Oct. 21, 1969 D. R. WALLACE 3,473,529

SQUEEZE-BAG RESUSCITATOR

Filed May 23, 1966 2 Sheets-Sheet 1

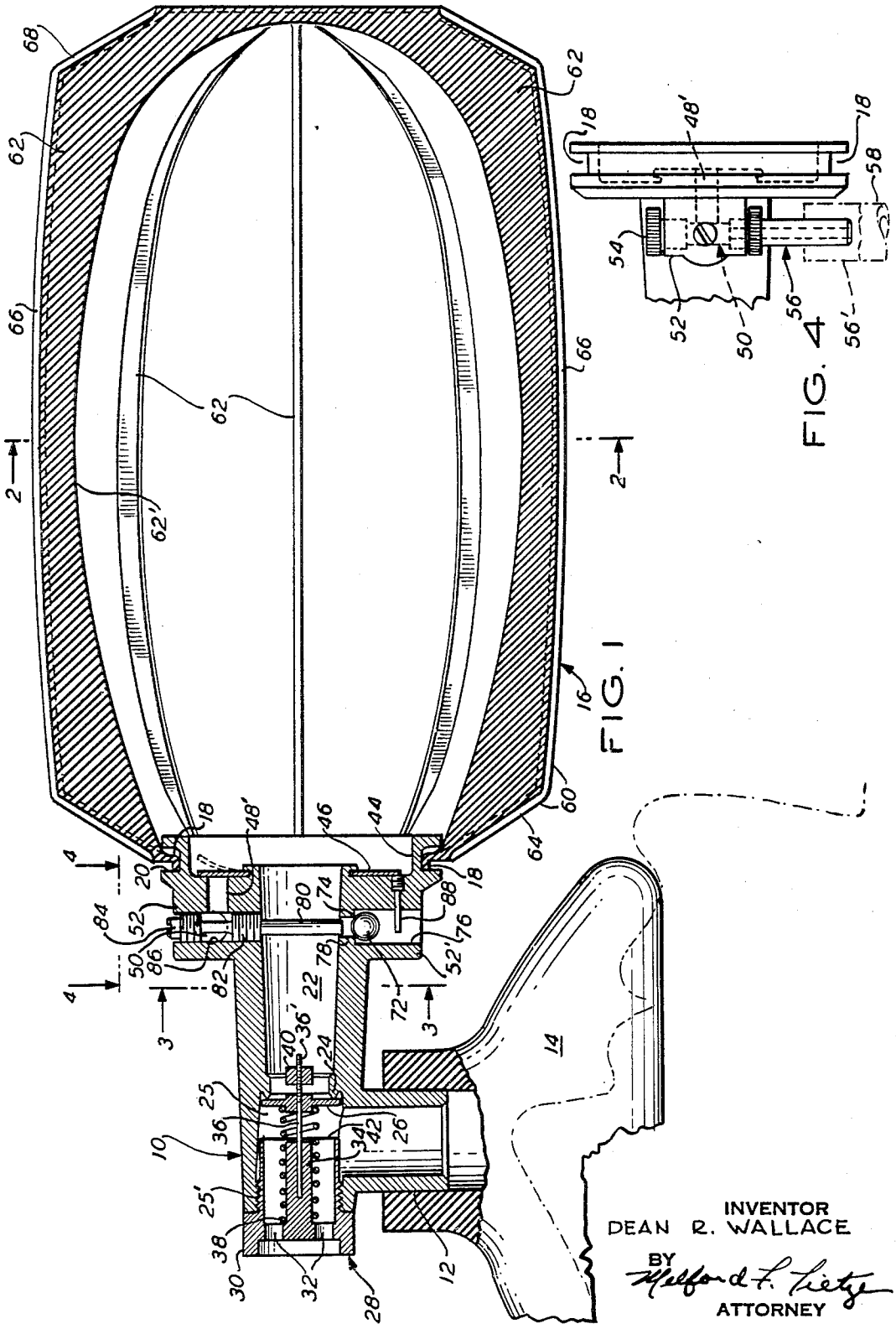

FIG. 1

FIG. 4

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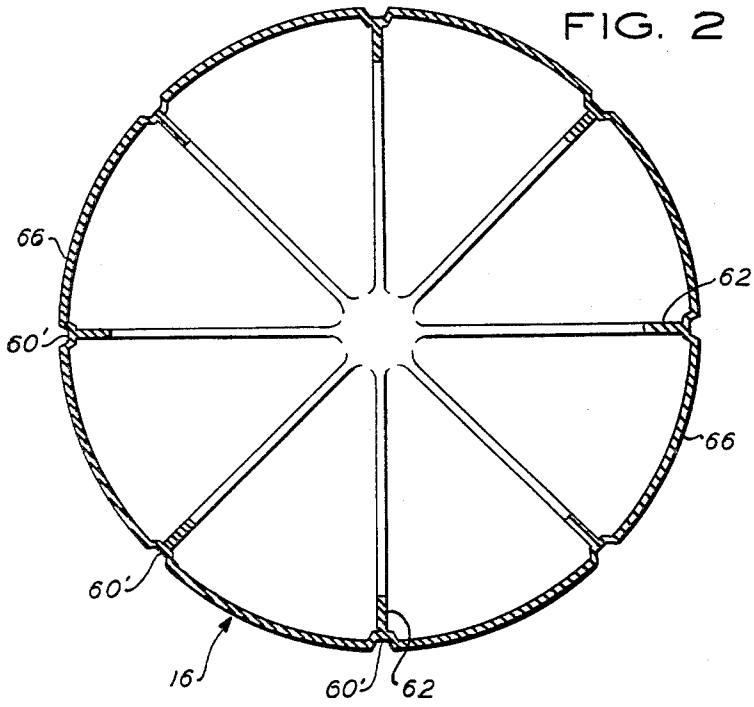
FIG. 2



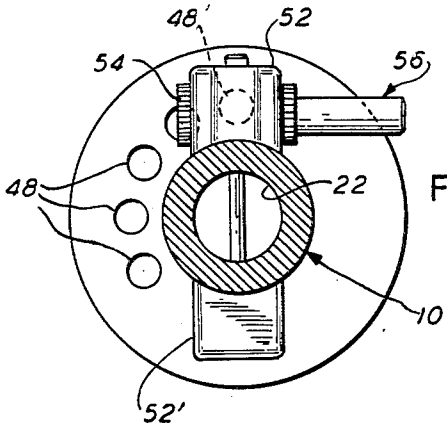


FIG. 3

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SQUEEZE-BAG RESUSCITATOR

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U.S. Cl. 128—145.7 5 Claims

ABSTRACT OF THE DISCLOSURE

A respiratory assisting device comprising a mask, a body member attached to the mask and having a compressible normally expanded bag carried thereon, the body member including valve means for controlling gas flow from the bag to the mask, the valve means including a pressure relief valve construction containing a valve seat and a magnetizable valve element adapted to be seated thereon, the bag being a one-piece unit of cylindrical configuration and having a plurality of longitudinally extending flexible rib means along the interior thereof.

This invention relates to hand-operated resuscitators, particularly of the type that are readily portable and effective for emergency use.

In such type apparatus it is highly desirable that the structure and operating mechanism be as compact and as simple as possible. It is also advantageous that the operating parts be capable of simple disassembly in order that they may be cleaned and/or sterilized for subsequent use. It frequently occurs that the patient subjected to emergency treatment will discharge mucus or vomitus which will contaminate and possibly interfere with subsequent proper functioning of the resuscitator device. In any practical instrument of this type, therefore, the ability readily to dismantle the equipment for cleaning or reservicing is highly important.

A particularly common complaint regarding instruments of this type that have heretofore been available has been the lack of an effective means for transmitting to the user a sensitive and accurate indication of the pressure being applied to the lungs of the patient. In the type of device to which the present invention is directed, a compressible bag or reservoir is manually compressed or squeezed by the operator to displace therefrom and force into the lungs of the patient a desired volume of air. The reservoir, however, must be retractable to normal expanded position to permit cyclic operation. By warrant of the constructions that have heretofore been employed in devices so far available, there is not afforded the ability of the operator to feel, and thus sense through touch, the conditions of pressure that exist within the system. In conventional devices, the compressible reservoir is simply of such thick-walled construction that, even though compressible, their internal resistance to flexing obliterates the subtle fluctuations of pressure in the patient's breathing tract.

Accordingly, it is a particularly important object of the present invention to provide a manually operated resuscitator having a hand-compressible bag possessing the necessary recovery characteristics for repeated cyclic operation but which, at the same time, is characterized by a thin-walled, pliant construction rendering the internal pressure conditions readily detectable by manual contact therewith.

It is a further objective of the present invention to provide in such devices an improved, simple, removable valve construction for governing and directing the flow of gases during operation of the compressible bag.

It is a still further object of the present invention to

provide an improved relief valve employing magnetic force for effecting closure thereof and which is characterized by a sensitivity of adjustment and a capability for extremely rapid movement to full open position in response to pressures in excess of its setting.

The invention and other of its advantages may be more fully understood by reference to the following description of a preferred embodiment thereof and to the accompanying drawings in which:

FIGURE 1 is a full sectional view of a resuscitator in accordance with the invention showing a reservoir bag mounted on a body member which in turn is attached to a face mask of a type normally used for administering respiratory gas to a patient. FIGURE 2 is a cross-sectional view along the line 2—2 in FIGURE 1, looking in the direction of the arrows and showing the internal construction of the resuscitator bag; FIGURE 3 is a sectional view through the body member along the line 3—3 in FIGURE 1, looking in the direction of the arrows and showing the boss in which the inlet connection for admitting auxiliary oxygen is arranged and the air-intake parts; and FIGURE 4 is a partial side view of the body member looking in the direction of the arrows 4—4 in FIGURE 1.

Referring now to the drawings, the resuscitator comprises a main body member or housing shown at **10** which has a tubular projection **12** defining a gas passage communicating with a conventional gas mask **14**. Also supported on the body is a compressible bag **16** which has an opening strengthened by a beaded portion **18** that is stretched over and seated within an annular recess **20** formed in an annular collar surrrounding the recess **44**.

Within the body is a longitudinal bore **22** which opens at one end into the chamber formed by the bag. In the opposite direction the bore terminates in an opening surrounded by a valve seat **24**, through which the bore communicates with a chamber **25**. The chamber **25** has a threaded opening **25'** and connects with the passage **12** defined by the tubular projection leading to the mask. A valve element **26** is adapted to be seated on the valve seat **24** to form a closure, isolating the mask connecting passage **12** from the bore **22** when the bag **16** is in its normal distended condition.

The valve element **26** is slidably carried on a removable valve assembly shown generally at **28**. The assembly consists of a threaded bushing **30** which is received in the threaded opening **25'** and in which openings **32** in its bottom wall afford communication between the chamber **25** and the atmosphere. Centrally within the bushing is an axial stud **34** in which is received an axial valve stem **36** on which the valve element **26** is slidably disposed. A valve spring **38**, supported on the stud, is compressed between the bottom wall of the bushing **30** and the valve element so as normally to urge it inwardly into seating engagement with the valve seat **24** when the valve assembly is mounted within the body **10**. The outer end of the valve stem **36** is threaded at **36'** and a stop nut **40** supported thereon, which upon removal of the valve assembly retains the valve element on the stem against the expansion of the valve spring so that the entire unit remains assembled when removed from the body and thereby easily remountable. The closing force acting on the valve element **26** is predetermined by the characteristics of the spring **38** and the degree of compression thereof created when the valve assembly is threaded into the opening **25'**. Advantageously, such force is preselected such that, when the bag **16** is manualy compressed during operation, the valve element will be urged outwardly by the superior gas pressure acting thereon and maintained in seated engagement with the outer annular lip **42** of the bushing **30**, thereby occluding the openings **32** and preventing the discharge to the atmosphere of gas displaced

from the bag 16. Such displaced gas flows from passage 22 into passage 12 and thence the face mask. Upon release of the bag and the return thereof to normal position, the inflation pressure forcing gas into the patient's lungs will be discontinued and the valve 26 returned to its seated position against the seat 24 by the action of the valve spring 38.

Mounted within a recess 44 defined by the collar at the bottom of the body and confronting the reservoir chamber within the bag 16 is a flexible rubber ring forming a flapper-type check valve 46 which is adapted to flex as shown by its dotted-line position to open or close the ends of a series of spaced air inlet passages 48 (see FIGURE 3) which opens to the atmosphere through the bottom wall of the recess 44. The passage 48' seen in FIGURE 1 is also subject to the flapper valve but connects with a transverse passage 50 in boss 52, FIGURE 1 and 4 through which auxiliary oxygen may be supplied. Referring to FIGURE 4, the passage 50 extends laterally through the boss 52. The passage 50 is threaded and adapted to receive a closure plug 54 at one end and a connector fitting 56 at the other end which may be reversed at their respective positions if convenience of operation makes this desirable. The plug 54 merely occludes one end of the passage 50. The connector 56 may receive a tubing such as shown in dotted lines 58 through which a gas such as oxygen may be delivered for enriching the air supplied during resuscitation of the patient. For normal use without oxygen enrichment the tube may simply not be connected to the tubular portion 56' of the connector in which event air will simply be drawn through the connector into the passage 50 and thence passage 48' into the bag 16.

It will be evident from the construction described above that in operation the user intermittently compresses the bag 16 which displaces valve 24 outwardly to occlude the discharge ports 32 and permits the displaced volume to be forced from the bag through passage 12 and mask 14 into the patent's lungs. During each such compression the flapper valve 46 is forced against the valve body closing the inlet ports 48 and 48'. Alternately, upon intermittent releasing, the bag 16 returns to its normal distended position; air enters through passages 48 and 48' past the flapper valve 46 to refill the bag, and valve 26 returns to seated position closing the passage 22 and opening the end of bushing 30. The patent's exhalation then passes to the atmosphere from the mask, through the passage defined by the tubular projection 12 and discharge openings 32.

The bag 16 has an outer wall 60 of thin flexible material, such as natural or synthetic rubber, characterized by being substantially passive and unresistant to deformation and capable of permitting the operator to sense pressure fluctuations and breathing resistance by touch. The walls 60 are therefore in themselves essentially flaccid and ineffective to operably reinflate the bag following compression. Thus, without further means the bag 60 would not reliably provide effective normal resuscitation, and futher provision as hereinafter described is required. The actual thickness of the wall 60 may vary depending upon the characteristics of the material used for the bag and the extent to which one is willing to sacrifice the utmost in "feel" sensitivity for the sake of additional wall thickness. By way of example, however, it has been found that in bags of rubber composition the wall 60 is advantageously not in excess of 0.07 inch in order that adequate "feel" be afforded.

A significant feature of the bag 16 is that reinforcing means are disposed at spaced intervals on the interior of the bag to render the bag operably self-inflating but without obstructing direct exposure of the thin walls 60 elsewhere to the gas pressure in the bag. Referring to the drawings, such reinforcing means are advantageously embodied in the form of a series of longitudinal, radially projecting ribs 62 formed along the inside of the bag. In the present embodiment there are eight such ribs equally spaced, the remaining portions of the bag walls 60 being free of any other reinforcing means and directly exposed to the interior chamber of the bag.

The bag 16 is preferably of molded cylindrical shape with a conical upper wall such as at 64 extending outwardly from the beaded aperture 18 which engages the bottom end of body 10, and having substantially cylindrical side walls 66 and a bottom wall 68. The side walls may have a slight outward bow which is maintained by the ribs formed on the inner side walls of the bag. Advantageously the length of the bag is one and one-half or more times its diameter. In such proportions the desired gas volume displaced from the bag during resuscitation may be achieved with less deformation of the longitudinal ribs and therefore with less overall resistance to manual squeezing.

The ribs 62 are formed preferably by molding integrally with the bag 16. Slight external indentation in the bag, seen at 60' preferably extend along the region at the base of each of the ribs. Such indentations may be formed in the wall of the bag during dip molding, which is a method highly suited to the manufacture of the present thin-walled bag. The ribs are embodied as thin radial vanes extending along the interior of the cylindrical side wall 66 between the upper and lower ends 64 and 68. The outward force exerted by the ribs upon squeezing the bag will depend largely upon their number, length, thickness and radial extent. Various combinations of these dimensions may be employed. In general, however, these dimensions in combination with the thickness of the wall of the bag are such that the bag returns to its normal distended position sufficiently rapidly to afford ample cyclic refilling within the limits normally required. For example, an average adult has a tidal exchange volume of about 500 cc., normally exchanged at a rate in the order of 12–18 cycles per minute. Infants may require 30 to 50 inflations per minute, although with smaller volume exchange. Accounting for leakage, such as around the face mask, and any necessary time safety-factor, the bag must be capable of exceeding these time and volume requirements. For effective reliable use it is advantageous that the bag should be so constructed in accordance with the above as to permit operative reinflation with a volume displacement of about 1000 cc.'s, at a rate in the order of 45 times per minute. Advantageously the ribs extend radially from the beaded edge 18 of the upper aperture to the side walls. Such arrangement cooperates with the seating of the bead 18 on the resuscitator body to support the upper end 64 outwardly from the housing and assists in rapid return of the bag to full distended position. In general, the bag operates best with minimum wall thickness and rib reinforcemnet. The mid portion of the ribs may be reduced in radial extent, the inner edges having a curvature such as shown at 62'. The curvature may readily be modified when the other dimensions have been fixed to yield the optimum balance between the desired rate of self-inflation of the bag and the resistance to manual compression.

In order to avoid the creation of excessive pressure within the resuscitator which it would be undesirable to impose upon the respiratory tract of the patient, the resuscitator is equipped with the relief valve shown in the drawings, which is of novel and advantageous construction. It will be apparent that one safeguard against such an occurrence is the construction of the resuscitator bag of the invention, hereinabove described. Thus, because of the sensitivity to the internal pressure afforded the operator, he will be less likely inadvertently to compress the bag in the face of any unusual or undue breathing resistance. However, in order to afford the utmost in safety, the relief valve 70 is incorporated in the device of the invention.

The relief valve, situated in the bosses 52 and 52',

which is formed in the body 10 in a position diametrically opposite to boss 52, comprises a ball element 72 which is seated against a valve seat 74 formed at the bottom of a venting bore 76 formed within the boss 52' and opening to the atmosphere. The seat 74 surrounds a passage 78 connecting with bore 22. Arranged to move axially toward and away from the ball element 72 is a magnetic element 80 in the form of a rod carried on a threaded stem 82 having a tool-engaging recess 84 projecting from its outer end. The stem 82 is threaded in a bore 86 formed in the boss 52 and intersecting transversely with the passage 50. The stem is provided with an unthreaded portion of reduced diameter in the region of such intersection to permit the free flow of gas through the interconnecting passageways 48 and 50 at this region of the threaded bore 86. The ball element 72 is held in closed position against the opening 74 by the magnetic force of the element 80 which is displaced axially to position its free end such that the resultant magnetic force is that desired for operation of the ball element. The housing 10 is advantageously made of material such, for example, as a polycarbonate plastic material which is non-magnetic and does not interfere with the magnetic field acting on the ball check element. It is important that the elements 80 and 72 be free of interference from surrounding magnetizable metals so that the magnetic field will be as uniform as possible, thereby to provide stability of operation. If desired, non-magnetizable metal elements, such as brass, may be employed for parts of the housing 10, for example, in the valve seat 74 to afford better seating characteristics.

The resuscitator of the present invention preferably incorporates the above magnetic check construction. It will be noted, for example, that in this construction, upon attaining a gas pressure sufficient to overcome the magnetic seating force acting on the ball element, the ball element will be displaced away from the magnetic rod 80. Inasmuch as the ball element is to be displaced away from the magnetic field, the force acting to retain the ball in seated position is diminished, with the result that the ball, once displaced to open the valve, is enabled rapidly to move to a full open position and to allow an immediate rapid venting of the excessive gas. This is to be distinguished, for example, from conventional spring-loaded relief valve elements in which normally the displacement of the seating element is accompanied by an increasing force tending to return it to closed position. In order to retain the ball element 72 within the discharge bore 76 when it is urged to its venting position, a retaining pin 88 is arranged to project transversely across the bore 76. The pin is disposed at a distance from the seat opening 74 such that upon reduction of the internal pressure to normal range the magnetic force acting on the ball element at such displacement from the element 80 is sufficient to draw the ball element inwardly and return it to its seated position. The use of the spherical valve element is also advantageous in the present construction in that its symmetry reduces the possibility of faulty operation of the valve due to displacement or rotation of the element.

I claim:

1. A respiratory assisting device comprising a mask for delivering and receiving respiratory gases to and from a patient, a body member attached to said mask having a compressible normally-expanded bag of cylindrical configuration carried thereon for displacing and forcing gas therein under pressure through said mask into a patient's lungs, discharge passage means in said body member normally connecting said mask with the atmosphere through which a patient's exhalation is discharged, delivery passage means in said body member for delivering gas displaced from said bag to said mask, check valve means operable upon alternate expansion and compression of said bag to admit gas to said bag during expansion, and control valve means actuated in response to manipulation of said bag to close said discharge passage means upon compression of said bag and to open said discharge passage means and close said delivery means upon expansion of said bag to normal position, said compressible bag being a one-piece unit comprising a thin wall defining a pliable enclosure sufficiently thin to permit an operator to sense the pressure within said wall by feel and having a plurality of longitudinally extending, flexible rib means formed at spaced intervals along the interior of said bag which are resistant to defromation and act resiliently outwardly on said wall to operatively reinflate said bag during resuscitation.

2. A device according to claim 1 wherein said bag has a strengthened aperture at its upper end received on said body member, an upper end wall extending radially outwardly from said aperture, side walls extending from said upper end wall to a bottom wall to define said cylindrical configuration, and said rib means comprise circumferentially spaced webs projecting radially inwardly from said side walls and joining with said upper and bottom end walls.

3. In a respirator assisting device comprising a delivery passage and an exhalation passage with valve means alternately opening and closing said passage in response to the supply and exhaust of respiratory gases, the improvement comprising a pressure relief valve including a venting passage connecting with the delivery passage and containing a valve seat and a magnetizable valve element adapted to be seated thereon to close said venting passage, and an extensible magnet member operable to generate a magnetic field at the terminal end thereof, said magnet members being adjustable relative to said valve element to exert a predetermined magnetic force thereon holding said element in seated position until the pressure in said delivery passage exceeds a predetermined value and means for retaining said valve element when unseated within the magnetic field of said magnetic member whereby said element will be reseated when the gas pressure in said passage means returns to a normal level.

4. In the respiratory assisting device according to claim 3, the pressure relief valve construction wherein said magnet member is an elongated cylindrical member arranged axially of said venting passage and disposed for axial displacement in said venting passage toward or away from said valve element, and said valve element is spherical.

5. In the respiratory assisting device according to claim 4, the pressure relief valve construction wherein said delivery passage and said venting passage are formed in a rigid plastic, non-magnetic body.

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CHARLES F. ROSENBAUM, Primary Examiner

U.S. Cl. X.R.

230—169; 251—65

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(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,473,529 Dated October 21, 1969

Inventor(s) Dean R. Wallace

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2,	line 37	The number "12" should be deleted
	line 38	The number -12- should be added after the word "projection"
Column 3,	line 14	"opens" should read -open-
	line 17	"FIGURE" should read -FIGURES-
Column 4,	line 19	"indentation" should read - indentations-
	line 54	"reinforcemnet" should read -reinforcement
Column 6,	line 5	the word -passage- should be inserted after the word "delivery"
	line 12	"defromation" should read -deformation-
	line 21	"prise" should read -prises-
	line 24	"respirator" should read -respiratory-
	line 26	"passage" should read -passages-
	line 34	"members" should read -member-

SIGNED AND
SEALED
MAY 19 1970

(SEAL)
Attest:

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