NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF:

March 29, 1971

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned
U.S. Patents in STAR

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,385,036

Corporate Source : Douglas Aircraft Company

Supplementary
Corporate Source :

NASA Patent Case No.: XMF-03212

Please note that this patent covers an invention made by an employee of a NASA contractor. Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of. . . ."

Gayle Parker

Enclosure:
Copy of Patent

N71-22721

May 28, 1968 JAMES E. WEBB 3,385,036

ADMINISTRATOR OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PORTABLE SUPERCLEAN AIR COLUMN DEVICE

Filed Sept. 6, 1966 3 Sheets-Sheet 1

Fig 1

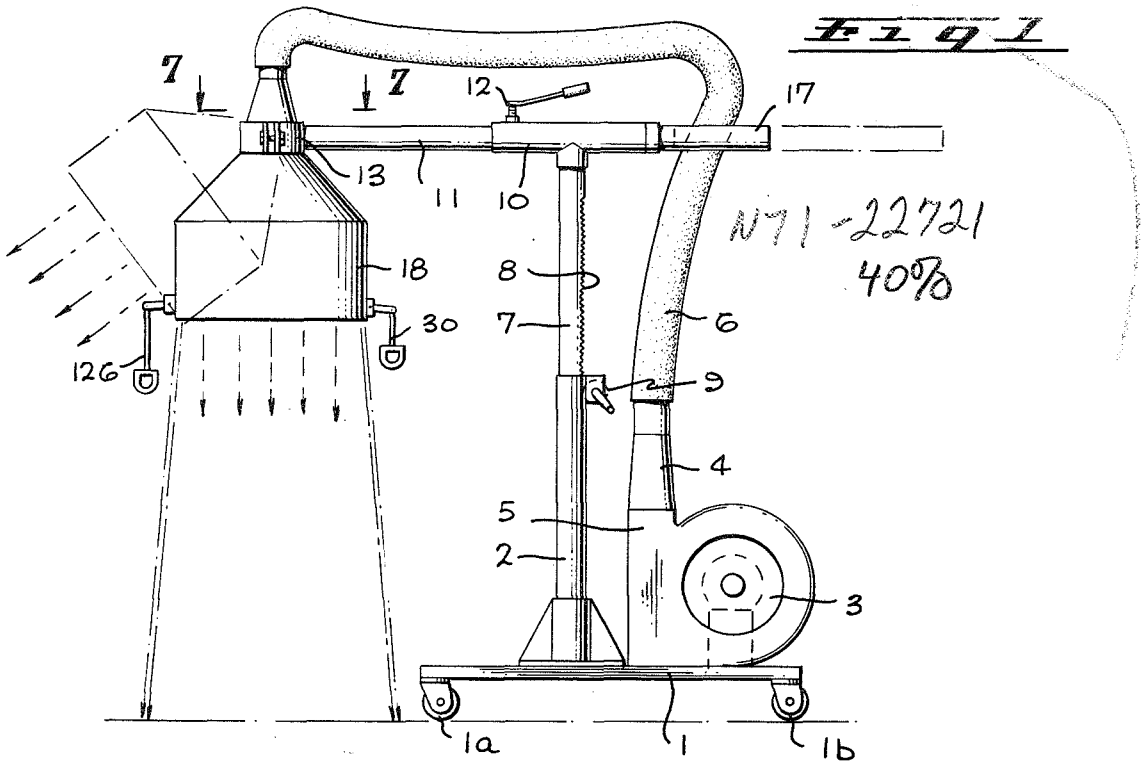

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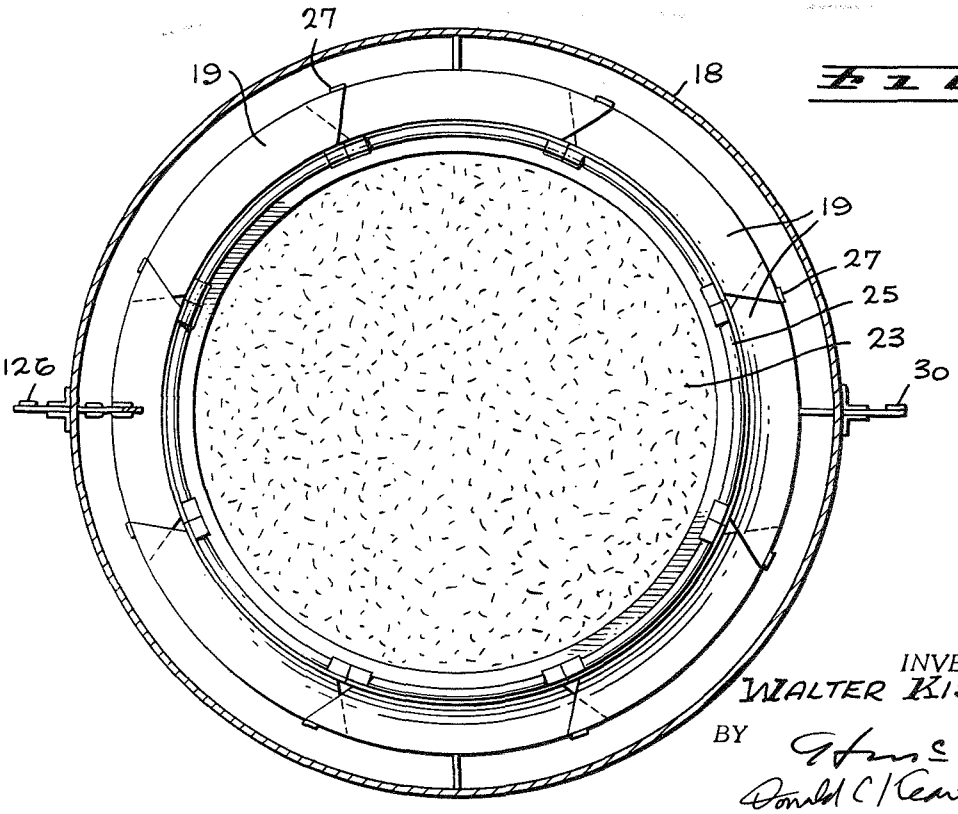
Fig. 3



INVENTOR.
WALTER KISZKO

BY Gross & Cory
Donald C. Kearney
ATTORNEYS

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May 28, 1968 JAMES E. WEBB 3,385,036
ADMINISTRATOR OF THE NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION
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Fig. 2

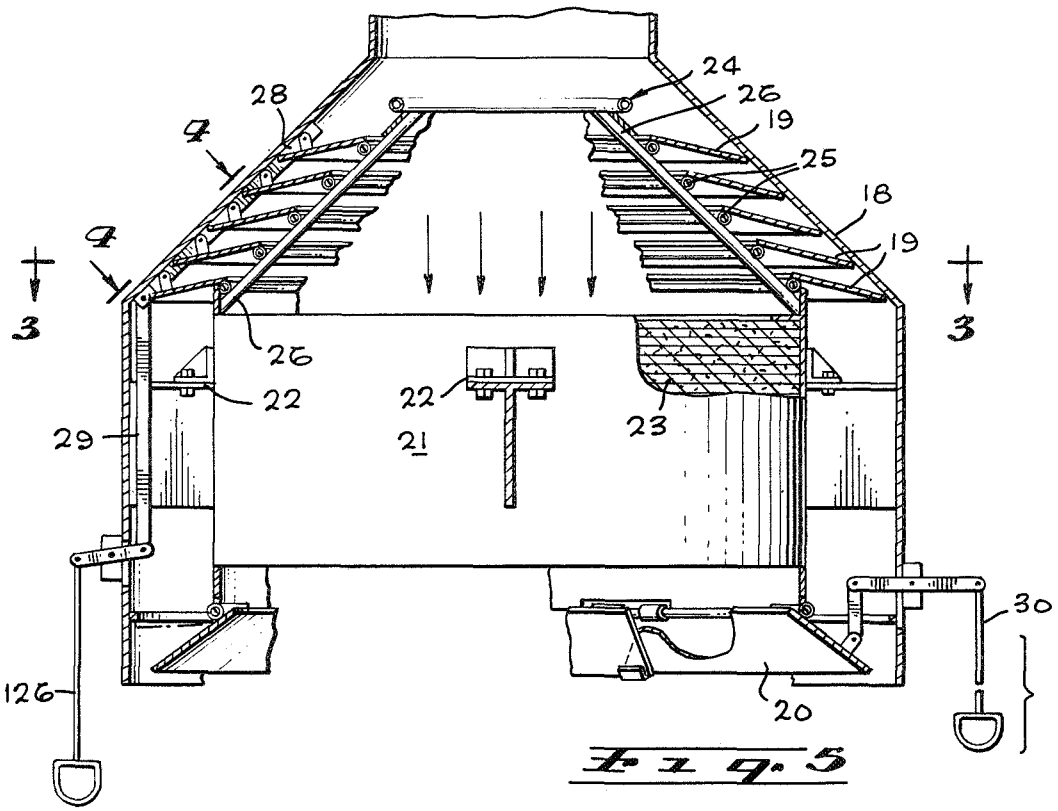
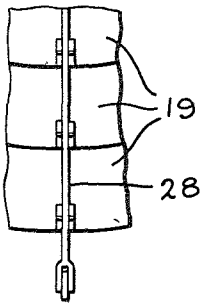
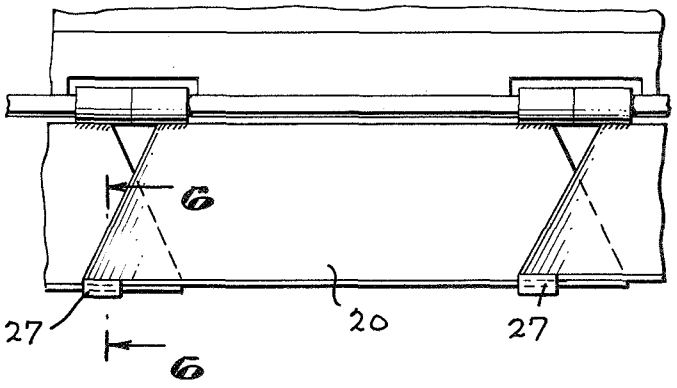


Fig. 5

Fig. 4





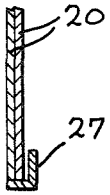


Fig. 6

WALTER KISZKO
INVENTOR.

BY Fulmer & Cox
Donald C. Kennedy
ATTORNEYS

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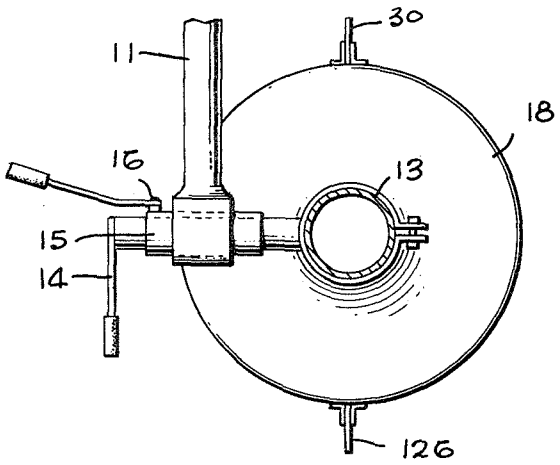
Fig. 1



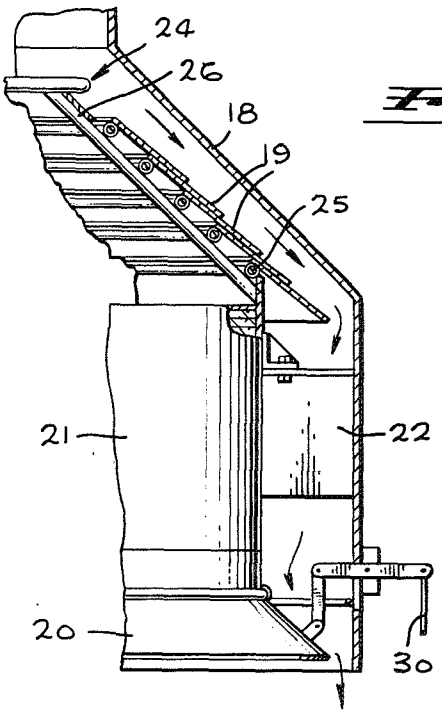


Fig. 2a

WALTER KISZKO
INVENTOR.

BY Fulwider Patton & Cary
Donald C. Kennedy
ATTORNEYS

United States Patent Office 3,385,036 Patented May 28, 1968

3,385,036

PORTABLE SUPERCLEAN AIR COLUMN DEVICE

James E. Webb, Administrator of the National Aeronautics and Space Administration with respect to an invention of Walter Kiszko, Costa Mesa, Calif.

Filed Sept. 6, 1966, Ser. No. 577,549
6 Claims. (Cl. 55—418)

ABSTRACT OF THE DISCLOSURE

A portable apparatus for producing a high velocity annular air column surrounding a central core of low velocity, filtered, superclean air to provide an atmosphere equivalent to that of a clean room at any desired work location. A plurality of adjustable louvers in an annular cavity of a projecting hood proportionally controls the volume of air delivered to the projecting hood central filter core and the annular passage. A second set of adjustable louvers controls the exhaust aperture size of the annular passage which governs the thickness and velocity of the annular air column.

The invention described herein was made in the performance of work under a NASA Contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85–568 (72 Stat. 435; 42 U.S.C. 4257).

The present invention relates to a portable apparatus for producing a high-velocity air column surrounding a central core of relatively low-velocity, filtered, superclean air to provide an atmosphere equivalent to that of a clean room at any desired work location.

In many industries today there is a need for exclusion of particulate contaminants. Contaminants are particularly disruptive in the process of manufacturing space vehicles, photographic film, pharmaceutical compounds and the like. Extensive effort is being expended to produce contaminant-free assembly, and subassembly area, to reduce the inclusion of contaminants which are detrimental to the performance of hydraulic control systems, sensitive relays, floated gyroscopes, high-gain optical systems, semiconductors and miniaturized electronic systems. Contaminants, whether of metallic or silicon dust, human flakes, or hydrocarbons, create a probability of failure for a given system due to loss of sealing qualities, or restriction of flow required to maintain and control critical fluid consumables in typical environmental control systems, propulsion systems, cooling systems, and photographic systems.

Contaminants in the form of hydrocarbons have caused violent and destructive explosions when inadvertently introduced to a liquid oxygen system. Particle migration under weightless conditions poses particular problems whereby the particles may restrict, or block minute orifices and prevent proper closure of valves. Size of contaminates are generally considered to cover the range of 0.5 micron to 300 microns and the degree of cleanliness is rated between these extremes and is governed by the application and specification of the system concerned. Additionally, metal dust particles have been graded according to the potential explosion hazards under certain conditions. Magnesium, magnesium-aluminum alloys, and aluminum, in concentrations under 75 microns, can be ignited by hot surfaces, or a weak electric spark even in a carbon dioxide atmosphere.

The general problem of cleanliness has been addressed by the provision of "clean rooms" whereby a discrete volume of work space is pressurized with filtered air and inhabitants are clothed in special garments to contain human flakes and fibrous materials from underclothing.

Tools and equipment are specially treated and construction material is given special consideration to reduce abrasive contamination. Clean rooms are extremely expensive to construct and maintain, especially when considered in terms of size required to assemble space capsules and the like. Typical equipment of such clean rooms filters 99 percent of all particles above one micron in size, and 90 percent of all particle 0.3 micron to 1.0 micron in size.

Another method of controlling manufacturing environments is the use of laminar-flow work stations. These devices are in the usual form of a booth having a working area over which a continuous, undisturbed, flow of clean air is passed. The air flow is regularly filtered to appropriate "clean room" specification, this filtered air passing over the work area, and exhausting to room ambient environment from the unenclosed front of the bench. Numerous modifications of the laminar-flow work station exist and produce a superclean environment above ambient. However, such apparatus lacks flexibility in portability and requires the assembly, or disassembly, of equipment to be performed within the working area of the laminar-flow booth. Laminar-flow booths, while serving the purpose for which designed, do not adapt to discrete and unique positioning of the super clean environment into confined working areas of the large assemblies comprised of numerous subassemblies.

Accordingly, it is an object of the present invention to provide a laminar or nonturbulent flow central column of filtered superclean air, said central air column having an annular curtain forming an air screen to prevent the incursion of external contaminated air into the central column of superclean laminar-flow air.

Another object of the present invention is to provide means for controlling the air flow volume or thickness of said annular curtain of air. A secondary purpose of the volume control means is to provide means for controlling the volume of air passing through filter means for providing superclean air supplying said central air column.

Another object of the present invention is to provide a portable, self-contained, filtered air supply which is adjustable as to height and direction of projected air flow.

The foregoing objects and advantages will lead to many applications such as in larger "clean room" installations to achieve areas of higher classification than ambient in any part of the room. Bio-clean facilities will be enhanced by the utility of the air curtain to isolate an assembly from aerosols generated by an assembler such as the assembler's exhalation, fallout from clothes, hair and other exposed body parts. This mobile air curtain may also be used in field hospital units to enable surgeons to operate under more aseptic conditions. Mobile laboratories engaged in particle counting or microbiological sampling may utilize the air curtain to produce work areas requiring aseptic conditions and techniques. Certain pharmaceutical operations may utilize the mobile air curtain in filling processes. Rescue squads may utilize the mobile air curtain as a shield which is injected with a water vapor or an inert gas to conduct rescue operations in toxic or obnoxious fume-filled areas.

Other objects, advantages, and applications of the apparatus in accordance with the present invention will become apparent from a consideration of the following description taken in conjunction with the accompanying drawings which are presented by way of example only and are not intended as a limitation upon the scope of the present invention, and in which:

FIG. 1 is a side view of the apparatus of the present invention showing the portability and adjustability thereof;

FIG. 2 is a side cross-section, partly cut away of the projection hood;

FIG. 2*a* is a fragmentary view partly in section showing the louvers in an open position;

FIG. 3 is a sectional view plan on line 3—3 of FIG. 2 showing the annular air curtain thickness control louvers and the central air column filter means;

FIG. 4 is a fragmentary view taken on line 4—4 of FIG. 2 showing the column control louver position control linkage;

FIG. 5 is a fragmentary view of a typical louver pivotal mounting structure showing the louver interleaving and louver interlocking flanges;

FIG. 6 is a cross-sectional view of the interleaving louvers taken on line 6—6 of FIG. 5 showing an interlocking flange;

FIG. 7 is a top view of the projecting hood taken on line 7—7 of FIG. 1 showing the hood rotating structure.

Referring now to the drawings wherein like reference characters refer to like parts throughout, FIG. 1 is an illustration of the portable superclean air column device in a typical operative use. The portability feature is provided by a rollable base 1 upon which is mounted a vertical stanchion 2 and an air impeller 3. Base 1 is provided with casters such as 1*a* and 1*b*.

Air impeller 3 has a primary filter means 4 for initial filtration of the ambient air intake affixed to it. Discharge duct 5 of impeller 3 is attached through filter 4 to a long flexible duct 6 for directing the efflux of said air impeller 3.

A vertical support member 7 is slidably mounted in vertical stanchion 2 and has a longitudinal rack 8 attached thereto. Said rack operatively engages a winch means 9 attached to the uppermost end of stanchion 2 for raising and lowering said vertical support member 7. The vertical support member 7 is fitted with a tubular housing 10 which is horizontally disposed at an uppermost end of said vertical support member.

The tubular housing 10 is adapted to slidably and rotably support a horizontal support member 11. Housing 10 further has a clamping means 12 for locking said horizontal support member 11 in a preselected position. The horizontal member 11 has a first and second end. The first end of the horizontal member 11 has a rotatable clamping bracket 13 mounted thereon, said bracket 13 having a crank means 14 for rotation of said clamping bracket 13. A guide sleeve 15 rigidly fixed to horizontal member 11 provides a bearing support for rotation of said clamping bracket 13. Locking means 16, mounted on guide sleeve 15, grips the crank means 14 at any preselected angle of rotation of said clamp bracket 13. At a second end of horizontal member 11 there is a duct supporting means 17 for holding flexible duct 6.

A projecting hood 18 is mounted in clamping bracket 13, said projecting hood 18 receives the exhaust end of said flexible duct 6. The projecting hood 18 is constructed to direct and diffuse a volume of air delivered by said air impeller means 3 through flexible duct 6. While the hood and its enclosed housing are illustrated herein as being generally round in cross-section to form an annular passage between them to form a surrounding air curtain, it will of course be understood that the structure could equivalently have a cross section which is square, rectangular, or of any other suitable shape.

The projecting hood 18 is shown in greater detail in FIG. 2. This figure shows the operative elements by which the annular air curtain air volume and thickness are controlled.

Air curtain volume control louvers 19 are shown in a full-open position in FIG. 2*a* and a full-damp position in FIG. 2.

The projecting hood 18 consists of an upper tubular segment joined to a frustro-conical portion having downwardly depending sides. A filter housing 21 is mounted centrally within the cavity formed by the downwardly depending sides of said projecting hood 18. The filter housing 21 is spaced inwardly from said downwardly depending sides and is supported by flanges 22 which are fixed to said downwardly depending sides, said flanges 22 being spaced equally around the internal perimeter of said cavity. An air filter means 23 (preferably of 0.3 micron rating or better) is disposed within the cavity formed by the sides of filter housing 21 for cleaning and filtration of air passing therethrough and thence into the control cavity of the hood. A frusto-conical framework 24 having a base mounted on filter housing 21 is comprised of a plurality of spaced, concentric rings 25 attached to radially spaced legs 26 forming the framework 24, said framework being spaced inwardly from the frusto-conical sides or prejecting hood 18. Air curtain volume control louvers 19 are pivotally mounted on rings 25, further being linked to louver actuating means 126 for pivotal movement about rings 25. Movement of louver actuating means 126 adjusts louvers 19 outwardly from a first position full open, to a position partially blocking the flow of air into the annular passage formed by the projecting hood 18 downwardly depending sides and filter housing 21. Adjusting the volume control louvers outwardly forces more air to pass into the filter means 23 for exhausting therethrough and reduces the amount of air flow forming the air curtain. When volume control louvers 19 are adjusted outwardly to block the annular air passage, air delivered by air impeller means 3 is diverted to pass through filter means 23 which is adapted to provide laminar flow therethrough. Certain working conditions requiring clean air also require a low velocity flow of clean air over a workpiece to insure that work being performed on the article does not contaminate the workpiece. Adjustment of the air curtain volume control louvers 19 provides a means for adjusting the velocity of air passing through the filter 23.

Louver interlocking flanges 27 as shown in FIGS. 5 and 6 are members installed to guide and control the uniform movement of each individual louver with respect to an adjoining louver. FIG. 4 shows a position control member 28 and a linkage 29 which coact to adjust the volume control louvers in an open or partially closed position. Louver actuating means 126 are preferably provided with a position locking means such as a clamp or ratchet to hold louvers 19 in a selected position.

An extended skirt is provided on filter housing 21 for pivotally mounting air curtain thickness control louvers 20. Louvers 20 are adapted to pivot outwardly from the filter housing skirt into a position to adjustably change the exhaust aperture of the annular cavity formed by the projecting hood 18 downwardly depending sides and filter housing 21. Louver adjustment means 30 are provided for setting the adjustment of the thickness control louvers 20. Interlocking flange members 27 are also provided on louvers 20.

In operation adjusting volume control louvers 19 provide a given flow volume into the annular cavity and into the filter 21. As louvers 20 are adjusted outwardly the annular air curtain thickness is reduced and the velocity of the air forming the curtain is increased. This feature provides a means for adjusting the effectiveness of the annular air curtain in achieving its objective or preventing the incursion of contaminated air currents into the central core of highly filtered air.

It is thus seen that the device provides a mobile or portable means for establishing a super clean area defined within a central core to which filter air is supplied and which is protected by a surrounding annular sheath of air. The relative volume of filtered air supplied to the central core and the annular sheath is adjustable by a first set of louvers. The thickness and hence the velocity of the annular sheath is independently adjustable by a second set of louvers. The core and sheath may be projected at any desired angle to provide an unrestricted work area. The velocity air curtain or annular sheath prevents contamination of the central air column.

In use this invention may also employ forms of sterilizing lamps or heaters to provide a clinically clean work-

space for emergency surgical use in military field stations, or disaster areas. A device such as described would also find use in the hospital operating room in the same manner as would be used in clean room assembly areas. Inert gases can be injected into the annular air curtain cavity to provide a rescue device permitting an operator to be disposed within the annular air curtain breathing filtered air and protected from noxious fumes and the like by the inert gas curtain. These and other uses may be found for this invention. It can be constructed to any scale and provided with appropriate sizing of the air impeller and can be adapted for a wide range of uses.

What is claimed is:

1. A portable superclean air column device comprising:
   (a) hood means forming an elongated chamber;
   (b) housing means mounted coaxially within said hood means in spaced relation therefrom and having downwardly depending sides to form an exhaust duct between said hood and said housing and to form a central cavity within said housing;
   (c) means to movably support said hood means;
   (d) means to introduce a high pressure gas flow into said exhaust duct and into said central cavity;
   (e) filter means to clean the gas supplied to said cavity and to reduce its velocity to produce a central body of low velocity superclean gas discharging from said cavity which is surrounded by a high velocity curtain of gas discharging from said exhaust duct;
   (f) and means to variably control the proportion of said gas flow which is supplied to said exhaust duct and to said central cavity respectively.

2. A portable superclean air column device, as recited in claim 1 in which the downwardly depending sides of said housing comprises:
   (a) a plurality of pivotably adjustable louvers, said louvers forming an extension of said housing downwardly depending sides and being pivotally mounted thereon, said louvers further having adjustment means for adjusting said louvers in an outward direction from the perimeter of said housing, forming a variable annular exhaust aperture of said hood for adjustment of the thickness of said annular exhaust duct.

3. A portable superclean air column device as recited in claim 1 in which said variable proportion control means comprises:
   (a) a plurality of volume control louvers pivotally mounted on rings which form the framework of said housing, said louvers having means to pivot outwardly from sides of a portion of said framework, said louvers extending into the annular duct formed by the sides of said hood and said housing when said louvers are adjusted outwardly for forming a variable flow restriction in said annular duct for control of air impeller efflux flow therethrough.

4. A portable superclean air column device which comprises:
   (a) a base having means to receive rollable support means for movement of said base;
   (b) an upright stanchion attached to said base, said stanchion receiving a vertical support member and having vertical adjustment means for vertical positioning of said support member, said stanchion further having releasable locking means for locking said support member in a preadjusted position;
   (c) a horizontal support member slideably and rotatably mounted on said vertical support member;
   (d) a frusto-conical hood, said hood having downwardly depending sides, said sides forming an elongated chamber, said hood being mounted on a first end of said horizontal support member;
   (e) a variable speed impeller mounted on said base, said impeller having electrical drive means for rotation of said impeller blades;
   (f) a conduit means attached to the discharge orifice of said impeller and to an inlet opening to said hood for directing the efflux of said impeller into said chamber;
   (g) a frusto-conical housing having downwardly depending sides forming an elongated central cavity, said housing being mounted within said chamber formed by said hood and spaced inwardly from said hood to form an annular exhaust duct between said hood and said housing and to form said central cavity within said housing;
   (h) a particle filter means mounted within the central cavity of said housing for particle filtration of said impeller efflux flowing therethrough, said filter means also having means for reducing the flow velocity of said impeller efflux passing therethrough for providing a low velocity, superclean flow of said impeller efflux into said cavity, said low velocity, superclean efflux being surrounded by a high velocity curtain of air impeller efflux exhausting downwardly through said hood annular exhaust duct;
   (i) and means to variably control the proportion of said efflux of said empeller which is supplied to said exhaust duct and to said central cavity respectively.

5. A portable superclean air column device as recited in claim 4 in which the downwardly depending sides of said housing comprises:
   (a) a plurality of pivotably adjustable louvers, said louvers forming an extension of said housing downwardly depending sides and being pivotally mounted thereon, said louvers further having adjustment means for adjusting said louvers in an outward direction from the perimeter of said housing to form a variable annular exhaust aperture of said hood for adjustment of the thickness of said annular exhaust duct high velocity efflux curtain.

6. A portable superclean air column device which comprises:
   (a) a variable speed impeller having electrical power driving means for rotation of said impeller blades;
   (b) a frusto-conical hood having an inlet and an outlet with downwardly depending sides forming an elongated exhaust cavity;
   (c) a support for mounting said hood thereon, said support having vertical adjustment means, said support further having a transversely slideable member and means for locking said slideable member in a selected position with respect to said support, said slideable member further having an axle at a first end, said axle being adapted to support said hood, said axle further having means for rotatable positioning of said hood with respect to said support;
   (d) a conduit attached to the discharge opening of said impeller for directing the efflux of said impeller, said conduit also being connected to said hood inlet opening;
   (e) an elongated housing having a central aperture, said housing being mounted within the elongated exhaust cavity formed by said hood downwardly depending sides, said housing being spaced inwardly from said sides to form an annular exhaust duct within said hood cavity, said housing central aperture further forming a central exhaust cavity in concentric relationship to said annular duct;
   (f) a frusto-conical framework installed within the conical portion of said hood, said framework extending upwardly from said elonged housing inlet end and spaced inwardly from said conical portion, said framework forming an annular passageway, said passageway being in communication with said annular exhaust duct formed by said housing, said frame further forming a central passageway, said central passageway being in communication with said housing central exhaust cavity.
   (g) a plurality of volume control vanes pivotally

mounted on the exterior perimeter of said framework and adapted to pivot therefrom, said vanes positioned in a downwardly depending position adjacent to sides of said framework forming an annular duct and a concentric central duct in said conical portion, said vanes further having adjusting means for positioning of said vanes outwardly from sides of said frame, said vane position adjustment forming a variable annular duct opening to variably control the proportion of the efflux of said impeller which is supplied to said exhaust duct and to said central cavity respectively;

(h) a particle filter means mounted within said housing central aperture for filtration of particles flowing therethrough, providing a low velocity efflux exhausting through said central cavity;

(i) a plurality of exhaust louvers pivotally mounted on the perimeter of said housing downwardly depending therefrom, said louvers having outward adjusting means for varying the width of said annular duct exhaust opening for controlling the thickness of the high velocity annular efflux of said hood, said annular efflux forming a high velocity curtain of flow

surrounding the low velocity efflux exhausting from said central aperture.

References Cited

UNITED STATES PATENTS

1,682,407	8/1928	Nelson et al.	
2,115,482	4/1938	Crewe	55—467
2,313,676	3/1943	Shaver	55—471
2,500,606	4/1950	Dosmar.	
2,550,810	5/1951	Heidbrink.	
2,627,217	2/1953	Hainke et al.	55—467
2,817,281	12/1957	Schwan et al.	
2,860,566	11/1958	Allsup et al.	
3,112,002	11/1963	Van der Lely.	
3,126,810	3/1964	Karlsson et al.	
3,151,929	10/1964	Potapenko.	
3,224,171	12/1965	Bowman	55—467
3,251,177	5/1966	Baker.	
3,273,323	8/1966	Whitfield	55—472

HARRY B. THORNTON, *Primary Examiner.*

B. NOZICK, *Assistant Examiner.*