United States Patent [19]

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[11] **3,738,105**

[45] **June 12, 1973**

[54] **GAS TURBINE ENGINE STRUCTURE**

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[22] Filed: **June 24, 1971**

[21] Appl. No.: **156,351**

[52] **U.S. Cl.**................ **60/39.31,** 60/39.37, 417/409

[51] **Int. Cl.**.. **F02c 7/20**

[58] **Field of Search**...................... 60/39.31, 39.32, 60/39.37, 39.69, 39.75; 417/409

[56] **References Cited**

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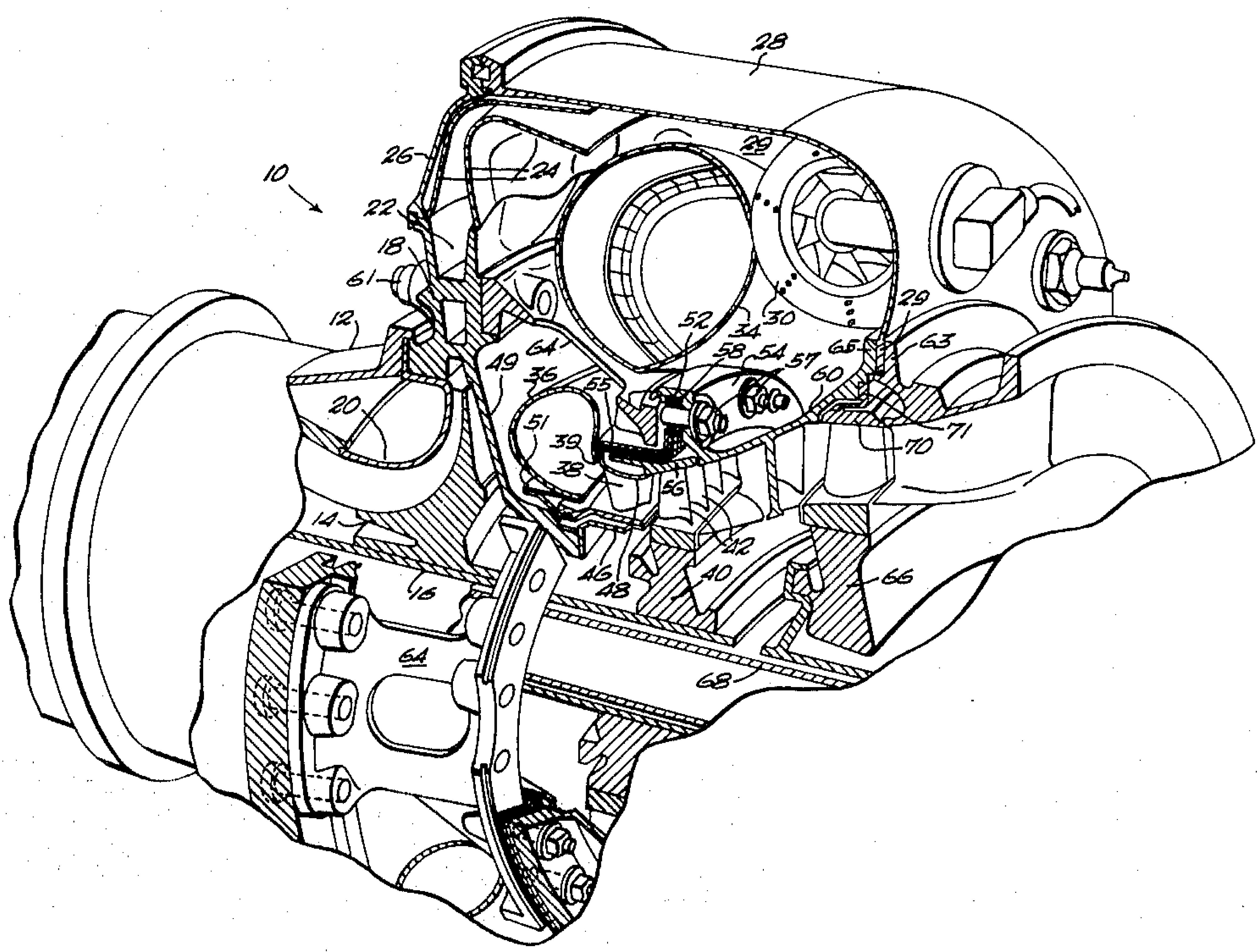
[57] **ABSTRACT**

The disclosure illustrates a gas turbine engine structure in which a turbine housing is structurally connected to a compressor housing by three equally spaced straight-lined struts. These struts pass in between three scroll-like ducts that carry combustion gases to an annular turbine inlet duct radially inboard of the straight-lined struts. The direct structural connection permits closer blade tip clearances and a substantial increase in efficiency. In addition it provides a lightweight design.

9 Claims, 3 Drawing Figures



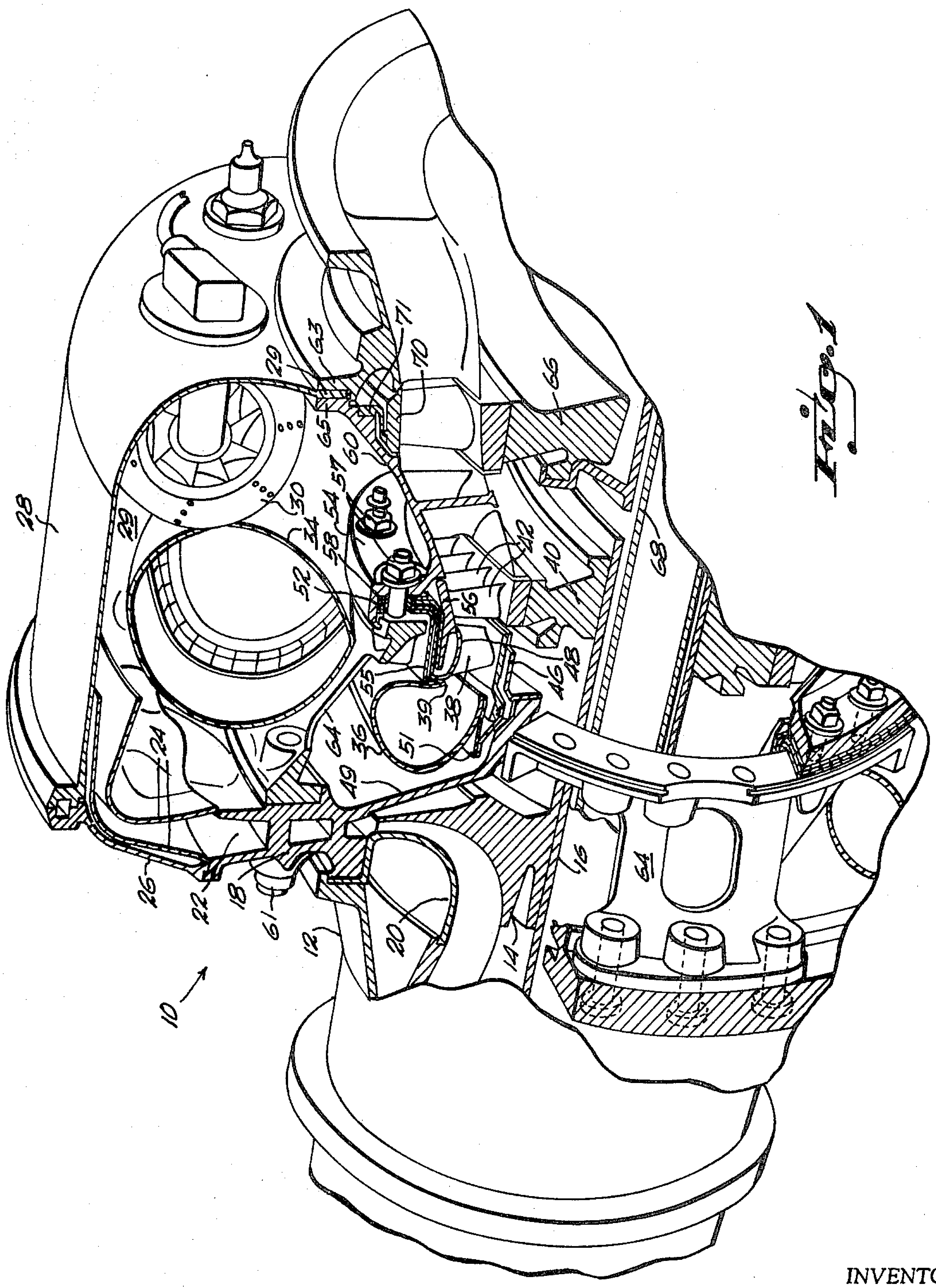


Fig. 1

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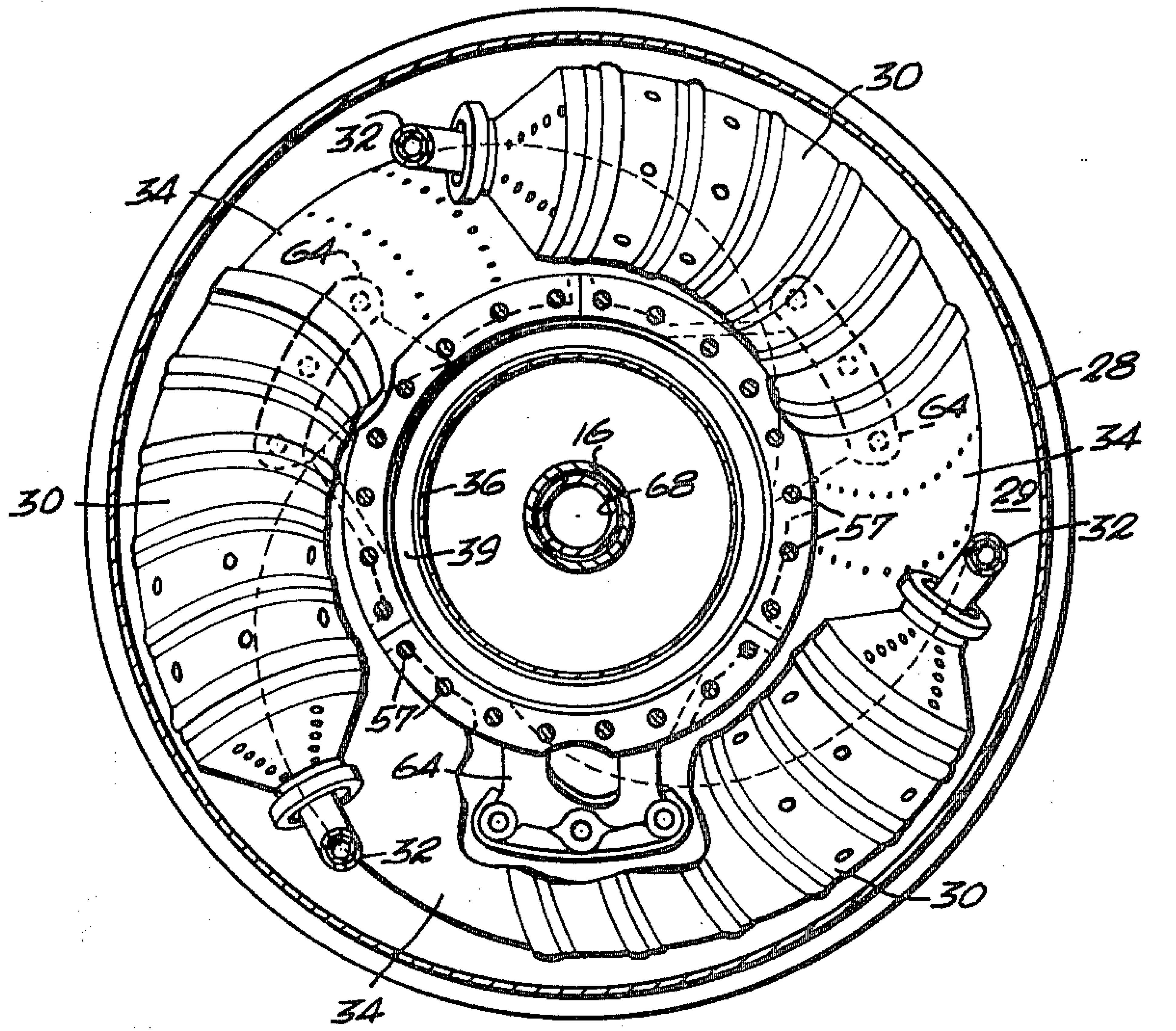

Fig. 2

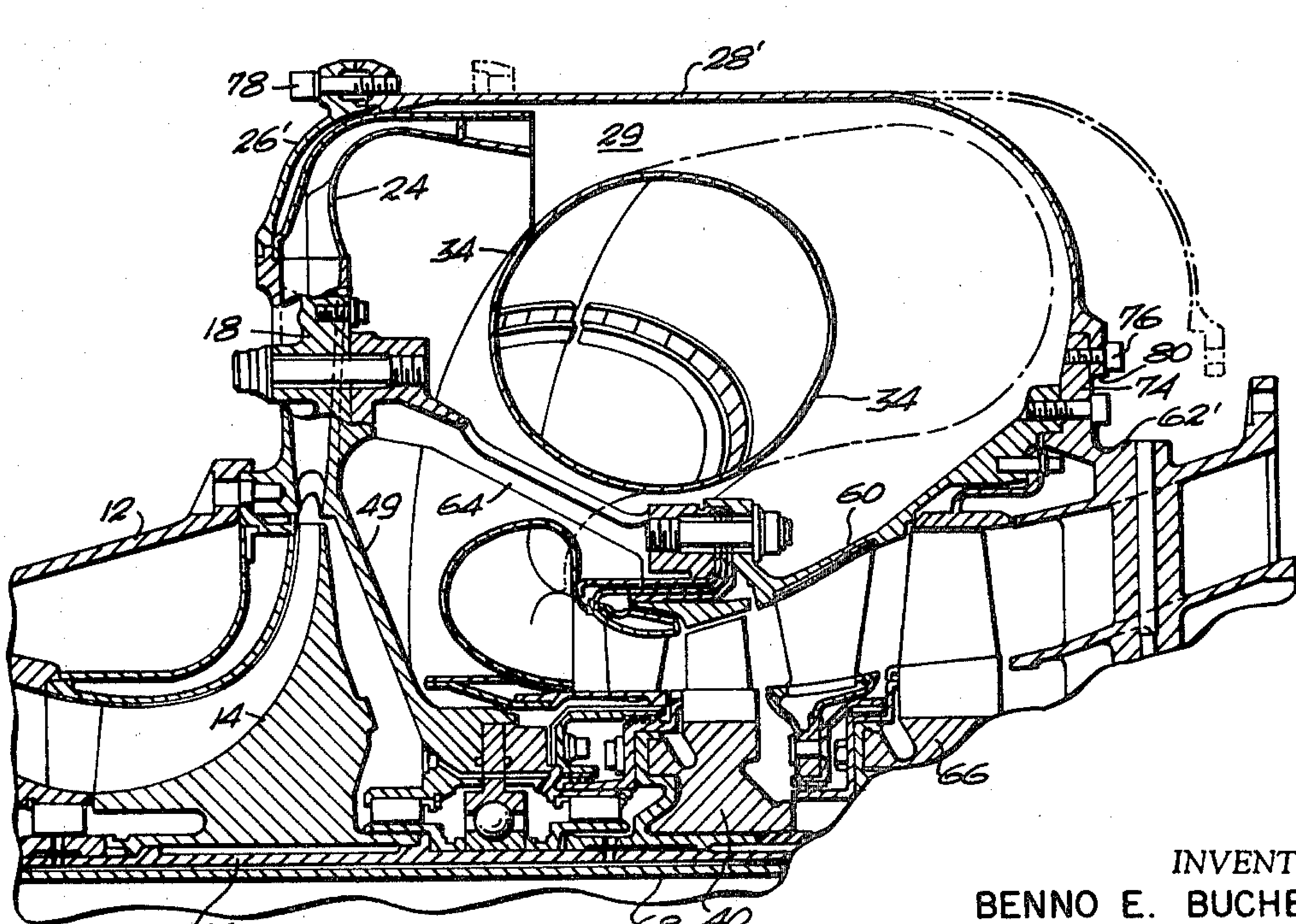

Fig. 3

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GAS TURBINE ENGINE STRUCTURE

The present invention relates to gas turbine engines and more particularly to the structural apsects of these engines.

Over the years the reverse flow type of gas turbine engine has enjoyed an ever increasing usage because of its short length and inherent stiffness. The reason for the short length is that the combustor unit is placed radially outboard from the turbine assembly, thereby permitting them to occupy the same axial spacing. An excellent example of this type of engine may be found in the patent to Anselm Franz, U. S. Pat. No. 3,088,278, and of common assignment with the present invention.

One of the problems that exists with this type of engine is that the turbine housing is not able to be closely coupled to the compressor housing. The reason for this is that the annular combustor and turbine inlet ducts completely surround the periphery of the turbine assembly, thereby necessitating support of the turbine shroud from the aft end of the combustor housing in a cantilever fashion. This requires that the large diameter housing surrounding the combustors be sufficiently stiff to carry the structural loads involved. As a result, the weight of the housing is substantially increased.

The substantial distance between the aft end of the engine and the turbine housing permits flexibility. As a result, the turbine shroud clearances must be maintained sufficiently great for the conical outer shroud contour to insure against rubbing of the turbine vanes during operation.

Therefore it is an object of the present invention to rigidly support the turbine housing in an engine of the above general type.

This is achieved by providing a plurality of scroll-like ducts that extend to an annular turbine inlet duct adjacent a turbine assembly. A series of struts extend from a structural portion of the engine housing directly between the scroll-like ducts to the turbine housing providing a direct connection through the straight line neutral axis of the struts.

The above and other related objects and features of the present invention will be apparent from a reading of the description of the disclosure shown in the accompanying drawing and the novelty thereof pointed out in the appended claims.

FIG. 1 is a fragmentary perspective view of a gas turbine engine embodying the present invention;

FIG. 2 is a cross-sectional view of the engine of FIG. 1; and

FIG. 3 is a fragmentary longitudinal section view of a gas turbine engine employing the invention.

Referring to FIG. 1 there is shown a gas turbine engine, generally indicated by reference character **10.** The engine comprises an annular structural housing **12** in which a centrifugal compressor impeller **14** is mounted on shaft **16** which is journaled for rotation by appropriate bearing assemblies, which are not shown to simplify the description of the invention. The compressor may additionally comprise a series of axial stages (not shown for the sake of simplicity) that discharge pressurized air to centrifugal impeller **14.** Centrifugal impeller **14** has a shroud **20** which is sandwiched between a flange on housing **12** and a diffuser housing **18** by suitable means. The diffuser **18** receives pressurized air from the periphery of impeller **14** and has a series of divergent passageways **22** formed in a radially outward and generally tangential direction to diffuse and further pressurize the air. An annular outer flange **26** is suitably secured to the periphery of diffuser **18** and also forms a forward peripheral support for a generally annular outer housing **28.** Housing **28** forms the outer bounds of a chamber **29** which receives pressurized air from diffuser **18** via a pair of diffusing and turning ducts **24.**

A series of can-type perforated combustors **30** are positioned in chamber **29** generally in a tangential direction (see also FIG. 2). It should be noted in FIG. 2 that the median axes of combustors **30** are curved to minimize the outer diameter of the annular outer housing **28.** The combustors **30** receive fuel via nozzles **32** from a suitable source and pressurized air within chamber **29** enters the combustors **30** to be mixed with the fuel.

The fuel-air mixture in combustors **30** is ignited and discharged into scroll-like ducts **34** that extend tangentially and somewhat forward to an integral annular turbine inlet duct **36.** Duct **36** has an outlet **39** through which the gases pass aft a series of turbine inlet vanes **38** supported by inner and outer shrouds **46, 48** respectively. Inner shroud **48** is connected to a structural conical element **49** integral with diffuser **18.** Inner shroud **46** forms a support for the inner wall of turbine inlet duct **36** through a suitable Z-joint **51.**

The gases then pass across a bladed turbine rotor **40** mounted on shaft **16** and having a plurality of blades **42.** Turbine rotor **40** is positioned generally within an annular structural turbine housing **60** having a forward mounting flange **54.** An annular turbine shroud **56,** surrounding the periphery of blades **42,** is supported by flange **54** through a mounting element **58.** A mounting element **52** for the shroud **48** abuts element **58.** A mounting element **55** for the outer wall of turbine inlet duct **36** abuts mounting element **52.** Mounting elements **58, 52** and **55** are held against flange **54** by bolt assemblies **57** suitably spaced around its periphery (see FIG. 2).

A plurality of struts **64** are secured to the sandwiched mounting elements **58, 52** and **55** by bolt assemblies **56** extending through flange **54.** Struts **64** extend forward and slightly radially outward over the turbine inlet duct **36** to the diffuser **18** where they are secured by bolt assemblies **61** extending through the space between the diffuser passageways **22.**

As shown in FIG. **2,** struts **64** are positioned to extend in between the adjacent scroll-like ducts **34** to the diffuser housing **18.** As herein illustrated there are three struts **64** positioned 120° apart. However, it will be apparent to those skilled in the art that other numbers may be utilized to structurally connect turbine housing **60** with diffuser **18.**

Turbine housing **60** has an aft mounting flange **61** which receives an aft flange **29** of the housing **28.** A mounting flange **63** of an exhaust duct housing **62** is secured to flanges **29** and **61** by a suitable arrangement.

A second bladed turbine rotor **66** is mounted on a shaft **68** within the engine outlet housing **62.** Shaft **68** is suitably journaled for rotation and extends forward through shaft **44.** Shaft **68** may be used to drive an additional compressor assembly or an output shaft. Turbine assembly **66** has a shroud **70** directly secured to structural element **60** through mounting element **71.**

It will be apparent that the struts **64** enable a closely coupled direct structural support of the turbine housing **60** by the diffuser housing **18** which forms a part of the outer structural housing of the engine. This greatly minimizes the deflection of the turbine housing **60** in response to the various stresses placed on it by the engine operating conditions.

The result of this direct connection is that the housing **28** need only be sized to support the pressure load from chamber **29** and the torque of the turbine for engine suspension at the compressor housing, rather than sized to provide the major support for the aft end of turbine housing **60.** The reduction in overall engine weight due to the lower stress requirements of housing **28** is significant.

Additionally, because there is a reduced deflection of turbine housing **60,** the shroud **56** which is supported by it may be formed to provide a closer clearance with respect to the turbine blades **42.** This generally increases the efficiency of the engine and particularly for small engines having scroll-like combustors. The scroll-like combustors offer small engines the advantage of an ample amount of fuel per nozzle due to the small number of nozzles. Complicated ways of compensating for shroud deflection are also eliminated.

FIG. 3 illustrates a somewhat modified embodiment of the present invention. The combustors **30,** as shown in FIG. **2,** are removable from the scroll-like ducts **34** by slipping them out the end of ducts **34** and removing them radially outboard. In the embodiment shown in FIG. **3** a housing **28'** is secured to a flange **74** integral with outlet housing **62'**. A series of screws **76** attach the inner portion of housing **28'** to the flange **74.** A series of screws **78** secure the forward end of housing **28'** to the housing **26'**. It can be seen that the inner diameter **80** of housing **28'** is sufficiently great to clear the maximum diameter of the annular outlet housing **62'** so that the housing **28'** may be removed in an axial direction, as shown in phantom, without disassembly of the engine. The result of this is that the combustors **30** may be removed radially for inspection or replacement without complete disassembly of the engine. This greatly facilitates maintenance of the engine.

While the preferred embodiment of the present invention has been shown, it will be apparent to those skilled in the art that modifications may be made without departing from the spirit and scope of the present invention.

Having thus described the invention, what is claimed as novel and desired to be secured by Letters Patent of the United States is:

1. A gas turbine engine comprising:
- a generally annular structural housing;
- a turbine journaled for rotation in said housing;
- an annular outer housing for said turbine;
- an annular turbine inlet duct adjacent said turbine, said turbine inlet duct having an annular outlet radially inward relative to said turbine housing;
- a plurality of generally tangentially and inwardly directed scroll-like ducts receiving a hot gas stream at a point radially outward relative to said turbine housing and connecting with said inlet duct;
- struts structurally interconnecting said turbine housing and said structural housing, said struts being positioned to extend directly between the scroll-like ducts outside of the hot gas stream passing into said turbine inlet duct to a position on said structural housing axially spaced from said turbine housing and radially outward relative to said turbine shroud,
- whereby said turbine housing is directly supported by said structural housing.

2. A gas turbine engine as in claim **1** further comprising:
- a centrifugal compressor journaled for rotation in said housing and positioned so that the turbine inlet duct is in between the turbine an the compressor;
- a structural radial diffuser receiving the discharge from the periphery of said compressor and forming a portion of said engine housing,
- said struts extending axially and radially outward from said turbine housing to said structural diffuser.

3. A gas turbine engine as in claim **1** wherein:
- said annular turbine inlet duct discharges a hot gas stream across said turbine in an aft direction; and
- said scroll-like ducts extend forwardly to said turbine inlet duct.

4. A gas turbine engine as in claim **3** wherein:
- said engine includes three scroll-like ducts equally spaced from one another; and
- said engine includes three struts spaced generally 120° apart and extending in between said scroll-like ducts.

5. A gas turbine engine as in claim **4** further comprising:
- a combuster for each of said scroll-like ducts wherein said hot gas stream is generated; and
- a generally annular peripheral housing surrounding said combustors and forming a portion of said engine housing.

6. A gas turbine engine as in claim **5** wherein:
- said combustors are removable from said scroll-like ducts in a direction which is generally radially outward with respect to the longitudinal axis of said engine housing; and
- said peripheral housing for said combustors is removable from said engine in an axial direction whereby the conbustors are free for radial removal.

7. A gas turbine engine as in claim **6** further comprising:
- a centrifugal compressor journaled for rotation in said housing and positioned so that the turbine inlet duct is in between the turbine and the compressor; and
- a structural radial diffuser receiving the discharge from the periphery of said compressor, said diffuser supporting the forward end of said struts and forming the forward connection for said peripheral combustor housing.

8. A gas turbine engine as in claim **1** wherein said turbine housing comprises an annular structural housing and an annular turbine shroud closely adjacent the periphery of said turbine.

9. A gas turbine engine as in claim **5** wherein the median axes of said combustors are curbed to minimize the diameter of said annular peripheral combustor housing.

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