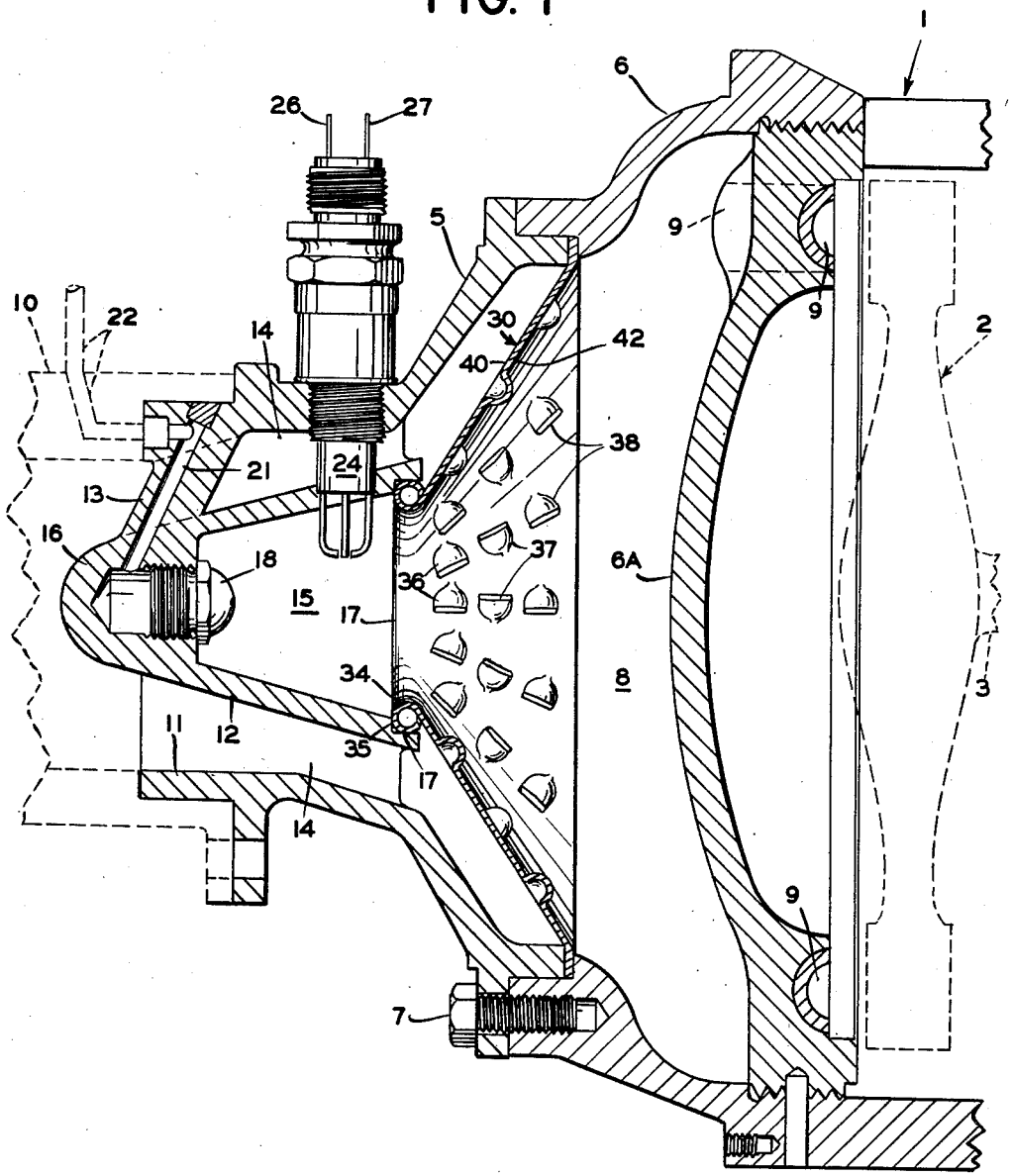
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COMBUSTOR FOR TURBINE OF AIRCRAFT STARTER

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FIG. 1



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FIG. 2

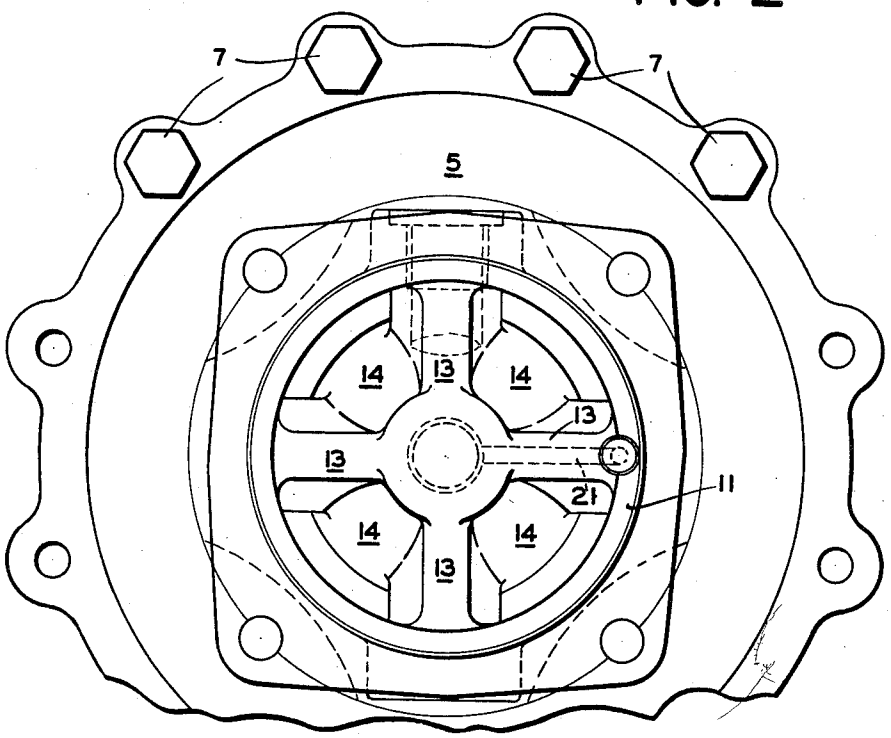


FIG. 3

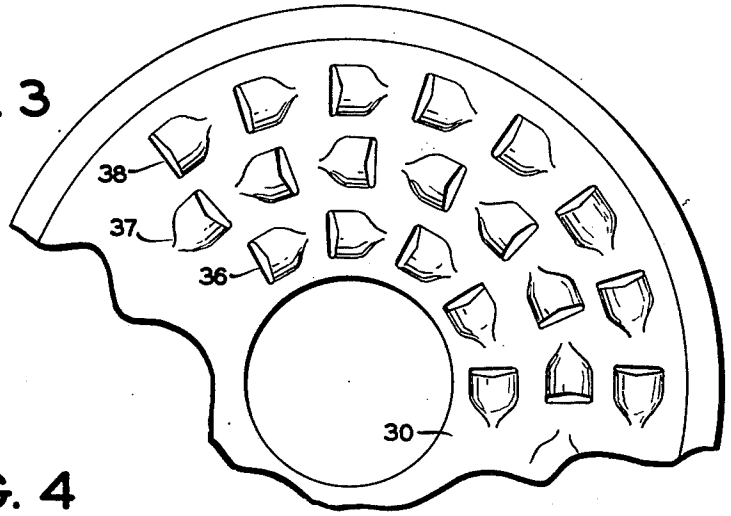


FIG. 4



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COMBUSTOR FOR TURBINE OF AIRCRAFT STARTER

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Application November 24, 1953, Serial No. 394,038

3 Claims. (Cl. 60—39.65)

The present invention relates to improvements in means for effecting the ignition and combustion of fuel in the combustion chamber of an air-fuel turbine type combustion starter such as disclosed and claimed in the copending application Serial No. 328,988, filed December 31, 1952, by Cameron D. Flanigen and William J. Dietz, Jr., now U. S. Patent No. 2,742,759, and assigned to Bendix Aviation Corporation, assignee of the present application.

More particularly an object of the invention is to provide novel means whereby high turbulence is induced in a combustion chamber so as to assure high burning efficiency and a high heat release per unit volume with a stoichiometric fuel air mixture.

Another object of the invention is to provide a combustion chamber having a fuel spraying nozzle mounted in a shield around which annular air inlet openings are provided for the admission of high velocity air, and down-stream of the annular air inlet openings is fitted a turbulator plate, the purpose of which is to provide a plurality of individual air streams directed into the main combustion chamber so as to assure that upstream air inlet channel conditions do not adversely affect the air flow by directing more air into one portion of the combustion chamber than another.

Another object of the invention is to provide a turbulator plate in the combustion chamber so arranged as to direct high velocity air into the combustion chamber in a swirling manner so as to isolate the main burning in the combustion chamber into a portion of the chamber remote from the spark plug and fuel nozzle, and in so doing prolong the service life of these components.

The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in connection with the accompanying drawings wherein one embodiment of the invention is illustrated by way of example.

In the drawings:

Figure 1 is a longitudinal sectional view of a device embodying the invention.

Figure 2 is an end view of Figure 1 illustrating the mounting of the fuel nozzle shield in the annular air inlet opening.

Figure 3 is a fragmentary plan view of the turbulator plate illustrating the oppositely directed louvers of the turbulator plate.

Figure 4 is a fragmentary sectional view of a louver of the tubulator plate showing the structure thereof.

Referring to the drawing of Figure 1, a starter drive section is indicated generally by the numeral 1 and may be of the type disclosed in the aforenoted copending application Serial No. 328,988, now U. S. Patent No. 2,742,759, including as shown by dotted lines in Figure 1 a turbine 2 connected through a shaft 3 and suitable gearing to a starter jaw of conventional type. The starter jaw is adapted to be connected to the engine to be started in a conventional manner. Details of the

turbine 2, reduction gearing and starter jaw have been omitted as the structure thereof forms no part of the present invention.

The device embodying the subject invention may be formed in two separable casing parts, indicated by numerals 5 and 6, secured together by bolts 7 and including in the casing part 6 a part of shallow bowl-shaped combustion chamber 8. The flared annular casing part 6 has provided therein an end plate 6A in which are formed stator nozzles 9 at the periphery for directing the exhaust gases from the chamber 8 so as to drive the turbine 2.

A source of compressed air is connected by a conduit 10 indicated by dotted lines to a high velocity air inlet cylindrical conduit 11 opening into the sharply-flared part of the casing part 5. The air inlet conduit 11 forming a part of the funnel-shaped casing part 5 has a frusto-conical air shield 12 mounted therein by legs 13, as shown in Figure 2, and between which legs suitable air openings 14 permit the high velocity air in conduit 11 to flow along the shield 12. The cone-shaped shield 12 extends longitudinally in the air inlet conduit 11 and has an internal opening or cavity 15, a closed upstream end 16 and an open downstream opening 17.

A fuel nozzle 18 is positioned in the closed end 16 of the air shield 12 and arranged so as to spray fuel through the internal opening 15 and out the open downstream end 17 into the combustion chamber 8, as shown by Figure 1. The fuel nozzle 18 is connected through a suitable passage 21 formed in one of the legs 13 of the casing part 5 and connected by conduit 22, indicated by dotted lines and leading to a suitable source of fuel under pressure.

A spark plug or ignitor 24 projects into the internal opening 15 adjacent the open end in the shield 12 to ignite the mixture of fuel spray and air which is in turn ejected into the combustion chamber 8 through the open end 17 of the shield 12. The ignitor 24 is electrically connected by conductor 26 and 27 in a suitable energizing circuit, such as shown and described for example in the aforenoted application Serial No. 328,988, now U. S. Patent No. 2,742,759.

As shown in Figure 1, downstream of the air inlet openings 14 in conduit 11, there is provided a sharply-flared turbulator plate indicated generally by the numeral 30 mounted in spaced relation to the inner surfaces of the casing parts 5 and 6 and secured at its peripheral edge between the casing parts 5 and 6. The truncated conical plate 30 is further positioned at an annular inner edge 34 in a seat 35 formed in the end 17 of the air shield 12.

The turbulator plate 30 is formed of a suitable high temperature resistant material and, as shown by Figure 3, has provided therein three concentric rings of openings 36, 37 and 38. As shown specifically by Figure 4, the openings 36, 37 and 38 are each constructed so as to form a small pocket-like louvre. These louvres 36, 37 and 38 direct the high velocity air stream from the openings 14 in a plurality of individual air stream along the inner circumferential surface of the plate in the direction of the center line of their respective rings into the main combustion volume in the chamber 8. It is to be noted from Fig. 3 that louvres of each ring are relatively closely-spaced so that there is a small circumferential surface in front of the openings extending to the closed back of the next louvre.

The louvre openings 36, 37 and 38 direct the air from the annular inclined air supply passage at a side 40 of the turbulator plate 30 in a swirling manner into the main combustion chamber 8 at the opposite side 42 of the plate 30.

The intermediate ring of louvres 37 direct the air

in an opposite direction to that of the inner and outer rings of louvres 36 and 38 so as to produce a greater degree of swirling turbulence in the combustion of the stoichiometric fuel-air mixture and thereby assure that upstream channel conditions do not adversely affect the air flow or cause the direction of more air into one portion of the chamber 8 than in another portion.

Further the ejection of the ignited fuel spray through the open end 17 of the shield 12 into the shallow, bowl-shaped combustion chamber 8 defined by the casing part 6, plate 6A, turbulator plate 30 and shield 12 serves to isolate the main burning in the combustion chamber 8 in a portion of that volume remote from the spark plug 24 and fuel nozzle 18 so as to decrease the wear thereon and thereby prolong the service life of the spark plug 24 and fuel nozzle 18.

The nozzles 9 formed in the casing plate 6A direct the exhaust gases from the combustion chamber 8 so as to drive a suitable turbine 2 cooperating therewith for starting an engine, as explained in the aforenoted application Serial No. 328,988, now Patent No. 2,742,759.

In operation it will be seen that the fuel is sprayed or ejected into the chamber 8 through the end 17 of the air shield 12 by fuel nozzle 18 and is ignited by the spark plug 24 within the frusto-conical air shield 12 which serves to shield the fuel nozzle 18 and ignitor 24 from the high velocity air which is admitted to the combustion chamber 8 in a high swirl downstream of the fuel nozzle 18 and ignitor 24 through the louvres 36, 37 and 38 of the turbulator plate 30.

This arrangement thus provides for the subsequent burning of the ignited fuel in a location of the combustion chamber 8 relatively remote from both the spark plug 24 and the fuel nozzle 18 so as to extend the service life thereof.

The applicants' novel arrangement provides for ready ignition, high burning efficiency, extremely high heat release per cubic inch of chamber volume and for burning at stoichiometric fuel air ratio with no excess air.

Although only one embodiment of the invention has been illustrated and described, various changes in the form and relative arrangements of the parts may be made to suit requirements.

What is claimed is:

1. A compact combustor for providing gases to a turbine of a starter for an aircraft jet engine comprised of a sharply-flared, truncated conical turbulator plate having a radially-outer large circular edge and radially inner small circular edge; wall means extending from said large edge to the outer edge of a circular nozzle end plate having a diameter somewhat larger than the diameter of said large circular edge; said turbulator plate, said wall means, and said end plate forming a shallow bowl-shaped combustion chamber; said end plate having a plurality of nozzles in the peripheral part thereof; said turbulator plate having a plurality of concentric rings of equi-spaced small, pocket-like louvres projecting into, and having an opening into, said combustion chamber; said pocket-like louvres of each of said rings being constructed and arranged so as to direct air circumferentially along the inner surface of said turbulator plate in the direction of the circle line of their respective rings; said louvres being so spaced that there is a short circumferential surface, in front of the louvre opening, extending to the back of the next louvre of each ring; the louvres of at least one ring being arranged to direct air oppositely to the direction of an adjacent ring of louvres so as to provide turbulence; wall structure closing off the opening of the radially-inner small circular edge of said sharply-flared turbulator plate; said wall structure having a fuel spray nozzle and an igniter projecting therefrom; outer wall means substantially uniformly spaced outwardly from said turbulator plate to provide an annular inclined air supply passage for air moving to said louvres; said annular air supply passage being free of any structure therein imparting direction to the air moving to said louvres; and means surrounding a portion of said outer wall structure and arranged to pass air uniformly to said annular air supply passage.

2. A compact combustor for providing gases to a turbine of a starter for an aircraft jet engine comprised of a funnel-shaped casing part having a generally-cylindrical rear section and a sharply-flared conical forward section which terminates in forward annular edge portion; a short flared annular casing part having a rearward edge portion extending forwardly and radially-outward from the forward edge portion of said funnel-shaped casing part; said short flared casing part terminating in a forward annular edge portion with a circular opening which has a diameter somewhat larger than the forward end of said conical section of said funnel-shaped casing part; a nozzle end plate extending across the circular opening of said short flared annular part; said nozzle end plate having a plurality of nozzles in the peripheral part thereof; a cone-shaped member axially-positioned in the interior of the generally-cylindrical rear section of said funnel-shaped casing part; said cone-shaped member having a closed rearward upstream end and an open forward downstream end which terminates at the transverse plane of the rear part of the sharply-flared section of said funnel-shaped casing part whereby annular air inlet passage means are provided around said cone-shaped member; a sharply-flared, truncated conical turbulator plate having a radially-outer, large circular edge and a radially-inner, small circular edge; said turbulator plate extending from the open forward end of said cone-shaped member to the rearward edge portion of said annular casing part; said turbulator plate, said annular casing part and said nozzle plate being so proportioned and arranged that a shallow bowl-shaped combustion chamber is formed; said sharply-flared turbulator plate being spaced from the sharply-flared forward section of said funnel-shaped casing part to provide an annular inclined air supply passage; the radially-outer circular edge of said turbulator plate being positioned and secured between the rearward edge portion of said short flared casing part and the forward edge portion of said funnel-shaped casing part by means securing these portions together; the annular inner edge of said plate being positioned in a seat formed in the forward end of said frusto-conical member; a fuel nozzle axially mounted in the closed end of said cone-shaped member and arranged to spray fuel into said shallow bowl-shaped combustion chamber; an ignition device extending into the interior of said cone-shaped member adjacent its open forward end; said turbulator plate having a plurality of concentric rings of equi-spaced small, pocket-like louvres projecting into, and having an opening into, said combustion chamber; said louvres of each of said rings being constructed and arranged so as to direct air circumferentially along the inner surface of said turbulator plate in the direction of the center line of their respective rings; said louvres being so spaced that there is a short circumferential surface in front of the louvre opening, extending to the back of the next louvre of each ring; the louvres of at least one ring being arranged to direct air oppositely to the direction of an adjacent ring of louvres so as to provide turbulence; and said annular air supply passage being free of structure for imparting direction to the air moving to said louvres.

3. A compact combustor for providing gases to a turbine of a starter for an aircraft jet engine comprised of a sharply-flared, truncated conical turbulator plate having a radially-outer large circular edge and radially inner small circular edge; wall means extending from said large edge to the outer edge of a circular nozzle end plate having a diameter somewhat larger than the diameter of said large circular edge; said turbulator plate, said wall means, and said end plate forming a shallow bowl-shaped combustion chamber; said end plate having a plurality of nozzles in the peripheral part thereof; said

turbulator plate having a plurality of concentric rings of equi-spaced small, pocket-like louvres projecting into, and having an opening into, said combustion chamber; said pocket-like louvres of each of said rings being constructed and arranged so as to direct air circumferentially along the inner surface of said turbulator plate in the direction of the circle line of their respective rings; said louvres being so spaced that there is a short circumferential surface, in front of the louvre opening, extending to the back of the next louvre of each ring; the louvres of at least one ring being arranged to direct air oppositely to the direction of an adjacent ring of louvres so as to provide turbulence; wall structure closing off the opening of the radially-inner small circular edge of said sharply-flared turbulator plate; said wall structure having a fuel spray nozzle and an igniter projecting therefrom; outer

wall means substantially uniformly spaced outwardly from said turbulator plate to provide an annular inclined air supply passage for air moving to said louvres; said annular air supply passage being free of any structure therein imparting direction to the air moving to said louvres; and means surrounding said wall structure and arranged to pass air uniformly to said annular air supply passage.

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