

May 30, 1967

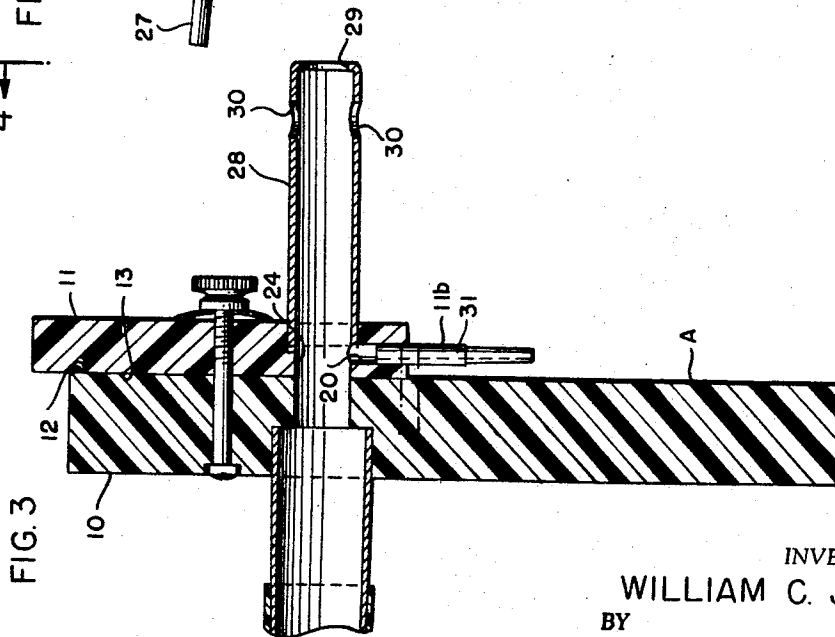
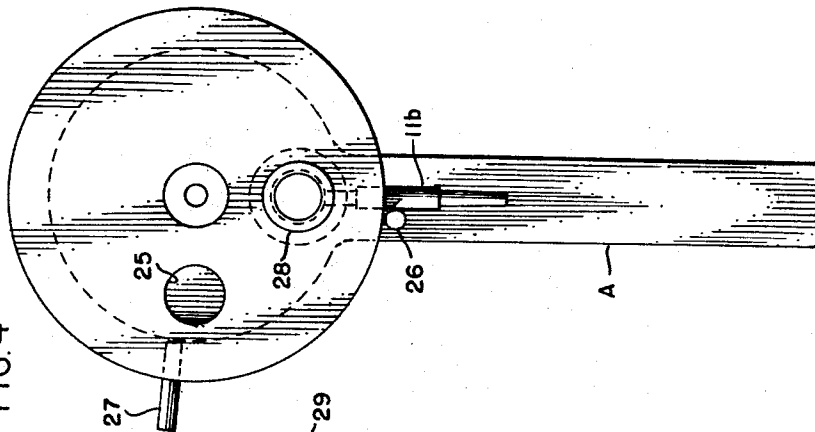
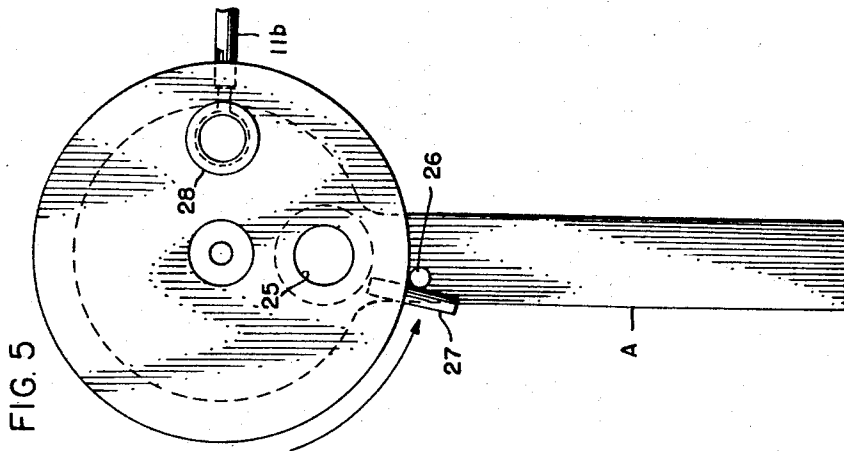
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3,321,976

EXPIRED AIR COLLECTOR AND METHOD OF MAKING THE SAME

Filed Aug. 17, 1964

3 Sheets-Sheet 2



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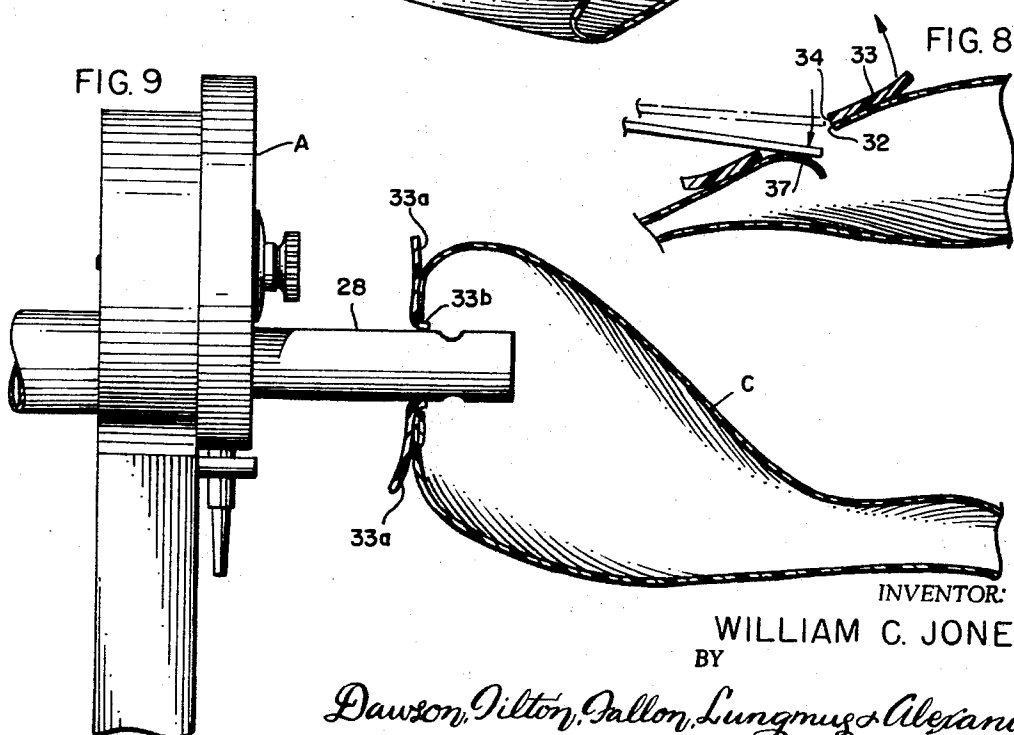
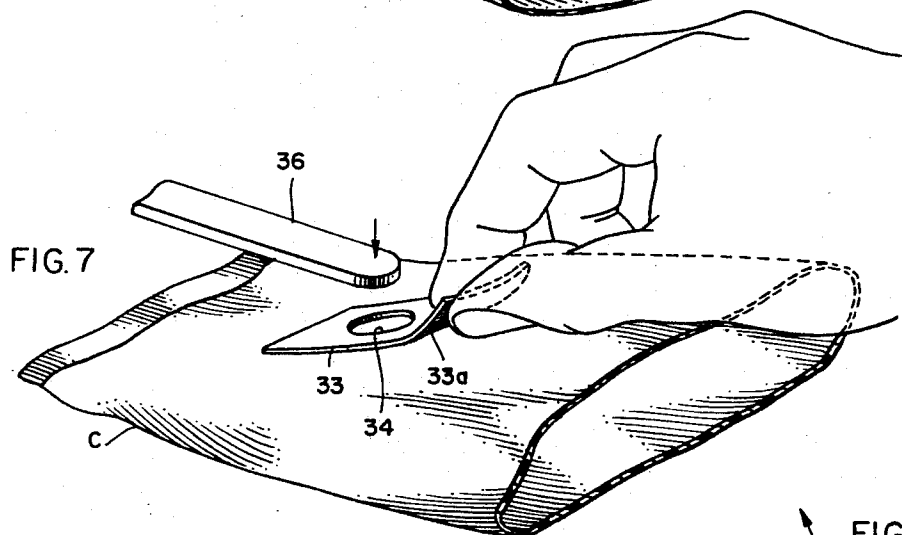
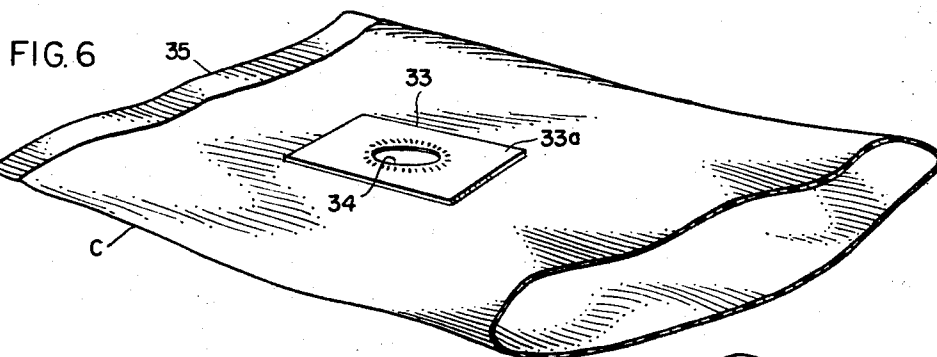
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EXPIRED AIR COLLECTOR AND METHOD OF
MAKING THE SAME

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10 Claims. (Cl. 73-421.5)

This invention relates to a device for collecting a quantity of exhaled air from a subject for the purpose of analyzing the carbon dioxide content thereof, or for any other suitable test purposes.

The equipment commonly used for collecting exhaled or expired air from a subject normally consists of a mouthpiece, an air-control valve connected to the mouthpiece, and a container for collecting the air passing through the valve. In the past, the containers have been bulky and expensive, the connections between such containers and the valve assemblies have been fairly complex, in order to insure a leak-proof seal between the parts, and the valve units have been expensive to manufacture and purchase, and have frequently presented problems of manipulation and cleaning for the user. The valve assemblies customarily used with such breathing equipment ordinarily employ tapered valve members which are rotatably received in casings having tapered valve seats, the combinations therefore being in the nature of standard stopcock constructions to insure an air-tight fit between the parts. Such parts are normally ground or lapped together, with the result that the assemblies are expensive to manufacture and are composed of parts which cannot be interchanged with the components of other similar assemblies.

Cleaning of the parts therefore presents problems for a user since care must be taken to avoid co-mingling of the components of similar assemblies. Furthermore, even when properly matched parts are assembled together, sticking of such parts frequently occurs and such sticking often requires interruption and re-running of the tests.

Accordingly, it is a principal object of the present invention to provide an expired air collector which is relatively inexpensive and trouble-free in construction and operation and which therefore overcomes the aforementioned defects and disadvantages of prior devices. In this connection, it is a specific object to provide a valve and mouthpiece assembly in which the operating parts are formed of plastic material and are capable of being interchanged with like parts of other similar units. A further object is to provide a valve assembly which is capable of being produced without grinding or lapping of the sealing surfaces.

Another object is to provide a valve-mouthpiece assembly in which the movable elements of the valve are relatively easy to manipulate and are non-sticking in operation. An additional object is to provide a valve which may be readily disassembled for cleaning and in which any of the parts thereof may be replaced or may be interchanged with corresponding parts of similar units.

A still further object of the invention is to provide an inexpensive and disposable breath-collecting container which is capable of forming an air-tight seal with the valve-mouthpiece components of the collector assembly. In this regard, it is a specific object to provide a disposable air-collection bag, and its method of manufacture, which includes a highly-effective connecting means for sealingly coupling the bag with a valve unit.

Other objects will appear from the specification and drawings in which:

FIGURE 1 is a perspective view of a collector assembly embodying the present invention;

FIGURE 2 is an exploded perspective view of the parts illustrated in FIGURE 1;

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FIGURE 3 is a vertical sectional view of the valve unit; FIGURE 4 is a rear elevational view taken along line 4-4 of FIGURE 3;

FIGURE 5 is an elevational view similar to FIGURE 4 but illustrating the parts in a different position of adjustment;

FIGURE 6 is a perspective view, taken partly in section, illustrating the disposable bag component of the collector assembly prior to perforation of that bag;

FIGURE 7 illustrates the step of perforating the bag; FIGURE 8 is a broken sectional view illustrating the perforating action;

FIGURE 9 is a fragmentary elevational view of the complete assembly showing the collector bag in section to reveal the sealing relationship between the parts.

Referring to the drawings, the air collector assembly essentially comprises a valve unit A, a mouthpiece tube assembly B mounted on the valve unit, and an air collection bag C. In use, all three components are assembled in the relationship illustrated in FIGURE 1.

The valve unit A comprises a pair of valve members 10 and 11 having flat opposing surfaces 12 and 13 in contiguous relation. The parts are joined for relative rotation about an axis normal to the plane of these contiguous surfaces by means of a connecting assembly 14 as shown in FIGURE 2.

The connecting assembly comprises a bolt or threaded stud 15, an adjustment nut 16, and a spring member 17. Bolt 15 extends through the aligned apertures 18 and 19 of valve members 10 and 11, and spring 17, which is interposed between the knurled adjustment nut 16 and the rear face of valve member 11, urges the opposing faces of the two valve members into snug sealing contact. When disassembly of the parts is desired, nut 16 is simply unthreaded from bolt 15, permitting separation of the major components 10 and 11 as illustrated in FIGURE 2.

Valve member 10 is preferably formed from a suitable molding plastic such as polystyrene or an acrylic resin and has a cylindrical shaped body portion 10a and an integrally formed depending handle portion 10b. Opening 18 extends along the axis of cylindrical portion 10a.

Valve member 11 is similarly formed of plastic material and also includes a cylindrical body portion 11a and radially extending handle 11b. In the illustration given, handle 11b is in the form of a stepped metal shaft having one end thereof cemented or otherwise anchored in a radial bore 20 provided in the valve member.

Mouthpiece B is composed of two parts: a metal tube 21 which is connected at one end to valve member 10 and which projects rearwardly therefrom, and a plastic sleeve 22 which is fitted over the free end of the metal breathing tube. Referring to FIGURES 2 and 3, it will be seen that the cylindrical body of valve member 10 is provided with a passage 23 extending longitudinally therethrough along a line spaced between the central axis of the body and the cylindrical periphery thereof. The rear end portion of the passage or bore is enlarged and tightly receives the forward end of breathing tube 21. While a tight frictional interfit between the parts is adequate to maintain them in operative relationship, the forward end of the breathing tube may, if desired, be cemented or otherwise permanently secured within the enlargement of the bore.

The rear end of the breathing tube is flattened slightly so that when viewed in transverse section it defines a horizontally extending ellipse. The mouthpiece sleeve 22 is composed of a deformable plastic material such as polyvinyl chloride and readily conforms to the shape of the tube's rear end portion when the sleeve is slipped in place (FIGURE 1). In use, the clear plastic sleeve projects rearwardly a short distance beyond the free end of the breathing tube. The sleeve thereby forms a protective

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covering for that portion of the breathing tube to be placed into a subject's mouth. After use of the air collecting device, the disposable plastic sleeve is simply removed and discarded and a new sleeve is slipped in place.

Cylindrical valve member 11 is provided with a passage 24 extending in an axial direction therethrough, the passage being disposed between the rotational axis of the member and the periphery thereof. As shown in FIGURE 3, passage 24 is in register with passage 23 of valve member 10 when the valve is in an open condition. As valve member 11 is rotated with respect to member 10, their respective passages 24 and 23 are moved out of alignment and opening 25 is brought into register with passage 23 (FIGURE 5). As shown most clearly in FIGURE 2, opening 25 extends in an axial direction through valve member 11 and is spaced circumferentially from flow passage 24. Opening 25 and passage 24 are of equal radial distances from the rotational axis of the valve member so that rotation of the valve member 11 over an arc of approximately 90 degrees will place either opening 25 or flow passage 24 in direct communication with passage 23 and mouthpiece B. To limit the extent of rotation of the valve member 11 with respect to valve member 10, the handle portion 10a is provided with a forwardly projecting stop pin 26 (FIGURES 4 and 5). When passage 24 communicates with the mouthpiece, the stop pin is engaged by handle 11b (FIGURE 4). A radially extending stop member 27 projects outwardly from the periphery of valve member 11 from a point spaced circumferentially approximately 90 degrees from handle 11b. Therefore, when the valve member 11 has been rotated approximately 90 degrees from the position illustrated in FIGURE 4, the radial stop member 27 engages pin 26 and prevents further rotation of the valve member 11 in the same direction. When stop pin 26 is engaged by member 27, the opening 25 of the valve member is in communication with mouthpiece B through the passage 23 of valve member 10. In this manner a gas to be re-breathed can be introduced in the bag, saved gas tight until re-breathed, then saved again until time is convenient for analysis.

A generally cylindrical probe tube 28 projects forwardly from valve member 11 and has its rear end portion received and secured within passage 24. As shown in FIGURE 3, the probe tube is provided with an axial opening 29 at its free end as well as with lateral openings 30. It will also be observed that the free end portion of the probe tube 28 is rounded to facilitate insertion of the probe into the opening of bag C.

Because of its length, handle 11b is the principal means for gripping valve member 11 and rotating it with respect to valve member 10. However, to the extent that stop member 27 projects radially from valve member 11, it may be used as an auxiliary or alternate handle for operating the valve.

Handle 11b functions not only as an operating lever but also as a fitting for coupling the valve to a spirometer or to some other device for analyzing the air collected in bag C. For this purpose, the stepped handle has a flow passage 31 extending axially therethrough and this passage communicates with passage 24 of the valve member 11 by means of radial bore 20. Thus, when the valve is adjusted into the position illustrated in FIGURES 3 and 4, both the probe 28 and the tubular handle 11b communicate with the mouthpiece B through passages 24 and 23 of the valve members. To facilitate connection of the tubular handle to a spirometer or other measuring device, the distal portion of the stepped handle is tapered slightly (FIGURE 3). This portion of the handle may therefore be readily inserted or plugged into the socket of the analytical device (not shown).

Bag C is formed from a polyester film and is completely sealed except for a single reinforced opening 32 in the side wall thereof. The polyester film, used because of its gas-impermeable properties, is relatively hard and

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nonstretchable. To reinforce opening 32 and to provide an effective means for sealingly attaching the bag to probe 28, I therefore laminate a patch 33 on the bag's surface. The patch is formed from a resilient and slightly elastic plastic material such as polyvinyl chloride and is provided with an opening 34 of a diameter slightly smaller than the outside diameter of probe 28. The patch is sealed to the bag by heat sealing or by suitable adhesives in the zone immediately adjacent the periphery of opening 34. As shown in FIGURE 9, the outermost portions of the patch remain unsealed to the bag and thereby define tab portions 33a.

Insertion of the probe 28 into the bag through opening 34 of the patch causes a stretching of the patch about the surface of the probe. In FIGURE 9 it will be seen that the patch stretches inwardly about the probe to define a tensioned collar 33b. It has been found that the formation of such a collar results in an effective air-tight seal between the bag and the inserted probe.

FIGURES 6-8 illustrate certain steps in the formation of the opening in bag C. As indicated by the sectioning of the bag, the bag may be formed as a segment of a continuous tube, each individual bag being cut from the tube and heat sealed along spaced heat-sealing zones 35 to form a completely imperforate bag structure. Thereafter, patch 33 with its preformed opening 34 is cemented or otherwise sealed to the outer surface of the bag. A tab portion 33a of the patch is then lifted either manually (as shown) or mechanically, the lifting action serving to separate opposite walls of the bag so that only one wall will be perforated by the flat spatula-like tool 36. The wall of the bag to which the tab is affixed is lifted into contact with the end of the tool, or the tool may be lowered into contact with the bag, or both, until the end of the tool bears against the unperforated wall of the bag within the opening 34 of the patch. Then, by continuing the downward movement of the tool and/or the upward movement of the bag's upper wall, the end of the tool tears the wall of the bag to form opening 32 and flap 37 (FIGURE 8). Since the film from which the bag is formed is thin (preferably 0.0005 of an inch in thickness), flap 37 is of no consequence and does not in any way interfere with the cooperative action of patch 33 and probe 28 when the bag and valve unit are connected together.

In operation of the air-collecting assembly, an operator first inserts probe 28 through opening 34 of the patch until the lateral apertures 30 of the probe are well within the bag. Valve member 11 is rotated into the position illustrated in FIGURE 5 so that mouthpiece B communicates with passage 25 which in turn communicates with the atmosphere. A subject, holding the apparatus by means of handle 10b, breathes several times through mouthpiece B until he becomes accustomed to the device and his breathing pattern reaches a normal level. Handle lever 11b is then swung clockwise (when viewed in FIGURE 4) to bring the mouthpiece into direct communication with probe 28 and bag C. The exhaled air flows directly into the bag and is collected therein. Since the passage of the probe 28 is substantially larger in cross sectional dimensions than that of handle-fitting 11b, and since no significant back pressure is exerted by the walls of the bag C, there is no significant leakage of air through handle 11b at the time the bag is being filled.

As soon as a sufficient quantity of air has been collected in the bag, valve member 11 is rotated in the position illustrated in FIGURE 5, thereby blocking the flow of gas between the mouthpiece and the bag. Handle-fitting 11b, which remains in constant communication with passage 24 and probe 28, is simply inserted into the socket of the gas analysis equipment (not shown) and the air collected in the bag is expelled through the handle by applying a slight pressure to the bag's side walls. The configuration of collar 33b permits substantial pressure with

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no significant leakage of air as its inward shape increasingly tightens in a check valve action.

After the air collected in the bag has been analyzed, the bag is disconnected from the probe and is discarded. Similarly, the plastic sleeve 22 is removed from mouth-
piece tube 21 and is also discarded.

Since the pressures involved in the operation of the apparatus are relatively low, and since the valve members 10 and 11 have large surface areas in mutual contact, there is no leakage of air between the flat opposing surfaces of such members. If desired, a small amount of a
lubricant may be smeared upon the opposing surfaces of the valve members to insure further against any possibility of leakage as well as to lubricate the parts for relative movement.

Interchangeability of the valve members is readily achieved because of the fact that the contacting surfaces of such parts are flat. Thus, valve member 10 may be operatively connected to a valve member 11 which is either a replacement part or which is taken from another valve assembly, without encountering problems of mis-matching and without danger that leakage will occur because of the substitution.

While in the foregoing I have disclosed an embodiment of the invention in considerable detail for purposes of illustration, it will be understood by those skilled in the art that many of these details may be varied without departing from the spirit and scope of the invention.

I claim:

1. An expired air collector comprising a valve unit having a generally cylindrical tubular probe projecting in one direction therefrom and having a mouthpiece extending in another direction and being mounted on said unit for communication with said probe, and a plastic air-collection bag having a patch of resilient plastic secured to a wall portion thereof, said patch on said wall portion of said bag having aligned openings therethrough, said probe extending through said openings and stretching the resilient plastic of said patch to form a tensioned plastic collar projecting inwardly into said bag about said probe, said collar forming a snug frictional air-tight seal with the outer surface of said probe, said patch being secured to said wall portion of said bag along a narrow zone extending about at the opening in said patch, said patch also having peripheral portions thereof unsecured to said bag.

2. A valve unit for an expired air collection assembly, comprising first and second valve members having flat faces in slidable sealing contact with each other, said members being relatively rotatable about an axis normal to said faces, said first valve member having a passage extending through to the face thereof and being adapted to communicate at its opposite end with a mouthpiece, and said second valve member having a passage extending through to the face thereof and being adapted to communicate at its opposite end with a tubular probe, said passages of said first and second valve members registering and communicating with each other when said members are rotated into a first position of adjustment and being out of register with each other when said members are in a second position of adjustment, spring means urging said first and second valve members into fluid-tight contact at the faces thereof, said spring means being adjustable to vary the tension thereof.

3. An expired air collector comprising a valve unit having a generally cylindrical tubular probe projecting in one direction therefrom and having a mouthpiece extending in another direction and being mounted on said unit for communication with said probe, and a plastic air-collection bag having a patch of resilient plastic secured to a wall portion thereof, said patch on said wall portion

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of said bag having aligned opening therethrough, said probe extending through said openings and stretching the resilient plastic of said patch to form a tensioned plastic collar projecting inwardly into said bag about said probe, said valve unit including a pair of valve members having flat faces in contiguous relation, said members being relatively rotatable about an axis normal to said faces, one of said members having a passage extending through to the face thereof and communicating with said mouthpiece, and the other of said members having passage communicating with said probe and being capable of registering with said first mentioned passage when said members have been rotated into one position of adjustment.

4. The structure of claim 3 in which said other valve member is provided with an opening communicating with the atmosphere and registering with the passage of said first-mentioned valve member when said members have been rotated into a second position of adjustment.

5. The structure of claim 3 in which spring means are provided for urging said valve members into fluid-tight contact at the faces thereof.

6. The structure of claim 5 in which said spring means is adjustable to vary the force of contact of said members.

7. A valve and mouthpiece combination for an expired air collection assembly, comprising a first valve member formed of plastic material and having a cylindrical body portion and a handle portion projecting radially therefrom, a second valve member formed of plastic material and being of generally cylindrical shape, said first and second valve members having flat opposing end faces in sealing but slidable surface engagement with each other, connecting means joining said valve members for relative rotation about an axis normal to said contacting faces, said valve members each having a flow passage extending therethrough along a line parallel with but spaced from said rotational axis, said flow passages being in communication with each other when said members are rotated into a first position of adjustment and being out of register with each other when said members have been rotated into a second position of adjustment, a mouthpiece tube secured to one of said valve members and communicating with the flow passage thereof, and a probe tube secured to the other of said valve members and communicating with the flow passage thereof.

8. The structure of claim 7 in which said other of said valve members is also provided with a radially-extending tubular fitting communicating with the flow passage thereof, said fitting being tapered for insertion into the socket of a suitable gas analyzing device.

9. The structure of claim 8 in which said tubular fitting provides a handle for rotation of said other valve member with respect to said one valve member.

10. The structure of claim 7 in which said other of said valve members is provided with a second flow passage extending through to the face thereof and communicating at its opposite end with the atmosphere, said second flow passage registering with the passage of said one member when said members have been rotated into said second position of adjustment.

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