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(72) Inventor GLYN PHILLIP REGINALD FARR

(54) IMPROVEMENTS IN HYDRAULICALLY OPERATED DISC BRAKES FOR VEHICLES

(71) We: GIRLING LIMITED, a British Company of Kings Road, Tyseley, Birmingham B11, 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 hydraulically operated disc brakes for vehicles, the disc brakes being of the kind comprising a stationary drag-taking member located adjacent to a rotatable disc, a clamp member comprising a yoke extending over the peripheral edge of the disc and slidably mounted on the stationary member for movement in a direction substantially parallel to the axis of the disc, friction pad assemblies for engagement with opposite faces of the disc, and an hydraulic actuator in the stationary member for applying one of the pad assemblies, known as the directly actuated pad assembly, directly to the adjacent face of the disc, the other friction pad assembly known as the indirectly actuated pad assembly, being carried by the clamp member and being applied to the other face of the disc by the reaction of the actuating means which causes the clamp member to slide with respect to the disc in a substantially axial direction, the drag on the indirectly actuated friction pad assembly being transmitted to the stationary member through the clamp member, and the hydraulic actuator comprising oppositely acting first and second pistons located in an hydraulic cylinder in the stationary member and of which the first acts on the directly actuated friction pad assembly and the second acts on the clamp member.

In one known disc brake of the kind set forth the clamp member is guided in grooves in the circumferentially outermost sides of the stationary member. The grooves are exposed to the elements so that interengaging slide surfaces are liable to rust or corrode which will impede operation of the brake. By providing large clearances between the clamp member and the grooves, rust and corrosion can be prevented from impeding operation, but when the direction of disc rotation is reversed and the brake is applied, the application of the brake is noisy due to a "clonk" which occurs due to the engagement of the clamp member with the stationary member as the clamp member tends to be carried round by the indirectly actuated friction pad which it carries.

According to our invention in a disc brake of the kind set forth guide means are incorporated for mounting the clamp member on the stationary member for relative sliding movement in an axial direction, the guide means comprising solely of a rigid pin which is rigidly connected to one of the members, is slidably mounted in the other member, and is located wholly on one axial side of the disc, and anti-rotation means for preventing relative rotation between the clamp member and the stationary member about the pin, the pin being constructed and arranged to transmit to the stationary member substantially all the drag on the indirectly actuated pad assembly, and the pin comprising the sole direct slidable connection between the members, the clamp member otherwise having no direct connection with the stationary member, and the anti-rotation means comprising a coupling between the second piston and the clamp member.

This construction has the advantage that it is not necessary to provide extra thicknesses of material or high strength material in the brake to support the pin. The hydraulic cylinder will already be surrounded by a sufficient thickness of

material that it will never distort and trap the piston. This provides an inherently rigid support for the pin or its slidable mounting without any further adaptations of the brake being necessary. The disc straddling part of the brake is usually made of high strength material. Thus rigid supports are provided for the pin and its mounting without adding to the cost of the brake and without compromising other aspects of brake design.

By providing the pin eliminates the need for providing other exposed sliding surfaces between the members.

Preferably a sealing boot is provided to seal the sliding surfaces of the pin from atmosphere.

Conveniently the pin is fixedly secured in the clamp member and is slidably guided in a blind bore in the stationary member.

The bore in the stationary member is alongside the rigid hydraulic cylinder and is therefore very robustly supported. The cylinder is cast in ordinary cast iron and the yoke is made from high strength material such as S.G. iron.

This construction also has the advantage that as the indirectly actuated friction pad assembly wears the confined space between the free end of the pin and the base of the blind bore expands to create a vacuum. In turn this tends to move the indirectly actuated friction pad assembly away from the disc, against the friction of an hydraulic seal carried by the second piston, thereby providing positive retraction of the indirectly actuated friction pad assembly away from the disc when the brake is released.

Preferably, the pin is located at the circumferential side of the brake at which any given point on the disc first comes into alingnment when the disc is rotating in a normal forward direction, and the directly actuated friction pad assembly is guided in the stationary member betwen spaced arms which extend towards the disc. Thus, when the brake is applied with the disc rotating in a normal forward direction, the drag on the directly actuated pad assembly is taken by the arms at the end of the brake remote from the pin, so that the stationary member is subjected to substantially balanced drag forces.

When the second piston is hollow and acts at its open end on the clamp member the coupling can be connected to the clamp member and be received in the bore of the piston.

Conveniently the pin is located as close as possible to the drag line comprising a tangent to the disc passing through the centre of pressure of the pad assemblies. In this way the anti-rotation connection is relieved of drag forces.

The pin is preferably located wholly on one axial side of the disc. It then does not occupy space between the disc and the wheel which can otherwise be occupied by the clamp member.

Some embodiments of our invention are illustrated in the accompanying drawings in which:—

Figure 1 is a section through a hydraulically operated disc brake for vehicle taken on a chord passing through the disc;

Figure 2 is an elevation of one end of the brake including a half section in the plane of the disc;

Figure 3 is a side elevation of another brake;

Figure 4 is a longitudinal section through the brake of Figure 3;

Figure 5 is a plan including a longitudinal section through one half of the brake on a chord passing through the axis of the pin;

Figure 6 is an end elevation on the line 6-6 of Figure 5 including a part section;

Figure 7 is a view of the sectioned part of Figure 5 showing a modified pin;

Figure 8 is a section similar to Figure 7 of another modified construction;

Figure 9 is an elevation of one end of the brake shown in Figure 8 including a half section on the plane of the disc;

Figure 10 is a side elevation of the brake of Figure 8;

Figure 11 is a longitudinal section through the brake of Figure 8;

Figure 12 is a section similar to Figure 7 of another modified construction;

Figure 13 is a section similar to Figure 7 of another modified construction;

Figure 14 is a section similar to Figure 7 of another modified construction;

Figure 15 is a section similar to Figure 7 of another modified construction;

Figure 16 is similar to Figure 5 showing the addition of a hand brake applying mechanism;

Figure 17 is a longitudinal elevation of the brake shown in Figure 1, showing the brake installed in a road wheel layout; and

Figure 18 is an elevation similar to Figure 9 of one end of the brake shown in Figure 17.

In the disc brake illustrated in Figures 1 and 2 of the drawings, a stationary member 1 is mounted on a stationary part adjacent to one face of a rotatable disc (not shown), and the stationary member is provided with circumferentially spaced arms 2, 3 which terminate close to the disc and between which a directly actuated friction pad assembly 4 for engagement with the said one face of the disc

is guided for axial movement with respect to the disc.

A clamp member 5 comprising a yoke of generally U-outline straddles the peripheral edge of the disc and the stationary member 1. The clamp member 5 comprises axially spaced inwardly directed limbs 7 and 8 which are interconnected by a bridge piece 9, and the limb 7 which is remote from the stationary member carries an indirectly actuated friction pad assembly 10 for engagement with the adjacent face of the disc.

As illustrated each friction pad assembly comprises a rigid backing plate 11 carrying a pad 12 of friction material.

An hydraulic actuator 13 is incorporated in the stationary member 1. As illustrated the actuator 13 comprises an open-ended cylinder bore 14 in which work opposed first and second hollow pistons 15 and 16 arranged with their open ends facing away from each other, and the pistons 15 and 16 slide through axially spaced hydraulic seals 17 and 18 in the wall of the cylinder bore 14. The first piston 15 acts directly on the directly actuated friction pad assembly 4, and the second piston 16 acts on the limb 8.

A pin 19 located at one end of the brake provides the sole slidable direct connection between the clamp member 5 and the stationary member. As illustrated the pin comprises an internally threaded sleeve 20 which is guided to slide in a bore 21 which extends axially through the arm 3 and is closed at one end adjacent to the disc by means of a sealing cap 22 received in a counterbore at that end. The arm 3 is increased in length, both circumferentially and axially, to accommodate the sleeve 20, and the sleeve 20 is connected to the limb 8 by means of a bolt 23 which is screwed into the bore of the sleeve 20 through an opening 24 in the limb 8.

A flexible sealing boot 25 seals the exposed end portion of the sleeve 20 from atmosphere. The boot 25 is connected at one end to a boss 26 integral with the arm 3 by means of a spring ring 27, and at the other end is clamped between the limb 8 and a retainer 28 which, in turn, is clamped between the limb 8 and the adjacent end of the sleeve 20.

When the brake is applied by pressurising the cylinder 14 to separate the pistons 15 and 16, the directly actuated friction pad assembly 4 is applied directly to the disc by the first piston 15, and the indirectly actuated friction pad assembly 10 is applied simultaneously and indirectly to to the opposite face of the disc by the second piston 16 which acts through the clamp member 5, causing the clamp member 5 to move axially with respect to the stationary member 1 with the sleeve 20 riding in the bore 21. The drag on the directly actuated pad assembly 4 is taken by the arm 2, 3 at the end of the brake with which any point on the disc last comes into alignment in that direction of disc rotation, and the drag on the pad assembly 10 is taken by the clamp member 5 and transmitted to the stationary member 1 through the sleeve 20.

Preferably for a normal forward direction of disc rotation the arm 2 takes the drag on the pad assembly 4 so that the drag is substantially shared between the arms.

The axis of the pin 19 is displaced radially inwards with respect to the drag line and the clamp member 5 is coupled to the piston 6 by anti-rotation means to prevent the clamp member 5 from rotating about the pin 19 as an axis when the brake is applied. As illustrated the anti-rotation means comprises a circular member 29 which is a good fit in the bore of the piston 16 and is carried by a spigot 30 engaged in an opening 31 in the limb 8.

As the pad 12 of the indirectly actuated friction pad assembly wears and the sleeve 20 is withdrawn, a space 32 between the inner end of the bolt 23 and the sealing cap 22 is subjected to vacuum which tries to move the pad assembly 10 away from the disc, against the friction in the seal 18. This provides a positive retraction for the indirectly actuated friction pad assembly 10.

Spaced pins, of which one is shown at 33, extend axially towards the disc from the stationary member 1 and support the directly actuated pad assembly 4 against movement in a radially inwards direction.

To replace the pad assemblies 4 and 10 the clamp member 5 can be moved angularly relative to the stationary member 1 with the pin 19 rotating in the bore 21. Of course, the member 29 must first be disengaged from the piston 16. This can be achieved by first removing the pad assembly 10 to permit the clamp member 5 to move axially with respect to the piston.

Alternatively the clamp member 5 may be provided with an opening of substantial dimensions through which the pad assemblies can be withdrawn.

In the brake illustrated in Figures 3 to 6 the pin 19 comprises a stud 34 which is guided to slide in a blind bore 35 in the arm 3, and the stud 34 has an extension 36 of reduced diameter which projects through the bore 24 and is permanently secured in position by rivetting over or otherwise deforming the free end of the extension into a head 37 engaging

with the limb 8. The retainer 28 is clamped between a plane shoulder 38 at the step in diameter and the limb 8.

The anti-rotation coupling comprises a radially extending strip of metal 39 which is secured by rivets 40 to the inner face of the limb 8, and the strip 39 is received in the piston 16 and has radiused ends engaging with the wall thereof at diametrically opposed positions. The strip 39 can be relatively narrow in a circumferential direction since it is necessary only to locate the clamp member 5 with respect to the stationary member 1 in a radial direction.

The construction and operation of the brake shown in Figures 3 to 6 is otherwise the same as that described above with reference to Figures 1 and 2 and corresponding reference numerals have been applied to corresponding parts.

In the construction illustrated in Figure 7 the plane shoulder 38 is omitted and the stud 34 leads into an extension 41 of frusto conical outline received in the bore 24 which is of complementary outline. The extension 41 has a threaded spigot 42 of reduced diameter which receives a nut 43, for example of the self-locking type, to clamp the stud relative to the limb 8. The boot 25 is retained in position at its end adjacent to the limb 8 by means of a spring clip 44.

In the construction illustrated in Figures 8 to 11 the stud 34 is similar to the stud shown in Figure 7. The stud is secured in a groove in the limb 8 by hot-rivetting. The boot 25 is a tight, no-slip fit on the pin.

The anti-rotation coupling comprises an adjustable eccentric 45 which is carried by spigot 46 secured in an opening 47 in the limb 8 by a bolt 48. A plastic spacer 49 prevents the eccentric from falling into the second piston 16. Alternatively a step could be provided in the piston for this purpose.

In order to change pads the bolts 48, 50 are removed, leaving the yoke free to pivot about the stud 34 without engaging the disc. The pads can then be replaced. Hence the hydraulic components of the brake are not disturbed during pad changes.

Figure 12 shows a construction in which the pin 13 comprises a cylindrical member which is guided to slide in a bore 51 in the clamp member 5. The pin is fixed in a bore portion in the stationary member 1 by an interference fit illustrated diagrammatically by the spots 52.

Figure 13 shows a modification in which the pin 13 is fixed in a bore in the yoke 5 adjacent to the disc (not shown) and slides in a bore provided in an extended part of the stationary member 1.

In the modified construction illustrated in Figure 14, the stationary member 1 and the clamp member 5 are provided with interdigitated fingers 53, 54 and 55 respectively. The pin 19 extends through coaxial bore portions in the fingers. The pin 19 comprises a cylindrical portion 56 which is slidable in the bore in finger 54 and a frusto-conical portion 57 received in a bore of complementary outline in the finger 55 of the clamp member 5. The portion 57 has a threaded extension 58 of reduced diameter which is received in sleeve 59 slidable in a bore in finger 53. Flexible sealing boots 60, 61 seal the exposed portions of the pin 19 and sleeve 59 between the faces of adjacent pairs of fingers from the atmosphere.

Figure 15 shows an inverted version of the construction of Figure 14. In this the yoke 5, rather than the stationary member 1 is of bifurcated construction and has two fingers 62, 63. The stationary member 1 has a single finger 64 positioned between fingers 62, 63. The construction of the pin 19 and the bores in the fingers is exactly the same as in Figure 14, the frusto-conical portion being received in a complementary bore in the fingers 64 in the stationary member rather than the yoke.

The constructions shown in Figures 14 and 15 are extremely strong since the pin 19 acts as a simple support beam. They are therefore suitable for heavy duty brakes.

Our invention has the advantage that the brake can be readily adapted to incorporate a hand brake applying mechanism. As illustrated in Figure 16 hand brake applying mechanism 67 is incorporated in an extension 68 of the outer piston 16 and acts between the limb 8 and the inner piston 15. The mechanism comprises an operating arm 69 splined on a shaft 70. An annular cam 71 is formed integrally with the shaft 70 and bears on one end of strut means 72 which acts on the inner piston 15. Three balls 73 are mounted in inclined grooves formed in the cam and undersurface of the extension 68. When the arm 69 is rotated the shaft 70 and cam 71 are rotated, thus causing displacement of the balls 73 in the grooves. This results in axial displacement of the strut means 73 and consequent application of the brake.

Figures 17 and 18 show a disc brake of similar construction to that shown in Figures 1 and 2 installed in a typical road wheel layout. The stationary member 1 is fixed to the hub axle 90 of the wheel. The rotatable disc 91 is bolted at 92 to a part of the wheel housing 93.

In an alternative arrangement the boot

sealing the sliding surfaces of the pin from the atmosphere is replaced by a bushing or aperture sleeve, the pin and sleeve combination being non-corrosive. For example, the pin may be stainless steel and the sleeve may be brass.

The brake described in the embodiments above has the advantages that the guide is mounted rigidly and robustly without incurring any substantial increase in the cost or weight of the brake, the brake is easy to manufacture and the pads can be changed easily without disturbing the hydraulic system. This brake construction substantially eliminates noise, or "klonk", of the yoke against its guiding surface, which often arose previously when a vehicle was braked, particularly on a slope, due to the yoke hitting against its guide surface. In this brake the yoke is guided on a pin and thus this problem does not arise to any great extent. The arrangement also substantially eliminates the risk of seizure of the yoke due to corrosion or ingress of dirt between the guiding surfaces.

In the majority of the embodiments described above the anti-rotation couplng is provided in the indirect piston, which is already sealed, lubricated and booted thus eliminating the need for extra seals for the anti-rotational coupling.

The form of the yoke in the above arrangements is such that it fits easily in the restricted gap between the disc and the wheel of a vehicle. The circumferential extremities of the yoke can be positioned at the centres of pressure of the pad assemblies such that the separation movement of the yoke limbs on application of the brake is restricted. The engagement of the yoke with the pads may be of small area such that some pad to clamp articulation is possible, as required in some commercial vehicles.

WHAT WE CLAIM IS:—

1. A disc brake of the kind set forth in which guide means are incorporated for mounting the clamp member on the stationary member for relative sliding movement in an axial direction, the guide means comprising solely of a rigid pin which is rigidly connected to one of the members, is slidably mounted in the other member, and is located wholly on one axial side of the disc, and anti-rotation means for preventing relative rotation between the clamp member and the stationary member about the pin, the pin being constructed and arranged to transmit to the stationary member substantially all the drag on the indirectly actuated pad assembly, and the pin comprising the sole direct slidable connection between the members, the clamp member otherwise having no direct connection with the stationary member, and the anti-rotation means comprising a coupling between the second piston and the clamp member.

2. A disc brake according to Claim 1, in which a sealing boot seals the sliding surfaces of the pin from the atmosphere.

3. A disc brake according to Claim 1 or 2 in which the pin is slidably guided in a blind bore in one of the members.

4. A disc brake according to Claim 1 or 2, in which the pin is slidably guided in an open bore in one of the members, the free open end being closed by a sealing cap.

5. A disc brake according to any preceding claim, in which the pin is fixedly secured in the clamp member and slidably guided in the stationary member.

6. A disc brake according to any preceding claim, in which the pin is located at the circumferential side of the brake at which any given point on the disc first comes into alignment when the disc is rotating in a normal forward direction and directly actuated friction pad assembly is guided in the stationary member between spaced arms which extend towards the disc.

7. A disc brake according to any preceding claim in which the second piston is hollow and acts at its open end, and the coupling is connected to the clamp member and received in the bore in the piston.

8. A disc brake according to any preceding claim, in which the pin is located as close as possible to the drag line, which comprises a tangent to the disc passing through the centre of pressure of the pad assemblies.

9. A disc brake according to any preceding claim, in which the pin comprises an internally threaded sleeve guided to slide in a bore in one of the members, the pin being connected to the other member by means of a bolt screwed into the bore of the sleeve through an opening in the member.

10. A disc brake according to any of Claims 1 to 8, in which the pin comprises a stud of stepped outline guided to slide in a bore in one of the members and secured to the other member.

11. A disc brake according to Claim 10, in which the stud has an extension of reduced diameter projecting through a bore in the other member and secured to it by rivetting.

12. A disc brake according to Claim 10, in which the stud has an extension of frusto-conical outline which is received in a bore of complementary outline in the other member.

13. A disc brake according to any pre-

ceding claim, in which the stationary member and the clamp member are provided with a total of at least three interdigited fingers, the pin extending through co-axial bore portions in the fingers and being slidably mounted in the fingers of one of the members and fixedly mounted in the or each finger of the other member.

14. A disc brake according to Claim 13, in which the exposed portions of the pin between the faces of adjacent pairs of fingers are sealed by flexible sealing boots.

15. A disc brake according to Claim 13 or 14, in which one of the members has two outer extending fingers and the other member has an inner extending finger positioned between the outer fingers and the pin comprises a first cylindrical portion slidable in a bore in one of the outer fingers, a second frusto-conical portion received in a complementary shaped bore in the inner finger and a third threaded portion of reduced diameter received in a sleeve which is slidable in a bore in the second outer finger.

16. A disc brake substantially as herein described with reference to and as illustrated in Figures 1 to 2 of the accompanying drawings.

17. A disc brake substantially as herein described with reference to and as illustrated in Figures 3 to 6 of the accompanying drawings.

18. A disc brake substantially as herein described with reference to and as illustrated in Figure 7 of the accompanying drawings.

19. A disc brake substantially as herein described with reference to and as illustrated in Figures 8 to 11 of the accompanying drawings.

20. A disc brake substantially as herein described with reference to and as illustrated in Figure 12 of the accompanying drawings.

21. A disc brake substantially as herein described with reference to and as illustrated in Figure 13 of the accompanying drawings.

22. A disc brake substantially as herein described with reference to and as illustrated in Figure 14 of the accompanying drawings.

23. A disc brake substantialy as herein described with reference to and as illustrated in Figure 15 of the accompanying drawings.

24. A disc brake substantialy as herein described with reference to and as illustrated in Figure 16 of the accompanying drawings.

25. A disc brake substantially as herein described with reference to and as illustrated in Figures 17 and 18 of the accompanying drawings.

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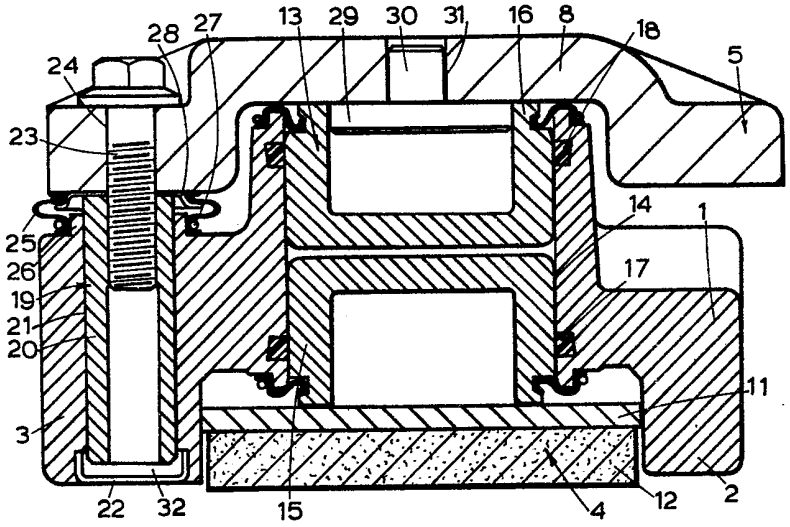

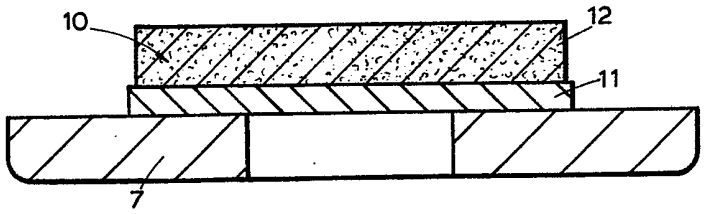

FIG.1.

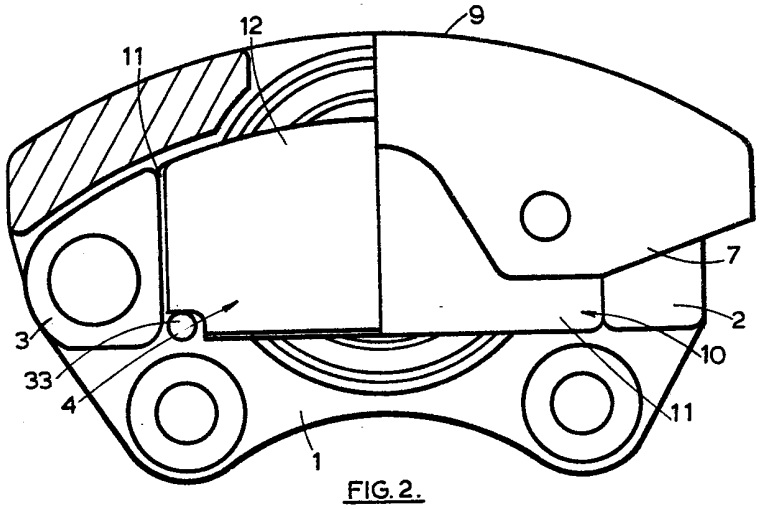

FIG. 2.

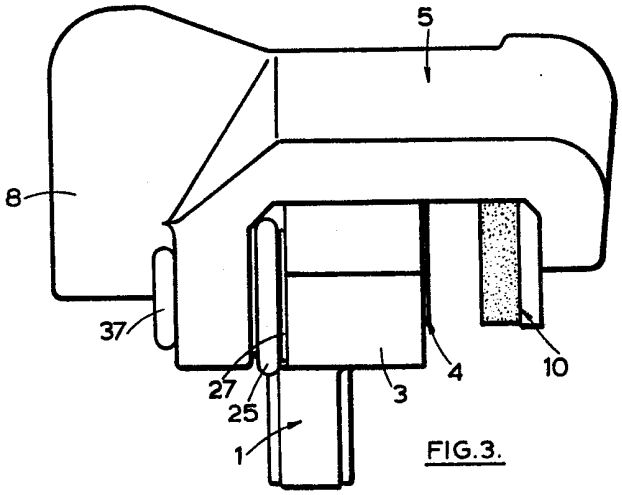

FIG.3.

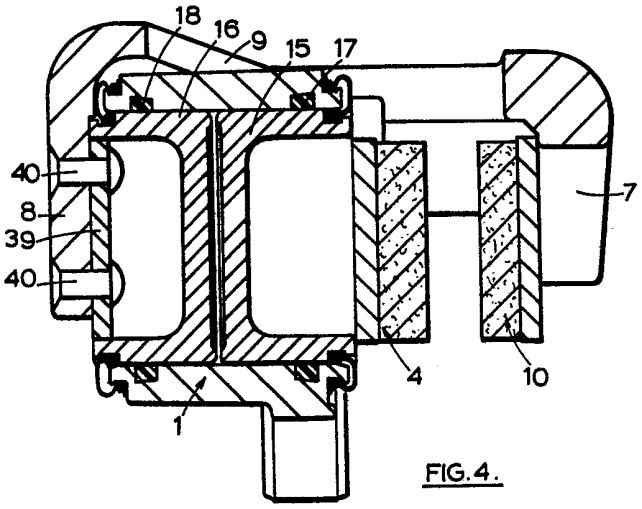

FIG.4.

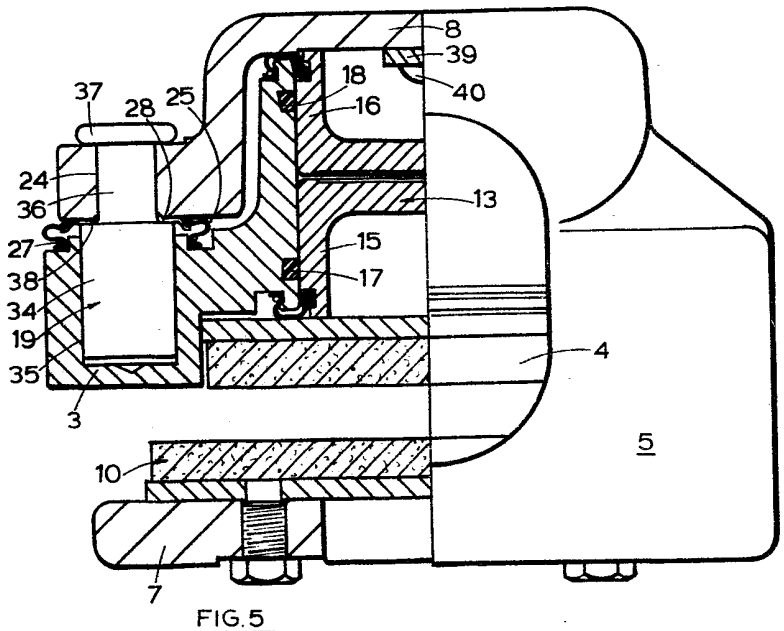
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FIG.5

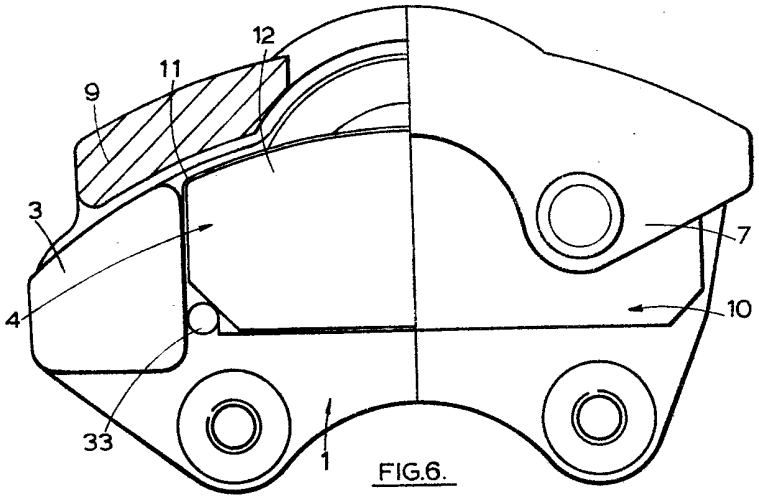
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FIG.6.

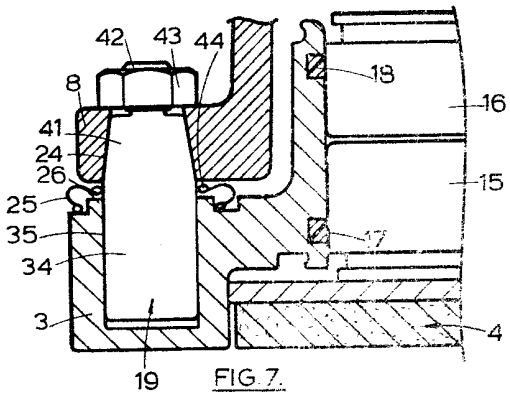
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FIG.7.

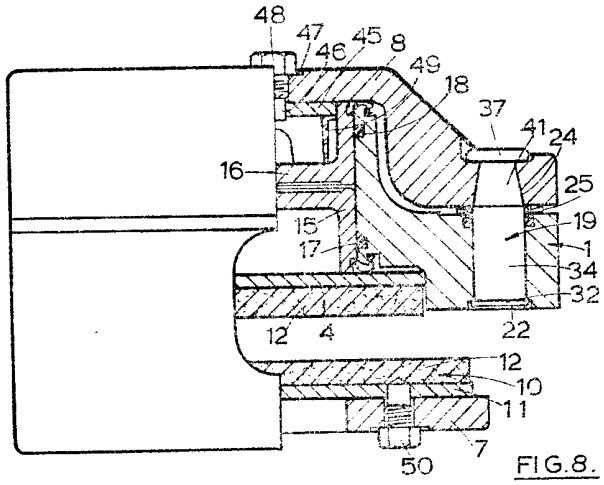
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FIG.8.

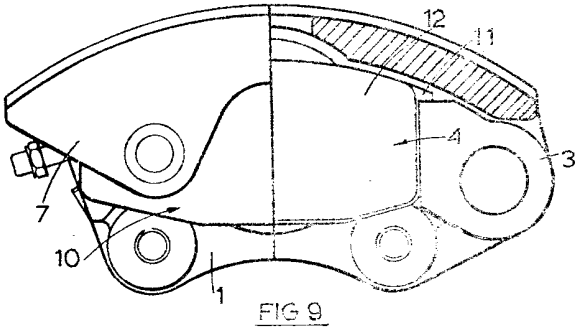


FIG 9

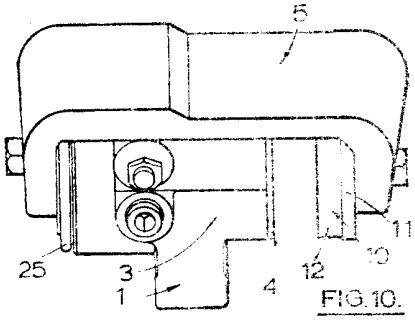
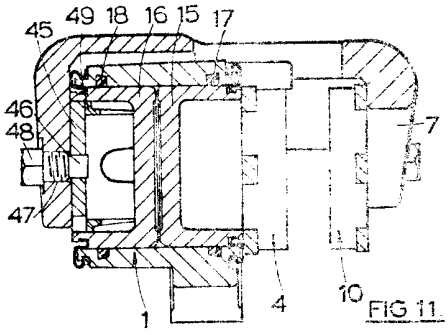


FIG.10.



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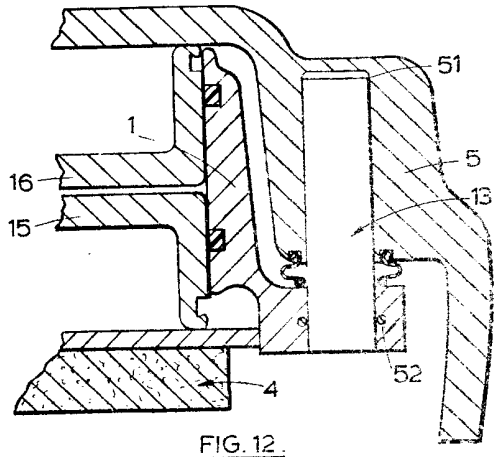

FIG. 12.

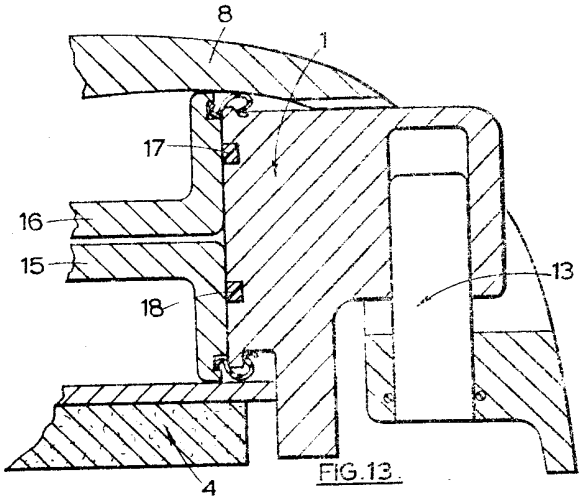

FIG. 13.

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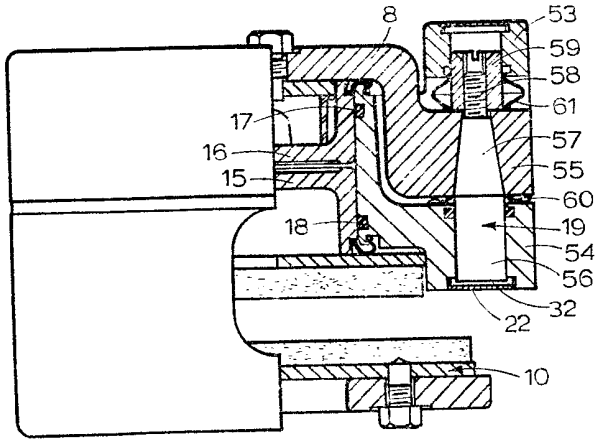


FIG 14.

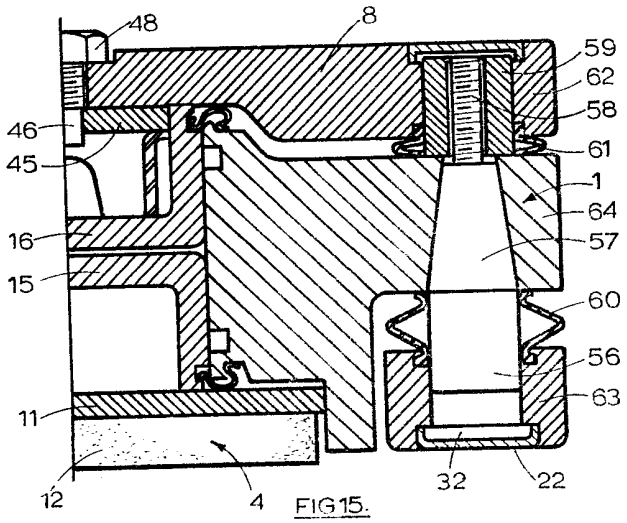
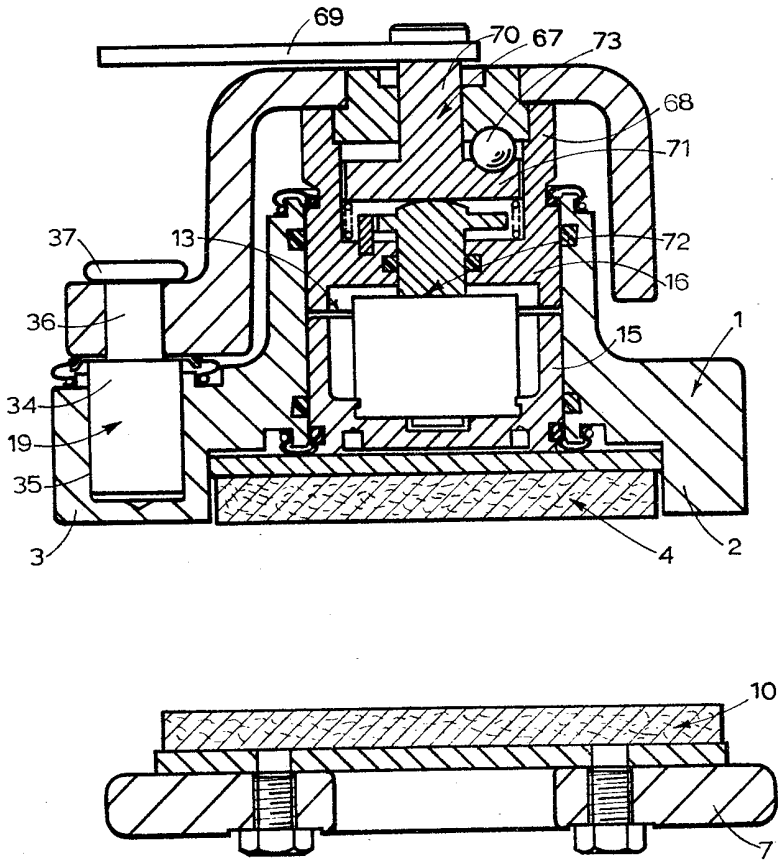


FIG15.

FIG.16



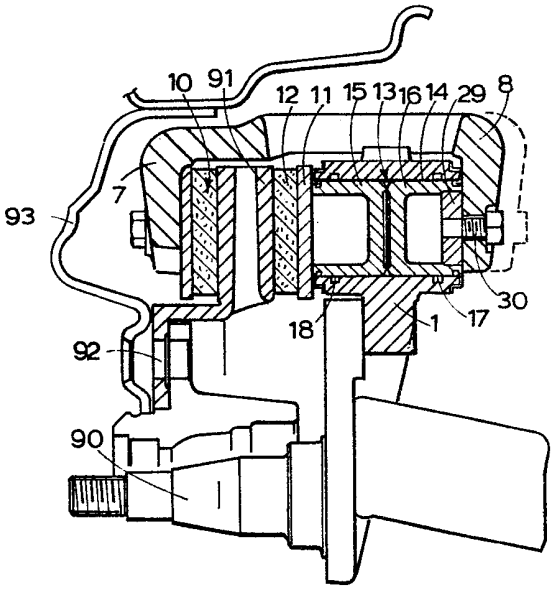


FIG.17.

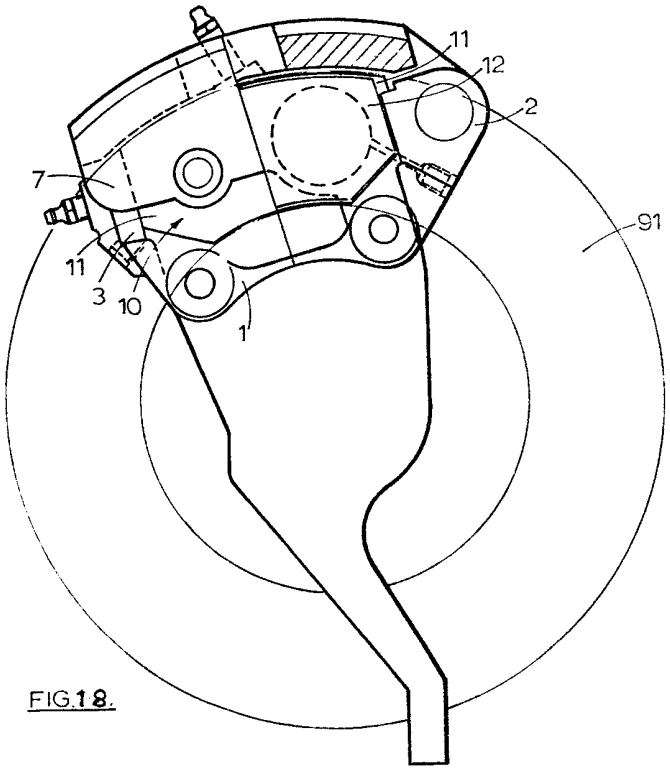


FIG.18.