March 13, 1962 D. A. WASHBURN 3,024,607

SUSTAINED OPERATION IGNITER FOR RAM-JET MISSILES

Filed Aug. 19, 1949

FIG. 1

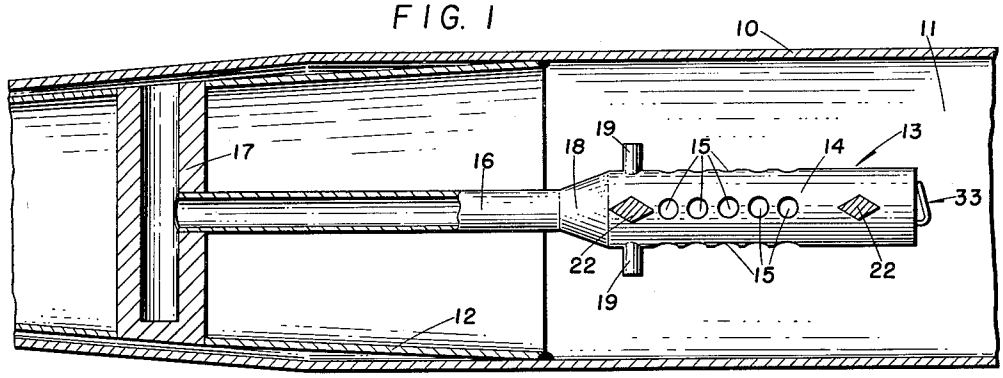


FIG. 2

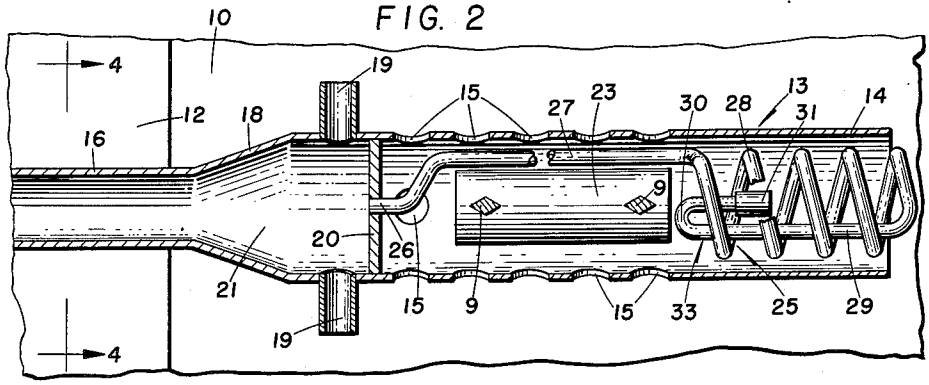


FIG. 4

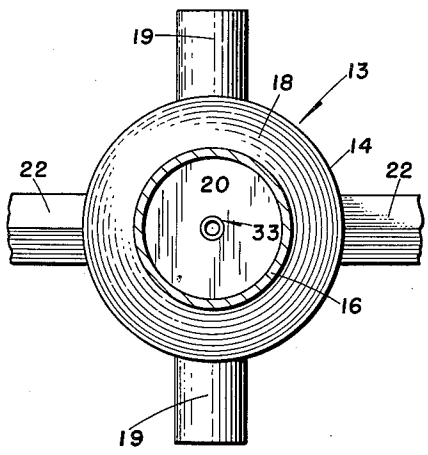
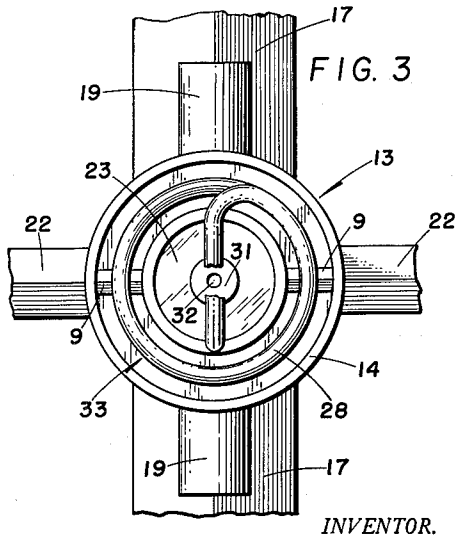


FIG. 3



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SUSTAINED OPERATION IGNITER FOR RAM-JET MISSILES

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The present invention relates in general to guided missiles and more particularly to an improved igniter for ram-jet missiles.

In carrying out tests of ram-jet guided missiles, it has been found necessary to employ pilot igniters to maintain burning in the combustion chambers of missiles under test. Igniters heretofore in use in burner tests in the laboratory, have included gas flames, pyrotechnic flares, and the like. In flight testing missiles, the pyrotechnic flare has been the only suitable ignition means, because the igniters of the other types mentioned require separate supplies of fuel and/or power, which it is impracticable to carry in an actual missile.

Pyrotechnic flares, however, burn for relatively short times and, as guided missiles have been improved, it has been demonstrated that improvements in the flares, with a view of extending their burning time, have not kept pace with improved operation and the lengthened flight time of the missiles. Consequently, a condition has been reached in which the operation of missiles is seriously affected by the burning time (life span) of the flares used for ignition. Further extension of flight time and range of a guided missile therefore depends upon the development and utilization of a new long-burning igniter of such design that it will operate as long as any fuel remains for the missile's ram-jet engine.

One of the principal objects of the present invention, therefore, is to provide an igniter for a ram-jet missile which will function for as long a time as the missile is in powered flight.

Another object of the invention is to provide an igniter which does not require an auxiliary fuel supply.

A further object of the invention resides in the provision of an igniter for the purpose set forth hereinabove, which will be simple in construction and efficient in operation.

Other objects and many of the attendant advantages of this invention will be appreciated readily as the same becomes understood by reference to the following detailed description, when considered in connection with the accompanying drawings, wherein:

FIG. 1 is an axial section of a portion of a ram-jet burner fitted with the improved igniter of the present invention, said igniter being shown partly in section and partly in side elevation;

FIG. 2 is an enlarged detail axial sectional view showing particularly the internal construction of the igniter;

FIG. 3 is an end view of the igniter, as seen from its discharge end and on a still larger scale; and

FIG. 4 is a correspondingly enlarged sectional view in the plane 4—4 of FIG. 2.

Referring now to the drawings in detail, a portion of the outer shell of a guided missile is shown at **10**. This shell **10** is a heavy-walled metal tube and its bore forms a central duct or combustion chamber **11**, fitted at its forward, or upstream, end with a diffuser **12** of substantially frusto-conical shape. The air for combustion enters the forward end of the missile and passes downstream through the diffuser **12** and chamber **11**.

The igniter of the present invention is shown as a whole at **13** and includes a cylindrical sleeve **14**, open at its downstream end and formed with circumferentially spaced ports **15**, arranged in longitudinal rows. The

sleeve **14** is supported axially in the chamber **11** by a fuel feed pipe **16** in turn supported by a tubular strut **17** and is additionally supported from the shell **10**, by radial struts **22**. More specifically, the upstream end of said sleeve **14** terminates in a frusto-conical neck **18**, and said neck is secured to the downstream end of the pipe **16**, the upstream end of said pipe being secured to said strut **17**. As best seen in FIG. 1, the bore of the strut **17** is closed at one end but provides a passage for fuel from the space surrounding the diffuser **12** through the pipe **16** into the sleeve **14**. Said strut is rigidly secured to the mid-portion of the diffuser **12**.

As best seen in FIG. 2, the sleeve **14** has, near its upstream end, two oppositely presented fuel discharge nozzles **19**, and within the sleeve, between the nozzles and the nearest of the ports **15**, there is a partition or wall **20**. The wall **20** and neck **18** cooperate to define an air-fuel mixing manifold **21**.

Supported axially within the sleeve **14**, medially of its length and downstream from the wall **20**, by struts **9**, is a pyrotechnic flare **23**, for initiating operation of the igniter. The flare **23** may be ignited by an electrically operated squib, not shown, or by any other suitable means.

A flame sustaining igniter unit is shown at **25** and is mounted axially within the sleeve **14** near its rear, or downstream, end. The igniter unit **25** consists of a pipe **33** having an end portion **26** mounted axially on the wall **20** and in communication with the manifold **21**. From the end portion **26** the pipe is bent to form an intermediate portion **27**, extending about the flare **23**, said portion **27** terminating at its rear, or downstream, end in a helical vaporizing coil **28**.

The pipe **33** is bent back and extends through the inside of the helix as shown at **29**, then has a U-bend at **30** and terminates in a burner nozzle **31**. This has a small aperture **32** directed downstream, as shown in FIG. 3, within the nozzle **31**.

The operation of the igniter will be clear from its structure, but for convenience may be summarized briefly as follows:

When the ram-jet burning is to be established, fuel is supplied from the fuel storage container of the ram-jet to the bore of tubular strut **17**, whence most of it flows through pipe **16** to the manfold **21** whence it issues through the nozzles **19**. A little of the fuel flows through the pipe **33**, entering it at **26**, and passing through portions **27**, **28**, **29** and **30** thereof, until it is discharged through the opening **32** of nozzle **31**.

Meanwhile the flare **23** has been ignited, and produces heat and flame within the sleeve **14**. This heats the coil **28** sufficiently to vaporize the fuel therein, which thereupon issues as a gas from nozzle **31**, and is ignited by the flame of the flare **23**. Thus a gas flame is produced at the said nozzle, and continues to heat the coil **28**, to maintain the gas supply to said nozzle, that is, the nozzle and coil constitute a regenerative burner.

In the space surrounding the sleeve **14** there is a combustible fuel-air mixture, produced from the fuel discharged from the nozzles **19** and the air stream flowing through the ram-jet. This mixture will be ignited initially by the flame of the flare, and its continuing combustion will be assured by re-ignition by the burning gas from igniter nozzle **31**, should it become extinguished. Occasionally during the flight of an aerial missile, combustion of the fuel-air mixture is "lost" or extinguished due to intense pressure fluctuations in the combustion chamber **11**, and, in addition, the flame at the igniter nozzle **31** is extinguished. However, the vaporizer arrangement with the igniter nozzle **31** is so designed to have self-igniting characteristics which are due to the

fact that the vaporizer coils **28** will still be sufficiently hot to continue to vaporize the liquid fuel contained therein. This fuel will then issue as a gas jet from igniter nozzle **31**, as previously described. The issuing jet will then re-ignite due to the auto-ignition feature of the vaporizer arrangement. Upon re-ignition of the pilot flame, the air-fuel mixture in the combustion chamber **11** will be re-ignited. The sleeve **14** acts as a protecting shield for the flame of the igniter, preventing it from being blown out, and at the same time the holes **15** in said sleeve permit free access of the surrounding fuel-air mixture for re-ignition purposes, and free access of the air required by the igniter flame itself.

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 claim the invention may be practised otherwise than as specifically described.

What is claimed is:

In an aerial missile of the ram-jet type having a body in the form of an elongated tubular duct, a diffuser and a combustor in said duct; in combination, an igniter for maintaining the burning of a combustible mixture entering said duct and passing through said combustor, said igniter comprising a conduit for liquid fuel, a manifold on the conduit and having fuel outlets directed substantially normally to the axis of the conduit, a second conduit for liquid fuel having its inlet end connected to said manifold and extending substantially the same direction as said first conduit, said second conduit having a burner nozzle at its outlet end, said nozzle being located so that the flame thereof will heat the second conduit to vaporize liquid fuel flowing therethrough, a perforated casing enclosing said second conduit and providing communication with the fuel air mixture, and a pyrotechnic flare for initially bringing said second conduit up to fuel vaporizing temperature.

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