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2,651,910

TURBINE STARTING MECHANISM

Filed March 13, 1951

3 Sheets-Sheet 1

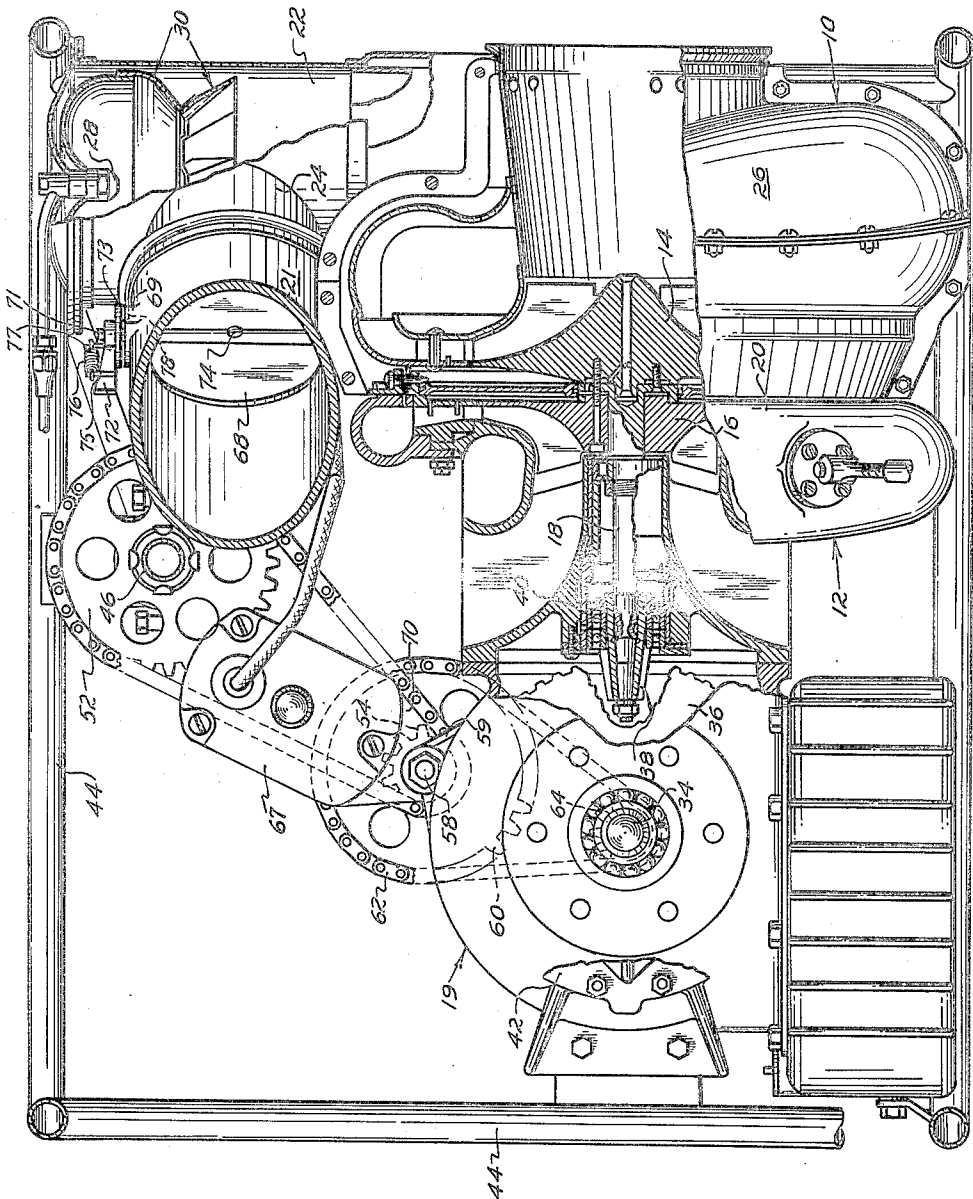


Fig. 1

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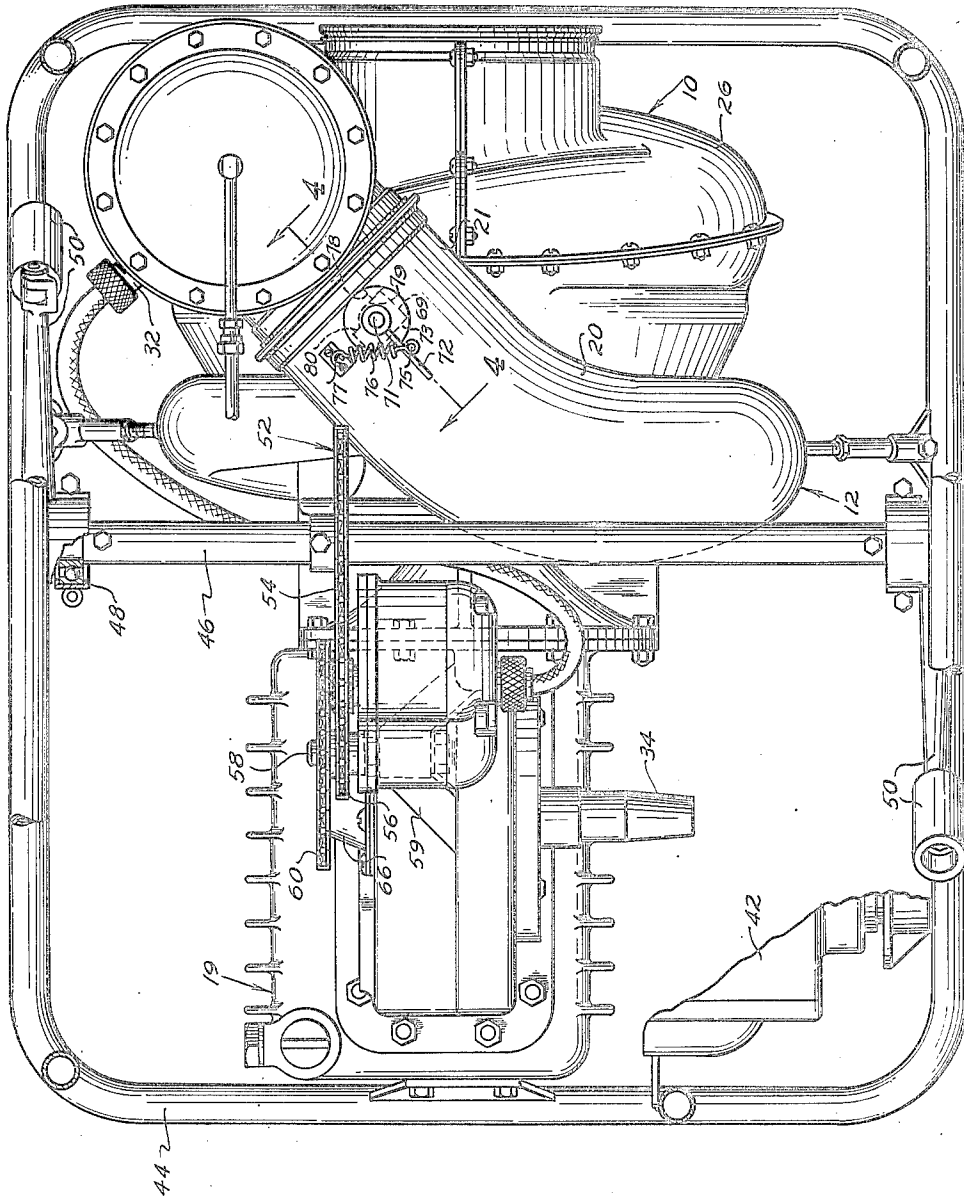
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

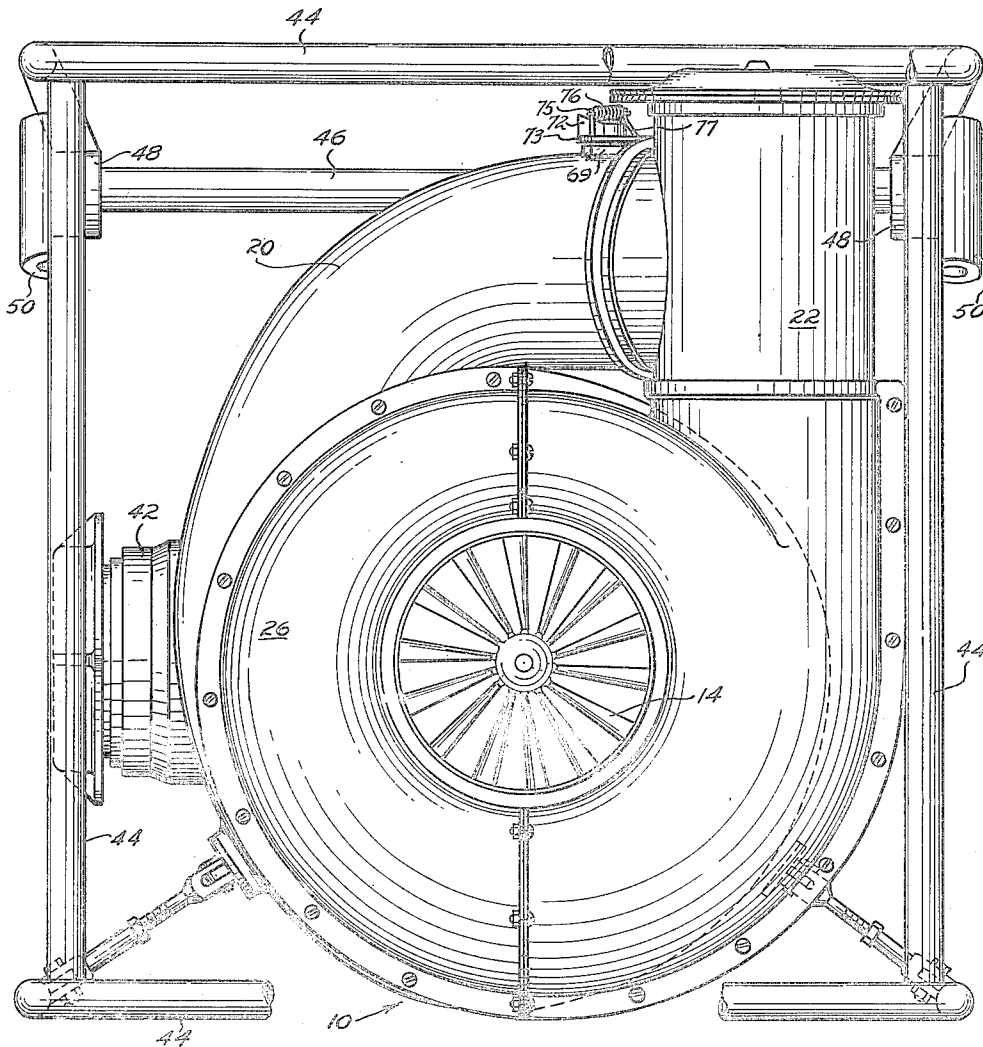


Fig. 1

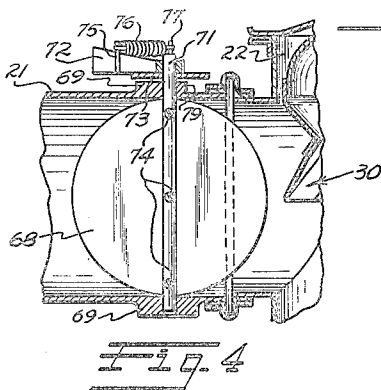


Fig. 2

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TURBINE STARTING MECHANISM

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Application March 13, 1951, Serial No. 215,252

11 Claims. (Cl. 60—39.14)

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This invention relates to starting means for turbo-compressor power plants and has for its general object and purpose to provide manually operable means for eliminating load on the turbine compressor assembly until it is brought to a predetermined starting speed.

Another object resides in providing a gas turbine, having a scroll connected with the outlet of a combustion chamber and a compressor having a scroll connected with an air intake port of the combustion chamber, with valve means operable to close communication between the compressor and the combustion chamber during the starting period.

A more detailed object of the present invention resides in providing the outlet duct of the compressor scroll of a gas turbine with a shut-off valve disk having an external operating lever to be selectively closed to unload the compressor and turbine rotors during starting of the gas turbine and accessible to an operator standing beside the gas turbine.

Still another object of the present invention resides in providing a gas turbine with a simple, inexpensive, valve means selectively operable to unload the compressor and turbine rotors and condition the gas turbine for manual starting.

With the above and other objects in view, the invention comprises the improved starting aid for turbo-compressor units as will hereinafter be more fully described, illustrated in the accompanying drawings and subsequently incorporated in the subjoined claims.

In the drawings, wherein is disclosed one simple and practical embodiment of the invention and in which similar reference characters designate corresponding parts throughout the several views:

Figure 1 is a side elevation partially in section of a gas turbine driven pump unit incorporating the starting aid of the present invention;

Figure 2 is a top plan view of Figure 1 with parts shown in section and other parts broken away to more clearly illustrate the nature and use of the present invention;

Figure 3 is an end elevation;

Figure 4 is a detailed vertical section taken on the line 4—4 of Figure 2, illustrating the details of the present invention.

For the purpose of illustrating one practical embodiment of the present invention, in the accompanying drawings, there is shown a gas turbine comprising a turbine unit 10 and an air compressor unit 12, each of the radial flow type, combined in a unitary assembly and having the rotors 14 and 16 (Figure 1), respectively, suitably fixed

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to one end of a turbine shaft 18 connected to a gear box unit 19 adapted to drive any suitable mechanism. Gear box unit 19, in a preferred use of the present invention, forms a part of a gas turbine driven, portable, high capacity pump unit fully described and claimed in the copending application of Leon R. Wosika and Arsham D. Zakarian, Serial No. 216,282, filed March 19, 1951, and entitled "Pump and Power Plant Assembly." For the purpose of the present invention, it will suffice to state that the compressor unit 12 is provided with an air conducting scroll 20 the circular outlet duct 21 of which is connected with the air intake port 24 of a combustion chamber 22 fully described and claimed in the copending application of Grant B. Hodgson, Serial No. 215,298 filed on even date herewith and entitled "Gas Turbine Combustion Chamber." It is, of course, to be clearly understood that the present invention may be embodied in any gas turbine construction and that its utility is not confined to either the portable pump or combustion chamber structures of the aforementioned applications.

Turbine unit 10 is provided with a similar scroll 26 having its inlet end connected with the outlet end of combustion chamber 22. Fuel is sprayed into the mixing head 30 of combustion chamber 22 through a nozzle 28 mounted in the chamber 22. Head 30, as clearly described in aforesaid Hodgson application, produces an intimate mixture of the fuel particles and air for ignition by a spark plug mounted in the wall of the combustion chamber at a suitable location indicated at 32 in Figure 2 of the drawings. Since the combustion chamber construction and air and fuel mixing means 30 forms no part of the present invention further detailed description thereof is not believed necessary here.

The other end of turbine shaft 18 is drivingly coupled to a power take-off shaft 34 of gear box 20. In the illustrated construction, shaft 34 is mounted in the horizontal plane of turbine shaft 18 and substantially at right angles thereto and the coupling means comprises a ring gear 36 fixed to power take-off shaft 34 and in constant mesh with a pinion 38 secured to the end of shaft 18 and journaled in a suitable anti-friction bearing assembly 40.

The power take-off shaft 34 may conveniently drive a centrifugal pump, partially illustrated at 42, which is suitably mounted together with the turbine and compressor units 10 and 12 in a supporting frame structure 44 to form a pump unit for use as portable fire fighting equipment on shipboard, the drainage of excavations, or for

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other purposes. The turbine compressor assembly and pump unit are preferably of small size and comparatively light weight, the frame with the turbine and compressor units, gear box, and pump structure being easily movable from place to place.

While the starting means for the turbo-compressor unit may take any desired form, the illustrated unit embodies a shaft 46 journaled at its ends in suitable bearings 48 on the frame structure 44. To each end of this shaft, a suitable folding operating crank 50 is fixed. A large diameter sprocket 52 is also fixed to shaft 46 and is connected by sprocket 54 with a small diameter sprocket 56 journaled on one end of a stub shaft 58 together with a large diameter sprocket 60. If desired the hub portions of sprockets 60 and 56 may be integrally formed. Shaft 58 is suitably fixed in a bracket 59 on the gear box casing 19. Sprocket 60 is connected by drive chain 62 with the drive sprocket 64 of a one-way overrunning clutch device of conventional type contained in housing 66 and mounted on one end of the power take-off shaft 34 and through which rotation is transmitted to the power take-off shaft 34 at an increased speed relative to the manually rotated shaft 46.

In the illustrated structure, the sprocket and gear ratios are such that the shaft 18, upon manual operation of cranks 50, will be rotated at approximately $\frac{1}{8}$ of the normal operating speed of the gas turbine, the gear 36 and the pinion 38 serving to step up the speed of turbine shaft 18 and the rotors 14 and 16 serving as fly wheels. The gearing 36-38, when the turbine is driving, transmit rotation of the power take-off shaft 34 at a comparable reduced speed.

In order to substantially eliminate load on the turbine compressor unit during starting, the present invention contemplates manually operable butterfly valve 68 mounted in the outlet duct 21 of the compressor scroll 20 for rotation around an axis, preferably in a plane containing the axis of the combustion chamber, constituting a diameter of duct 21. Such mounting of valve 68 assures a minimum restriction of the inlet passage and whatever division of the air stream results is in a vertical plane containing the axis of the combustion chamber thereby assuring a substantially equal flow of air lengthwise of the combustion chamber.

While the journals for valve 68 may be formed in any suitable manner, the illustrated embodiment provides diametrically opposed integral bosses 69 of substantially greater thickness than the wall of duct 21 formed near the outlet end of duct 21. These bosses have aligned bores therethrough for rotatably receiving a valve supporting and operating shaft 71, the upper end of which protrudes beyond its adjacent boss to receive an operating lever 72 on which a round base 73 is integrally formed.

The bores in bosses 69 provide axially extending journal surfaces of substantial area to assure a mounting for valve 68. The round base 73 of lever 72 prevents marring of the face of boss 69 and holds shaft 71 against axial displacement when valve attachment screws 74 are removed.

A pin 75, welded to the lever 72, is notched at its upper end to support one end of a spring 76, the other end of which is secured to an L-shaped bracket 77 mounted on the duct 21.

A downwardly projecting wedge-shaped stop 78 is welded to the lower surface of the base 73 and is adapted in one position to engage the flat

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shoulder 79 formed at one side of boss 69 and in its other position flat shoulder 80 formed on boss 69. The shoulders 79 and 80 are positioned on boss 69 so that the spring 76 urges the lever and stop 78 against one or the other depending upon which side of the center of shaft 71, pin 75 lies. In one position, the valve 68 will occupy its full open position. When the lever and stop 78 are moved away from the open position the opposite radial edge of stop 78 will engage the shoulder 80 at the opposite side of shaft 71 when the fully closed position of the valve is reached. It will be noted that in this latter position, the axis of spring 76 passes slightly beyond the axis of shaft 71. The spring 76 is thus effective to hold the valve in either the closed or open position.

Upon closing valve 68, communication between the compressor and the combustion chamber 22 is cut off so that the compressor vanes on rotor 16 will move in still air, the major portion of the air being simply carried around by the compressor vanes after a slight head has been built up in the scroll 20. The compressor 12 thus does practically no useful work, after equilibrium has once been established. This is also true of the turbine rotor. When equilibrium is established the air in the turbine rotor vane passages merely revolves with the rotor. Thus, in effect, the closing of the valve 68 practically eliminates the load on the compressor turbine assembly and allows it to be brought to speed in an unloaded condition, in a manner similar to an inertia starter.

As soon as the turbine is brought to starting speed, fuel from any suitable source is supplied to the nozzle 28, valve 68 is opened, and the fuel mixing with the air supplied by the compressor forms a combustible mixture in combustion chamber 22. This combustible mixture is ignited by the spark plug which is energized momentarily through any suitable means, such as magneto 67 supported by a suitable support bracket 70 mounted on shaft 58 and bracket 59 and energized by the rotation of cranks 50, shaft 46 and sprockets 52, 56, 60, and the sprocket of the one way clutch in housing 66.

After initial combustion is effected, cranking is continued to $\frac{1}{4}$ rated speed, and the turbine, due to the temperatures produced by the products of combustion, becomes self sustaining and the products of combustion discharged through scroll 26 from combustion chamber 22 against the vanes of the turbine rotors 14 drive the compressor, gear box, and pump unit in well known manner. When the drive is then transmitted by the turbine through gear 36 and pinion 38 to power take-off shaft 34, the overrunning clutch unit releases the driving connection with the manually operated sprocket chains so that the starting mechanism remains stationary.

While valve means 68 may be of any suitable type, a conventional butterfly type valve is believed preferable. It will also be understood that the driving couple between the turbine shaft 18 and power take-off shaft 34 as above described is merely suggestive and in certain instances the two shafts might be arranged in coaxial alignment and connected by a conventional type planetary gear drive or other equivalent means.

From the above description, it will be seen that the present invention provides manually operable means minimizing the manual or other starting effort by the substantial elimination of retroactive load forces on the gas turbine unit and assuring rapid establishment of the effective

power transmitting operation of the gas turbine. Since the several parts of my invention are of standard structural form, the improved starting means will not materially increase the overall production cost of such turbo-compressor units and expense incident to the necessary replacement of parts is reduced to a minimum.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In combination with a turbo-compressor power plant including a single compressor and gas turbine unit, a single combustion chamber having an outlet passage leading to said turbine and an air intake passage leading to said compressor, and auxiliary means for applying cranking torque to said turbo-compressor power plant; a compressor turbine unloader valve disposed between the compressor and said combustion chamber in said intake passage selectively operable during operation of said auxiliary means to close communication between said compressor and said turbine thereby unloading said power plant and adapting it for free rotation whereby said power plant may be quickly brought up to starting speed with a minimum of cranking effort.

2. The combination defined in claim 1 wherein said valve comprises a butterfly valve.

3. The combination defined in claim 1 wherein said intake passage is of circular configuration in cross section and said valve comprises a butterfly valve journaled in the opposite walls of said passage for rotation around an axis constituting a diameter of said passage.

4. The combination defined in claim 3 wherein the axis of rotation of said butterfly valve lies in a plane containing the axis of said combustion chamber.

5. A starting valve assembly for unloading a turbo-compressor power plant having a compressor scroll terminating in a single air outlet duct to facilitate starting of said turbo-compressor and comprising apertured journal bosses formed on said duct adjacent its outlet end in diametrically opposed relation; a valve support shaft journaled in said apertured bosses and having one end protruding outwardly from its adjacent boss; a valve disk removably secured to said shaft between its journaled portions and having an area equal to the internal area of said duct whereby said valve, in its passage closing position, closes said passage preventing fluid movement in said duct and said compressor to effectively unload the compressor and turbine to permit said power plant to be easily and quickly brought up to starting speed; and an operating lever secured to the protruding end of said shaft for selectively moving said valve to its closed and open positions.

6. For use in a turbo-compressor power plant having a single compressor outlet passage lead-

ing to a single combustion chamber; a starting valve for unloading the compressor and turbine rotors during manual cranking and starting of the power plant comprising valve supporting structure disposed along said passage; a valve body supported by said supporting structure and adapted when closed to prevent communication between said compressor and combustion chamber through said passage whereby fluid in said compressor and duct will be stalled to effectively unload said compressor and said turbine will be starved and also effectively unloaded; and valve operating means accessible from the exterior of said passage for moving said valve to closed position during cranking of said power plant and opening said valve when said power plant reaches starting speed.

7. The combination defined in claim 6 wherein said valve body comprises a relatively thin disk mounted for selective rotation in said passage from one to the other of its open or closed positions.

8. The combination defined in claim 6 wherein the axis of rotation of said disk coincides with a diameter of said passage.

9. The combination defined in claim 7 wherein the axis of rotation of said disk lies in a plane containing the axis of said combustion chamber to thereby assure substantially equal flow of fluid axially from said passage to the axially extending areas of said combustion chamber.

10. In combination with a single compressor and gas turbine assembly a single combustion chamber having an outlet port connected with the turbine and an air inlet port connected with the compressor, a power shaft connected through a gear transmission to a driven member, and manually operable means for transmitting starting torque to said power shaft through said gear transmission: a starting aid comprising a valve in the compressor outlet to close communication between the compressor and combustion chamber to stall fluid movement therebetween and effectively unload the compressor and turbine during the starting period.

11. In combination with a power plant having turbine-compressor units; a conduit having a portion adapted to carry all of the gas passing from the compressor unit to the turbine unit, combustion means operatively connected to said conduit portion for combusting said gas to provide motive force to be delivered to said turbine through said conduit, and movable valve means mounted within said conduit for selectively opening and closing said conduit to fluid flow between said compressor and said turbine units whereby when valve is in closed position fluid movement between said compressor and said turbine units is stalled and the turbine and compressor units are effectively unloaded and can be easily brought up to a high starting speed.

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