

PATENT SPECIFICATION

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✓ (54) IMPROVEMENTS IN AND RELATING TO LINE-THROWING ROCKETS

(71) ✓ We, PAINS-WESSEX LIMITED, a British Company of High Post, Salisbury, Wiltshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to line-throwing rockets, which are used, for example, during rescue operations when it is desired to get a line aboard a vessel.

The invention provides a line-throwing rocket having means for coupling a line thereto, the propellant of the rocket being solid and arranged to combust in a cigarette burning configuration and with neutral burning characteristics for at least a major portion of its burning life.

It is to be understood that references to propellant burning in a cigarette burning configuration (sometimes referred to instead as a cigar burning configuration) mean that the propellant burns at an end face only, and that references to propellant burning with neutral burning characteristics mean that the propellant burns with approximately constant thrust.

Because the burning area of the propellant column will be constant during the period of cigarette burning with neutral burning characteristics, a rocket having any desired total impulse can be made simply by inserting an appropriate length of propellant column into the rocket, and to produce easily rockets with different total impulses is important for line-throwing rockets where it may be desired to use different lengths of line. To produce rockets with different total impulses with a conventional line-throwing rockets might well involve making a separate design for the propellant configuration for each rocket. The fact that the propellant combusts in a cigarette burning configuration

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and with neutral burning characteristics over a major portion of its burning life enables the thrust to be sustained longer (before it drops below a useful value) as compared with an arrangement where the mass of the propellant that burns neutrally is arranged in (or as part of) a non-neutral burning configuration (for example, as in a conventional line-throwing rocket employing progressive burning characteristics).

The burning area will be small if the rocket is to be small, but the rocket thrust can be kept at an acceptable value by arranging that the rate of burning (which is proportional to the thrust) is sufficiently high, and this can be achieved by arranging that the chamber pressure is sufficiently high, by making the nozzle throat area sufficiently small.

Advantageously, the propellant is not provided with any cavities or passageways and is contained in a tubular casing, the propellant being in contact with the wall of the casing or with a liner for the casing, thereby giving a high packing density. Preferably, a forward part of the casing contains ballast, for example, a mass of clay. This facilitates the manufacture of a number of rockets having different ranges, since the relative amounts of the ballast and propellant, and the type of propellant, to be inserted in the casing can be varied without altering the total weight or overall length of the rocket. Preferably, the ballast is of approximately the same density as the propellant so that the total length of propellant and ballast (in a casing of constant diameter), in addition to the total weight, can be made the same for all rockets employing propellant of that density, no matter what the range of the rocket is.

The said portion of its burning life is preferably at least 75% of the burning life and may be at least 90% of the burning

life. The propellant may combust in a cigarette burning configuration and with neutral burning characteristics for substantially its entire burning life; an advantage of such a rocket is that the same line can be projected the same distance with such a rocket with a lower maximum thrust (by maintaining that thrust over a longer period) than with a rocket of the type having non-neutral characteristics, and the fact that the maximum thrust is lower means that the maximum chamber pressure is also lower which enables the rocket propellant casing to be constructed so that it has to withstand only a lower pressure. It may in some cases be advantageous for the thrust of the rocket to rise sharply at the beginning of its flight, then to fall and then to remain at a constant value for the remainder of the flight; for example, the rear end of the propellant may have a recess in it so that the initial burning area is greater than the subsequent burning area. A sharp initial rise of thrust is important since any inaccuracies in the direction of the rocket, for example, due to the propellant not being properly ignited at that stage, have a much greater effect at the start of the flight than later on.

The rocket may be mounted on a suitable launching device for firing. Advantageously, however, the rocket is housed in a rocket launcher, and there is provided an ejection charge arranged so that ignition of the ejection charge both causes the rocket to be ejected from the launcher and causes the rocket propellant to be ignited.

The propellant may comprise an oxidising agent and a binder and have elastomeric properties as, for example, when the binder is of a polysulphide rubber or a polyurethane, but advantageously the propellant comprises an oxidising agent and a binder and is a plastic propellant, that is to say, it can be plastically deformed. Both of these types of propellants give good storage properties since they are not prone to the developing of the cracks or strains encountered with some propellants, and both can be case-bonded, that is to say, bonded to the propellant casing or to a layer of inhibiting material lining the casing. Plastic propellants have the added advantage that they can be safely and readily formed into even a complex configuration.

The binder of the plastic propellant may be a viscous polymer; the binder may be a polymeric aliphatic hydrocarbon having side groups and which is a visco-elastic liquid having a viscosity in the range of from 250 000 to 7 000 000 poises

at 25°C. Preferably, the binder comprises a polyisobutene, and the oxidising agent is preferably ammonium perchlorate. Plastic propellants in general, and the combination of ammonium perchlorate and a polyisobutene in particular, have high specific impulses. This enables the size of the rocket to be reduced, and permits a line-throwing rocket suitable for being held in the hands to be produced. In order to improve the action of the binder, a small quantity of a surface-active agent may be incorporated in the propellant. Preferably, the surface-active agent is a mixture of at least two organic compounds of which at least one is an organic sulphate, an inorganic salt of an esterified dibasic sulphonic acid, or an ester of a long chain fatty acid. Advantageously, the proportion of the surface-active agent in the propellant is about 1% by weight. The propellant may also include a moderating agent such as, for example, ammonium picrate or oxamide.

Further information concerning plastic gas-producing compositions suitable for use as the propellant in accordance with the invention may be found in United Kingdom Patent Specification No. 915 910.

The propellant may be 'case-bonded' by lining the casing (or the liner) with a layer of adhesive, for example, a suitable Bostic (Trade Mark). This case-bonding serves to prevent combustion spreading down the sides of the propellant mass in advance of the main flame front, which would cause an undesirable increase in chamber pressure, and might result in a plastic propellant, whose shape can be easily changed, being forced from the casing by the pressure of combustion gases. The casing is generally filled with plastic propellant under vacuum to prevent pockets of air being trapped in the propellant or between the propellant and the casing.

Advantageously, when the propellant is a plastic propellant and especially when the binder of which is a polymeric aliphatic hydrocarbon of the kind defined above, there is copper chromate exposed on at least part of the propellant surface that is to be ignited. This facilitates ignition of the propellant. Preferably, copper chromate is distributed discontinuously over the whole of the exposed propellant surface, that is to say, the distribution is not such that a continuous layer of copper chromate covers the surface and completely masks the propellant. Such a discontinuous distribution ensures that, on ignition, the flame front spreads uniformly over the propellant surface. Although it is in general advantageous for there to be a discontinuous distribution of copper chromate

over the whole of the exposed propellant surface, it will be sufficient in many cases merely to arrange that there is a discontinuous layer of copper chromate on the propellant surface in the region where it is desired that initial ignition should occur.

Copper chromate may be applied to the propellant surface in a variety of ways. Thus, for example, the copper chromate can be applied by a dusting or sprinkling treatment, the solid particles being held on the surface by the mild adhesive action or "tack" of the binder. Alternatively, the copper chromate may be applied in the form of a slurry in a volatile liquid, the liquid then being allowed or caused to evaporate. It is desirable to use a volatile liquid which is a solvent capable of dissolving the binder, for example, petroleum ether, as the action of such a solvent results in the copper chromate particles being embedded more firmly in the propellant surface. It is sometimes advantageous, where the copper chromate is to be applied to the propellant surface in a slurry in such a solvent, to increase the viscosity of the solvent by dissolving small quantities of a visco-elastic material therein, for example, to give a 0.5% to 5% solution. An example of a suitable visco-elastic material is the high molecular weight polyisobutene known as OPPANOL (Trade Mark) B 150.

It is important that the thickness of any layer of copper chromate applied to the propellant surface should not be too great, as such a layer may act as a thermal insulator and so retard or inhibit ignition. In general, the quantity of copper chromate applied to the propellant surface should be less than that which would be required in order to form a continuous layer.

Advantageously, the particle size of the copper chromate is such that substantially all of it will pass through a 120 mesh (B.S.S.) screen.

Instead of, but, advantageously, in addition to there being copper chromate exposed on the propellant surface, copper chromate may be distributed within the propellant mass. The distribution of copper chromate within the propellant mass has the important advantage of giving the propellant a faster burning rate, and this enables the diameter of the rocket to be reduced. Advantageously, the propellant is an intimate mixture of constituents including at least 0.5% by weight of copper chromate. Preferably, the propellant includes from 1% to 2% by weight of copper chromate. It will generally be found that little or no advantage is gained by using proportions of copper chromate above about 2% by weight.

When a propellant is used which includes

a quantity of copper chromate distributed throughout its mass, there will usually, be copper chromate present in the surface to be ignited and, in general, little or no advantage will then be gained by applying additional copper chromate to the surface. If, however, there is an exuded layer of binder on the propellant surface, it is desirable to apply copper chromate to the surface, for example, by a dusting or sprinkling treatment, in order to ensure that there is sufficient copper chromate at the surface to facilitate ignition. Alternatively, it may be possible to expose copper chromate particles embedded in the propellant mass by dissolving at least part of the exuded layer by means of a suitable solvent.

The following are two examples of plastic gas-producing compositions suitable for use as propellants in the line-throwing rockets in accordance with the invention with copper chromate exposed on at least part of the propellant surface the first including copper chromate and the copper chromate being applied to the surface of the second, all the percentages being by weight:

I. Ammonium perchlorate	84.5%	
Polyisobutene	12.5%	95
Surface-active agent	1%	
(Pentaerythritol dioleate	30%	
Ethyl oleate	40%	
Sodium dioctyl		
sulphosuccinate	30%)	100
Copper chromate	2%	
II. Ammonium perchlorate	85.5%	
Polyisobutene	12.5%	
Titanium dioxide	1.0%	
Surface-active agent	1.0%	105

Further details of the inclusion of copper chromate in a plastic gas-producing composition will be found in United Kingdom Patent Specification No. 1 309 548.

Instead of, but preferably in addition to, the inclusion of copper chromate with the propellant, there may be provided a mass of readily combustible material between the nozzle of the rocket and the propellant for igniting, or assisting the ignition of, the propellant, the material being capable of being ignited by a flame through the nozzle of the rocket. The provision of such a mass of combustible material between the nozzle and the propellant gives more reliable ignition of the propellant than if ignited directly by a flame through the nozzle since the propellant can be ignited over a larger area and, since the mass of combustible material is actually carried in the rocket, the propellant can be subjected to a flame from the combustible material longer than it can to a flame passing through the nozzle from outside the rocket. Preferably, the mass of readily

combustible material is in the form of a sheet formed with slits or holes: this promotes rapid spreading of the combustion to both sides of the sheet and therefore facilitates ignition of the propellant. The readily combustible material is preferably primed cambric, although other substances, for example, nitro-cellulose, may be used. Preferably, a recess is formed in the side of the nozzle of the rocket adjacent to the propellant, which recess is laterally spaced apart from the outlet in the nozzle, and there is located in the recess igniter substance. The igniter substance is ignited by the flame from the readily combustible material, and the provision of such igniter substance increases the reliability of ignition of the propellant. Preferably, the recess is an annular groove. Preferably, the igniter substance comprises a mixture of magnesium and potassium nitrate with a superposed layer of gunpowder, the whole being pressed into the groove to form a compact mass. Further details of the arrangement employing the recess are given in United Kingdom Patent Specification No. 1,138,192.

When a rocket launcher is provided, and an ejection charge is arranged to ignite and eject the rocket, the ejection charge may comprise gunpowder. Advantageously, the ejection charge comprises sulphurless gunpowder, and magnesium and/or aluminium powder is mixed therewith. Preferably, the weight of magnesium and/or aluminium powder is less than 40% of the weight of the mixture of gunpowder with magnesium and/or aluminium powder. Ignition by the flame from the ejection charge is facilitated by hot particles of magnesium and/or aluminium which get carried with the flame. The ejection charge with such additives may, in certain cases, be used without the mass of readily combustible material or with propellant not including copper chromate, but is preferably used in conjunction with both of these.

The ejection charge is preferably ignited by a percussion igniter, for example, by the flame from a percussion primer.

A line-throwing rocket constructed in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a view, partly in section, of the line-throwing rocket, a launcher for the rocket, and of a line for the rocket.

Figure 2 is an axial section of a part of the arrangement shown in Figure 1.

Referring to Figure 1, the line-throwing rocket indicated generally by the reference

numeral 4 is contained in an outer casing 1, the upper end of which is closed by a removable protective cap 2 and the lower end of which is closed by a member 3. A line 5 is coupled to the rocket. A handle, indicated generally by the reference numeral 6, extends parallel to the casing 1 and is bent inwardly and secured to the casing at each end; this enables the device to be hand-held. A continuation of the handle 6 is formed into a loop 7 through which the fingers can pass.

The rocket 4 is contained in a relatively close fit in a tubular rocket launcher 8, which is secured to the portion of the wall of the casing 1 adjacent to the handle 6 so as to reduce the effect of any hand-shake on the accuracy of firing to a minimum. The launcher tube 8 is secured by two supporting members 9, and a small clearance is provided between the wall of the casing 1 and the wall of the launcher tube 8.

A hollow tubular member 10 is secured in an end portion of the launcher tube 8 behind the rocket 4, the portion of the tubular member adjacent to the rocket 4 being outwardly flared. A bayonet-cap fitting igniter assembly (not shown) which includes an ejection charge is received in a tube 11a, one end of which extends into the tubular member 10. The ejection charge comprises sulphurless gunpowder mixed with a small quantity of aluminium powder (not shown).

The igniter assembly is a percussion igniter assembly of the cocked type (although an igniter assembly of the uncocked type may be employed if desired), and it is operated by pulling a trigger 12 outwardly in the direction of the arm of the trigger that extends normal to the axis of the launcher tube 8. This causes a percussion primer, which forms part of the igniter assembly, to be struck, and the flame from the primer ignites the ejection charge. The fact that the igniter assembly is bayonet-fitting is important from the safety point of view, since it only need be inserted into the tube 11a when it is desired to use the line-throwing rocket; the closure 13 of the chamber 11 is merely removed and the igniter assembly clipped into position.

The rocket has means for coupling the line to the rocket comprising U-shaped members 14 and 16, a band 15 and a wire 'trace' 17. The U-shaped yoke 14, which is secured to the band 15 which rests against the upper end of the launcher tube 8, is fitted over the end of a rocket 4 inserted in the launcher tube, so as to couple the line 5 to the rocket 4. The two arms of the yoke 14 extend parallel to the axis of the launcher tube 8 and

are spaced apart from the outer surface of the launcher tube 8 by the same distance. The yoke 14 is connected to the U-shaped member 16 which also has two parallel arms, the arms being spaced apart by the same distance as those of the yoke 14. The end portions of the arms of the yoke 14 at the open end of the yoke are pivotally secured to the respective end portions of the arms of the U-shaped member 16 at the open end.

The centre of the U-shaped member 16 is secured to a wire 'trace' 17 which is asbestos sleeved, and the other end of the trace 17 is connected to one end of the line 5. The line 5 is coiled in a tubular container secured in the casing 1.

Referring to Figure 2, which shows the propulsion unit alone, the propulsion unit comprises a tubular casing 18 which has an opening at the rear end. The casing 18 contains, in the forward portion, ballast in the form of clay 19 and, in the rear portion, a plastic gas-producing composition 20. The composition 20 has the composition I given hereinbefore. The clay 19 is pressed into the casing 18 and the composition 20 is bonded to the casing 18 with a layer of Bostic (Trade Mark): they are separated from each other by a millboard disc 21. The clay 19 is chosen to have approximately the same density as the propellant 20 to facilitate the manufacture of rockets of different range.

The lower portion of the casing 18 contains a nozzle 22 and a millboard washer 23 which are held in position by a waist 24 and the turned-in lower edge of the casing 18. A primed cambric disc 25 formed with a number of parallel slits which extend from side to side of the area of the aperture in the millboard washer 23 is secured with adhesive to the washer 23. An annular groove in the surface of nozzle 22 contains igniter substance in the form of a mixture of magnesium and potassium nitrate with a superposed layer of gunpowder, which are pressed into the groove to form a compact mass after first applying shellac to it.

In operation, the cap 2 is removed from the casing 1, and the line-throwing rocket is aimed in the desired direction. The percussion igniter (not shown) is then operated so that the percussion primer is ignited, which in turn ignites the ejection charge (not shown) in the tubular member 10.

Ignition of the ejection charge both causes the rocket 4 to be ejected from the launcher tube 8 and the rocket 4 to be ignited. The fact that the rocket 4 fits closely in the launcher tube 8 ensures that the arms of the yoke 14 and U-shaped member 16 remain clear of the launcher

tube as the rocket leaves the tube. Simultaneously with the rocket being forced out of the launcher tube 8, the flame from the ejection charge passes through the aperture in the nozzle 22 and ignites the primed cambric disc 25 and, because of the slits in the disc, combustion spreads rapidly to both sides of the primed cambric disc. Flames from the burning primed cambric disc 25 ignite the igniter substance 26, which in turn ignites the propellant mass 20. Flames from the burning primed cambric disc 25 also assist in igniting the propellant mass 20. The fact that the propellant has copper chromate exposed on part of its lower surface also facilitates ignition.

The line 5 is gradually paid out of its tubular container, and the asbestos-sleeved wire trace 17, which is, in flight, between the lower end of the rocket and the line 5, serves to prevent the flames from the rocket igniting the line 5.

The rocket propellant burns only at its rear end face in so-called "cigarette" burning so that the area of burning remains constant, and the thrust developed by the rocket in flight remains substantially constant. It has been found that the line-throwing rocket is as effective as conventional line-throwing rockets which employ, for example, gunpowder as propellant, and which have a progressively increasing thrust, despite the fact that the drag of the line increases progressively.

If desired, when the rocket 4 has been fired, the line 5 can be recovered and the yoke 14 fitted over a replacement rocket 4 which is placed in the launcher tube 8. A further igniter assembly can then be inserted in the tube 11a and the device fired as before.

WHAT WE CLAIM IS:—

1. A line-throwing rocket having means for coupling a line thereto, the propellant of the rocket being solid and arranged to combust in a cigarette burning configuration and with neutral burning characteristics for at least a major portion of its burning life.

2. A line-throwing rocket as claimed in claim 1, in which the said portion of its burning life is at least 75% of the burning life.

3. A line-throwing rocket as claimed in claim 1, in which the said portion of its burning life is at least 90% of the burning life.

4. A line-throwing rocket as claimed in any one of claims 1 to 3, in which the propellant is arranged to combust in a cigarette burning configuration and with neutral burning characteristics for substantially its entire burning life.

are spaced apart from the outer surface of the launcher tube 8 by the same distance. The yoke 14 is connected to the U-shaped member 16 which also has two parallel arms, the arms being spaced apart by the same distance as those of the yoke 14. The end portions of the arms of the yoke 14 at the open end of the yoke are pivotally secured to the respective end portions of the arms of the U-shaped member 16 at the open end.

The centre of the U-shaped member 16 is secured to a wire 'trace' 17 which is asbestos sleeved, and the other end of the trace 17 is connected to one end of the line 5. The line 5 is coiled in a tubular container secured in the casing 1.

Referring to Figure 2, which shows the propulsion unit alone, the propulsion unit comprises a tubular casing 18 which has an opening at the rear end. The casing 18 contains, in the forward portion, ballast in the form of clay 19 and, in the rear portion, a plastic gas-producing composition 20. The composition 20 has the composition I given hereinbefore. The clay 19 is pressed into the casing 18 and the composition 20 is bonded to the casing 18 with a layer of Bostic (Trade Mark):

they are separated from each other by a millboard disc 21. The clay 19 is chosen to have approximately the same density as the propellant 20 to facilitate the manufacture of rockets of different range.

The lower portion of the casing 18 contains a nozzle 22 and a millboard washer 23 which are held in position by a waist 24 and the turned-in lower edge of the casing 18. A primed cambric disc 25 formed with a number of parallel slits which extend from side to side of the area of the aperture in the millboard washer 23 is secured with adhesive to the washer 23. An annular groove in the surface of nozzle 22 contains igniter substance in the form of a mixture of magnesium and potassium nitrate with a superposed layer of gunpowder, which are pressed into the groove to form a compact mass after first applying shellac to it.

In operation, the cap 2 is removed from the casing 1, and the line-throwing rocket is aimed in the desired direction. The percussion igniter (not shown) is then operated so that the percussion primer is ignited, which in turn ignites the ejection charge (not shown) in the tubular member 10.

Ignition of the ejection charge both causes the rocket 4 to be ejected from the launcher tube 8 and the rocket 4 to be ignited. The fact that the rocket 4 fits closely in the launcher tube 8 ensures that the arms of the yoke 14 and U-shaped member 16 remain clear of the launcher

tube as the rocket leaves the tube. Simultaneously with the rocket being forced out of the launcher tube 8, the flame from the ejection charge passes through the aperture in the nozzle 22 and ignites the primed cambric disc 25 and, because of the slits in the disc, combustion spreads rapidly to both sides of the primed cambric disc. Flames from the burning primed cambric disc 25 ignite the igniter substance 26, which in turn ignites the propellant mass 20. Flames from the burning primed cambric disc 25 also assist in igniting the propellant mass 20. The fact that the propellant has copper chromate exposed on part of its lower surface also facilitates ignition.

The line 5 is gradually paid out of its tubular container, and the asbestos-sleeved wire trace 17, which is, in flight, between the lower end of the rocket and the line 5, serves to prevent the flames from the rocket igniting the line 5.

The rocket propellant burns only at its rear end face in so-called "cigarette" burning so that the area of burning remains constant, and the thrust developed by the rocket in flight remains substantially constant. It has been found that the line-throwing rocket is as effective as conventional line-throwing rockets which employ, for example, gunpowder as propellant, and which have a progressively increasing thrust, despite the fact that the drag of the line increases progressively.

If desired, when the rocket 4 has been fired, the line 5 can be recovered and the yoke 14 fitted over a replacement rocket 4 which is placed in the launcher tube 8. A further igniter assembly can then be inserted in the tube 11a and the device fired as before.

WHAT WE CLAIM IS:—

1. A line-throwing rocket having means for coupling a line thereto, the propellant of the rocket being solid and arranged to combust in a cigarette burning configuration and with neutral burning characteristics for at least a major portion of its burning life.

2. A line-throwing rocket as claimed in claim 1, in which the said portion of its burning life is at least 75% of the burning life.

3. A line-throwing rocket as claimed in claim 1, in which the said portion of its burning life is at least 90% of the burning life.

4. A line-throwing rocket as claimed in any one of claims 1 to 3, in which the propellant is arranged to combust in a cigarette burning configuration and with neutral burning characteristics for substantially its entire burning life.



5. A line-throwing rocket as claimed in any one of claims 1 to 4, in which the propellant is not provided with any cavities or passageways and is contained in a tubular casing, the propellant being in contact with the wall of the casing or with a liner for the casing.

6. A line-throwing rocket as claimed in claim 5, in which a forward part of the casing contains ballast.

7. A line-throwing rocket as claimed in any one of claims 1 to 6, in which the propellant comprises an oxidising agent and a binder and is a plastic propellant.

8. A line-throwing rocket as claimed in claim 7, in which the binder is a polymeric aliphatic hydrocarbon having side groups and which is a visco-elastic liquid having a viscosity in the range of from 250,000 to 7,000,000 poises at 25°C.

9. A line-throwing rocket as claimed in claim 7 or claim 8, in which the binder comprises a polyisobutene.

10. A line-throwing rocket as claimed in claim 9, in which the oxidising agent is ammonium perchlorate.

11. A line-throwing rocket as claimed in any one of claims 7 to 10, in which there is copper chromate exposed on at least part of the propellant surface that is to be ignited.

12. A line-throwing rocket as claimed in any one of claims 7 to 11, in which there is copper chromate distributed within the propellant mass.

13. A line-throwing rocket as claimed in any one of claims 1 to 12, in which there is provided a mass of readily combustible material between the nozzle of the rocket and the propellant for igniting, or assisting the ignition of, the propellant, the material being capable of being ignited by a flame through the nozzle of the rocket.

14. A line-throwing rocket as claimed in claim 13, in which the mass of readily combustible material is in the form of a sheet provided with slits or holes.

15. A line-throwing rocket as claimed in claim 14, in which the readily com-

combustible material is primed tambric.

16. A line-throwing rocket as claimed in claim 14 or claim 15, in which a recess is formed in the side of the nozzle that is adjacent to the propellant, the recess is laterally spaced apart from the outlet in the nozzle, and igniter substance is located in the recess.

17. A line-throwing rocket as claimed in any one of claims 1 to 16, in which there is provided a rocket launcher, in which the rocket is housed, and an ejection charge arranged so that ignition of the ejection charge both causes the rocket to be ejected from the launcher and causes the rocket propellant to be ignited.

18. A line-throwing rocket as claimed in claim 17, in which the ejection charge comprises gunpowder.

19. A line-throwing rocket as claimed in claim 18, in which the ejection charge comprises sulphurless gunpowder, and magnesium and/or aluminium powder mixed therewith.

20. A line-throwing rocket as claimed in claim 19, in which the weight of magnesium and/or aluminium powder is less than 40% of the weight of the mixture of gunpowder with magnesium and/or aluminium powder.

21. A line-throwing rocket substantially as hereinbefore described with reference to, and as shown in, Figures 1 and 2 of the accompanying drawings.

22. The combination of a line-throwing rocket as claimed in any one of claims 1 to 21 and a line coupled thereto.

23. The combination as claimed in claim 22, in which the thrust of the rocket is arranged to rise sharply at the beginning of the flight, then to fall, and then to remain at a constant value for the remainder of the flight.

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