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(71) Applicant *(for all designated States except US)*: TWIFLEX LIMITED [GB/GB]; The Green, Twickenham, Middlesex TW2 5AQ (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)* : STEWART, John [GB/GB]; Martindale, Edwin Road, West Horsley, Leatherhead, Surrey KT24 6LN (GB). PATEL, Jagdish, Gordhanbhai [GB/GB]; 77 Edington Road, Abbey Wood, London SE2 9JX (GB).

(74) Agent: FORRESTER KETLEY & CO.; Chamberlain House, Paradise Place, Birmingham B3 3HP (GB).

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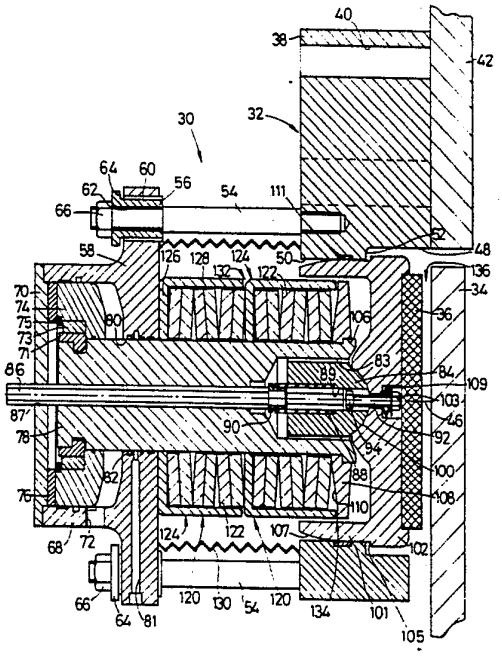
(54) Title: DISC BRAKE

(57) Abstract

A disc brake (30) comprises a brake pad (36) arranged to engage a disc (34), a stack of disc springs (122) arranged to urge the pad into contact with the disc, and a piston and cylinder assembly (68, 74) operable to move the pad away from the disc compressing the springs. The stack of springs (122) is arranged in a plurality of sub-stacks each contained in a cup (124) having a base (126) extending through the stack and a wall (128) extending parallel to the stack and limiting compression of the sub-stack.



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DISC BRAKE

This invention is concerned with a disc brake of the type in which a plurality of disc springs is arranged in a stack to cooperate in urging a brake pad into contact with a disc to be braked. The springs, thus, provide the operating force to press the brake pad against the disc to provide a braking force. Such brakes generally are provided in pairs on opposite sides of a disc to operate simultaneously.

With this type of disc brake, a problem arises due to the limited deflection which individual disc springs can tolerate while giving an acceptable fatigue life. In practice, it is found that the springs in a stack at the active end, i.e. nearest to the brake pad, undergo more deflection than those at the static end. Particularly where the disc makes axial or tilting movements relative to the brake pad, the air gap required between the brake pad and the disc when the disc is not being braked may exceed the amount of movement which the stack of disc springs can tolerate with acceptable fatigue life. The air gap cannot exceed the deflection of the disc spring at the active end of the stack which is found to be approximately 4mm whereas for some applications an air gap of 25mm would be desirable. The total spring force is also difficult to adjust by varying the amount of compression available without fatigue life problems arising.

It is an object of the present invention to provide a disc brake of the type referred to in which a larger air gap can be achieved with acceptable fatigue life.

The invention provides a disc brake comprising a brake pad, a plurality of disc springs arranged in a stack to cooperate in urging the brake pad into contact with a disc to be braked, and withdrawing means operable to move the brake pad away from the disc compressing the springs, characterised in that the springs are arranged in a plurality of sub-stacks each contained in a cup comprising a base extending through the stack and a wall extending parallel to the stack to limit the compression of the sub-stack.

In a disc brake in accordance with the last preceding paragraph, the stack of springs is divided into a plurality of units each of which acts as a separate stack with an active end and a static end so that the maximum deflection experienced by any spring is reduced increasing fatigue life and allowing a larger air gap.

Preferably, the withdrawing means comprises a piston and cylinder assembly which preferably has means for adjusting its stroke. In order to enable easy force adjustment, the disc brake preferably comprises means for adjusting the distance of the piston and cylinder assembly from the disc.

In order to adjust the air gap between the brake pad and the disc, the disc brake preferably comprises means for adjusting the position of the brake pad towards and away from the disc relative to the withdrawing means.

In order to provide force equalisation across the brake pad, the brake pad may be mounted on a tiltable support, which preferably comprises a partly spherical tilting surface allowing tilting in two dimensions. The support may also have a partly spherical surface

concentric with the tilting surface and arranged to transmit braking force to a fixed body of the disc brake.

There now follows a detailed description, to be read with reference to the accompanying drawing of a disc brake which is illustrative of the invention.

The drawing is a longitudinal cross-section taken through the illustrative disc brake.

The illustrative disc brake 30 comprises two half calipers 32 (only one of which is shown in the drawing) arranged on opposite sides of a disc 34 mounted on a shaft (not shown) which is to be braked. Each half caliper 32 is operable to bring a brake pad 36 into contact with the disc 34 to apply a braking force to the disc. The half calipers 32 are arranged to operate simultaneously to bring their brake pads 36 into contact with the disc 34 on opposite sides thereof.

Each half caliper 32 comprises a caliper body 38 which is provided with bolt holes 40 by which the body 38 is bolted to a fixed support 42 by bolts (not shown). The bodies 38 of the two half calipers 32 are bolted to opposite sides of the support 42. As the half calipers 32 are of identical construction only one is described hereinafter.

The caliper body 38 is in the form of a disc extending parallel to the disc 34. The body 38 has a hole passing therethrough. The hole has a portion 50 which is cylindrical about an axis 46 extending normally of the disc 34 and an enlarged portion 48 nearest the disc 34 into which the portion 50 opens. The portion 48

is rectangular in transverse cross-section. The portions 48 and 50 are separated by a step 52.

Four posts 54 of the half caliper 32 are mounted on the body 38 and project parallel to the axis 46 away from the disc 34. In modifications of the illustrative brake 30, there may be three or more than four posts 54. The posts 54 have their end portions which are remote from the body 38 screw-threaded and provide steps 56 on which a cross-beam member 58 of the half caliper 32 is supported.

The cross-beam member 58 is in the shape of a disc extending parallel to the disc 34 and the body 38. The member 58 has four screw-threaded holes therein into which are screwed four spacers 60. Each spacer 60 is generally cylindrical with a central bore 62 therethrough and an external flange 64 at the end remote from the disc 34. The spacers 60 are of greater extent than the thickness of the cross-beam member 58. The threaded end portion of each of the posts 54 is received in the bore 62 of a spacer 60 until the non-flanged end of the spacer abuts the step 56 and the spacers 60, and hence the cross-beam member 58, are held on the posts 54 by nuts 66 threaded on to the posts 54 until they abut the flanges 64 of the spacers 60. The spacing of the cross-beam member 58 from the body 38 can be adjusted by rotating the spacers 60 in the threaded holes in the member 58. The flanges 64 set a limit to this adjustment when they abut the member 58.

Formed integrally with the cross-beam member 58 is a cylinder 68 of the half caliper 32. The cylinder 68 is symmetrical about the axis 46 and projects from the member 58 in a direction away from the disc 34. The

cylinder 68 has an end cap 70 and its interior is entered by a port 72 which extends radially adjacent to the member 58. A piston 74 is movable within the cylinder 68 between limits defined by the member 58 and by an annular spacer 76 secured to the end cap 70 within the cylinder. Introduction of hydraulic fluid through the port 72 causes the piston 74 to move away from the disc 34 until it engages the spacer 76 (as shown in the drawing). The spacer 76 provides means for adjusting the stroke of the piston and cylinder assembly 68, 74 since it can be replaced by a spacer of a different thickness. The piston 74 is secured to a piston rod 78 which has its longitudinal axis co-incident with the axis 46. The piston 74 is secured to the piston rod 78 by means of a split-collet 71, a retaining ring 73, and a spring clip 75. The piston rod 78 projects out of the cylinder 68 towards the disc 34 through a bore 80 through the cross-beam member 58, the bore 80 being provided with seals 82. A drain port 81 is provided to drain off fluid which may pass the seals 82. The piston rod 78 has a cylindrical threaded recess 83 in its end which is closest to the disc 34. In the recess 83, a threaded support member 84 is threadedly received. The position of the member 84 in the recess 83 can be adjusted towards or away from the disc 34 by means of a spindle 86 which extends through an axial bore through the piston rod 78 and through a bore 87 in the end cap 70. The spindle 86 is hexagonal in transverse cross-section so that it can be turned by means of a spanner applied to the end which projects beyond the end cap 70. The spindle 86 enters a closely-fitting hexagonal passage 89 in the support member 84 so that when the spindle is turned so is the member 84. A spring 88 is contained in a cylindrical passage in the member 84 which enters the passage 89. The spring 88 acts between a step of the member 84 at the

end of the passage 89 and a flanged bush 90 mounted on the spindle 86 so that the spindle 86 is urged away from the disc 34. The spindle 86 continues beyond the member 84 towards the disc 34 as a threaded end portion 92. The threaded end portion 92 extends into a recess in the end 100 of the member 84 and has a first nut 94 thereon which serves to prevent the spindle 86 from moving away from the disc 34 relative to the member 84.

The surface 100 of the threaded support member 84 which is closest to the disc 34 is part spherical and is engaged by a complementary tilting surface of a pressure plate 102 of the half caliper 32 on which the brake pad 36 is mounted. The plate 102 provides a tiltable support for the brake pad 36. The engagement of the part spherical surfaces of the support member 84 and the pressure plate 102 allows rocking movement to adjust the pad 36 relative to the disc 34. The pressure plate 102 is secured to the support member 84 by a second nut 103 on the threaded end portion 92 of the spindle 86 which passes through a bore in the pressure plate 102 (this bore provides clearance around the portion 92). The nut 103 is received in a recess in the pressure plate 102 which is covered by the brake pad 36 and acts on a spring 109 contained in the recess. The pressure plate 102 has a cylindrical projection 101 towards the cross-beam member 58. The projection 101 forms a step 105 with the main body of the plate 102 (which step 105 faces the step 52 so that movement of the plate 102 away from the disc 34 is limited). The outer surface 107 of the projection 101 is part spherical about the same centre of curvature as the surface 100 of the support member 84 and is hence concentric with the tilting surface of the plate 102. The surface 107 engages the surface of the portion 50 of

the hole through the body 38, a bearing ring 111 being set into this surface.

The piston rod 78 also has an external flange 106 at its end which is closest to the disc 34. This flange 106 is abutted by an annular reaction member 108 which has a frusto-conical surface 110 facing the cross-beam member 58 and tapering towards it. The reaction member 108 is within the projection 101 of the pressure plate 102.

Between the reaction member 108 and the cross-beam member 58, two spring units 120 of the half caliper 32 are located. Modifications of the illustrative brake 30 may, however, have more than two spring units 120. The spring units 120 together provide a plurality of disc springs 122 threaded on the piston rod 78 and arranged in a stack to cooperate in urging the brake pad 36 into contact with the disc 34 to be braked. Each spring unit 120 comprises a sub-stack of six disc springs 122 received within a cup 124. There may, however, be more or less than six disc springs 122 in a sub-stack. Each cup 124 has an annular base 126, extending through the stack and around the piston rod 78, and a cylindrical wall 128 integral with the base 126, projecting from the base parallel to the stack. The wall 128 acts to limit the compression of the sub-stack. The sub-stack of disc springs 122 engages the base 126 within wall 128 and projects away from the base further than the wall 128. The base 126 of one of the cups 124 abuts the cross-beam member 58 while its sub-stack abuts the base of the other cup 124 whose sub-stack in turn abuts the surface 110 of the reaction member 108. A cover 130 in the shape of a concertina extends from the body 38 to the cross-beam member 58 around the spring units 120 to prevent dirt from reaching the spring units. The cover 130 can extend

or contract when the distance between the body 38 and the cross-beam member 58 is adjusted and is readily removable to allow inspection of the springs 122. The bases 126 act to divide the stack of disc springs 122 up into sub-stacks while the walls 128 limit the compression of each sub-stack. The springs 122 are thus arranged in a plurality of sub-stacks each contained in a cup 124 comprising a base 126 extending through the stack and a wall 128 extending parallel to the stack to limit compression of the sub-stack.

In the operation of the illustrative disc brake 30, so long as a supply of hydraulic fluid under pressure is maintained to the port 72, the piston 74 is urged against the spacer 76 (to the left viewing the drawing). The piston 74 urges the piston rod 78 away from the disc 34. This moves the support member 84 away from the disc 34 so that the action of the spring 88 moving the spindle 86 with the member 84 moves the brake pad 36 clear of the disc 34. The flange 106 of the piston rod 78 is also urged away from the disc 34 so that the reaction member 108 compresses the spring units 120. It should be noted that the two spring units 120 are equally compressed so that the gap 132 between the wall 128 of one spring unit 120 and the base 126 of the other is equal to the gap 134 between the wall 128 of the other spring unit 120 and the reaction member 108. Thus, in the compression of the spring units 120, the individual springs 122 move more uniformly than if the cups 124 were absent. In particular, the spring 122 nearest to the reaction member 108 makes a smaller movement than if the cups 124 were absent. The piston and cylinder assembly 68, 74 provides withdrawing means operable to move the brake pad 36 away from the disc 34 compressing the springs 122. The amount of compression of the springs 122 is controlled by the

setting of the spacers 60 which form means for adjusting the distance of the piston and cylinder assembly 68, 74 from the disc 34. The spindle 86 provides means for adjusting the position of the brake pad 36 towards and away from the disc 34 relative to the piston and cylinder assembly 68, 74 to thereby adjust the air gap 136 between the pad 36 and the disc 34.

When it is desired to apply braking force to the disc 34, the port 72 is connected to tank and the springs 122 press the reaction member 108 so that the piston rod 78, the piston 74, the pressure plate 102, and the brake pad 36 are urged towards the disc 34. The brake pad 36 engages the disc 34 applying a braking force which is reacted to the caliper body 38 by engagement of the surface 107 and the surface of the portion 50 and thence to the support 42. It should be noted that during this movement, the presence of the cups 124 reduces the maximum movement made by any of the springs 122 as the movement required is shared more equally among the springs 22 than would be the case in a conventional stack.

It is found in practice that the air gap 136 in the withdrawn position between the disc 34 and the brake pad 36 can be made approximately 4mm for each sub-stack of disc springs 122 and that acceptable fatigue life is achieved.

CLAIMS

1. A disc brake (30) comprising a brake pad (36), a plurality of disc springs (122) arranged in a stack to cooperate in urging the brake pad into contact with a disc (34) to be braked, and withdrawing means (68, 74) operable to move the brake pad away from the disc compressing the springs, characterised in that the springs (122) are arranged in a plurality of sub-stacks each contained in a cup (124) comprising a base (126) extending through the stack and a wall (128) extending parallel to the stack to limit the compression of the sub-stack.

2. A disc brake according to Claim 1, characterised in that said withdrawing means (68, 74) comprises a piston and cylinder assembly.

3. A disc brake according to Claim 2, characterised in that the brake also comprises means (76) for adjusting the stroke of said piston and cylinder assembly (68, 74).

4. A disc brake according to either one of Claims 2 and 3, characterised in that the brake also comprises means (60) for adjusting the distance of said piston and cylinder assembly (68, 74) from the disc (34).

5. A disc brake according to any one of Claims 1 to 4, characterised in that the brake also comprises means (84, 86) for adjusting the position of the brake pad (36) towards and away from the disc (34) relative to the withdrawing means (68, 74).

6. A disc brake according to any one of Claims 1 to 5, characterised in that the brake pad (36) is mounted on a tiltable support (102).

7. A disc brake according to Claim 6, characterised in that the tiltable support (102) comprises a partly spherical tilting surface.

8. A disc brake according to Claim 7, characterised in that the support (102) has a partly spherical surface (107) concentric with the tilting surface and arranged to transmit braking force to a fixed body (38) of the disc brake.

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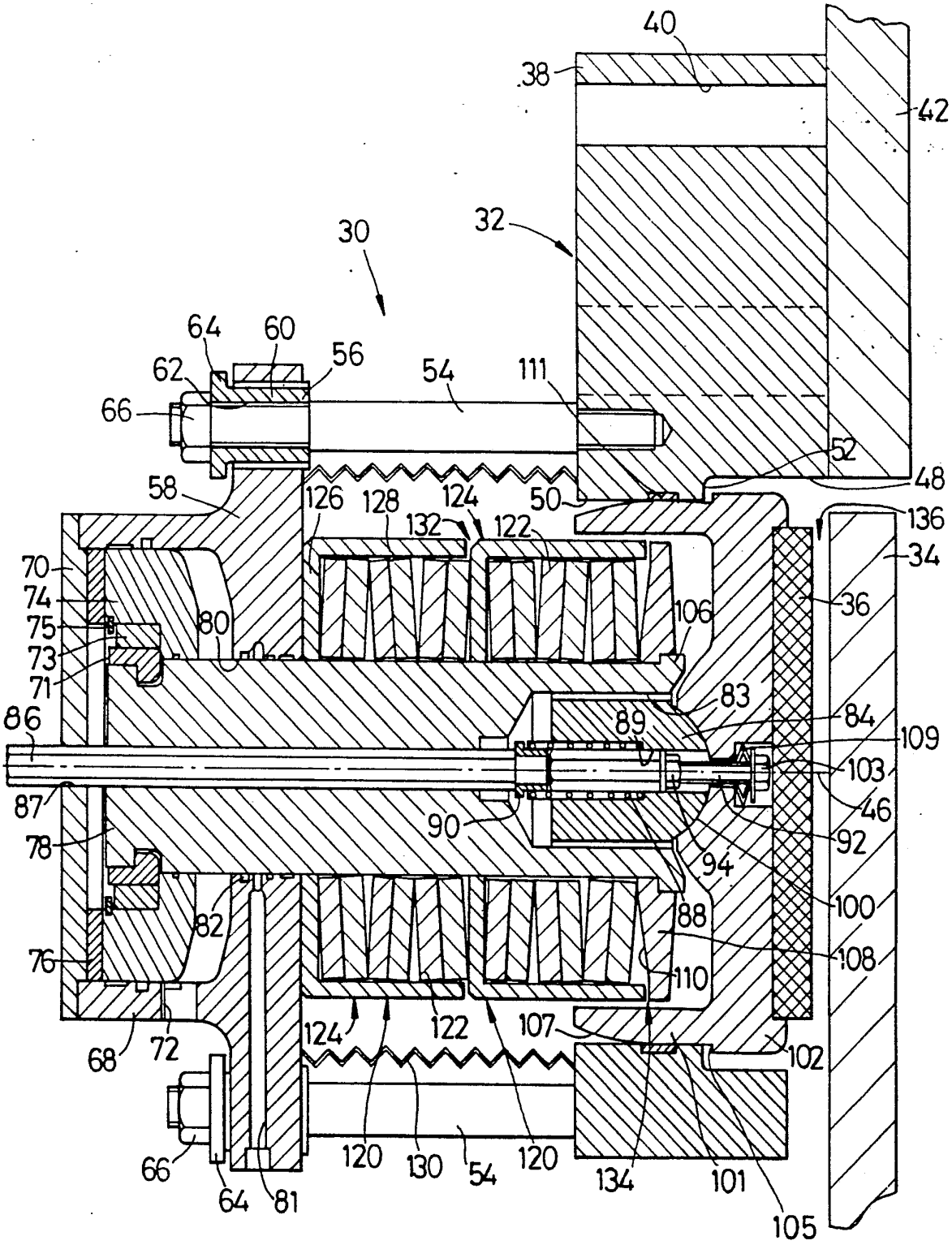
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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/01360

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 16 D 55/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 16 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	US, A, 3159247 (R CHARLTON) 1 January 1964, see figure 2; claim 3 --	1
A	US, A, 3842949 (NEWSTEAD) 22 October 1974, see abstract; figure 2 --	1
A	DE, A, 2124120 (THE BENDIX CORP) 2 December 1971, see figure 1 --	1
A	US, A, 4014414 (YAMAMOTO ET AL) 29 March 1977, see figure 1 --	1

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12th December 1990	15. 01. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	miss T. MORTENSEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/GB 90/01360

SA 40194

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 3159247	01/01/64	NONE		
US-A- 3842949	22/10/74	AU-B-	467484	04/12/75
		AU-D-	5189973	08/08/74
		DE-A-	2306460	13/09/73
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