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(72) Inventors:
• **Lopez Gomez, Jose Luis**
28230 Las Rozas, Madrid (ES)
• **Frutos Aguado, Julio**
28230 Las Rozas, Madrid (ES)

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(74) Representative: **Elzaburu, Alberto de et al**
Elzaburu S.A.
Miguel Angel, 21
28010 Madrid (ES)

(71) Applicant: **PATENTES TALGO, S.A.**
28230 Las Rozas (Madrid) (ES)

(54) **System for optimizing the steering of railway axes**

(57) A system for optimizing the automatic steering of a wheelset (1) with independent wheels (4) in which a rolling parameter of each of said wheels is continuously sensed, with the parameters detected on the two wheels of a single wheelset being continuously compared and with the steering of said wheelset being controlled, in response to variations detected in said relationship, by means of actuating mechanisms (15) to

change the position of, at least, one steering bar (13) on said wheelset. Preferably, said parameter sensed is the speed of rotation of each wheel (4) and steering is performed using means that act upon at least one of the steering bars (9,13) of said wheelset (1) in response to variations in the result of said continuous comparison in relation to a pre-set benchmark that is based on the radii of each of said wheels (4) and their speed of rotation at a particular time.

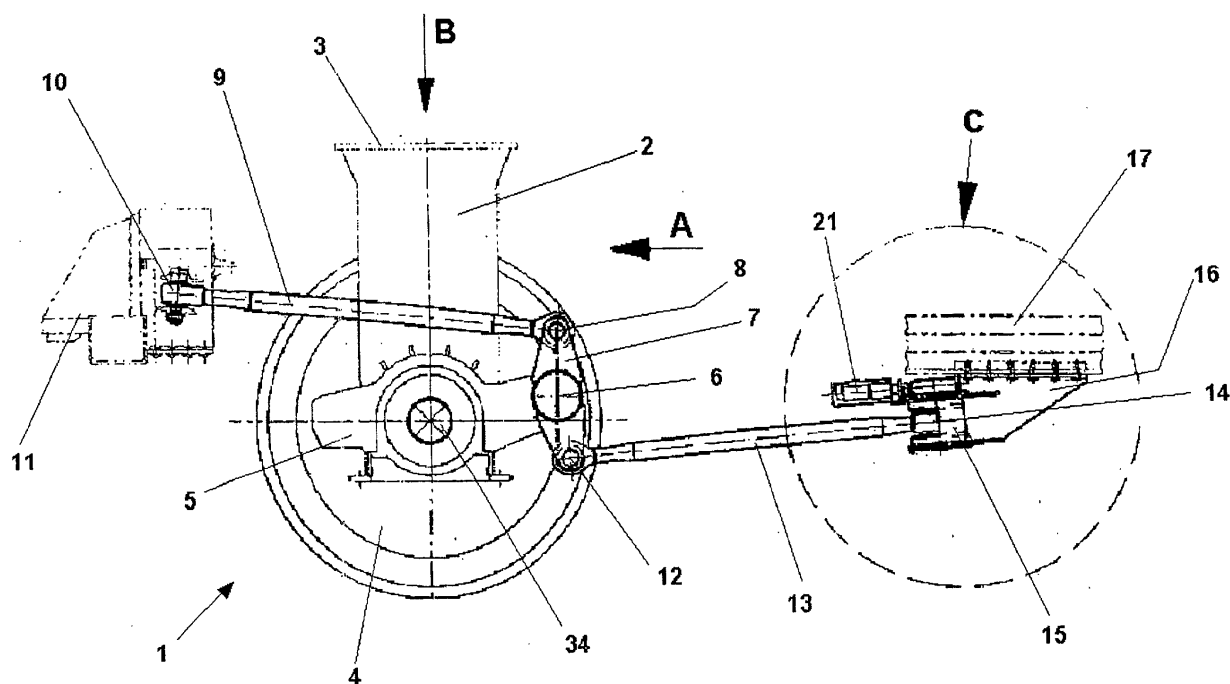


Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention relates to the steering of axles of railway rolling stock and, in particular, to the active steering of single-axle wheelsets with independent wheels.

[0002] In particular, the invention applies especially to the TALGO ® type wheelsets of variable width or others of similar design.

[0003] More particularly, the invention is applicable to wheelsets of the aforementioned classes, designed to be fitted on railway vehicles that have to form part of formations for high-speed travel.

BACKGROUND OF THE INVENTION

[0004] As is already known, rail/track assemblies are inherently subject to damage caused by rolling contact and adhesion between the wheel and the rail. This damage typically manifests itself as wear on the wheels and rails and incipient and extended cracks on the latter.

[0005] Consequently, vehicle/track interaction and optimization of the wheel/track interface have been given increasing amounts of attention over the last few years, with the realization that the contact area between the wheel and the track constitutes a variable interface that is subject to changes which involve numerous parameters with complex interactions.

[0006] The development of an optimized wheel/rail interface, together with an effective management programme for friction, allows contact stresses and deflecting forces, which are, in turn, responsible for fatigue and wear, lateral and longitudinal forces, deformation, noise and, ultimately, the stability of wheelsets, to be controlled to some extent.

[0007] Contrary to general belief, in an optimized relationship between a wheel and the rail, the flange must not touch the rail, since it solely constitutes a final recourse to prevent derailment of the wheel; in other words, the flange is a safety feature.

[0008] When negotiating a bend, the outer wheel of a wheelset obviously has to travel a greater distance than the inner one. This fact, combined with the lateral forces that occur during the movement round a bend and the fact that the wheels of a railway vehicle sit on top of the rail without any steering whatsoever apart from that derived from the shape of the wheel tread in relation to the rail head, means that the inherent reaction of the wheelset is to tend to move laterally relative to the rail track, so that on the outer rail on the bend the corresponding wheel revolves at its largest radius, in other words with its circumference located more towards the inside of the wheel tread, in contact with the track. For its part, the inner wheel revolves with the outer edge of its wheel tread in order to reduce the distance travelled during the movement round the bend.

[0009] The immediate consequence of this displacement of the wheelset in a radial direction towards the outside of the bend is that the flange of the outer wheel comes into contact with the rail if the movement of the wheelset on the bend is not in exact correspondence with the geometry of the track. When said contact takes place, an unpleasant noise is produced as well as, naturally, the associated wear. If this is considered in the context of the fact that the invention has a particular application - high-speed travel - it is obvious that consequences may be significant and lead to serious damage.

[0010] A very primitive technique for improving the wheel/rail interaction consisted in using lubricants on the flange or rail, for example, using devices fitted on the track or on the vehicle itself. This method, of course, does not solve the problems that arise in the technical field to which the invention belongs and, furthermore, poses numerous disadvantages since it is difficult to apply the correct amount of said lubricant, with consequent fouling of the wheel tread and/or rail that makes the wheel slip and causes flattened areas on its tread to form.

[0011] Another, more recent, known approach, for example, based on the applicant's document WO 98/28176, comprises the incorporation of a steering system for single-axle wheelsets with movable wheels, designed to ensure that the angle formed by the flange of each wheel with the tangent on a bend in the track is zero at the point of contact with the latter. This steering system comprises steering rocker arms on the carrying frame of the wheelset and steering bars, arranged on either side of the vehicle, secured at one of their ends to said rocker arms and attached by their other ends (in the case of an end wheelset in the above document) to the respective adjacent ends of the rolling stock that shares the single-axle wheelset. The description in that document is incorporated herein as a reference.

[0012] This solution, of which various versions are found in the patent bibliography and which in said document WO 98/28176 is indicated as being applicable to platform wagons for the transport of motor vehicles designed to form part of formations that travel at high speeds, for example at some 200 km/h, satisfies the principle that the rail must not steer the train but rather that the train must move on top of the rail, and is based on the interaction of the frames of railway vehicles on top of their single-axle wheelsets, with movable wheels of the type indicated above, so that the relative moment of said frames directs the wheelsets appropriately in order to meet the requirement indicated above for automatic steering of axles at a zero angle, i.e. so that the flanges of the wheels always remain parallel to the track, including when going round a bend, in order to increase operating safety and to reduce wear on both the wheels and the track.

[0013] This type of steering of wheelsets controlled by the relative position of the bodies or frames of coupled railway vehicles or of an articulated vehicle makes

wheelsets that exert very little force on rails a possibility, and also provides a high degree of safety and good stability while at the same time allowing the traditional "hunting" that causes low level wear of wheels and rails to be eliminated.

[0014] However, bearing in mind the construction of the aforementioned steering system, based on bars, which in some cases, have to transmit longitudinal movements over significant distances, and the particular nature of the system in accordance with which it is the relative position of the frames of coupled vehicles (of large dimensions and high inertia forces) that controls the steering of the wheelset relative to the track, without taking account of the rolling circumstances of the basic element of the wheel/rail interface, means that it does not possess a sufficiently high degree of precision. This lack of precision is much more acute when the use of this system is extended to wheelsets designed to be fitted on high-speed (of the order of 300 km/h) formations.

SUMMARY OF THE INVENTION

[0015] The subject of the present invention, therefore, is a system for increasing the precision of the automatic steering of the wheels in a wheelset with independent wheels of the class indicated in the preamble to this description, which obviates the defects exhibited by steering systems of the prior art.

[0016] The novelty of the invention resides in the fact that, in order to obtain said optimization, a rolling parameter from each of the wheels in a single-axle wheelset of the type to which the invention relates is continuously sensed, with the parameters detected on the two independent wheels on a single wheelset being continuously compared and with the steering of said wheelset being controlled, in response to variations detected in said relationship, by means of actuating mechanisms that operate in order to change the position of, at least, one of the steering bars on said wheelset, with all the foregoing being according to the characterizing part of Claim 1 attached.

[0017] Preferably, said rolling parameter that is measured and compared, according to the preferred embodiment of the present invention, is the speed of rotation of each independent wheel of said single-axle wheelset and the steering of the latter is performed by means of actuating means that operate on at least one of the steering bars of said wheelset, in response to variations in the result of said continuous comparison in relation to a predetermined benchmark based on the radii of each of said wheels of the wheelset and of the speed of rotation of each one at a particular time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention is described hereafter with reference to the attached drawings in which a preferred

embodiment of the invention incorporated on a wheelset of independent and movable wheels is shown for purely illustrative purposes, in which:

- 5 Fig. 1 is an end view in diagrammatic form of a wheelset of the aforementioned class, which incorporates the system according to the invention;
- Fig. 2 is a diagrammatic view of the wheelset steered according to the present invention, seen along arrow A of Fig 1;
- 10 Fig. 3 is a diagrammatic view of the wheelset steered according to the present invention, seen along arrow B of Fig 1;
- Fig. 4 is an enlarged view that illustrates in greater detail the area surrounded by the circle C in broken lines in Fig 1;
- 15 Fig. 5 is a diagrammatic view in cross section along plane D-D' of Fig. 4; and
- 20 Fig. 6 is a diagram of the logic control system for steering according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

- 25 **[0019]** First with reference to Figs 1 to 3, in the first of these, 1 generally denotes a single-axle wheelset steered by means of the system according to invention, shown in a lateral view, with 2 indicating the carrying frame of the wheelset, in the form of a yoke (see Fig. 2), fitted with upper platforms 3 designed to hold the suspension posts (not shown) of the body or frame of a railway vehicle. On said wheelset 1 are fitted separate independent wheels 4 that can move in a direction that is transverse to the direction of travel of the railway vehicle by means of outer and inner bearings C₁, C₂ that can move and be immobilized, of a known type, for example such as are fitted on TALGO® wheelsets that can be adapted for changes in gauge.

- 30 **[0020]** Bearing in mind that said wheelset 1 and the steering system according to the invention are symmetrical with respect to the central vertical plane V-V' of the track, hereafter the invention will be described with reference solely to one half of said wheelset 1.

- 35 **[0021]** At each outer end of each short installation axle of each wheel 4 is fitted a support 5, which in this case takes the form of two essentially radial arms, on one of which arms a rocker arm 7 is pivotably fitted at 6, which rocker arm comprises, for example, two parallel plates 7', 7'' (see Fig. 2) between the top ends of which one end of a passive bar 9 for steering the wheelset is articulated at 8, the other end of which is articulated at 10 on the frame or body 11 of a first railway vehicle of the two that share said wheelset 1. In operation, and apart from the expected movements due to operation and the distance travelled by suspension systems, the position and the size of said steering bar 9 are fixed, i.e. its articulation 8 with the rocker arm 7 acts as a point of support for the latter in order to obtain the forward or back-
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ward movement of the end of the axle with which said bar 9 is coupled.

[0022] Articulated by one of its ends at 12 on the bottom arm of the rocker arm 7 there is a second steering bar 13, or active bar, which at its other end is articulated at 14, by means of a cam device 15 secured by means of brackets 16 to the frame or body 17 of a second railway vehicle, as described in detail hereafter.

[0023] With reference now to Figs 4 and 5, the first of these shows, on a larger scale, the coupling of the end 14 of the active steering bar 13 with the frame or body 17 of said second railway vehicle (not shown in this figure).

[0024] Said end 14 articulates on a cam fitted on the inside of the housing 15 secured by means of upper and lower plates 18, 19 to brackets 16 (only one of these is shown in Fig. 4) secured, for example, by means of bolts or rivets at 20 to the body or frame 17 of said second railway vehicle. A motor 21, for example, an electric motor, permanently fixed on the upper plate 18 and whose output shaft 22 transmits its rotational movement to said cam via a gear box 23, acts on the cam contained in the housing 15.

[0025] As can be seen in Fig. 14, the cam mechanism/motor assembly with which the bar 13 is coupled slopes slightly with respect to the horizontal such that the geometric axes of the cam and bar 13 form an angle that is essentially a right angle so that the movement of the latter does not subject its articulation with said cam mechanism to undue stresses.

[0026] Fig. 5, which is a cross section along plan D-D' of Fig. 4, illustrates in greater detail the cam mechanism for the installation of the active steering bar 13 on the body or frame of said second railway vehicle.

[0027] Said end 14 of said bar 13 is fitted so that it can rotate, with the intercalation of a resilient support of the usual type generally comprising external and internal bushings 24, 25 with a resilient element 26 between them, on a short shaft 27 supported in rotation in an eccentric manner by its ends 28, 29 on bearings 30, 31 housed in said upper plate 18 and lower plate 19 respectively, secured to the housing 15 of the cam by means of, for example, T bolts.

[0028] The upper end 28 of the shaft 27 whose diameter is considerably larger than the eccentric rod part of said shaft has fitted on and secured to it a toothed wheel 32 designed to engage with a worm 33 fitted on the actuating shaft 22 of the motor 21. This gear allows the rotation of the motor 21 to be converted into rotation of the cam shaft 27 on which is fitted one end 14 of the steering bar 13, which consequently moves longitudinally in either direction.

[0029] The operation of the optimized automatic steering system according to the present invention will be described hereafter with reference for this purpose also to Fig. 6 in the drawings.

[0030] Said Fig. 6 shows, in diagrammatic form, the measurement system for the outphasing of the wheels,

comprising the following elements:

- a pulse generator 34 that generates pulses whose frequency is in proportion to the speed of rotation of the wheel 4. A pulse generator is provided for each wheel and this role can be perfectly fulfilled by the detector of the antilock braking system (ABS) (not shown) with which each of the wheels 4 of a wheelset 1 of this class are usually fitted; and
- an electronic system 35 for measuring the outphasing of the wheels (SMD) that receives the pulses generated by each generator 34 and allows, based on the radii of the wheels and the pulses generated by each of the sensors of said generators 34, the benchmark for the actuating motors 21 of the active steering bars 13 to be determined, taking account of the outphasing of the pulses of each of said wheels.

[0031] In operation, when the formation moves along a straight line in normal conditions, the diameters of the circumferences of the wheel treads of the wheels 4 in contact with the rails are, normally, equal, so that the generators 34 of each of the wheels of a wheelset 1 will provide identical signals. However, when the wheelset moves out of centre relative to the track, for example when entering a bend, owing to the tapered configuration of its wheel treads (with a taper, for example, of 5%) one of them, usually the outer one on the bend, will rotate more slowly than the other one with result that the system will react by sending a signal to the motor 21 on the same side as that wheel 4 to cause a displacement of the steering bar 13, which, when there is action on the rocker arm 7, will move forward to the wheel that is rotating more slowly or to the other of the motors 21 in order to ensure that the wheel that is rotating more quickly is slowed so that the wheels 4 of wheelset 1 return to their ideal positions relative to the rails.

[0032] Persons skilled in the art will understand that modifications may be made to the above description of the currently preferred embodiment of the invention, provided solely for illustrative purposes, without departing from the scope of the present invention as defined by the content of the attached claims.

Claims

1. System for optimizing the steering of railway axles of the type that comprises a single-axle wheelset with independent wheels, which wheelset comprises:
 - a) a wheelset frame;
 - b) at least one axle comprising two independent wheel assemblies arranged co-axially opposite one another, each of which comprises a wheel fitted on a short wheel-carrying shaft supported

in rotation at its ends on individual bearing housings; and
c) a steering system for said wheelset comprising, for each end of said wheelset:

- 1) a first, passive steering bar articulated at one of its ends on the side of the frame of a first of said railway vehicles and articulated at its other end on a first arm of a rocker arm pivotably fitted on the outer bearing housing of the corresponding wheel assembly, and
- 2) a second, active steering bar articulated at a first of its ends on a second arm of said rocker arm and whose second end is connected to the side of the frame of the other of said coupled railway vehicles,

characterized in that for each end of said wheelset there are provided:

- a cam fitted in rotation on the side of the frame of said second railway vehicle, to which is connected said second end of said second, active steering bar such that the rotation of said cam in either direction causes the longitudinal displacement of said second steering bar in either direction with respect to the frame of said second railway vehicle;
- means of actuating said cam;
- signal generating means, designed to generate signals that vary according to the speed of each wheel of said wheelset; and
- monitoring means that receive said signals that vary according to the speed of the wheels of said wheel assemblies of said wheelset and are designed to selectively actuate said means of actuating said cams in order to selectively displace said second, active steering bars longitudinally.

2. System according to Claim 1, **characterized in that** said means of actuating said cam comprise a motor/worm/crown wheel assembly, with the latter being secured to said cam.
3. System according to Claim 1, **characterized in that** said means that generate signals that vary according to the speed of the wheels comprise the sensors of the antilock braking system.
4. System according to any one of the preceding claims, **characterized in that** the tilting plane of the rocker arm is essentially vertical, said first, passive steering bar being connected to the upper arm of said rocker arm and said second, active steering bar being connected to its lower arm.

5. A method for optimizing the steering of a railway axle according to any one of Claims 1 to 4 **characterized in that** it comprises the operations of:

sensing the speed of rotation of each of the wheels in said wheelset;
generating signals that vary according to said speed of rotation of each wheel;

supplying said signals to an electronic device capable of determining, based on the radii of each of the wheels and the signals received from said signal generation means, a benchmark for said actuating means for said second, active steering bars in response to the outphasing produced between the signals that vary according to the rotation speed of each wheel in the wheelset; and activating said means of actuating said cams in accordance with said benchmark for selectively causing the displacement of said second, active steering bars in a longitudinal direction in order to move each end of said wheelset forward and/or backward in order to maintain a zero angle between the rail and the flange of each wheel of said wheelset while running.

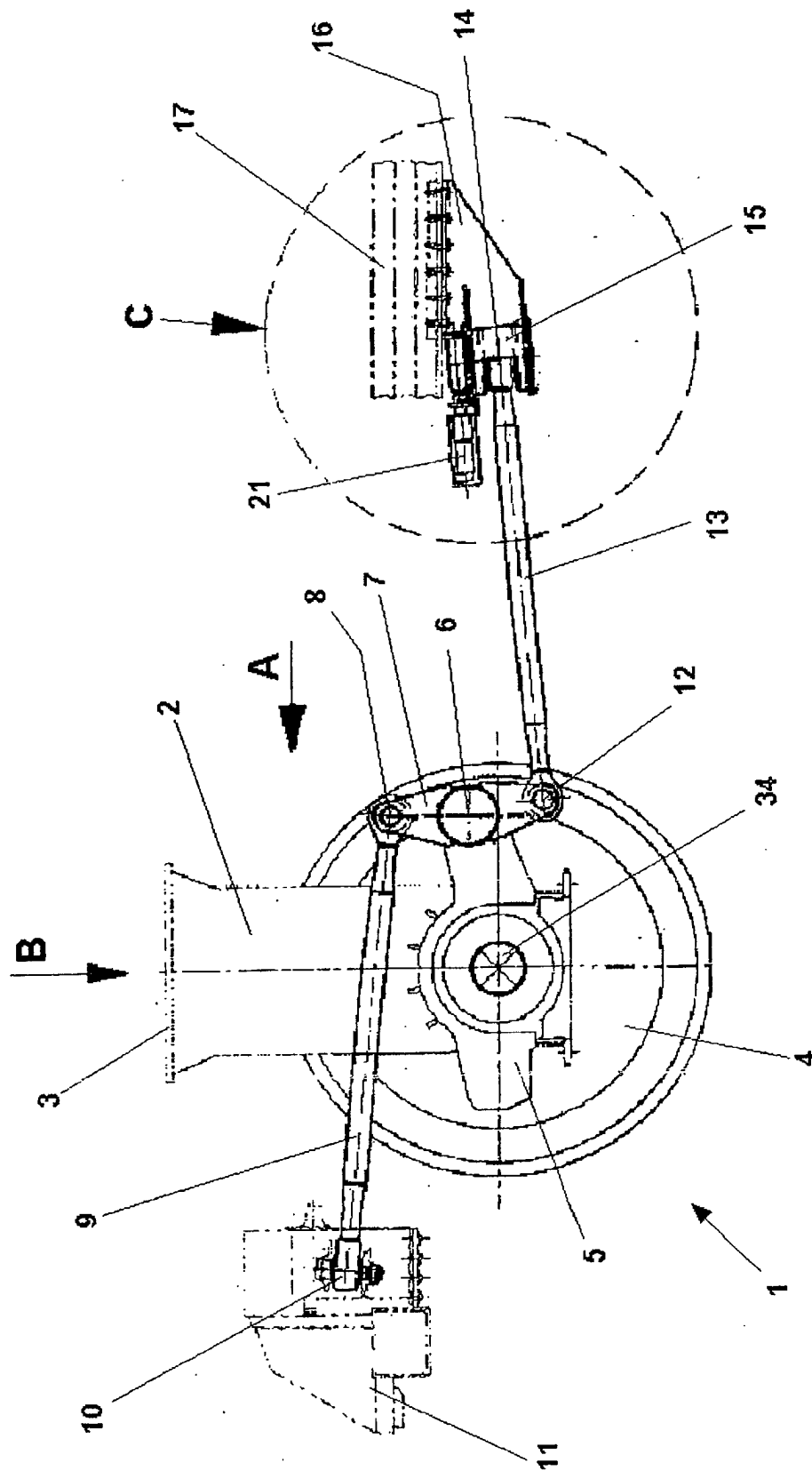


Fig. 1

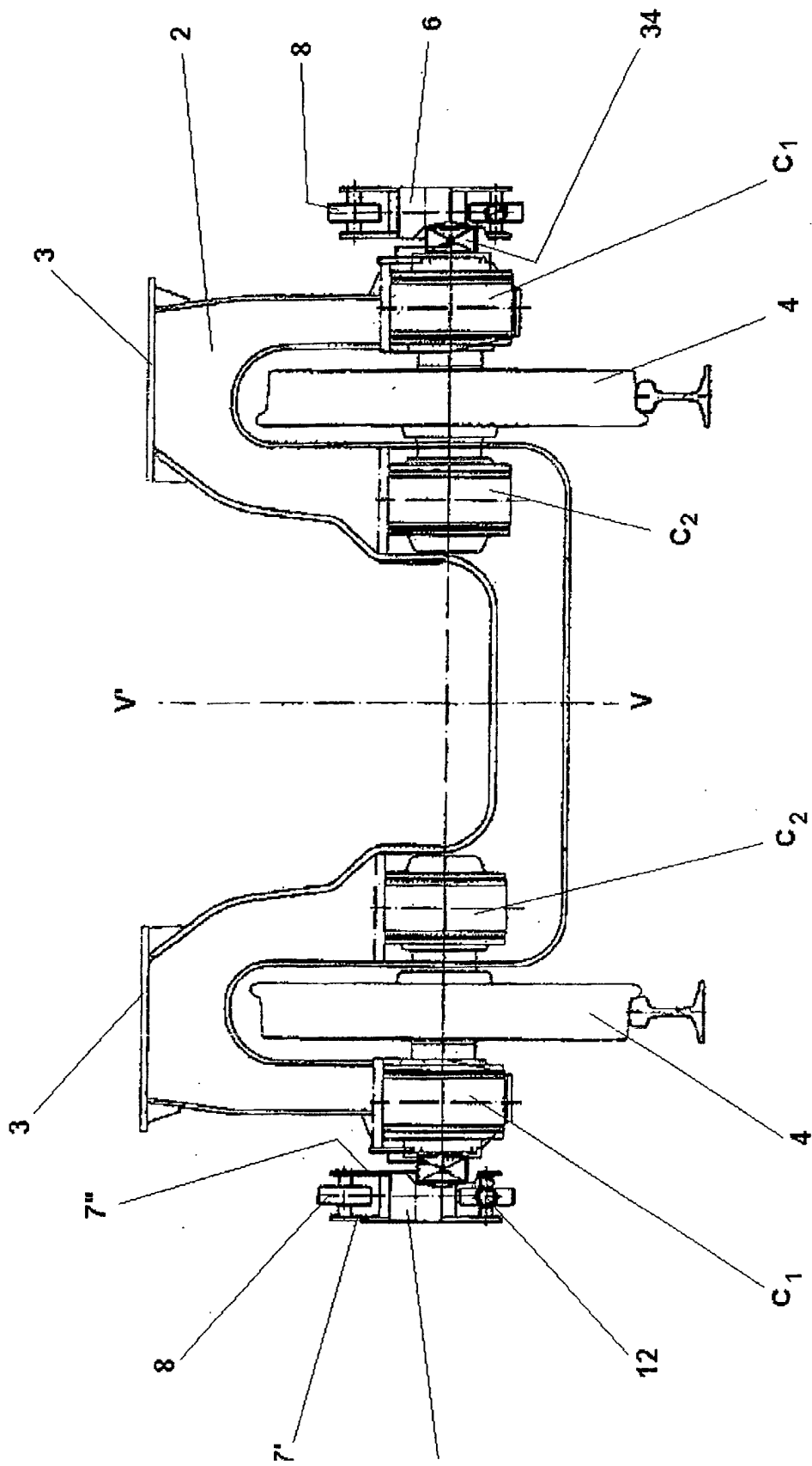


Fig. 2

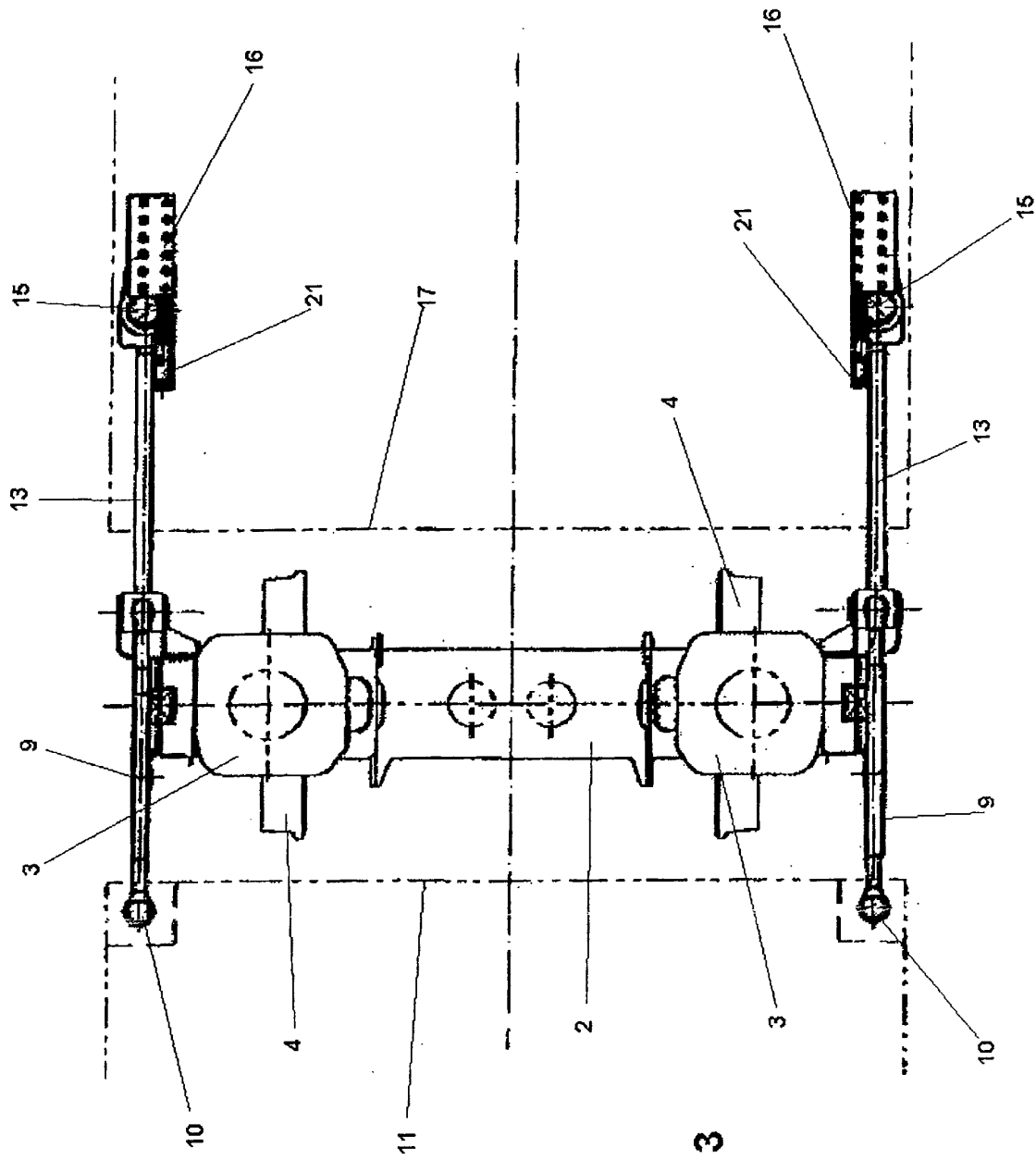
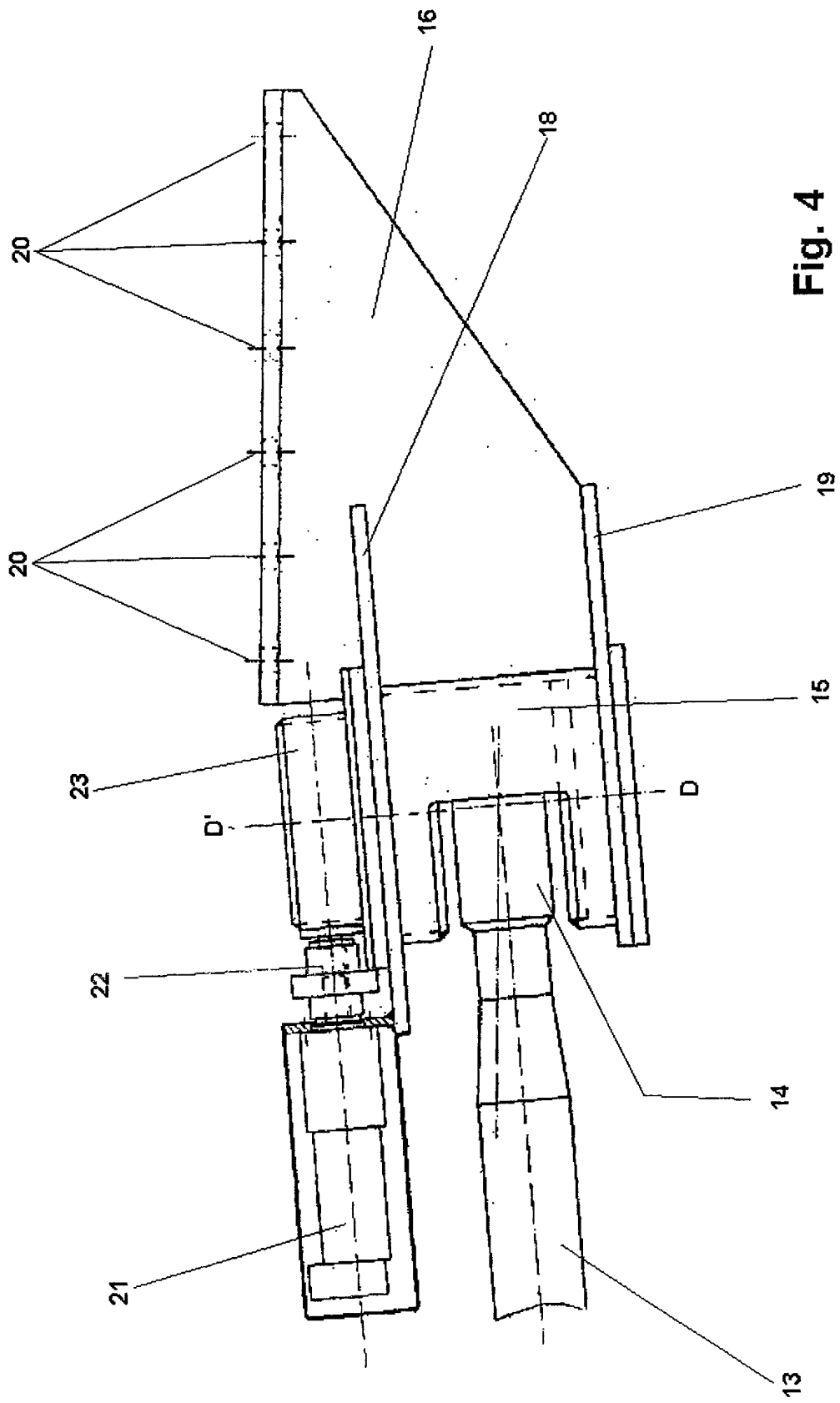


Fig. 3



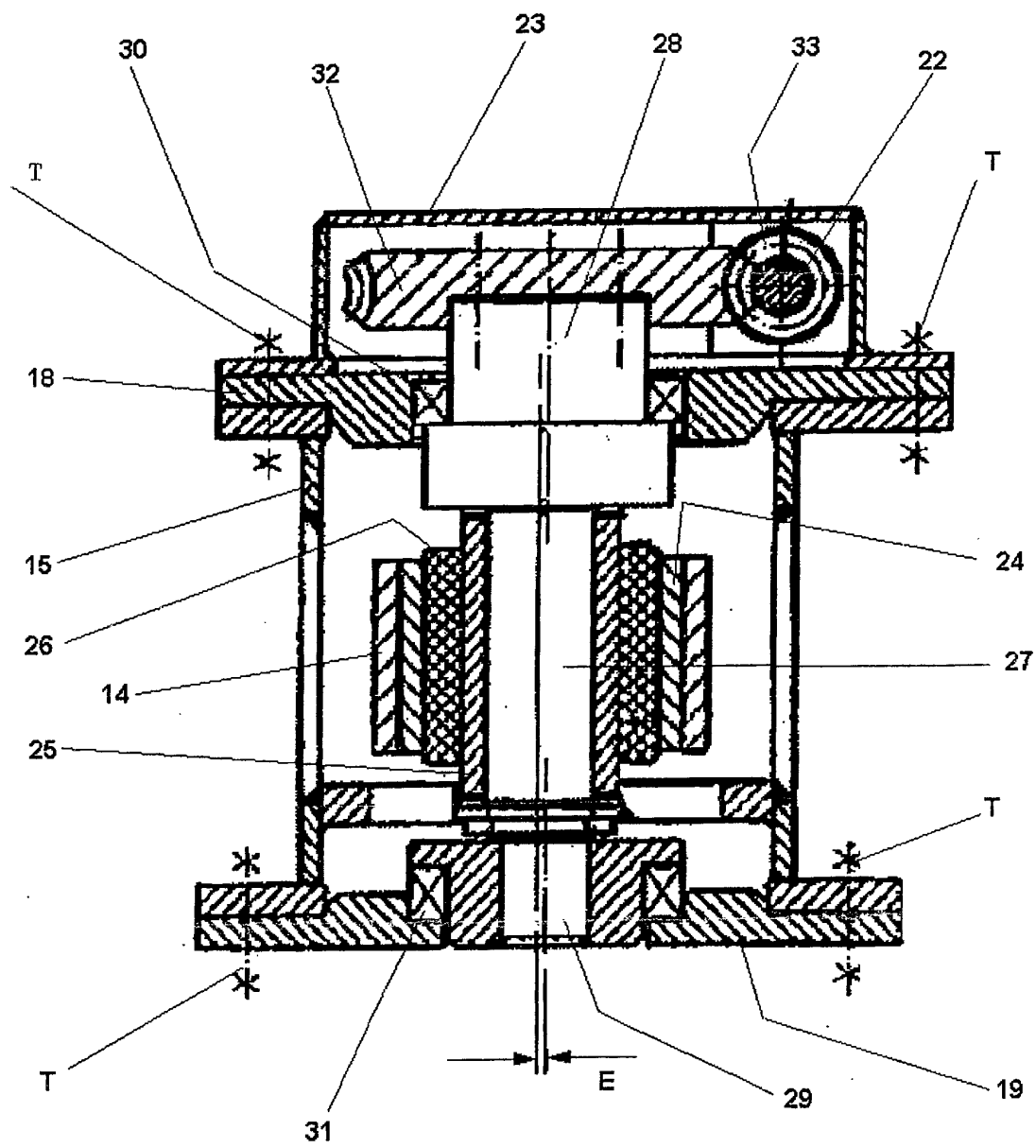


Fig. 5

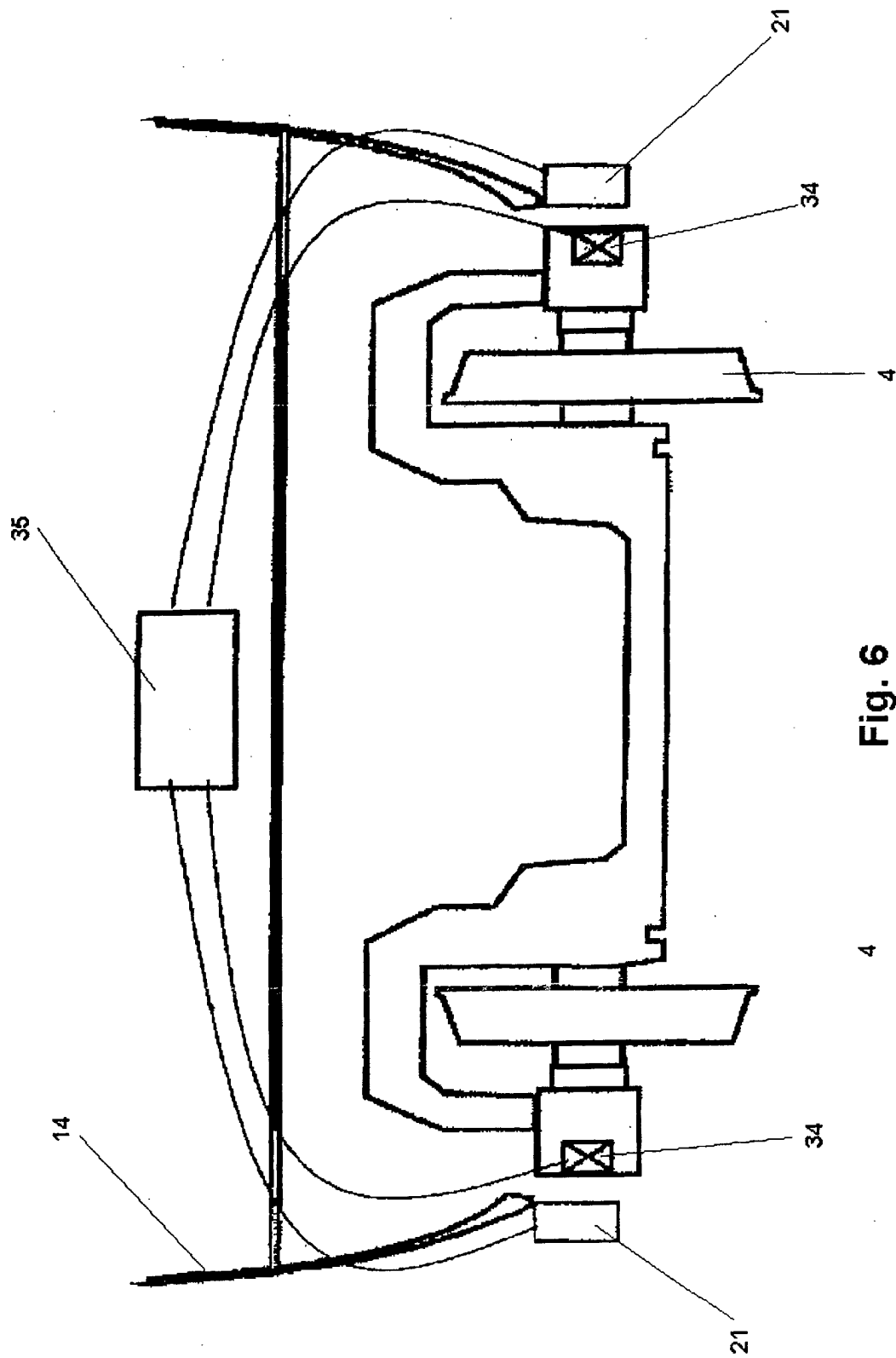


Fig. 6



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Place of search MUNICH		Date of completion of the search 15 April 2003	Examiner Ferranti, M
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