[Third Edition.]

PATENT SPECIFICATION

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Complete Specification Accepted: Jan. 5, 1933.

COMPLETE SPECIFICATION.

Spring Suspension of Independent Car Wheels, especially for Motor Vehicles.

We, Dr. Ing. h.c. F. PORSCHE G.M.B.H., of Kronenstrasse 24, Stuttgart, Germany, a body corporate organised under the laws of Germany, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the spring suspension of vehicle wheels especially for motor vehicles, and has for its object to provide an improved wheel suspension of this kind.

The improved spring suspension of car wheels according to our invention is applicable to wheels of all kinds (driving, steering, and running wheels), and is characterised by the principal feature that the wheels are supported independently of one another by means of two carrier levers each pivoted at one end upon the car frame and connected at the other end with the wheel by a ball joint, so that the end pivots and ball bearing centres form the pivots of an articulated parallelogram or trapezoid, swinging up and down in the direction of travel of the car.

Owing to this arrangement the braking and driving moments of reaction of the wheels are compensated by two forces acting in opposite directions upon the carrier levers and having no influence on the spring. In consequence of the provision of the two ball joints on the wheel, the latter can not only follow the swinging motion of the carrier levers, but at the same time can also swing round the connecting line of the two ball joints. Therefore, the arrangement is especially suitable for steering wheels and constitutes a plain, cheap and space-saving construction. It does not make any difference whether freely-running or driven steering wheels are concerned, as between the ball joints there is room enough to pass the driving shaft through. Therefore, the invention is applicable to all kinds of car wheels.

The invention also comprises the direct connection of the carrier lever pivots with the elastic and shock-absorbing elements, so that each wheel can move on springs independently of the others. It is possible to arrange springs where both carrier levers are connected with the elastic elements, so that the reaction effects of the two carrier levers can be balanced. Other arrangements are possible, where one of the carrier levers is connected with the elastic elements and the other with the shock-absorbing elements. In this case the reaction effects of the elastic elements must be transferred to the frame, and the latter must be kept sufficiently rigid. This is done by means of a hollow stiffening element such as a tube connecting the ends of the frame with each other and which may also serve to enclose the elastic elements, the usual plate springs being replaced by spiral or helical torsion-springs or torsional and elastic bars arranged transversely to the car. Besides the better overall efficiency which these kinds of springs possess in comparison with the usual plate springs with their considerable internal friction, there is another advantage, viz: that they are very compact and therefore can be easily placed in the casing of the bearing for the carrier lever pivots or in the above-mentioned stiffening element of the frame, whereby they are withdrawn from the detrimental influence of the weather and street.

In the accompanying drawings several constructional examples of the invention are illustrated, as applied to the left-hand front steering wheel of a motor vehicle, in which drawings

Fig. 1 is a combined longitudinal section on the line *x—x* of Fig. 2 through the hub of a driven steering wheel, and its suspension on the frame in elevation (crosswise to the direction of travel);

Fig. 2 is a plan of the arrangement shown in Fig. 1;

Fig. 3 is a side elevation of the arrangement shown in Fig. 1;

Fig. 4 is a vertical section on the line *w—w* of Fig. 1;

Fig. 5 is a diagrammatic illustration of the articulated parallelogram in accordance with Figs. 1 to 4;

Fig. 6 is a diagrammatic illustration of an articulated trapezoid which may re-

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place the arrangement according to Fig. 5;

Fig. 7 is a combined longitudinal section on the line *y—y* of Fig. 8 through the hub of an ordinary steering wheel and its suspension on the frame in elevation (crosswise to the direction of travel);

Fig. 8 is a plan of the arrangement shown in Fig. 7, partly in section;

Fig. 9 is a side elevation of the arrangement shown in Fig. 7;

Fig. 10 is a vertical section on the line *v—v* of Fig. 7;

Fig. 11 is a longitudinal section on the line *t—t* of Fig. 8;

Fig. 12 is a sectional plan of a construction which may replace that shown in Fig. 8;

Fig. 13 is a section on the line *u—u* of Fig. 12;

Fig. 14 is a view from the front of the car of the bearing of the two steering wheels in accordance with Fig. 7 to 13.

Fig. 15 is a sectional plan of an alternative construction which may replace Fig. 8 or Fig. 12;

Fig. 16 is a section on the line *s—s* of Fig. 14;

Fig. 17 is a broken sectional elevation on the line *z—z* of Fig. 15.

In the construction illustrated in Figs. 1—4 the wheel hub 1 is connected with the driving shaft 2 through the coupling piece 3. The hollow stump axle 5 is journalled in the wheel hub by means of the two ball bearings 4 and secured by the nut 6 against the hub 1. At the other end (inside of the wheel) the stump axle 5 has the form of a fork 7 in which two balls 8 and 9 rest in the respective sockets 10 and 11. The upper socket 11 is adjustable by means of the screw-thread 12 and can be secured by a clamping-screw 13. The counter-sockets 14 and 15 for the balls 8 and 9 respectively are provided for in the carrier levers 16 and 17, which rest on a loading bar 18 the ends 19 and 20 of which are spherical and seated in the corresponding sockets 21 and 22 of the carrier levers 16 and 17 respectively. The bolt-shaped ends 23 and 24 of the carrier leaves 16 and 17 are arranged in bearings in the spring casing 28 and surrounded by the bushes 25 and 25a, and 26 and 26a, and are kept in their position by the discs 29 and 30. Between the bushes 25 and 25a, and 26 and 26a, the bolts 23 and 24 are connected, by means of the serrations 31 and 32 respectively, with the eyes of the flexion spring 33 which surrounds them like a spiral in form of a sign of interrogation. The spring casing 28 is rendered accessible by a cap 34 and is screwed on the dished end of the frame 35, for instance by means of the bolts 36. The steering lever 37 is firmly connected with the axle fork 7.

If the wheel is springy, both carrier levers 16 and 17 swing parallel to each other, whereby the flexion-spring 33 connected with them is stretched, without transmitting any reaction effects to the frame. The spring case 28 is filled with grease which is pressed out through the intermediate spaces of the spiral and acts as a damper of the spring motion, because the edges of the spring 33 are in contact with the wall of the casing. In order that the carrier levers 16 and 17 may be adjusted as far as possible without any play, the screw-socket 11 is provided which can be regulated at will. The steering of the wheel mounted on the shaft 2 is effected round the axis formed by the line connecting the ball centres 8 and 9, in the usual way by means of the steering lever 37.

When the springing of the wheel takes place by the amount *a*, as illustrated in Fig. 5, the steering axis is shifted parallel to itself. The vertical transverse plane containing the steering axis remains in front of the vertical transverse plane containing the axis of the wheel to the extent *b*, which sometimes causes difficulties in steering. This disadvantage is avoided by the formation of an articulated steering trapezoid according to Fig. 6. Here the transverse plane containing the steering axis is somewhat inclined towards the front relatively to the vertical transverse plane containing the axis of the wheel but always intersects this vertical plane at the bottom point of the wheel whenever the wheel springs so that the steering can be easily handled for all positions of the wheel.

In the constructional examples illustrated in Figs. 5—17 the wheel hub 38 is connected in the usual way with the rim 39. By means of the roller bearings 40 and 41 the stump axle 42 is seated in the hub and secured by the nuts 43. At the other end (inside of the wheel) the stump axle 42 terminates in an enlargement 44 in which a divided axle bolt 45 and 46 is fixed by means of the clamping-screws 47 and 48. The ends 49 and 50 of the axle bolt 45 and 46 respectively are spherical and seated in corresponding bearings 51 and 52 on the carrier levers 53 and 54. These bearings 51 and 52 respectively can be adjusted and regulated by means of the caps 55 and 56. The bolt-shaped ends 57 and 58 of the carrier levers 53 and 54 are doubly seated in the shock-absorbing case 63 by means of the bushes 59, 60, and 61, 62. The upper bolt 58 carries a lever 64 fixed by means of the screw 65 which

lever with each swing motion of the bolt 58 operates a shock-absorbing piston of a known kind working in a cylinder or tube 66. The shock-absorber casing 63 is firmly connected with the frame 69 by means of the flange 67 and the screws 68.

In the examples illustrated in Figs. 7—11 the lower bolt 57 is hollow. Its outer end (on the side of the wheel) is firmly connected with one end of the bar-shaped torsion-spring 70 arranged co-axially within the bolt and is secured against displacement by means of a pin 71. The torsion spring 70 passes within a tube 83 intended to stiffen the frame and extends about up to the middle line 72 of the car, where it is firmly connected with the perforated cylindrical block 73 which is freely movable within the tube 83. A number of other bar-shaped torsion springs 74 are arranged around the central spring 70 so as to fill the inner space of the tube, said outer springs 74 being fixed, on the one hand, in the perforated block 73, and on the other hand in a flange piece 75 which is secured to the frame 69 and the flange 67 of the shock absorber casing 63. The connection between the bar-shaped springs 70 and 74 and the bolt 57 or the block 73 or the flange piece 75 is effected by serrated portions. The steering takes place in the way indicated in the foregoing example.

The torsion springs 70 and 74 may be replaced by the cylindrical torsion spring 76 illustrated in Figs. 12 and 13, and which is inserted into the tube 83. The spring 76 has a rectangular section and is suitably cut from a smooth pipe the ends 78 and 79 of which form closed bushes in which the lateral projections 80 and 81 are milled. By means of the projections 80 and 81 the flexion spring 76 is connected with corresponding projections on the bolt 57 on the one hand, and on the block 82, on the other hand, which is fixed within the tube 83 this arrangement ensuring an easy regulation and adjustment.

If the wheel swings upwardly the bolt 57 partakes in the swinging and tightens the spring (either the torsion spring 70 and 74 or the torsion spring 76), whilst at the same time the bolt 58 drives by its swinging motion the hydraulic shock absorber by means of the lever 64. The torsion springs act in such a manner that the turning moment is transmitted through the central spring 70 and the block 73 to the outer springs 74 and thence through the flange piece 75 to the frame 69. The tensile spring 76 acts in such a way that the turning moment is transmitted to the block 82 and thence to the torsion-proof tube 83.

In the examples illustrated in Figs. 14—17 the steering wheels are mounted in the manner illustrated in Figs. 7—11. Their suspension by springs, however, is effected by means of a single torsion bar 70 for one wheel and 70^1 for the opposite wheel. One end of bar 70 is fastened to the bolt-shaped end 57 of the carrier lever 54 exactly as before, and the other end is fixed in a flange piece 84^1 which is screwed to the cross beam 69^1 on the opposite side. In order that the bars 70 and 70^1 may pass each other, their fixing points 85^1 and 85 are arranged eccentrically to the axes of the carrier lever bolts 57 and 57^1 respectively, in a horizontal plane, so that the point of passage of the bar 70^1 through the flange piece 84^1 is alongside of the fixing point 85^1 of the other bar 70 in the flange piece 84^1. Between the flange pieces 84 and 84^1 extends the stiffening tube 83 through which the bars 70 and 70^1 are passed so as to be invisible from the outside.

If for instance one wheel swings upwards a turning movement is transmitted to the torsion bar 70 exactly as in the foregoing example, but the reaction of the former acts now on the opposite cross beam 69^1 of the frame, whilst the shock absorber 66 is actuated exactly as before. In consequence of the eccentricity of their fixing points, the torsion bars will be bent but owing to this arrangement the advantage is gained that the necessary length of spring and thence the useful amount of spring can be provided in a single torsion spring per wheel.

The invention is not limited to the illustrated examples of execution. For instance the torsion bars can be replaced by torsion tubes; instead of fastening the torsion springs by means of serrations the fixing can be effected also by means of flanges or teeth; combinations of torsion and tensile springs are possible, for instance a central torsion spring surrounded by a helical torsion spring.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A spring suspension of car wheels of all kinds (driving, steering, and running-wheels), hereby characterised, that the wheels are supported independently of one another by means of two carrier levers each pivoted at one end upon the car frame and connected at the other end with the wheel by a ball joint so that the end pivots and ball bearing centres form the pivots of an articulated parallelogram or trapezoid swinging up and down in the direction of travel of the car.

2. A formation of the carrier levers

according to claim 1 for driven steering wheels, in which the ends (on the side of the wheel) of the carrier levers as well as the fork-shaped ends of the stump axle have sockets corresponding to each other, in each of which sockets a ball is arranged, the ends of the carrier levers being pressed against the balls by a loading bar engaging the levers outside of the wheel centre.

3. A formation of the carrier levers according to claim 1 for steering wheels, in which the enlarged end of the stump axle of the wheel is secured upon a swivelling steering axle formed by two co-axial and contiguous bolts the outer ends of which are spherical and are secured in spherical sockets carried upon the outer ends of the corresponding carrier levers.

4. A bearing for the carrier levers on the frame according to claim 1, in which the bolt-like ends of the carrier levers are supported rotatably in a casing which is connected with the frame end or with a stiffening tube of the frame end, the said bolt-like ends being doubly seated and arranged parallel and one above the other.

5. A spring suspension of car wheels according to claim 1, comprising a double-coil spring of which one coil surrounds the end pivot of one carrier lever and the other coil surrounds the end pivot of the other carrier lever in the form of a sign of interrogation, the inner end of each coil being firmly connected to the corresponding end pivot whereby the swinging motion of the carrier levers is damped by a consistent lubricant which is pressed out between the turns of the double-coil spring.

6. A spring suspension of car wheels according to claim 1, comprising a bar-shaped torsion spring which is connected co-axially parallel with the lower carrier lever end pivot and to the opposite side of the car frame, in such a manner that the torsion spring of one wheel leaves free the torsion spring of the opposite wheel, and both are enclosed in a transverse stiffening tube of the frame.

7. A spring combination for the suspension of car wheels according to claim 1, comprising a number of torsion bars, i.e. a central and stronger torsion bar which is connected between the end pivot of the carrier lever and a cylindrical block arranged rotatably in the stiffening tube of the frame, about in the middle of the car, and weaker torsion bars surrounding the said central torsion bar and connected between the said cylindrical block and the side of the frame, the set of torsion bars being enclosed in one half of the transverse stiffening tube.

8. A spring suspension of car wheels according to claim 1, comprising a helical torsion spring arranged co-axially with the lower carrier lever end pivot and extending into a transverse stiffening tube of the frame and connected between the said carrier lever end pivot and a block arranged within and connected rigidly to the said stiffening tube at about the middle of the car.

9. A spring combination for the suspension of car wheels according to claim 1, consisting of a central torsion bar which is connected between the carrier lever pivot and a cylindrical block arranged rotatably in the stiffening tube of the frame, about in the middle of the car, and a helical tensile spring which surrounds the torsion bar and is connected between the said cylindrical block and the side of the frame, both springs being enclosed in one half of the stiffening tube.

10. A damping for the spring systems in accordance with claims 6 to 9, in which the upper carrier lever pivot pin is formed as part of a hydraulic shock-absorber, or is connected with a hydraulic shock absorber, built in the casing.

11. The improved spring suspension of car wheels as herein described and shown in the accompanying drawings.

Dated this 8th day of Aril, 1932.

MEWBURN, ELLIS & Co.,
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Chartered Patent Agents.

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Fig. 1

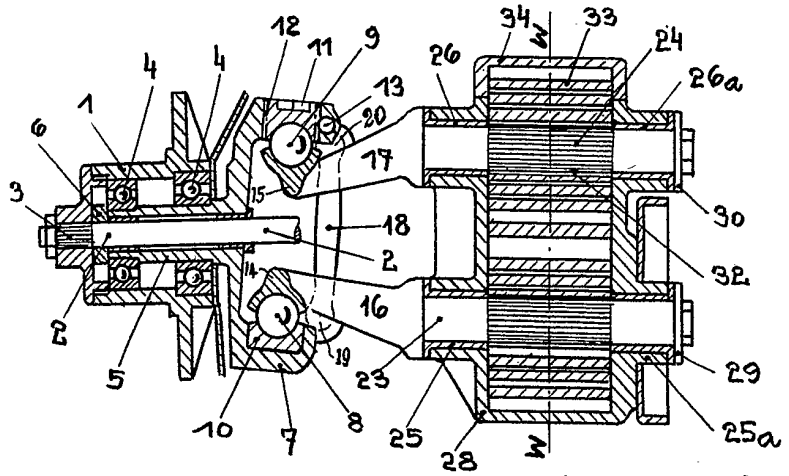

Fig. 2

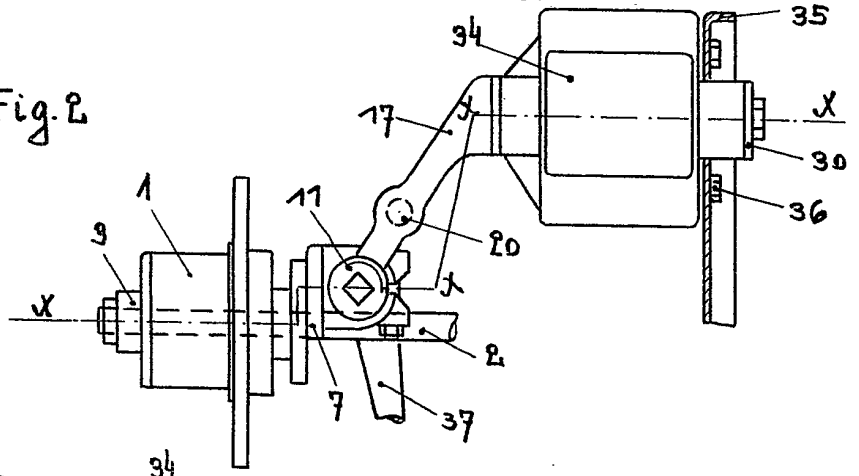

Fig. 3

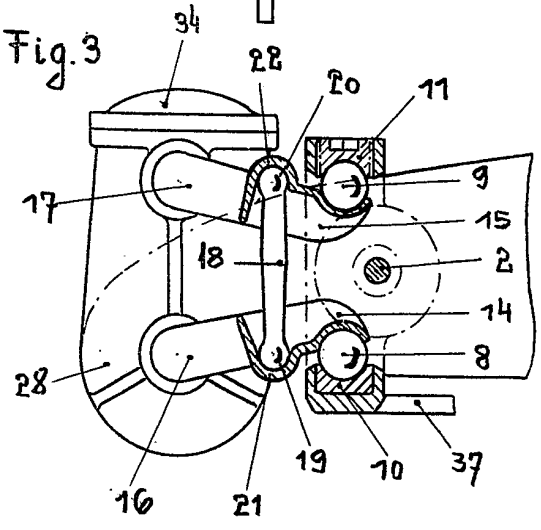

Fig. 4

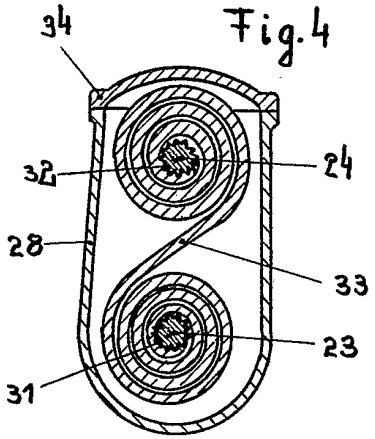

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Fig.7

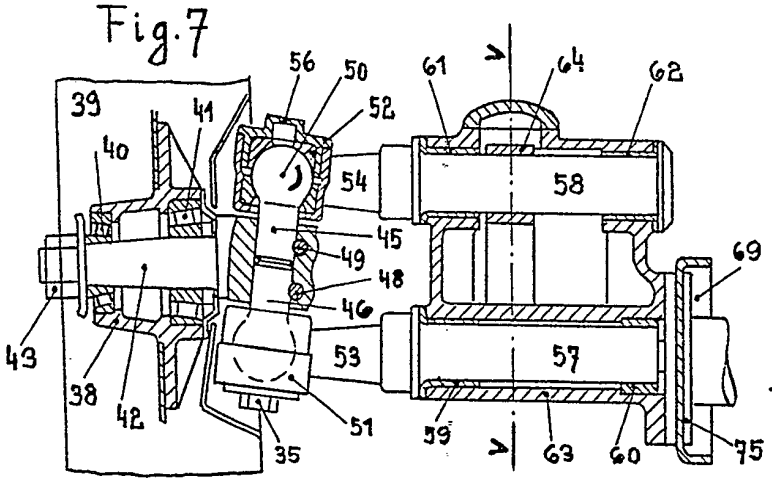
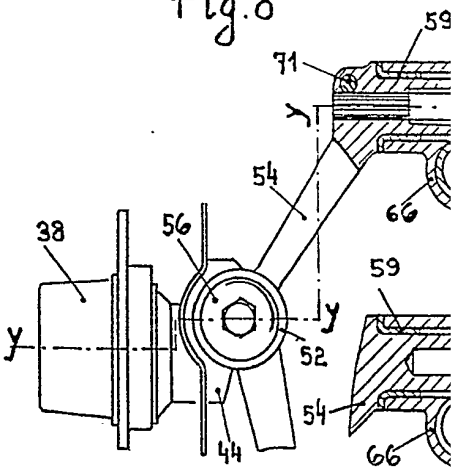


Fig.8



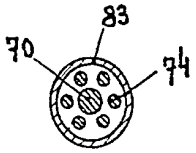


Fig.11

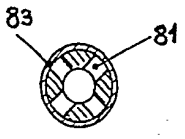


Fig.13

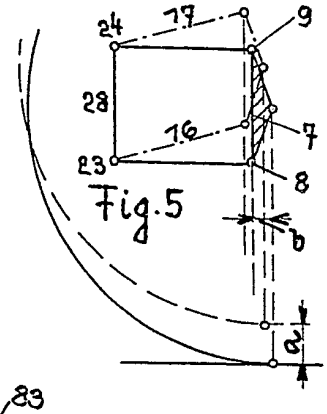


Fig.5

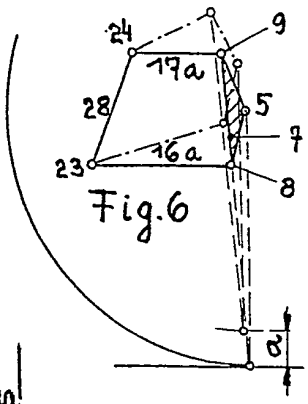


Fig.6

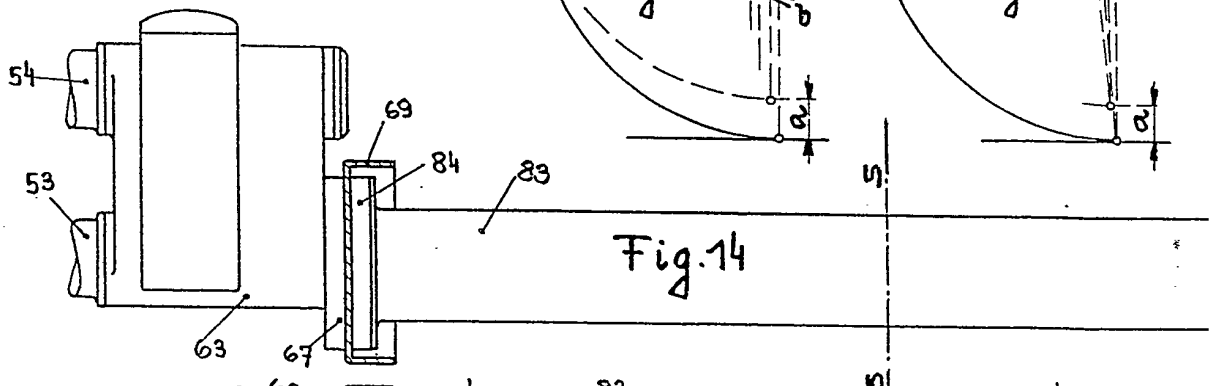


Fig.14

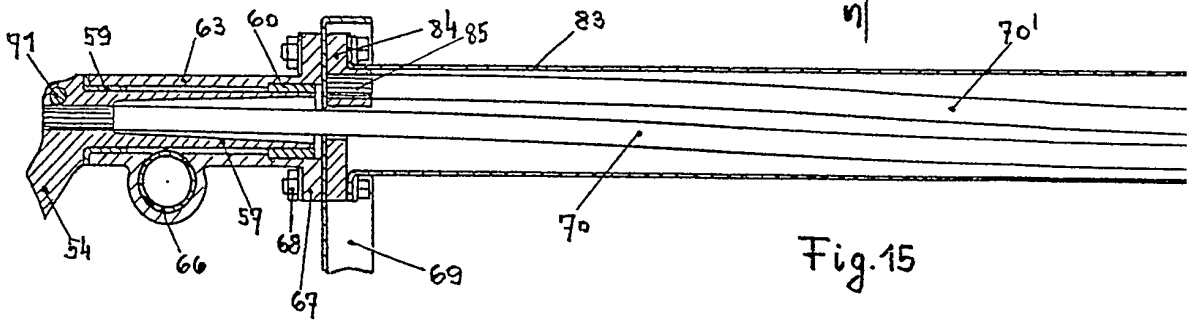


Fig.15

Fig.8

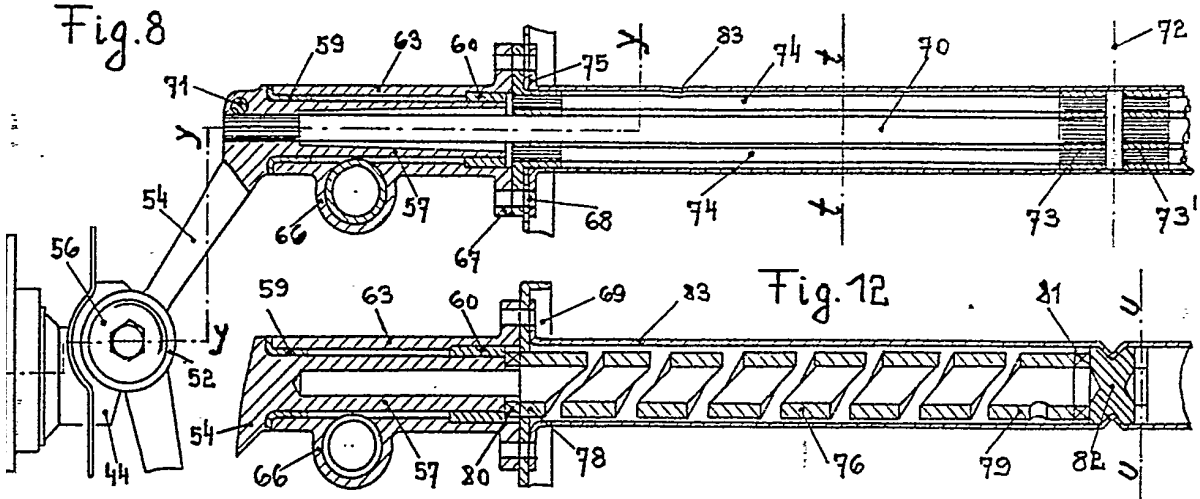


Fig.12

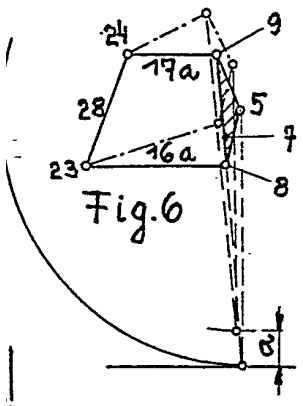


Fig.6

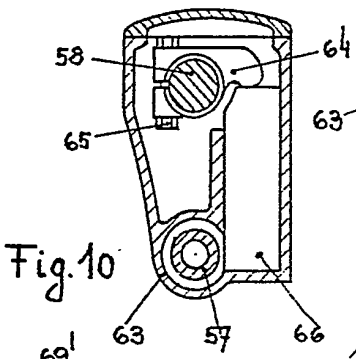


Fig.10

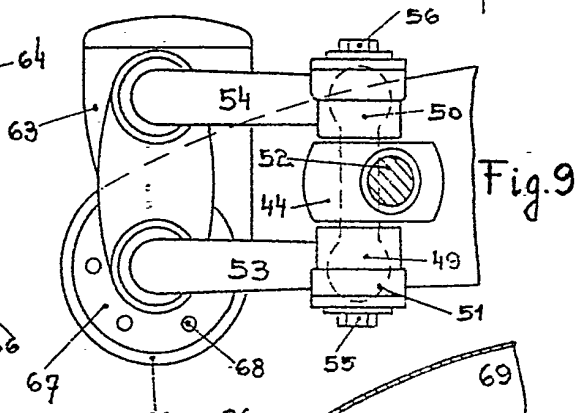


Fig.9

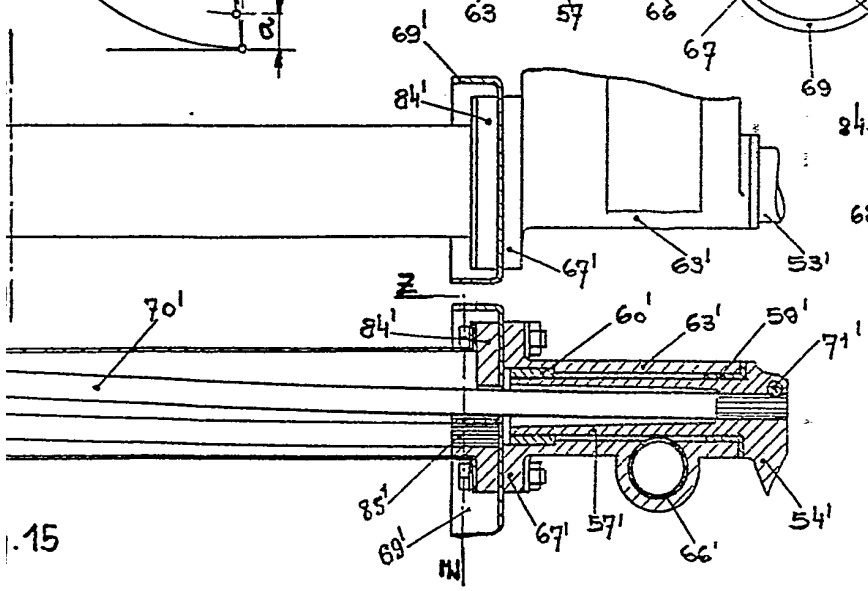


Fig.15

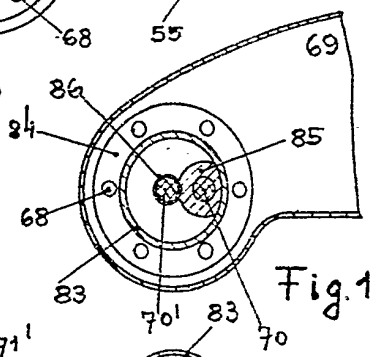


Fig.17

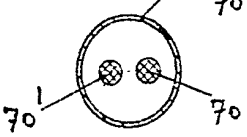


Fig.16

385,812 COMPLETE SPECIFICATION
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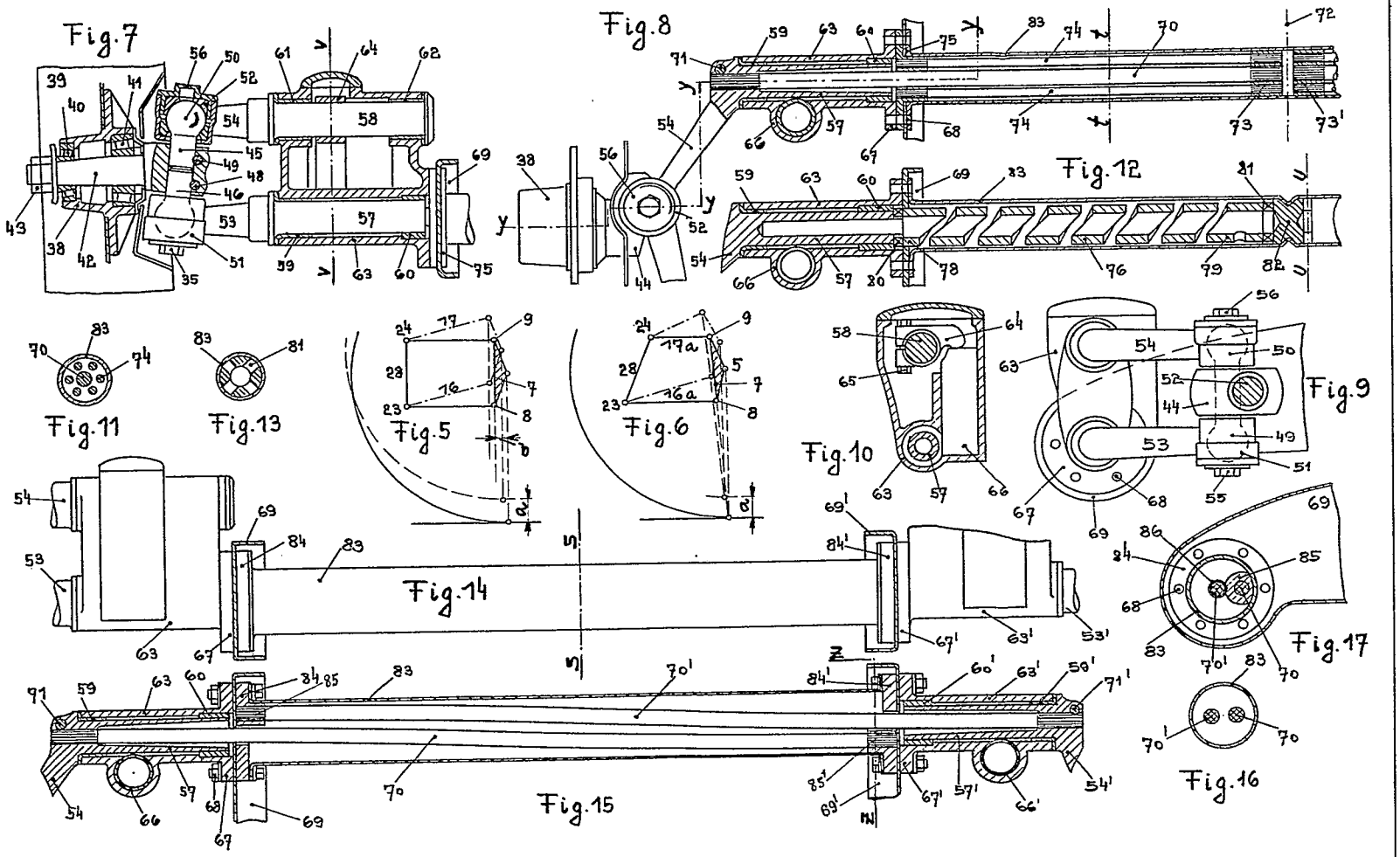

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