United States Patent [19]

Keetley

[11] **3,904,309**

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[54] **VARIABLE ANGLE TURBINE NOZZLE ACTUATING MECHANISM**

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[73] Assignee: **Caterpillar Tractor Company**, Peoria, Ill.

[22] Filed: **Aug. 12, 1974**

[21] Appl. No.: **496,730**

[52] **U.S. Cl.** **415/148**; 415/160

[51] **Int. Cl.**[2] **F01D 17/00**; F01D 17/14

[58] **Field of Search** 415/147, 148, 149, 150, 415/151, 160, 163

[56] **References Cited**

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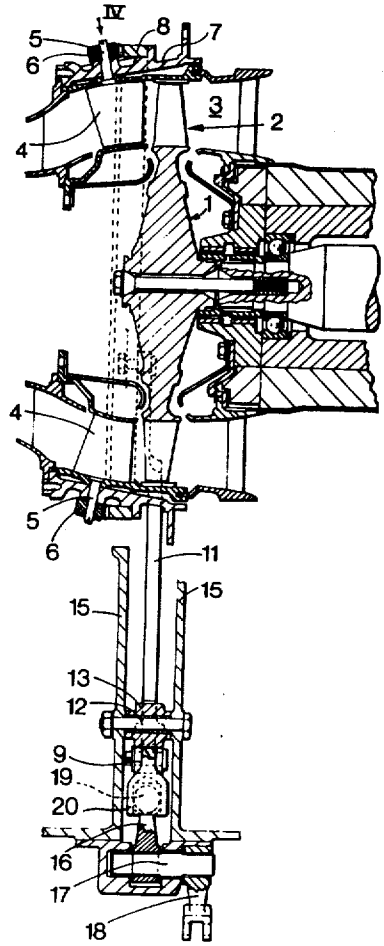
Primary Examiner—Henry F. Raduazo

Attorney, Agent, or Firm—Gifford, Chandler & Sheridan

[57] **ABSTRACT**

A variable angle turbine nozzle actuating mechanism in which a nozzle-actuating ring is mounted co-axially of the nozzle-defining members and is operatively connected thereto to effect their angular movement. The mechanism includes a pair of links pivotally connected to the nozzle-actuating member, a lever pivotally connected to the opposite end of each of the links and itself pivotally mounted on a support between the pivotal points thereon of the links, and a pivotally-mounted rocker arm drivingly engaged at its outer end with the lever. On turning the rocker arm, the lever will be swung about its pivot thereby simultaneously to push one link and to pull the other link to turn the nozzle-actuating member through a corresponding circumferential distance and hence to turn the nozzle-defining members through predetermined angles and to hold them in those angular positions. The lever is slidable on its support in the plane of the lever and the point of engagement of the rocker arm with the lever is also movable in the plane of the lever. On temperature change effecting expansion or contraction of one or both the links, the lever will slide with respect to the support and the rocker arm and expansion or contraction of the links will be accommodated without effecting any substantial movement of the nozzle-actuating member.

3 Claims, 4 Drawing Figures



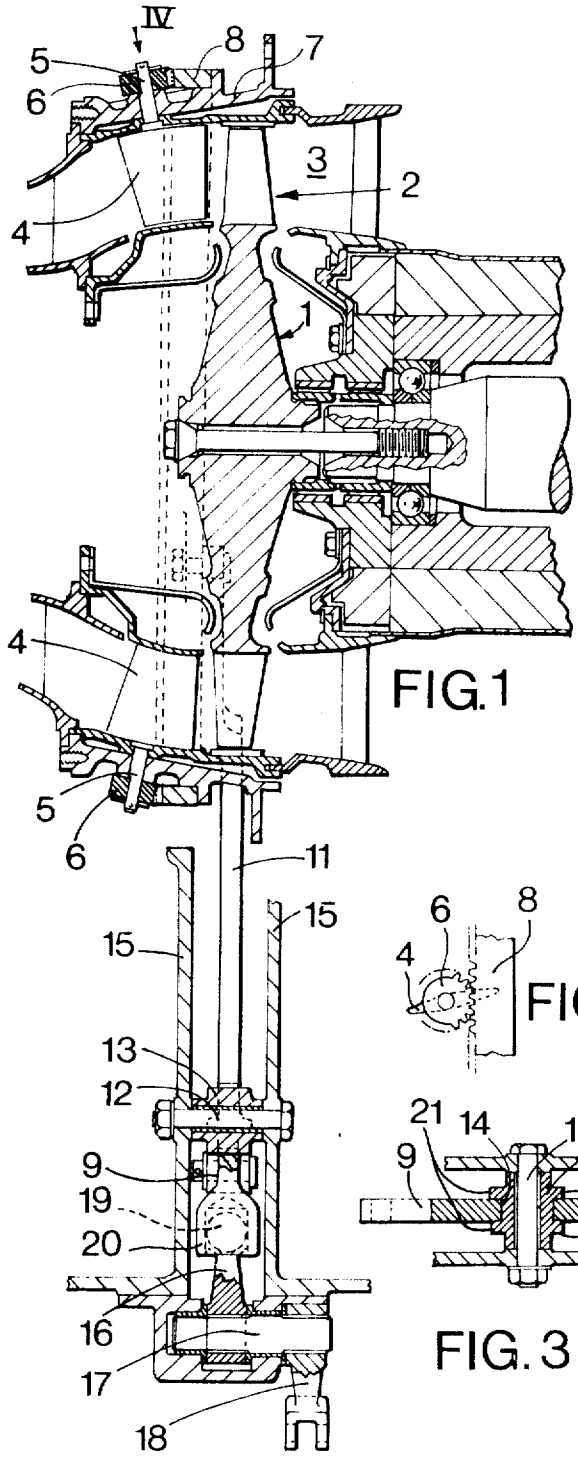


FIG.1

FIG.4

FIG. 3

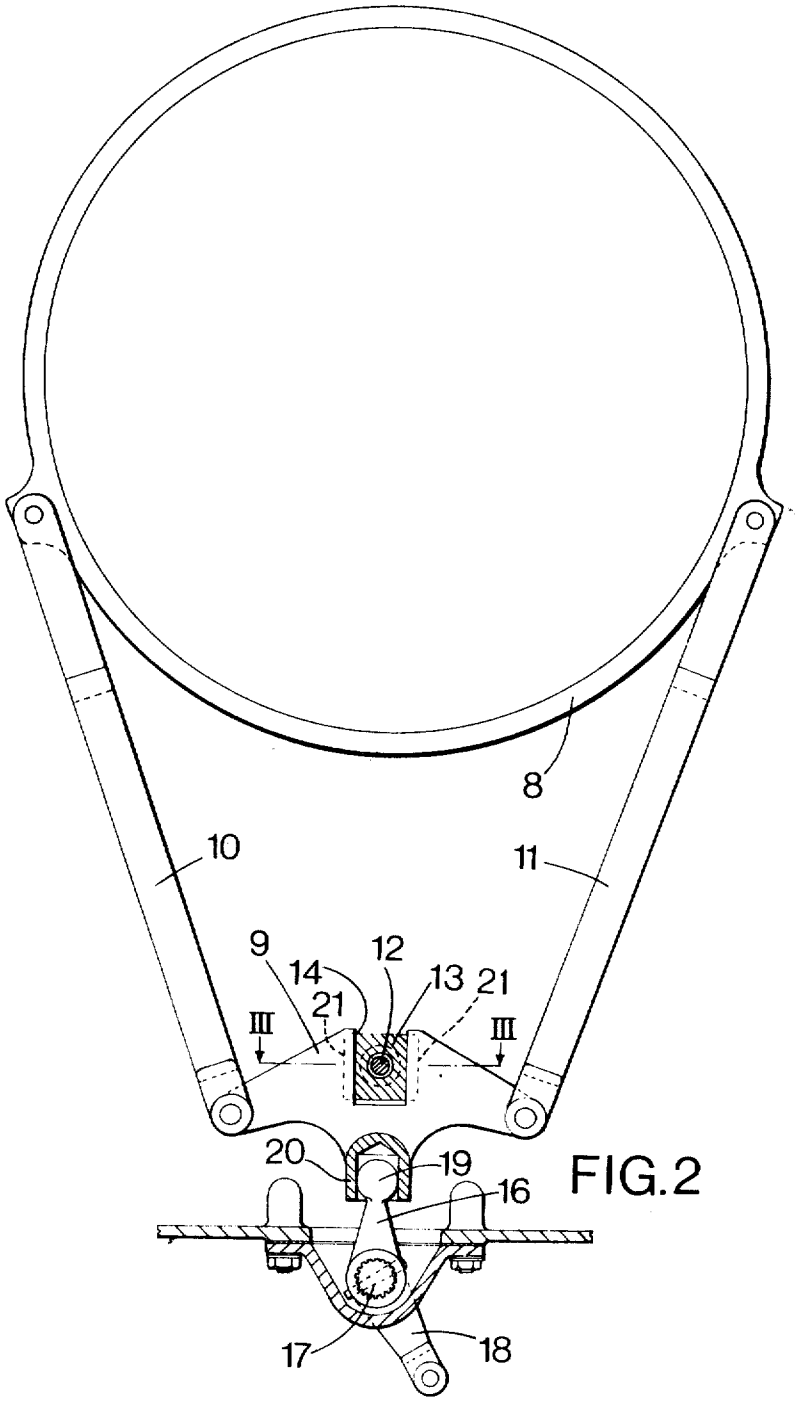


FIG.2

VARIABLE ANGLE TURBINE NOZZLE ACTUATING MECHANISM

BACKGROUND OF THE INVENTION

I. Field of the Invention

The invention relates to variable angle turbine nozzle actuating mechanism.

II. Description of the Prior Art

In gas turbine engines the turbine nozzles are often of variable angle; that is their angle of delivery to the turbine blades is variable. The nozzle-defining members are usually nozzle guide vanes defining nozzles of variable angle and are mounted for pivoting about individual axes by circumferentially moving an annular gear engaging individual driving pinions on the nozzle-defining members. Usually the annular gear is itself turned by a pinion actuated by a control arm. The individual parts of the actuating mechanism, particularly the annular gear and the pinion by which it is turned become hot during operation of the engine and differential expansion between parts may occur causing undesirable movement of the nozzle-defining members from the angular positions to which they have been set. An object of the invention is to provide an actuating mechanism for variable angle turbine nozzles by which the extent of undesirable movement of the nozzle-defining members from the positions to which they have been set, due to temperature change, is reduced or eliminated.

SUMMARY OF THE PRESENT INVENTION

According to the invention, a variable angle turbine nozzle actuating mechanism comprises a nozzle-actuating member in the form of a complete or substantially complete annulus arranged to be mounted coaxially of the nozzle-defining members and operatively connected thereto to effect their angular movement, a pair of links pivotally connected to the nozzle-actuating member at positions thereon spaced apart circumferentially, a lever pivotally connected to the opposite ends of the links and itself pivotally mounted on a support between the pivotal points thereon of the links, and a pivotally-mounted rocker arm drivingly engageable at its outer end with the lever, whereby on turning the rocker arm, the lever will be swung about its pivot thereby simultaneously pushing one link and pulling the other link to turn the nozzle-actuating member through a corresponding circumferential distance and hence to turn the nozzle-defining members through predetermined angles and to hold them in those angular positions, the lever being slidable on its pivotal support in the plane of the lever and the point of engagement of the rocker arm with the lever also being movable in the plane of the lever, whereby on temperature change effecting expansion or contraction of one or both the links, the lever will slide with respect to the support and the rocker arm, thereby to permit said expansion or contraction of the links to be accommodated without effecting any substantial movement of the nozzle-actuating member.

BRIEF DESCRIPTION OF THE DRAWING

By way of example, in accordance with the invention a variable angle turbine nozzle actuating mechanism for a gas turbine engine will now be described with reference to the accompanying drawings, in which:

FIG. 1 is an axial section through a turbine and showing the nozzle actuating mechanism;

FIG. 2 is an elevation of part of the mechanism shown in FIG. 1;

FIG. 3 is a section on the line III—III in FIG. 2, and

FIG. 4 is a scrap view in the direction of arrow IV in FIG. 1 showing part of the nozzle-actuating mechanism.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Referring to FIG. 1, the turbine comprises a rotor 1, having a row of rotor blades 2 positioned in an annular passage 3 and arranged to receive working fluid from a row of variable angle nozzle guide vanes 4. As is well-known, the nozzle guide vanes 4 are each mounted for swinging about individual axes and usually each has an outwardly-extending shaft 5 carrying a pinion 6 positioned outside the turbine casing 7 which is in mesh with an annular rack 8 guided for circumferential movement around the turbine casing 7. The rack 8 may be a complete annulus or be split to permit free thermal expansion and contraction. Circumferential movement of the annular rack 8 effects simultaneous movement of all the pinions 6. Thus all the nozzle guide vanes 4 are swung simultaneously about their axes, thereby altering the angles of the nozzle passages defined between adjacent nozzle guide vanes 4. FIG. 4 is a scrap view in the direction of arrow IV in FIG. 1 and shows one pinion 6 in mesh with a portion of the annular rack 8.

As shown in FIGS. 1 and 2 the annular rack 8 is connected to a lever 9 by a pair of links 10, 11 of substantially equal length and each pivotally connected at its ends to the annular rack 8 and the lever 9 respectively. The pivotal connections of the links 10, 11 to the annular rack 8 are spaced apart circumferentially thereof and are desirably equidistant on opposite sides of a diameter of the annular rack 8 as shown in FIG. 2. The pivotal connections of the links 10, 11 on the lever 9 are on either side of a pivot pin 12 extending through a block 13 mounted in a slot 14 in the lever 9, the latter being slidable with respect to the block 13 and hence to the pivot pin 12 and being located in directions perpendicular to the plane of the lever 9 by flanges 21 on the block 13 on each side of the lever 9. The pivot pin 12 is supported between parts 15 (see FIGS. 1 and 3) of the turbine housing or other fixed structure. The lever 9 is turned about the pivot pin 12 by a rocker arm 16 carried by a shaft 17, also carrying an actuating arm 18 by which shaft 17 is turned. The end 19 of the rocker arm 16 remote from the shaft 17 is of ball shape and is engageable in a socket 20 formed on the lever 9, the end 19 and the socket 20 together forming a slidable knuckle joint.

The nozzle guide vane actuating mechanism operates as follows:

When the shaft 17 is turned by the actuating arm 18, the arm 16 is swung from left to right or vice versa as viewed in FIG. 2. This movement causes the lever 9 to be swung about its pivot pin 12, thereby pushing one of the links 10, 11 and pulling the other. The links 10, 11 turn the annular rack 8, which effects movement of the pinions 6 and therefore the nozzle guide vanes 4. By holding the actuating arm 18 and the shaft 17 in the angular positions to which they have been set, the nozzle guide vanes 4 will be held in their desired angular posi-

tions. If both the links **10, 11** expand or contract under a change in operating temperature, the lever **9** will slide on the pivot pin **12** under the guidance of the slot **14.** The socket **20** will also slide over the ball end **19** of the rocker arm **16** and hence neither the annular rack **8** nor the rocker arm **16** will be moved and hence the nozzle guide vanes **4** will not be moved. If one of the links **10** or **11** should expand or contract relatively to the other, the lever **9** will be tipped about its pivotal connection with one of the links **10** or **11** and the lever **9** will slide on the block **13** with respect to the pivot pin **12.** Similarly the socket **20** will slide on the ball end **19** and only small movement of the rocker arm **16** will occur, thereby effecting only a small alteration in the angle of inclination of the rocker arm **9,** with no alteration in the angles of inclination of the nozzle guide vanes **4.**

The ability of the lever **9** to slide with respect to the block **13** and the pivot pin **12** and the rocker arm **16** also permits easy assembly of the nozzle guide vane actuating mechanism particularly where, due to manufacturing errors, one link **10** or **11** is longer than the other, or the pivotal connections of the links **10, 11** on the annular rack **8** or the lever **9** are not symmetrical, since the lever **9** will tip to permit the links **10** and **11** to be connected to the annular rack **8** and to the lever **9.**

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. A turbine having a variable angle turbine nozzle actuating mechanism comprising a nozzle-actuating member in the form of a substantially complete annulus to be mounted co-axially of nozzle-defining members and operatively connected thereto to effect their angular movement, a pair of links pivotally connected to said nozzle-actuating member at positions thereon spaced apart circumferentially, a lever pivotally connected to the opposite end of each of said links, a support on which said lever is pivotally mounted at position on said lever between the pivotal points thereon of the links, and a pivotally-mounted rocker arm drivingly engaged at its outer end with the lever, whereby on turning said rocker arm, said lever will be swung about its pivot thereby simultaneously to push one said link and to pull other said link to turn said nozzle-actuating member through a corresponding circumferential distance and hence to turn the nozzle-defining members through predetermined angles and to hold them in those angular positions, said lever having means whereby it is slidable on said support in the plane of said lever and the point of engagement of said rocker arm with said lever also having means movable in the plane of said lever, whereby, on temperature change effecting change of length of at least one of said links, said lever will slide with respect to said support and said rocker arm, thereby to permit change of length of the links to be accommodated without effecting any substantial movement of the nozzle-actuating member.

2. A turbine having a variable angle turbine nozzle actuating mechanism as claimed in claim **1** and means in which said lever is slidable in its own plane on a pivotally-mounted block supported on a fixed pivot.

3. A turbine having a variable angle turbine nozzle actuating mechanism as claimed in claim **2** in which said rocker arm is formed with a ball end slidable in a socket on said lever, the ball end and socket together forming a slidable knuckle joint.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,904,309
DATED : September 9, 1975
INVENTOR(S) : Reginald George Keetley

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Change the assignee to read:

--Caterpillar Tractor Co.--

Signed and Sealed this

Tenth Day of August 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks