Oct. 26, 1954 H. C. HILL 2,692,478

TURBINE BURNER INCORPORATING REMOVABLE BURNER LINER

Filed Feb. 24, 1951 2 Sheets-Sheet 1

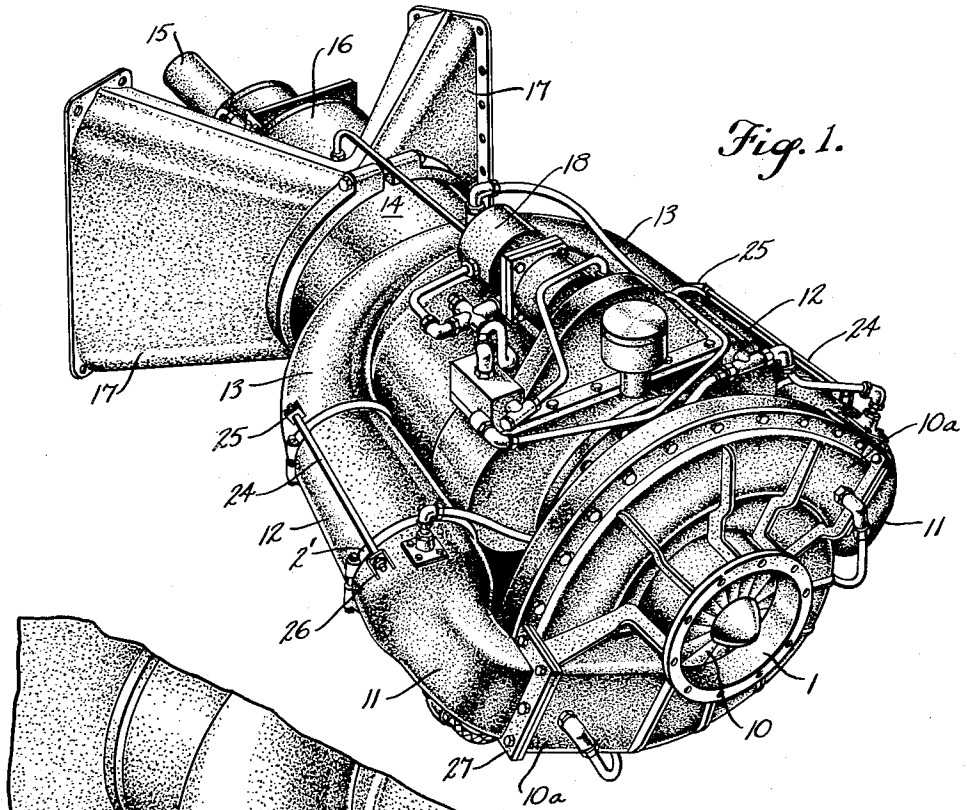


Fig. 1.

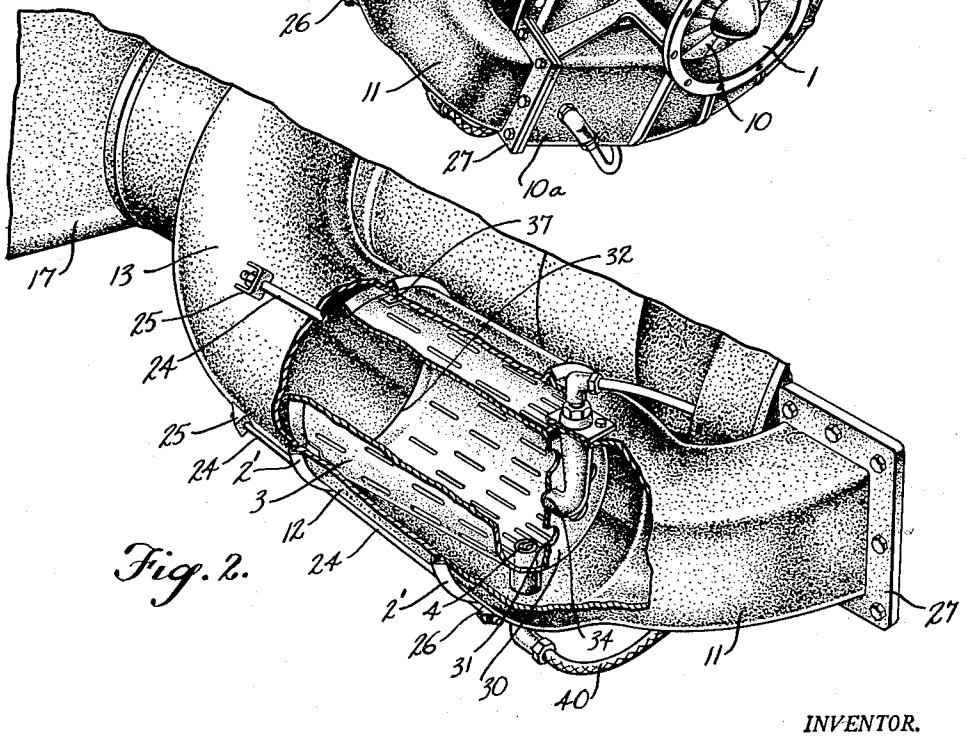


Fig. 2.

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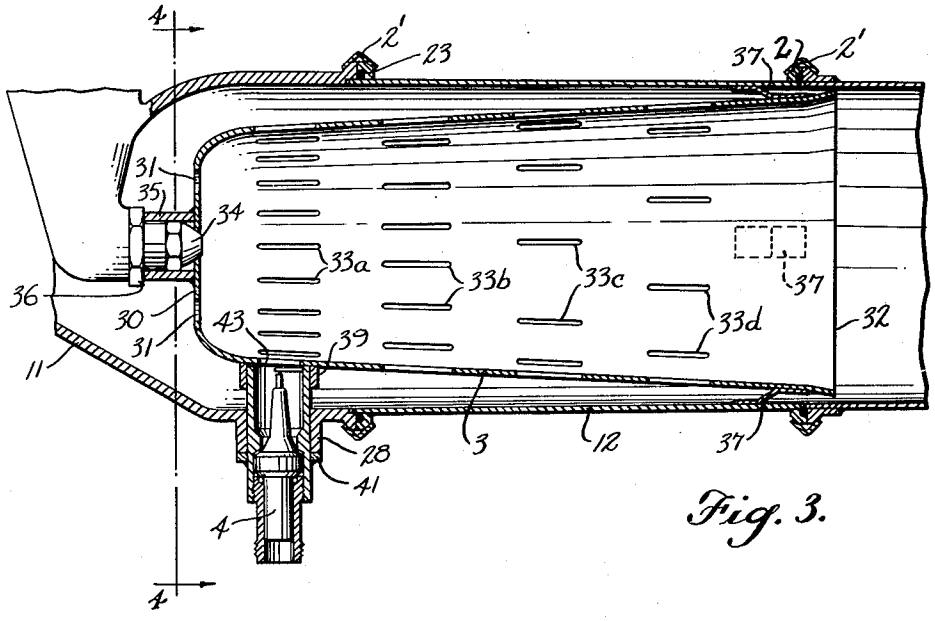


Fig. 3.

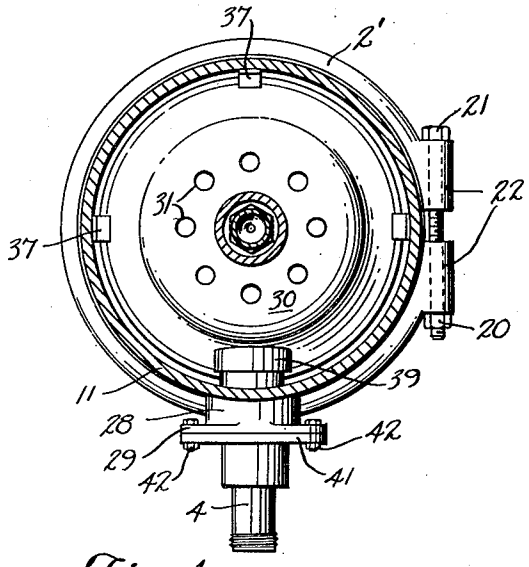


Fig. 4.

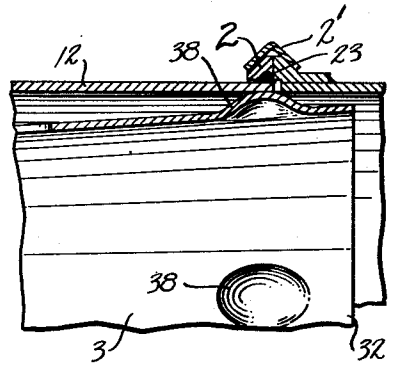


Fig. 5.

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Patented Oct. 26, 1954

2,692,478

UNITED STATES PATENT OFFICE

2,692,478

TURBINE BURNER INCORPORATING REMOVABLE BURNER LINER

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Application February 24, 1951, Serial No. 212,590

1 Claim. (Cl. 60—39.65)

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The present invention relates to gas turbines, in particular the burner assembly and construction, and especially to structure for locating and anchoring liners within the burners of gas turbines.

A principal advantage of gas turbines generally is their high power to weight ratio, but in order to operate at a favorable ratio of this type it is necessary that the burners function at high temperature, yet be constructed of light parts. Where the parts of such a burner are formed as separate elements, structure for securing them together which will be effective under high temperature conditions must be employed.

A further consideration is that a gas turbine intended principally for vehicle propulsion, whether air, land or water, should be capable of being disassembled for servicing quickly and economically.

With these requirements in mind, it is an object of the invention to provide a burner which can be installed in a gas turbine and removed from it quickly and easily. At the same time it is an object to enable a burner liner to be located accurately and quickly within the burner, while being held securely.

Bearing in mind the high temperature conditions to which the burner and its locating and securing means will be subjected, it is an object to avoid the use of screw or clamp mechanism for securing the burner liner, and instead both to locate and secure the burner in position by simple slip-fit connections.

For simplicity and lightness it is also an object to utilize elements necessary to accomplish other functions for anchoring the burner liner, so that their liner securing function is an added advantage. As a consequence, the burner retaining structure is very economical.

In essence the invention contemplates a gas turbine having a compressor section and a turbine section, between which sections are connected burners. The burner assembly is formed of end-abutting tubes capable of being disconnected readily to disassemble the burner structure without altering the relationship of the compressor and turbine sections. The tubes constituting the burner assembly also enclose a liner spaced slightly from the burner wall and secured in position within the burner assembly by engagement with the fuel supply nozzle as one reference element, to establish the location of the burner transversely of the flow of gases through it, and by engagement with a spark plug or igniter extending transversely of the direction of flow of the gases as a second reference element, to establish the location of the burner liner at the proper position longitudinally of the flow of gases through the burner. Moreover, engagement of the burner liner with such reference elements constitutes the sole provision for holding the inflow end of the burner liner in its proper position thus established.

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The burner construction of the invention is illustrated in the drawings in a preferred installation, but the principles of the invention can be applied to installations of other types, as will be evident from the following detailed description.

Figure 1 is a top perspective view of a gas turbine to which the present invention is applied, and Figure 2 is an enlarged generally similar top perspective view of a portion of the turbine, with parts of the burner structure broken away to reveal the liner installation within it, parts of such liner also being broken away to show its interior.

Figure 3 is a vertical longitudinal section through the burner of the gas turbine shown in Figure 1, and Figure 4 is a transverse section through such burner structure taken on line 4—4 of Figure 3.

Figure 5 is an enlarged vertical section through a portion of the burner and liner, showing an alternative type of liner spacing construction.

The gas turbine shown in Figure 1, incorporating the burner construction of the present invention, includes an air intake opening 1, into which air is drawn by the centrifugal compressor or blower 10, by which the air is compressed and projected into the air supply passages 11 of the individual burners shown located in symmetrical relationship at opposite sides of the turbine. Through these passages the air flows through the burner tubes 12 to support the combustion of the fuel supplied to the burners.

The combustion gases from the two burners 12 under much higher pressure and at a temperature greatly elevated above that of the air supply are discharged from the burner tubes through the combustion gas discharge passages 13 to the axial flow turbine section 14, where the gases from the two passages 13 intermingle. The power derived from the hot gases in this section is absorbed by one turbine section to drive the blower 10, and by a separate section of the turbine to drive the power take-off shaft 15 through reduction gearing in the housing 16. The burned gases are exhausted from the turbine section 14 through the divided exhaust ducts 17, which straddle the reduction gearing case.

The discharge passages 13 for the combustion gases may be formed integrally with the turbine

casing 14 to establish the disposition of the burner tubes 12 at opposite sides of the turbine. Between the burners are mounted, in readily accessible position, the fuel pump 18, fuel distribution valves, electrical distribution system, starter, and other accessories. The forward ends of the inflow portions of the combustion gas discharge ducts 13 diverge somewhat, so that the straight tubular burner tubes 12 disposed in end-abutting relationship to the ducts 13 will likewise diverge toward the blower section of the turbine.

The individual air supply ducts 11 constitute transition pieces between the circumferentially directed discharge passages 10*a* of the centrifugal compressor 10 and the longitudinally directed openings of the burner tubes 12. These transition pieces, then, lead the compressed air along a path curved through approximately 90 degrees, and, as shown best in Figures 1 and 2, are formed best to guide the airflow into the burners with the least possible turbulence.

To secure the opposite ends of the burner tubes to the adjacent ends of the combustion gas discharge ducts 13 and air supply ducts 11 an annular flange is secured on one part, cooperating with a ring 2 loosely encircling the other part, as shown best in Figure 5, which flange and ring may be brought into abutment. To hold the flanges and rings together the oppositely directed outer corners of each flange and ring assembly are chamfered for engagement by a clamping ring 2′ of angle cross section. These clamping rings may be constricted circumferentially by tightening the nut 20 on a bolt 21 which extends through aligned apertures in ears 22, formed on the end of the clamping ring, as seen in Figure 4.

To seal the joint between the flanges of the ducts a sealing ring 23 of copper-asbestos material is received in an annular groove in the face of each ring 2 paired with a flange. As the ring 2′ is constricted circumferentially, therefore, the wedging effect on the duct flange and cooperating ring 2 produced by the angular shape of ring 2′ will force the flange and ring together to compress the sealing ring 23 and press it against the duct, thus producing a gas-tight joint. Preferably reliance is not placed on the rings 2′ for securing the parts together lengthwise, but tie rods 24 extend between lugs 25 on the combustion gas discharge ducts 13 adjacent to the burner tubes 12 and lugs 26 on the compressed air supply ducts 11 adjacent to the burners to hold such supply ducts in place.

The ends of compressed air supply ducts 11 remote from the burners 12 are secured by complemental bolted flanges 27 to the discharge ducts 10*a* of the centrifugal compressor 10.

Within the burner assembly including ducts 11 and tubes 12 are lodged sheet metal liners 3, which are symmetrical about a vertical plane and hence interchangeable between opposite sides of the engine. Preferably these liners have end walls 30 at the air inflow ends of the burners, which walls are perforated such as by holes 31. From such end walls the side walls of the burner liners preferably flare in the direction of flow of the gas through the burners to the open ends 32 of the liners. The sides of the liners are also perforated, such as by having slits elongated lengthwise of the liners and arranged in rows 33*a*, 33*b*, 33*c* and 33*d*, numbered from the air inflow ends of the burners toward their combustion gas discharge ends. As shown best in Figures 2 and 3, the rows of apertures progressively farther from the air intake end of the burner have progressively fewer apertures, which consequently are more widely spaced circumferentially.

Air supplied to the burners by the air supply ducts 11 can pass through the apertures 31, 33*a*, 33*b*, etc., into the interior of the burner liner 3 within which the combustion occurs. A greater number of apertures is provided in the inflow end of the the burner liner in order to promote combustion as rapidly as possible of the fuel supplied within the inflow end of the liner by the fuel nozzle 34. It is desirable, however, to provide supplemental air progressively along the burner liner as the combustion gases flow through it to insure as complete combustion of the fuel as possible. By making the liner 3 flared and the outer burner tube 12 cylindrical, the annular space between these elements decreases progressively in radial width toward the discharge end of the burner, which induces air to flow from such space through the apertures into the interior of the burner liner.

Since the burner tube 12 and burner liner 3 are symmetrical about their center lines, and since the apertures 31 are symmetrically arranged in the end wall 30 of the burner, as shown in Figure 4, and the slits 33*a*, 33*b*, etc., are arranged symmetrically about the center line, uniformity of combustion is promoted by locating the tip of fuel supply nozzle 34 on the center line of the burner, as shown in Figures 3 and 4. Also, to provide as much combustion space as possible for the fuel, such fuel supply nozzle should be located close to the air supply end of the burner, as shown in Figure 3.

Ignition of the fuel in a gas turbine of the type herein disclosed is not obtained spontaneously, at least initially, and it may be desirable to provide fuel igniting means which operate continuously, or which, if desired, may operate intermittently. These igniter means likewise must be near the air supply end of the turbine in order to be most effective. The igniter means are shown as the spark plugs 4, extending radially of the burners, and preferably located in their lower sides. Wires 40 of the ignition system supply current to such spark plugs.

From the end wall 30 of the burner liner projects axially an exterior collar 35 of a diameter to slip easily, though reasonably snugly, over the fuel supply nozzle 34. This collar is of a length such that when its projecting end abuts the shoulder 36 on the nozzle it will dispose the liner in the desired lengthwise position relative to the discharge aperture of the nozzle. The collar 35, therefore, will limit axial movement of the burner liner toward the air supply end of the burner, and also will anchor the end of the liner at the inflow side of the burner against displacement in all directions relative to the burner transversely of the flow of gas through it.

The open end 32 of the buner liner is held in proper transverse position relative to the burner tube 12 by spacing means on such end of the liner. Such spacing means may take the form of sheet metal tabs 37, as shown in Figure 3. These tabs are formed of strips of metal having one end offset from the other. The inner ends of these strips are secured to the liner, and the outer ends bear resiliently against the burner wall.

An alternate type of spacing means structure is illustrated in Figure 5. In this instance the burner liner is pressed outwardly locally at circumferentially spaced intervals to form bulges

38. Such bulges are preferred to a continuous annular bead in order to provide a small gap between the open end 32 of the liner and the burner wall for flow of air under pressure between the burner wall and liner. By the collar 35 at one end engaging the fuel nozzle and such spacer means at the opposite end engaging the burner wall, therefore, the liner is held in proper transverse relationship to the burner wall.

The spark plug 4, as shown best in Figure 4, is mounted on a boss 28, formed on the air supply transition piece 11. This boss has a flange 29 matching a flange 41 on the spark plug body, and bolts 42 secure the spark plug in place with such flanges abutting. The length of boss 28 is selected such that, when the spark plug body is secured in this fashion, its inner end will project into the burner to a location adjacent to the liner 3.

On one side of the burner liner 3 is mounted a collar 39 encircling an aperture 43 establishing communication between the interior of the spark plug 4 and the interior of the liner. This collar is of a diameter to fit snugly about the inner end of the spark plug body, and will be located in a position axially of the liner such that the spark plug, when engaged with such collar, will hold the end of collar 35 approximately in abutment with shoulder 36.

Whereas collar 35 and spacer means 37 or 38 maintain the burner liner in proper position transversely of the burner, therefore, engagement of collar 39 with the body of spark plug 4 will maintain the liner in proper longitudinal position relative to the burner and fuel supply nozzle. While in the construction illustrated the burner liner is symmetrical about its longitudinal center line, so that except for the location of aperture 43 the rotative position of the burner liner about its longitudinal axis is immaterial, the burner liner locating means will also serve to maintain the liner in a desired predetermined rotative position. While the spark plug is a convenient element projecting through the burner wall thus to anchor the liner, thereby serving a double function, an element could be provided to act only as an anchoring member. Also the anchoring member, whether the spark plug or some other member, could be formed to cooperate with a projection on the liner of a shape different from the collar 39.

While the burner liner is held securely and firmly in relation to the burner by the locating mechanism described, the burner can be quickly disassembled and the liner removed. Such operation is accomplished by first unbolting the flanges 27 connecting the air supply duct 11 with the casing of blower 10 and removing the tie bolts 24. By loosening its nut 20 the band 2' securing the joint between the burner tube and the air supply duct 11 may then be removed. When the air supply duct 11 is withdrawn from the burner it will carry with it the burner liner. To remove the liner from the air supply duct it is merely necessary to take out bolts 42 and withdraw spark plug 4 to disengage its inner end from collar 39. Collar 35 may then be slipped off nozzle 34 to separate the burner liner from the air supply duct.

The burner tube 12 can, of course, also be disconnected from the combustion gas discharge duct 13 by loosening the nut 20 on the band 2' securing the joint between these parts and removing the band. As pointed out above, however, it is not necessary to disconnect these parts in order to remove the burner liner and afford access to the fuel nozzle. The liner 3 may again be supported on the air supply duct 11, and the duct 11, tube 12 and duct 13 reassembled by reversing the procedure described.

I claim as my invention:

A gas turbine burner comprising a unitary tubular burner liner including a side wall portion and an integral end wall portion substantially closing one of the ends of such side wall portion and the side wall portion being open at its other end, an air supply duct encircling the closed end of said burner liner, a gas discharge conduit spaced lengthwise from said air supply duct toward the open end of said burner liner, a fuel supply nozzle projecting inwardly from said air supply duct and having its tip directed toward said gas discharge conduit and engageable with said burner liner for locating and anchoring the closed end of said burner liner transversely of its length relative to said air supply duct, a spark plug projecting inwardly from said air supply duct and engageable with the periphery of said burner liner for locating and anchoring said burner liner against movement lengthwise of said air supply duct, a removable burner conduit interposed between said air supply duct and said gas discharge conduit of a length less than the distance between said spark plug and said gas discharge conduit, disconnectible joint means securing together said air supply duct and the adjacent end of said burner conduit and securing together said gas discharge conduit and the adjacent end of said burner conduit to enable said burner conduit to be removed from between said air supply duct and said gas discharge conduit, and spacer means interengaged between but not securing together said burner liner side wall portion and one of said conduits and holding the open end of said burner liner against appreciable movement transversely of such conduit.

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