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(54) **Gas turbine engine**

Gasturbine

Turbine à gaz

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Description

[0001] The present invention relates to gas turbine engines, and particularly to an engine having a compressor bleed valve for improving the control of surge in such engines.

[0002] U.S. Patent 3,809,490, Harner, issued May 7, 1974, describes the on-going problem of trying to avoid surge in gas turbine engines. The solution proposed over the years has been the provision of bleed valves to bleed off compressor air at different stages of the compressor. Thus, controls, mechanical or pneumatic, are provided for anticipating a surge condition by causing the valves to be opened to thereby bleed off air before a surge condition is to happen. Thus, in high power requirement conditions, the bleed valves are maintained closed, but during low power, the bleed valves are opened.

[0003] A pneumatic bleed valve having the features of the preamble of claim 1 is described in U.S. Patent 5,477,673, Blais et al., issued December 26, 1995. This patent describes a bleed valve in the form of a piston extending radially through a bypass flow path, and operable to bleed compressor air into the bypass flow path when the piston type valve is open. The valve may be closed when air from a source downstream of the compressor impeller is fed to the head of the piston and such air is at a higher pressure than air from a downstream stage of the compressor. The pneumatic force to close the valve acts against a spring normally urging the valve to an open position.

[0004] As the engine speed changes from low to high, the bleed valve moves from an open to a closed position gradually. If during this transition the opening becomes too small, the engine may be in a surge condition.

[0005] It is an object of the invention to seek to provide an engine having an improved pneumatic valve of the type described in U.S. Patent 5,477,673 that includes a means for maintaining the bleed valve open with a larger bleed opening during gradual closing of the bleed valve during pneumatic control of the valve.

[0006] According to the invention there is provided a gas turbine engine including a compressor with an axial fluid flow path, a bypass fluid flow path concentric with the compressor fluid flow path, a bleed valve in fluid communication with the compressor fluid flow path and the bypass fluid flow path whereby the bleed valve comprises a piston extending radially, with a piston head radially remote from the compressor fluid flow path, a pneumatic chamber surrounding a portion of the piston head and means for introducing compressed fluid into said chamber, the piston including a valving means and a rigid member extending between the piston head and the valving means whereby the piston is effective to open or close the communication between the compressor fluid flow path, characterised in that there is provided a precompressed spring associated with the piston to normally urge the piston radially outwardly relative to the

compressor fluid flow, the arrangement being such that the pneumatic pressure in the chamber surrounding the piston head must overcome the precompressed spring in order to close said valving means and the precompression spring is such that the closing schedule of the bleed valve will avoid the surge conditions of the engine.

[0007] Thus using the invention it is possible to provide a precompressed spring on the piston forming the operable portion of the valve.

[0008] In a more specific embodiment of the present invention, the spring is precompressed to 40 lbs (178 N).

[0009] It has been found that by precompressing the spring in the bleed valve described in U.S. Patent 5,477,673, significant improvement can be obtained in avoiding possible engine surging by maintaining the bleed valve open longer and especially maintaining a larger opening of the bleed valve until the surge conditions are passed and the valve can definitely close.

[0010] Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration, a preferred embodiment thereof, and in which:

Fig. 1 is an axial cross-section of a compressor portion of a gas turbine engine shown in dotted lines and illustrating in cross-section a bleed valve in accordance with the prior art in an open position;

Fig. 2 is a cross-section taken in a vertical plane of the bleed valve in accordance with the present invention in an open position;

Fig. 3 is a cross-section, similar to Fig. 2, showing the bleed valve of the present invention in a closed position; and

Fig. 4 is a graph illustrating the operating schedule of the bleed valve in accordance with the present invention compared with a prior art bleed valve.

[0011] Referring now to the drawings and particularly to Fig. 1, a bleed valve 10 is shown mounted in a compressor section 14 of a gas turbine engine having a bypass fluid flow path 12. The bleed valve 10, shown in Fig. 1, is according to U.S. Patent 5,477,673, Blais et al., which is herewith incorporated by reference. As shown in Fig. 1, the compressor section includes a fluid flow path 16 which is somewhat concentric with the bypass fluid flow path 12. The compressor includes a downstream compressor stage outlet port 22 in shroud 18, adjacent the centrifugal impeller 24.

[0012] The bleed valve 10 is a piston type bleed valve having a closed casing with a piston 26 and a guide rod 28 fixed to the upper chamber housing 27 which defines a closed chamber 32. A piston head 34 slides within the chamber 32 in sealing relationship. The piston 26 includes a sleeve 30 and 30a which slides on the rod 28. The rod 28 is connected to the chamber housing 27 by means of a nut 31. The rod 28 is connected at its other end to the valve chamber housing 52 by means of nut 29. The valve chamber 52 is in the form of an open bas-

ket with openings 42. The valving element 36 includes a frusto-conical surface 37 and a partial cylindrical skirt 38 defining an opening 39 which corresponds with opening 40 in the bypass fluid flow inner wall 20.

[0013] As described in U.S. Patent 5,477,673, the bleed valve, when in an open position as shown in Fig. 1, allows bleed air from the downstream portion of the compressor to pass through openings 42 and through opening 40 to the bypass fluid flow path 12 downstream of the bleed valve 10. The spring 44 normally urges the valve to its open position, as shown in Fig. 1, and the valve is closed pneumatically as described in the above United States patent.

[0014] It has been found that the valve, under the pneumatic pressure from a source downstream of the compressor impeller, as described in the above-mentioned patent, will prematurely close the valve against the spring 44 while the engine is still vulnerable to a surge condition.

[0015] Referring now to Figs. 2 and 3, the bleed valve, in accordance with the present invention, is shown and identified as 110. All of the reference numerals which correspond to reference numerals in Fig. 1 have been raised by 100.

[0016] The bleed valve 110 of Figs. 2 and 3 is shown in cross-section in a radial plane, that is, at 90° to the cross-section of Fig. 1.

[0017] The bleed valve 110 includes an upper casing 127 defining a piston chamber 132 communicating with an inlet 150. Bleed valve 110 is a piston-type bleed valve and includes a piston 126 which includes the sleeve 130 having bushings 148 sliding on rod 128. Rod 128 is fixed at the casing 127 by means of nut 131. At the other end, rod 128 mounts a valve housing 152 in the form of an open basket which defines a valve seat 154 adjacent the inner wall 120 of the bypass fluid flow path 112.

[0018] The sleeve 130 mounts a piston head 134 which is adapted to slide in sealing engagement within the chamber 132. At the other end of the sleeve 130 is an aerodynamic cap 146 to which is connected a valving element 136. The valving element 136 includes a frusto-conical surface surrounded partially by a skirt 138 which is adapted to slide within the basket 152. The valving element 136 defines an annular spring recess 143 which houses a coil spring 144. The skirt 138 defines an opening 139 in the downstream side of the valving element 136 (although the opening 139 is shown to one side in Figs. 2 and 3 for the purposes of illustration only).

[0019] Referring to Fig. 4, the curve N represents the bleed valve as shown in Fig. 1 of the spring 44. Thus, it can be seen that curve N, as it is closing, passes through the so-called surge bucket S. As the valve 36 is being closed, it is difficult to control the valve opening.

[0020] It has been found, however, that by precompressing the spring 144, as shown in Figs. 2 and 3, the air pressure entering inlet 150 in Fig. 2 required to urge the piston head 134 and thus the piston 126 to close against the valve seat 154 will need to be higher since

the precompressed spring 144 offers more resistance. Since the necessary force required to overcome the spring 144 will be greater, the valve will remain open longer and will naturally be larger since the valving member will not readily close the opening unless a larger force is applied.

[0021] The curve P shown in Fig. 4 represents the schedule for closing valve 136 using a precompressed spring 144.

[0022] It has been found that a preferred spring rating will include a precompression of 40 lbs. (178 N) when the valve is completely opened, although a precompression of 20 lbs. (89 N) should be sufficient to clear the surge bucket 144. This compares to zero compression in terms of spring 44 in Fig. 1 when the valve is completely opened. It is anticipated that the spring could also be precompressed to 50 lbs (222 N). It is noted that when the valve 36 is closed, the spring 144 is compressed to 60 lbs. (267 N) which is similar to the spring 44 in Fig. 1.

Claims

1. A gas turbine engine including a compressor (14) with an axial fluid flow path (116), a bypass fluid flow path (112) concentric with the compressor fluid flow path (116), a bleed valve (110) in fluid communication with the compressor fluid flow path (116) and the bypass fluid flow path (112), the bleed valve (110) comprising a piston (126) extending radially, with a piston head (134) radially remote from the compressor fluid flow path (116), a pneumatic chamber (132) surrounding a portion of the piston head (134) and means (150) for introducing compressed fluid into said chamber (132), the piston including a valving means (136) and a rigid member (130) extending between the piston head (134) and the valving means (136) whereby the piston (126) is effective to open or close the communication between the compressor fluid flow path and the bypass fluid flow path, **characterised in that** there is provided a precompressed spring (144) associated with the piston (126) to normally urge the piston (126) radially outwardly relative to the compressor fluid flow path (116), the arrangement being such that the pneumatic pressure in the chamber (132) surrounding the piston head (124) must overcome the precompressed spring in order to close said valving means (136) and the precompression spring (144) is such that the closing schedule of the bleed valve (110) will avoid the surge conditions of the engine.
2. The engine according to Claim 1, **characterised in that** the precompressed spring (144) is a coil spring precompressed to between 20 and 50 lbs (89 and 222 N).

3. The engine valve according to Claim 2, **characterised in that** the spring is precompressed to 40 lbs (178 N).
4. The engine according to any preceding claim, **characterised in that** the bleed valve (110) includes a casing (127) defining the pneumatic chamber (132) mounted to the outer shroud (121) of the bypass fluid flow path (112) and a valving means housing (152) is mounted to the other end of a rod (128) fixed to the chamber casing (127) whereby the valving means housing (152) is mounted to the inner wall of the bypass fluid flow path (112), the piston (126) includes the piston head (134) and an elongated sleeve (130) connecting the piston head (134) to the valving element (136) such that the sleeve (130) slides on the rod (128) between a valve opened position and a valve closed position and the precompressed spring (144) is mounted in the valving element housing (152) between the valving element (136) and the housing (152) so as to urge the piston (126) and the valving element (136) to an open position.
5. The engine according to Claim 4, **characterised in that** the spring (144) is precompressed to 40 lbs (178 N).

Patentansprüche

1. Gasturbinenmaschine aufweisend einen Verdichter (14) mit einem Axialfluid-Strömungsweg (116), einem Bypassfluid-Strömungsweg (112) konzentrisch zu dem Verdichterfluid-Strömungsweg (116), einem Zapfventil (110) in Fluidverbindung mit dem Verdichterfluid-Strömungsweg (116) und dem Bypassfluid-Strömungsweg (112), wobei das Zapfventil (110) einen sich radial erstreckenden Kolben (126) mit einem radial von dem Verdichterfluid-Strömungsweg (116) entfernten Kolbenboden (134), einer Pneumatikkammer (132), welche einen Teil des Kolbenbodens (134) umgibt, und einer Einrichtung (150) zum Einbringen von verdichtetem Fluid in die Kammer (132) aufweist, wobei der Kolben eine Ventileinrichtung (136) und ein starres Element (130) aufweist, welches sich zwischen dem Kolbenboden (134) und der Ventileinrichtung (136) erstreckt, wodurch der Kolben (126) effektiv ist, die Verbindung zwischen dem Verdichterfluid-Strömungsweg und dem Bypassfluid-Strömungsweg zu öffnen und zu schließen,
dadurch gekennzeichnet, dass eine dem Kolben (126) zugeordnete vorkomprimierte Feder (144) vorgesehen ist, um normal den Kolben (126) relativ zu dem Verdichterfluid-Strömungsweg (116) radial nach außen zu drängen, wobei die Anordnung derart ist, dass der pneumatische Druck in der den Kol-

benboden (124) umgebenden Kammer (132) die vorkomprimierte Feder überwinden muss, um die Ventileinrichtung (136) zu schließen, und die vorkomprimierte Feder (144) derart ist, dass der Schließablauf des Zapfventils (110) die Pumpzustände der Maschine meiden wird.

2. Maschine nach Anspruch 1, **dadurch gekennzeichnet, dass** die vorkomprimierte Feder (144) eine Schraubenfeder ist, die auf zwischen 20 und 50 lbs. (89 und 222 N) vorkomprimiert ist.
3. Maschine nach Anspruch 2, **dadurch gekennzeichnet, dass** die Feder auf 40 lbs. (178 N) vorkomprimiert ist.
4. Maschine nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Zapfventil (110) ein die Pneumatikkammer (132) definierendes Gehäuse (127) aufweist, das an der äußeren Ummantelung (121) des Bypassfluid-Strömungsweg (112) angebracht ist, und dass ein Ventileinrichtungsgehäuse (152) an dem anderen Ende einer Stange (128) angebracht ist, die an dem Kammergehäuse (127) befestigt ist, wodurch das Ventileinrichtungsgehäuse (152) an der Innenwand des Bypassfluid-Strömungswegs (112) angebracht ist, wobei der Kolben (126) den Kolbenboden (134) und eine längliche Manschette (130) aufweist, welche den Kolbenboden (134) mit dem Ventilelement (136) derart verbindet, dass die Manschette (130) an der Stange (128) zwischen einer offenen Position des Ventils und einer geschlossenen Position des Ventils gleitet und die vorkomprimierte Feder (144) in dem Ventilelementgehäuse (152) zwischen dem Ventilelement (136) und dem Gehäuse (152) derart angeordnet ist, dass sie den Kolben (126) und das Ventilelement (136) in eine offene Position drängt.
5. Maschine nach Anspruch 4, **dadurch gekennzeichnet, dass** die Feder 144 auf 40 lbs. (178 N) vorkomprimiert ist.

Revendications

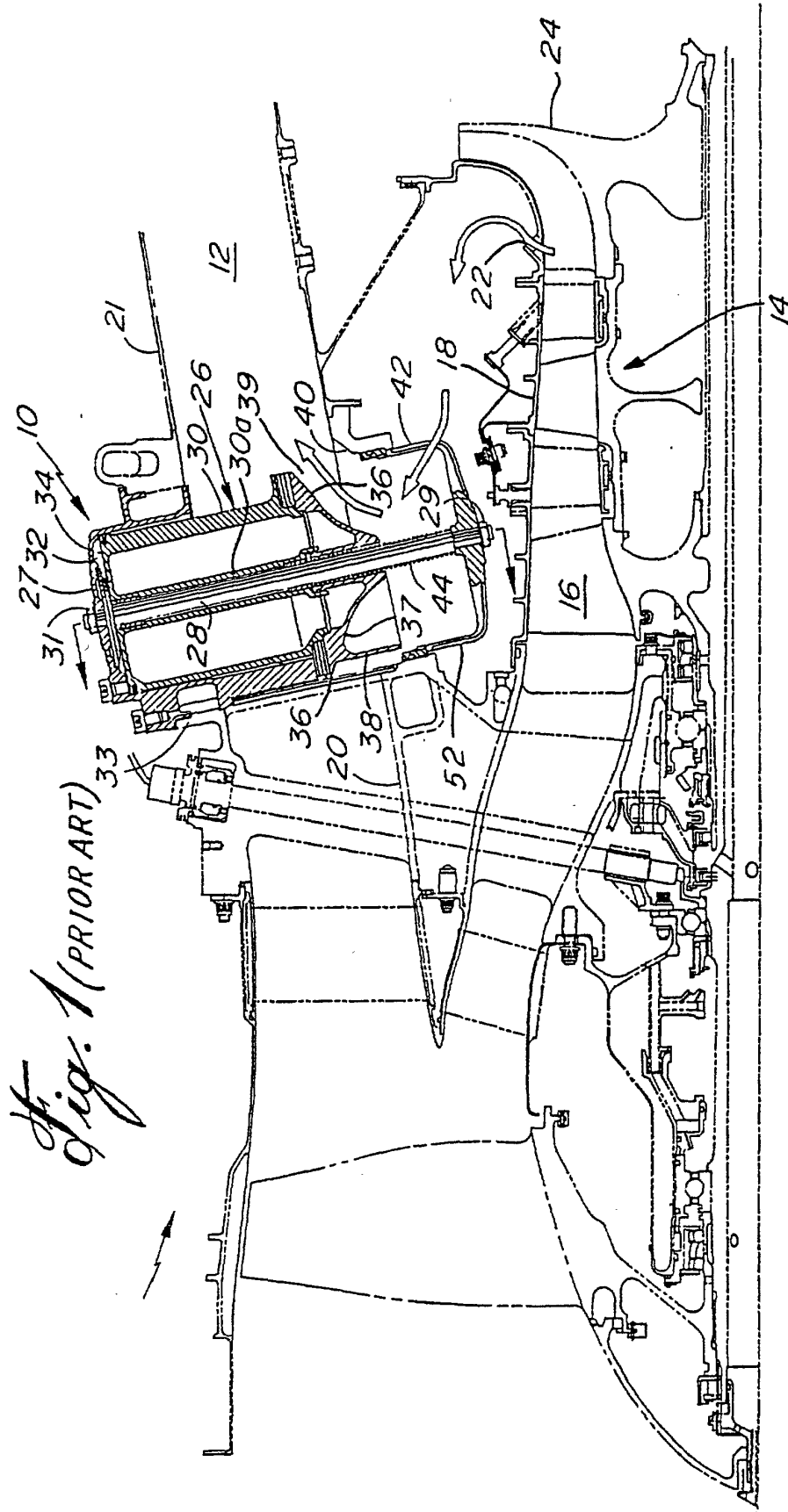
1. Turbine à gaz comprenant un compresseur (14) avec un cheminement d'écoulement de fluide axial (116), un cheminement d'écoulement de fluide secondaire (112) concentrique avec le cheminement d'écoulement de fluide du compresseur (116), une valve de prélèvement (110) en communication fluide avec le cheminement d'écoulement de fluide du compresseur (116) et le cheminement d'écoulement de fluide secondaire (112), la valve de prélèvement (110) comprenant un piston (126) s'étendant radialement, avec une tête de piston (134) ra-

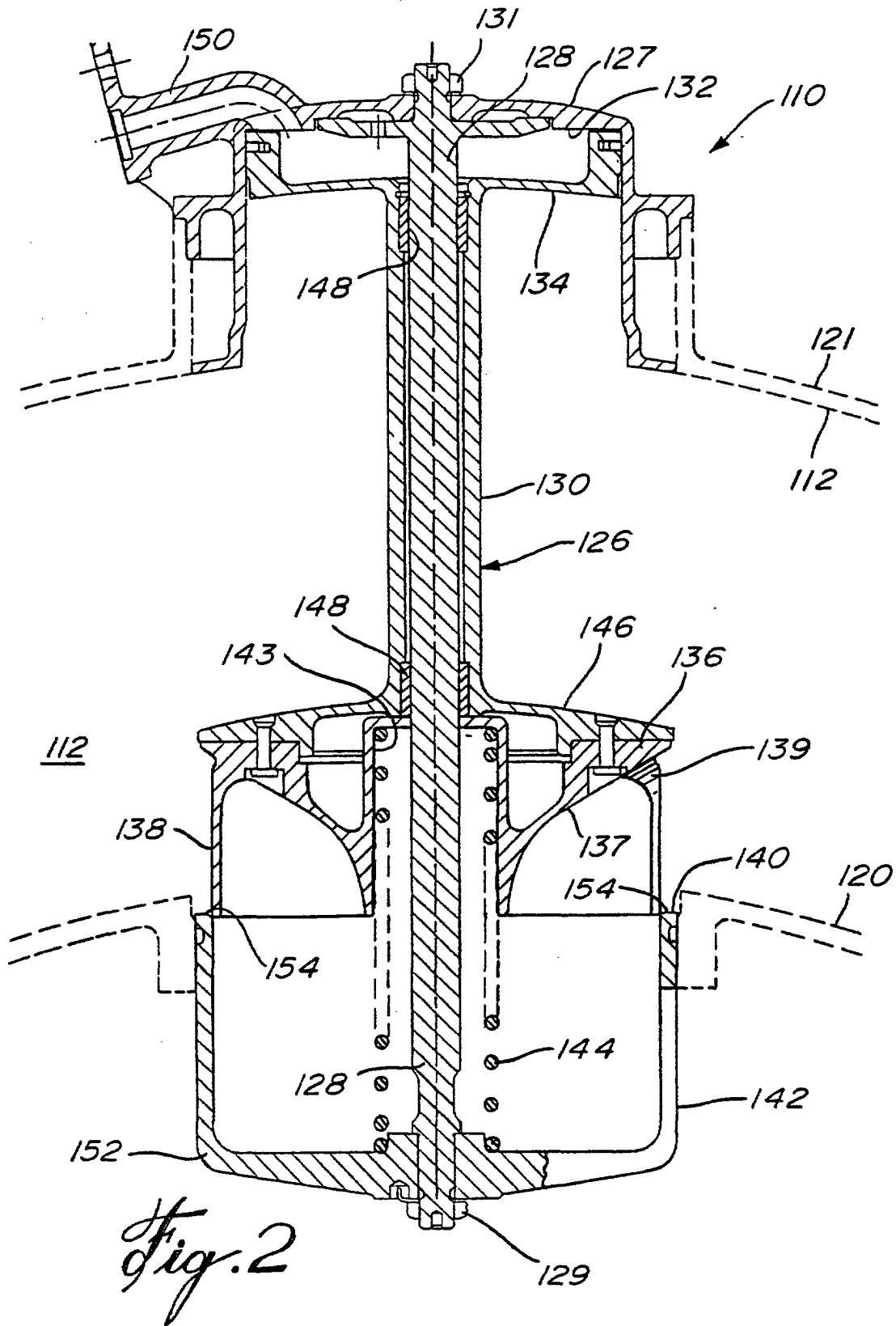
dialement éloignée du cheminement d'écoulement de fluide du compresseur (116), une chambre pneumatique (132) entourant une partie de la tête de piston (134), et un moyen (150) destiné à introduire le fluide comprimé dans ladite chambre (132), le piston comprenant un moyen de régulation par valve (136) et un élément rigide (130) s'étendant entre la tête de piston (134) et le moyen de régulation par valve (136), moyennant quoi le piston (126) est efficace pour ouvrir ou fermer la communication entre le cheminement d'écoulement de fluide du compresseur et le cheminement d'écoulement de fluide secondaire, **caractérisée en ce qu'il** est prévu un ressort pré comprimé (144) associé avec le piston (126) afin de pousser normalement le piston (126) radialement et vers l'extérieur par rapport au cheminement d'écoulement de fluide du compresseur (116), l'agencement étant tel que la pression pneumatique dans la chambre (132) entourant la tête de piston (134) doit venir à bout du ressort pré comprimé afin de fermer ledit moyen de régulation par valve (136) et le ressort de pré compression (144) est tel que la programmation de fermeture de la valve de prélèvement (110) permettra d'éviter les conditions de pompage du moteur.

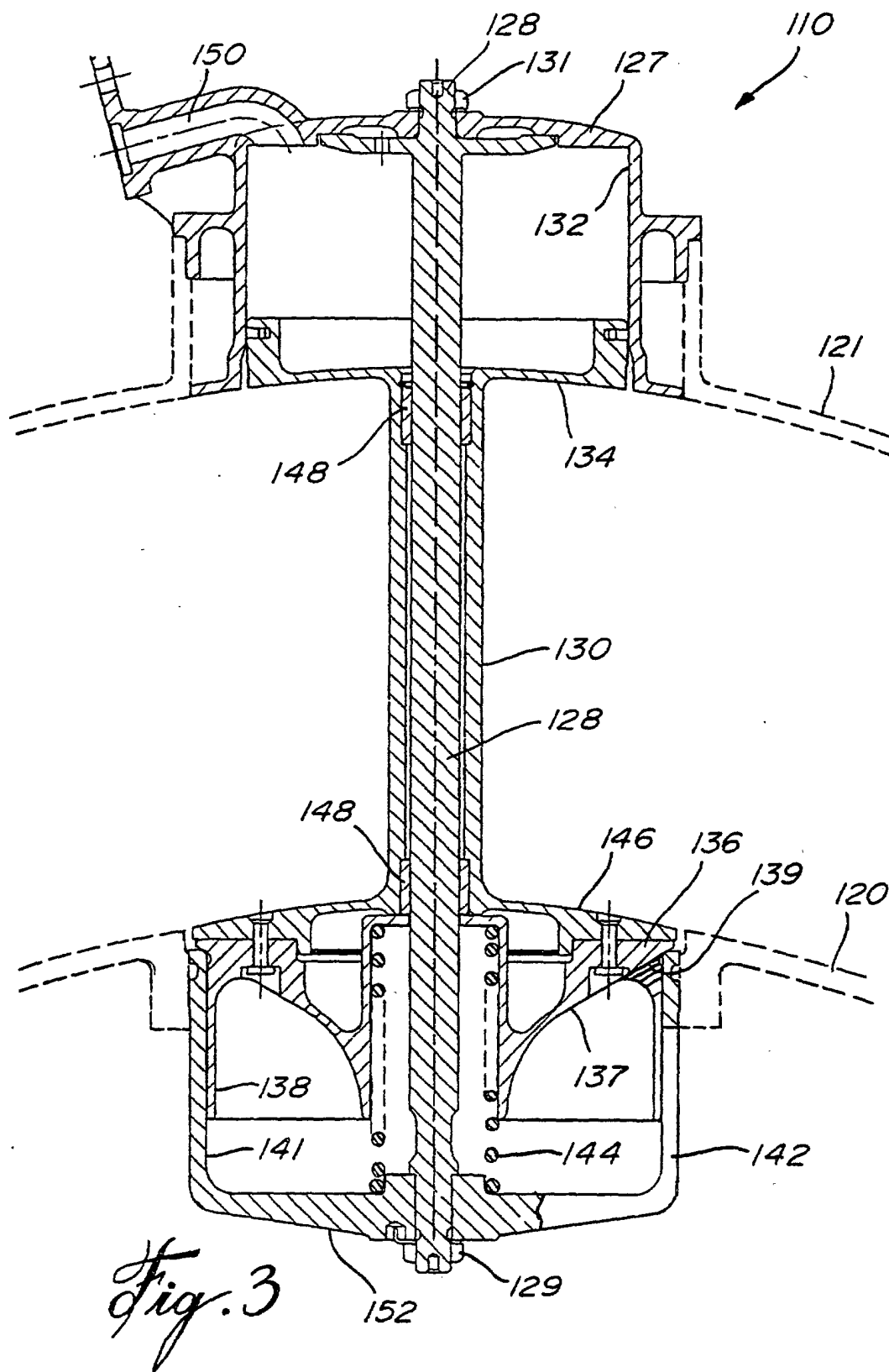
2. Turbine selon la revendication 1, **caractérisée en ce que** le ressort pré comprimé (144) est un ressort à spirales pré comprimé à une valeur comprise entre 20 et 50 livres (89 et 222 N).
3. Turbine selon la revendication 2, **caractérisée en ce que** le ressort est pré comprimé à 40 livres (178 N).

4. Turbine selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la valve de prélèvement (110) comprend un carter (127) définissant la chambre pneumatique (132) montée sur le carénage externe (121) du cheminement d'écoulement de fluide secondaire (112) et un logement pour le moyen de régulation par valve (152) est monté à l'autre extrémité d'une tige (128) fixée au carter de chambre (127) moyennant quoi le logement du moyen de régulation par valve (152) est monté sur la paroi interne du cheminement d'écoulement de fluide secondaire (112), le piston (126) comprend la tête de piston (134) et un manchon allongé (130) reliant la tête de piston (134) à l'élément de régulation par valve (136) de telle sorte que le manchon (130) coulisse sur la tige (128) entre une position de vanne ouverte et une position de vanne fermée et le ressort pré comprimé (144) est monté dans le logement de l'élément de régulation par valve (152) entre l'élément de régulation par valve (136) et le logement (152) de façon à pousser le piston (126) et l'élément de régulation par valve (136) vers une position ouverte.

5. Turbine selon la revendication 4, **caractérisée en ce que** le ressort (144) est pré comprimé à 40 livres (178 N).







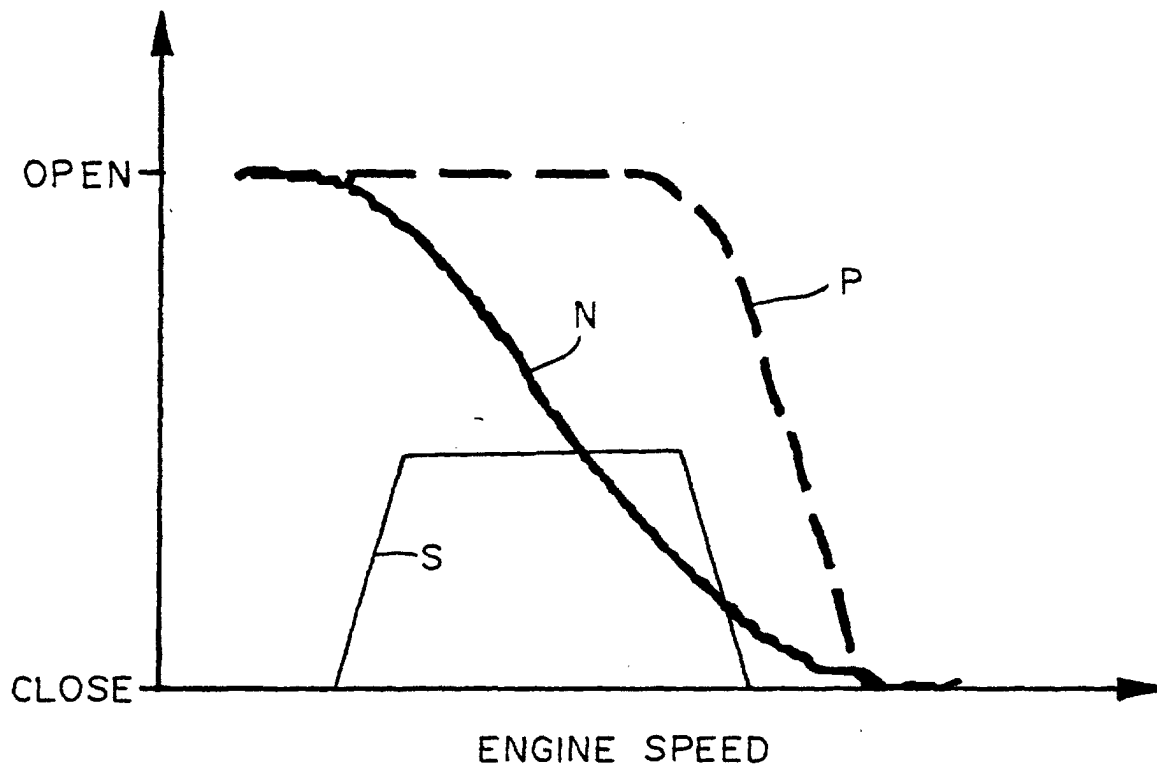


Fig. 4