

[54] CARBON DIOXIDE ABSORBER
APPARATUS[76] Inventor: **Casimer M. Guzay**, 7705 Peterson
Ave., Chicago, Ill. 60631[22] Filed: **July 23, 1969**[21] Appl. No.: **843,947**[52] U.S. Cl. **23/284, 23/252 R, 128/191 R**[51] Int. Cl. **B01d 15/00**[58] Field of Search 128/191, 188, 203, 142.6,
128/142, 142.2, 142.3, 142.4, 145-145.6,
145.7, 145.8, 146.6, 146.7; 55/267, 316,
387, 482, 496; 137/533, 533.19, 559;
23/252, 288, 284; 209/315-319

[56]

References Cited**UNITED STATES PATENTS**

2,325,657	8/1943	Burkness.....	55/316 X
2,586,670	2/1952	Lambertsen	55/387
2,614,561	10/1952	Fox	128/191 R
2,837,413	6/1958	Hay.....	23/252
2,848,309	8/1958	Hay.....	23/284
2,951,551	9/1960	West.....	55/316
3,088,810	5/1963	Hay.....	23/252

3,367,498 2/1968 Tonjes et al. 209/319

Primary Examiner—Richard A. Gaudet

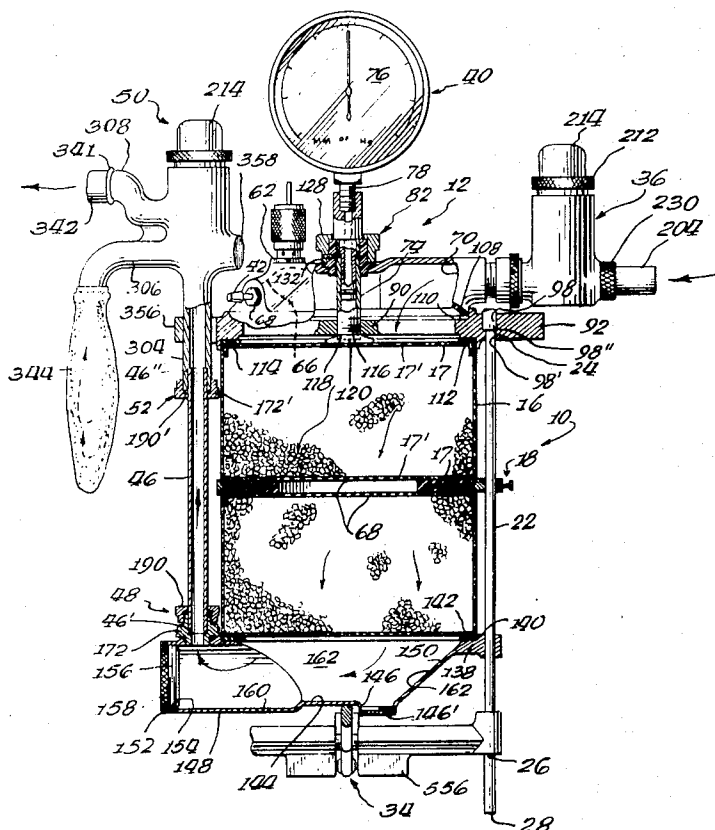
Assistant Examiner—Henry J. Recla

Attorney, Agent, or Firm—Silverman and Cass

[57]

ABSTRACT

A carbon dioxide absorber apparatus for use in the administration of anesthesia to enable respiratory gases from a patient undergoing surgical procedures to be cleared of carbon dioxide and returned to the patient, said absorber utilizing disposable absorbent cartridges and being capable of quick assembly and disassembly into component parts all capable of being sterilized in an autoclave apparatus, the absorber apparatus also being characterized by inlet and outlet valve means of novel construction and by the provision of minimal length passageways and channels throughout for directing gas flow, all being accessible and capable of being easily cleared of residue. Novel quick coupling means are provided to aid in the assembly and disassembly of the absorber as well as partial disassembly to remove and replace absorbent cartridges.

9 Claims, 17 Drawing Figures

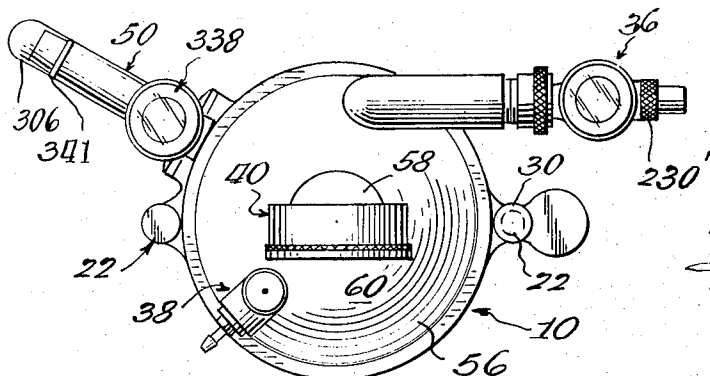


Fig. 2

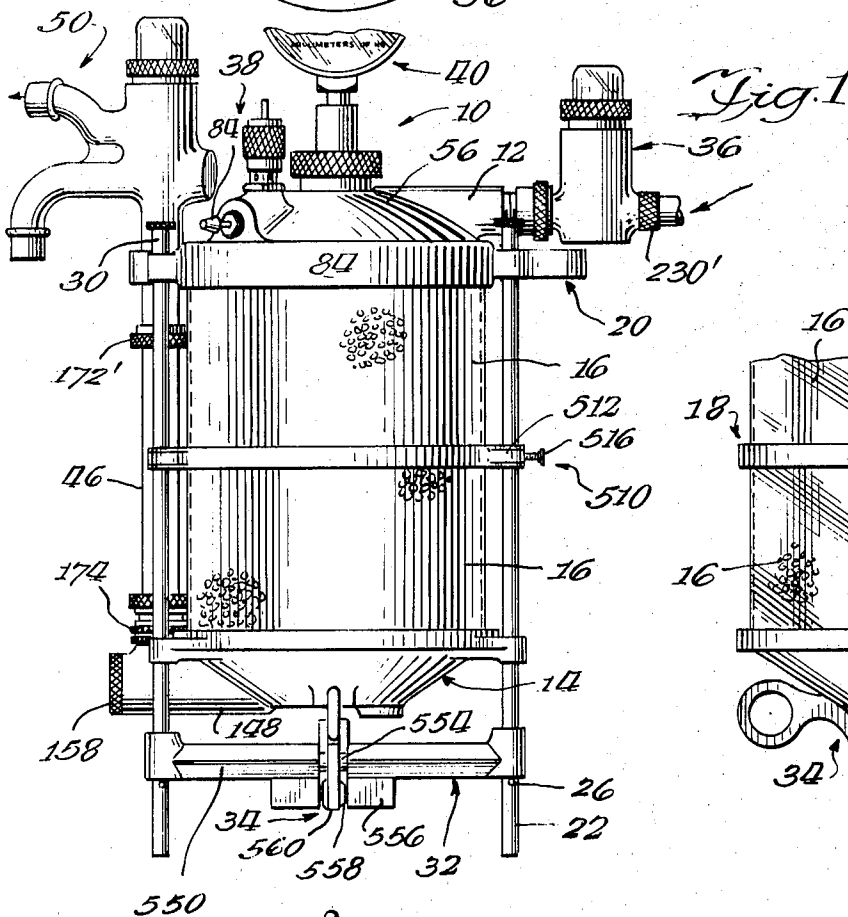


Fig. 1

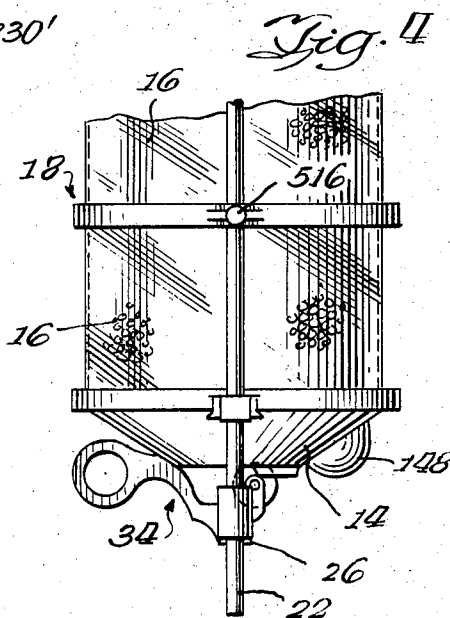


Fig. 4

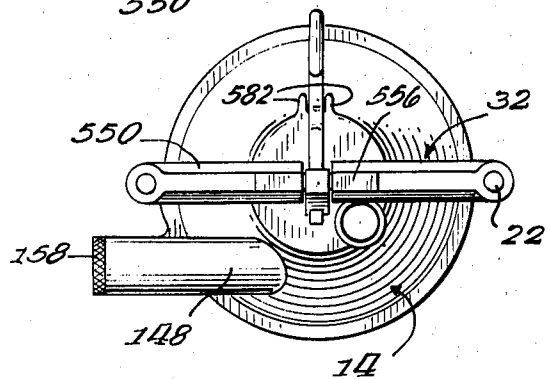
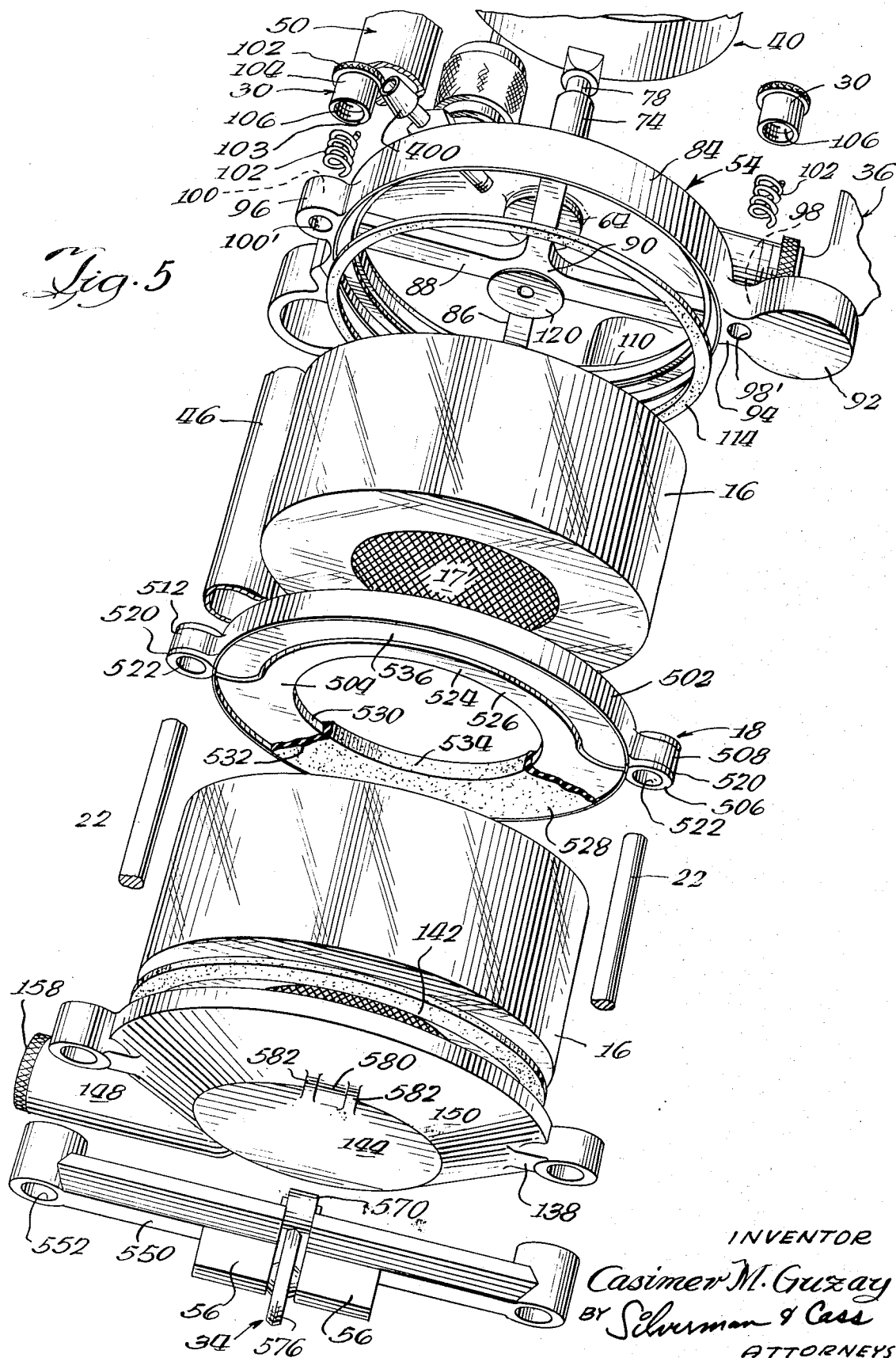


Fig. 3

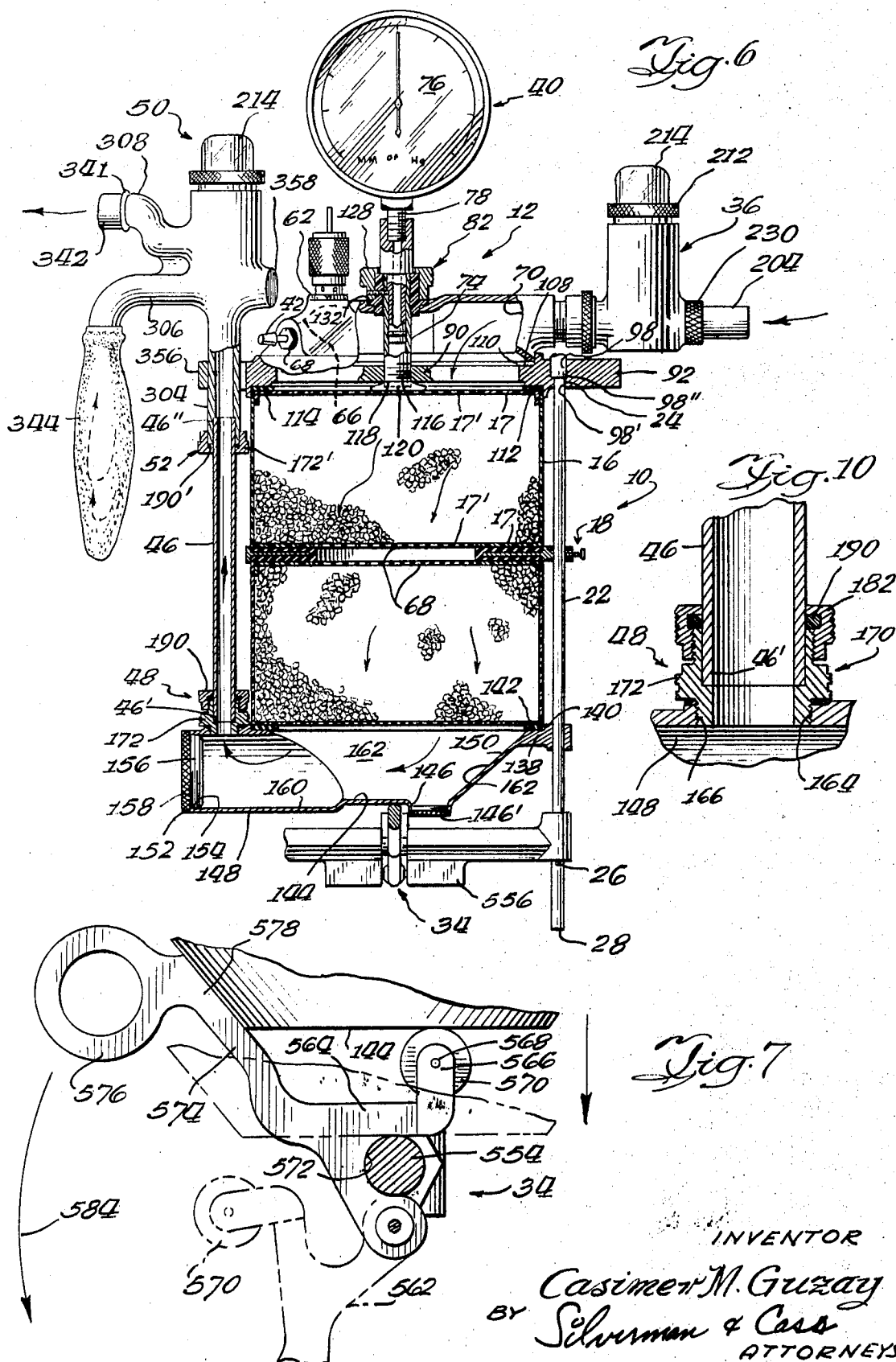
INVENTOR
Casimer M. Guzay
 BY *Silverman & Case*
 ATTORNEYS

Fig. 5



INVENTOR

Casimer M. Guzey
BY *Silverman & Case*
ATTORNEYS



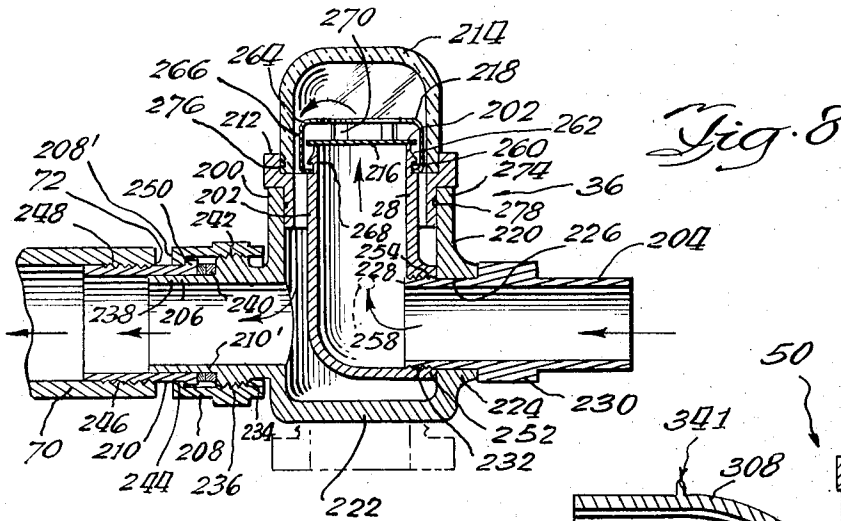


Fig. 9

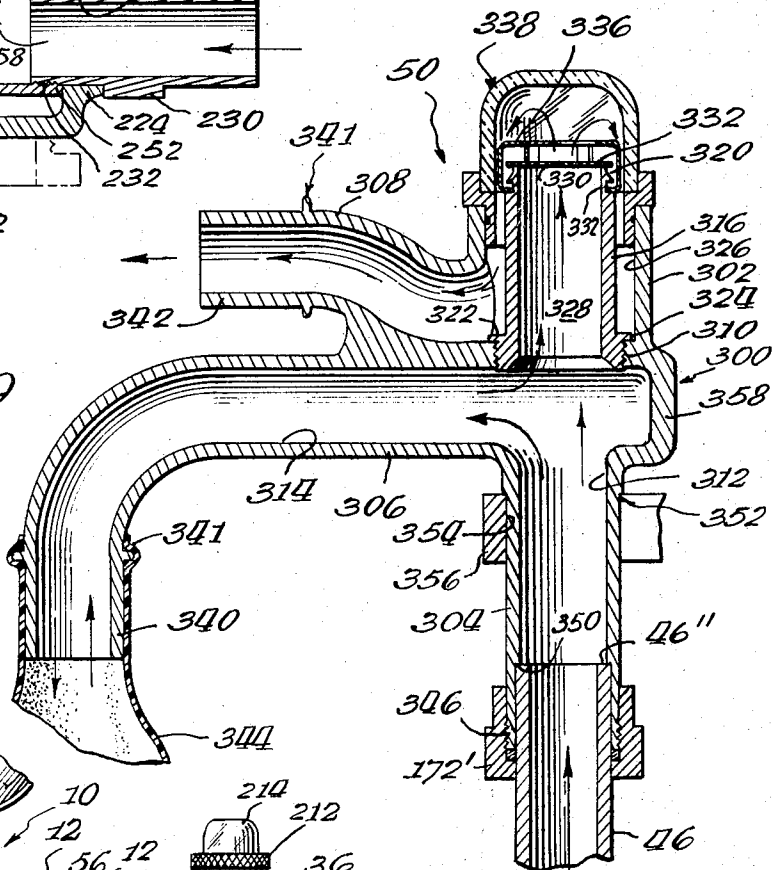


Fig. 12

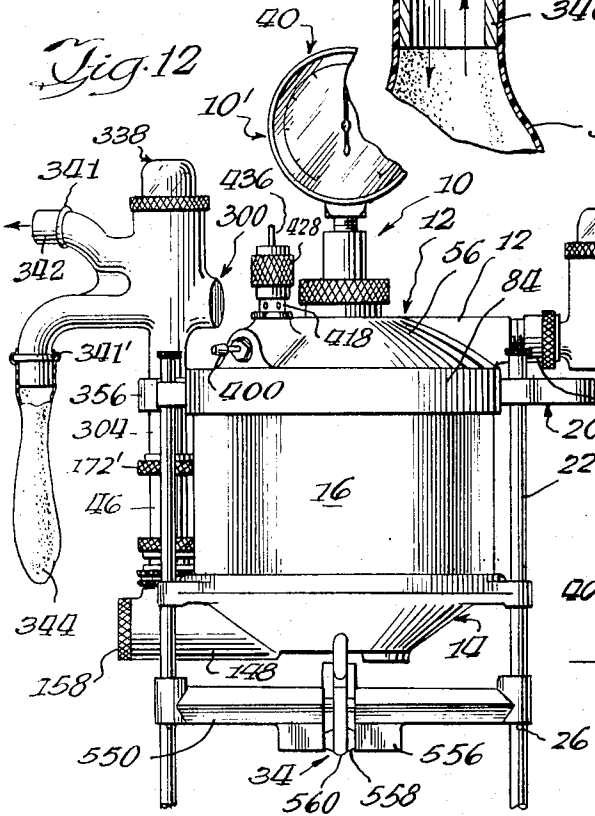
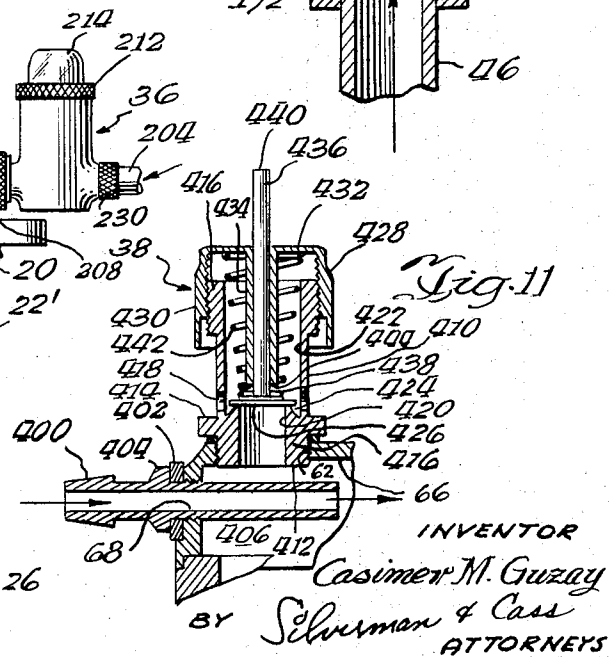
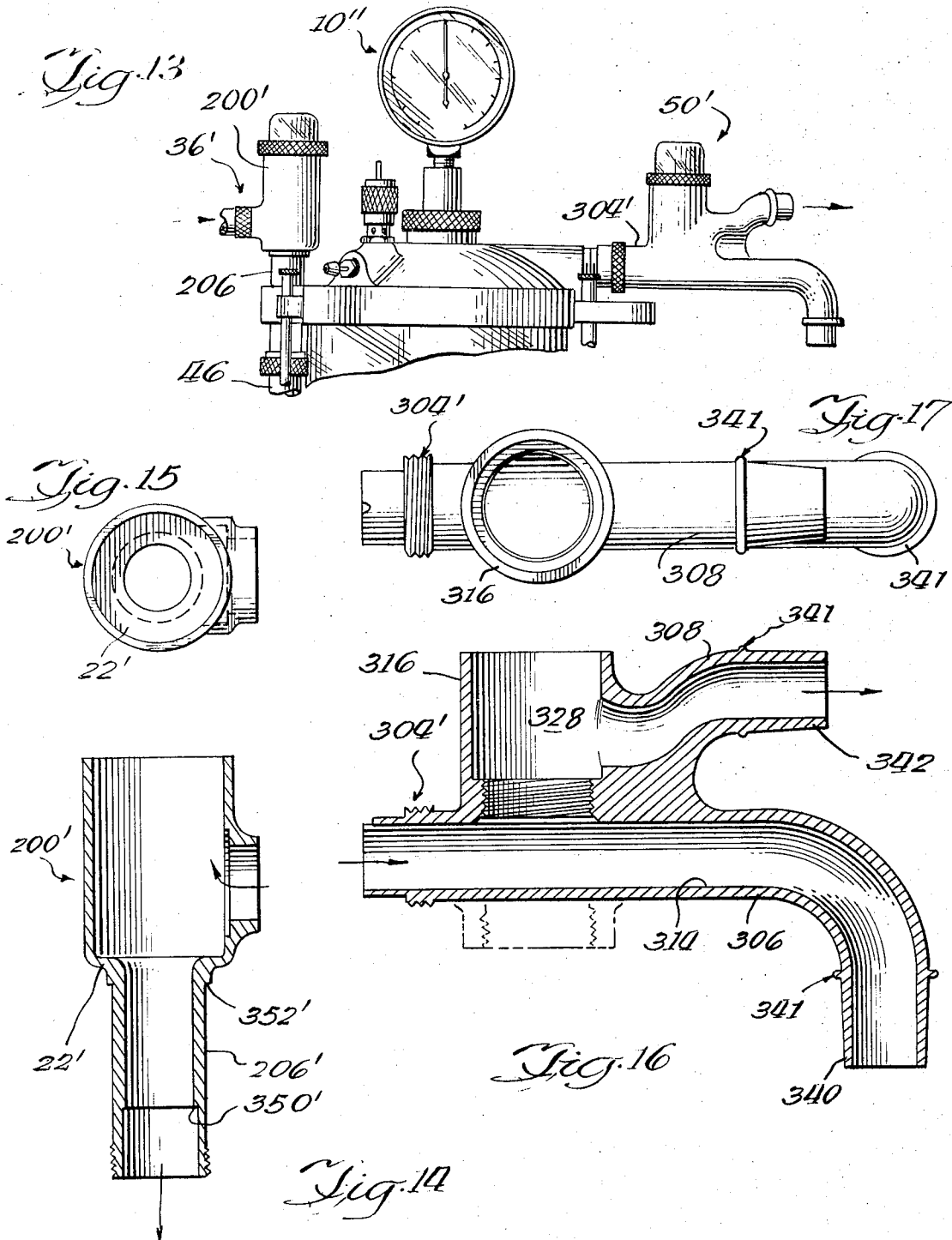


Fig. 11



INVENTOR
Casimir M. Guryay
BY Selberman & Cass
ATTORNEYS



INVENTOR

Casimer M. Guzey

BY *Schuman & Carr*

ATTORNEYS

CARBON DIOXIDE ABSORBER APPARATUS

FIELD OF THE INVENTION

This invention relates generally to apparatus utilized to remove carbon dioxide from respiratory gases in the course of procedures utilizing the administration of anesthesia, and more particularly, concerns the provision of a carbon dioxide absorber apparatus capable of being disassembled and sterilized in its entirety utilizing conventional hospital sterilization procedures such as disposition in an autoclave apparatus.

BACKGROUND OF THE INVENTION

The type of apparatus concerned herein is utilized for absorbing carbon dioxide from respiratory gases containing an anesthetic vapor administered to patients undergoing anesthesia. Use of this apparatus permits the maintenance of a desired level of a specific concentration of the anesthetic gas used and normally exhaled, to remain within the circuit of the apparatus, the respiration and the blood stream of the patient, hence its use is generally as a so-called "closed circuit" absorber.

Prior devices of this type generally require plural ducting and piping, often crude convoluted, which cannot be satisfactorily cleaned and sterilized. Over a period of time, substantial accumulation of residue or deposit material occurs rendering the absorber useless. In some absorber structures, some separable component parts are provided but the interior passageways still are of a configuration incapable of being completely cleared of residue for sterilization. In fact, so far as applicant is aware, no absorber apparatus prior to the herein disclosed invention, was capable of being demounted and sterilized in its entirety, excepting the disposable absorbent containing canisters. None were capable of sterilization in an autoclave apparatus, primarily due to the nature and arrangement of the interior passageways.

In addition to the presence of tubes, convolutions, and other internal intricacies which prevented autoclave method sterilization, prior absorber devices were generally crude functional structures difficult to assemble and disassemble, not versatile or adaptable to multiple demand usage, say use of the same structure for administration of anesthetic gases to adult and to child patients. Another disadvantage of prior absorber structures known to the art concerned the presence of pipes, tubes, passageways or chambers closed to visual inspection so that the user could not immediately ascertain the presence or absence of accumulant such as residue, deposit, etc.

Other difficulties encountered with prior absorber structures include the absence of directivity in gas flow control so that much unwanted diffusion occurs in the passage of gas from the absorber head to the absorbent containing canisters, for example, and return. Also, much metal interior surface area was encountered, encouraging disadvantageous and unwanted condensation of liquid from the respiratory gases, in turn resulting in contamination and reduction of the effectiveness of the absorbent. Obviously, the absorbent should be maintained at maximum effectiveness throughout the procedure.

Accordingly, the primary object of this invention is to provide, for what is believed the first time, a carbon dioxide absorber apparatus for the function concerned which eliminates the aforementioned disadvantages

and is capable of being disassembled to component parts sterilizable in their entirety utilizing conventional autoclave apparatus.

Another object of this invention is to provide a carbon dioxide absorber apparatus capable of being assembled from a plurality of sterilizable separable component parts, all channels and passageways of said absorber apparatus being easily accessible for cleaning utilizing conventional methods.

A still other object of this invention is to provide carbon dioxide absorber apparatus which includes an absorber head formed of a pair of components each fabricated as a unitary casting, said head including mounting structure for internal pressure indicating means, relief valve means, means for introducing oxygen for enrichment of the respiratory gases and valve means for conducting the respiratory gases from the patient into the absorber.

A still other object of this invention is to provide absorber apparatus which includes an absorber head and an absorber base each removably mounted on a vertical support structure with canisters containing absorbent removably mounted therebetween; valve means removably coupled to the absorber head for introducing, into the absorber apparatus, respiratory gases received from the patient; and means removably mounted on and communicating with the base for directing flow of carbon dioxide-free gases to the patient wherein both said valve means are characterized by demountable airways and accessible interior ducts and channels whereby to permit conventional sterilization procedures to be followed.

A further object of the invention is to provide quick-coupling means for said absorber apparatus wherein the absorbent containing canisters can be removed and replaced without complete disassembly of the apparatus.

Other objects and advantages of the absorber apparatus according to the invention will become evident to one skilled in the art as a description of a preferred embodiment thereof is set forth hereinafter with reference to the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of the carbon dioxide absorber apparatus according to the invention shown in its fully assembled condition;

FIG. 2 is a top view of the absorber apparatus illustrated in FIG. 1;

FIG. 3 is a bottom view of the absorber apparatus illustrated in FIG. 1;

FIG. 4 is a fragmentary elevational view of the absorber apparatus illustrated in FIG. 1 but shown herein positioned rotated about 90° from the position shown in FIG. 1;

FIG. 5 is an enlarged fragmentary exploded perspective view of the absorber apparatus illustrated in FIG. 1, portions of which are shown in section;

FIG. 6 is a slightly enlarged elevational view of the absorber apparatus illustrated in FIG. 1, portions of which being removed and other portions being shown in section to illustrate interior details;

FIG. 7 is an enlarged detail of the coupling means of the absorber apparatus illustrated in FIGS. 1 through 6 inclusive;

FIG. 8 is an enlarged sectional detail of the inlet or exhalation valve means utilized in the absorber apparatus illustrated in FIGS. 1 through 6;

FIG. 9 is an enlarged sectional detail of the outlet or inhalation valve means utilized in the absorber apparatus illustrated in FIGS. 1 through 6;

FIG. 10 is a fragmentary detail of the means for coupling the airway conduit to the absorber base;

FIG. 11 is an enlarged sectional detail of the means provided by the invention for introduction of oxygen for enrichment of the respiratory gases in the absorber head and the relief valve means provided by the invention;

FIG. 12 is an elevational view of the absorber apparatus illustrated in FIG. 1 modified for use with a single absorbent canister, say for administration of anesthesia to an infant patient;

FIG. 13 is a fragmentary elevational view of a modified embodiment of the invention;

FIG. 14 is an elevational view of a modified housing for the exhalation valve means utilized in the embodiment of FIG. 13, portions thereof being shown in section;

FIG. 15 is a top plan view of the valve housing of FIG. 14;

FIG. 16 is an elevational view of a modified housing for the inhalation valve means utilized in the embodiment of FIG. 13, portions thereof being shown in section; and

FIG. 17 is a top plan view of the valve housing of FIG. 16.

DESCRIPTION OF A PREFERRED EMBODIMENT

A carbon dioxide absorber apparatus, according to the invention as designated generally by reference character 10 in FIG. 1 and includes an absorber head 12 at the upper end thereof and an absorber base 14 at the lower end thereof. A pair of transparent canisters 16, each having top and bottom walls 17 carrying center screen portions 17', arranged in a vertical series between the head 12 and the base 14, separated by intermediate axial support means 18. The head 12, intermediate support means 18 and the base 14 are mounted for limited vertical movement upon vertical support means designated generally at 20 and comprising a pair of elongate rods 22, each having a threaded upper end 24 and stop means in the form of an outwardly extending pin 26, spaced from the lower end 28 thereof. Locking caps 30 are provided to engage the upper ends 24.

The carbon-dioxide absorber apparatus 10 may be carried by a conventional anesthetic gas machine (not shown) by attachment of the vertical support means 20 to clamping means (not shown) conventionally provided on many of the conventional machines available for administration of anesthetic gases. Brace means 32 also is provided mounted to the rods 22 for slidable vertical movement therealong, between the base 14 and pins 26. The head 12, intermediate support means 18, base 14 and brace means 32 are mounted on the rods and the locking caps 30 applied.

Inlet or exhalation valve means 36, relief valve means 38 and pressure indicating means 40 are mounted upon the absorber head 12. In addition, nipped conduit means 42 is carried by the absorber head 12 to permit introduction of oxygen gas to the respiratory gases for

enrichment thereof as they pass through the absorber apparatus 10.

Absorber base 14 includes drain means 44 and is coupled to one end 46' of an airway tube 46 by coupling means 48. The airway tube 46 is coupled to the outlet or inhalation valve means 50 at its opposite, upper end 46'' by coupling means 52. The outlet or inhalation valve means 50 is supported adjacent to the absorber head 12 by clamping means (to be described hereinafter) which is secured removably to said absorber head 12. As illustrated, the inhalation valve means 50 communicates only with the absorber base through airway 46 and does not communicate with the interior of the head 12. Means 36 and 50 hereinafter may be referred to as gas fixture means.

The absorber head 12 comprises a frame 54 and a head cover 56, each formed as a unitary casting. The head cover 56 is of hollow, dish-shaped configuration having a top wall 58, a generally tapered annular wall 60 terminating in an annular lip formation 61. A center opening 64 is formed in the top wall 58. An oxygen entry duct formation 66 is formed as a part of annular wall 60 and carries a top-opening port 62 offset from said center opening 64. A side opening 68 also is formed in said duct formation 66. An inlet duct formation 70 is formed in the annular wall 60 spaced at least 180° from the formation 66 and extends tangentially relative to the annular lip formation 61. Formation 70 has a side opening port 72 and the interior of said formation 70 opens at its inner end substantially tangentially relative to the cover 56. The center opening 64 is of a size and configuration to accommodate hollow stem 74 therethrough. The depending stem 78 of pressure indicating means 40, here in the form of manometer 76, is received within the hollow stem 74 to place the manometer 76 operatively in communication with the interior of the absorber apparatus 10. A head bushing 82 also is mounted upon said stem 74 coupling the cover 56 to the frame 54.

The frame 54 comprises an annular ring 84 having symmetrically arranged diametric spokes 86 and 88 intersecting through a center portion 90. The ring 84 is formed with an outwardly disposed, circular flange 92, linked thereto by bridge 94. A smaller, outwardly extending flange 96 is arranged diametrically opposite thereof and unitary with said ring 84. A top opening socket 98 is formed in bridge 94 and a similar top opening socket 100 is formed in flange 96. Sockets 98 and 100 open upwardly and have an inner diameter slightly larger than the outer diameter of locking caps 30 so as to receive same therein. Openings 98' and 100' are formed in the floor 98' and 100' of said sockets respectively. The diameters of such openings 98' and 100' are selected to accommodate passage of the rods 22 therethrough while the seats 98'' and equivalent seat coil springs 102. Coil springs 102 are disposed in the sockets 98 and 100 surrounding the respective upper ends 24 of rods 22 when the latter are positioned within said sockets.

Each locking cap 30 is of cuplike configuration having a thin wall lower rim 103, an outer rim 104 and a threaded inner wall portion 106 arranged to engage the threaded upper ends 24 of rods 22. When the caps 30 are engaged with the rod ends 24 by rotation against the spring bias of springs 102 in each of the sockets 98 and 100, some degree of movement of the resulting assembly is permitted in each instance against the bias of

the respective spring 102. This is important when the quick coupling means 34 (described later) is considered. As shown, each of the locking nuts 30 carry an annular knurled surface 105 functioning as means to effect a manipulative purchase on said caps.

The annular ring 84 has an upper annular gallery 108 to seat a flat ring gasket 110, sometimes descriptively referred to as the "cover to frame" gasket. The lip formation 61 of cover 56 is seated on said gasket 110 within said gallery 108 on assembly of cover 56 to frame 54. The annular ring 84 also has a lower annular gallery 112 in which is seated another similar flat ring gasket 114 sometimes referred to as the "frame to canister" gasket. At final assembly of apparatus 10, the frame 54 is seated upon the upper one of canisters 16 in a sealed connection effected by said gasket 114.

A hollow, open-ended stem 74 is passed through center opening 116 formed in center portion 90 of frame 54. The stem 74 has a bottom enlarged rim 118 over which is disposed a flexible diaphragm such as balloon 120 closing off that end of stem 74. The upper end 122 of stem 74 carries threads 123 and passes through center opening 64 of cover 56. The center opening 64 of cover 56 has an enlarged diameter entrance 124 to define an annular gallery 126. The head bushing 82 has a knurled rim 128 and an axial threaded passage 130 to be engaged upon the threaded upper end 122 of stem 74 and thus mount the cover 56 to frame 54.

The elongate hollow stem 78 of manometer 76 has an annular groove 134 in which is mounted O-ring 136. Said stem 78 is received within the stem 74 is a slidable, sealed friction fit. The enlarged upper portion 80 of stem 78 seats in the gallery 126.

The apparatus 10 is grounded to prevent accumulation of static electrical charges thereon. Preferably, grounding is accomplished in apparatus 10 by providing a metal contact between the stem 74 and the head bushing 82, particularly, where the interior of the bushing 82 includes a threaded insert 132 made of insulating material such as tetrafluoroethylene to facilitate engagement of the bushing 82 and stem 74. As will be seen, all other joints are gasketed with resilient gaskets formed of electrical insulating material for effecting airtight seals. Therefore, this is the basis for grounding at this location.

As stated above, cover 56 and frame 54 coupled together comprise the absorber head 12 and each are formed as unitary castings. However, absorber base 14 is formed also as a single unitary casting. The base 14 is of dish-shaped configuration terminating in an annular rim 138 and is arranged opening toward the head 12. An upper annular gallery 140 is defined by the rim 138, said gallery functioning to seat a flat ring gasket 142, sometimes referred to as the "canister to base" gasket. The floor 144 of the base 14 has a circular configuration and is provided with a passage 146 into which a plug 146' is introduced, preferably threadably engaged therein. Passage 146 and plug 146' comprise drain means 44 described earlier enabling moisture accumulations in the base to be removed without disassembly of apparatus 10. These accumulations often occur upon saturation, with moisture, of the absorbent contained in the canisters 16 during use of the apparatus 10.

The base 14 includes, as a unitary portion thereof, a conduit formation 148 opening to the interior of the base 14 through the tapered wall 150 thereof and ex-

tending horizontally outwardly therefrom. The axis of conduit formation 148 is substantially parallel to the plane of floor 144 of base 14. The outer end 152 of conduit formation 148 carries interior threads 154 to receive plug 156 engaged therein, plug 156 having a knurled rim 158 to enable easy purchase in handling.

The duct 160 defined interior of conduit formation 148 opens into interior chamber 162 of base 14. Port 164 is provided in the conduit formation 148 closely adjacent the end 152 thereof. The axis of port 164 is normal to the axis of conduit formation 148. The interior port or mouth 166 defining port 164 threaded to receive the lower threaded portion 168 of adapter coupling 170, comprising one component of coupling means 48. The adapter coupling 170 is provided with an enlarged median ring 172 having a knurled outer surface 174 for effecting good manipulating purchase thereof. The upper portion 176 of adapter 170 carries outer threads 178 to engage the inner threads 180 of ring 182, comprising the other component of coupling means 48. The adapter 170 has an enlarged diameter socket 184 extending laterally the length of the upper portion 176. The ring 172 is provided with an inner groove 188 to hold a ring gasket 190 of diameter slightly less than the diameter of socket 184. The inner diameter of said socket 184 is selected only slightly larger than the outer diameter of the airway tube 46.

Accordingly, with the gasket 190 seated in groove 188, the ring 172 and airway tube 46 sealingly are coupled. The upper portion 176 of adapter 170 is disposed between the tube 46 and the inner threaded surface 180, with the end 46' of tube 46 seated on the floor 192 of socket 184. The ends 46' and 46'' preferably are beveled to facilitate entry of end 46' past gasket 190 of ring 172 and entry of end 46'' past similar gasket 190' of ring 172'. Ring 172' is one component of the coupling means 52 and is identical in structure with ring 172.

Attention now is directed to the various valve means utilized as a part of absorber apparatus 10, and in particular, the gas fixture means of the invention. In FIG. 8 there is illustrated a detailed representation of the inlet gas fixture means, as will be referred to hereinafter, the exhalation valve means 36. The term "exhalation" as used herein describes the carbon dioxide containing respiratory gases expelled from the patient. The exhalation valve means 36 is coupled to the absorber head 12 and serves as the entry port for carbon dioxide containing exhalent from the patient to the absorber apparatus 10.

Exhalation valve means 36 is formed of a plurality of separable component parts coupled one to the other to form, what heretofore was always a unitary structure. The said component parts include a cuplike housing 200, an interior airway conduit 202 removably seated within the housing, an entry conduit 204 removably coupled through the housing and to the airway duct 202, an outlet conduit 206 unitary with the housing, a pair of coupling sleeves 208 and 210 for connecting the outlet conduit 206 to the duct formation 70 at the port 72 thereof, a coupling ring 212, a viewing bubble 214 and a valve disc 216 retained within retainer basket 218.

The housing 200 is of substantially cylindrical cup-shaped configuration, having an annular wall 220 and a base 222. A thickened portion 224 is provided in the

annular wall 220 spaced slightly from the base 222. The portion 224 carries a smooth wall bore 226 to receive one end 228 of entry conduit 204 therethrough. The entry conduit 204 has an enlarged diameter portion 230 limiting insertion of said conduit into the bore 226. Portion 230 has an outer knurled circumferential surface 230' enabling better manipulative purchase. The end 228 of entry conduit 204 carries threads 232 and is arranged to be coupled to the airway 202 interior of the housing 200 as will be explained.

Outlet conduit 206 extends from the housing 200 unitary therewith and diametrically opposite to the position of bore 226 and coaxial therewith. The outlet conduit 206 is provided with a unitary annular flange 234 spaced from the wall 220, said flange 234 carrying annular threads 236 on the outer circumferential surface thereof. The remaining, narrow diameter portion 238 of conduit 206 has a smooth outer surface. A pair of ring gaskets 240 is mounted frictionally upon said portion 238. The inner wall of sleeve 208 carries threads 242 engagable with the threads 236. An annular inwardly directed flange 244 is provided at opposite end 208' of the sleeve 208. Sleeves 210 carry outer threads 246 for engagement with inner threads 248 provided at port 72 at duct formation 70. The sleeve 210 is provided with an outer annular flange 250 at end 210' thereof.

The airway 202 is of hollow, L-shaped tubular configuration having its outer diameter less than the inner diameter of the housing 200. The short leg 252 of airway 202 carries inner threads 254 for coupling end 228 of entry conduit 204 thereto. The long leg 256 of airway 202 is provided with a pair of diametrically opposed centering protrusions 258 disposed approximately 90° from the axis of conduit 206. The upper end 259 of airway 202 carries an annular groove 260 spaced therefrom and terminates in the tapered lip 262. Groove 260 serves to seat the retainer basket 218 while the valve disc 216 rests upon the lip 262 covering the airway.

The basket 218 comprises a flat annular ring 264 having legs 266 depending therefrom. Legs 266 are each provided with radially inwardly bent portions 268 which are seated in groove 260 positioning the ring 264 spaced from the lip 262. The legs are sufficiently resilient to enable their temporary bending while engaging the bent portions 268 in groove 260. Several radially inward but downwardly slanted portions 270 are provided along the inner edge of ring 264 and function to limit the travel of the valve disc 216.

A coupling ring bushing 212 is fitted frictionally within the upper end 274 of housing 200 and has an upwardly opening seat 276 for receiving in a frictional engagement the inverted cup-shaped bubble 214. An O-ring 278 is provided seated in the inner circumference of the bushing 272 to assure a sealed connection between said bushing and the housing 200.

The exhalation valve means 36 is assembled by first introducing airway 202 into housing 200. The airway 202 then is centered within the housing and arranged so that the leg 252 is coaxial with the bore 226 of the housing. The end 228 of conduit 204 then is introduced through said bore 226 and the threads 232 and 254 interengage until the end of leg 252 engages the inner surface of wall 220 of the housing 200. Now the airway is arranged concentric within the housing 200.

The sleeve 210 is engaged through the sleeve 208 with flanges 244 and 250 abutting one another. The

sleeve 210 then is engaged threadably with threaded portion 248 at port 72 of cover 56. The gaskets 240 are engaged upon the portion 238 of conduit 206 and the said portion 238 is introduced telescopically to engage the sleeve 210. The engagement of threads 236 and 246 then is effected. The sleeve 208 is tightened to establish the necessary tight coupling. The basket 218 is coupled to the airway 202 with the disc 216 resting upon the lip 262 thereof. The coupling ring bushing 272 and bubble 214 are engaged frictionally whereupon said assembly is engaged frictionally within the housing 200. The assembly of said exhalation valve means 36 takes but a few minutes, each of the components thereof being easily cleaned and autoclavable.

The outlet gas fixture means or, as will be referred to hereinafter, the inhalation valve means 50 is represented in detail in FIG. 9. The term "inhalation gases" as used herein comprise the carbon dioxide free respiratory gases subsequent to the passage of the carbon dioxide exhalant gases through the absorbent-filled canisters 16 and returned to the patient for inhalation. The inhalation valve means 50 receives the inhalation gases from the absorber base 14 by way of airway tube 46.

The inhalation valve means 50 includes a housing designated generally by reference character 300. Housing 300 is formed as a unitary casting having an upper, valve housing, portion 302, a depending entry pipe 304, a by-pass pipe 306 communicating with the entry pipe 304 at the upper end thereof and an outlet pipe 308 disposed above, generally aligned with and substantially parallel to, the by-pass pipe 306.

The valve housing 302 is of cylindrical configuration open at both upper and lower ends and is provided with an interior annular flange 310 setting off same from the interior of the entry channel 312 and from the by-pass channel 314 defined within hollow pipes 304 and 306 respectively. A hollow tubular airway stem 316 is removably engaged within the valve housing 302. The stem 316 has a threaded end 318 and a grooved opposite end 320. When disposed within the valve housing portion 302, end 320 is threadably engaged with flange 310. The stem 316 also carries an outwardly extending annular flange 322 for seating upon the shoulder 324 defined by annular flange 310 when the threaded engagement of stem and flange is effected to its completeness.

An outer chamber 326 and an inner chamber 328 is defined upon the engagement of stem 316 within the portion 302 of housing 300. Communication between outer and inner chambers 326 and 328 normally is blocked by valve disc 330 seated upon tapered end rim 332 formed on opposite end 320 of stem 316. An annular groove 334 similar to groove 260 is formed in said stem end 320 spaced from the mouth of chamber 328 by the rim 332. A retainer basket 336 similar to basket 218 is coupled to the upper stem end 320 with the valve disc 330 being movable therebetween. Passage of gases through chamber 328 is one way with back-flowing being prevented by disc 330. The bubble and coupling assembly 338 disposed in the upper end of valve housing portion 302 is identical to that described in connection with the exhalation valve means 36 and, in fact, is interchangeable therewith. The by-pass pipe 306 is L-shaped and terminates in a free end portion 340. Both pipes 306 and 308 carry annular exterior hose coupling rib means 341 spaced from their free end portions 340

and 342 respectively. A well-known reservoir bag 344 is mounted over the free end 342 and a hose (not shown) is arranged to be coupled to end 340 of pipe 306 for leading the carbon dioxide free gases to the patient.

The lower end of entry pipe 304 is provided with outer circumferential threads 346 and has a wider diameter inner-mouth portion 348 defining annular shoulder 350 interior of the pipe 304. The upper end 46" of airway tube 46 is seated upon shoulder 350. A second shoulder 352 is defined on the circumferential upper end of the entry pipe so that when same is passed through the passage 354 defined by mounting U-clamp bracket 356 to the annular ring 84 of absorber head 12, the shoulder 352 serves to support the housing 300 adjacent the head 12. Housing 300 may be provided with a circular unitary boss formation 358 as a part thereof and located substantially axially aligned with the bypass pipe 306. A threaded port (not shown) can be formed in said formation 358 and an access plug can be inserted therein (also not shown).

Assembly of the inhalation valve means 50 simply involves the threaded engagement of the stem 316 within the housing 300 and the coupling of basket 336 to valve stem 316 with subsequent coupling of the bubble and coupling assembly 338 to housing 300. No interior convoluted or long passageways herein are present to deny easy access thereto, nor are there inaccessible abutments or protrusions therewithin to encourage depositions or accumulation of residue or debris which cannot be easily removed. All components of said inhalation valve means are easily disassembled and cleaned and sterilized utilizing conventional sterilization methods such as autoclaving.

It is conventional in devices of this type to provide means for enrichment of the respiratory gases with fresh oxygen in controlled amounts. Likewise, relief valve means ordinarily should be provided. The invention makes accommodation thereof by provision of means to introduce oxygen into the absorber head 12 and by providing relief valve means 38; both illustrated in detail in FIG. 10.

Referring to FIG. 11, a nipple ended conduit 400 threadably is engaged through side opening 68 formed in duct formation 66 of cover 56, said conduit 400 mounting gasket 402. Annular flange 404 may be provided with a hexagonal or similar outer circumferential configuration to enable facile manipulation to effect assembly and disassembly thereof from the cover 56. The duct formation 66 defines an interior cavity 406, the side and upper walls thereof carrying the opening 68 and port 62 mentioned earlier. The cavity 406 communicates directly with the interior chamber 408 of the absorber head 12 and hence the oxygen introduced through conduit 400 from a source (not shown) thereof is mixed with the respiratory gases entering the interior chamber from the channel defined by formation 70.

Relief valve means 38 comprises a hollow stem 410 having an outwardly threaded end 412 and a hexagonal or like configured flange 414 spaced from said end 412. The stem 410 terminates in an enlarged diameter threaded end 416 and carries a plurality of side openings 418 between said end 416 and the flange 414, and closely adjacent the last mentioned flange 414. The end 416 is thickened and a bore 420 is formed therethrough opening into an open-mouth deep socket 422 formed with the remainder of the stem 410. A tapered lip 424

surrounds the opening of bore 420 and a valve disc 426 is seated on said lip 424 over the mouth of said bore 420 normally closing off same.

An interior threaded cap 428 is arranged to close off the socket 422 by engagement with the end 416 of the stem. The cap 428 has an annular depending wall 430 which is internally threaded, and a centrally perforate top wall 432 from which hollow tubular stem 434 concentrically depends. A valve plunger 436 is arranged to be slidably, sealingly engaged within the stem 434. Plunger 436 carries a piston 438 at one end while the opposite free end 440 extends outwardly from the cap 428 when plunger 436 is so engaged within tubular stem 434. Piston 438 is a flat disc integral with the plunger 436, the plane thereof being normal to the axis of said plunger 436. The piston 438 is biased against the disc 426 by conical helical spring 442. When the cap 428 is fully engaged upon the stem end 412, the inner end 444 of the stem 434 forces the piston 438 tightly against the disc 426. As the cap 428 is rotated toward disengagement, the disc 426 can be reciprocated against the bias of spring 442 between the lip 424 and the end 444 of the hollow stem 434. Thus, the degree of relief afforded can be easily controlled with like control of the interior pressure within the absorber. Again, the relief valve means 38 also is disassembled quickly and easily to enable cleaning and sterilizing. Likewise, said means 38 is also capable of facile reassembly and reinstallation on the absorber head cover 56.

The absorber apparatus 10 illustrated in the FIGS. 1 through 6, supports a pair of like canisters 16, sometimes referred to as absorbent cartridges. Each of the canisters 16 contain an absorbent, such as lime, for removing carbon dioxide from the respiratory gases received from patients undergoing anesthetic procedures. The anesthesia in said gases, of course, remains unaffected and the said respiratory gases are enriched with oxygen within the absorber. The upper canister 16 is supported by intermediate axial support means 18 while the lower canister is supported on the base 14.

The intermediate axial support means 18 comprises a pair of arcuate semicircular arms 502 and 504 of flat bandlike configuration. Arms 502 and 504 are coupled together in a swivel joint 506 through which one of the vertical support rods 22 is passed. One arm 502, hereinafter called the locking gate 502, has a bearing portion 508 through which the rod 22 passes and by which gate 502 is pivoted on said rod. The opposite end of gate 502 comprises an arcuate hook formation 510 including one arm 512 longer than the other arm 514 thereof. The arm 512 carries a threaded passageway through which a screw 516 is passed whereby to lock the gate 502 in place with the hook formation 510 engaged on the rod 22 and the screw 516 blocking withdrawal of the rod 22 therefrom.

The other arm 504 carries like yoke portions 520 each of which has passageways 522 to accommodate the rods 22 therethrough. In fact, said rods 22 are slidable in said openings 522. Arm 504 has a radial blade formation 524 carrying a center passage 526 of diameter substantially equal to the diameter of the perforate top and bottom center screen portion 17' of canister 16. Said center passage 526 is disposed axially aligned with said portions 17' when assembly is complete. An intermediate gasket member 528 is mounted on the blade formation 524 and consists of a pair of flat ring

portions 530 and 532 spaced apart and secured at their inner diametric edges by annular bridging portion 534 to define the annular gasket 528 as having a U-shaped cross-sectional configuration. Gate 502 carries a radial blade formation 536 complementary to that absent portion of blade formation 524 which otherwise would have completed a circular blade of uniform width. Blade formations 524 and 536 can be described as mating flanges, or fixed and gate blades, respectively, if desired. When pivoted into closed condition, gate 502 carries blade formation 536 between the ring portions 530 and 532 of the intermediate gasket 528.

The quick coupling means 34 according to the invention, is diagrammatically illustrated in detail in FIG. 7 as mounted to brace means 32. The brace means 32 comprises a bar 550 having a pair of end passageways 552 through which are passed the vertical rods 22. Pins 26 are mounted to the rods 22 to support the bar 550. The location of the pins 26 is selected to assure automatic proper positioning of the completed assembly of the absorber apparatus 10 when coupling is effected. The bar 550 has a reduced diameter median portion 554 and a pair of laterally spaced depending formations 556 on either side of said portion 554. A pin 558 is disposed between said formations 556 and immediately below portion 554. One end 560 of a crank lever arm 562 is journaled for pivotal rotation on the pin 558. A follower arm 564 is provided unitary with the lever arm 562 but intermediate the ends thereof. The follower arm 564 is provided with a terminal yoke formation 566 carrying a pin 568 on which a cam wheel 570 is mounted for free rotation. A U-shaped concavity 572 is defined between arms 564 and the end 560 of lever arm 562. Said concavity 572 is capable of engaging the bar portion 554 in locking condition of the quick coupling means 34. The opposite end 574 of arm 562 terminates in a handle portion 576 and has a portion 578 thereof arranged to engage against the tapered outer surface of base 14 at 580. A pair of spaced abutments 582 is provided at said surface 580 to serve as lateral retaining means for the lever arm 562 when the quick coupling means 34 is engaged against the base 14.

The full line representation illustrated in FIG. 7 shows the condition of the quick-coupling means 34 in fully engaged locked condition of the assembled absorber apparatus 10 while the phantom line representation illustrates the uncoupled condition of said means 34. To uncouple, one merely pulls the handle 576 in the direction of arrow. The wheel 570 moves along the outer surface of floor 144 until it passes the center of said floor, coincident with the axis of the absorber apparatus. The bias of springs 102 permit the rods 22 to be moved vertically causing the wheel 570 to move off the outer surface of the base along the radius of the floor 144. The base 14 and the intermediate support means 34 thus are permitted to move downward to permit the canisters 16 to be removed and replaced without complete disassembly of the apparatus 10 by swinging out of gate 502 from arm 504 of means 18.

To couple, one simply reverses the process thus described. The brace means 32 is moved against the spring bias of springs 102 and then partially released, still under spring bias, so that there is a tight sealed connection between all parts. The pins 26 are located, as stated above, to fix the position of the component properly and automatically with coupling of the quick coupling means 34 to the undersurface of the base with the

portion 578 thereof engaged between abutments 582.

In accordance with medical practice, certain standardized volumes are required for the passage of respiratory gases through carbon dioxide absorbers. These volumes differ between adults and infants so that only half of the capacity of volume of absorber apparatus 10 is required when the apparatus is intended to be used with infants, for example. The apparatus 10 shown in FIG. 1 therefore can be easily adapted for use with only a single canister 16. All that is required is that one simply removes the intermediate support means 19 and interchanges, for rods 22, rods of lesser length such as rods 22' as shown in the absorber apparatus 10' illustrated in FIG. 12. Filling of both canisters of the absorber apparatus 10, affords absorbent material sufficient for the normal procedures. If a lesser amount of absorbent material is required as for a procedure of markedly less duration, only one of the canisters 16 need be filled with absorbent. However, the same capacity utilizing two canisters 16 is required for adults.

The relative position of the exhalation valve means and the inhalation valve means relative to the cover and to the airway tube may be interchanged simply by election of fittings and couplings so that the apparatus 10 can be utilized in practically any given anesthetic administration application. The versatility such as possible here with apparatus 10 and 10' heretofore was not possible with carbon dioxide absorber apparatus as known in the art.

It should be pointed out that the diaphragm closing off the lower end of the valve stem 114 enables the pressure within the absorber head to be monitored without disposing the manometer or its stem to the respiratory gases. Specifically, the interior pressure reacts upon the diaphragm which in turn transmits such reaction to the manometer.

The assembly of the absorber apparatus 10 is evidenced from the description of the particular component parts thereof. When assembled, the absorber apparatus then receives the exhalation of gases from the patient through entry conduit 204 into airway 202 raising the disc 216 from the tapered lip 262. The gases then enter the interior of viewing bubble 214 into the interior of housing 200 and then through the assembled conduits and sleeves 206, 208 and 210 to enter the interior of the absorber head through port 72 of the duct formation 70. As said gases travel, as seen by the arrows through to the duct formation 70 to enter the interior of the absorber head 12 at the inner end of formation 70 tangentially to the cover 56 of the head 12. The gases within the absorber head 12 are enriched with oxygen entering the absorber head through the nipples conduit 400.

The resulting mixture then travels past the frame to enter the first canister 16 through the perforate screen portion 17'. Passing through the first canister 16, the gases enter the second canister 16 by way of the screen portions 17' and the passage defined by bridging portion 534 of annular gasket 528. After passing through the second absorber canister 16, the gases are carbon dioxide free and enter the interior of the base 14 by way of the bottom screen portion 17' of the lower canister 16. Because of the shape and configuration of the base, the gases are directed into the interior chamber

162 of base 14, into the duct or channel 160 of the formation 148 and from there, into the airway 46.

The carbon dioxide free gases enter the outlet or inhalation valve means through channel 312 defined in pipe 304, a portion of the flow continuing therethrough to enter the airway 316 while the remaining portion enters the by-pass duct 314 defined within pipe 306 to fill the reservoir bag 344. The reservoir bag 344 is intended to monitor the patient's respiration and, as well, to provide a means for forcing oxygen containing gases into the patient.

It should be noted that in the application described herein, the patient's breathing is confined entirely to the anesthetic circuit formed by the absorber and the connecting conduits with a face mask on the patient so that the patient's exhalation gases pass to the inlet valve of the absorber, is circulated through the absorber and to the outlet valves and thence, are returned to the face mask for inhalation by the patient.

In any event, the carbon dioxide free gases to be directed to the patient enters the airway 316 to dislodge the disc 330, pass into the bubble and coupling assembly 338 and enters the interior of pipe 308. From there, by hose (not shown), the gases are directed to the face mask of the patient for inhalation thereof. Well-known expedients for monitoring the absorbing capacity of the absorbent can be introduced since the interior of the canisters 16 can be viewed due to the transparency of container 16.

As can be noted from the description above, the invention has avoided the use of pipes in the absorber apparatus which are closed to inspection and instead utilize channels or ducts to direct the flow of the patient's exhalation through the absorber. The interior of the absorber can be opened up for full and easy view and for sterilization. The passageways are of a minimal length and diametric dimension to enable cleaning easily with a brush as is the conventional practice of cleaning other equipment but not prior carbon dioxide absorber apparatus. Since screens in the form of portions 17' are incorporated in the absorbent canisters 16, no special screens need be used. The exhalation enters the base, and passes therethrough directly without the interposition of ducts of a convolute or fragmented nature. The base 14 is as easily accessible as the other portions of the absorber apparatus 10. It should be noted that the utilization of removable airway portions within the respective valve means permits all to be disassembled and thoroughly cleaned by simple conventional procedures, and sterilized by conventional hospital procedures such as introduction into a steam autoclave.

Referring now to FIGS. 14 to 17 inclusive, there is illustrated another embodiment of the absorber apparatus assembly according to the invention herein. In FIG. 14, an absorber apparatus 10''' is illustrated with the gas fixture means 36' and 50' interchanged in position in comparison with the respective positions of attachment of the gas fixture means 36 and 50 of the absorber apparatus 10 and 10'.

The inlet gas fixture means 36', arranged to receive the exhalation gases from the patient is positioned coupled to the airway 46 while the outlet gas fixture means 50' for delivery of carbon-dioxide free gases to the patient is arranged coupled to the absorber head 12. The path of flow of the gases still remains unidirectional but proceeds in a direction opposite to the direction of flow in absorber apparatus 10 and 10'. Instead of first pass-

ing through the absorber head 12, thence to and through the canisters 16 into and out from the absorber base 14; the carbon dioxide laden gases from the patient enter and pass through the airway 46 into the absorber base 14 via conduit 148 thereof. The gases then enter the canisters 16 from the bottom of the apparatus and pass therethrough into the absorber head 12. The path of flow then continues from the absorber head 12 into the gas fixture means 50', and from there, returns to the patient.

In order to permit the reversal of locations, modification only of the housings of each of the gas fixture means is required. In FIG. 15, the inlet gas fixture means or exhalation valve means 36' is illustrated. The housing 200' is identical to housing 200 except that the coupling conduit or outlet conduit 206 is formed in the base 22' of housing 200 as elongate pipe 206'. Pipe 206' is quite similar to the entry conduit 304 of the outlet gas fixture means 50 carrying the shoulder 352' to enable seating upon jacket 356, and likewise, carrying the necessary sledding and the shoulder 350 to enable coupling to the upper end 46'' of airway 46. Otherwise, the construction of the inlet conduit 204, the airway duct 202, as well as the interior valving arrangements of the inlet gas fixture means 36 are retained in gas fixture means 36'.

In fact, if desired, one can merely provide a boss on exterior of base 222 and form a passage therethrough, thereafter capping the same with a removable threaded cap. Then a length of conduit equivalent to outlet duct 206' can be simply threaded in the thus formed passageway. The outlet conduit 206 likewise can comprise a length of conduit threadably engaged with a threaded passageway to form the arrangement illustrated in FIG. 8 except for the capped passageway formed in base 22. In this manner one can make a single casting adaptable for utilization either in the form shown in FIG. 1 or in the form shown in FIG. 14.

The outlet gas fixture means 50' has been modified as shown in FIG. 16 to remove inlet conduit 304 and provide an inlet conduit 340' disposed where capped boss 358 would appear as shown in FIG. 6. Inlet conduit 304' is similar in most respects to the conduit 206 shown in FIG. 8 so that it is capable of being coupled to conduit 70 in the absorber head. The means of enabling such coupling can be identical with the means for coupling conduit 206 to conduit 70.

Otherwise, the interior valving arrangement would be identical to those incorporated in the outlet gas fixture means 50. In fact, a boss can be formed in the bottom wall of housing 300' much as in the same manner as described in respect of the inlet gas fixture means so as to make such fixture means 50' interchangeable either for connection to the absorber head or to the airway 46.

Thus it can be noted that the invention either can be made with the gas fixture means interchangeable, or a specific attachment to one or the other of the airway and absorber head.

I claim:

1. In a carbon dioxide absorber apparatus assembly for use in closed circuit administration of anesthesia and including an absorber head, an absorber base, perforate canister means arranged between the absorber head and base, carbon-dioxide absorbent material disposed in the canister means, means coupling the absorber head and absorber base with said canister means sandwiched therebetween and inlet and outlet gas fix-

ture valve means coupled to said absorber head and base and in communication respectively therewith, the improvement comprising:

said absorber head comprising a pair of castings, one of said castings being a hollow dish-shaped member and the other of said castings being an annular spoked frame;

releasable coupling means for demountably securing said pair of castings one to the other in a sealed relationship;

said absorber base comprising a single dish-shaped casting;

a tubular elongate airway arranged for connection to said absorber base and disposed alongside the canister means and exterior of said absorber head; means for demountably coupling said tubular elongate airway at its lower end to said base and at its upper end, to one of the gas fixture valve means the other of said gas fixture valve means being releasably coupled to the absorber head; the overall interior of said absorber head and base respectively each defining a chamber respectively communicating directly to the canister means and thereby establishing a unidirectional path of travel through said apparatus traversing said absorber head and base interiors; said assembly being reducible to demounted condition establishing direct access to all interior surfaces for cleaning and autoclave sterilization thereof.

2. The absorber apparatus as claim in claim 1 in which said inlet gas fixture means is coupled to said absorber head.

3. The absorber apparatus as claimed in claim 1 in which said outlet gas fixture means is coupled to said absorber head.

4. The absorber apparatus as claimed in claim 1 in which said inlet and outlet gas fixture valve means include one way valve means comprising, a tubular entry airway defining an inner chamber, and a housing for receiving said airway and defining an outer chamber; means respectively releasably coupling said entry airway within said housing, disc means separating said entry airway from said outer chamber and disc retaining means engaged upon said entry airway to limit movement of said disc means curing passage of gases through said valve means, said entry airway being selectively separable from said housing to establish direct access to the interior surfaces of said gas fixture valve means from the exterior thereof for cleaning and autoclave sterilization.

5. The absorber apparatus as claimed in claim 4 in which said airway and housing are threadably engaged.

6. The absorber apparatus as claimed in claim 1 and selectively operable drain means provided in the absorber base, said drain means comprising means defining an opening formed in said base at the deepest portion thereof and a cap member arranged for releasable

engagement in said opening.

7. The absorber apparatus as claimed in claim 1 and quick coupling means comprising, a swingably mounted lever arm coaxial with said base and having a graspable portion at one end and a roller means spaced therefrom, a retaining formation on the undersurface of said base to engage said lever arm in only one positional condition thereof and said lever arm being swingable first to engage said roller means upon said base undersurface, said roller means being movable along said base undersurface until said lever arm is engaged with said retaining formation, vertical rod means coupling said absorber head and base together and brace means carrying said lever arm and being rigidly coupled to said vertical rod means for limited movement therealong, and stop means on said vertical rod means, said roller means capable of applying force against said base to move same upwardly and thereafter partially to release said base to drop same to the limit permitted by said stop means.

8. The absorber apparatus as claimed in claim 7 and spring means coupled to said vertical support means to permit limited vertical movement of said support means and said base responsive to actuation of said lever means.

9. A carbon dioxide absorber apparatus for use in the administration of anesthesia wherein exhalent respiratory gases are introduced thereinto, exposed to an absorbent medium contained therein to remove carbon dioxide therefrom and released for return as inhalent gases and being demountable to plural components each capable of cleaning sterilization by autoclave methods, said absorber apparatus comprising: vertical support means, a hollow absorber head and a hollow absorber base removably mounted to said support means for limited vertical movement therealong, perforate canister means containing the absorbent medium and arranged between said absorber head and absorber base and sealingly engaged therewith, inlet valve means and outlet valve means coupled respectively to one of said absorber head and absorber base, and to the other of said absorber head and absorber base, said absorber head comprising a pair of unitary castings, one being of dish-shaped configuration and the other being a spoked wheel-like annular frame, and means for releasably coupling said castings one to the other, the entire interior of said absorber head and said absorber base respectively, each defining a chamber respectively communicating directly to the canister means and with the respective one of said inlet and outlet valve means, the interiors of said head and base being isolated one from the other except through said canister means, the path of travel for gases traversing said head and base interiors only once and unidirectional, the said interior surfaces being directly accessible from the exterior thereof in demounted condition of said apparatus.

* * * * *