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FUEL FEEDING MECHANISM FOR A GAS TURBINE

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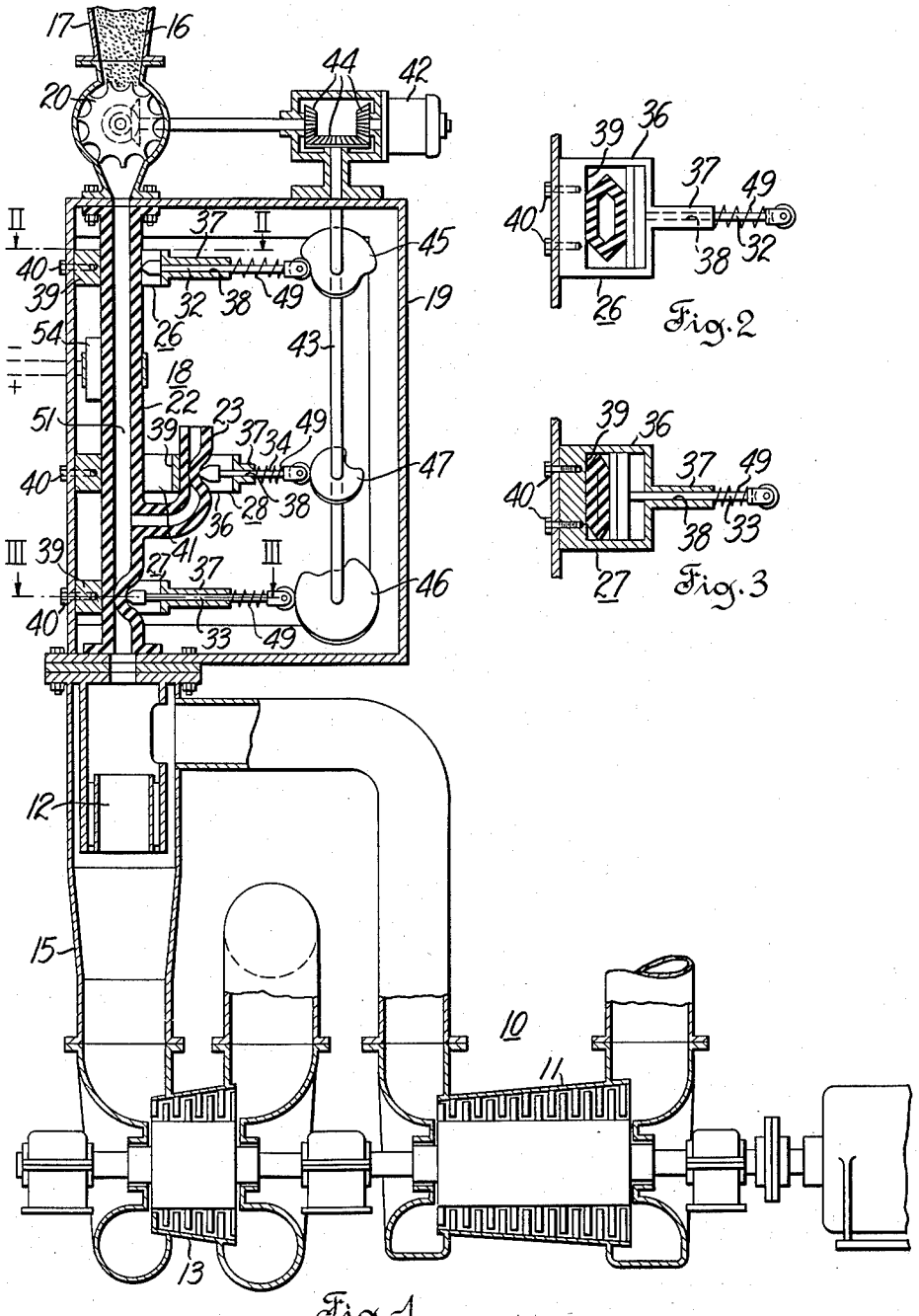


Fig. 1

Fig. 2

Fig. 3

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FUEL FEEDING MECHANISM FOR A GAS TURBINE

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This invention relates generally to gas turbines. More particularly this invention relates to a structure for feeding fuel into the combustion chamber of a gas turbine especially the coal burning type.

One of the problems facing the gas turbine industry is providing an efficient means for feeding fuel from its source, for example, a hopper, at atmospheric pressure into the combustion chamber of the gas turbine power plant which is at the cycle pressure of the plant. The cycle pressure of gas turbine power plants is considerably higher than atmospheric pressure and there is a tendency to force air from the turbine into the source of fuel which renders the feeding process inoperative. This phenomenon is known as a blowback. Various well known valve structures have been applied to fuel feeding devices in an attempt to seal the source of fuel from the high pressure zone of the turbines while a predetermined charge of fuel is being injected into the combustion chamber of the turbine. Although such valves may have been effective seals when first installed they had a short operating life because the abrasive action of the powdered coal. The powdered coal in the air passing through the valves wore away the material on the valves which formed the seal thereby rendering the valves ineffective as seals within a relatively short time.

This invention contemplates a fuel feeding mechanism having a vertically disposed flexible member extending between the source of fuel and the combustion chamber of a gas turbine and valve means positioned at either end of the member to collapse and thereby seal the member at appropriate times during the feeding cycle, to effectively seal the source of fuel from the high pressure air in the turbine during the fuel feeding cycle.

The flexible member is made of a material having good resistance to the abrasive wear of the powdered coal, such as rubber, in order to preserve the sealing qualities of the flexible member. The flexible member has a separate relief tube vented to atmosphere which has sealing means which operate in coordination with the sealing means of the flexible member. A vibrator is mounted on the member to aid the gravitation feed of fuel through the member into the combustion chamber.

Therefore it is the object of this invention to provide a new and novel device for feeding fuel from a source at atmospheric pressure into the high pressure zone of a gas turbine power plant.

Another object of this invention is to provide a new and novel device for feeding fuel into a gas turbine that will seal the source of fuel from the high pressure zone of the turbine power plant during the feeding operation and thereby prevent a blowback into the source of fuel.

Another object of this invention is to provide a new and novel fuel feeding device for a gas turbine having a seal which has good abrasive wear characteristics.

Another object of this invention is to provide a new and novel gravitational fuel feeding device for a gas turbine.

Objects and advantages other than those set forth above will be apparent from the following description when read in conjunction with accompanying drawings in which:

Fig. 1 is a schematic view, partly in section, of a gas turbine power plant embodying the feeding device of this invention;

Fig. 2 is a cross section view taken along the line II—II of Fig. 1 showing the flexible member and a valve in the open position; and

Fig. 3 is a cross section view taken along the line III—III of Fig. 1 showing the flexible member and a valve in the closed position.

A gas turbine power plant **10** is illustrated in Fig. 1 and comprises a compressor **11**, a combustion chamber **12**, and a gas turbine **13** operably connected together by suitable ducts **15**. Air enters the compressor **11** where it is compressed and then flows into a duct **15** where it mixes with the fuel. The air-fuel mixture then enters the combustion chamber **12** where it is burned and converted to a hot gas which exhausts through the turbine **13** imparting rotary motion thereto. The fuel may be any of the suitable fuels adapted for use with gas turbines, however, powdered coal **16** stored in a bin **17** has been illustrated for use in this gas turbine. A feeding mechanism **18** is provided between the source of fuel in the bin **17** and the combustion chamber **12** which is positioned in a duct **15** between the compressor **11** and the gas turbine **13**.

The feeding mechanism **18** is mounted on a frame **19** and includes means for measuring and depositing a predetermined amount of fuel, herein illustrated as a star metering wheel **20** positioned immediately below the bin **17** in which the powdered coal **16** is stored. Although a star metering wheel is illustrated, any device for repeatedly feeding a predetermined charge of fuel may be used in the feeding mechanism of this invention. A flexible tubular member **22** is connected to the star metering wheel **20** immediately beneath the wheel, and extends to the duct **15** in which the combustion chamber **12** is positioned. Preferably as shown the member **22** extends vertically downward to aid the flow of coal therethrough. This member **22** is provided with a relief tube **23** which exhausts to atmosphere. The relief tube **23** is preferably a flexible tube and positioned intermediate the vertically spaced extremities of the member **22**. Although the relief tube **23** is illustrated and described as a flexible tube, any suitable tube having cooperating valve means may be used as the relief tube.

Valve means **26**, **27**, **28** are provided for collapsing and thereby sealing the member **22** and the tube **23**. Valve means **26** and **27** are for controlling the flow of fuel through the member **22** and for sealing the member **22** to prevent a blowback of high pressure air from the ducts **15** into the powdered coal **16** in the bin **17**. These valve means **26** and **27** are positioned adjacent the vertically spaced extremities of the member **22**. One of the valves **26** or **27** is closed at all times during the feeding cycle to seal the powdered coal **16** in the bin **17** from air in the power plant at cycle pressure. Valve means **28** acts as a pressure relief valve and is positioned adjacent the end of the relief tube **23** that exhausts to atmosphere. The valve means comprise sliding cam rods **32**, **33**, **34**, guides **36**, and means for actuating the cam rods. As shown in Figs. 2 and 3, the guides **36** are substantially rectangular in cross section and have a stem **37** projecting outwardly from one side. The stem **37** of each guide **36** has a longitudinally extending bore **38** and is positioned to extend toward one of the cam rods **32**, **33**, **34**. The side of the guide **36** opposite the stem **37** acts as a backing plate **39** for the member **22** and the tube **23**. The guides **36** are mounted on the frame **19** in any of the well known ways such as by mounting screws **40** and

if necessary extension pieces 41. The member 22 and the tube 23 fit within the rectangular portion of the guides 36. The cam rods 32, 33, 34 are slidably mounted in the bores 38 of the stems 37 of their respective guides 36 so that they can be actuated in a manner hereinafter described to engage and collapse the flexible member 22 and tube 23 against the backing plates 39 with sufficient force to form a seal against leakage of high pressure air in the ducts 15.

Figure 2 illustrates a section of the flexible member 22 and the valve 26 in an open position to permit a charge of fuel to drop from the star metering wheel into the member 22. Fig. 3 illustrates a section of the flexible member 22 and valve 27 in a closed position. In the closed position the member 22 is collapsed against the backing plate 39 to form a seal within the member.

The flexible member 22 and the tube 23 are preferably constructed of a rubber base material which will resist the abrasive wear caused by the powdered coal suspended in air and which passes through the member 22 and the tube 23. However, any flexible material having a good abrasive wear resistant characteristic may be used for the tube 23 and member 22 with good results. The tube 23 and member 22 are collapsed by the rods acting against the backing plates to form a seal. This type of seal is effective in preventing leakage of air under the high pressures generated by the compressor in the gas turbine power plant. A small amount of wear on the inner sides of the tube or member due to the abrasive action of the coal suspended in air passing through will not materially decrease the effectiveness of the seal because the tube and member can be compressed a little more to compensate for the wear.

The entire feeding mechanism 18 is driven by an independently operated source of power such as the electric motor 42 illustrated in Fig. 1. The motor 42 is operably connected to the star metering wheel 20 and a cam shaft 43 by beveled gears 44. The cam shaft 43 is rotatably mounted on the frame 19 in a position substantially parallel to and spaced apart from the flexible member 22. Mounted on the cam shaft 43 are suitable cams 45, 46, 47 positioned to operable engaging the sliding rods 32, 33, 34, respectively. Resilient means, illustrated as coil springs 49, are provided for keeping the cam rods 32, 33, 34 in constant working engagement with their respective cams 45, 46, 47. One of the coil springs 49 surrounds each cam rod 32, 33, 34, respectively, between the end of the rod engaging its corresponding cam and the stem 37 of corresponding guides 36. These springs 49 cooperate with the ends of the cam rods 32, 33, 34, and the stems 37 to bias the cam rods into constant working agreement with their respective cams 45, 46, 47. The cams 45, 46, 47 are arranged on the cam shaft 43 to actuate their respective cam rods 32, 33, 34 during a portion of each revolution of the cam shaft 43 to open and close the valves 26, 27, 28 according to a predetermined sequence. The cam shaft 43 and the star metering wheel 20 are cooperatively arranged with the beveled gears 44 to drive the feeding mechanism 18 repeatedly through the same cycle.

The feeding mechanism 18 of this invention operates in the following way. The star metering wheel 20 is continually rotating and depositing a predetermined charge of fuel from the bin 17 into the upper portion of the tubular member 22. The cam shaft 43 and cams 45, 46, 47 are also continually rotating and thereby actuating the cam rods 32, 33, 34 according to the following predetermined sequence. When the cycle begins all the valves 26, 27, 28 are closed thereby collapsing the tubular member 22 and the relief tube 23 at three separate points and forming a cavity 51 therein. The valve 26 is then opened permitting the predetermined charge of powdered coal supplied by the wheel 20 to drop by gravity into the cavity 51. Valve 26 is then closed. When valve 26 closes valve 27 opens permitting the cycle pressure of the turbine power plant 10 to force air under pressure into the tubular member 22. When the pressure in the tubular member 22 is equal to the cycle pressure the powdered coal 16 falls down through the tubular member 22 into the combustion chamber 12 by means of gravity. A vibrator 54, such as the electrical vibrating device disclosed in U.S. Patent 1,005,612, may be attached to the tubular member 22 for vibrating the member 22 and thereby aid the powdered coal 16 in dropping through the tubular member 22 and prevent the powdered coal 16 from sticking to the sides of the tubular member 22. After the powdered coal 16 has dropped into the combustion chamber 12, valve 27 is closed and valve 28 which operates the relief tube 23 opens. The relief tube 23 opens to atmosphere and permits the high pressure air in the cavity 51 to escape until the pressure in the cavity 51 is reduced to atmospheric pressure. When the air in the cavity 51 is back to atmospheric pressure the valve 28 again seals the relief tube 23. Valve 26 then opens and the cycle is repeated.

The described apparatus has provided for gravitational feed of powdered coal into the combustion chamber 12 and insures that blowback into the storage bin will be prevented.

Although but one embodiment has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A device for feeding fuel into a high pressure zone of a gas turbine power plant comprising a vertically disposed flexible tubular member having its lower end adaptable to be connected to said high pressure combustion zone, a source of fuel, a star metering wheel connected to the other end of said member and to said source of fuel for supplying a predetermined charge of fuel to said member, first and second cam rods positioned adjacent the vertical extremities of said member near said star metering wheel and said high pressure zone respectively, a flexible relief tube connected to said member intermediate said cam rods for exhausting to atmosphere, a third cam rod positioned adjacent the end of said relief tube open to atmosphere, said cam rods engaging said member and said tube in alternate sealing and unsealing relation, guide means cooperating with said cam rods in sealing said tube and said member, a rotatably mounted cam shaft, cams mounted on said cam shaft and positioned to operatively engage corresponding said cam rods, said cams being formed so that corresponding said cam rods are actuated during a portion of each revolution of said cams according to a predetermined sequence, said cams at all times maintaining at least one of said control valves in a sealing position and opening said relief valve after said second cam rod seals said member and before said first cam rod unseals said member, and means for rotating said wheel and said cams repeatedly through the same cycle whereby fuel is fed by gravity through said member into said combustion zone and said source of fuel is at all times sealed from the high pressure air in the plant.

2. A device for feeding fuel into a high pressure zone of a gas turbine power plant comprising a vertically disposed flexible tubular member having its lower end adaptable to be connected to said high pressure combustion zone, a source of fuel, a star metering wheel connected to the other end of said member and to said source of fuel for supplying a predetermined charge of fuel to said member, first and second cam rods positioned adjacent the vertical extremities of said member near said star metering wheel and said high pressure zone respectively, a flexible relief tube connected to said member intermediate said cam rods for exhausting to atmosphere, a third cam rod positioned adjacent the end of said relief tube open to atmosphere, said cam rods engaging said member and said tube in alternate sealing and unsealing relation, means for guiding said cam rods, said guide

means having back up plates positioned adjacent said member and said tube and spaced from said cam rods for cooperating with said rods in sealing and unsealing said member and said tube, a rotatably mounted cam shaft, cams mounted on said cam shaft and positioned to operatively engage corresponding said cam rods, said cams being formed so that corresponding said cam rods are actuated during a portion of each revolution of said cams according to a predetermined sequence, said cams at all times maintaining at least one of said control valves in a sealing position and opening said relief valve after said second cam rod seals said member and before said first cam rod unseals said member, and means for rotating said wheel and said cams repeatedly through the same cycle whereby fuel is fed by gravity through said member into said combustion zone and said source of fuel is at all times sealed from the high pressure air in the plant.

3. A device for feeding fuel into a high pressure zone of a gas turbine power plant comprising a frame, vertically disposed flexible tubular member having its lower end adaptable to be connected to said high pressure combustion zone, a source of fuel, a star metering wheel connected to the other end of said member and to said source of fuel for supplying a predetermined charge of fuel to said member, first and second cam rods positioned adjacent the vertical extremities of said member near said start metering wheel and said high pressure zone respectively, a flexible relief tube connected to said member intermediate said cam rods for exhausting to atmosphere, a third cam rod positioned adjacent the end of said relief tube open to atmosphere, guide means mounted on said frame, said cams being slidably mounted in said guide means, said guide means having back up plates positioned adjacent said member and said tube and spaced from said cam rods for cooperating with said rods in sealing and unsealing said member and said tube, a rotatably mounted cam shaft, cams mounted on said cam shaft and positioned to operatively engage corresponding said cam rods, said cams being formed so that corresponding said cam rods are actuated during a portion of each revolution of said cams according to a predetermined sequence, said cams at all times maintaining at least one of said control valves in a sealing position and opening said relief valve after said second cam rod seals said member and before said first cam rod unseals said member, and means for rotating said wheel and said cams repeatedly through the same cycle whereby fuel is fed by gravity through said member into said combustion zone and said source of fuel is at all times sealed from the high pressure air in the plant.

4. A device for feeding fuel into a high pressure zone of a gas turbine power plant comprising a vertically disposed flexible tubular member having its lower end adaptable to be connected to said high pressure combustion zone, a source of fuel, a star metering wheel connected to the other end of said member and to said source of fuel for supplying a predetermined charge of fuel to said member, first and second cam rods positioned adjacent the vertical extremities of said member near said start metering wheel and said high pressure zone respectively, a flexible relief tube connected to said member intermediate said cam rods for exhausting to atmosphere, a third cam rod positioned adjacent the end of said relief tube open to atmosphere, guides mounted on said frame and positioned to surround said member and said tube, said guides having an outwardly extending stem having a bore therein, said cam rods being slidably mounted in the bores of said stems for engaging said member and said tube in alternate sealing and unsealing relation, a cam shaft rotatably mounted on said frame, cams mounted on said cam shaft and positioned to operatively engage corresponding said cam rods, said cams being formed so that corresponding said cam rods are actuated during a portion of each revolution of said cams according to a predetermined sequence, said cams at all times maintaining at least one of said control valves in a sealing position and opening said relief valve after said second cam rod seals said member and before said first cam rod unseals said member, and means for rotating said wheel and said cams repeatedly through the same cycle whereby fuel is fed by gravity through said member into said combustion zone and said source of fuel is at all times sealed from the high pressure air in the plant.

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