INFRA-RED EMITTING DECOY FLARE

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ABSTRACT
An infra-red emitting decoy flare capable of diverting an incoming missile equipped with a counter-countermeasures system away from an intended target consisting of a primer flare (2), a spectral flare (4) and a means for igniting the primer flare (22, 30), all contained within a flare casing (6). The primer flare (2) is formed from a fast burning pyrotechnic composition and is adapted to produce an intense infrared source of short duration on ignition. The spectral flare (4) is ignited by the burning of the primer flare (2) and is adapted to produce a slower burning composition having a fixed ratio in the intensity of infra-red radiation emitted, when burning, in at least two fixed bands.
INFRA-RED EMITTING DECOY FLARE

[0001] This invention relates to an infra-red (IR) emitting decoy flare capable of being launched from a target to divert a missile equipped with an IR seeker system away from that target, and particularly to an IR emitting decoy flare capable of diverting a missile having a seeker operating with a counter-countermeasures (CCM) system using a spectral discriminator.

[0002] Most infra-red seeker systems operate in a certain wavelength range, or band, of the infra-red spectrum. In this band, the radiated energy from non natural sources is generally easy to detect and the hot components of aircraft exhausts or tank engines, for example, radiate strongly, enabling targets to be easily identified and located.

[0003] Known decoy flares conventionally comprise pyrotechnic compositions bound together with an organic binder and pressed to form pellets. When an incoming missile is detected a pellet is launched from the target and ignited. The pellet burns over its surface to produce an intense infra-red source in this band, which can lure the infra-red seeker system of the missile away from the target.

[0004] UK patent application GB 2,300,035 describes an infra-red decoy flare which is formed from a pyrotechnic composition which burns to emit infra-red radiation. The composition is formed into a plurality of different blocks with different volumes and different surface areas so as to have different rates of burning. Ignition of all the blocks produces an infra-red source which is intense enough to cause the missile to lock onto the flare. After a short time the aircraft will be outside of the field of view of the missile and some of the fast burning blocks will burn completely away. The flare will then radiate comparatively weak radiation for a time in order to complete the diversion of the missile.

[0005] However, advances in missile seeker systems and CCM systems have led to seeker systems being able to recognise a decoy flare and ignore it. Some advanced seeker systems are equipped with CCM systems that compare the ratio of the intensity of IR radiation in one band with the intensity of IR radiation in another band of the IR spectrum. Due to the temperature difference between a conventional flare and the radiating parts of a typical target and the corresponding different 'grey body' radiation spectrums, the CCM system can identify and disregard the flare.

[0006] It is therefore an object of the invention to provide a decoy flare which alleviates at least some of the aforementioned disadvantages and which is capable of diverting a missile equipped with an infra-red seeker system and a spectral counter-countermeasures system away from its intended target.

[0007] Thus according to the present invention there is provided an infra-red emitting decoy flare comprising a flare casing, two pyrotechnic components housed within the flare casing and an ignition means for igniting the pyrotechnic components characterised in that the two pyrotechnic components comprise a primer flare and a spectral flare wherein the primer flare consists of at least one primer pellet, each primer pellet being composed of a fast burning pyrotechnic composition and being adapted such that, in use, ignition of one primer pellet causes rapid ignition of all the primer pellets to produce an intense infra-red source, wherein the spectral flare consists of at least one spectral pellet, each spectral pellet being of a pyrotechnic composition adapted such that, in use, ignition of the spectral pellets produces a spectral infra-red source wherein the ratio of the intensity of the infra-red spectrum at least two fixed bands is within a fixed range, and wherein the primer flare and spectral flare are adapted such that, in use, the spectral flare is still burning after the primer flare has finished burning.

[0008] In use, the ignition of the primer flare creates an intense IR source of short duration. The sudden increase in energy can trigger a missile's CCM system. Due to the short duration of burning of the primer flare however, by the time the missile's CCM system is active the primer flare will have stopped burning but the spectral flare will still be burning. The spectral flare has pre-set ratios of intensity between different bands of the IR spectrum and therefore appears to the missile's CCM system to have the intensity ratios that an intended target would have. Indeed, due to the varying aspects that a target may present to a missile seeker and the fact that the ratio of intensities of the different bands alters when viewing a target from a different angle, say an aircraft head on as oppose from the rear, the spectral flare may be judged by the missile seeker and CCM system to be more target like, in terms of the required ratio of intensities at different bands, than the actual target itself.

[0009] Preferably the spectral flare is adapted such that at the fixed bands of the IR spectrum the flare is more intense than the intended target. The spectral flare will then be the most intense IR source with the correct spectral characteristics. Further, the very intense radiation from the primer flare can saturate some missiles seeker systems. This would not only cause a missile to activate its spectral CCM system but could also cause automatic brightness compensators to come into operation. After the primer flare has stopped burning the automatic compensators will start to reduce to their previous levels. However, if the intensity of the spectral flare in the bands measured by the missile is greater than that of the intended target then the intensity compensators of the missile seeker may not reduce to a level that would include the target. Therefore the spectral flare will be the only object with the correct spectral characteristics in the field of view of the missile.

[0010] Also, on initial ejection the primer pellet lights up and burns extremely quickly. Thus the flare will still be close to the target on ignition and energy from the burning flare will be reflected from the surface of the target. This can increase the radiation seen by the missile's seeker system. Further, the radiation reflected from the target can cause the target to appear to be flare like to the seeker system thus prompting the missile to actually ignore the target.

[0011] In order to achieve a fast burn rate the primer pellets are preferably discs and the primer flare consists of a stack of said discs. By dividing the primer flare into discs the surface area available for burning is increased over that of a single pellet of the same dimensions as the stack. The burn rate is therefore correspondingly increased. The discs are also preferably provided with a central hole which again increases the burn rate, but also aids in rapid ignition of the primer flare by allowing the passage of hot particles through the stack. Alternatively a single primer pellet is used and is provided with plurality of holes through the pellet. This again increases the surface area for burning and increases the burn rate. Another means of increasing the burn rate is
providing the primer pellet or pellets with deep grooves to create more burning surface area. Other arrangements for the primer pellet will be readily apparent to the skilled addressee.

[0012] A fast burn time is required so that the primer flare has finished burning by the time that the seeker system has adjusted. The burn time of the primer flare is therefore preferably between 100-600 ms, more preferably between 150-250 ms. Too short a burn time however can reduce the efficiency of the primer flare as there would be insufficient time for efficient combustion processes to occur.

[0013] The primer flare is conveniently comprised of a composition of an oxidisable metallic material, an oxidising halogenated polymeric material and an organic binder. Suitable metallic fuels are well known in the art and include magnesium, aluminium, alloys of magnesium or aluminium, titanium, boron and zirconium. Preferable the oxidisable metallic material is magnesium. When ignited magnesium undergoes an energetic and vigorous exothermic reaction with halogenated polymers and therefore is particularly suitable for the heat and speed of combustion required.

[0014] Similarly the oxidising halogenated polymeric material used in preferred compositions for the primer flare is a fluorinated polymer because fluorine is a better oxidising agent than other halogens and therefore will react more vigorously and create a more intense IR source. Suitable fluorinated polymers include polytetrafluoroethylene (Teflon (TM) or PTFE) and its copolymers with perfluoropolyethylene, polytrifluorochochloroethylene, copolymers of trifluoroethylene with vinylidene fluoride, homopolymers of perfluoropolyethylene and copolymers of perfluoropolyethylene with vinylidene fluoride, homopolymers of hexafluoropropylene and copolymers of hexafluoropropylene with vinylidene fluoride. PTFE is particularly suitable as it has a high percentage of fluorine in it.

[0015] Suitable organic binders are well known in the art and include polyvinylchloride, straight chain chlorinated paraffins such as Alcoprene (TM) or Cereclors (TM) and the triplymer of vinylidene fluoride, hexafluoropropylene and tetrafluoroethylene. Fluorinated organic binders are advantageous in that the binder, also being an oxidising agent, will join in the reaction. A preferred binder is a copolymer of vinylidene fluoride and hexafluoroethylene, for example VRFON A (TM), which coats and binds the constituents very well as well as adding to the reaction.

[0016] A preferred composition for the primer flare is therefore a magnesium-Teflon-Viton (MTV) composition. The ratio of the constituents will be chosen so that there is the smallest amount of unreacted material after combustion, allowing for the amount of atmospheric oxygen present that will join in the reaction in a particular flare application. The ratio of the constituents will be easily determined by the skilled person.

[0017] As the spectral flare needs to have a longer burn time than the primer flare the spectral flare may usefully be formed from a single pellet. The spectral pellet can therefore burn relatively slowly and consistently.

[0018] In order to ensure that the intensity of the spectral flare is bright enough the spectral pellet may be provided with a central hole through the pellet. The hole will not only increase the intensity of the radiation from the spectral pellet by providing an internal burning surface but with also ensure consistency of the radiation. As the intensity of the flare is related to the surface area of the burning pellet, a pellet burning from the outside only will slowly drop in intensity as the surface area of burning decreases. Having a central hole, however, means that as the outside surface area of burning decreases, the internal burning surface increases, resulting in a relatively consistent burn, increasing the viability of a flare to be mistaken as the target by the missile system. A central hole will also aid in rapid and consistent ignition of the whole of the spectral flare.

[0019] Conveniently the spectral flare and primer flare may be adapted such that, in use, the spectral flare is ignited by the burning of the primer flare.

[0020] The spectral pellet may advantageously be formed to produce quantities of hot gas. Conveniently the spectral pellet may be formed from an organic fuel, an oxidant and a binder. Organic fuels decompose to produce gases such as carbon dioxide which can be similar to the elements produced by an aircraft engine say. Thus use of an organic fuel can provide the required spectral characteristics. Suitable fuels include organic compounds such as sucrose, lactose or starch and also compounds such as potassium benzoate. As an alternative to organic fuels the spectral pellet may be formed from a boron fuel with a suitable oxidant and binder.

[0021] Suitable oxidants include potassium perchlorate, potassium nitrate, sodium nitrate or ammonium nitrate. Suitable binders include Viton A, dextrin or polybutyl rubber although organic binders are preferred as again they decompose into relevant gases thus binders such as Viton A or GAP are preferred. Particularly advantageously however explosive materials with a waxy composition may be used as binders. Such explosives will be able to function as binders due to their consistency and will add to the energetic reaction on ignition. Suitable explosives include RDX, HMX and HNS and can also be added to the hot gases produced by the fuel and oxidant. Other oxidants and binders may be used however and could be easily determined by the skilled person.

[0022] One advantageous spectral composition comprise approximately 30% by weight potassium nitrate, 65% by weight potassium perchlorate and 5% by weight of binder, say Viton A or RDX.

[0023] Another advantageous spectral composition has, excluding binder, approximately 30% by mass of boron and 70% by mass of potassium nitrate, with Viton A as a binder in a sufficient amount as could be easily determined by one skilled in the art. The composition may also include other materials to enhance the spectral effect. Another advantageous composition has, again excluding binder, 20% by mass of boron fuel with 70% potassium nitrate and 10% by mass of silicon.

[0024] In some instances it will be beneficial that the primer flare burn with some visible component or without a spectral characteristic, say when utilising reflection from the target surface. However, in other circumstances it would be advantageous that the primer flare also burn with a spectral component. In such instances the primer flare may comprise a fast burning spectral composition. The actual composition could be the same as could be used or the spectral pellet but to ensure a fast light up and generation of sufficient energy
grooves or a plurality of discs would be used and smaller particle sizes would be used as is well understood in the art. Explosive binders would preferably be used to add to the intensity produced by the primer pellet.

[0026] FIG. 1 shows a decoy flare according to an embodiment of the invention,

[0027] FIG. 2 shows the spectral and primer flares used in a decoy shown in FIG. 1,

[0028] FIG. 3 shows the IR intensity against time for a decoy flare such as shown in FIG. 1,

[0029] FIG. 4 shows a primer flare pellet according to an alternative embodiment of the invention,

[0030] FIG. 5 shows a primer flare pellet of a further embodiment of the present invention.

[0031] Referring to FIG. 1 a primer flare 2 and a spectral flare 4 are housed in an open ended cylindrical flare casing 6. The spectral flare is made up of a single cylindrical spectral pellet 10 housed at the closed end of the casing whereas the primer flare 2 comprises a stack of primer pellet discs 8 located next to the open end. Each of the primer pellets discs 8 and the spectral pellet 10 are provided with a central hole, 12 & 14 respectively, extending throughout the pellets.

[0032] The open end of the casing 6 is sealed by a plug 16, the plug being secured by crimping the rim 18 of the casing 6 into a groove 24 in the plug 16. An expulsion charge 20 is located in a recess in the outside face of the plug, as is a primary ignition charge 22.

[0033] In use, expulsion charge 20 and primary ignition charge 22 are ignited, for example by conventional electric igniters (not shown) in the flare tube of the target. The expulsion charge 20 is formed from a propellant compositions such as a gunpowder or nitrocellulose composition and on ignition generates a large volume of gas which projects the flare from the flare tube (not shown).

[0034] Once clear of the flare tube, spring 26 is released and allows the ignition stimulus from primary ignition charge 22 to travel down the channel 28 and ignite the secondary ignition charge 30. Should the flare casing 6 become jammed in the flare tube, spring 26 is prevented from release and therefore stops the propagation of the ignition stimulus, thereby preventing ignition of the flare in the flare tube.

[0035] Ignition of the secondary ignition charge 30 provides a source of ignition for the primer flare 2. The outer and inner surfaces of the primer flare 2 and spectral flare 4 are also coated in a primer paste to further aid ignition. Further, the primer flare 2, and also the spectral flare 4, are wrapped in aluminium foil 32 and 34 respectively, with both flares being then wrapped together in aluminium foil 38. The aluminium foil aids the ignition of the primer flare 2 and spectral flare 4 by initially confining the ignition gases thus increasing the initial pressure and thereby aiding the speed and reliability of the ignition stimulus. Wrapping the pellets in aluminium foil also helps to protect the pellets during storage. The high temperature generated during burning of the primer flare 2 may additionally cause the aluminium foil to combust, adding to the radiation from the primer flare 2.

[0036] Ignition of the primed surfaces of the primer flare 2 cause the primer flare to be very rapidly ignited over all of its outer surface. Hot particles and combustion gases also travel down the central hole 12 igniting the inner surface and the faces between the primer pellet discs 8. This is aided by the confining effect of the aluminium foil 32.

[0037] The primer pellet discs 8, shown more clearly in FIG. 2, are formed from a fast burning composition such as a composition of MTV. Such a composition creates an intense source of IR radiation having a fast burn rate and reaches temperatures of 1900 °C.

[0038] The burn rate of the primer flare is also determined by the thickness of the primer pellet discs 8. For an MTV primer pellet composition where the discs are of 47 mm diameter and have a central hole of 6 mm diameter, a stack of 4 to 8 discs of thickness 5-10 mm give the desired burn rates.

[0039] Alternatively the primer pellet could be formed from a similar stack of discs formed from a composition of potassium benzoate and potassium perchlorate of small particle size and RDX as a binder.

[0040] Referring back to FIG. 1, ignition of the primer flare 2 causes ignition of the spectral flare 4 which is wrapped in aluminium foil 34. Spacers 36 are located between the primer flare 2 and the spectral flare 4. This allows for hot particles produced from the burning of the primer flare 2 to ignite the spectral flare over its surface. The spacers 36 also help prevent premature ignition due to friction during launch or transit.

[0041] In an alternative embodiment (not shown) an ignition transfer medium, such as an MTV cord, could be located next to the secondary ignition charge 30 and run through the hole 12 in the primer flare 2 and the hole 14 of the spectral flare 4. Ignition of the secondary ignition charge 30 could then ignite the ignition transfer medium which would burn down its length igniting the interior surfaces of the primer flare 2 and the spectral flare 4 in turn. The spectral pellet, also shown in FIG. 2, is formed from a single cylindrical pellet. The composition may conveniently be a potassium benzoate, potassium perchlorate and Viton A mix. Potassium benzoate comprises 30% by mass of the spectral pellet with 65% potassium perchlorate and Viton A making up the rest of the pellet. The fuel and oxidant have particle sizes of less than 60 microns.

[0042] Alternatively the spectral pellet can be formed from a boron, potassium nitrate, Viton A mix. The potassium nitrate is 70% by mass of the composition and has a typical particle size of 100 μm. The boron is amorphous and sub-micron size and makes up 50% by mass of the composition or 20% by mass if an additive like silicon is used. If used, the silicon particles are around 10 μm in size. Boron, potassium nitrate and Viton A gives a hard composition which may be easily cast into the required pellet shapes. Use of a binder such as polybutyl rubber would lead to a more flexible composition which could, for example, be extruded.

[0043] As the spectral flare 4 is formed from a single cylinder the burn rate is much slower than that of the primer
flare 2 and due to the central hole 14, the intensity of the spectral flare 4 is substantially constant throughout the duration of burning.

[0044] FIG. 3 shows a plot of the IR intensity against time for a decoy flare as shown in FIG. 1 for two fixed IR bands. The primer flare was 47 mm in diameter and 40 mm in length, consisting of 8 discs, each 5 mm thick, formed from an MTV composition. The spectral flare was a single pellet of potassium benzate, potassium perchlorate, Vlon A mix and was 47 mm in diameter and was 110 mm in length. Both the primer flare and the spectral flare were provided with a central hole 6 mm in diameter.

[0045] It can be seen that as the primer flare ignites there is a rapid increase in intensity to a very intense peak which rapidly drops away again. The duration of burning of the primer flare is not sufficient in the region of 200 ms. It can also be seen that one IR band is very much more intense than the other. This is the situation with conventional flares but not with targets such as aircraft. After the primer flare has finished burning it can be seen that the spectral flare is already burning and that the intensity of both bands drops off to a lower level. However, the band which was, during burning of the primer flare, of lower intensity is now of greater intensity, which is the opposite situation to what would be expected for a conventional decoy and is similar to what the output from the target would be. This occurs a few hundred milliseconds after the primer flare is ignited and therefore solely the spectral flare will be burning by the time the spectral discriminator of a missile’s CCM system will have been activated.

[0046] It can be seen that the spectral flare burns with relatively consistent intensity in both bands for a few seconds, more than long enough for the target to be well outside the missile’s field of view when the flare finally stops burning.

[0047] FIGS. 4 & 5 show alternative embodiments of a primer flare suitable for use in decoy flare according to the present invention. Where appropriate like numerals have been used to designate like components.

[0048] Referring to FIG. 4 the primer flare 2 is formed from a single cylindrical pellet 42 having a central hole 12. The pellet 42 is also provided with a number of other holes 44 which pass through the pellet, the inside surfaces of the central hole 12 and the holes 42 being coated with a primer paste to aid in ignition. The use of a single pellet with a number of holes can simplify the production of the primer flare as a single pellet can be easily machined, however the loss of material from the primer flare could necessitate the use of a larger pellet, depending upon the application.

[0049] For a 47 mm diameter and 40 mm long primer flare made from an MTV composition the desired burn rate can be achieved with one central hole 12 and five surrounding holes 42, each hole being of 6 mm diameter. Alternatively transverse holes could be provided down the length of the primer pellet.

[0050] FIG. 5 shows an rectangular primer flare 50 comprising a single pellet with a central hole 52 and a number of grooves 54 running down the length of the pellet. The grooves may be a few mm thick and about 15 mm deep depending upon the application and may be filled with primer paste to aid ignition.

1-26. (canceled)
27. An infra-red emitting decoy flare comprising a flare casing, two pyrotechnic components housed within the flare casing, and an ignition system for igniting the pyrotechnic components, the two pyrotechnic components comprising a primer flare and a spectral flare, the primer flare including at least one primer pellet comprising a fast burning pyrotechnic composition that causes rapid ignition of the primer pellet to produce an intense infra-red source, the spectral flare including at least one spectral pellet comprising a pyrotechnic composition that produces a spectral infra-red source having ratios of the intensity of the infra-red spectrum measured at at least two fixed bands at the same time lying within a fixed range, and wherein the spectral flare is still burning after the primer flare has finished burning, and wherein the spectral flare further comprises an explosive material with a waxy composition.
28. An infra-red emitting decoy flare as claimed in claim 27 wherein the intensity of the infra-red radiation emitted from the spectral flare is greater than that normally emitted from an intended target.
29. An infra-red emitting decoy flare as claimed in claim 27 wherein the primer flare comprises a stack of discs of a pyrotechnic composition.
30. An infra-red emitting decoy flare as claimed in claim 27 wherein the primer flare is provided with a central hole.
31. An infra-red emitting decoy flare as claimed in claim 27 wherein the primer flare is provided with a plurality of holes.
32. An infra-red emitting decoy flare as claimed in claim 27 wherein the primer flare has a plurality of grooves in its surface.
33. An infra-red emitting decoy flare as claimed in claim 27 wherein the burn time of the primer flare is within the range of 100 to 600 ms.
34. An infra-red emitting decoy flare as claimed in claim 27 wherein the burn time of the primer flare is in the range of 150 to 250 ms.
35. An infra-red emitting decoy flare as claimed in claim 27 wherein the spectral flare comprises a single pellet.
36. An infra-red emitting decoy flare as claimed in claim 35 wherein the spectral flare is provided with a central hole.
37. An infra-red emitting decoy flare as claimed in claim 27 wherein the spectral flare is ignited by the burning of the primer flare.
38. An infra-red emitting decoy flare as claimed in claim 27 wherein the primer flare is formed from a fast burning magnesium-Teflon-Viton composition.
39. An infra-red emitting decoy flare as claimed in claim 27 wherein the ignition of the primer pellet produces an intense spectral infra-red source wherein the ratio of the intensity of the infra-red spectrum at least two fixed bands is within a fixed range.
40. An infra-red emitting decoy flare as claimed in claim 39 wherein the primer flare is comprised from a composition of potassium benzate, potassium perchlorate and a binder comprised of an explosive material with a waxy composition.
41. An infra-red emitting decoy flare as claimed in claim 27 wherein the spectral flare pyrotechnic composition produces quantities of gas on ignition.
42. An infra-red emitting decoy flare as claimed in claim 27 wherein the spectral flare is formed from a composition having an organic fuel or a boron fuel, an oxidant and a binder.

43. An infra-red emitting decoy flare as claimed in claim 42 wherein the oxidant is chosen from the group of potassium perchlorate, potassium nitrate, sodium nitrate and ammonium nitrate.

44. An infra-red emitting decoy flare as claimed in claim 42 wherein the binder is chosen from the group of Viton A, dextrin or polybutyl rubber.

45. An infra-red emitting decoy flare as claimed in claim 42 wherein the spectral flare composition comprises an additive such as silicon.

46. An infra-red emitting decoy flare as claimed in claim 42 wherein the organic fuel is chosen from the group comprising sucrose, lactose, starch and potassium benzoate.

47. An infra-red emitting decoy flare as claimed in claim 27 wherein the explosive material is chosen from the group of RDX, HMX and HNS.

48. An infra-red emitting decoy flare as claimed in claim 27 wherein the spectral flare composition is formed from a mix of 30-40% by mass of potassium benzoate and 60-70% by mass of potassium perchlorate together with 3-8% by mass of RDX, HMX or HNS.