

June 13, 1950

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2,511,432

SUPPORT FOR MULTIPLE FLAME TUBES

Filed Feb. 13, 1946

3 Sheets-Sheet 1

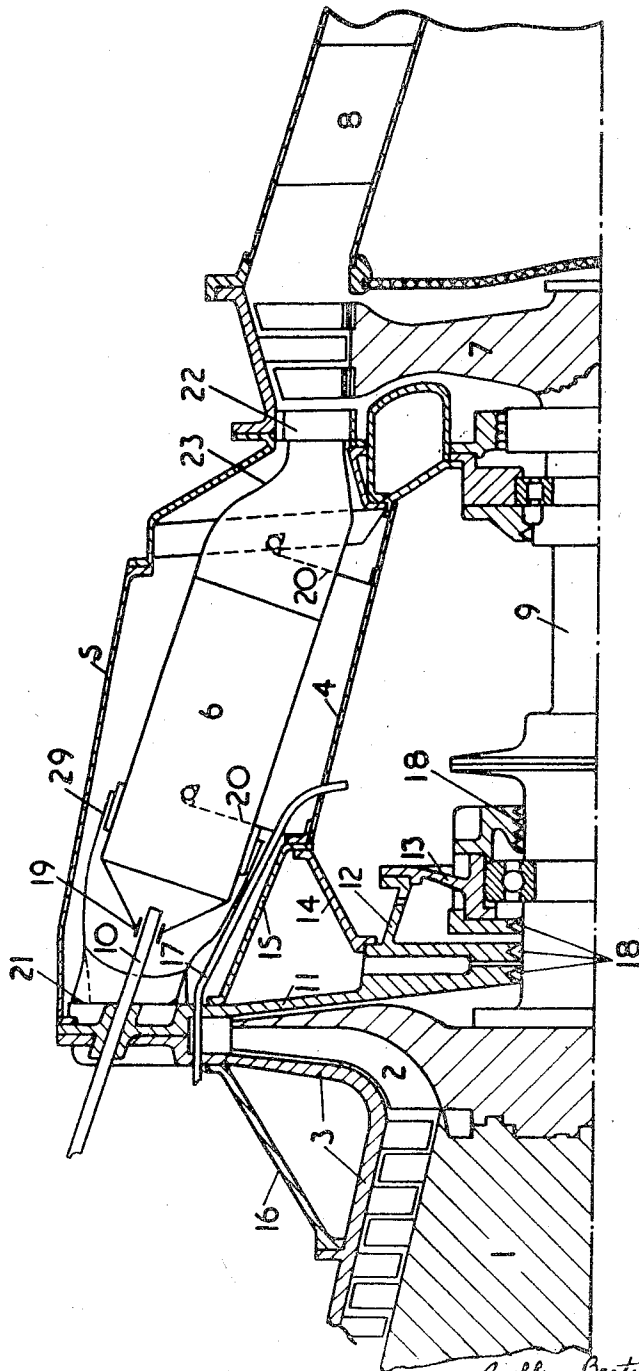


Fig. 1.

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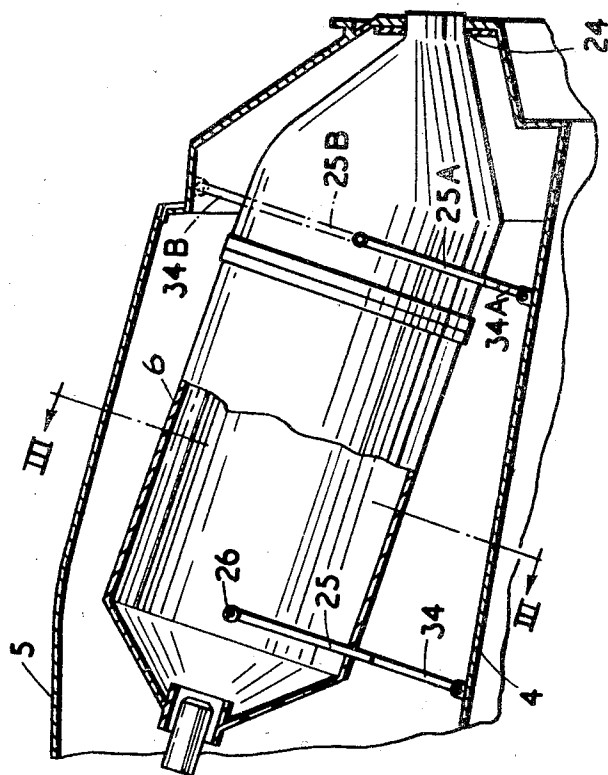


Fig. 2

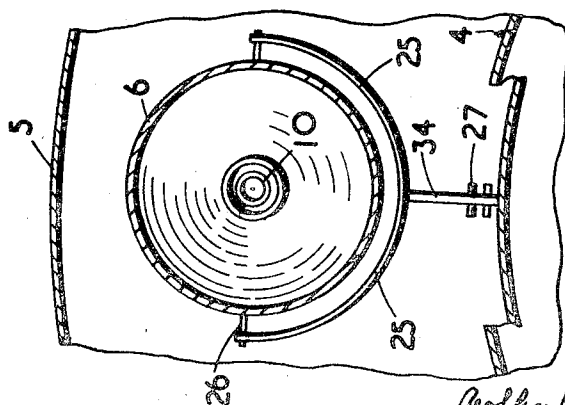


Fig. 3.

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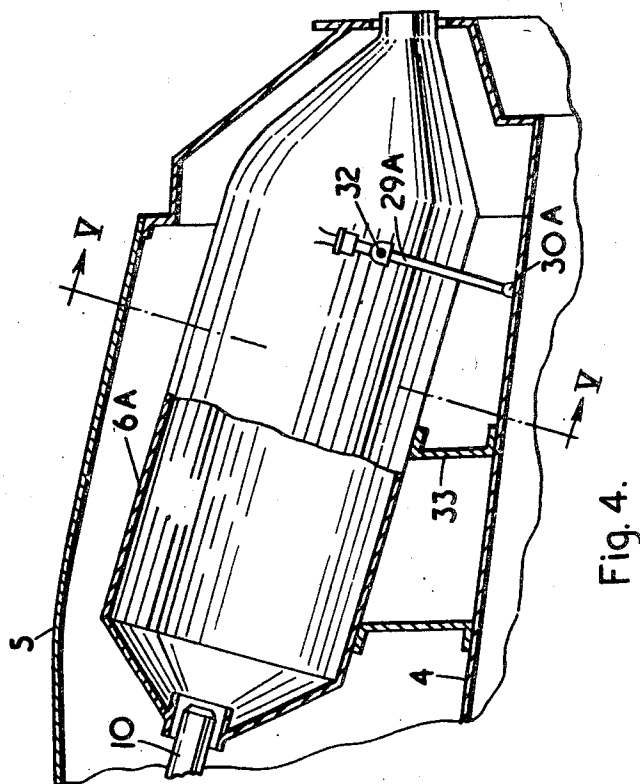


Fig. 4.

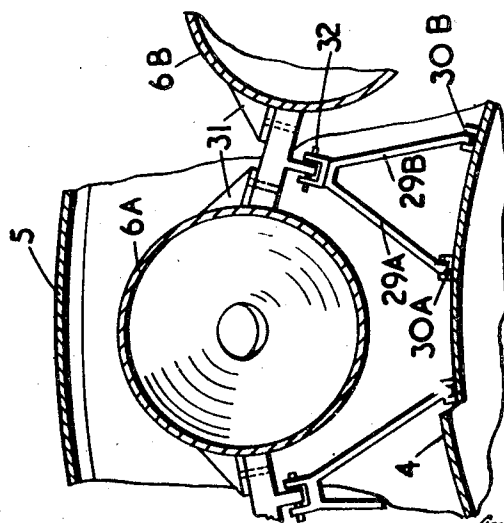


Fig. 5

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UNITED STATES PATENT OFFICE

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SUPPORT FOR MULTIPLE FLAME TUBES

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2 Claims. (Cl. 60—44)

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This invention relates to combustion apparatus and more particularly to apparatus for inclusion in a gas turbine comprising a compressor, combustion apparatus supplied therefrom and a turbine which supplies the compressor with mechanical power. Among the many arrangements proposed for such machines are designs in which the combustion apparatus lies between the compressor and the turbine occupying a certain proportion of the axial length of the machine. In such designs it is necessary to allow for expansions and deformations primarily due to thermal conditions but also due sometimes to stress conditions. It therefore becomes desirable to contrive the combustion apparatus in such a way that it not only fulfils its functions as such with a high degree of efficiency and with the lowest possible pressure loss in the gases passing through it, but also to allow for changes of dimension either overall or locally. Especially in the case of an aero engine gas turbine lightness is a primary consideration, whilst the desirability of freedom from trouble and accessibility for inspection or replacement is evident. The invention seeks to satisfy these requirements. Its application is not, however, limited to cases in which the combustion apparatus lies between the compressor and the turbine though such application is at present preferred. The invention may also be applied to engines of the type in which the combustion apparatus extends beyond the turbine and there is reversal of direction of flow of the working gas.

The invention is concerned with the construction, arrangement and mounting of flame tubes, that is to say, chambers in which combustion is to take place and into which fuel is injected and into and through which the working gas passes. Desirably, though not essentially, the invention is intended to be applied to arrangements in which flame tubes being in themselves in the main cylindrical bodies are contained as a circular series centred on the axis of the machine within an annular aircasing which receives the air from the compressor, the flame tubes being led at their outlets to the nozzle of the turbine.

According to one feature of the invention, combustion apparatus for a continuous combustion engine includes a flame tube supported within an aircasing by support means comprising at least one pair of support members connected to said tube at diametrically opposite locations thereof and to said casing by means adapted to deflect in a direction parallel to the axis of said tube.

According to a further feature of the invention

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each of the said pair of members comprises a curved arm which partly envelops the flame tube. Each pair may consequently together form an approximately semi-circular shaped element which partially encircles the flame tube, and the attachment to the aircasing may be by means of a link connected to the common ends of the arms. This device supports the flame tube with certain freedom for lengthwise movement either as a whole or locally, and a third attachment is provided preferably at the outlet of the flame tube and in this case to the structure in the vicinity of the turbine nozzle ring. At the other end of the flame tube an arrangement is preferably provided whereby the wall of the flame tube converges to a burner for fuel injection which is mounted in the structure of the machine and extends slightly in the axial sense into the flame tube, and the apex of the latter surrounds the burner with freedom for axial motion and preferably with a slight radial clearance through which some of the airflow can pass.

In a modified form of embodiment as applied to a circular series of flame tubes, one of a pair of members supporting one flame tube is connected to or made rigid with the adjacent member of the pair of members supporting the immediately adjacent flame tube. In this case the two members so connected may be formed by a V-shaped strut located between adjacent flame tubes, each leg being pivotally attached to the casing so as to pivot in the axial direction, and the walls of the adjacent flame tubes are connected together by a common bracket which is itself pivotally attached to the strut.

The above and other features of the invention will be better understood from the description given hereinafter by way of example and made with reference to the accompanying drawings in which:

Figure 1 is a sectional elevation of one form of a gas turbine power unit to which the invention may be applied;

Figure 2 is an enlarged view of a flame tube with one form of mounting;

Figure 3 is a sectional view on the line III—III of Figure 2;

Figure 4 is an enlarged view of a flame tube with a second form of mounting;

Figure 5 is a sectional view on the line V—V of Figure 4.

In Figure 1 a gas turbine plant comprises a compressor having a multistage axial flow section 1 and a centrifugal final stage 2 accommodated in a unitary casing 3, the general form of the

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axial flow section being convergent to its outlet to the centrifugal stage; a combustion system comprising an annular aircasing formed by inner and outer sheet metal walls 4, 5 enclosing an annularly arranged series of flame tubes 6 and a turbine 7 exhausting to a propulsive jet duct 8 and driving the compressor through a shaft 9. In this arrangement the compressor supplies air both through and around the flame tubes 6 but combustion of fuel which is supplied by burners 10 takes place only within the tubes 6. The entire power plant is assumed to be symmetrical about its horizontal centre line passing through the shaft 9.

The compressor 2 has a circular series of axially directed outlets 21. On a circle within this series there is attached to the compressor wall 11 the inner wall 4 of the annular aircasing which extends from the compressor 2 to the inner margin of a continuous entry turbine nozzle ring 22. To the periphery of the compressor casing (outside the series of outlets 21) is likewise attached the edge of the outer aircasing wall 5 which extends to the outer margin of the nozzle 22, these two walls 4, 5 both being appropriately pressure-resistant. The inner chamber enclosed by the aircasing wall 4 is maintained under pressure by air supplied through a pipe 17 from a convenient point in the plant, thus compensating for the external pressure in the aircasing. The outer wall, or a section of it, may be arranged to be displaceable for internal inspection by being moved bodily in an axial or radial direction. Within the aircasing so formed a circular series of flame tubes 6 is provided half as numerous as the compressor outlets 21, and each flame tube converges at its downstream end to a segmental outlet 23 corresponding to a segment of the turbine nozzle 22 and attached to the structure in the region thereof by a plate 24. At the other ends of the flame tubes 6 they are also convergent conically to a comparatively small circular margin in which a sleeve or bush 19 is fixed, this being intended to surround the inwardly extending burner 10.

The flame tube 6 is mounted in the aircasing 4, 5 by means of support members which are shown diagrammatically in Figure 1 at 20, and which are pivotably connected to the flame tube 6 and the aircasing 4, 5.

One form of flame tube mounting according to the invention is shown in detail in Figures 2 and 3 in which towards the upstream end of each flame tube 6 a virtually semi-circular supporting strut or link comprising two arms 25 is pivoted at 26 to the outside of the flame tube wall 6 on an axis which lies on a diameter of the tube and these arms have a common link 34 itself pivoted at 27 to the inner wall 4 of the aircasing, the arm 25 in normal conditions lying in a plane approximately at right angles to the axis of the flame tube and pivotable axially. A similar structure 25A, 34A is provided towards the downstream end of the tube 6, and this may alternatively be pivoted to the outer wall 5 of the aircasing as shown in broken lines at 25B, 34B, the two linkages 25, 25A, thus forming an almost parallel armed mounting system which in con-

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junction with the fixing 24 at the outlet end supports the flame tube 6 in all possible degrees of freedom whilst permitting, by slight angular movement, expansions or like small displacements. The upstream end of each tube 6 is enshrouded and overlapped by an air duct 28 which is branched further upstream so as to be connected to adjacent compressor outlets.

A second form of mounting is shown in Figures 4 and 5 in which the flame tubes 6A, 6B, etc., are arranged in a circular series within the annular aircasing 4, 5. In this case one of the pair of support members for tube 6A is attached to the adjacent member of the pair of support members for tube 6B, the combined structure presenting the form of a V-shaped strut 29A, 29B pivoted at 30A, 30B respectively to the inner aircasing wall 4, and brackets 31 attached to the tubes 6A, 6B and pivoted at 32 to the V strut.

In this embodiment the flame tube 6 is free at its outlet end but is held rigidly to the inner aircasing wall 4 by a strut 33.

Although the invention has been described with reference to a centrifugal compressor it is to be understood that it may also be applied to the case of a purely axial compressor in which case segmental portions of the outlet thereof may be connected to a circular series of individual aircasings in each of which a flame tube is mounted. The supporting struts shown may instead of being pivotably mounted be adapted to be flexible while achieving the objects of the invention.

I claim:

1. In or for a gas turbine engine, combustion apparatus comprising an air casing and a plurality of flame tubes arranged within said casing with their axes extending in the same general direction, each flame tube being supported by support means comprising at least one pair of support members each connected to said tube at substantially diametrically opposite locations thereof, the members being mounted on said casing by means adapted to deflect in a direction substantially parallel to the axis of the tube and one member of a pair of support members of one tube being attached to the immediately adjacent member of the pair of support members for an immediately adjacent tube.

2. In or for a gas turbine engine, the combustion apparatus according to claim 1 wherein the attached members are mounted on said casing by a common strut adapted to deflect in a direction substantially parallel to the axis of said tube.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
160,716	Rigby	Mar. 9, 1875
1,986,675	Hobson	Jan. 1, 1935
2,268,464	Seippel	Dec. 30, 1941
2,399,046	Larrecq	Apr. 23, 1946
2,432,359	Streid	Dec. 9, 1947