



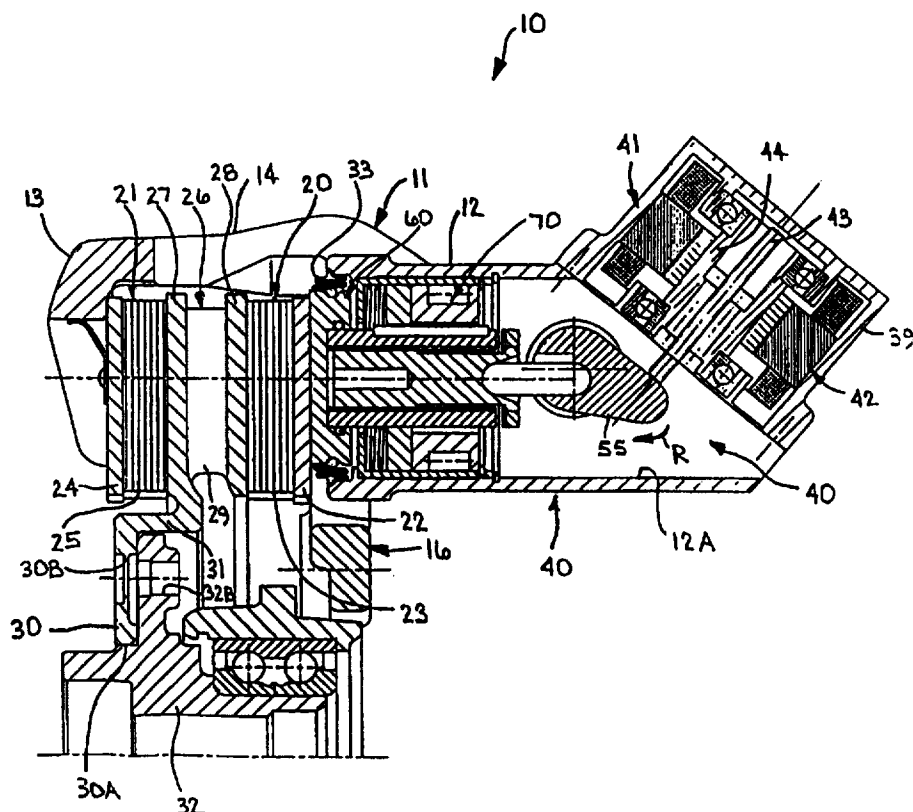
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(21) International Application Number: PCT/US97/14462 (22) International Filing Date: 15 August 1997 (15.08.97) (30) Priority Data: 60/024,361 15 August 1996 (15.08.96) US (71) Applicant (for all designated States except US): KELSEY HAYES COMPANY [US/US]; 12025 Tech Center Drive, Livonia, MI 48150 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): WEIGERT, Thomas [DE/DE]; Königsteiner Strasse 96, D-65812 Bad Soden (DE). KINGSTON, Andrew [DE/DE]; Graben Strasse 37, D-55262 Heidesheim (DE). OLIVERI, Salvatore [DE/DE]; Markt Strasse 11, D-56341 Filsen (DE). (74) Agent: INKS, Allen, W.; MacMillan, Sobanski & Todd, 4th floor, One Maritime Plaza, 720 Water Street, Toledo, OH 43604 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>Without international search report and to be republished upon receipt of that report.</i>

(54) Title: ELECTRO-MECHANICAL ACTUATION MECHANISM FOR DISC BRAKE ASSEMBLY

(57) Abstract

An improved structure for an electro-mechanical disc brake caliper assembly. The electro-mechanical disc brake caliper assembly includes an electro-mechanical actuation mechanism, a piston unit, and a freewheeling clutch. The electro-mechanical actuation mechanism includes an electrical actuating unit, an eccentric actuating lever, a mechanically actuated piston unit, and an automatic adjustment mechanism. The electrical actuating unit includes an electric motor and a motor spindle operatively coupled to the motor so as to convert rotary motion of the motor into axial movement of the motor spindle. The motor spindle operatively engages the lever so as to cause the lever to pivot relative to a lever pivot axis. The piston unit is operatively coupled to the lever and includes a piston spindle and a piston. The piston spindle is operatively coupled to the lever so as to be axially moved during actuation of the lever. The piston spindle is operatively coupled to the automatic adjustment mechanism so as to cause adjustment of the piston spindle during actuation of the electro-mechanical actuation mechanism if the piston moves more than a predetermined brake clearance distance. The freewheeling clutch is adapted to limit the adjustment provided by the automatic adjustment mechanism.



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TITLE

ELECTRO-MECHANICAL ACTUATION MECHANISM FOR DISC BRAKE ASSEMBLY

5

BACKGROUND OF THE INVENTION

This invention relates in general to vehicle disc brake assemblies and in particular to an improved electro-mechanical actuation mechanism adapted for use in such a vehicle disc brake assembly.

10 Most vehicles are equipped with a brake system for retarding or stopping movement of the vehicle in a controlled manner. A typical brake system for an automobile or light truck includes a disc brake assembly for each of the front wheels and either a drum brake assembly or a disc brake assembly for each of the rear wheels. The brake assemblies are actuated by hydraulic, pneumatic, or
15 electrical mechanisms when an operator of the vehicle depresses a brake pedal. The structures of these drum brake assemblies and disc brake assemblies, as well as the actuators therefor, are well known in the art.

A typical disc brake assembly includes a rotor that is secured to the wheel of the vehicle for rotation therewith. Pins secured to an anchor plate slidably
20 support a caliper assembly. The anchor plate is secured to a non-rotatable component of the vehicle, such as the vehicle frame. The caliper assembly includes a pair of brake shoes that are disposed on opposite sides of the rotor. The brake shoes are operatively connected to one or more hydraulically, pneumatically, or electrically actuated pistons for movement between a non-
25 braking position, wherein they are spaced apart from opposed axial sides or braking surfaces of the rotor, and a braking position, wherein they are moved into frictional engagement with the opposed braking surfaces of the rotor. When the operator of the vehicle depresses the brake pedal, the piston urges the brake

shoes from the non-braking position to the braking position so as to frictionally engage the opposed braking surfaces of the rotor and thereby slow or stop the rotation of the associated wheel of the vehicle.

SUMMARY OF THE INVENTION

This invention relates to an improved structure for an electro-mechanical disc brake caliper assembly. The electro-mechanical disc brake caliper assembly includes an electro-mechanical actuation mechanism, a piston unit, and a freewheeling clutch. The electro-mechanical actuation mechanism includes an electrical actuating unit, an eccentric actuating lever, a mechanically actuated piston unit, and an automatic adjustment mechanism. The electrical actuating unit includes an electric motor and a motor spindle operatively coupled to the motor so as to convert rotary motion of the motor into axial movement of the motor spindle. The motor spindle operatively engages the lever so as to cause the lever to pivot relative to a lever pivot axis. The piston unit is operatively coupled to the lever and includes a piston spindle and a piston. The piston spindle is operatively coupled to the lever so as to be axially moved during actuation of the lever. The piston spindle is operatively coupled to the automatic adjustment mechanism so as to cause adjustment of the piston spindle during actuation of the electro-mechanical actuation mechanism if the piston moves more than a predetermined brake clearance distance. The freewheeling clutch is adapted to limit the adjustment provided by the automatic adjustment mechanism.

Various advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a portion of an electro-mechanical disc brake caliper assembly in accordance with this invention.

Fig. 2 is a top plan view, partially in section, of a portion of the electro-mechanical disc brake caliper assembly.

Fig. 3 is an elevational view of an adjusting pin and adjusting lever of the electro-mechanical actuation mechanism taken along line 3-3 of Fig. 2.

Fig. 4 is an outboard view of the electro-mechanical disc brake caliper assembly.

Fig. 5 is an enlarged sectional view of a portion of the electro-mechanical disc brake caliper assembly illustrated in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is illustrated in Figs. 1 and 2 a portion of an electro-mechanical disc brake caliper assembly, indicated generally at 10, in accordance with this invention. The disc brake caliper assembly 10 includes a caliper, indicated generally at 11. The caliper 11 includes an inboard leg portion 12 and an outboard leg portion 13 that are interconnected by an intermediate bridge portion 14. As will be discussed below, the inboard leg portion 12 of the caliper 11 includes an annular recess 12A for receiving an electro-mechanical actuating mechanism, indicated generally at 40, for effecting the operation of the disc brake assembly 10 under normal operating conditions.

As shown in Fig. 4, the caliper 11 is slidably supported on a pair of pins 15 which are secured to an anchor plate indicated generally at 16. The pins 15 extend through respective non-threaded apertures (not shown) formed through the inboard leg 12 of the caliper 11. The pins 15 have threaded ends (not shown) which are received in respective threaded apertures (not shown) formed through the anchor plate 16. The pins 15 permit the caliper 11 to slide in both the

outboard direction (toward the left when viewing Figs. 1 and 2) and the inboard direction (toward the right when viewing Figs. 1 and 2). Such sliding movement of the caliper 11 occurs when the disc brake assembly 10 is actuated, as will be explained below. A pair of bolts 17 extend through respective non-threaded
5 apertures (not shown) formed through the anchor plate 16 to secure the anchor plate 16 to a stationary component of the vehicle, such as the steering knuckle (not shown) in a front wheel drive vehicle.

The anchor plate 16 includes a pair of outwardly extending arms 18 and 19 having upstanding guide rails 18A and 19A, respectively formed thereon.
10 The guide rails 18A and 19A extend transverse to the arms 18 and 19 and parallel to one another. The guide rails 18A and 19A are provided to slidably support an inboard brake shoe, indicated generally at 20, and an outboard brake shoe, indicated generally at 21, of the disc brake caliper assembly 10.

The inboard brake shoe 20 includes a backing plate 22 and a friction pad
15 23 (Fig. 1). The opposed ends of the inboard backing plate 22 have notches 22A and 22B formed therein for supporting the inboard brake shoe 20 on the guide rails 18A and 19A of the anchor plate 16. The outboard brake shoe 21 includes a backing plate 24 and a friction pad 25. The opposed ends of the outboard backing plate 24 have notches (not shown) formed therein for supporting the
20 outboard brake shoe 21 on the guide rails 18A and 19A of the anchor plate 16. Alternatively, as is known in the art, the inboard brake shoe 20 can be supported on a brake piston 63, while the outboard brake shoe 21 can be supported on the outboard leg portion 13 of the caliper 11.

Now referring again to Figs. 1 and 2, the disc brake assembly 10 further
25 includes a rotor, indicated generally at 26, which is connected to a hub, indicated generally at 32, and a wheel (not shown) of the vehicle for rotation therewith. The illustrated rotor 26 is ventilated and includes a pair of opposed friction plates 27 and 28 which are spaced apart from one another by a plurality of

intermediate ribs or posts 29 in a known manner. The rotor 26 extends radially outwardly between the inboard friction pad 23 and the outboard friction pad 25.

The rotor 26 further includes an inner mounting flange portion 30 connected to the friction plate 27 by a circumferential wall or hat portion 31.

5 The inner mounting flange portion 30 includes a centrally located pilot hole 30A that defines an axis of rotation for the rotor 26. A plurality of lug bolt receiving holes 30B (only one of such plurality of lug bolt receiving holes 30B is shown in Fig. 1) are equally spaced circumferentially on the rotor 26 about the pilot hole 30a. A lug bolt (not shown) extends through a respective one of a plurality of
10 lug bolt receiving holes 32A provided in the hub 32, and through each of the lug bolt receiving holes 30B for mounting and securing the rotor 26 to the hub 32 and vehicle wheel for rotation therewith.

The disc brake caliper assembly 10 also includes a dust boot seal 33 and a pair of retractor clips 34 and 35. The dust boot seal 33 is formed from a flexible
15 material and has a first end that engages an outboard end of the recess 12A. A second end of the dust boot seal 33 engages an annular groove formed in an outer side wall of the piston 63. A plurality of flexible convolutions are provided in the dust boot seal 33 to permit relative movement between the first and second ends thereof. The dust boot seal 33 is provided to prevent water,
20 dirt, and other contaminants from entering into the recess 12A. In the illustrated embodiment, the retractor clips 34 and 35 are supported on and secured to the guide rails 18A and 19A, respectively of the anchor plate 16. The retractor clips 34 and 35 are operative to spread the brake shoes 20 and 21 apart from one another when the disc brake caliper assembly 10 is not actuated.

25 The disc brake caliper assembly 10 further includes an electro-mechanical actuation mechanism, indicated generally at 40, for effecting the operation of the disc brake caliper assembly 10 under normal operating conditions. In the illustrated embodiment, the electro-mechanical actuation mechanism 40 includes

an electrical actuating unit 41, an eccentric actuating lever 55, a mechanically actuated piston unit 60, and an automatic adjustment mechanism 70.

In the illustrated embodiment, the electrical actuating unit 41 is disposed in a separate housing 39 which is secured to the inboard leg 12 of the caliper 11 by suitable means. The electrical actuating unit 41 includes an electric motor 42 and a spindle 43 operatively coupled to the motor 42 by an output shaft 44.

As best shown in Fig. 5, the illustrated electrical motor 42 is preferably a brushless DC motor and includes a pair of coils 42A and 42B, and magnets 42C. As will be discussed below, the spindle 43 is operatively coupled to motor 42 so as to move axially relative thereto to cause the eccentric lever 55 to pivot relative to a lever pivot axis A.

The output shaft 44 is supported in the opening inboard leg 12 of the caliper 11 by a pair of bearings 45 and 46. The output shaft 44 is coupled to the magnets 42C by suitable means, such as for example, by an adhesive or a binding band, to thereby effectively couple the output shaft 44 to the motor 42 for rotary motion when the motor 42 is actuated. The output shaft 44 also includes an outboard portion 44A provided with internal threads 47.

A plurality of planetary rollers 48 are interposed between the outboard portion 44A of the output shaft 44 and the spindle 43. A pair of roller guides 49 and 50 are disposed within and secured to the output shaft 44 between the opposed ends of the planetary rollers 48. The planetary rollers 48 are provided with external threads 51, which are effective to operatively engage the internal threads 47 of the outboard portion 44A of the output shaft 44, and internal threads 52, which are effective to operatively engage external threads 53 provided on the outer surface of the spindle 43. As a result, the planetary rollers 48 are effective to operatively couple the motor output shaft 44 to the spindle 43 to thereby convert the rotary motion of the output shaft 44 of the motor 42 into axial movement of the spindle 43.

The piston unit 60 includes a spindle 61, an adjustment nut 62 (which also is a part of the automatic adjustment mechanism 70), and a piston 63. The spindle 61 includes an inboard end 61A having a recess 64 formed therein, and an outboard end 61B having an opening 65 formed therein. The recess 64 is adapted to receive an end of a thrust pin 66. The other end of the thrust pin 66 is disposed in an opening 55A formed in the eccentric lever 55. The spindle 61 further includes external threads 67 provided on an outer end portion thereof. The external threads 67 are effective to operatively engage internal threads 68 provided on the adjustment nut 62 so as to cause rotation of the nut 62 relative to the spindle 61 during actuation of the electro-mechanical actuation mechanism 40. The inboard end 61A of the spindle 61 is secured to the inboard leg 12 of the caliper 11 by a suitable means to prevent rotation thereof. In the illustrated embodiment, the means for preventing rotation is a generally rectangular shaped pin 69. Also, a spring 37 is provided for biasing the spindle 61 to the normal brake position (to the left in Fig. 5) when the brake is released.

The adjustment nut 62 further includes an inboard end 62A and an outboard end 62B. The outboard end 62A of the nut 62 is disposed in a recess 63A formed in the piston 63, and engages an inner end surface of the recess 63A. An elastomeric member 38 is disposed in an annular recess formed in the piston 63, and engages an outer surface of the adjustment nut 62. The elastomeric member 38 allows rotation of the adjustment nut 62 relative to the piston 63, and may function as a roll back member to move the piston 63 to its normal unactuated position (not shown) when the electro-mechanical actuation mechanism 40 is released from the actuated position, as shown in Fig. 1.

The automatic adjustment mechanism 70 includes the adjustment nut 62, a generally hollow cylindrical sleeve 71, a clutch device 72, a driven ring, 73, and a spring 74. The sleeve 71 is rotatably supported in the recess 12A of the inboard leg 12 of the caliper 11. To accomplish this, an inboard end 71A of the

sleeve 71 is disposed adjacent a retaining ring 75, and an outboard end 71B of the sleeve 71 is disposed adjacent a shoulder 12B provided in the recess 12A. Also, in the illustrated embodiment, an air gap 76 is defined between a portion of the outer surface of the sleeve 71 and the inner surface of the recess 12A.

5 Alternatively, other means, such as for example bearings (not shown), can be provided between the outer surface of the sleeve 71 and the inner surface of the recess 12A. Also, alternatively, the outer diameter of the sleeve 71 can be reduced so that it can be installed from the left side of the recess 12A (not shown). This would allow the diameter of the recess 12A in the region of the
10 lever 55 to be smaller thereby improving the mounting of the lever 55 on lever pivot axis A.

The sleeve 71 further includes an opening formed in an inner surface thereof adjacent the inboard end 71A. As will be discussed below, an adjusting pin 77 (shown in Figs. 2 and 3) is disposed in the opening of the sleeve 71 and is
15 effective to operatively couple the sleeve 71 to an adjusting lever 78 for rotation therewith. The adjusting lever 78 is operatively coupled to the eccentric lever 55 and located on the lever axis A. As shown in Fig. 3, the mouth of the adjusting lever 78 is normally separated from the adjusting pin 77 by a predetermined gap *G*. In operation, if the piston 63 moves more than a predetermined normal brake
20 clearance, which is defined as the clearance between the friction pads 23 and 25 and the rotor friction plates 28 and 27, respectively, when the disc brake caliper assembly is in the non-braking condition, the sleeve 71 is rotated by the adjusting lever 78 via the adjusting pin 77 to thereby accommodate for the wear of the friction pads 23 and 25.

25 The clutch 72 is disposed in the sleeve 71 about the adjusting nut 62 between a retaining ring 79 and an inboard end 73A of the driven ring 73. The driven ring 73 is disposed in the sleeve 71 about the adjusting nut 62. A key 73B couples the driven ring 73 to the adjusting nut 62 to prevent relative rotation

therebetween, but permitting the driven ring 73 to move axially relative to the adjusting nut 62. The driven ring 73 is urged against an outboard end 72A of the clutch 72 by an outboard end of the spring 74. The inboard end of the spring 74 engages an inner end surface of the sleeve 71. The outboard end 72A of the clutch 72 and the inboard end 73A of the driven ring 73 are coupled together by a friction coupling, or other suitable means, to thereby limit the torque transmitted by the sleeve 71 to the adjusting nut 62 via the ring 73.

When it is desired to actuate the disc brake caliper assembly 10 to slow or stop the rotation of the rotor 26 and the vehicle wheel associated therewith, the driver of the vehicle depresses the brake pedal (not shown). The depression of the brake pedal generates an electrical signal that is operative to actuate the electro-mechanical actuation mechanism 40. In particular, the signal actuates the electric motor 42 which rotates the output shaft 44 and imparts rotary motion to the rollers 48 which in turn, axially move the spindle 43 (toward the left when viewing Figs. 1 and 2) causing the end of the spindle to rotate the eccentric lever 55 in a clockwise direction, as indicated by arrow *R* in Figs. 1 and 3. This movement of the lever 55 causes axial movement of the thrust pin 66 (toward the left when viewing Figs. 1 and 2) causing axial movement of the spindle 61 and the piston 63 (toward the left when viewing Figs. 1 and 2). As a result, the piston 63 engages the backing plate 22 of the inboard brake shoe 20 and moves the friction pad 23 of the inboard brake shoe 20 into frictional engagement with the inboard friction plate 28 of the rotor 26. At the same time, the caliper 11 slides on the pins 15 in the inboard direction (toward the right when viewing Figs. 1 and 2) such that the outboard leg 13 thereof moves the friction pad 25 of the outboard brake shoe 21 into frictional engagement with the outboard friction plate 27 of the rotor 26. As a result, the friction pads 23 and 25 frictionally engage the opposed friction plates 27 and 28 of the rotor 26.

If the electro-mechanical actuation mechanism 40 is actuated and the piston 63 moves more than the predetermined brake clearance, the adjusting lever 78 rotates in the direction of the arrow *R* more than the width of the gap *G* and engages the adjusting pin 77 (as shown in Fig. 3). The adjusting pin 77
5 causes the sleeve 71 to rotate in the recess 12A. As a result of this and so long as the torque of the clutch 72 is below a predetermined limit, the rotation of the sleeve 71 is operative to rotate the ring 73 via the clutch connection therewith and cause the adjusting nut 62 to rotate relative to the spindle 61 to thereby accommodate for brake wear. When the brake is released, since the clutch is a
10 freewheeling type of clutch, the sleeve 71 rotates back to its normal position and defines the gap *G* between the mouth of the adjusting lever 78 and the adjusting pin 77 as shown in Fig. 3.

One advantage of this invention is that any lever 55 ratio can be realized so that optimal torque-speed characteristics of the motor 42 can be used. Also,
15 the direction of the axis *A* can be varied by rotating the axis *A* and moving the contact point between the lever 55 and the spindle 43 so that the position of the actuating unit 41 can be changed relative to the space in the wheel area of the vehicle.

Although the invention has been described and illustrated in connection
20 with the electrical actuating unit 41, other types of actuating units can be used to actuate the lever 55. For example, the lever 55 can be actuated by a cable (not shown) which is operatively connected to an electrical actuating unit (not shown) located remote from the disc brake caliper assembly 10, or by a motor gear or planetary gear unit which directly transmits the torque from the motor to the
25 lever 55. In addition, although the invention has been described and illustrated in the context with a sliding caliper disc brake assembly 10, it will be appreciated that this invention may be used with other types of brake assemblies. For example, this invention may be used in a fixed caliper disc brake assembly

(not shown), and in a drum-in-hat type of disc brake assembly (not shown), wherein the brake assembly includes a disc type service brake and a drum type parking and emergency brake.

The principles and mode of operation of this invention have been
5 described and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. A disc brake assembly comprising:

an anchor plate adapted to be connected to a non-rotatable component of a vehicle;

5 a caliper adapted to be connected to said anchor plate;

a pair of brake shoes adapted to be movable into frictional engagement with opposed sides of a rotor under normal brake operating conditions to slow a moving vehicle; and

an electro-mechanical actuation mechanism for effecting the operation of
10 the disc brake caliper assembly under normal operating conditions in order to selectively move said brake shoes from a non-braking position, wherein said brake shoes are disengaged from the rotor, to a brake position, wherein said brake shoes frictionally engage the rotor, said electro-mechanical actuation mechanism including an electrical actuating unit, an actuating lever operatively
15 coupled said electrical actuating unit, a mechanically actuated piston unit operatively coupled to said actuating lever, an automatic adjustment mechanism to accommodate for wear of said brake shoes, and a clutch for limiting the adjustment provided by said automatic adjustment mechanism.

20 2. A disc brake assembly comprising:

an anchor plate adapted to be connected to a non-rotatable component of a vehicle;

a caliper adapted to be connected to said anchor plate;

25 a pair of brake shoes supported on said anchor plate and adapted to be movable into frictional engagement with opposed sides of a rotor under normal brake operating conditions to slow a moving vehicle;

an electro-mechanical actuation mechanism carried by said caliper for effecting the operation of the disc brake assembly under normal operating

conditions in order to selectively move said brake shoes from a non-braking position, wherein said brake shoes are disengaged from the rotor, to a brake position, wherein said brake shoes frictionally engage the rotor; said electro-mechanical actuation mechanism including an electrical actuating unit, an
5 eccentric actuating lever, a mechanically actuated piston unit, and an automatic adjustment mechanism, said electrical actuating unit including an electric motor and a motor spindle operatively coupled to said motor so as to convert rotary motion of said motor into axial movement of said motor spindle, said motor spindle operatively engaging said lever so as to cause said lever to pivot relative
10 to a lever pivot axis, said piston unit being carried by said caliper and operatively coupled to said lever, said piston unit including a piston spindle and a piston, said piston spindle being operatively coupled to said lever so as to be axially moved during actuation of said lever, said piston spindle being operatively coupled to said automatic adjustment mechanism so as to cause adjustment of
15 said piston spindle during actuation of said electro-mechanical actuation mechanism if said piston moves more than a predetermined brake clearance distance; and

a freewheeling means carried by said caliper for limiting the adjustment provided by said automatic adjustment mechanism.

20

3. The disc brake assembly of Claim 2 wherein said piston spindle is operatively coupled to said piston by a nut threaded to said piston spindle.

4. A disc brake assembly comprising:

25 a brake shoe adapted to be selectively moved between a non-braking position, wherein said brake shoe is disengaged from a rotor, to a brake position, wherein said brake shoe frictionally engages the rotor; and

an actuation mechanism for operatively coupled to said brake shoe and operative to selectively move said brake shoe between said non-braking position and said braking position, said actuation mechanism including an actuating unit, an actuating lever operatively coupled said actuating unit, a mechanically
5 actuated piston unit operatively coupled to said actuating lever, an automatic adjustment mechanism to accommodate for wear of said brake shoes, and a clutch mechanism for limiting the adjustment provided by said automatic adjustment mechanism.

10 5. The disc brake assembly of Claim 4, wherein said actuating unit includes an electrical motor which can be selectively energized and a motor spindle operatively coupling said motor to said actuating lever whereby said actuating lever can be selectively actuated by selectively energizing said motor.

15 6. The disc brake assembly of Claims 2 or 5 wherein said motor is a brushless DC motor.

7. The disc brake assembly of Claims 2 or 5 wherein said motor includes an output shaft having internal threads thereon, said motor spindle
20 having external threads thereon and further including means for preventing rotation of said motor spindle while permitting axial movement of said motor spindle, said disc brake assembly further including a plurality of planetary rollers interposed between said output shaft and said motor spindle, said planetary rollers effectively coupling said output shaft to said motor spindle and converting
25 rotary motion of said output shaft into axial movement of said motor spindle.

8. The disc brake assembly of Claim 4 wherein said piston unit includes a piston spindle operatively coupled to said actuating lever, and a nut

operatively coupled to said brake shoe, said piston spindle and said nut being coupled together in an axial relationship which is adjusted by said automatic adjustment mechanism to accommodate wear of said brake shoe.

5 9. The disc brake assembly of Claim 8 wherein said piston unit further includes a piston interposed between said nut and said brake shoe for operatively coupling said nut to said brake shoe.

10 10. The disc brake assembly of Claim 9 wherein said piston defines a cylindrical recess formed in an axial face thereof, said piston further defining a radially extending annular recess in the radial surface of said cylindrical recess, said nut extending into said cylindrical recess, said disc brake assembly further including an elastomeric member seated in said annular recess and engaging said nut.

15

 11. The disc brake assembly of Claims 3 or 8 wherein said automatic adjustment mechanism includes a hollow cylindrical sleeve disposed about said nut, an annular clutch device, an annular driven ring, and a spring, said clutch device being disposed about said nut and spaced radially apart therefrom, said
20 annular clutch device further being disposed within and engaging said sleeve, said annular driven ring being disposed about and being movable axially relative to said nut while being restrained against rotation relative thereto, said spring acting between said sleeve and said driven ring to urge said driven ring into frictional engagement with said clutch device, whereby said sleeve and said nut
25 are frictionally coupled.

 12. The disc brake assembly of Claim 11 wherein said actuating lever is operatively coupled to sleeve.

13. The disc brake assembly of Claim 12 wherein said actuating lever includes an adjusting lever having a notch formed therein and said sleeve has a pin fixed thereto, said pin being disposed in said notch to form a lost motion connection between said actuating lever and said sleeve whereby operation of
5 said actuating lever periodically actuates said automatic adjustment mechanism as said brake shoe wears.

14. The disc brake assembly of Claims 2 or 4 wherein said actuating lever defines an axis of rotation and further defines a first recess skew to said
10 axis, and wherein said piston defines a second recess in an axial face thereof, the disc brake assembly further including a pin having a first end and a second end, said first end being seated in said first recess and said second end being seated in said second recess to eccentrically couple said actuating lever and said piston.

15 15. A disc brake assembly as disclosed in the specification.

16. A disc brake assembly having any of the inventive features disclosed in the specification.

20 17. A disc brake assembly as disclosed in the drawings.

18. A disc brake assembly having any of the inventive features disclosed in the drawings.

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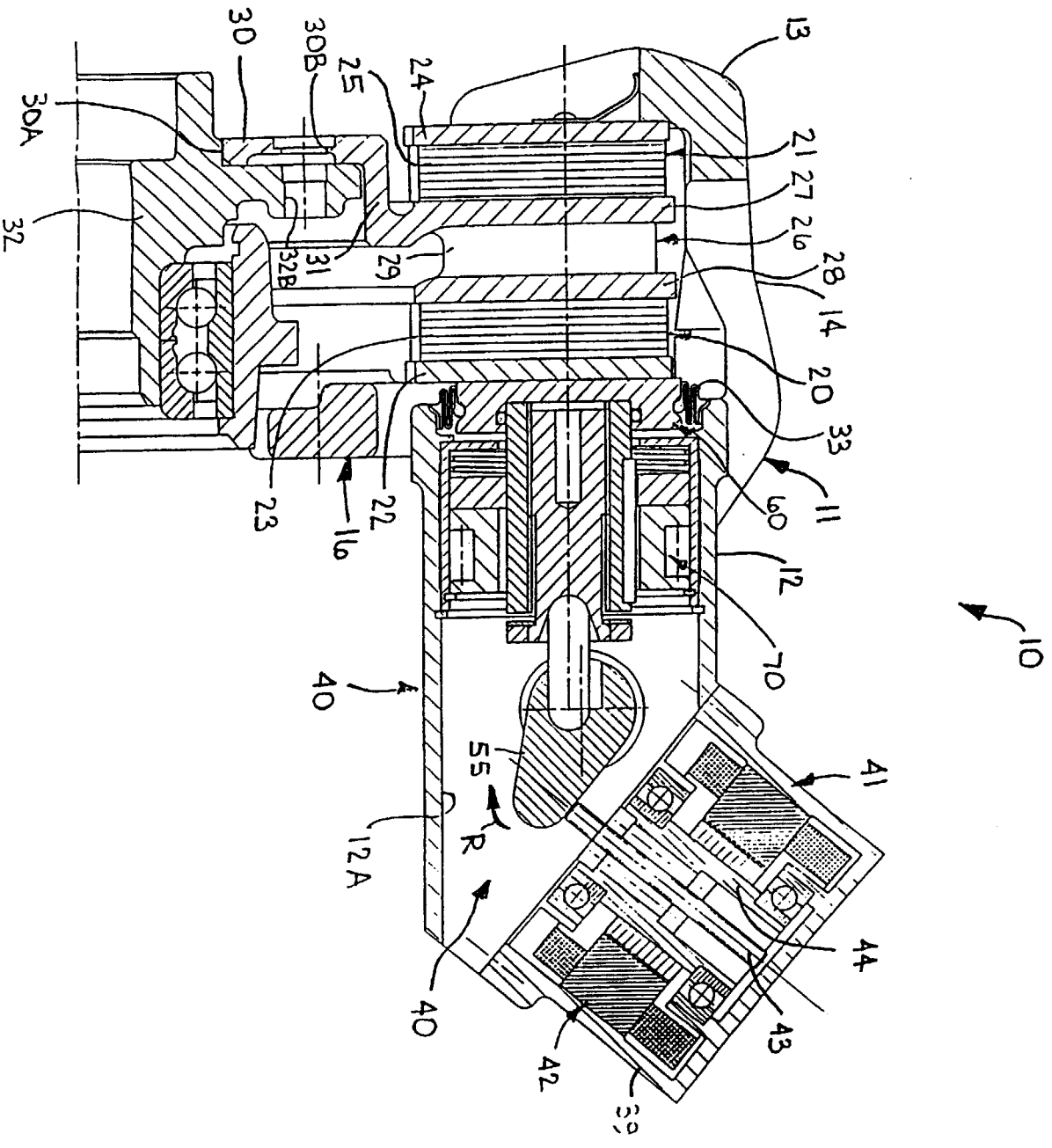


FIG. 1

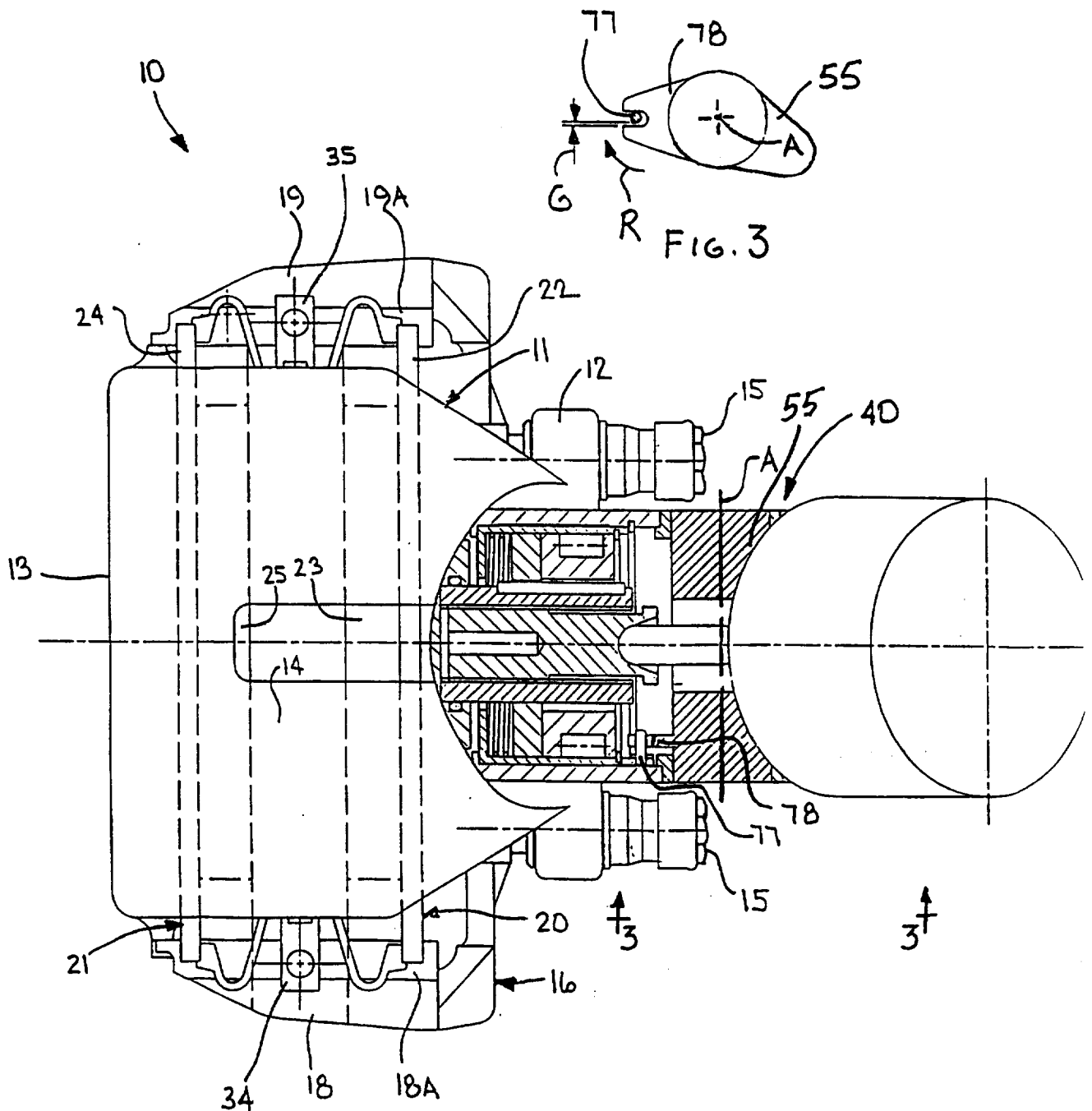


FIG. 2

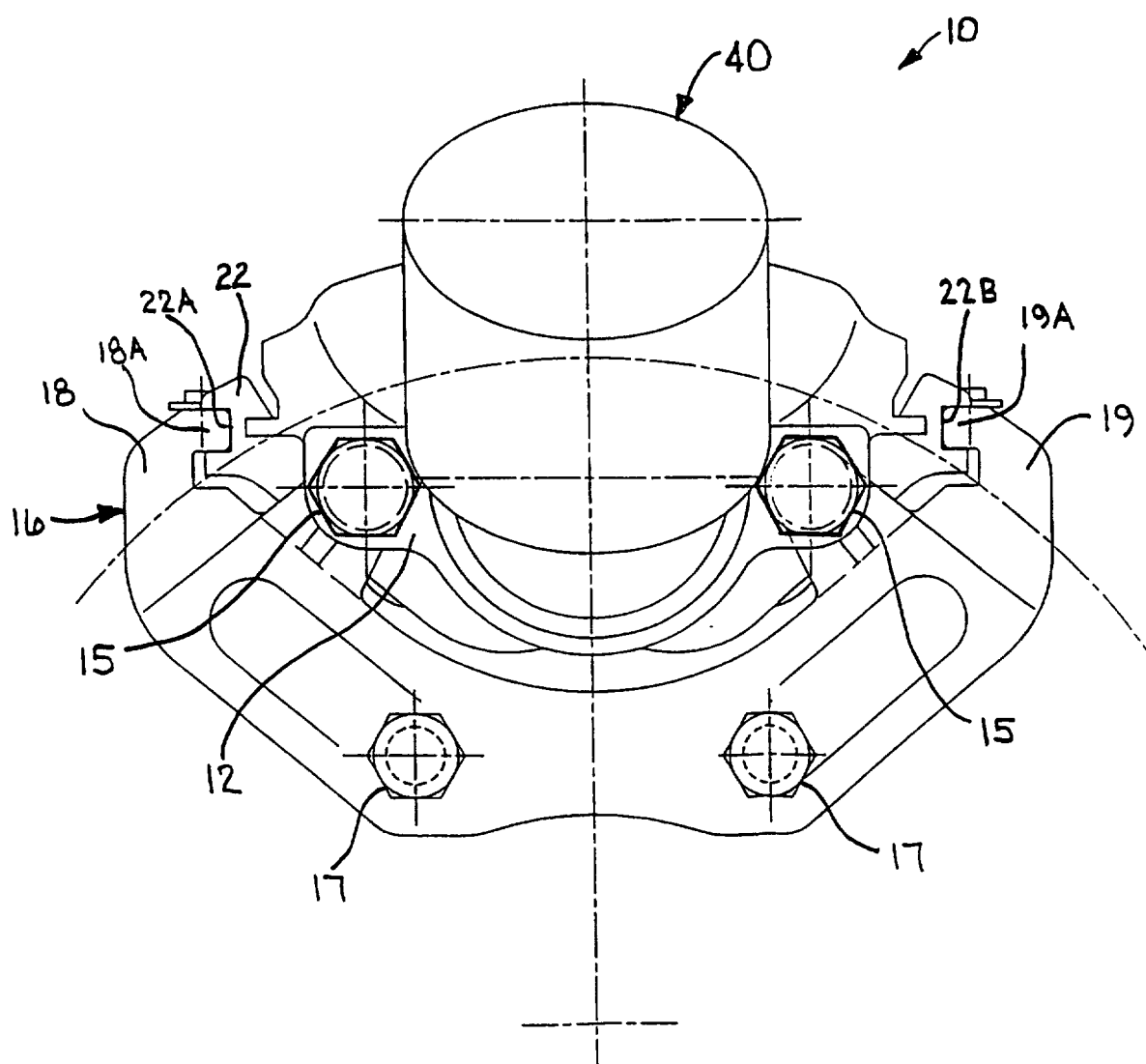


FIG. 4

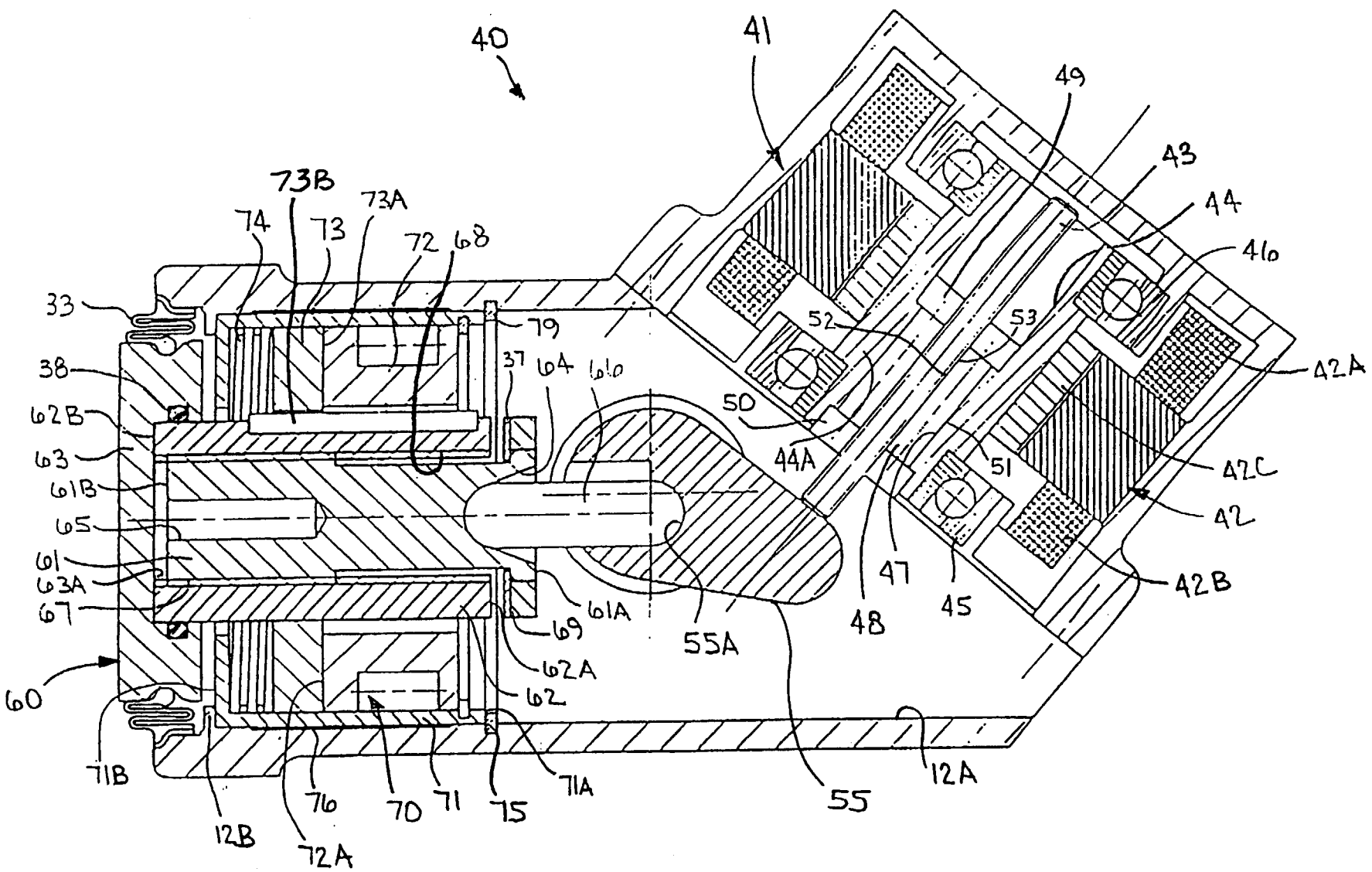


FIG. 5