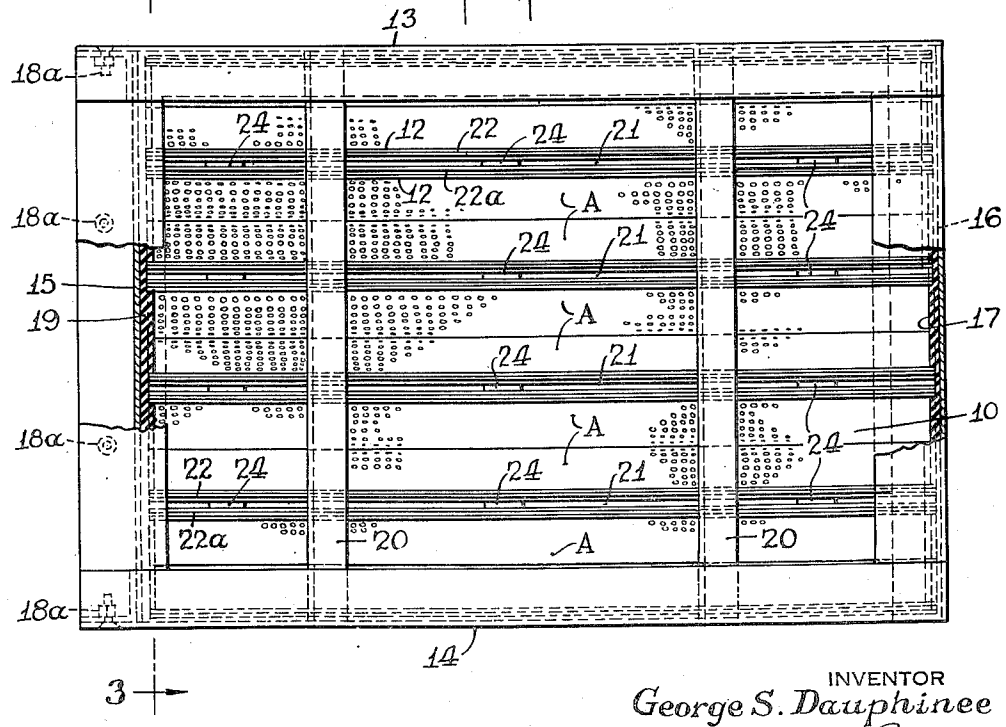
Filed Aug. 14, 1946 4 Sheets-Sheet 1

Fig. 1.



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Fig. 2.



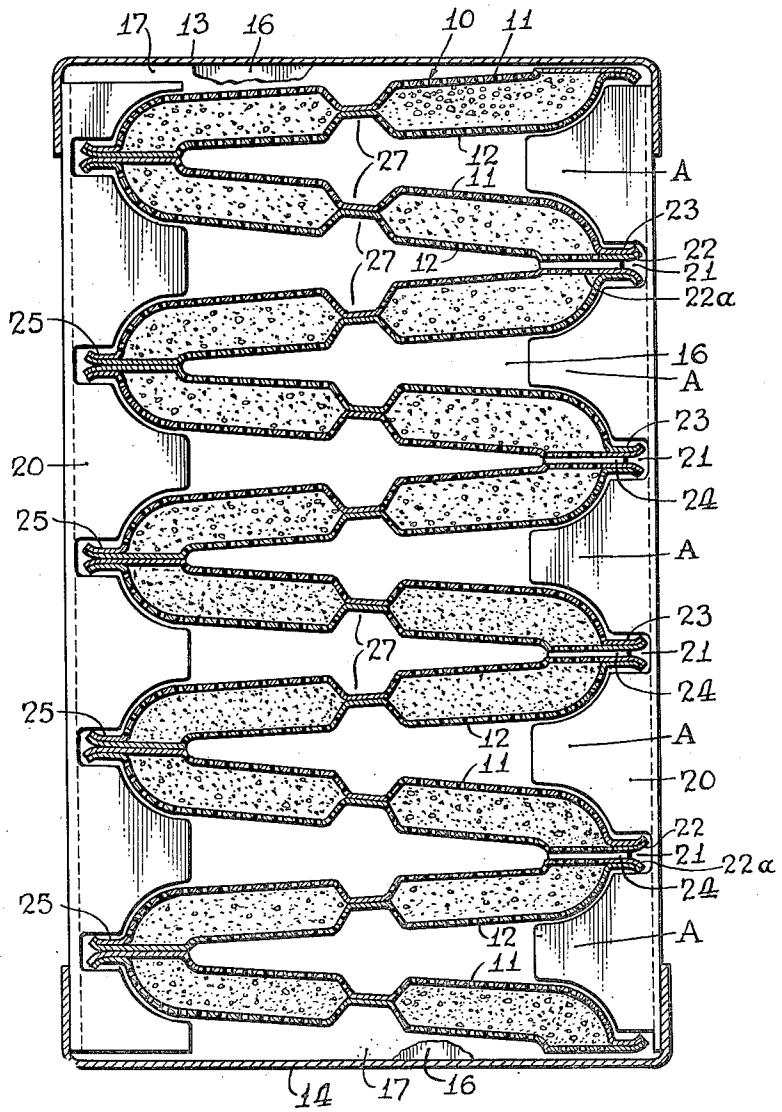
INVENTOR
George S. Dauphinee
BY
Eric G. Fuller
ATTORNEY

March 18, 1952 G. S. DAUPHINEE 2,589,229

ADSORBING DEVICE

Filed Aug. 14, 1946 4 Sheets-Sheet 2

Fig. 3.



INVENTOR
George S. Dauphinee
BY Eric G. Freeman
ATTORNEY

March 18, 1952 G. S. DAUPHINEE 2,589,229

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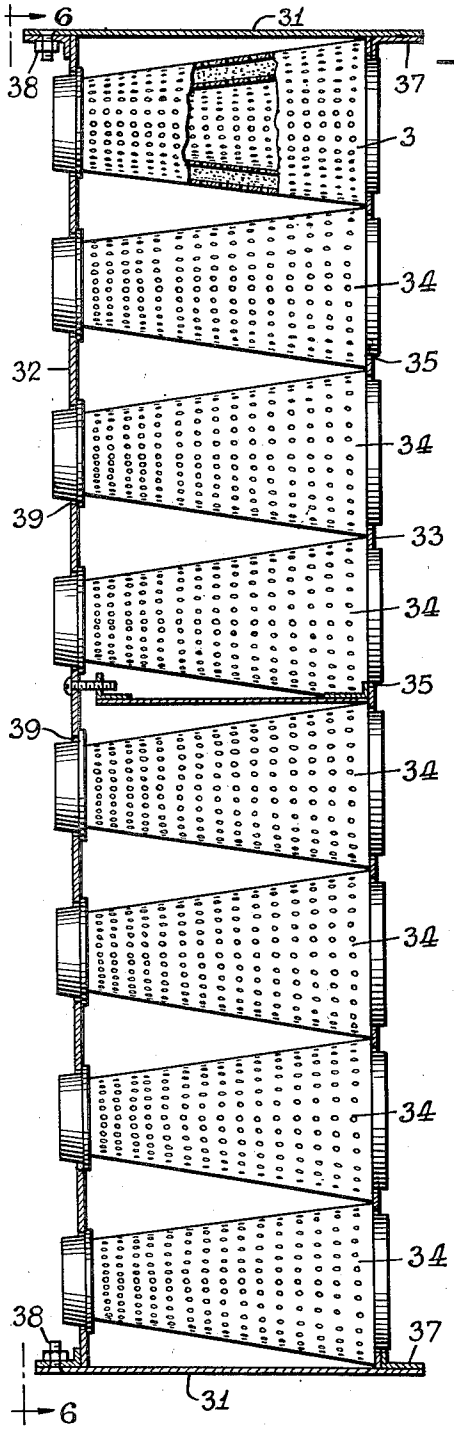
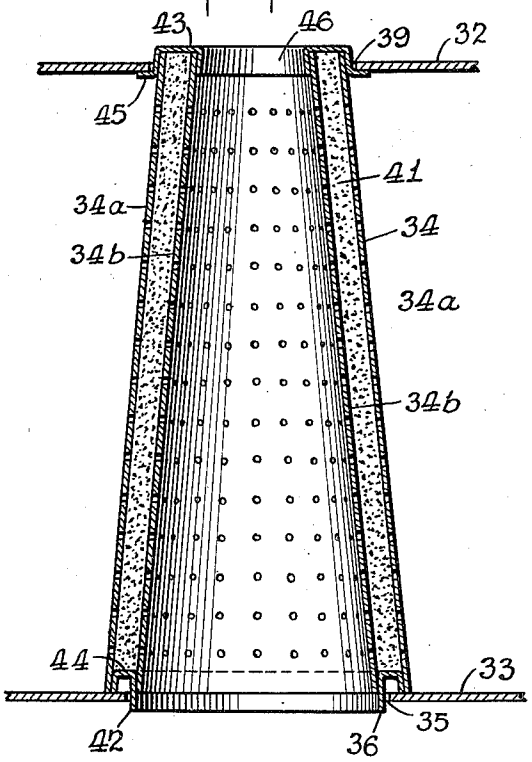


Fig. 4.

Fig. 5.



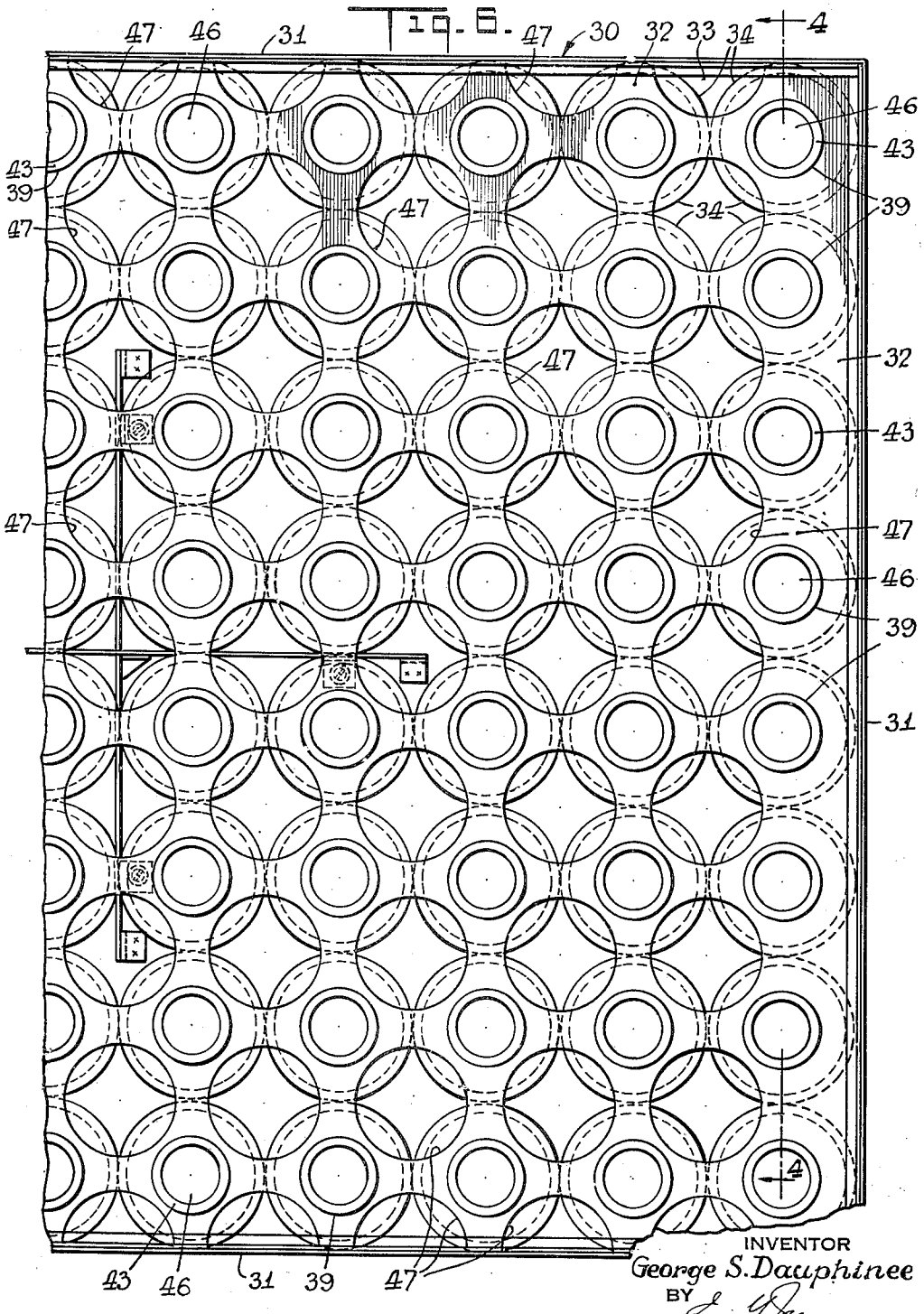
INVENTOR
George S. Dauphinee
BY
Eric J. Neeson
ATTORNEY

March 18, 1952 G. S. DAUPHINEE 2,589,229

ADSORBING DEVICE

Filed Aug. 14, 1946 4 Sheets-Sheet 4

Fig. 6.



INVENTOR
George S. Dauphinee
BY
Eric Jamieson
ATTORNEY

Patented Mar. 18, 1952

2,589,229

UNITED STATES PATENT OFFICE

2,589,229

ADSORBING DEVICE

George S. Dauphinee, Brooklyn, N. Y., assignor, by mesne assignments, to W. B. Connor Engineering Corporation, New York, N. Y., a corporation of New York

Application August 14, 1946, Serial No. 690,551

6 Claims. (Cl. 183—4.0)

1

This invention relates to improvements in air conditioning apparatus and the like and more particularly to an improved air recovery device for removing odorous and adulterating gases or fluids from a re-circulated portion of the surrounding air.

The invention is particularly applicable although not limited to the process of continuously extracting accumulated gaseous impurities from used ventilating air in the circuit of an air conditioning system so that this air may be used over again repeatedly. In this manner the high thermal and psychrometric values of the air will be conserved which otherwise would have been wasted because of the presence of these gaseous impurities.

Certain present conditions have created a definite demand for more compact equipment of this type, that is devices which will purify a greater quantity of air per unit face area and with less resistance to air flow. This requirement applies particularly to systems serving comparatively small areas, such as the passenger space in railroad cars, busses, aeroplanes and the like where the bulk and the weight of the equipment must be kept at a minimum without decrease of its capacity.

The air purification device to which the present invention is applicable is constructed along the same principle as that disclosed in my Patents No. 2,214,737, dated September 17th, 1940, and No. 2,303,332, dated December 1st, 1942. It has been found, however, that the space requirement for the device disclosed in the first mentioned patent is entirely too high for the aforementioned type of service even though it has a satisfactorily low resistance to the air flow. On the other hand, the space requirement of the device disclosed in the last mentioned patent might be satisfactory but the resistance to the air flow is too high at the desired rate of flow.

It is therefore among the objects of the present invention to provide an air recovery device that will meet the aforementioned requirements as to space and weight and resistance to the air flow.

Furthermore in the equipment heretofore used the renewal of the carbon in the individual units required separate handling. This would present a great obstacle in the small and compact device according to the invention.

It is, therefore, a further object to provide an air recovery device in which the carbon in the individual units can be removed and renewed in a single operation.

Other objects and advantages inherent in the invention will become apparent from the following specification taken in conjunction with the accompanying drawings which disclose by way of example two different embodiments of the invention.

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Referring in greater detail to the drawing throughout which the same reference characters are used to indicate the same or analogous parts:

Figure 1 is a top plan view of an air recovery device according to the invention partly in section.

Figure 2 is a front elevation thereof.

Figure 3 is a section taken along the line 3—3 of Figure 2.

Figure 4 is a section of a modification taken along the line 4—4 of Figure 6.

Figure 5 is a section of the individual carbon canister used in the modification shown in Figure 4 and drawn to an enlarged scale.

Figure 6 is a front elevation of the front plate taken in the direction of the arrows 6—6 in Figure 4.

The device as heretofore indicated consists of a cell or panel comprising several individual carbon containing units. For the purpose of the invention, the capacity of this cell should be at least 250 cubic feet per minute per square foot face area of the panel and the resistance to this rate of air flow should not be more than 0.2" w. g. (water gauge). In the conventional devices it has not been possible to reduce the resistance to such a low value and still maintain the capacity mentioned. It is not absolutely necessary however to circulate all of the air through the carbon bed, as the volume of circulation required for air conditioning is based upon other considerations than that of merely extracting the impure gases from the air. Thus quite satisfactory conditions from an air purification standpoint can be obtained by passing only about 75% of the recirculated air through the carbon bed and by-passing the other 25%.

The present invention contemplates therefore an air recovery device having means for letting a portion of the recirculated air by-pass the carbon bed. This by-pass is so located as to discharge into the stream on the downstream side of the porous carbon wall and obviously this arrangement lessens the general resistance considerably. Furthermore, the air by-passed in this manner will have an aspirational effect and promote the air flow through the porous carbon wall in the general direction of the air flow.

Referring in greater detail to the Figures 1 to 3 of the drawing, the carbon containing element or cell generally indicated at 10 consists of a pair of spaced substantially parallel perforated sheets of

metal or other self sustaining material 11 and 12 which are bent in zig-zag or accordion pleated fashion to form a plurality of alternately reversed V-shaped elements which extend between the flanged top casing 13 and the flanged bottom casing 14 and the side members 15 and 16.

The carbon containing cell 10, formed by the sheets 11 and 12, is closed at one end by means of the side member 16 which is provided with a pad or gasket 17 of rubber or similar material against which are pressed the edges of the metal sheets 11 and 12 to provide a tight closure when the device is assembled. The side member 16 may be welded to or otherwise permanently connected to the top and bottom casings 13 and 14.

The other end of the cell formed by the sheets 11 and 12 is closed by the side member 15, which is detachable and which presses the rubber pad 19 firmly against the edges of the sheets.

The side member 15 may be clamped firmly in position by means of the angle irons 18 which are welded to the side member 15 and bolted to the top and bottom casing 13 and 14 by means of bolts 18*a*.

The V-shaped cell may be supported between the casings 13 and 14 by means of the alignment bars 20.

Thus the cell presents a large porous perforated area providing a plurality of pockets A. As indicated, however, the entire volume of the recirculated air is not passed through this porous area. In order to carry out the objects of the invention, the V-shaped cell may be provided with slots 21 on the intake side or front side of the cell. These slots are preferably located at the bend of the V and are formed by extensions 22 and 22*a* of the sheets 11 and 12 respectively which are welded or otherwise attached to one another to provide flared openings for the slots 21. The gap or opening of the slot is maintained at the desired width by means of the spacer members 24 which are spot welded or otherwise connected intermediate the extensions 22 and 22*a* at predetermined intervals.

It has been found that with an air flow of 250 cubic feet per square foot face area and a resistance of 0.2" w. g. the width of the gap should be about $\frac{1}{16}$ of an inch.

The sheets 11 and 12 which form the porous element defining the pockets A are spot welded or otherwise joined at the rear or exit side of the cell at the extreme ends of the extensions 25 and 26 of the sheets 11 and 12 respectively. Because of the thinness of the sheets, these joints are pliable and therefore can act as hinges to allow a variation of the space between the slots 21. The aforementioned space may be varied within the limits to suit the dimensions of the panel as dictated by space requirements. For example, if the cell dimensions were 24 inches and the number of pockets 16, the space between the slots would be 1.50 inches. On the other hand, if the cell dimension were 20 inches and the number of pockets 13, then the spacing would be 1.50 inches.

It will be understood that the alignment bars 20 can be stamped to suit any desired spacing with a common stamping die.

If the aforementioned cell were positioned in railroad service, for example, with the pockets A standing vertically, the carbon would, due to the excessive vibration, settle to the lower portion and no container except a truly circular one would withstand the bulging action produced by the settled carbon mass. In the cell described, however, a rectangular cross sectional form has been adopted which normally has little resistance against the bulging action but, to eliminate all anxiety from this standpoint, the porous element is placed horizontally so that the depth of the indivdual carbon mass, which influences the said bulging action is very small. Thus vibration in this case will not cause a packing action but will have a beneficial effect in that the shallow mass will be kept in loose formation.

In order to still further insure against bulging, the perforated sheets 11 and 12 enclosing the carbon mass may be formed with small circular depressions 27 which are spaced along the sheets, to suit requirements. The flat bottoms of these depressions register with those of similar depressions in the opposite sheet and are spot welded at point of contact. These depressions obviously add to the structural strength of the porous member and the reduction in purifying surface area caused by these depressions is negligible.

When assembling or filling the cell with carbon, a special screen cover is placed over the open end, that is the end with the detachable cover 15. The cover is so made that the carbon space is open and the pocket space is closed. The cell is now dropped into a box, a few inches taller than the cell and open at the top, into which it fits closely. Carbon can now be poured over the top of the cell and the carbon space of the perforated elements so filled. The rubber pad 19 is now placed over the open end and then the cover 15 is placed over this and pressed down so that the edge of the element metal penetrates into the surface of the rubber pad. The cover 15 is then bolted in place and the cell is complete.

It will thus be readily seen that the assembling, filling and replacement of carbon can be accomplished without handling of the individual elements.

Assuming now that the air capacity of the cell or panel shown, to meet the demand, is at least 250 cubic feet per square foot face area of panel, 75% of this enters the pocket and passes through the porous activated carbon wall forming the said pocket, 25% passes through the by-pass indicated. The preferred air velocity through the porous wall is 50 feet per minute and the overall resistance to air flow is 0.2" w. g. Since velocity varies as the square root of the pressure and since according to the standard formula the square root of 1" w. g. pressure corresponds to a velocity of 4005 feet per minute under standard air conditions, the air velocity through the by-pass is

$$4005\sqrt{0.2''}=1790$$

feet per minute. Due to this high velocity, the width of the slot comprising the by-pass is small, being in the order of $\frac{1}{16}$". It is obvious that the capacity per square foot of face area could be increased by increasing the depth of the cell in the general direction of airflow, thus increasing the width or area of the porous wall. This however, would cause an increase in the air velocity through the space between the pockets A and thus increase the overall resistance. From my experience in the service mentioned above, the above width of the porous wall should be preferably not more than 4½" and the rate of air flow per square foot face area 250 feet and resistance not more than 0.2" w. g. With these requirements, the design is predicated on passing 75% through the carbon and 25% through the by-pass, 100% constituting the entire air circulated. As previously stated, the volume of cir-

culation required for air conditioning is based on other considerations than that of air purification from the standpoint of extraneous gas extraction and I have found that quite satisfactory conditions from an air purification standpoint can be maintained by treating only 75% of the recirculated air for removal of these gases. This by-pass is so located as to discharge into the stream on the downstream side of the porous wall and lessens the general resistance as the effect of this by-pass is to promote air flow through the porous wall in the general direction of air flow.

The equipment covered by Patent No. 2,303,332 at the same capacity as the cell above described has a resistance of 0.55" w. g. or 275% greater than the new cell. The resistance of 0.55" w. g. is not practical for the services mentioned.

Referring now to the modification illustrated in Figures 4 to 6 the panel or cell comprising a casing **30** defining a rectangular enclosure, a front plate **32** and a rear plate **33** and a plurality of conical carbon containing perforated canisters **34** which are assembled between the plates **33** and **32**.

The rear plate **33** is provided with spaced circular openings **35** to receive the base projection **36** of the canister **34** into which it fits snugly. This rear plate is in fixed assembly with the casing **31** by means of the flange **37** which is spot welded or otherwise securely fastened to both the casing **31** and the plate **33**.

The front plate **32** is in construction similar to plate **33** except it is detachable by means of bolts **38**. The top plate is provided with spaced circular holes **39** to receive the top of the canisters **34** and they are concentric with the holes **35** of the bottom plate. It is also provided with holes **47** (see Figure 6) located between the holes **39** to admit the air to be purified.

The canister comprises an outer conical casing **34***a* and an inner conical casing **34***b*. These casings are concentric and the intervening space **41** is of uniform thickness throughout. This spacing is maintained by means of the bottom closure member **42** and the upper closure member **43**. In addition to closing the space **41**, the lower member **42** is provided with a flange extension **44** to reenforce the end **36** of the conical casing **34***b* which projects through the opening **35**.

In the case of the top closure **43** this is provided with an outstanding flange **45** which in cooperation with the top plate **32** serves to lock the canister **34** into fixed position. It will be further noted that this closure is provided with a central opening **46** for the purpose explained later.

The conical casings **34***a* and **34***b* are perforated and can be made of any suitable sheet material, preferably tinplate 0.010" to 0.015" thickness. The space **41** is filled with granular activated carbon and the canister vibrated to completely pack the granules so that no serious further settlement will occur when the cell is in service.

The cell or panel is positioned into the air circuit passage or duct so that the air to be purified will transverse it, entering through the hole **47** in front plate **32** and leaving through hole **35** in rear plate **33**. To be more specific, the air path is as follows: It enters through holes **47**, thence passes through the perforated conical casing **34***a*, thence through the porous carbon mass in the space **41**, thence through the perforated conical casing **34***b* and thence outward through the open base of the conical canister. In passing through the carbon mass, the gaseous impurities contained in the air are adsorbed and retained by the action of the activated carbon.

Air also enters the opening **46** in the closure **43**. This quantity of air is approximately 25% of the total quantity passing and is not purified. As previously indicated, the purification of approximately 75% of the air in the circuit of an air conditiong system, I have found to be sufficient and most practical as the cell or panel now occupies only 75% of the space it would otherwise occupy if 100% of the air were purified, which, as stated above, is not necessary.

This cell illustrated has been designed for total capacity of 250 cubic feet of air per square foot face area of the defined rectangle. 75% of this is purified and 25% is by-passed as above explained. The resistance to air flow at the above capacity is not more than 0.2" w. g. Accordingly, it satisfies the present demand as outlined and accomplishes the main object.

Like the embodiment in Figures 1 to 3, in this conical canister type provision is also made to fill the canister with carbon and to renew the carbon without handling the individual canisters separately. The procedure when renewing the carbon is as follows:

Plate **32** is removed, also end closures **43**. Another plate (not shown) similar to plate **32** but with the air access holes omitted is now substituted for plate **32** and bolted in place. The top open end of the canisters will now extend upward through the aforementioned plate leaving the carbon space exposed and open. The cell may be tipped over to allow the carbon to flow out into any suitable container. For refilling, the cell is now set down with the plate upward. The holes **46** are fitted with any suitable plugs or otherwise closed in any suitable manner. Carbon is now poured over the top area and the canisters so filled. When filled and vibrated to complete settlement, the plugs and the extra plate are removed and the regular plate **32** put back and bolted up. The cell is now ready and complete for use.

In this type, the carbon canisters being circular, there is no anxiety in regard to distortion or bulging due to carbon settlement.

The smaller the diameter of the cones chosen the greater will be the carbon wall area obtainable in any given rectangular area. I have by preference chosen approximately 3" for the major diameter. These are suitable for rectangles 27", 24", 21", 18", 15" and 12", as all of these lengths are exactly divisible by 3. 20" and 16" are quite popular. Accordingly, for 20" the diameter of the cone would be approximately 2⅞" and for the 16" the diameter of the cone would be approximately $3\frac{3}{16}$".

For the width of carbon space between the cone wall, I have chosen $\frac{7}{16}$" as experience has shown this to be about correct for the service outlined. A greater thickness of bed would, of course, give longer life but the thicker the bed the greater the resistance to air flow. Accordingly, the $\frac{7}{16}$" bed and 0.2" w. g. resistance, I have found to be a good compromise.

It should be understood that this disclosure is given by way of example and not by way of limitation. On the other hand, the invention lends itself to a variety of expressions within the scope of the appended claims.

What is claimed is:

1. A device for adsorbing adulterants comprising a casing having an intake side and an outlet side for permitting circulation of air there-

through, a series of hollow adsorbing elements extending between the inlet side and the outlet side of said casing, the adsorbent wall members of said hollow elements converging towards the intake side of said casing, each of said elements having an enlarged outlet opening adjacent the outlet side of said casing and a restricted inlet opening adjacent the intake side of said casing whereby a portion of the air circulated through said device will be jetted through said hollow elements.

2. A device for adsorbing adulterants having an intake side and an outlet side for permitting circulation of air through said device, comprising an adsorbing element penetrable by the circulated air and having side walls converging towards the intake side of said device and defining an intermediate space, said element having a restricted inlet opening adjacent the intake side of said device and an enlarged outlet opening adjacent the outlet side of said device, whereby a portion of the air circulated through said device will be jetted through said elements.

3. A device for adsorbing adulterants having an intake side and an outlet side for permitting circulation of air through said device, comprising an adsorbing element penetrable by the circulated air and having side walls converging towards the intake side of said device and defining an intermediate space, said element having a restricted inlet opening adjacent the intake side of said device and an enlarged outlet opening adjacent the outlet side of said device, whereby a portion of the air circulated through said device will be jetted through said elements, and means for varying the degree of slant of said converging walls.

4. A device for adsorbing adulterants having an intake side and an outlet side permitting circulation of air through said device, comprising an adsorbing element penetrable by the circulated air and extending in zig-zag formation across said device defining a plurality of intermediate alternately reversed triangular shaped pockets, said element having an inlet opening in the bends adjacent the intake side of said device, said inlet opening being restricted with respect to the base of said pockets, whereby a portion of the air circulated through said device will be jetted through said elements.

5. A device for adsorbing adulterants having an intake side and an outlet side permitting circulation of air through said device, comprising an adsorbing element penetrable by the circulated air and extending in zig-zag formation across said device defining a plurality of intermediate alternately reversed triangular shaped pockets, said element having an inlet opening in the bends adjacent the intake side of said device, said inlet opening being restricted with respect to the base of said pockets, whereby a portion of the air circulated through said device will be jetted through said elements and hinge means at the bends of said adsorbing element adjacent the outlet side of said device for varying the width of said pockets.

6. A device for adsorbing adulterants having an intake side and an outlet side for permitting circulation of air through said device, comprising a conically shaped hollow adsorbing element defining an annular space, said element having an enlarged outlet opening adjacent the outlet side of said device and a restricted inlet opening adjacent the intake side of said casing, whereby a portion of the air circulated through said device will be jetted through said elements.

GEORGE S. DAUPHINEE.

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