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[54] **DUMP COMBUSTOR WITH NONCOHERENT FLOW**

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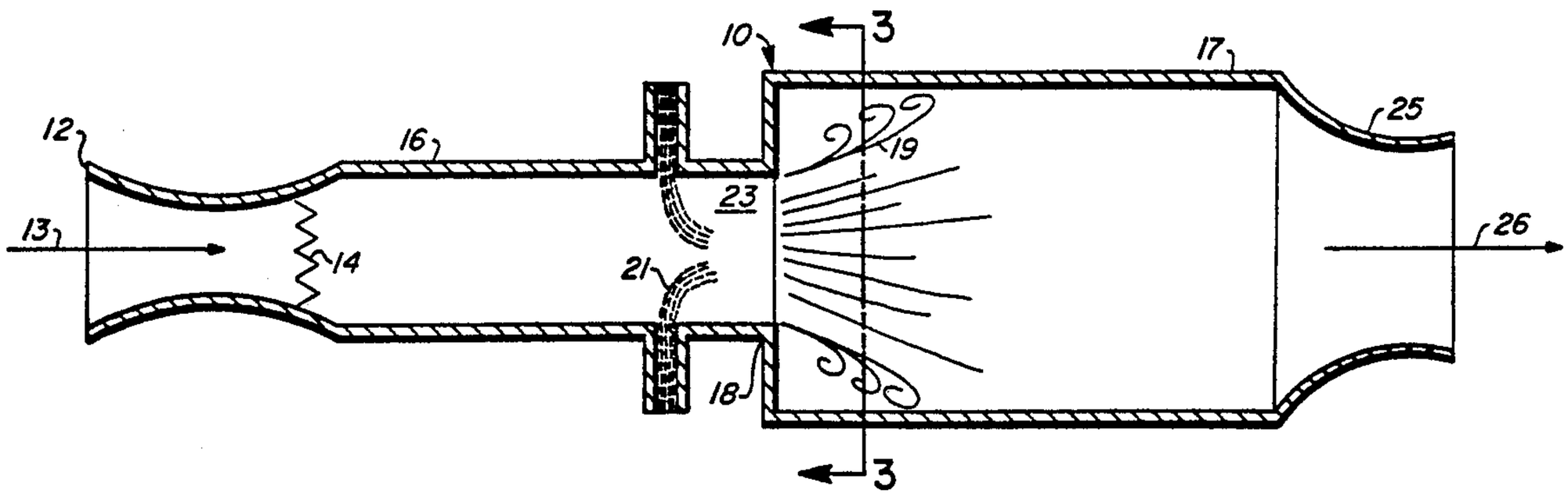
[57] **ABSTRACT**

In a combustor in which a flow area for fuel and air increases suddenly at a dump so as to generate vortices which mix the fuel and air for combustion downstream of the dump, the improvement in which the flow cross section upstream of the dump is noncircular, as triangular or rectangular, causing flow downstream of the dump to be noncoherent so that mixing by the vortices is aperiodic with the result that heat release on mixing is uniform in time and does not drive oscillations in the combustor.

3 Claims, 1 Drawing Sheet



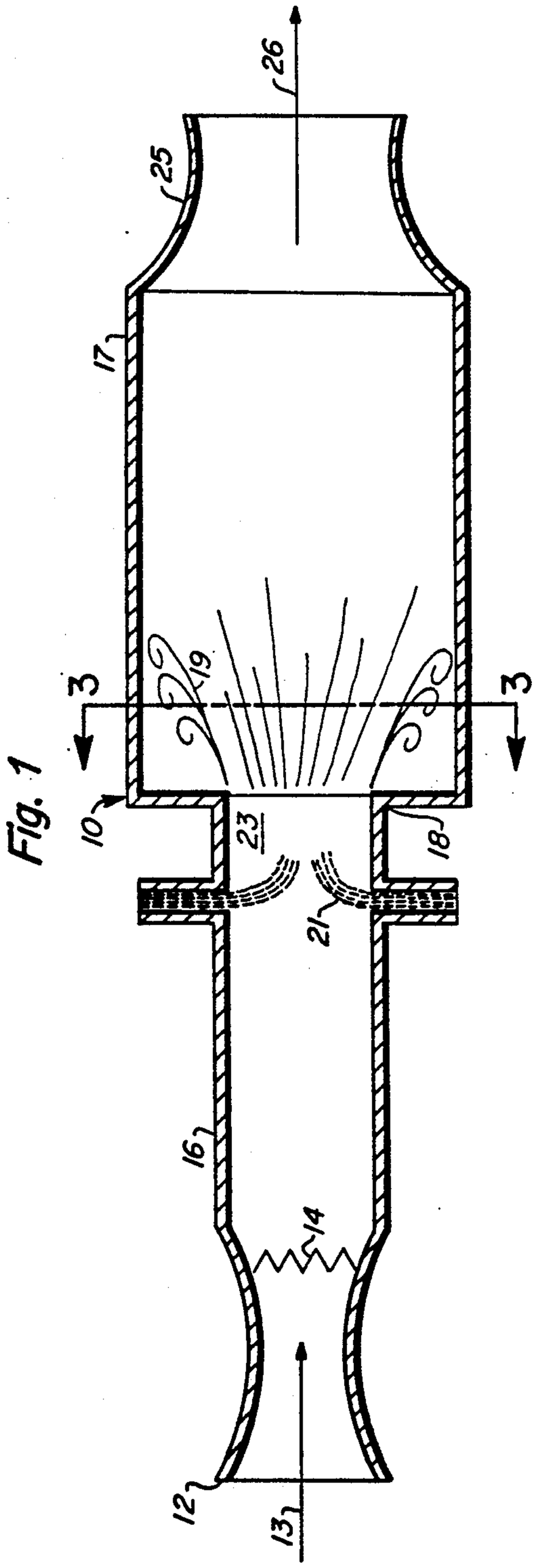


Fig. 1

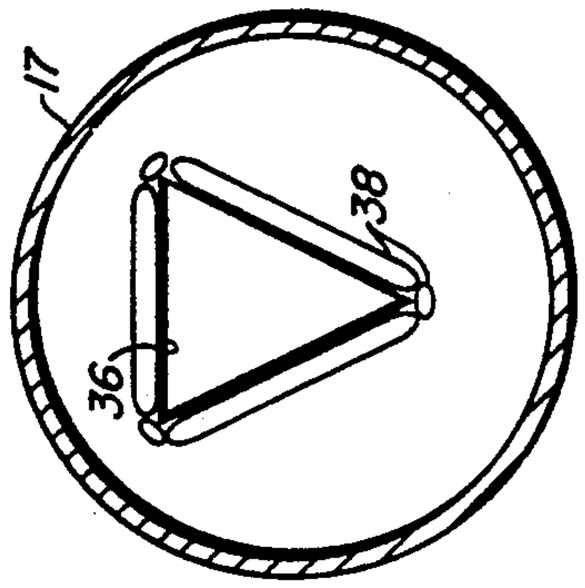


Fig. 3B

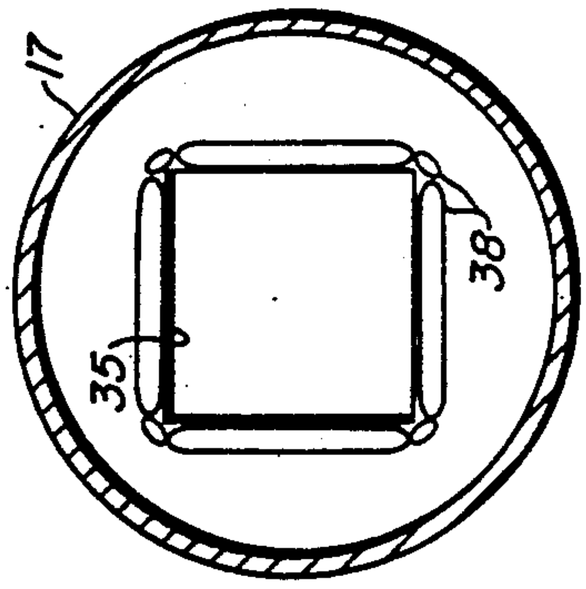


Fig. 3A

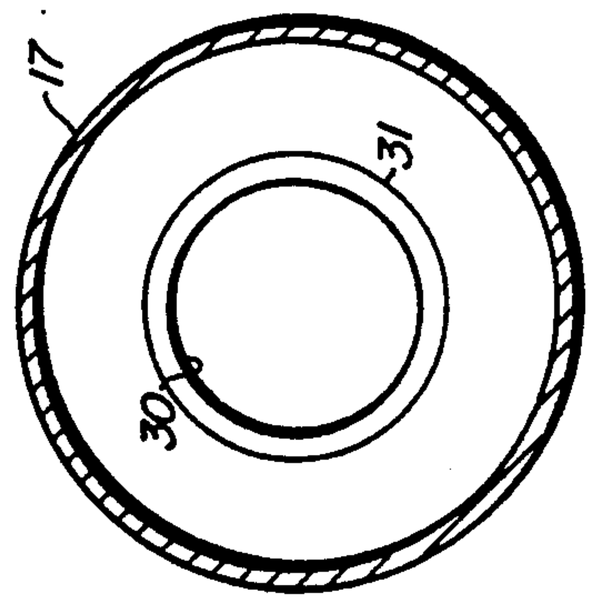


Fig. 2

DUMP COMBUSTOR WITH NONCOHERENT FLOW

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to the field of reaction motors in which air is supplied by ram effect and in which a mixture of fuel and oxidizer is injected into the reaction zone.

2. Description of the Prior Art

In a well known dump combustor, as used for example in a ramjet, fuel and air mixed insufficiently for combustion flow through a duct having a relatively small cross section upstream of a "dump" at which the flow cross section increases substantially instantaneously generating vortices which thoroughly mix the fuel and air for combustion downstream of the dump. In prior art combustors of this type the cross section upstream of the dump, insofar as is known, is substantially circular resulting in coherent flow downstream of the dump so that such vortices are uniform circumferentially of flow issuing from the smaller diameter section. These vortices, being uniform, form and break away at uniform intervals so that heat release upon mixing by the vortices is periodic with resulting pressure oscillations in the combustor. If these oscillations resonate with other accoustic oscillation natural to the combustor, very high amplitude oscillations result with damage to the combustor, an engine employing it, or the structure of a vehicle provided with the engine. Such high amplitude oscillations may, in any event, perturb a guidance system of the vehicle or expel a desired shock from the inlet of such an engine causing an unstart thereof. As a result the advantages of such a prior art dump combustor, such as simplicity in construction and efficient combustion, are often not practically useable.

SUMMARY OF THE INVENTION

A dump combustor in which, the flow area immediately upstream of the dump is substantially noncircular so that vortices induced by the dump are aperiodic and flow downstream thereof is noncoherent so that fuel/air mixing and the resulting combustion and heat release are substantially uniform in time and do not drive accoustic oscillations.

It is an object of the subject invention to provide a dump combustor having a configuration which does not result in periodic fluctuation in heat release in the combustor.

A further object is to provide a dump combustor which has the foregoing advantage, is simple in construction, and provides efficient combustion.

BRIEF DESCRIPTION OF THE DRAWING

Other objects and advantages of the subject invention be apparent from the following detailed description of the invention when considered with the accompanying drawing in which:

FIG. **1** is a longitudinal section of a ramjet engine having a dump combustor;

FIG. **2** is a view taken from the position of line **2—2** of FIG. **1** showing a circular flow area used with such a dump combustor of the prior art; and

FIGS. **3A** and **3B** are views similar to FIG. **2** showing, respectively, a triangular flow area and a rectangular flow area utilized in such a combustor embodying the subject invention.

DETAILED DESCRIPTION OF THE PRIOR ART AND OF THE PREFERRED EMBODIMENTS

FIG. **1** schematically depicts an exemplary ramjet engine having a representative dump combustor **10** The engine has an inlet **12** for compressing supersonic airflow indicated by arrows **13**, a substantial part of the compression occurring in the inlet at a shock **14**. The compressed air flows through a duct **16** to downstream portion **17**, of combustor **10**, portion **17** having a substantially larger cross sectional flow area than duct **16**. The transition or "dump" **18** between duct **16** and combustor portion **17** is abrupt, so as to induce vortices, indicated in FIG. **1** by the numeral **19**, in the shear layer between fluid in combustor portion **17** and fluid entering this portion from duct **16**. Fuel, typically liquid, is injected as indicated by numeral **21** at a point somewhat upstream of dump **18**. However, the air velocity and conditions of injection are such the air and fuel are not mixed effectively enough for combustion in duct **16**, although the region of duct **16** between the fuel injection indicated by numeral **21** and dump **18** may be considered as an upstream portion **23** of combustor **10** contiguous with downstream portion **17** thereof. However, immediately downstream of dump **18** the air and fuel are mixed sufficiently for combustion, the combustion occurring in the shear layer which contains vortices **19** during mixing thereby so that combustion is, in effect, retained in downstream portion **17**. After combustion the products thereof exhaust through a nozzle **25** as indicated by arrows **26**.

It should be noted that, in a dump combustor suited for practice of the subject invention, there may be a plurality of inlet ducts corresponding to duct **16** entering an enlarged combustor portion corresponding to portion **17**, that an inlet duct need not be coaxially related to such an enlarged portion, and that the direction of flow into such an enlarged portion need not be in the direction of other flow therein nor in the direction of flow from a nozzle corresponding to nozzle **25**.

In prior art dump combustors configured and functioning similarly to combustor **10**, the upstream portion **23**, insofar as known to the applicants, has, at dump **18**, a substantially circular cross section, as indicated in FIG. **2** by numeral **30**. As a result, vortices **31** corresponding to vortices **19** in FIG. **2** are uniform circumferentially of fluid entering enlarged portion **17** causing the oscillations and resulting previously described problems.

However, in the practice of the subject invention the upstream portion **23** has, at dump **18**, a substantially noncircular cross section such as the rectangular cross section **35** shown in FIG. **3A** or the triangular cross section **36** shown in FIG. **3B**. As a result, the resulting vortices **38**, corresponding to vortices **19** in FIG. **1**, are nonuniform in space and in time a in direction circumferentially of fluid entering enlarged portion **17** so that the above described mixing of fuel and air during which combustion occurs does not have periodic fluctuations. The heat release in combustor portion **17** is thus substantially steady and does not drive accoustic oscillations in combustor **10** or other portions of an engine or vehicle having such a combustor. The noncircular cross section may be provided by an orifice at dump **18**, with duct **16** being circular, or duct **16** itself may be noncircular in cross section.

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

What is claimed is:

1. In a dump combustor having an upstream portion through which effectively unmixed air and fuel flow, having a downstream portion contiguous with said upstream portion and of substantially larger cross sectional flow area than the flow area of said upstream portion, and having an abrupt transition between said flow areas to induce vortices in a shear layer between fluid in said downstream portion and fluid entering said portion from said upstream portion, said vortices mixing the fuel and air immediately downstream of said

transition with combustion of the fuel and air occurring during said mixing, the improvement comprising said upstream portion having a cross section which is substantially noncircular at said transition so that said vortices occur nonuniformly in time in a direction circumferentially of said fluid entering said downstream portion and said mixing does not have a periodic fluctuation, with the result that heat release from such combustion is substantially steady and does not drive accoustic oscillations in combustor.

2. The improvement of claim 1 wherein said noncircular cross section is substantially triangular.

3. The improvement of claim 1 wherein said noncircular cross section is substantially rectangular.

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