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(54) BRAKE APPARATUS FOR VEHICLES MORE PARTICULARLY FOR RAILWAY VEHICLES, WITH A SPRING ACCUMULATOR BRAKE UNIT

(71) We, RACO-ELEKTRO-MASCHINEN GmbH, of Jesinghauser Strasse 56-64, 5830 Schwelm, Federal Republic of Germany, a Body Corporate organised under the laws of the Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a brake apparatus for vehicles, more particularly for railway vehicles, of the kind having a spring accumulator brake unit, a spring-loaded reciprocally guided actuating member of which is movable into a stressed position by means of a rotary drive means, such as an electric motor, and is operatively connected for movement with a coupling element actuating one calliper arm of a brake calliper, a reduction gear being interposed in the path of force between the rotary drive means and the coupling element.

In the foregoing known brake apparatus a rotary drive means in the form of an electric motor acts upon a ball and thread drive, the connecting rod of which actuates one side of the actuating member of the spring accumulator. The other side of said actuating member acts upon a lever transmission by means of which the coupling element movable reciprocatingly in translation transversely to the longitudinal axis by the rotary drive means, ball and thread drive and spring accumulator actuates one calliper arm of the brake calliper. The other calliper arm is not driven directly but is simply articulated to the housing of the reduction gear. The two calliper arms are connected together for entrainment by a link.

The known brake apparatus, more particularly the known spring accumulator brake unit, has proved successful in many cases in practice. The known brake apparatus is

used both as a parking brake and as a service brake.

Starting from the known brake apparatus, the underlying aim of the invention is to modify the aforesaid brake apparatus in such a way that it permits a considerably smaller overall size for comparable braking capacity.

To this end, the present invention consists in a brake apparatus of the kind hereinbefore set forth, wherein the reduction gear is constructed as a high efficiency reduction gear and is arranged between the rotary drive means and the spring accumulator, the output member of said reduction gear being associated in rotation with an eccentric arrangement moving the spring-loaded actuating member.

In the brake apparatus according to the invention the spring-loaded actuating member - i.e. the spring accumulator - acts directly upon the one calliper arm of the brake calliper. Due to the short braking stroke after the reduction of the rotary drive movement, the overall axial length of the spring accumulator - and hence the entire overall volume of the spring accumulator - can be kept small. At the same time the spring accumulator is actuated in an entirely novel manner through an eccentric arrangement which also converts the rotary movement initiated by the high efficiency reduction gear into a translatory movement. In this case it is advantageous to utilize the peculiar property of an eccentric arrangement, that in contradistinction to the known brake apparatus the translatory movement received can without further change of direction act directly upon one calliper arm with interposition of the spring accumulator.

Because the reduction gear has a high efficiency - i.e., is practically nonself-locking - the spring accumulator can extend rapidly when braking is initiated, while the

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reduction gear and the control motor (rotary drive means), being driven counter to their driving sense of rotation (in the reverse direction of rotation) by the spring accumulator, follow passively substantially without obstruction.

In the known brake apparatus the rotary movement generated by the rotary drive means is converted by means of a ball and thread drive into a translatory movement. Since in this case the spring accumulator is arranged between the rotary drive means and the reduction gear, due to the relatively long spring accumulator stroke a corresponding adjustment stroke of the ball and thread gear necessarily occurs with the overall size required for that purpose. In contradistinction thereto, the eccentric arrangement which according to the invention is arranged downstream of the reduction gear in the direction of force transmission, and which likewise converts a rotary into a translatory movement, requires only small overall dimensions due to the short adjustment stroke.

In application of the invention it is convenient to choose a relatively high reduction ratio in order to keep the overall size of the rotary drive means small. In order to achieve a sufficiently high reduction ratio, according to a preferred embodiment of the invention an epicyclic gear is provided which is preferably of multistage - i.e., two stage or three stage - construction. Such an epicyclic gear permits a high reduction ratio for minimum overall dimensions and very high efficiency.

The brake apparatus according to the invention may likewise advantageously be used both as a parking brake and also as a service brake.

Further features and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawings which illustrate diagrammatically and by way of example several embodiments thereof, and in which:-

Figure 1 is a schematic plan of two driven wheel sets of a railway vehicle with brake apparatus;

Figure 2 is a side elevation on an enlarged scale of the brake apparatus in the direction of the arrow II of Figure 1;

Figure 3 is a plan of the brake apparatus in the direction of the arrow III of Figure 2;

Figure 4 is a side elevation corresponding to Figure 2, showing another embodiment;

Figure 5 is a plan view on the arrow V of Figure 4;

Figure 6 is a partial longitudinal section through the spring accumulator brake apparatus taken on the line VI-VI of Figure 3;

Figure 7 is a partial horizontal longitudinal

section through the brake unit alone approximately according to the line VII-VII of Figure 4;

Figure 8 is a vertical section through the spring accumulator eccentric arrangement somewhat according to the line VIII-VIII of Figure 5;

Figure 9 is a partial horizontal longitudinal section based on the sectional view according to Figure 7, but of another embodiment;

Figure 10 is a vertical section through the spring accumulator eccentric arrangement according to Figure 9, otherwise based on the view according to Figure 8;

Figure 11 is a partial plan of a brake apparatus with incorporated take-up device;

Figure 12 is a cross-section through the take-up device on the line XII-XII of Figure 11;

Figure 13 is a cross-section through the take-up device on the line XIII-XIII of Figure 11, in which two types of construction of a ratchet are shown; and

Figure 14 is a partial sectional view taken on the line XIV-XIV of Figure 11.

In Figure 1, the brake apparatus is designated generally by the reference numeral 10 and comprises a spring accumulator brake unit 11, and articulated thereto, a brake calliper 12 having two calliper arms 13, 14, a link 15 joining the two calliper arms 13, 14 together, and brake shoes 16 each attached to the end face of a calliper arm 13, 14. In the unbraked state a stirrup spring 17 maintains the two calliper arms 13, 14 apart so that the brake shoes 16 are spaced from a brake disc 18 fast on a driven wheel axle 19 of the vehicle. An electric drive motor 20 drives in common, through gearboxes 21 provided on its two end faces, the two wheel axles 19 and with them the rail wheels 22.

It will be further seen from Figure 1 that the calliper arm 13 is connected to articulation point 23 on a housing of the unit 11 and the calliper arm 14 is connected to a reciprocatingly movable articulation point 24 on the spring accumulator brake unit 11. As will also be clearly visible from the detail drawings, the articulation point 24 moves outwards in the direction of the arrow x in Figure 1 in order to effect the braking stroke. Because the housing is maintained only in the calliper arm 13, the housing also moves outwards, namely in the direction of the arrow y, so that both brake shoes 16 actuate the brake disc 18 simultaneously.

The same reference numerals as in Figure 1 are used in the remaining figures for functionally comparable components.

Figures 2 to 5 show that the spring accumulator brake unit 11 comprises three sub-assemblies. Of the latter, the sub-assembly 25 comprises an electric motor, the sub-assembly 26 a reduction gear and

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the sub-assembly 27 a spring accumulator which simultaneously accommodates an eccentric arrangement to be described more fully hereinbelow.

5 The spring accumulator brake unit 11 is provided substantially only at the brake calliper 12 - i.e., by its calliper arms 13, 14. The calliper arms 13, 14 are suspended by means of straps 29 provided on a chassis component 28, and is pivotable only in one plane.

10 The articulation point 23 for the calliper arm 13 which may be seen in Figure 1 is constituted by two plug journals 30, 31 secured in their installation position, which are penetrated by the calliper arm 13 extending in two vertical planes.

15 The plug journal 31 inserted from below upwards has an enlarged head 32 in the form of a plane plate. The head 32 rests upon a plane bracing plate 33 preferably fixed resiliently to the chassis, which is provided on its upper side with a lining having lubricating properties, e.g., made of "Ultramid".

20 The advantage of this arrangement resides in the fact that the position of the spring accumulator brake unit 11 can adapt itself automatically to the calliper movement. Especially, this has made it possible to mount the straps 29 virtually play-free at their pivot bearings 35, 36 on the brake shoes and chassis, so that the brake shoes 16 advantageously move only in one precisely defined pivotal plane, whereas the slidingly mounted spring accumulator brake unit 11 can slide forward a certain distance towards the brake disc 18 due to the pivotal movement of the calliper arms 13, 14 when the brake shoes 16 are applied to the brake disc 18. A sliding movement of the spring accumulator brake unit 11 in the opposite direction naturally occurs when the brake shoes 16 are lifted. The brake shoes 16 are also deflected downwards or upwards - depending upon the direction of travel - when they are applied to the brake disc 18. Furthermore, relative oscillations in the vertical direction occur between the chassis and the wheel axles 19 sprung with respect thereto (to which the brake discs 18 are connected). Said movements, which in known brake units fixed rigidly to the chassis stress the brake unit/brake calliper articulation points, are insignificant in the apparatus according to the invention because the spring accumulator brake unit 11 can participate in these movements.

55 The arrow x is also marked in Figures 3 and 5 (of Figure 1 and also further figures). The arrow x is intended to designate the direction of movement upon the initiation of the braking process, of a coupling element generally designated by the reference numeral 37 in the figures, which is extensible by

the spring accumulator.

As may be seen from Figures 3 and 5, the brake shoes 16 engage with their brake linings 38 against the brake disc 18. Should the electricity supply fail in the case of an electrically driven tramway vehicle, the spring-loaded actuating member of the spring accumulator 27, to be described more fully hereinbelow, moves outwards with the coupling element 37 (in the direction of the arrow x) so that the brake shoes 16 press against the brake disc 18 without any possibility of lifting the brake shoes 16 operationally if the vehicle is required to be towed away. In order that the brake shoes 16 may be released in such a case, a manually operable release device is provided. To this end the coupling element 37 is articulated to a bearing part locked releasably to the calliper arm 14 in the direction counter to the relaxing movement (counter to the arrow x). Such releasably locked bearing part may be of different constructions corresponding to Figures 2 and 3 and 4 and 5 respectively.

According to Figures 2 and 3 the releasably locked bearing part is constituted by an eccentric bolt 40 provided with an eccentric section 39 which is mounted centrically in bores 41, 42 of the calliper arm 14 and which engages by its eccentric section 39 through the head of the coupling element 37 in a bearing eye 43. A fishplate 44 is connected fast to the eccentric bolt 40. In the braking position illustrated in Figures 2 and 3, a conically tapered plug bolt 46 provided with a handle 45 extends into mutually aligned plug apertures 47 (in the fishplate 44) and 48 (in the upper region of the calliper arm 14). The handle 45 is simultaneously constructed as a spanner at its free end. When it is required to actuate the release device - i.e., to release the brake shoes 16 - the plug bolt 46 is first extracted, after which the eccentric bolt 40 can be turned with the spanner 45 through a square head 49. This causes the calliper arm 14 adjacent to the spring accumulator 27 to move inwards (counter to the arrow x) and the calliper 12 is loosened in this manner.

In the embodiment of Figures 4 and 5, the coupling element 37 is constructed at its end as a ball spigot (see Figure 9) which engages into a ball socket 51 pivotable about an axis 50 on the calliper. A cheek of the ball socket 51 remote from the axis 50 also urges against the eccentric section 39 of the eccentric bolt 40. Otherwise the individual components resemble, in construction and in function, those which have already been described in conjunction with Figures 2 and 3.

Connected fast to the output shaft or to the output member 52 of the reduction gear 26 is a shaft section A (see Figure 7 and Figure 9) which carries a disc cam 53

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mounted fast thereon. The disc cam 53 commences approximately flush with the circular cylindrical envelope surface of the shaft section A and extends through a peripheral angle which is greater than 270° (Figure 8). As may be seen from the vertical section according to Figure 8, the envelope surface of the disc cam 53 follows an approximately spiral curve receding constantly from the rotary axis of the shaft section A.

A spring-loaded actuating member B₁ has a bracing flange F₁ which serves as outer movable abutment for a cup spring packet 54 (only a few cup springs are shown in Figure 7 in order to simplify the drawing). The cup spring packet 54 is braced internally against a stationary housing surface G₁ of the spring accumulator 27.

A pressure wheel 55 is fixed rotatably to the spring-loaded actuating member B₁. The pressure wheel 55 is in abutment by its outer peripheral surface with the disc cam 53. As soon as the output member 52 of the transmission gear 26 rotates, and the shaft section A together with the disc cam 53 consequently executes a counter-clockwise rotary movement (see Figure 8), the pressure wheel 55 is urged inwards counter to the arrow x and the cup spring packet 54 is then placed under tension by the actuating member B₁. As soon as braking is required the rotational blockage of the drive region is cancelled, so that the cup spring packet 54 can expand, whereupon the arrangement A, 53 rotates backwards clockwise subject to the spring action, so that the arrangement reassumes the position illustrated in Figure 8. It should also be mentioned that the shaft section A is mounted in rolling-contact bearings at both ends (Figure 7 and Figure 9).

In the embodiment according to Figures 9 and 10, the shaft section A connected fast to the output member 52 of the reduction gear 26 has a circular eccentric disc 59 which is surrounded rotatably by the terminal section of a connecting rod 57 with interposition of a rolling-contact bearing. The other terminal region of the connecting rod 57 is articulated rotatably to a gudgeon-like journal 58 on the spring-loaded actuating member B₂ with interposition of a plane bearing. Accordingly the shaft section A, in common with the eccentric disc 56 conveniently shaped integrally with it, constitutes an eccentric shaft.

The cup spring packet 54 is illustrated completely in the embodiment according to Figures 9 and 10. In Figures 9 and 10 the bracing flange for the cup spring packet 54 constituted by the spring-loaded actuating member B₂ is designated F₂ and the stationary housing surface is designated G₂.

The interior space provided to accommo-

date the cup spring packet is protected from dust and moisture by a annular rubber sleeve 59 secured by screws. In the embodiment according to Figures 7 and 8 a corresponding rubber sleeve of somewhat bellows-like construction is provided but is not shown in order to simplify the drawing.

The function of the spring accumulator brake unit 11 illustrated in Figures 9 and 10 is similar to the embodiment according to Figures 7 and 8. In the embodiment according to Figures 9 and 10, when the output member 52 is rotated appropriately, the eccentric disc 56 causes, by the action of the connecting rod 57 against the actuating member B₂, a compression of the cup spring packet 54 counter to the direction designated x. When the rotational blockage of the drive means (braking) is cancelled, the spring-loaded actuating member B₂ moves outwards in the direction of the arrow x, while a rotation of the output member 52 in the opposite direction occurs.

Whereas in the embodiment according to Figures 7 and 8 the rotary angle associated with the disc cam 53 may be greater than approximately 270°, in the embodiment according to Figures 9 and 10, in order to avoid an unfavourable dead-centre position, it is necessary to prevent the rotary angle associated with the eccentric disc 56 attaining 180°. Both embodiments have cut-out devices limiting the rotary angle. In the embodiment illustrated in Figure 7 an adjustable screw stop 60 is provided on the movable flange F₁, which operates a control member 61 of an electric switch when the disc cam 53 has attained its predetermined rotary angle and has tensioned the cup spring packet 54. As soon as the cup spring packet 54 has been tensioned and the control member 61 has been actuated, the output member 52 is held indirectly by a solenoid brake 64 illustrated in Figure 6. As soon as the cup spring packet 54 occupies its tensioning position and the control member 61 has been actuated, the solenoid brake 64 is actuated. This occurs in that an armature disc 66 arranged with limited axial mobility on the rotor shaft 62 of the electric motor 25, and provided internally with a friction lining, moves counter to a spring, not shown, between the armature disc 66 and the armature disc bracket 63 fitted integrally in rotation on the rotor shaft 62, towards the stationary-mounted electrically energised solenoid 65. The armature disc 66 then comes into contact with a stationary friction surface of the solenoid 65, causing braking. If the braking device 10 is now required to be brought into the braking position, then the solenoid brake 64 is switched off, whereupon the armature disc 66 moves away from the stationary friction surface of the solenoid 65 by spring action, with the

result that the rotor shaft 62, the gear wheels of the reduction gear 26 which remain to be described, the output member 52 and the disc cam 53 are freely rotatable. Due to said free rotatability the cup spring packet 54 can expand and extend the coupling element 37 in the braking direction x .

In the embodiment according to Figures 9 and 10 the control member 61 of an electric switch is provided inside the spring accumulator 27 behind a protective membrane 67. The connecting rod 57 is provided adjacently to the eccentric disc 56 with a control cam 68 which actuates the control member 61 as soon as the eccentric disc has described a prescribed angle of rotation which is smaller than 180° . As soon as the control member 61 is actuated, it disconnects the electric motor 25 from the electric supply and activates the solenoid brake 64 as already described in conjunction with Figure 9.

The electric motor 25 and the reduction gear 26 are equally advantageous for use independently of the various embodiments (Figures 7 and 8, 9 and 10).

As electric motors it is convenient to consider only those which develop a high starting torque. Accordingly, a series motor should be adopted in the case of direct-current traction, and conveniently a suitable special bar rotor in the case of alternating-current traction.

As reduction gears, considered in principle, all gears having high efficiency (practically nonself-locking gears) may be considered, more particularly gear trains. However, a two-stage or three-stage epicyclic gear (planetary gear) is specially preferred in conjunction with the spring accumulator brake unit 11 according to the invention.

According to Figure 6 the rotor shaft 62 of the electric motor 25 (the rotor of the electric motor 25 is shown by dash lines) drives a toothed first central or sun wheel S_1 . The rotating sun wheel S_1 meshes with three satellite or planet wheels P_1 which are arranged rotatably on a rotatably mounted satellite carrier T_1 . The satellite wheels P_1 also mesh with the stationary internal tooth system of a ring gear H_1 . The satellite carrier T_1 accordingly rotates more slowly than the sun wheel S_1 .

The satellite carrier T_1 constitutes a second sun wheel S_2 which, similarly as previously described, meshes with satellite wheels P_2 which are in turn mounted on a satellite carrier T_2 and roll upon the internal tooth system of a second ring gear H_2 .

The components S_1 , T_1 , P_1 and H_1 thus constitute a first gear stage, whereas the components S_2 , T_2 , P_2 and H_2 constitute a second gear stage. As may be seen from Figure 6, a third gear stage is also provided with components S_3 , T_3 , P_3 and H_3 in similar manner. The satellite carrier T_3 lastly con-

stitutes the output member 52 which (see Figures 7 to 10) is connected integrally in rotation to the shaft section A and to an eccentric arrangement 53 or 56 associated in rotation therewith in order to drive the spring-loaded actuating member B_1 , B_2 .

Each gear stage illustrated in Figure 6 permits a reduction ratio of 4:1, so that overall a reduction ratio of 64:1 is obtained. The space-saving epicyclic gear containing three gear stages has very small overall dimensions in spite of the high reduction ratio and makes possible, due in fact to the high reduction ratio, a rotary drive means which is likewise of small dimensions, in the present case an electric motor 25 of small overall dimensions.

It will be seen clearly from Figure 6 in conjunction with Figures 7 to 10 that the rotor shaft 62, the principal axes of rotation of the reduction gear 26 corresponding to the sun wheels S_1 , S_2 and S_3 , and the central axis of rotation of the shaft section A are mutually aligned. In this case the axis of movement of the spring-loaded actuating member B_1 , B_2 forms a right angle with the central axis of rotation of the shaft section A.

Figures 11 to 14 illustrate a take-up device and its essential components in detail.

As may be seen from Figure 11, the shaft section A is prolonged beyond the housing of the spring accumulator 27. A circular disc 69 is fitted fast on said prolongation of the shaft section A. An arcuate groove 72 is provided in the disc 69, which forms a stop 70 or 71 at each of its two ends. The peripheral angle between the two stops 70 and 71 is smaller than 180° in the present case, so that this angle is adapted to the eccentric shaft arrangement described hereinbefore (see Figures 9 and 10).

A control pin 87 projects into the groove 72 with substantial play in the radial direction of the disc 69. The control pin 87 extends substantially parallel to the axis of rotation of the shaft section A and is fixed in a primary part 73 of a ratchet. The primary part 73 is surrounded by a housing part 74 of circular cross-section and is mounted in plane bearings therein with interposition of an elastic ring seal 75. The ring seal 75 prevents any accidental rotation of the primary part 73.

A secondary part 76 of the ratchet co-operating with the primary part 73 is connected fast to a worm shaft 80 through the intermediary of a divided shaft 77, 78 in which a flange coupling 79 is included. The worm shaft 80 meshes with a worm wheel 82 arranged integrally in rotation on a control spindle 81. The control spindle 81 is mounted rotatably about its longitudinal axis in a retaining part 83 and is otherwise mounted firmly in traction and compression

in the retaining part 83. The retaining part 83 is in turn mounted pivotably on the calliper arm 13 in the pivot point 84 in the calliper plane.

The control spindle 81 engages by its other end through a screwthreaded nut 85 mounted fast on the calliper arm 14. The screwthreaded nut 85 is mounted pivotably with respect to the calliper arm 14.

The shaft section 77 is retained rotatably in a bearing block 86 which is in turn fixed to the retaining part 83 and is penetrated in the region of the retaining part 83 by the control spindle 81.

The mode of function of the take-up device is as follows: so long as no wear has occurred in the brake lining on the brake shoes, the disc 69 executes a rotary movement with the shaft section A between the relaxed and the tensioned position of the spring accumulator 27 or its actuating member B_1 , B_2 , so that the control pin 87 just does not come into contact with one of the stops 70, 71. As soon as slight wear occurs to the brake lining, the disc 69 rotates during the braking movement with a greater angle of rotation than for a normal braking stroke so that one of the stops, e.g., the stop 71, entrains the control pin 87 - and hence the primary part 73 - in rotation. The secondary part 76 of the ratchet is not rotated thereby. Then at the end of the return stroke (lifting stroke) the other stop 70 strikes against the control pin 87 in the opposite direction of rotation, so that the secondary part 76 of the ratchet is loaded in the blocking direction and is thus likewise co-rotated. A rotary movement of the secondary part 76 is transmitted through the shaft sections 77, 78 including coupling 79 to the worm shaft 80 and hence to the worm wheel 82, which rotates the control spindle 81 so that the two brake shoes 16 can be moved towards one another in order to compensate the brake lining wear.

Instead of the ratchet of Figure 11, it is possible to use both a clamping directional ratchet or freewheel (right-hand side of Figure 13) and a pawl ratchet (left-hand half of Figure 13). These components are however so well known that they require no further explanation.

The entire take-up device is arranged between the two calliper arms 13, 14 in a space-saving manner.

WHAT WE CLAIM IS:-

1. A brake apparatus of the kind hereinbefore set forth, wherein the reduction gear is constructed as a high efficiency reduction gear and is arranged between the rotary drive means and the spring accumulator, the output member of said reduction gear being associated in rotation with an eccentric arrangement moving the spring-loaded actuating member.

2. Brake apparatus as claimed in claim 1, wherein the eccentric arrangement comprises a disc cam arranged fast on a shaft section of the output member and braced against the spring-loaded actuating member, the envelope surface of said disc cam, considered in cross-section, follows an approximately spiral curve receding constantly from the axis of rotation of the shaft section.

3. Brake apparatus as claimed in claim 2, wherein the envelope surface of the disc cam commences approximately flush with the circular cylindrical envelope surface of the shaft section and extends over a peripheral angle of at least approximately 180° to approx., 270° .

4. Brake apparatus as claimed in claim 2 or 3, wherein the disc cam is braced against a pressure wheel fixed to the spring-loaded actuating member.

5. Brake apparatus as claimed in claim 1, wherein the eccentric arrangement has a shaft section constituting an eccentric shaft, of which the eccentric region of circular cylindrical cross-section is surrounded rotatably by a terminal section of a connecting rod, whilst its other terminal section is articulated rotatably to the spring-loaded actuating member.

6. Brake apparatus as claimed in claim 5, wherein the angle of rotation of the eccentric shaft between the maximally tensioned and the relaxed position of the spring accumulator is less than 180° .

7. Brake apparatus as claimed in any one of the preceding claims, wherein the angle of rotation of the eccentric arrangement between the tensioned and the relaxed position of the spring accumulator is determined by a stop rotatable with the eccentric arrangement or reciprocatingly movable with the spring-loaded actuating member, which actuates a control element switching off the rotary drive and switching on a brake restraining the rotary drive in the tensioning position of the spring accumulator.

8. Brake apparatus as claimed in any of the preceding claims, wherein the reduction gear is a gear train.

9. Brake apparatus as claimed in claim 8, wherein the reduction gear is a multistage epicyclic gear.

10. Brake apparatus as claimed in claim 9, wherein the shaft of the rotary drive means, the principal axis of rotation of the epicyclic gear and the axis of rotation of the shaft section constituting the eccentric arrangement are mutually aligned.

11. Brake apparatus as claimed in any one of the preceding claims, wherein the spring accumulator brake unit is composed of three separate sub-assemblies which comprise the rotary drive means, the reduction gear and the eccentric arrangement with



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in the retaining part 83. The retaining part 83 is in turn mounted pivotably on the calliper arm 13 in the pivot point 84 in the calliper plane.

5 The control spindle 81 engages by its other end through a screwthreaded nut 85 mounted fast on the calliper arm 14. The screwthreaded nut 85 is mounted pivotably with respect to the calliper arm 14.

10 The shaft section 77 is retained rotatably in a bearing block 86 which is in turn fixed to the retaining part 83 and is penetrated in the region of the retaining part 83 by the control spindle 81.

15 The mode of function of the take-up device is as follows: so long as no wear has occurred in the brake lining on the brake shoes, the disc 69 executes a rotary movement with the shaft section A between the relaxed and the tensioned position of the spring accumulator 27 or its actuating member B₁, B₂, so that the control pin 87 just does not come into contact with one of the stops 70, 71. As soon as slight wear occurs to the brake lining, the disc 69 rotates during the braking movement with a greater angle of rotation than for a normal braking stroke so that one of the stops, e.g., the stop 71, entrains the control pin 87 - and hence the primary part 73 - in rotation. The secondary part 76 of the ratchet is not rotated thereby. Then at the end of the return stroke (lifting stroke) the other stop 70 strikes against the control pin 87 in the opposite direction of rotation, so that the secondary part 76 of the ratchet is loaded in the blocking direction and is thus likewise co-rotated. A rotary movement of the secondary part 76 is transmitted through the shaft sections 77, 78 including coupling 79 to the worm shaft 80 and hence to the worm wheel 82, which rotates the control spindle 81 so that the two brake shoes 16 can be moved towards one another in order to compensate the brake lining wear.

45 Instead of the ratchet of Figure 11, it is possible to use both a clamping directional ratchet or freewheel (right-hand side of Figure 13) and a pawl ratchet (left-hand half of Figure 13). These components are however so well known that they require no further explanation.

50 The entire take-up device is arranged between the two calliper arms 13, 14 in a space-saving manner.

WHAT WE CLAIM IS:-

60 1. A brake apparatus of the kind hereinbefore set forth, wherein the reduction gear is constructed as a high efficiency reduction gear and is arranged between the rotary drive means and the spring accumulator, the output member of said reduction gear being associated in rotation with an eccentric arrangement moving the spring-loaded actuating member.

2. Brake apparatus as claimed in claim 1, wherein the eccentric arrangement comprises a disc cam arranged fast on a shaft section of the output member and braced against the spring-loaded actuating member, the envelope surface of said disc cam, considered in cross-section, follows an approximately spiral curve receding constantly from the axis of rotation of the shaft section.

3. Brake apparatus as claimed in claim 2, wherein the envelope surface of the disc cam commences approximately flush with the circular cylindrical envelope surface of the shaft section and extends over a peripheral angle of at least approximately 180° to approx., 270°.

4. Brake apparatus as claimed in claim 2 or 3, wherein the disc cam is braced against a pressure wheel fixed to the spring-loaded actuating member.

5. Brake apparatus as claimed in claim 1, wherein the eccentric arrangement has a shaft section constituting an eccentric shaft, of which the eccentric region of circular cylindrical cross-section is surrounded rotatably by a terminal section of a connecting rod, whilst its other terminal section is articulated rotatably to the spring-loaded actuating member.

6. Brake apparatus as claimed in claim 5, wherein the angle of rotation of the eccentric shaft between the maximally tensioned and the relaxed position of the spring accumulator is less than 180°.

7. Brake apparatus as claimed in any one of the preceding claims, wherein the angle of rotation of the eccentric arrangement between the tensioned and the relaxed position of the spring accumulator is determined by a stop rotatable with the eccentric arrangement or reciprocatingly movable with the spring-loaded actuating member, which actuates a control element switching off the rotary drive and switching on a brake restraining the rotary drive in the tensioning position of the spring accumulator.

8. Brake apparatus as claimed in any of the preceding claims, wherein the reduction gear is a gear train.

9. Brake apparatus as claimed in claim 8, wherein the reduction gear is a multistage epicyclic gear.

10. Brake apparatus as claimed in claim 9, wherein the shaft of the rotary drive means, the principal axis of rotation of the epicyclic gear and the axis of rotation of the shaft section constituting the eccentric arrangement are mutually aligned.

11. Brake apparatus as claimed in any one of the preceding claims, wherein the spring accumulator brake unit is composed of three separate sub-assemblies which comprise the rotary drive means, the reduction gear and the eccentric arrangement with

spring accumulator.

12. Brake apparatus as claimed in any one of the preceding claims, wherein the spring accumulator brake unit is supported exclusively or at least substantially only by the brake calliper.

13. Brake apparatus as claimed in claim 12, wherein the spring accumulator brake unit is additionally braced slidably against a support surface fitted preferably resiliently to the chassis of the vehicle.

14. Brake apparatus as claimed in any one of the preceding claims, wherein the coupling element provided to connect the spring-loaded actuating member to a calliper arm is articulated at its calliper and to a bearing part releasably locked counter to the direction of the relaxation movement of the spring-loaded actuating member.

15. Brake apparatus as claimed in claim 14, wherein the bearing part is constructed as an eccentric bolt and urges by an eccentric section against the coupling element and the eccentric bolt is retained in that position by means of a fishplate on the calliper arm fixed to it and penetrated by a plug bolt.

16. Brake apparatus as claimed in any one of the preceding claims, having an automatic take-up device for brake shoe wear actuated by the brake shoe movement, which comprises a reciprocatingly movable control member by which the primary part of a ratchet is movable, the secondary part of which is associated in rotation with a control drive performing the brake shoe take-up, characterised in that the shaft section constituting the eccentric arrangement carries at its terminal region adjacent to the brake calliper two stops arranged integrally in rotation on it, which are arranged at a mutual interval corresponding to the angle of rotation of the eccentric arrangement for the nominal stroke of the brake shoes, while into the space between the two stops there protrudes freely the control member arranged rotatably with the secondary part of the ratchet in the form of a control pin, while the control drive has a control spindle joining the two calliper arms pivotably together which is mounted rotatably and at least firmly in traction on one calliper arm and penetrates the other calliper arm in a screwthreaded nut fixed to the latter and while the control spindle is associated in rotation with the secondary part of the ratchet through the intermediary of a - preferably self-locking - gear.

17. Brake apparatus as claimed in claim 16, wherein the gear is constituted by a worm wheel arranged integrally in rotation on the control spindle and by a worm shaft meshing therewith mounted rotatably in a support part fixed to a calliper arm, which is associated in rotation with the secondary part of the ratchet through the intermediary

of a drive shaft.

18. Brake apparatus as claimed in claim 17, wherein the drive shaft is divided into two shaft sections which are associated mutually in rotation through a coupling or a three-dimensional joint, such as a cardan joint.

19. Brake apparatus as claimed in any of claims 16 to 18, wherein the primary part of the ratchet is slidably mounted at its circumference on a housing part with interposition of a ring seal.

20. Brake apparatus as claimed in any of claims 16 to 19, wherein the interval between the stops co-operating with the primary part of the ratchet is adjustable and lockable.

21. Brake apparatus as claimed in any of claims 16 to 20, wherein the take-up device is arranged substantially in the space between the two calliper arms.

22. A brake apparatus for vehicles substantially as herein described with reference to and as shown in the accompanying drawings.

23. A vehicle having a brake apparatus as claimed in any of the preceding claims.

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