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

REPLY TO
ATTN OF: GP

March 27, 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. : 3,337,279

Corporate Source : Lewis Research Center

Supplementary
Corporate Source :

NASA Patent Case No.: XLE-02531

Gayle Parker

Enclosure:
Copy of Patent

NASA-HQ

Aug. 22, 1967 G. REINHARDT ETAL 3,337,279

GAS PURGED DRY BOX GLOVE

Filed Jan. 12, 1965

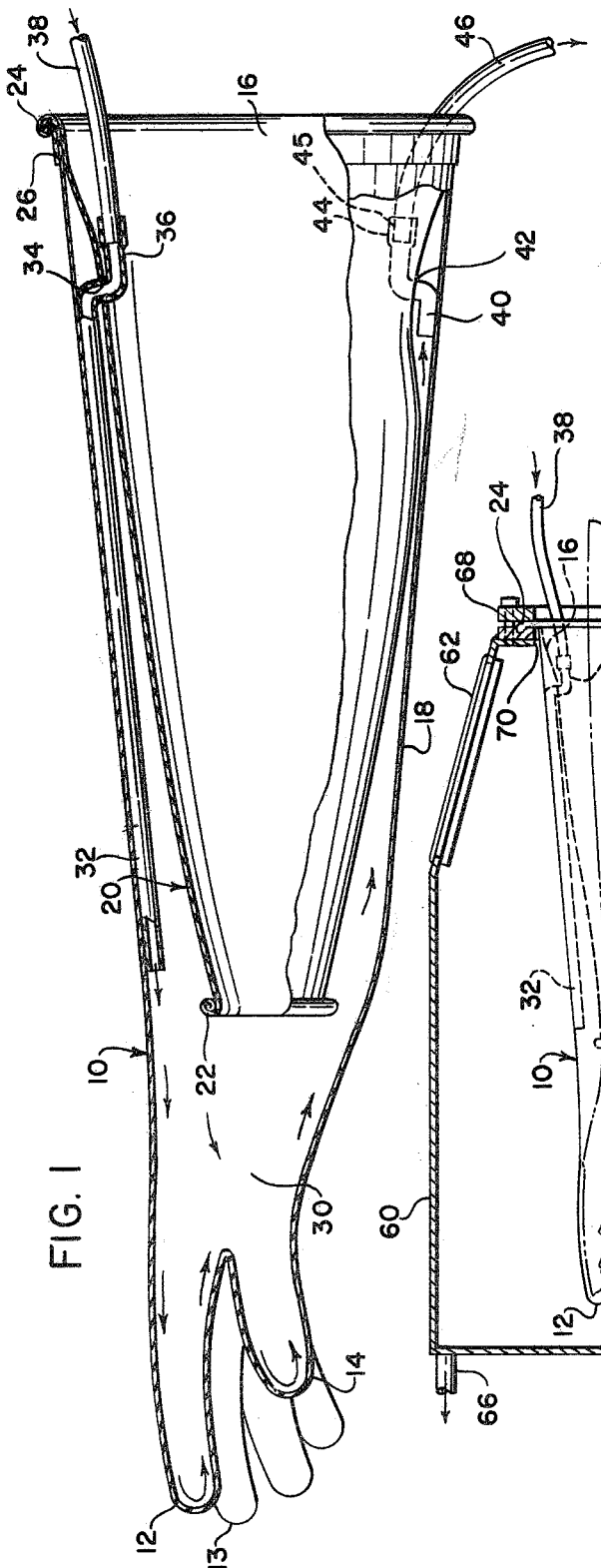

FIG. 1

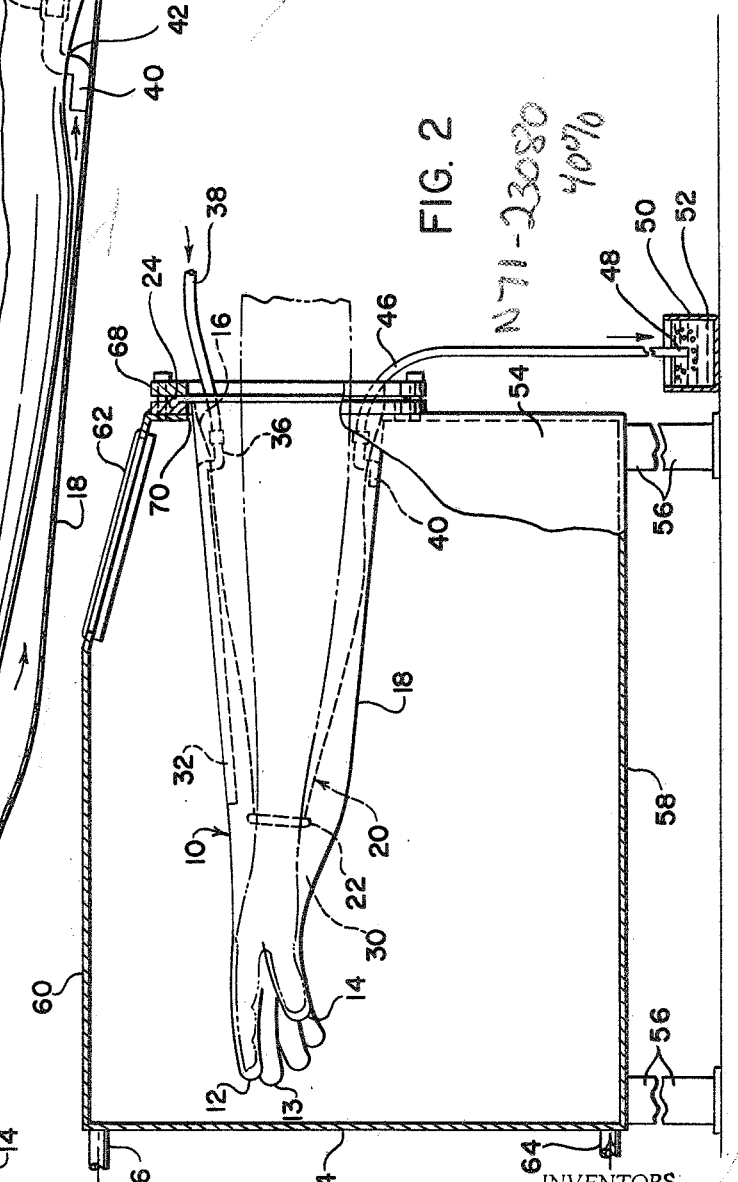

FIG. 2

N71-23080

40070

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GAS PURGED DRY BOX GLOVE

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12 Claims. (Cl. 312—1)

ABSTRACT OF THE DISCLOSURE

A dry box glove comprising an inner glove and an outer glove, the inner glove being adapted to sealingly engage the wrist of a wearer, the space between the inner and outer gloves being maintained at a pressure slightly higher than atmospheric by an inert gas admitted near the hand enclosing portion and exhausted near the hand receiving end, the inner and outer gloves being sealingly joined at the hand receiving end.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention concerns a gas purged dry box glove, and it is particularly adapted for use in dry box operations involving material sensitive to air or moisture such as submicron metal powders. The term "dry box" is meant to include nuclear dry boxes, bacteriological isolators, laboratory controlled atmosphere chambers, safety enclosures, electronic assembly boxes, semiconductor assembly boxes and inert gas welding boxes.

In its broadest sense, the invention relates to a dry box glove having an elongated outer flexible hollow skin with a plurality of appendages adjacent one end thereof for receipt of the thumb and fingers of the wearer. At the end of the outer skin opposite the appendages is an enlarged opening for receipt of the arm of the wearer. A continuous tubular intermediate portion is provided between the finger and thumb appendages and the arm opening. On the inside of the flexible outer skin of the glove in sealed engagement with the outer skin adjacent the arm opening is a gauntlet or flexible tubular member which extends toward the appendages and has an open end for tight engagement around a portion of the arm of the wearer such as the wrist.

A gas inlet or port is provided between the hollow skin and the gauntlet at a location which is longitudinally spaced from a gas outlet similarly located between the hollow skin and the gauntlet. Suitable gas supply means is connected to the gas inlet means during use and a gas pressure regulating device is utilized in connection with the gas outlet means.

The gas supply means may be in the form of a conventional gas storage tank or receptacle having gas therein under pressure and suitable valving means for release of the gas. The pressure regulating means for use with the gas outlet means may be in the form of a conventional bubbler which requires a pressure in excess of atmospheric pressure to force the gas out of the outlet means and through a liquid medium in the bubbler into the atmosphere. Such bubblers are well known in the art and conventionally use oil or other viscose liquid through which the gas is bubbled. It has been found that an inert gas such as argon is preferred for the purposes of the invention, but the use of other dry gases in accordance with the principles of the invention is contemplated.

It is a purpose of the invention to reduce the permeation of air or moisture into a dry box or isolator by diffusion of moisture through the gloves into the box. The use of dry boxes to process materials which are poisonous, radio active or in other ways harmful to the human system is widely practiced in laboratories and research facilities throughout the world. Dry boxes must also be used for the handling and treating of materials which are subject to harmful contamination or reaction with the normal atmosphere as, for example, in the processing of fine metal powders or highly reactive materials such as the alkaline earth metals.

In general, dry boxes consist of air-tight chambers with windows for observing manipulative operations performed therein with one or more pairs of flexible gloves sealed to the edges of openings in the chamber walls in such a manner that an operator may place his arms forward into the sealed chamber.

The dry box chamber is generally filled with an atmosphere which is nonreactive with respect to the materials being handled. Gasses such as argon, helium, and nitrogen are commonly used for this purpose. A problem has been present in the prior art, however, which results from the nature of the thin flexible materials or skins which are used to make the gloves. The thinness and flexibility of the glove material is necessary, of course, to provide ease of physical manipulation by the operator. It has been found, however, that air and moisture will diffuse through most flexible materials at appreciable rates which thereby contaminate the atmosphere and degrade the materials being worked on in the dry box. This has been a problem of the prior art which, until the time of the present invention, has not been satisfactorily eliminated, and prior attempts to reduce moisture diffusion have not been entirely successful.

Attempts to eliminate the prior art problem of moisture diffusion into the dry box through the materials of the dry box gloves have been varied. Thicker outer skins have been tried but because of their lack of flexibility they have been found to be too clumsy for use. Another attempt involved selecting a material for the skin which has a small permeability, but this was found unsatisfactory for the same reason. Another attempt involved the incorporation of a small diameter tube leading into the glove adjacent the palm of the hand of the operator. Air was blown through the tube into the glove cavity adjacent the operator's hand in an attempt to cool the hand and reduce perspiration.

The air circulation method, however, did not in any way reduce air diffusion into the dry box. The reason for its failure was that generally in a dry box, the internal pressure of the gas within the chamber is slightly greater than the atmospheric pressure. Accordingly, little or no cooling of the hand and the arm within the glove resulted because the glove collapsed and fitted tightly against the hand and arm of the operator due to the pressure differential it was supporting. On account of this pressure differential and the collapsing of the glove tightly against the skin the circulation around the hand and the arm was poor and moisture permeation was substantially the same as with no attempt at cooling. If a higher pressure of air had been used within the glove, the moisture diffusion rate through the glove would have obviously increased.

With the problems of the prior art devices and attempts in mind, and a recognition that moisture diffusion into a dry box is detrimental to the operations normally involved, it is a general object to provide an improved dry box glove and method which reduces permeation of moisture into a dry box during use.

It is a more specific object of the invention to provide a dry box glove having an outer flexible hollow skin and an inner gauntlet which together define a hand receiving cavity which is gas purged during use to reduce the per-

meation of moisture by diffusion through the glove into a dry box.

It is still another object of the invention to provide a dry box glove which is more comfortable for the wearer during the performance of operations in dry boxes.

It is a more specific object of the invention to provide an improved dry box glove which reduces permeation of air or moisture into a dry box by diffusion through the glove and which provides increased comfort and maneuverability for the operator in a construction which is relatively simple and inexpensive to manufacture.

Other and more specific objects of the invention will be apparent from a detailed description to follow.

In the drawings:

FIG. 1 is a horizontal elevational view of a dry box glove constructed according to the principles of the invention with certain of the parts broken away and in section for clarity.

FIG. 2 illustrates the dry box glove in use in a chamber of a dry box.

The glove of FIG. 1 has an elongated hollow flexible outer skin, generally designated by the numeral **10**, of polyvinyl chloride or other suitable elastomeric material conventionally used for dry box gloves. The polyvinyl chloride skin **10** has suitable appendages such as fingers **12**, **13**, and thumb **14** provided in conventional manner on one end thereof. On the end of the skin **10** opposite the appendages **12**, **13**, and **14** is an opening **16** to receive the arm and hand of the wearer. An intermediate continuous tubular outer sleeve section **18** connects the end having the appendages **12**, **13**, and **14** with the open end **16** in a conventional manner.

A hollow, sleeve-like gauntlet member **20** having a relatively small wrist engaging end or cuff **22** is suitably spaced from appendages **12**, **13**, and **14** such that when the wearer's hand is inserted into the glove with the fingers and thumb in the appropriate appendages, the end of the gauntlet member **22** tightly grips the wrist of the wearer. The opening of the cuff **22** is surrounded by a bead-like formation suitably formed by laminations of material rolled back upon the outside of the gauntlet **20** and sealed therein in a manner which permits expansion and contraction of the opening upon insertion or removal of the hand of the operator.

The gauntlet **20** is preferably made of the same polyvinyl chloride flexible skin material as the elongated outer hollow skin **10**, and extends from the cuff **22** to the arm opening **16** wherein it is rolled and sealed with the outer skin **10** into a bead means **24** having a suitable reinforcing band **26**.

The outer flexible hollow skin **10** and the inner gauntlet **20** form a cavity **30** in which the hand of the wearer is positioned during use. A tubular conduit **32** preferably of polyvinyl chloride or other flexible material extends into the cavity **30** adjacent the cuff **22** of the gauntlet from a point in the gauntlet near the opening **16** where it passes through an opening **34**. This construction provides an exposed end **36** of the tube **32** within the gauntlet and adjacent the opening **16**. The opening **34** in the gauntlet **20** forms with the outer wall of the tube **32** a gas-tight seal such that no leakage into the cavity **30** from the atmosphere or interior of the gauntlet can occur at that point.

A gas supply tube **38** is provided by suitable gas-tight connection in communication with the end **36** of the tube within the gauntlet **20** such that a supply of gas from a conventionally higher pressurized gas storage tank (not shown) can be connected to the supply tube **38**. The gas enters the end **36** of the tube and passes into the cavity **30** through the tube **32** at a point preferably adjacent the hand of the operator.

The gas outlet tube **40** makes a gas-tight connection **42** with the gauntlet **20** and has an exposed end **44** within the gauntlet **20** adjacent the opening **16** in a manner similar to that of the gas supply inlet tube **32**. A gas

exhaust tube **46** is suitably connected by means of a gas-tight telescopic connection **45** to the end **44** of the outlet tube **40**. The gas exhaust tube **46** has an end **48** which extends downwardly into a gas bubbler receptacle **50**. The gas bubbler receptacle **50** has an oil or other suitable viscose liquid **52** therein which insures that a pressure greater than atmospheric pressure is required to force the gas from the end **48** of the gas exhaust tube **46** into the atmosphere. The pressure within the cavity **30** of the glove is dictated by the depth at which the end **48** of the tube **46** is placed in the oil **52**. It, of course, would be obvious that other pressure regulating devices might be used to maintain a desired pressure in excess of atmospheric pressure within the cavity **30**.

The dry box illustrated in FIG. 2 comprises a box-like structure having sidewalls **54** and legs **56** or other suitable supports therefor with a base or floor **58** and a top enclosing structure **60**. A suitable observation window **62** with a sufficient seal to the box to prevent leakage of gas is provided in the known manner. A gas supply tube or inlet **64** to the box is provided such that in co-operation with a gas exhaust or outlet tube **66** a constant purging of the environment of the box may be accomplished. This purging preferably is at a pressure just slightly above atmospheric pressure within the box so as to minimize collapsing of the outer hollow skin **10** of the glove and the attendant disadvantages thereof previously discussed.

The pressure in the cavity **30** of the glove is maintained by adjusting the depth of the tube **46** in the oil **52** of the gas bubbler **50**, above atmospheric pressure at all times and is preferably substantially equal to the pressure within the box during purging to prevent a complete collapsing of the glove about the hand and arm of the operator. It has been found that a slight tolerance of pressure variation within the glove which is either slightly above or below the pressure in the box is acceptable, but it is generally preferable to have the pressure about that of the box atmosphere. However, in all cases this pressure must be in excess of atmospheric pressure to maximize the reduction of moisture diffusion through the skin **10** of the glove into the gas in the box.

It will normally be found that the composition of the gas in the interior chamber of the dry box is the same as that in the glove, although it would be possible in certain instances to use different inert gases for the purging of the dry box and the purging of the glove without detrimental effects to the contents of the dry box.

The bead **24** which surrounds the opening **16** of the dry box glove is sealed about its entire periphery of the opening **70** in the dry box through which the glove and arm of the operator are inserted. Plate **68** is of conventional construction and equivalent glove-to-box sealing means may be utilized to seal the aperture **70** and the outer skin of the glove **10** against gas leakage.

It will also be readily recognized that design modifications in the form of alternate embodiments of the invention could be provided. One modification which has been specifically contemplated includes the provision of a much longer gauntlet which would come down to the palm of the hand or even cover the entire hand and fingers. Also, it is possible to purge the cavity within the gauntlet such that the entire arm would be surrounded by inert gas further to minimize the effects of moisture from perspiration of the operator. It will be seen in this connection that various systems of purging lines more elaborate than that illustrated could be utilized to maximize the circulation of the inert gas about the hand and arm of the operator. However, in the illustrated embodiment it has been found that by providing the inlet tube near the appendages of the hollow outer skin and the outlet tube near the opposite end of the hand cavity **30**, adequate circulation may be effected with a minimum of complex requirements.

In an actual test of the illustrated embodiment of the novel glove, argon gas was purged through a dry box

at the rate of 20 cubic feet per hour. An operator performed a standard exercise with one hand in a glove constructed as in the illustrated embodiment with argon gas purged through the hand receiving cavity at 20 cubic feet per hour. The exercise consisted of shaking a 4 pound weight for a 50 percent duty cycle, that is, 15 seconds of work and 15 seconds of rest, alternately for a period of 1 hour. Subsequently, during a second 1 hour period, the operator performed the same exercise without the weight alternating with periods of 15 seconds of work and 15 seconds of rest. The gas from the dry box was monitored with a moisture analysis instrument which showed that after an initial period of varying moisture buildup from perspiration of the arm and diffusion through the glove, a steady state condition was achieved in which the moisture content in the dry box increased over a constant rate of 60 parts per million per hour.

In a second test using the same times and exercises with no argon purging of the glove, the steady rate of moisture buildup was 122 parts per million per hour. This is more than twice the moisture contamination rate than the test in which the glove was purged.

It should be noted that the gauntlet used in the test was an experimental device which was handmade and did not have perfect seals about the cuff or the joints of the gauntlet with the inlet and outlet tubes. However, despite the crudeness of the test, the argon purging was effective to reduce the moisture contamination rate to one-half the value obtained without purging. Moreover, it is obvious that although not specifically measured, it would be expected that oxygen contamination within the dry box would also show at least a comparable decrease when the purged glove is used as opposed to the nonpurged glove.

Another observation made during these tests was that the operator's hand was saturated with perspiration in the test where no purging was utilized, but the hand was normally colored and practically free from perspiration after the test in which the glove was purged.

For ease of description the principles of the invention have been set forth in connection with but a single illustrated embodiment showing one design of purged dry boxed gloves. It is not our intention that the illustrated embodiment nor the terminology employed in describing it be limiting inasmuch as variations of these may be made without departing from the spirit of our invention. Rather, we desire to be restricted only by the scope of the appended claims.

We claim:

1. A dry box glove comprising:
an elongated outer flexible hollow skin having a plurality of appendages adjacent one end thereof,
an enlarged opening at the end opposite said one end,
a continuous tubular intermediate portion between said appendages and said opening,
a gauntlet inside of said intermediate portion and in sealed engagement with said outer skin adjacent said opening,
a gas inlet in communication with the cavity between said outer skin and said gauntlet,
and a gas outlet in communication with the cavity between said outer skin and said gauntlet.

2. The glove of claim 1 in which the gas outlet and the gas inlet are on opposite sides of said opening at longitudinally spaced locations in the cavity between the outer skin and the gauntlet.

3. The glove of claim 1 in which the gas outlet communicates with the cavity between the outer skin and the gauntlet adjacent the location at which the sealed engagement between the outer skin and the gauntlet is effected and the gas inlet communicates with the cavity between the gas outlet and the appendages.

4. The glove of claim 1 in which the gauntlet has a length sufficient to extend over at least a portion of a hand of a wearer of the glove.

5. The glove of claim 1 in which the outer flexible hollow skin and the gauntlet are of an elastomeric material.

6. The glove of claim 5 in which the elastomeric material is primarily polyvinyl chloride.

7. The glove of claim 1 in which the gas outlet is provided with pressure regulating means to control the pressure within the cavity between the outer skin and the gauntlet.

8. The glove of claim 7 in which the pressure regulating means is a gas bubbler which maintains the pressure within the glove above atmospheric pressure at all times.

9. The glove of claim 1 in which the enlarged opening in the outer skin is defined by a bead of material which effects the sealed engagement between the outer skin and the gauntlet.

10. A dry box glove comprising:
an elongated outer elastomeric hollow skin having a plurality of appendages adjacent one end thereof for receipt of the fingers and thumb of a wearer,
an enlarged opening having a reinforced perimeter at the end opposite said one end for receipt of an arm of the wearer,
a continuous tubular intermediate portion between said appendages and said opening,
a gauntlet for tightly fitting about the wrist of the wearer inside of said intermediate portion and in sealed engagement with said outer skin adjacent said opening,
a gas outlet in communication with the cavity between said outer skin and said gauntlet,
and a gas inlet in communication with the cavity between said outer skin and said gauntlet at a location between said appendages and said gas outlet,
and a pressure regulating means maintaining the pressure within said glove above atmospheric pressure at all times during use.

11. A method of reducing the contamination of a first body of gas by a second body of gas separated therefrom by a permeable membrane comprising introducing a quantity of circulating inert gas between said second gas and said permeable membrane and maintaining said inert gas at a pressure at least equal to that of said second gas.

12. A method of reducing the passage of atmospheric contaminants into an airtight box through a permeable glove member mounted on an opening in said box comprising purging the cavity of said glove with an inert gas and maintain said inert gas at a pressure at least equal to that of the atmosphere.

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