United States Patent

Flatau

[15] **3,645,694**

[45] **Feb. 29, 1972**

[54] **AUTOROTATING BODY GAS DETECTOR AND METHOD OF USING THE SAME**

[72] Inventor: **Abraham Flatau,** Joppa, Md.

[73] Assignee: **The United States of America as represented by the Secretary of the Army**

[22] Filed: **Sept. 16, 1968**

[21] Appl. No.: **761,390**

[52] **U.S. Cl.** .....**23/232 R,** 23/254, 416/197

[51] **Int. Cl.** **G01n 31/22**

[58] **Field of Search** 23/232, 254; 416/110, 111, 416/112, 197

[56] **References Cited**

UNITED STATES PATENTS

3,507,622	4/1970	Tammelin et al.	23/254
1,022,955	4/1912	Leech	23/254
1,697,574	1/1929	Savonius	416/110

FOREIGN PATENTS OR APPLICATIONS

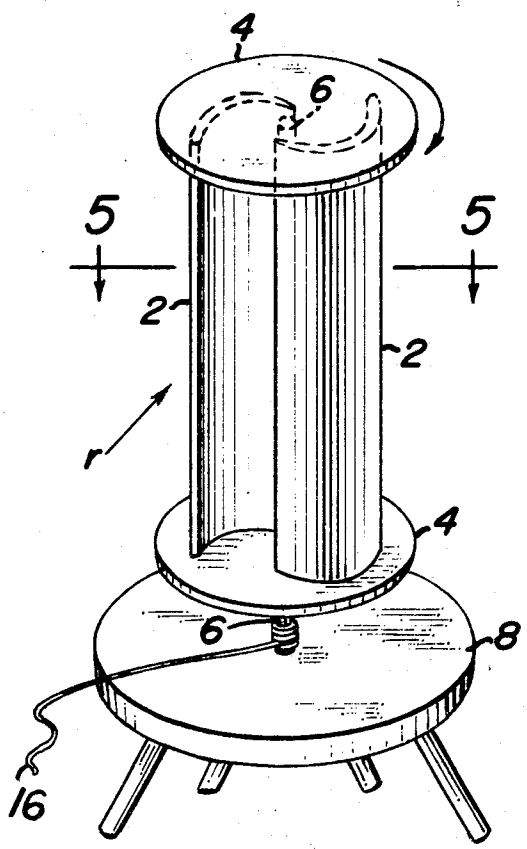
643,133	9/1950	Great Britain	416/111

Primary Examiner—Morris O. Wolk
Assistant Examiner—R. M. Reese
Attorney—Harry M. Saragovitz, Edward J. Kelly, Herbert Berl and Jacob Ziegler

[57] **ABSTRACT**

The method of detecting various constituents comprising placing an autorotating body in a fluid medium fitted with absorbent materials capable of retaining the various fluid components which are subsequently tested for presence or absence by known chemical and/or physical means.

9 Claims, 7 Drawing Figures



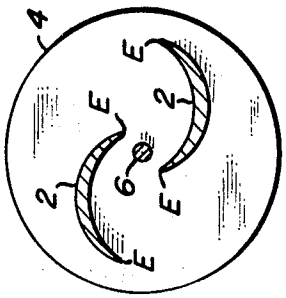


Fig.3

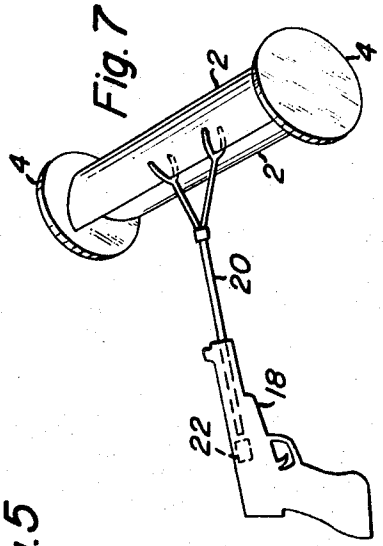


Fig.7

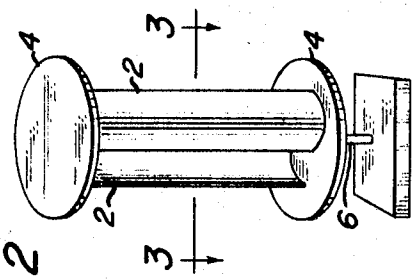


Fig.2

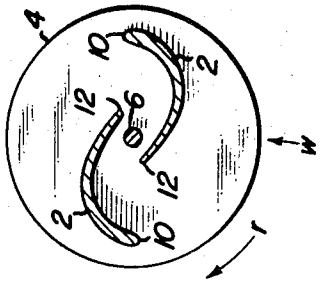


Fig.5

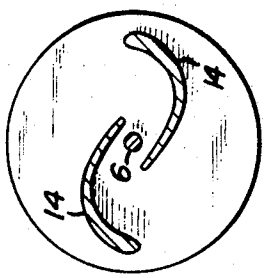


Fig.6

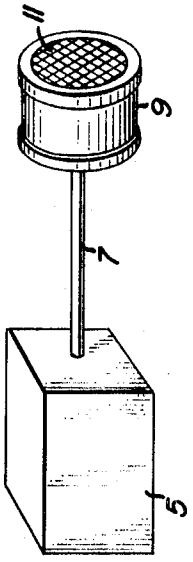


Fig.1

Figs. 1,2,3 Indicate Prior Art

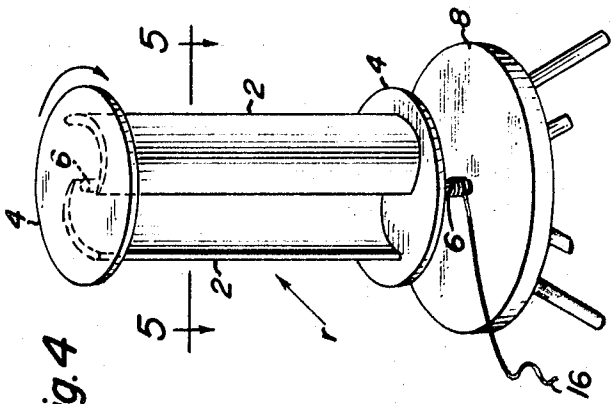


Fig.4

INVENTOR.
Abraham Flatau
BY Harvey M. Saragovitz
Edward J. Kelly
Herbert Berl
Jacob Ziegler (AGENT)
ATTORNEYS

AUTOROTATING BODY GAS DETECTOR AND METHOD OF USING THE SAME

DEDICATORY CLAUSE

The invention described herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention is directed to the method of detecting various constituents in the atmosphere utilizing an autorotating body as the support means.

An object of this invention is to provide a new aerodynamic configuration.

It is a further object of this invention to provide an autorotating body with increased rotational and aerodynamic performance.

A still further object of the invention is that the atmosphere sampled includes not only the fluid immediately surrounding the testing device, but also the distant fluid media which is pumped toward the device by its enhanced autorotating properties.

A further object is to provide a detecting system which will permit the sampling of the atmosphere prior to the entrance of combat troops.

The inventive methodology is directed to an autorotating body fitted with various absorbent materials capable of retaining the various fluid components which are subsequently tested for presence or absence by known chemical and/or physical means.

The autorotating structure is based upon the utilization of an aerodynamic device comprising two coaxial cylindrical members positioned adjacent to each other. The general convex and concave surfaces of each member are cambered with the added requirement that the forward (leading) and rearward (trailing) edges are rounded so that the leading edge radius is noticeably greater in radius than the trailing edge. The coaxial members are positioned so that their concave sides are confronting each other thus forming an air space by means of which the flow field is assisted so that the effect of the rotating means on the fluid medium is equivalent to a pumping action. This action provides an increase in the fluid circulation into and around the rotating means. The rearward edge of each coaxial member is positioned between the forward and rearward edges of the confronting member. End plates are attached at the ends of the coaxial members to increase the aerodynamic and rotational performance efficiency.

The various commercial sampling devices for detecting air contaminates are well known. The construction of such a commercial sampler, FIG. 1, is a housing fitted with a removable filtering means such as filter paper or screen. The force necessary for drawing the air through the filtering means is any conventional vacuum pump enabling the sucking of atmosphere through the filtering means which entrain the components to be identified.

Savonius, U.S. Pat. No. 1,697,574, FIGS. 2–3, discloses a rotor functioning for driving pumps, dynamos nd other machinery. The rotor consists of splitting a symmetrical circular tube into two equal parts positioned about its axis of rotation which is approximately midway between said two equal parts. This rotor has certain characteristics which are undesirable. The autorotor is in a fixed position relative to the earth. The design of the structure results in requiring a high starting torque which in turn requires a strong wind. The rate of autorotation over a sufficient period of time may be inadequate to be fully useful.

An investigation was instituted to determine the best mode of protecting the members of our armed forces from the probability of entering or remaining in various contaminated areas containing toxic or noxious material.

As a result of my studies the concept emerged of utilizing a sampling structure which is unattended and does not require any power supply. In addition, it is a monitoring system which has complete mobility, minimum weight, and is not required to be in a fixed or stationary position. The concept is to utilize an autorotor configuration covered with an absorbent covering.

The monitoring system of this invention also contemplates an autorotor incorporating airfoil configurations. The resulting performance of the system is based upon the interaction of two curved sections with the leading edges which are continually changing their angle of attack in reference to the direction of the airflow.

At fixed angles of attack or attitudes, the conventional airfoil with the sharp leading or trailing edge produces a bound vortex. Applying his conventional design to the autorotating body, I discovered under conditions of rotations the sharp edge produces separated airflow resulting in increased drag which is obviously undesirable. In addition, the static or initial position of the autorotor with the sharp or conventional edges may result in low starting torque for the rotating body. It is to be noted that the edges of the rotor vanes of Savonius are also sharp.

I have found for optimum rotational properties in designing the configuration of the cylindrical members of the autorotating body that the leading (forward) and trailing (rearward) edges may be rounded as distinguished from the sharp edges, coupled with a change in the shaping of the surfaces by cambering. The result of these design changes given rise to unexpected results. A higher static moment is created to produce rotation. There is greater rotational sensitivity at low air speed which is an important consideration in view of the fact that the surrounding fluid is the force powering the monitoring system. In the absence of the sharp forward and rearward edges, there is substantial reduction in flow separation resulting in minimum vortices and drag. There is increased initial flow acceleration over the curved leading edge area of the upper surfaces through the contouring and no evidence of flow discontinuity or decrease in rotational efficiency resulting from the curved trailing edge. The radius of the forward edge is larger than the radius of the trailing edge.

The relative position of the two coaxial cylindrical members can be varied within certain limitations in view of the fact of the autorotating feature of the structure. Upon evaluation of the various aerodynamic considerations such as drag, angle of attack, pitching moment, aspect ratio, and dynamics of rigid bodies, it was determined that the channel or airgap between the two cylindrical members is to be in a constant cross section in order to maintain substantially constant flow velocity and pressure. The effect of the airspace or gap is that the inner airflow through the gap undergoes a minimum of acceleration, deceleration, pressure changes and disturbance of flow field.

The air pressure, resulting from the rotation, in the air space between the two adjacent cylindrical means is near static pressure conditions, that is, relatively low flow velocities are in the air space. The autorotating efficiency is increased inasmuch as there is a reduced resistance or damping effect resulting from the near static pressure in the air space.

A further structural requirement is in the utilization of circular plates or end plates which are contiguous with the ends of the cambered cylindrical members. These circular plates enhance the airflow characteristics of the autorotor by not permitting the airflow to veer outward toward the ends of the coaxial members. The end plates direct the fluid medium over the cambered cylindrical members and through the gap thus enlarging the pumping action of the autorotor. The end plates are large in diameter, that is, of sufficient size to extend beyond the sides of the positioned coaxial cylindrical members and intensify the rotational efficiency of the sampling device.

These and other objects, advantages, and features of the novelty of the invention will be evident hereinafter.

In the accompanying drawing wherein the embodiments and best modes contemplated by the inventor for carrying out his invention are illustrated.

FIG. 1 is a side elevation view of a conventional air sampler.

FIG. 2 is a side elevation view of the rotor described in U.S. Pat. No. 1,677,574.

FIG. 3 is horizontal expanded sectional view along line 3—3 of FIG. 2.

FIG. 4 is a side elevation view of the autorotor of this invention.

FIG. 5 is a horizontal expanded sectional view along line 5—5 of FIG. 4.

FIG. 6 is similar to FIG. 5 with the added feature of illustrating the location of the absorbent material.

FIG. 7 is a further modification of my invention.

FIG. 1 describes the commercial sampler with a conventional vacuum pump 5 with a conduit 7 connecting said pump with the filtering head 9 containing the filtering screen 11 upon which the air contaminates are collected.

FIGS. 2–3 illustrate the two symmetrical hollow-shaped vanes 2 overlapping each other to such an extent that the edge E of each vane extends to the segmented space between the edges of the vane. The mast 6 passes through the center of the rotor and coincides with the axis of rotation. The circular end plates 4 being contiguous with the said vanes.

In the embodiment of my invention shown in FIGS. 4–6, there are two hollow cambered coaxial cylindrical members 2, end plates 4 are contiguous with said members 2 and are adapted to turn said members together. A mast 6 extends the entire length of the autorotor with an extension below the adjacent end plate 4 for attachment to a supporting base 8 with the autorotating body having free rotation about 6 which is also the axis of rotation. The rotational directional is indicated by arrow *r*. A rotating means pull cord 16 may be employed if desired. There may be environmental conditions becalming the detecting system. Thus a spring-driven or a simple wraparound pull cord can initiate the rotation of the system.

FIG. 5 illustrates the autorotor rotating about the mast 6. The wind direction by the arrow *w*, and the direction of rotation by the arrow *r*. The aerodynamic configuration comprises two coaxial cambered cylindrical members positioned adjacent to each other. The general concave and convex surfaces of each member are cambered with the added requirement that the forward (leading) 10 and rearward (trailing) 12 edges are rounded so that the leading edge radius is greater than the radius of the trailing edge. The coaxial members 2 are positioned so that their concave sides are confronting each other thus forming an air space by means of which the surrounding atmosphere passes through resulting in a pumping action for rotating the body. The rearward edge of each coaxial member is positioned between the forward and rearward edges of the confronting member. The end plates 4 are attached at the ends of the coaxial members to increase the aerodynamic and rotational performance efficiency.

FIG. 6 is similar to FIG. 5 with the added feature of showing the location of the absorbent or data-collecting material 14 which covers the entire surface area of the cambered members.

FIG. 7 demonstrates another modification of the invention, that is, pyrotechnic pistol 18, spigot 20, and charge 22, ejecting the inventive autorotor, FIGS. 4–6, with a horizontal rotational axis to a position distant from the launching site. The said pistol is in the field as a standard military ordnance item disclosed in the Department of the Army Technical Manual (TM 9-1095-201-15), Nov. 1962, as Pyrotechnic Pistol AN-M8.

An optimum position for rotational speed is by aligning the two coaxial sections in such a manner that the distance between trailing edge of each member is one-half the radius of the cambered member.

There is no upper or lower limit in overall size imposed upon the autorotor. The dimensions are based upon the aspect ratio e.g., the quotient of the length (span) of the cylindrical member over the chord of the member, from about 1:1 :: 5:1. A small rotor can be 2 inches by ½ inch (aspect ratio 4). A larger rotor for collecting data can be 25 inches by 5 inches (aspect ratio of 5). The higher the aspect ratio the higher the rotational value.

The diameter of the end plates is related to chord of the two adjacent positioned cambered cylindrical members or arms. This diameter may vary from 1½ to 2 times the chord of the said cylindrical member.

The autorotor may be fabricated from any substance which will be rigid as wood, metal, alloys, and synthetic material. It is best that the structure is fabricated from the light material which is not adversely effected by the weather. The materials can be steel, cast iron, aluminum, magnesium, plywood, acrylic resins, urea-formaldehyde resins.

A requirement of sampling a large volume of atmosphere was imposed upon the detecting system for confirmatory evidence of the various components in the atmosphere.

A result of modern warfare has imposed upon the combat soldier great mobility in pursuing hostile forces. It is imperative that proper determination of the atmosphere be made in advance of troop movements into hostile territories. As a result of my invention it is now feasible to sample the atmosphere originally some distance from the detector and thereby determining the atmospheric composition of these forward areas without jeopardizing the safety of the armed personnel.

In principle, the invention for detecting the air pollutants depends upon the fact that these contaminants are in the form of or carried along by clouds, smoke, mist, droplets, gases, and moisture thus contacting the surface of the detecting system. The use of any known chemical or physical method for detecting the presence of the air pollutants can be utilized with the monitoring system of this invention.

The skin or exposed surfaces of the autorotating monitoring system can be covered with natural, synthetic or manufactured absorbent materials capable of entraining the various air components or adhering to the surface of the absorbent with subsequent treatment with a proper detecting reagent. The absorbent materials may be thin sheets like material such as natural and synthetic rubber, woven fabric as cotton and synthetic i.e., nylon, rayon, the various cellulose filtering means utilized in chemical procedures i.e., filter paper, or viscous materials such as silica gel and silicone grease. The woven fabric can be porous with interstices between the interwoven threads of the textile cloth and may be utilized for collecting the various micro organisms found in the atmosphere. The absorbent material can be applied directly to the surface of the device by cementing as with a filter paper, textile cloth, coating with silica gel or by using a liner or attaching base upon which the absorbent material is first applied, then covering the coaxial members with the modified liner. The absorbent material after exposure to the fluid media is removed and processed for the detection of the various air pollutants by art-recognized methods.

It is also within the concept of this invention that several different detecting absorbents for different air pollutants are maintained at the same time on the autorotating body. The multipurpose method is achieved by having several detecting agents on separate absorbent material attached at different locations on the two coaxial cambered members.

It is also within the concept of this invention that the hollow central portion of the cylindrical members be utilized either by having porous slots for fluid connection with the exterior cambered surface or as a reservoir for containing the detector with fluid contact to the absorbent material which is attached to the exterior surface of the cambered member.

It is also within the scope of this invention that the monitoring system can be ejected from an aircraft thus passing through the upper atmosphere until impacting with the ground.

The chemical or physical detection methods are those conventional in the art and in this regard the following procedures are deemed illustrative. The method of Zadrozinska, J. Roczniki Panstwowego Zakladu Hig., 12, 5 (1964) for detecting parathions, malathions and diazinon. Getz and Friedman method for detecting cholinesterase inhibition in J. Assoc. Offic. Agr. Chemists, 46, 960 (1963). Silica gel impregnated with various reagents for collecting the dispersants in the atmosphere and then analyzed with aniline, arsine and sulfur

dioxide disclosed by Lidzey et al., Chem. Ind., 150, (1964). The detection of various aromatic and chlorinated hydrocarbons by Cropper et al., Anal. Chem. 35, 735 (1963) and Erley, Am. Ind. Hyg. Assoc. J., 23, 388 (1962). The use of biological substrates or bacteria for bioassaying pollutants, for example, Thomas et al., Air Pollution Symposium, 145th Meeting, ACS, New York City, New York, Sept. 8–13, 1963, detecting changes in bacteria cultures in assaying polycyclic hydrocarbons. The U.S. Pat. No. 2,929,791 describes the crayon for detecting "G agents" by Robert W. Pfeil. The detection for lewisite described by Gehauf et al. in U.S. Pat. No. 2,689,831. Falkof et al. illustrates a method for detecting cyanide in U.S. Pat. No. 2,678,260.

EXAMPLE 1

The detection can be a visual color change as with lewisite, chlorovinyldichlorarsine. A viscous film comprising silica gel impregnated with copper sulfate covers the two coaxial cambered members of the rotor. The monitoring system is exposed to the atmosphere for a preselected period of time and then the viscous film is removed and processed in the method known in the art for lewisite. The method comprises treating the exposed viscous film with a solution comprising sodium hydroxide, hydroxylamine, and reducing agent thereby producing the red color indicating the presence of lewisite.

EXAMPLE 2

The absorbent material or cellulose material is glued to the cambered cylindrical members of the autorotating body. A marking with the crayon for detecting "G Agents" is made upon he cellulose material. The autorotating body is placed in the desired location for a predetermined period of time and then autorotates under the influence of the surrounding atmosphere. The crayon markings change to a magenta or purple after contact with the "G Agents." This color change can be seen at a distance with the assistance of binoculars or telescope.

The crayon composition is set forth in U.S. Pat. No. 2,929,791 by Pfeil.

The "G Agents" are selected from the group consisting of isopropyl methylphosphonofluoridate, ethyl dimethylphosphoramidocyanidate, pinacolyl methylphosphonofluoridate and cyclohexyl methylphosphonofluoridate.

EXAMPLE 3

The absorbent material, filter paper, is adhesively fixed to the two coaxial cambered cylindrical members of the autorotating body. The filter paper is treated with a solution containing pyridine or one of its derivatives and 1-phenyl-3-methyl-5-pyrazolone. The autorotating body is placed in the desired fluid medium location for a selected period of time with a color change from magenta to deep blue indicating the presence of the cyanogen agent.

EXAMPLE 4

The one cambered arm of the autorotating sampler is prepared with the absorbent material and crayon, as in Example 2, and the other cambered arm of the sampler with absorbent material covered with the pyridine solution, as in Example 3. After a preselected time the two different absorbent materials accordingly processed will disclose the presence or absence of the G-Agents, crayon markings or cyanogen agent with the pyridine solution.

The above method was repeated with the exception of utilizing a noncambered arm of the autorotating sampler fitted with the absorbent material, as in Examples 2 and 3, and indicating the presence or absence of the G-Agents or cyanogen agent.

I claim:

1. A method for detecting gaseous constituents in the atmosphere, the steps comprising placing a rotatable device rotating about a central axis in said atmosphere, said device including chemical absorbent materials covering a substratum autorotatable about a central axis, maintaining said device in a state of rotation solely by the impinging of the atmosphere upon the chemical absorbent materials, the absorbent materials entrapping absorbable components from the atmosphere, and colorimetrically testing the presence of the absorbable components.

2. The method according to claim 1, wherein the absorbent material is natural rubber, synthetic rubber, woven cotton fabric, woven synthetic fabric, cellulose materials or viscous materials.

3. The method according to claim 1 wherein the chemical absorbent material is cellulose containing a colorimetric crayon mark for the absorbable components, said components selected from the group consisting of isopropyl methylphosphonofluoridate, ethyl dimethylphosphoramidocyanidate, pinacolyl methylphosphonofluoridate and cyclohexyl methylphosphonofluoridate, and the crayon mark changing color to magenta or purple indicating the presence of the absorbable components.

4. The method according to claim 1 wherein the chemical absorbent material is silica gel containing copper sulfate, the absorbable component is chlorovinyldichlorarsine, and treating said silica gel and said component with a solution comprising sodium hydroxide, hydroxylamine and a reducing agent, and producing a red color indicating the presence of the chlorovinyldichlorarsine.

5. A device rotating about a central rotary axis comprising two coaxial cylindrical members adjacent to each other in axial rotation, a confronting surface of each cylindrical member defining an airspace for a fluid medium effecting a pumping action, a chemical-absorbent material covering each coaxial cylindrical member, a trailing edge of each member extending to the segmented space ordered by the said confronting member, and extremities of each member attached to an axially positioned end plate.

6. The device according to claim 5, wherein chemical-absorbent material is natural rubber, synthetic rubber, woven cotton fabric, woven synthetic fabric, cellulose materials or viscous materials.

7. The device according to claim 5, wherein said each coaxial member surface comprises a cambered upper and cambered lower surfaces.

8. The device according to claim 7, wherein the cambered surfaces merge into rounded leading and trailing edge sections.

9 The device according to claim 8, wherein the rounded leading edge section shape is a different radius of curvature than the radius of curvature of the rounded trailing edge section.

* * * * *