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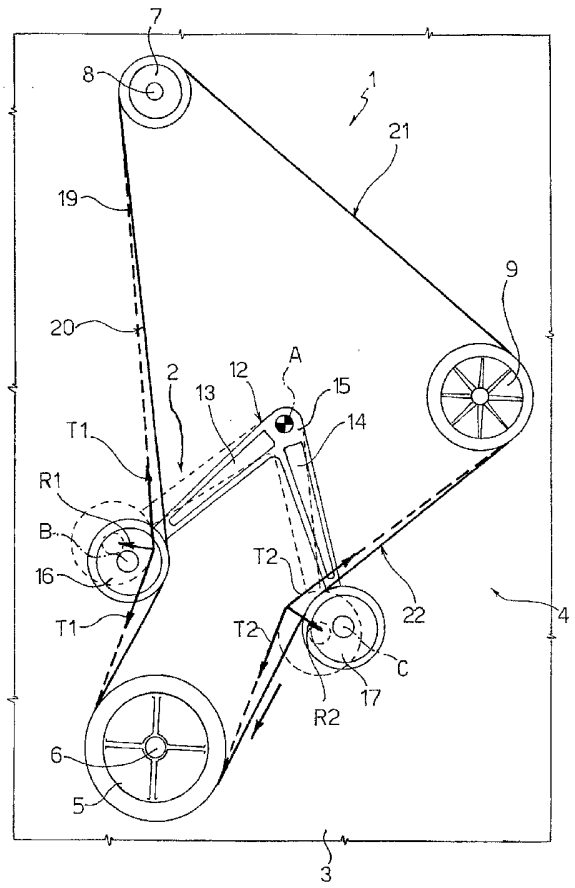
(54) Title: A TENSIONER FOR A DRIVE BELT OF A MOTOR VEHICLE



(57) Abstract: A tensioner (2, 50, 53, 58, 66) for a belt (19) of a drive (1) for a motor vehicle, comprises at least two idler pulleys (16, 17), which can turn about respective axes (B, C) and are designed to co-operate with respective branches (20, 22) of the belt (19), said tensioner comprising a connection device (12), which constrains the idler pulleys (16, 17) to one another so that one of the pulleys, for example (16), is displaced in a way dependent upon the displacement of another (17) of the pulleys, and so that, starting from a resting position, in which the tension is substantially uniform along the belt (19), a displacement of the idler pulleys (16, 17) tends to produce a lengthening of the belt (19).

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A TENSIONER FOR A DRIVE BELT OF A MOTOR VEHICLE

TECHNICAL FIELD

The present invention relates to a tensioner for a belt drive, particularly for an internal-combustion engine, to which reference will be made in what follows for greater clarity, without this implying any loss of generality.

BACKGROUND ART

As is known, the internal-combustion engine of a motor vehicle is connected by means of a belt drive to one or more auxiliary devices, such as for example a current generator and a compressor of a conditioning system.

In order to ensure a minimum tension of the belt sufficient for transmitting the torque required in each operating condition, there is normally envisaged the use of a spring-operated tensioner that provides an initial pre-tensioning of the belt.

In greater detail, the tensioner acts on the slack branch of the belt, the tension of which tends to decrease progressively as the transmitted torque increases; moreover, the length of the belt increases with the life of the belt itself. The value of pre-tensioning is calculated so as to ensure that the slack branch of the belt will maintain a minimum value of tension in every condition of operation throughout the useful working life of the belt.

A high pre-tensioning value increases the transmissible torque but also increases the stresses of the belt and of the other components of the drive, in particular the bearings of the shafts, even in operating conditions in which this would not be necessary, for example at low values of transmitted torque.

DISCLOSURE OF INVENTION

A purpose of the present invention is to provide a tensioner for a belt drive which will enable a solution of the problems linked to known tensioners, as specified above.

There are moreover known so-called "start-stop" systems, in which a reversible electrical machine of the motor-alternator type is able to operate both as electrical generator driven by the internal-combustion engine and as starting motor that drives the internal-combustion engine. During operation of the drive according to these two modalities, the torque that stresses the drive changes sign, and consequently the tensioned branch and the slack branch of the belt are reversed. In drives of the type described above, the tensioning of the belt is entrusted to a two-arm tensioner designed to co-operate simultaneously with two distinct branches of the belt.

There are known two-arm tensioners that comprise a pair of substantially rectilinear arms having a first end pivoted on a common axis set inside or outside the closed path of the belt, and a second end carrying an idler pulley, which co-operates with the back of the belt itself. Known two-arm tensioners further comprise a spring that acts by causing the arms to approach one another and by exerting a tensioning force on the belt.

In addition to what has been described with reference to conventional single-arm tensioners, known two-arm tensioners present further drawbacks, such as a relative structural complexity, the high costs, and the critical nature of sizing of the spring, which is subject to conditions of operation that can vary within a far wider range of values.

A further purpose of the present invention is to provide a tensioner suitable for a drive for a "start-stop" system that

will be free from the drawbacks described above. The purposes of the present invention are achieved thanks to a tensioner for a belt drive as defined in Claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention there is now described a preferred embodiment, purely by way of non-limiting example and with reference to the annexed drawings, in which:

- Figure 1 illustrates a front view of a belt drive for an internal-combustion engine, which comprises a tensioner according to a first embodiment of the invention, in two positions of operation; and
- Figures 2, 3, 4 and 5 are schematic illustrations of drives provided with respective tensioners made according to different embodiments of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

In Figure 1, designated as a whole by 1 is a belt drive for an internal-combustion engine 4 of a motor vehicle, comprising: a two-arm tensioner 2 hinged on an external wall 3 of the engine 4; a first pulley 5 connected to the engine shaft 6 of the engine 4 and set on the external wall 3; a second pulley 7 carried by an output shaft 8 of a motor-alternator (not illustrated); and a third pulley 9 for driving an accessory (not illustrated either), for example a compressor of a conditioning system.

The tensioner 2 comprises a rigid fork 12 of a substantially triangular shape, having two rectilinear arms 13, 14 diverging from a connection portion 15, and a pair of idler pulleys 16, 17, carried by free ends 18 and 19 of the arms 13, 14.

Finally, the drive 1 comprises a belt 19, for example of a poly-V type, which runs over the pulleys 5, 7 and 9 and passes between the idler pulleys 16, 17 to form a closed path having

a first branch 20 comprised between the first pulley 5 and the second pulley 7, a second branch 21 comprised between the second pulley 7 and the third pulley 9, and a third branch 22 comprised between the third pulley 9 and the first pulley 5.

According to an important characteristic of the present invention, the idler pulleys 16, 17, carried by the respective arms 13, 14 fixed to one another and hinged to the wall 3 of the engine 4, are fixedly mobile about the axis A in such a way as to increase the tension of the belt starting from a resting position, as will be described in greater detail in what follows.

Operation of the tensioner 2 is described in what follows.

In use, the angular position of the tensioner 2 is determined by the condition of equilibrium to rotation about the axis A of the resultants R1, R2 of the tensile forces T1, T2 exerted by the branches 20, 22 on the pulleys 16, 17 and, hence, on the respective arms 13, 14 of the fork 12. The said resultants R1, R2 are proportional to the respective tensions T1, T2 of the branches and are correlated to the angles of winding of the belt 19 around the respective pulleys 16, 17.

In conditions of zero transmitted torque, and in particular with the engine turned off, the tension on the belt 19 is uniform on all the branches (T1 = T2), and the tensioner 2 is in the resting position illustrated by a dashed line in Figure 1.

Given the direction of rotation of the engine shaft 6, in a clockwise direction, as viewed in Figure 1, in the presence of a torque transmitted from the engine 4 to the motor-alternator and (or) to the accessory, the tension of the belt 19 in the branch 22 (tensioned branch) becomes greater than the tension in the branch 20 (slack branch). This difference between the

tension in the branch 20 and the tension in the branch 22 determines a rotation of the tensioner 2 towards the tensioned branch, until a new position of (dynamic) equilibrium is reached, in which the resultants of the tensile forces are again balanced.

According to the present invention, the tensioner 2 is mounted in such a way that any departure from the resting position tends to produce a lengthening of the belt. Consequently, it is clear that the rotation imposed on the tensioner 2 by the difference in tension existing between the two branches 20, 22 tends to lengthen the belt 19 and to produce a consequent increase in the (mean) tension as a result of elastic reaction.

The above description corresponds to normal operation of the drive when the vehicle is travelling.

The tensioner 2 operates in a similar way also in the engine-starting transients, when the motor-alternator operates as an electrical motor and drives the internal-combustion engine 4. In this case, the direction of the torque is reversed, i.e., the branch 20 becomes the tensioned branch and the branch 22 becomes the slack branch, and the tensioner 2 rotates in the opposite direction (i.e., towards the tensioned branch 20), also in this case producing an increase in of the mean tension of the belt.

From an examination of the characteristics of the tensioner 2 built according to the present invention, the advantages that it makes possible emerge clearly.

Since the idler pulleys 16, 17 move in a mutually dependent way and with a law of motion determined in such a way that the length of the belt tends to increase as the tensioner 2 departs from the resting position (in the example illustrated,

the two pulleys 16, 17 are carried by a common rigid supporting structure), the tensioner determines a functional relation between the transmitted torque and the tension of the belt 19, enabling transmission of high torques starting from initial low tensions of the belt 19. In particular, the tensioner sets the belt in tension as the transmitted torque increases, enabling stressing of the components of the drive in a way proportional to the load and exclusively for the time necessary.

It is moreover interesting to note how the increase in tension due to elastic reaction to the lengthening of the belt corresponds functionally to the action on the slack branch of a traditional spring tensioner, preventing, however, the continuous tensioning characteristic of traditional tensioners.

Finally, the tensioner 2 is constructively simple, with contained production costs, and does not present any problems of installation.

In general, the aforesaid functional relation between the transmitted torque and the tension of the belt depends upon the geometrical characteristics of the drive and of the tensioner and can be obtained also by means of other constructional arrangements, in which the pulleys are not fixed together or else do not rotate with respect to a common axis.

Described in what follows are some further examples of tensioners with reference to Figures 2 to 5, which illustrate, for reasons of simplicity, idealized belt drives, with just two pulleys 5, 7.

With reference to Figure 2, the tensioner, designated as a whole by 50, comprises a rigid supporting structure 51, guided

so as to translate linearly substantially along a straight line passing through the axes of the idler pulleys 16, 17 perpendicular to a plane P containing the axes of the pulleys 5, 7. In the absence of torque, the drive sets itself in a resting condition, in which the tensions in the branches of the belt 19 are equal to one another, and the idler pulleys 16, 17 are set on opposite sides symmetrically with respect to the plane P. Also in this case, any departure from the resting position described, brought about by the application of a torque in one of the pulleys 5, 7 in turn determines an increase in the tension of the belt 19.

Figure 3 illustrates a further embodiment of a tensioner, designated by 53, in which the supporting structure 54 is not rigid, but of an articulated type. In particular, the supporting structure 54 comprises a first arm 55, hinged to a fixed axis D, in the example illustrated external to the path of the belt 19 but not necessarily, which carries at an one end opposite thereof one (16) of the idler pulleys 16, 17. A second arm 57 is hinged to the first arm 55 in an intermediate area of the latter, and in turn carries, at one free end thereof, the other idler pulley 17. In this case, the tensioner 53 sets itself always in a position of equilibrium, in which the second arm 57 is directed along the bisector of the arc of winding of the belt 19 on the pulley 17. Consequently, the displacements of the idler pulleys 16, 17 are mutually dependent and, as the torque increases, the displacement imposed by the increase in the tension of the belt 19 on the pulley 17, towards the outside of the path of the belt 19, is transmitted from the second arm 57 to the first arm 55 and "amplified" by the latter. The displacement of the pulley 16 towards the inside of the path of the belt 19, is consequently greater, thus accentuating the effect of tensioning of the belt 19 as the transmitted torque increases.

Illustrated in Figure 4 is a tensioner 58 with a rigid T-shaped supporting structure 59, formed by a stem 60 hinged, at one end, about an adjustable axis A, as will be described in greater detail in what follows, and by a pair of arms 61, which are rigidly constrained to a free end of the stem itself, extend in cantilever fashion on opposite sides of the latter, and carry the idler pulleys 16, 17 at their own opposite ends. The axis A is conveniently defined by a pin 61 carried eccentrically by a bushing 62, which can rotate about a fixed axis E, which may in turn be fixed in an angular position as desired, for example by means of an axial screw 63.

According to the present invention, the tensioner 58 operates with a minimum tension of the belt 19 at rest. However, this tension could decrease until it goes to zero following upon a permanent lengthening of the belt 19 during its life and thus cause sliding under load. In order to prevent this drawback, there may be provided a return spring 64 acting on the stem 60. This spring, illustrated only schematically in the figure, has the mere function of ensuring a minimum tension at rest even in the presence of the aforesaid permanent elongations. It should be emphasized that the elastic action required of this spring is in any case much smaller than that of springs of traditional tensioners, which must ensure tensioning on the slack branch not only at rest, but also during operation, and hence its sizing is much less critical.

A further advantage connected with the use of the return spring 64 is represented by the fact that the tensioner, following upon lengthening of the belt and in the presence of dynamic oscillations, maintains a mean position away from the initial resting position, which, being characterized by the minimum value of tension of the belt 19, is subject to the risks of sliding described above.

Finally, Figure 5 illustrates a tensioner 66 similar to that of Figure 2, in which, however, the rigid supporting structure 51 forms one of the sides of an articulated quadrilateral and is guided in its own motion, in which the idler pulleys 16, 17 remain equidistant from one another, by a pair of oscillating arms 67.

Finally, it is clear that modifications and variations may be made to the tensioners described herein, without thereby departing from the sphere of protection of the present invention, as defined in the annexed claims.

The tensioner can also be provided with a device for adjustment of the relative position between the idler pulleys 16, 17 in such a way as to be able to adjust the tension of the belt 19 at rest.

For example, in the embodiment according to Figure 1, the arms can be hinged independently to the axis A and present clamping means for connecting them rigidly together in an adjustable relative position.

In the embodiment of Figure 2, the distance between the idler pulleys 16, 17 could be easily adjusted, for instance by means of an external thread-internal thread device.

In addition, means may be envisaged for damping the movement of the tensioner in order to improve the stability of operation under dynamic conditions.

CLAIMS

1. A tensioner (2) for a belt (19) of a drive (1) of a motor vehicle, comprising at least two idler pulleys (16, 17), which can turn about respective axes (B, C) and are designed to co-operate with respective branches (20, 22) of said belt (19), said tensioner being characterized in that it comprises a connection device (12), which constrains said idler pulleys (16, 17) to one another so that one of said pulleys, for example (16), is displaced in a way dependent upon the displacement of another of said pulleys (17), and that, starting from a resting position in which the tension is substantially uniform along said belt (19), a displacement of said idler pulleys (16, 17) tends to produce a lengthening of said belt (19).

2. The tensioner according to Claim 1, characterized in that said connection device (12) comprises at least two arms (13, 14; 55, 57; 61), which are functionally connected to one another and support the respective said idler pulleys (16, 17).

3. The tensioner according to Claim 2, characterized in that at least one of said arms (13, 14; 55) is hinged about a fixed axis (A, D).

4. The tensioner according to Claim 2 or Claim 3, characterized in that said arms (13, 14; 61) are connected to one another in a rigid way.

5. The tensioner according to Claim 3 or Claim 4, characterized in that one of said arms (57) is hinged to the other of said arms (55).

6. The tensioner according to Claim 1, characterized in that said pulleys are carried by a rigid supporting structure (12,

51, 54, 61).

7. The tensioner according to Claim 6, characterized in that it comprises means of constraint for constraining said rigid supporting structure (51) in a slidable way to a fixed wall.

8. The tensioner according to Claim 6, characterized in that said rigid supporting structure (51; 61) is carried by at least one arm (60; 67) hinged about at least one fixed axis (A).

9. The tensioner according to Claim 6, characterized in that said connection device is an articulated quadrilateral of which said rigid supporting structure (51) forms one side.

10. The tensioner according to any one of the preceding claims, characterized in that it comprises adjustment means for adjusting the tension of the belt (19) in a resting condition.

11. The tensioner according to Claim 10, characterized in that said adjustment means comprise adjustment means for varying the relative position of said idler pulleys (16, 17).

12. The tensioner according to Claim 10 or Claim 11, characterized in that said adjustment means comprise adjustment means for varying the conditions of constraint of said connection device (12, 51, 54, 59).

13. The tensioner according to any one of the preceding claims, characterized in that it comprises elastic means (64) acting on said connection device (12, 51, 54, 59) for forcing at least one of said idler pulleys (16, 17) towards said belt (19) and compensating any permanent elongation of the belt itself.

14. The tensioner according to any one of the preceding claims, characterized in that it comprises damping means for damping the movement of said connection device (12, 51, 54, 59) in response to dynamic variations of load.

15. A belt drive comprising at least one first pulley (5), one second pulley (7) and a drive belt (19) co-operating with said first and second pulleys (5, 7), characterized in that it comprises a tensioner (2, 50, 53, 58, 66) according to any one of the preceding claims.

16. The drive according to Claim 12 for an internal-combustion engine provided with a start-stop system which uses a reversible electrical machine operating selectively as electric motor and as electrical generator, said drive being characterized in that said first and second pulleys (5, 7) are connected, respectively, to an engine shaft (6) of the internal-combustion engine (4) and to a shaft (8) of said reversible electrical machine.

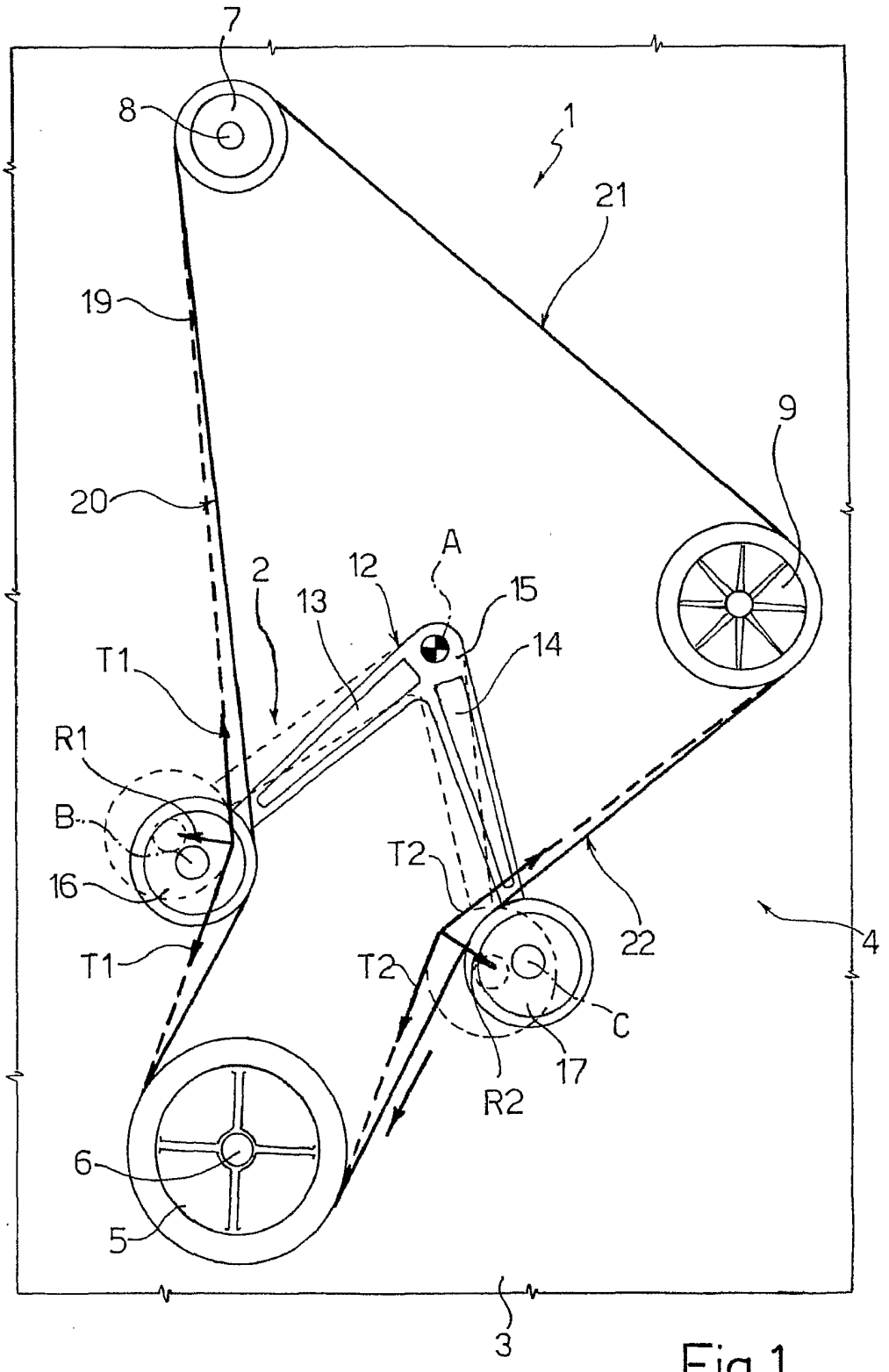

Fig.1

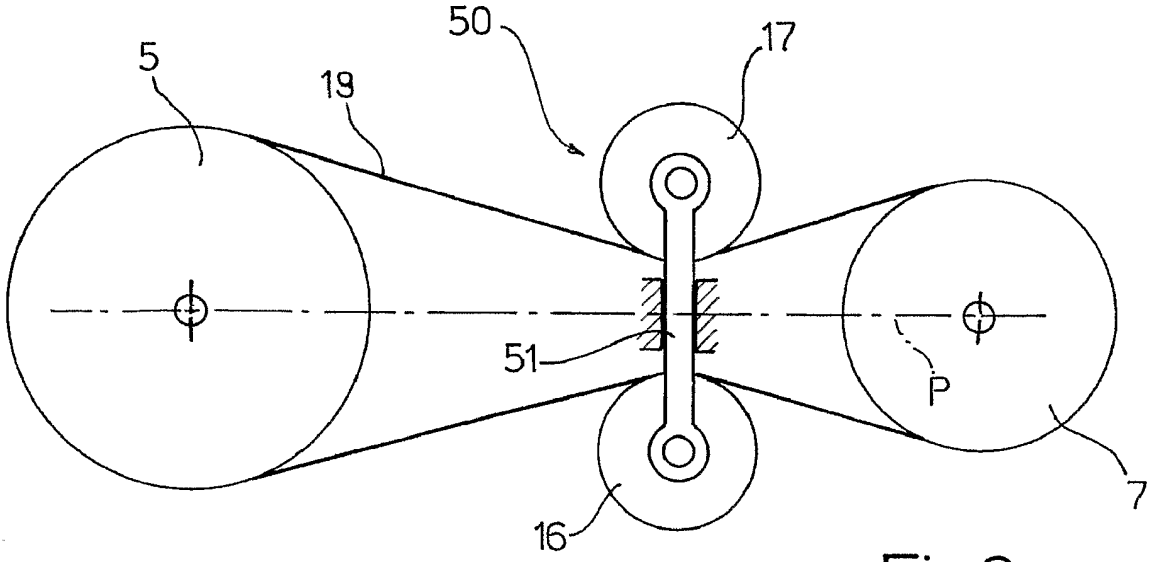

Fig.2

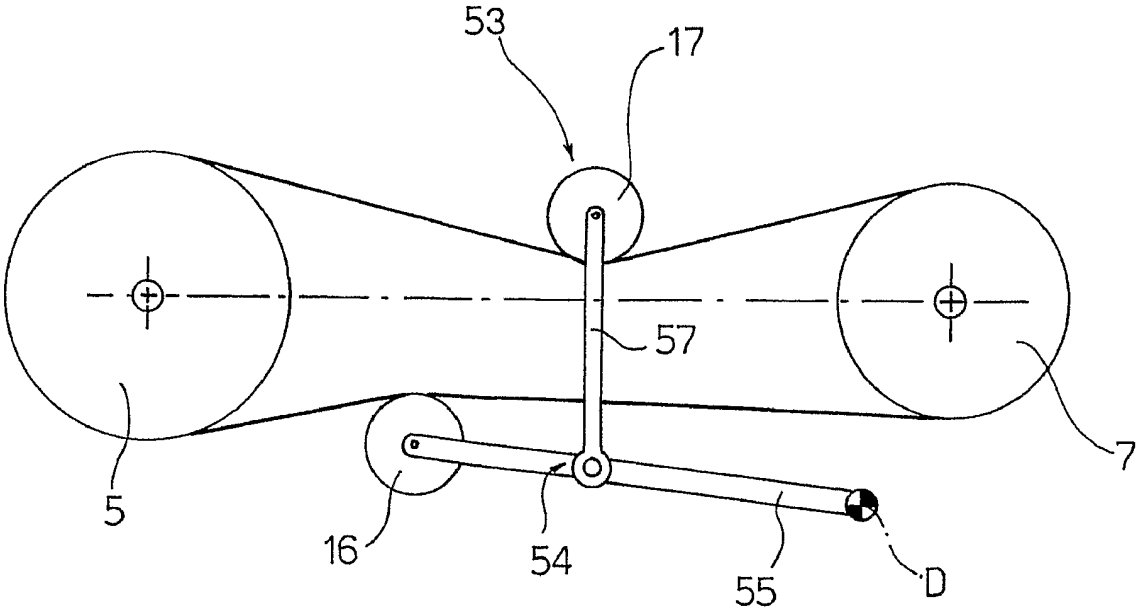

Fig.3

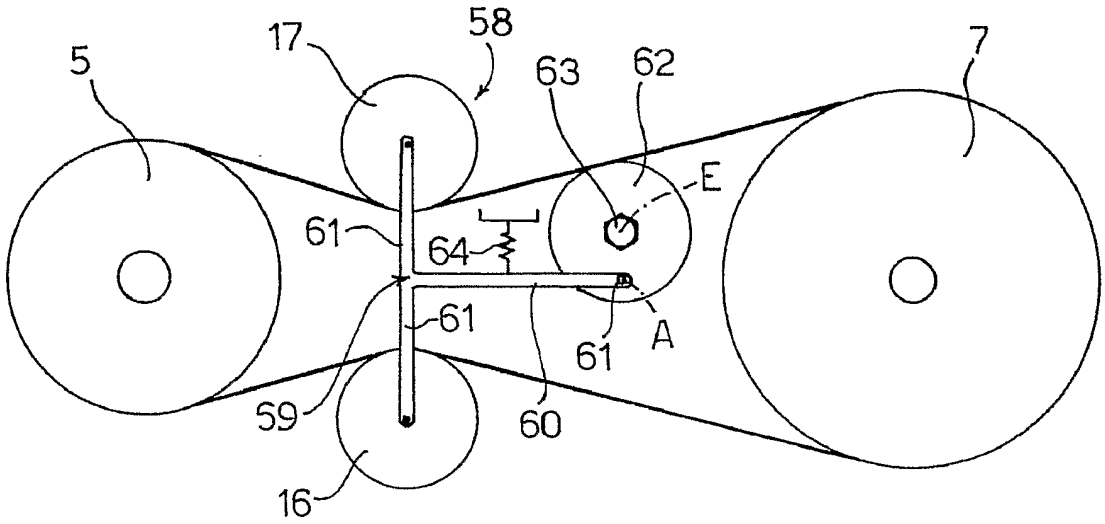

Fig.4

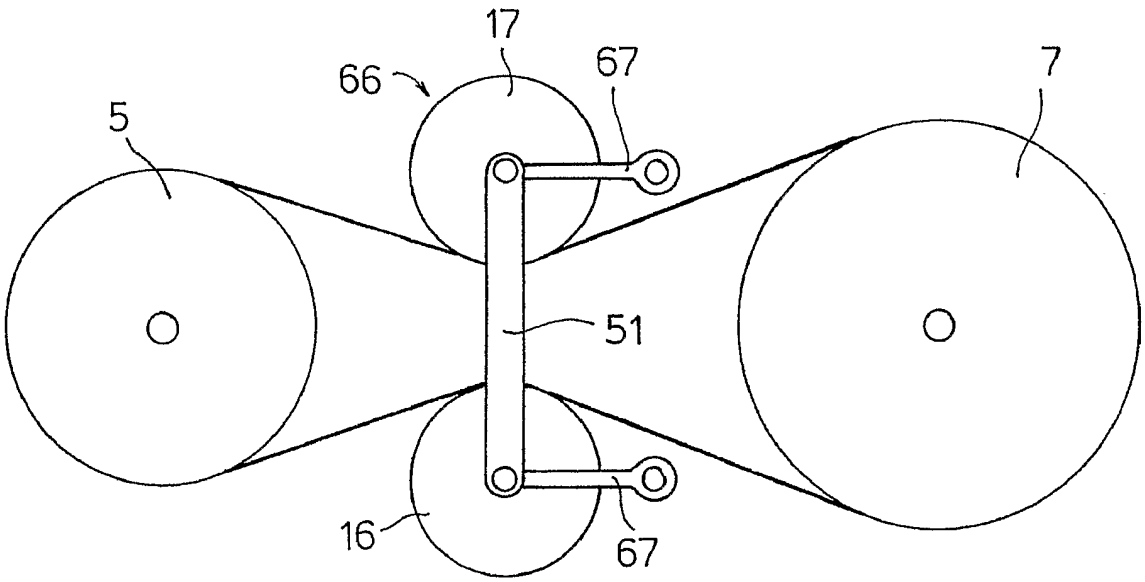

Fig.5

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16H7/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	page 3, line 30 - line 34	5,7-12
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Y	US 1 016 787 A (JAMES H. SEWALL) 6 February 1912 (1912-02-06) figures	8

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 November 2004	30/11/2004

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