United States Patent

Stetter

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[54] **PYROTECHNIC EMITTER**

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[51] **Int. Cl.**.....**F42b 13/40**

[58] **Field of Search**.....102/37.8, 37.5, 37.52, 87; 431/3, 347; 240/2.25

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[57] **ABSTRACT**

A pyrotechnic emitter particularly for the infrared spectral range comprises a radiation emitting body and an energy source for heating the body. The device is particularly applicable for use in the infrared tracking of automatically movable bodies such as a missile and may advantageously be formed in an annular shape of a plurality of annular segmental parts. The emitter includes a thin-walled tubular housing of any desired cross section which is bent in accordance with the geometry of its arrangement for example into an annular shape to fit adjacent the discharge end of the nozzle of a missile. The energy source comprises a pyrotechnic glow charge which fills the tubular member and gives off its heat energy without appreciable evolution of gas. The thin-walled tube may comprise a metal tube having a wall thickness of less than 1 milimeter or it may be made of oxide ceramic, or graphite. The housing is advantageously held in place in association with a device such as a missile by securing claws, eyelets or attaching cuffs which are advantageously made of the same material as the individual tube sections of the housing. A mirror coating is advantageously arranged around and faces the emitter in order to reduce the emission losses in a direction other than the desired emission direction.

16 Claims, 4 Drawing Figures

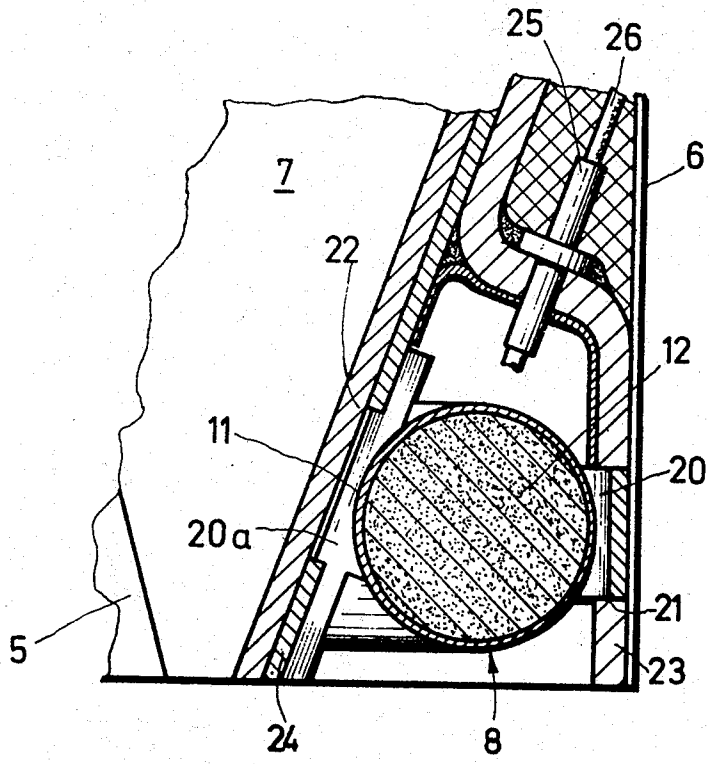


Fig. 1

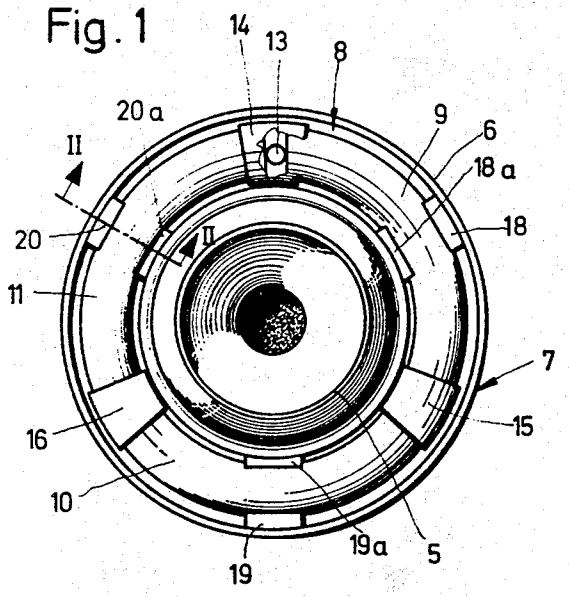


Fig. 3

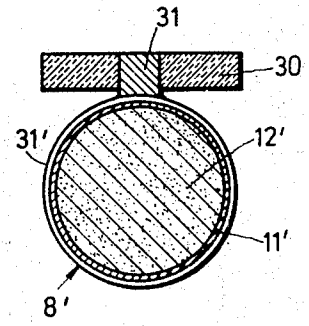


Fig. 2

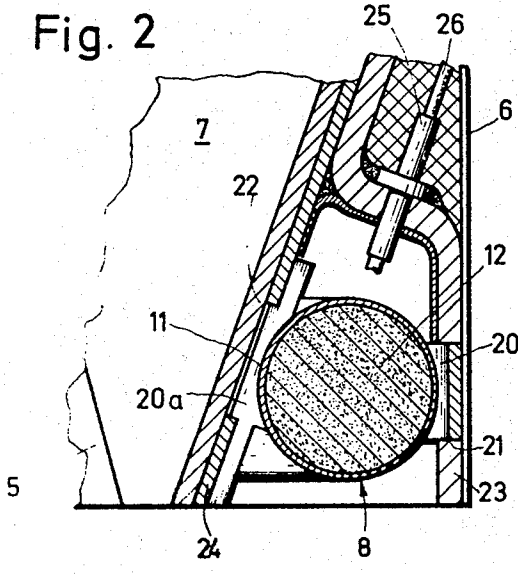
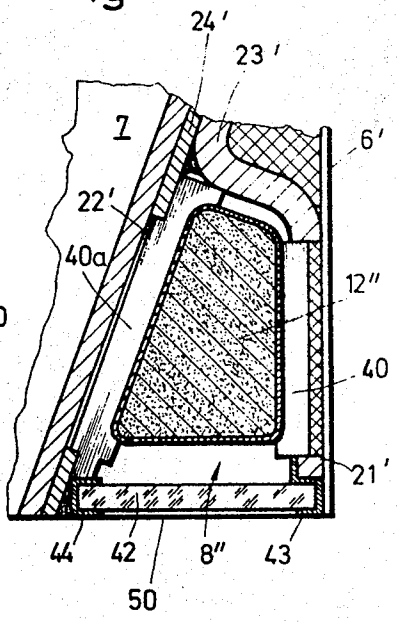


Fig. 4



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PYROTECHNIC EMITTER

This invention relates in general to the construction of pyrotechnic emitters and in particular to a new and useful pyrotechnic emitter for the infrared spectral range which comprises a radiation emitting body and a energy source for heating the body.

Pyrotechnic emitters independent of external energy sources are used preferably in connection with automatically moving bodies such as missiles and have the function of rendering the bodies carrying them visible to an infrared position finder operating in their spectral range and/or directly to an observer. For the generation of infrared and/or visible radiation energy required for these purposes they have been used in respect to the pyrotechnic aspect essentially so-called pyrotechnic flame emitters where the flames of a pyrotechnic burning charge, for example, of a magnesium base serve as an actual radiation source. The pyrotechnic charge is then enlarged in a tubular vessel and burns down from one end face. Since the very hot flame has a much greater surface then the outlet opening of the tube it is possible to achieve, at a relatively small surface of the charge, a high total power emitted per unit of the solid angle measured in W-steradian, which is available for a limited time, namely the burning time of the pyrotechnic charge.

Such pyrotechnic flame emitters also called 'flare charges' or 'flare compositions' correspond with respect to the spectral disposition of the emitted total energy, in a first approximation, to a black body or emitter whose temperature correspond to that of the flame. There is the possibility that in the visible and/or near infrared spectral range (less than 1.5 μ) greater deviations may occur due to the discrete spectra of the individual components of the burning charge substance. In accordance with the high flame temperature of about +2,000° C. the radiation maximum lies in the visible or near infrared range. As experiments have shown it is not possible with flame emitters to appreciably raise desired regions within the emitted infrared spectral range, for example, by admixtures, in their intensity as compared with corresponding spectral ranges of a pure temperature emitter. It is equally impossible to suppress emissions in undesired spectral ranges by applying optical filters. For one thing no filters are known which would withstand the thermal load of the flame of a flame emitter and for another due to a large surface of a flame, such a filter would have to be disposed at some distance from the emitter. This is impossible to do at least in the case missiles for aerodynamic reasons.

With pyrotechnical flame emitters, therefore, it is not quite possible to fill all of the requirements for the application of the device, namely to emit a very high power in a certain infrared spectral range in which a position finder operates for example, while producing little radiation power in the remaining spectral range; that is, particularly the remaining visible spectral range and the spectral range not taken into consideration by image amplifiers and infrared image converters in order that an observer will not be blinded by such an emitter especially at night. In addition, the image screen of an infrared image converter or of an image amplifier must not be over radiated by the emitter.

A further problem is the smoke evolution of the flame emitters which is generally undesirable. When used in the open atmosphere, for example, smoke evolution impairs the invisibility of the device and leads additionally to a partial absorption of the radiation energy of the emitter. When such an emitter is used in an enclosed atmosphere such an evolution of smoke will lead to a very strong absorption of the radiation energy and to fouling of the structural parts arranged within this smoke atmosphere to such a degree that the operation is impaired.

Finally the production of pyrotechnic emitters involves special difficulties. Pyrotechnic substances, as is known, are not easy to press so that homogeneous filling of containers ensuring a constant radiation power over the entire burning time is difficult, in particular when the filling must be into containers having complicated forms as determined by the particular use. In addition, such containers must offer reliable protection from environmental influences for many years of storage and also must be ready for use in the fraction of a second.

In consideration of all the difficulties of the construction and use of emitters it is an object of the invention to provide a pyrotechnic emitter especially well suited for use in connection with missiles and independent of any external energy sources.

In accordance with the invention, such an emitter is easy to manufacture, is storable for long time, is safe in operation and easily adaptable to the spatial considerations which must be employed in missiles and without loss of radiation power. The emitter of the invention is designed to permit the use of optical filters which influence the spectral distribution of the emitted radiation in its immediate vicinity as well as other filter means such as movable operable and closeable diaphragms for the purpose of modulating the emitted radiation.

Proceeding from a pyrotechnic emitter for the infrared and/or visible spectral range and which comprises a radiation emitting body and an energy source for heating the body which is provided in particular, for the infrared location of automatically moving bodies, the problem of the invention is solved by a radiation emitting body including a thin-walled tube of a selected cross section which may be bent according to the geometry of its employment, for example, around the nozzle of a missile. The energy source of the body is a pyrotechnic glow charge which completely fills the tube and which gives off thermal energy without any appreciable evolution of gas. Unlike the known flame emitters therefore the pyrotechnic burning charge is a glow charge, which is arranged inside a thin walled tube which can be closed in a gas and pressure tight manner at its end faces and which may be of relatively small cross section. Such a tubular housing may have any desired cross sectional form but in particular it should have one adapted to the available space for the positioning of such an emitter in the object which will carry it. The tubular element is advantageously made so that it can be bent into any desired form. The pyrotechnic glow charge is inserted into the desired interior of the tube before it is bent and therefore such emitters can be produced continuously in a simple manner. The manufactured form may be easily transformed to any

desired configuration by bending. The production costs of such emitters are therefore considerably lowered. A further advantage is that the emitter which is closed on all sides is relatively easy to insulate from other structural parts which must be protected against heat. Only simple retention devices are necessary for the attachment of such an emitter to the body carrying it. Optical filters for the spectral limitation of the radiation and/or diaphragms for the modulation of the emitted radiation can be provided in a simple manner in the immediate vicinity of the radiation emitting body.

In accordance with the preferred form of the invention, the radiation emitting body is a metal tube of a wall thickness of less than 1 milimeter. The radiation tube is preferably a tube made of an oxide ceramic or of a graphite. It is particularly advantageous if the housing of the radiation emitting body be composed of individual tubular sections having ignition elements at the joints between sections for setting off the pyrotechnical glow charges therein. In this manner, emitters having relatively large diameters or correspondingly long circumferances are especially easy to produce in the form of tube sections. Such emitters can be ignited in a relatively short period of time approximately simultaneously over their entire surface so that immediately after ignition the entire available surface of the emitter emits radiation.

Accordingly, it is an object of the invention to provide a pyrotechnic emitter for the infrared spectral range which comprises a radiation emitting body and an energy source for heating the body which includes a thin wall tube forming the housing of the emitter and which is made of any desired cross section and filled with a pyrotechnic glow charge which gives off its heat energy without appreciable evolution of gas; and wherein the center is formed so that it may be bent into a desired configuration in accordance with the manner in which it is to be oriented, for example on a moving object or like device.

A further object of the invention is to provide a pyrotechnic emitter which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

FIG. 1 is an end elevational view of the rear of a missile having a pyrotechnic emitter constructed in accordance with the invention;

FIG. 2 is a section taken on the lines II—II of FIG. 1;

FIG. 3 is a view similar to FIG. 2 of another embodiment of the device; and

FIG. 4 is a view similar to FIG. 2 of still another embodiment of the device.

Referring to the drawings in particular the invention embodied therein comprises a missile or flying body 7 having an engine discharge nozzle 5 shown in FIG. 1 oriented rearwardly. The missile 7 includes an outer shell or wall 6 to which is attached a circular ring shaped or torroidal pyrotechnic emitter generally designated 8. The emitter 8 is composed, in the embodiment shown, of three separate partial annular segmental portions or sections 9, 10 and 11'. Each section 9, 10 and 11 comprises a thin-walled tube 11' of a material such as tantalum, oxide ceramic or graphite. The tube 11 is completely filled in accordance with the invention with a pyrotechnic glow charge 12 which evolves little or no gas.

An example, of a glow charge comprises a mixture of an energy carrier with an oxygen carrier which increases the processability. These are combined or bound with a nitrocellulose lacquer by the addition of inorganic binders. The glow charge comprises for example, about 66 percent lead minimum (Pb_3O_4), about 24 percent silicon (Si), about 6 percent ferrosilicon, and about 2 percent iron trioxide (Fe_2O_3). When metal tubes are used, the wall thickness is less than 1 mm.

In the embodiment indicated in FIG. 1, the individual sections 9, 10 and 11 are spaced apart circumferentially and between the end faces of adjacent sections there are arranged ignition devices such as an ignition element 13. The individual sections 9, 10 and 11 with the ignition elements arranged therebetween are held together by cuffs or surrounding collars 14, 15 and 16 respectively. The cuffs 14, 15 and 16 are preferably produced from the same material as that of the walls of the individual sections. The complete ring shaped emitter thus formed is retained concentric to the engine nozzles on the stern of the missile 7 by means of three sets of mounting clamps or securing claws 18 and 18*a*, 19 and 19*a*, and 20 and 20*a*, respectively and these are preferably made of a material such as ceramic.

As indicated particularly in FIG. 2, the individual securing claw sets include separate clamp parts 18 and 18*a*, 19 and 19*a*, and 20 and 20*a* are adapted to the cross sectional form of the emitter and are secured in corresponding recesses formed in partitions or walls 23 and 24 which are arranged at circumferentially spaced locations as indicated in FIG. 2 adjacent the stern of the missile 7. As best indicated in FIG. 2, the claw part 20 is secured for example in the recess 21 and the claw part 20*a* is secured in a recess 22. Wall 23 also has a leadin 25 for ignition lines 26 which is cemented in place and leads to the ignition elements 13 and is connected at its opposite end with a source of current (now shown).

In order to increase and concentrate the radiation power which is given off by the emitter 8 through the open rear end of the missile 7, the faces of the partitions 23 and 24 which face toward the emitter 8 are provided with a mirror coating 26' which is produced, for example, by vapor deposition of aluminum or by the insertion of an aluminum foil positioned around the emitter.

The emitter 8 is constructed in the manner of an electric heating coil and is made pressure proof and gas proof on all sides. It is bent according to the available space for its accommodation in the missile and is retained in position by clamps or claws which are arranged in the space. Upon its operational start, the same will take place simultaneously at several ignition points and will give off radiation energy immediately

because of the low heat capacity of the metal tube which holds the pyrotechnic glow charge. Thus for example, a missile carrying such an emitter can be attracted by an infrared position finder immediately after its launching. By the provision of the mirror coating the portion of the radiation generated which does not become effective and which is not exposed to the exterior of the missile is thus greatly reduced.

In the embodiment indicated in FIG. 3, there is provided another form of construction for the retention of the emitter 8'. This emitter contains the pyrotechnic glow charge 12' and a thin housing wall 11' as in the other embodiment. The emitter 8' is retained in position by means of a metal eyelet 31 which is cemented into a partition 30 of a ceramic material and which includes an encompassing eyelet portion 31' which surrounds the tube 11'.

Another example of construction of the emitter 8'' is shown in FIG. 4. The emitter 8'' has a somewhat trapezoidal cross sectional form and it is retained in position by means of securing clamps or claws 40 and 40a which are formed in accordance with the cross section with which they engage. The claws 40 and 40*a* advantageously comprise a ceramic material and they are secured in corresponding openings 21' and 22' of partitions 23' and 24'. In this arrangement filter means in the form of an optical filter 42 is provided for filtering out undesirable spectral portions of the radiations given off by the emitter 8''. Instead of the filter 42 which is secured in retentions or brackets 43 and 44 of the partitions 23' and 24' there may be arranged filter means in the form of a spoke diaphragm which may be driven by a motor, not shown, to modulate the radiation given off by the emitter 8''. Such a spoke diaphragm may be operated to alternately open and close at least a portion of the opening 50 at the lower end of the housing 6' and it may be used either alone or in combination with the filter 42.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A pyrotechnic emitter for the infrared spectral range and in particular for use in the infrared tracking of an automatically moving object, such as a missile; comprising, in combination, a relatively thin-walled and closed tubular member made of glowable material forming a radiation emitting surface of a body of predetermined cross section and of a configuration facilitating accommodation of said body within a selected mounting space of said object, said tubular member being chargeable with a pyrotechnic glow-substance of the type which gives off heat energy devoid of any exterior flame effect and appreciable gas evolution, and ignition means for said substance disposed adjacent at least one end of said tubular member to effectuate glow radiation from the latter.

2. A pyrotechnic emitter, according to claim 1, wherein said radiation emitting body comprises a tube of oxide ceramic.

3. A pyrotechnic emitter, according to claim 1, wherein said radiation emitting body comprises a graphite tube.

4. An emitter according to claim 1, wherein said radiation emitting body is formed by at least one tubular member having a wall thickness of less than 1 mm, and holding means constructed for anchoring said member within said space of said object.

5. An emitter according to claim 4, wherein said tubular member comprises a plurality of tubular sections arranged in succession to each other within said space, said ignition means being in contact with respective ends of said tubular sections.

6. An emitter according to claim 5, including clamp means forming said holding means and engaging said tubular sections in their operative position.

7. An emitter according to claim 6, said holding means being constituted by the same material as that of said tubular member sections.

*. An emitter according to claim 1, including a mirror coating arranged for coaction with said tubular member and facing at least a portion of the latter for enhancing the radiation emitting surface.

9. An emitter according to claim 1, including optical filter means provided at a location spaced from said tubular member for filtering out undesirable spectral radiation portions, thereby to control the spectral range of radiation emission.

10. An emitter according to claim 1, including optical filter means constructed for modulating radiation emanating from the charge of said member.

11. A heat tractible movable body comprising a missile having a discharge nozzle, an annular pyrotechnic emitter arranged around said nozzle, said annular emitter comprising a plurality of torroidal sections, cuff means on said missile body surrounding said pyrotechnic emitter and holding said pyrotechnic emitter in position adjacent the rear of said missile nozzle, and ignition means for said pyrotechnic emitter, said pyrotechnic emitter comprising a thin-walled tube having a pyrotechnic glow charge which gives off its heat energy without appreciable evolution of gas.

12. A device, according to claim 11, including spaced wall members carried by said missile having an opening at the rear end of said missile, clamping means carried by said spaced wall members and surrounding said pyrotechnic emitter and holding said emitter in position located between said emitter sections.

13. A device, according to claim 11, said emitter is of cylindrical cross section.

14. A device, according to claim 11, wherein said emitter is of substantially trapezoidal cross section.

15. A device, according to claim 11, including an eyelet carried on said missile and having a cylindrical eyelet portion engaged over said emitter.

16. A pyrotechnic emitter for the infrared spectral range and particularly for use in the infrared tracking of an automatically moving body, such as a missile, comprising a thin-walled closed tubular member forming a radiation emitting body of predetermined cross section, said tubular member being filled with a pyrotechnic glow charge of a type which will give off its heat energy without appreciable evolution of gas, said thin-walled tube being constructed to permit it to be bent to any desired configuration in order to accommodate its shape to mounting space therefor, said radiation emitting body comprising a plurality of individual tubular sections arranged together in a con-

tinuous unit and being spaced apart to define joints therebetween, and ignition means disposed in the joints between said parts for igniting the individual parts.

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