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PARTICLE DETECTION APPARATUS

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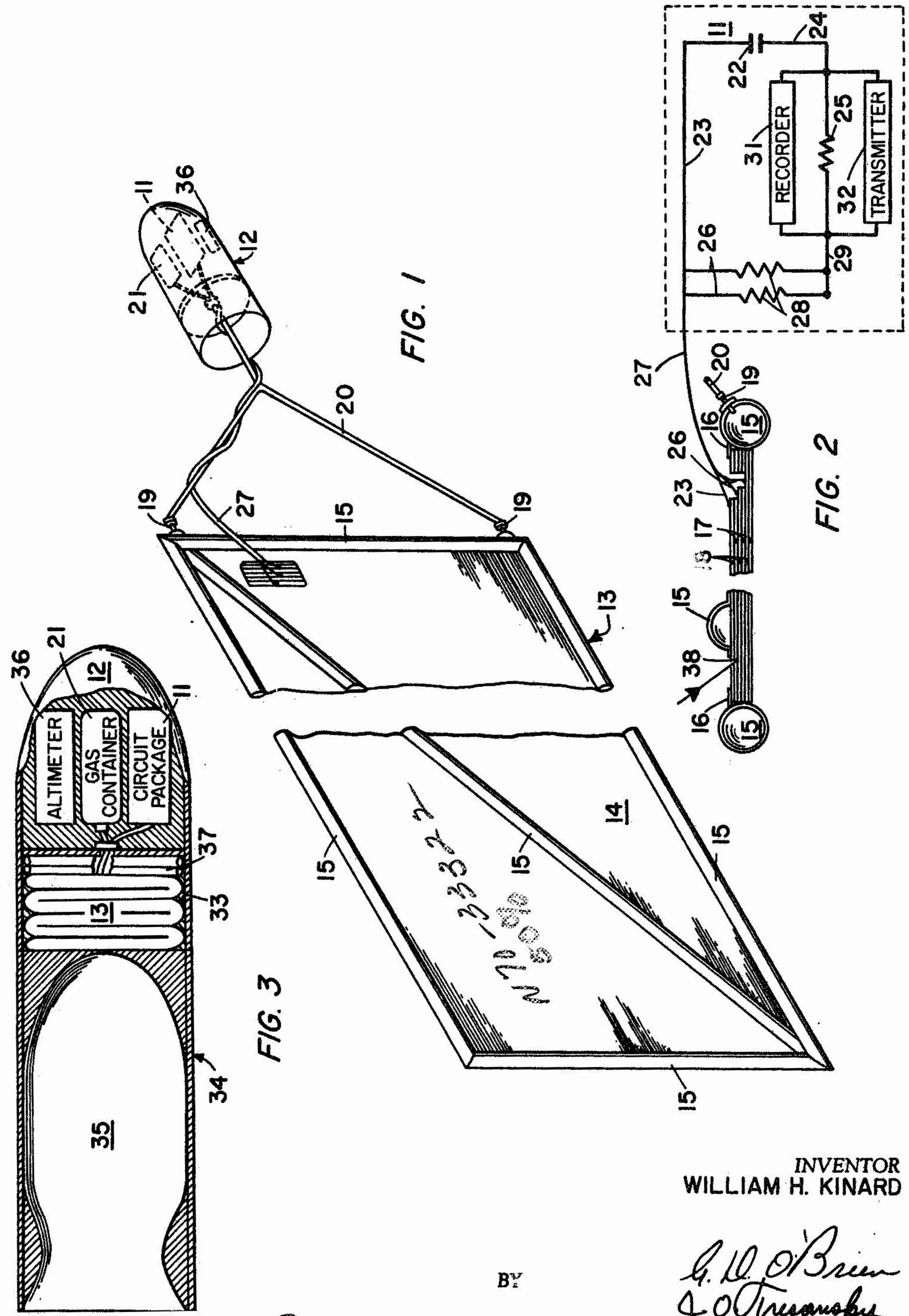

FIG. 1

FIG. 2

FIG. 3

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PARTICLE DETECTION APPARATUS

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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 royalities thereon or therefor.

This invention relates generally to particle detectors, and more particularly to detector apparatus for indicating the frequency of incidence and energy of minute space particles.

In space craft intended for orbital or interplanetary flight, it is necessary for the skin thereof to be capable of withstanding collisions with minute space particles, such for example as micro-meteorites, or the like, to protect the instruments and/or occupants carried by the space craft. In order to insure the adequacy of the skin, or shell, structure, it is desirable that the design thereof be based upon information indicative of the collision conditions likely to be encountered by the space craft, or vehicle.

Although particle collision detecting devices have been heretofore devised and utilized, in general, these prior art devices have been found to be incapable of providing adequate statistical data upon which a shell design could be reliably based. In one present day system, a closely spaced continuous wire grid is wrapped around a space vehicle, such for example as a rocket casing. An electrical energy source and a counting apparatus is serially coupled across the wire grid. Since a colliding particle severs the wire grid at the point of impact, thereby rendering the electrical circuit discontinuous, this system only provides for a "one-shot" detection. Another present day detection device provides for the disposition of a microphone and counter within the casing of the space vehicle. The microphone provides a signal to the counter in response to the acoustic noise generated by each particle collision with the vehicle casing. Although this latter system overcomes the aforementioned shortcoming of the former system, neither of these prior art arrangements are capable of providing a measurement of the energy content of the colliding particle.

An object of this invention is therefore to provide a new and improved apparatus for determining the incidence and energy content of minute particles.

Another object of the instant invention is the provision of a new and improved electrical system for accurately counting the frequency of occurrence of small-sized solid particles.

Still another object of the present invention is the provision of a new and improved electrical system for accurately indicating the magnitude of momentum of small-sized solid particles.

A further object of this invention is to provide a novel towable aerospace target selectively responsive to the impingement of minute particles of matter.

A still further object of the present invention is the provision of a novel target characterized by flexibility, light weight and collapsibility.

Another still further object of the instant invention is to provide a new and improved particle impingement responsive target capable of being maintained in a compact packaged condition and of being erected to a fully extended condition.

According to the present invention, the foregoing and

other objects are attained by the provision of an erectable sail composed of multiple layers of electrically conducting and insulating materials, a common source of potential energy, a common indicating device, and an electrical impedance individually coupling each of the conductive layers to the energy source and indicator.

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

FIG. 1 is a side elevational view of the aerospace particle detector in its fully extended and operational condition;

FIG. 2 is an enlarged view, partially in section, of the electrical circuitry utilized in the present invention; and,

FIG. 3 is a side elevational view, partially in section, of the aerospace particle detector in its stored for launching condition.

Referring now to the drawing, wherein like reference numerals designate identical or corresponring parts throughout the several views, and more particularly to FIGS. 1 and 2, the particle detector apparatus according to the instant invention is shown as consisting essentially of a data recording system **11** shock-mounted in a nose cone **12** and a target body **13** capable of being towed behind the nose cone. The target body, or sail, **13** is constructed of a central planar section **14**, composed of several superposed thin sheets of laminated material, and interconnected peripheral and diagonal tubuluar channels **15** adhesively secured thereto as at **16**. The laminated sheets are formed of a base layer **17** of tensionally strong and flexible insulating material, such for example as the polyester "Mylar," to which is secured a layer **18** of lightweight and bendable electrically conductive material, such for example as aluminum. The aluminum may be secured to the base layer by the use of an adhesive or by a conventional metal depositing process. The tubular channels **15** may be formed of rubber, parachute cloth, or the like, but "Mylar" is a preferred material. A pair of valves **19** are provided in a forward tubular channel through which an inflating medium, such for example as compressed air, or a plastic foam, such for example as a polyester, is introduced for distribution to all of the channels **15** thereby imparting a degree of rigidity thereto and full extension of the target sail **13**. The inflating or stiffening medium may be applied to the valves **19** through a hose-like tow line **20** connected to a storage container **21** positioned within the nose cone **12**. The tow line is preferably in threaded engagement with the valves **19** and container **21**. To minimize the likelihood of buckling of the target sail, one or more diagonal channels also may be formed thereon. It will be apparent to one skilled in the art that by reason of the lightweight structural nature of the target body **13**, a substantially large sized sail can be deployed for sampling a greater spatial area thereby increasing the statistical accuracy of the data obtained.

As more clearly shown in FIG. 2, the data recording system **11** utilized in the present invention consists of an electrical energy source, such for example as a charged condenser **22**, one plate of which is electrically coupled through conductor **23** to an outermost aluminum layer **18** of the target sail, and the other plate of which is electrically coupled through conductor **24** to a load impedance, such for example as a resistance **25**. Each of the remaining aluminum layers **18** is coupled through an individual conductor **26** of an electrical cable **27** to individual dropping resistances **28**. All of the dropping resistances are commonly connected to the load resistance **25** through a conductor **29**. A conventional miniature sized electroresponsive recorder **31** and/or a conventional miniature sized telemetering transmitter **32** is parallel coupled to the common load resistance **25**.

Prior to assuming the fully extended and operational condition illustrated in FIG. 1, the target sail **13** is carried aloft in a collapsed and compactly folded condition within an open ended container **33** formed in the after portion of the nose cone **12** of a launching vehicle, or rocket, **34**, as shown in FIG. 3. The nose cone **12** is secured to the propellant motor **35** by conventional means, not shown. When the rocket **34** has reached the desired altitude at which it is desired to deploy the target sail, as may be determined by a conventional altimeter, or timing mechanism, **36**, the nose cone **12** is detached from the motor **35** by conventional means, not shown. Upon separation of the nose cone **12**, the collapsed target sail **13** is ejected from its container **33** by conventional means, such for example as a compressed spring **37**. Flow of the inflating medium from storage container **21** will then be initiated through towing conduit **20** and unfolding of the target sail until fully extended will result.

In operation, an impinging space particle **38** will penetrate the target sail **13** to a depth proportionate to the level of momentum thereof, as shown in FIG. 2. The penetration of each layer will be attended by the release, in the small immediate area, of a high level of energy, which is sufficient to successviely vaporize the nearby target materials and then ionize the resultant vapor. Thus, as the particle penetrates the stacked array of laminated sheets of the central sail portion **14**, ionization of each layer of aluminum penetrated will occur, thereby effectively producing a short circuit path between adjacent penetrated aluminum layers **18**. As successive adjacent aluminum sheets become short circuited, successive ones of resistors **28** will be placed in parallel with one another in the discharge path of charged condenser **22**. The discharge time constant of the circuit will be correspondingly reduced with a consequent increase in the potential signal, or drop, across load resistor **25**. Prior calibration of the potential signal developed across the load resistance **25** in response to the introduction of successive ones of resistors **28** will allow for a measurement of the depth of penetration of the colliding particles, from which data the momentum of the particles can be readily determined. The potential signal across the load resistor is recorded by the recorder **31** and/or suitably transmitted by transmitter **32** to a remote receiving station. Inasmuch as the ionization phenomenon is short lived; i.e., two milli-seconds duration, and with the exceeding rarity of simultaneous particle impingement, an accurate measurement of each particle collision and the momentum thereof will be obtained.

Whereas the operation of the device according to the present invention has been described in connection with a missile, or rocket, nose cone, it is not so limited, and may also be used with equal advantage in connection with aerial vehicles, such for example as aircraft, or the like.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A collapsible target comprising a planar section formed of alternate layers of flexible and tensionally strong non-conductive material and lightweight and bendable metallic material, a continuous enclosed channel formed of flexible and tensionally strong non-conductive material connected to the periphery of said planar section, and means for introducing an inflating medium into said channel to effect erection of the target.

2. A collapsible aerospace target comprising a planar section formed of superposed alternate layers of polyester material and aluminum material, a continuous tubular member formed of polyester material adhesively attached to said planar section along the entire periphery thereof, a valve positioned in said tubular member, and means coupled to said valve for introducing an inflating medium into said tubular member to effect erection of the aerospace target.

3. A collapsible aerospace target according to claim 2 and including at least one tubular member diagonally attached to said planar section and formed integrally with said continuous tubular member.

4. A collapsible aerospace target according to claim 3 wherein said inflating medium is a plastic foam.

5. A particle detection system comprising a target formed of superposed alternate layers of flexible and tensionally strong nonconductive material and lightweight and bendable metallic material, a plurality of impedances, each of which is individually coupled to one of said metallic layers, an electrical energy source coupled to one metallic layer, and means coupled between said energy source and said plurality of impedances responsive to potential variations resulting from the momentary ionization of said metallic layers penetrated by particles colliding with said target.

6. A system according to claim 5 wherein said means comprises a recording device.

7. A system according to claim 5 wherein said means comprises a transmitter.

8. A system according to claim 5 wherein said electrical energy source comprises a charged condenser.

9. An aerospace particle detection system comprising a propelled vehicle, a target sail disposed in said vehicle in a collapsed condition, said target sail being formed of alternate layers of polyester and aluminum materials, a continuous flexible tube attached to the periphery of said target sail, a container of an inflating medium disposed in said vehicle, a flexible conduit coupled to said container and to said tube for towing said target sail behind said vehicle upon ejection therefrom and for transmitting said inflating medium to said tube thereby effecting erection of said target sail, circuit means disposed in said vehicle, said circuit means including an electrical energy source coupled to one of said aluminum layers, a plurality of impedances, each of which is individually coupled to one of said aluminum layers, and means coupled between said energy source and all of said plurality of impedances responsive to energy flow variations in said circuit means resulting from the momentary ionization of said aluminum layers penetrated by particles colliding with said target sail.

10. An aerospace system according to claim 9 wherein said means comprises a recording device.

11. An aerospace system according to claim 9 wherein said means comprises a transmitter.

12. An aerospace system according to claim 9 wherein said means comprises a recording device and a transmitter.

13. An aerospace system according to claim 9 wherein said electrical energy source comprises a charged condenser.

14. A particle detection system comprising a target formed of superposed alternate layers of nonconductive material and metallic material, a plurality of impedances, each of which is connected to one of said metallic layers, an electrical energy source connected to one metallic layer, and means coupled to said energy source and to said plurality of impedances for responding to potential variations resulting from the momentary ionization of said metallic layers penetrated by particles colliding with said target.

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