Dec. 12, 1967 K. G. FERREL ET AL 3,357,657

FIRE BARRIER

Filed April 27, 1966

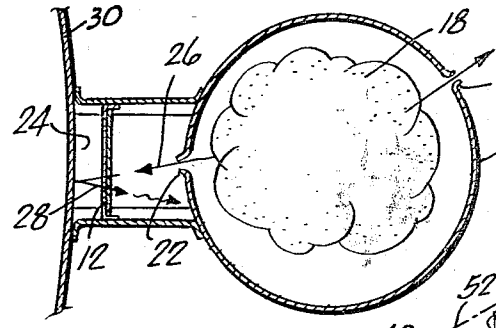

Fig. 2

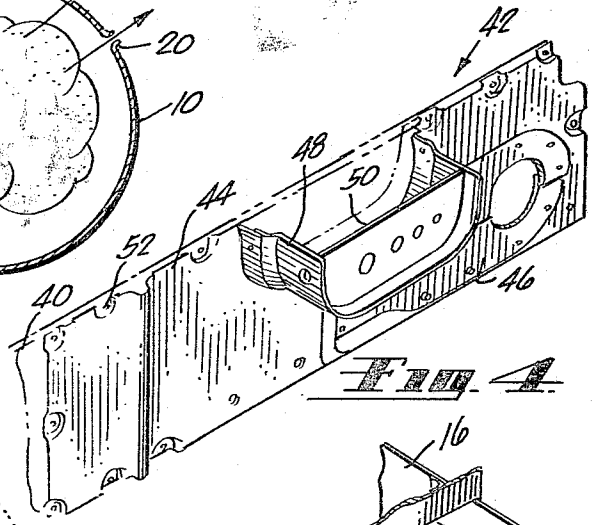

Fig. 4

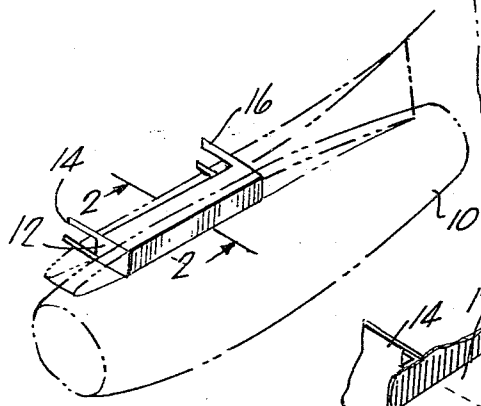

Fig. 1

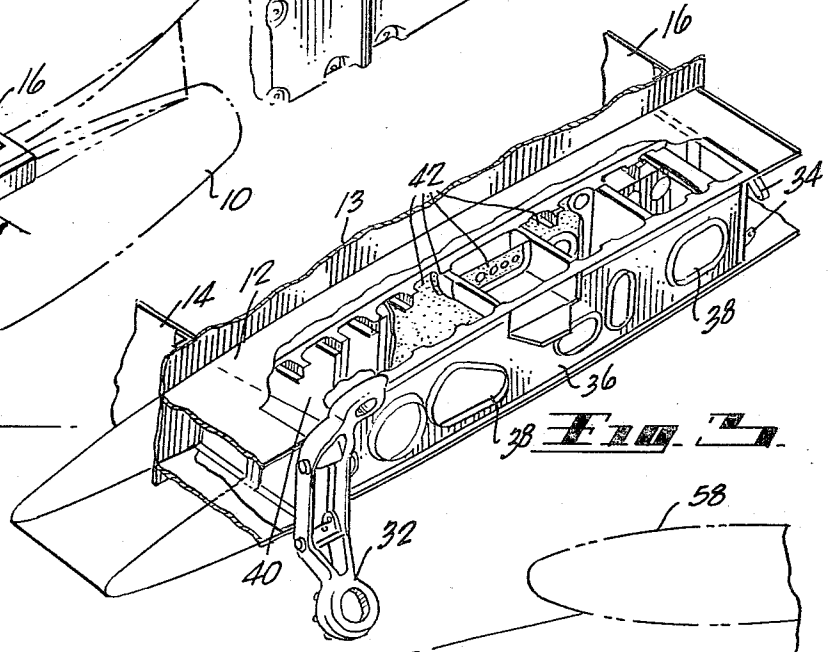

Fig. 3

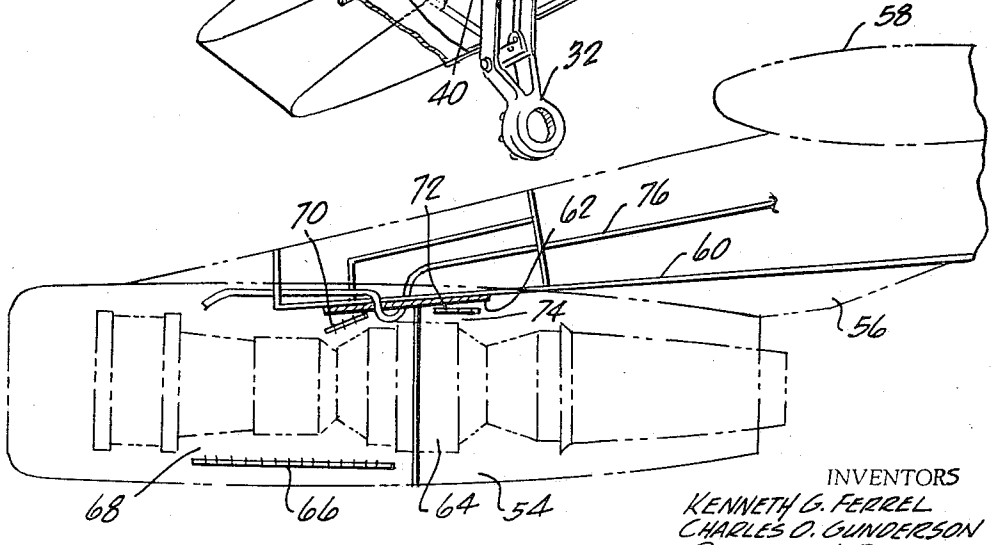

Fig. 5

INVENTORS
KENNETH G. FERREL
CHARLES O. GUNDERSON
RAYMOND J. PALMER
By Robert Q. Richardson
ATTORNEY

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FIRE BARRIER

Kenneth G. Ferrel, Los Alamitos, Charles O. Gunderson, Rolling Hills, and Raymond J. Palmer, Newport Beach, Calif., assignors, by mesne assignments, to McDonnell Douglas Corporation, Santa Monica, Calif., a corporation of Maryland

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This invention relates to a fire barrier between an aircraft engine and primary structure on which it is mounted for preventing serious damage from a burn-through flame. More specifically an impregnated laminated cloth material is placed between the engine and fire wall for diffusing an engine burn-through flame as an aid to detection of flame and prevention of resulting damage.

Within an aircraft engine casing there are fuel lines and other highly combustible elements which could cause serious fire if a small leak occurs and the fluid escaping were to contact the hot components of the engine. Of course, there are many safety features that tend to prevent such fire from becoming uncontrollable or invoking serious damage to the aircraft. Typically, engines are mounted on pylons which are attached to the wings or fuselage of the aircraft and these pylons contain all the conductors of fluid, electrical current and other externally applied elements necessary for the operation of the engine. For this reason, it is desirable that an effective fire wall be placed between the wing or fuselage and the engine.

There is another source of fire hazard, however, that is caused by a failure of the jet engine combustion chamber wall. An engine case burn-through at the diffuser or burner section results in a high velocity, torching flame of small diameter having a temperature as high as 3500° F. and a pressure of 125 p.s.i. at its origin. A flame of this type directed through the attach structure is a potential danger. Thus, a special fire barrier is necessary, particularly in the area of the engine diffuser and the burner section where a burn-through flame would occur. It also is desirable that such a fire barrier be of a lightweight material that may be bolted on, so that it may be removed to provide ready access to the other side of the barrier. Another desirable feature of a fire wall is that the fire barrier retain a flame at least until the detector elements nearby indicate a fire and permit remedial action before serious damage occurs.

It has been found, in accordance with the present invention, that a fire wall may be constructed which consists of a sheet of light-weight, heat resistant material, such as titanium, for example, and placing on the surface thereof which would be subjected to the heat of an engine fire, a material that will form a barrier to disperse and deflect the flame back toward the engine. In this manner the heating of laterally displaced fire detector elements adjacent the fire wall is insured before the burn-through flame cuts through the fire wall.

It is therefore an object of the present invention to provide for a new and improved fire barrier material.

Another object is to provide for a fire wall of a lightweight removable material which will withstand an engine burn-through flame.

Another object is to provide for a fire wall between a fuselage or wing and an engine mounted therein or thereon which will prevent an engine burn-through flame from cutting through the fire wall by dispersing and deflecting back said flame toward the engine.

Another object is the provision of a fire wall, between a fuselage or wing and an engine mounted thereon, which will disperse heat from a flame to laterally displace fire detector elements adjacent said fire wall.

Other objects will become more apparent as a description of this invention proceeds, having reference to the drawings, wherein:

FIGURE 1 is a perspective view showing in phantom the relationship between an engine casing, pylon, and fuselage in one embodiment,

FIGURE 2 is a sectional view taken along the line 2—2 in FIG. 1, showing the deterents and dispersal of a burn-through flame when the present invention is used,

FIGURE 3 is a perspective view of the pylon main box,

FIGURE 4 is a perspective view of the main pylon fire barrier, and

FIGURE 5 is a phantom sectional view of the fire barrier in another embodiment.

There have been several instances of burn-through of gas turbine engines. In a recent two-year period there have been reported thirty-three failures and accordingly, the possibility of a major incident has been of great concern to airplane manufacturers and airline operators for some time. The actual thermal protection of the pylon to which the engine is mounted has not been satisfactory. For example, a 3500° F. flame will penetrate a .025" titanium sheet in about two seconds. The engine outer case and bypass airflow are the first obstructions to such a flame. In general an engine fire wall is located some distance from the engine case, possibly 18 to 20 inches. The maximum flame temperature at the engine would be approximately 3500° F. but this temperature would be reduced to below 3000° F. at the fire wall because of the separation distance and the by-pass airflow cooling effect. Accordingly, a temperature of 3000° F. was established as a realistic temperature that this fire wall must withstand.

A material has been found, in accordance with the present invention, which utilizes a multi-ply laminate of high silica glass, carbon or graphite cloth impregnated with a ceramic filled organic resin system such as a phenolic resin. This material is now available in two forms under the trade names of "Rezcoat," RF–192 or MXS–6192 made by the Fiberite Corporation in Los Angeles, Calif. After laminating and curing, the material resembles fiber glass board approximately 1/16" thick. When this barrier is bolted to the fire wall and subjected to a high intensity 3000° flame, it prevents burn-through for a duration of at least fifteen minutes. With a 3500° flame the same material prevents a burn-through for three minutes. In contrast, when a bare titanium fire wall is used, the burn-through occurs within twenty seconds with a 3000° flame and almost instantly with a 3500° flame.

A characteristic of an engine burn-through flame is that the flame is highly concentrated and if directed on bare metal, a hole will develop in the metal the size of the flame and very little heat deflection will occur. A fire detector element only inches away from the flame probably would not be heated sufficiently to cause the fire warning system to function. It has been found that with the fire barrier material of the present invention, the flame is dispersed and deflected back toward the engine to thus insure heating of fire detector elements in near proximity to the flame. In order to insure protection of the fire wall against an engine burn-through flame, this fire barrier material is installed along the length of the fire wall adjacent to the diffuser and burner section.

Reference is now made to FIGURE 1 which shows in phantom a gas turbine engine housing **10** and pylon **12** connecting the engine housing to the fuselage of an aircraft by means of spars **14** and **16**. This particular embodiment has the engines mounted near the tail of the aircraft adjacent the fuselage and is of the type popularly known as the Douglas DC–9. A sectional view taken along the line 2—2 of FIGURE 1 is shown in FIGURE 2. For purposes of simplicity, the internal structure of the engine is

not shown but is represented by flame and gases **18**. An engine burn-through may be caused by excessive heat, metal fatigue, or other factors which cause a rupture **20** in the engine housing **10**. The rupture indicated by numeral **20** is in a direction away from the pylon **12** and accordingly, does not present the potentially dangerous condition such as would be caused by a rupture **22** in the direction of the pylon. As previously mentioned, a fire barrier **24** is placed in such a position that it will disperse and deflect back a burn-through flame. This action is represented by arrows **26** and **28**. The fuselage wall **30** in this case represents a structure through which it would be highly undesirable for a burn-through flame to pass.

A more detailed disclosure of the fire barrier for this embodiment is shown in FIGURES 3 and 4. In FIGURE 3 there is shows a left pylon **12** having a front spar **14** and rear spar **16** for secure mounting of the pylon to the fuselage **30**. The gas engine, not shown, is mounted on the pylon by forward engine mount yoke **32** and aft engine mount supports **34**. Closing rib **36** has the necessary openings **38** therein for the passage of necessary conductors, not shown, and to provide the best possible strength-to-weight ratio. Adjacent the fuselage **30** is an inboard rib primary fire wall **40**, of fire resistant material such as titanium or stainless steel, against portions of which is positioned the fire barrier material **42** in accordance with the present invention.

The fire barrier comprising the present invention is shown in greater detail in FIGURE 4. Here fire barrier **42** consists of a shield **44**, cover **46**, trough **48** and shield **50**, all having suitable openings and configurations to permit its installation with a minimum of interference with other structural parts of the aircraft. Bolts or screws **52** permit removal of the barrier **42** for access to the other side, as desired. These bolts or screws preferably are made of titanium or stainless steel which exhibits a high strength-to-weight ratio and have a relatively high melting point. Outwardly from this shield and adjacent or in proximity thereto is the fire barrier material forming part of the present invention. This material may be laminated to the outer surface and accordingly, can have the same configuration as the metallic structure.

While the preferred embodiment shown in FIGURES 1 through 4 is found on an aircraft wherein the engines are mounted to the side of the fuselage, this fire barrier has application on other types of aircraft. For example, in FIGURE 5, the engine housing **54** is suspended from pylon **56** attached to the lower surface of wing **58**. The pylon has a fire wall **60**, under which is mounted the engine burn-through fire barrier **62** which forms part of the present invention. This barrier is in line to protect against a burn-through flame from the burner compartment **64**. A lower engine fire detector loop **66** is in the compressor and accessory compartment area **68** whereas the upper forward and aft pylon fire detector loops **70**, **72**, are in the burner compartment area **74**. Piping **76** carries a fire extinguishing agent.

It is to be noted that all embodiments of this invention are characterized by the fire barrier material being placed between the burner section of the engine and the metallic fire wall so that a small hole will not be burned there-

through, and that a burn-through flame will be dispersed and deflected back toward the burner compartment, thereby actuating the fire detector loops in close proximity thereto.

While one embodiment of this invention relates to a multi-ply laminate of approximately 1/16" thickness for preventing a burn-through of a 3000° flame for at least 15 minutes, an increase in thickness of the laminate will also increase the time before penetration by the flame is made.

It will be evident from the foregoing description that various modifications are possible and will readily occur to those skilled in the art and it is to be understood that these variations are to be considered part of the present invention when within the scope of the invention as defined by the appended claims.

What is claimed is:

1. In combination:
an aircraft having a support structure thereon,
an aircraft engine mounted on said support structure,
a fire wall mounted between said support structure and said engine for preventing damage from an engine burn-through flame,
said fire wall comprising a sheet of light-weight heat resistant material and a fire barrier thereover,
said fire barrier comprising:
a laminate cloth material impregnated with an organic resin system whereby an engine burn-through flame is dispersed and deflected back toward the engine.

2. The combination as set forth in claim **1** wherein said fire wall has fire detector elements laterally displaced therefrom and said engine flame, when dispersed and deflected back, heats said elements.

3. The combination as set forth in claim **1** wherein said fire wall is in the area of the engine diffuser and burner section.

4. The combination as set forth in claim **1** wherein said laminate is from a class consisting of high silica glass cloth, carbon cloth and graphite cloth impregnated with a phenolic resin.

5. The combination as set forth in claim **1** wherein said sheet is titanium.

6. The combination as set forth in claim **1** wherein said glass cloth is multi-ply laminated of high silica and said phenolic resin is ceramic filled.

7. The combination as set forth in claim **1** whereby an engine burn-through flame of up to 3000° F. will require 15 minutes to burn through said fire wall.

8. The combination as set forth in claim **1** wherein said sheet is approximately .032" thick, said laminate is approximately 1/16" thick and both are detachably mounted.

References Cited

UNITED STATES PATENTS

2,968,920 1/1961 Wayne et al. ..... 60—35.6

MILTON BUCHLER, *Primary Examiner.*

B. BELKIN, *Assistant Examiner.*