



(22) Date de dépôt/Filing Date: 2002/02/11

(41) Mise à la disp. pub./Open to Public Insp.: 2003/08/11

(51) Cl.Int.⁷/Int.Cl.⁷ A61G 5/02

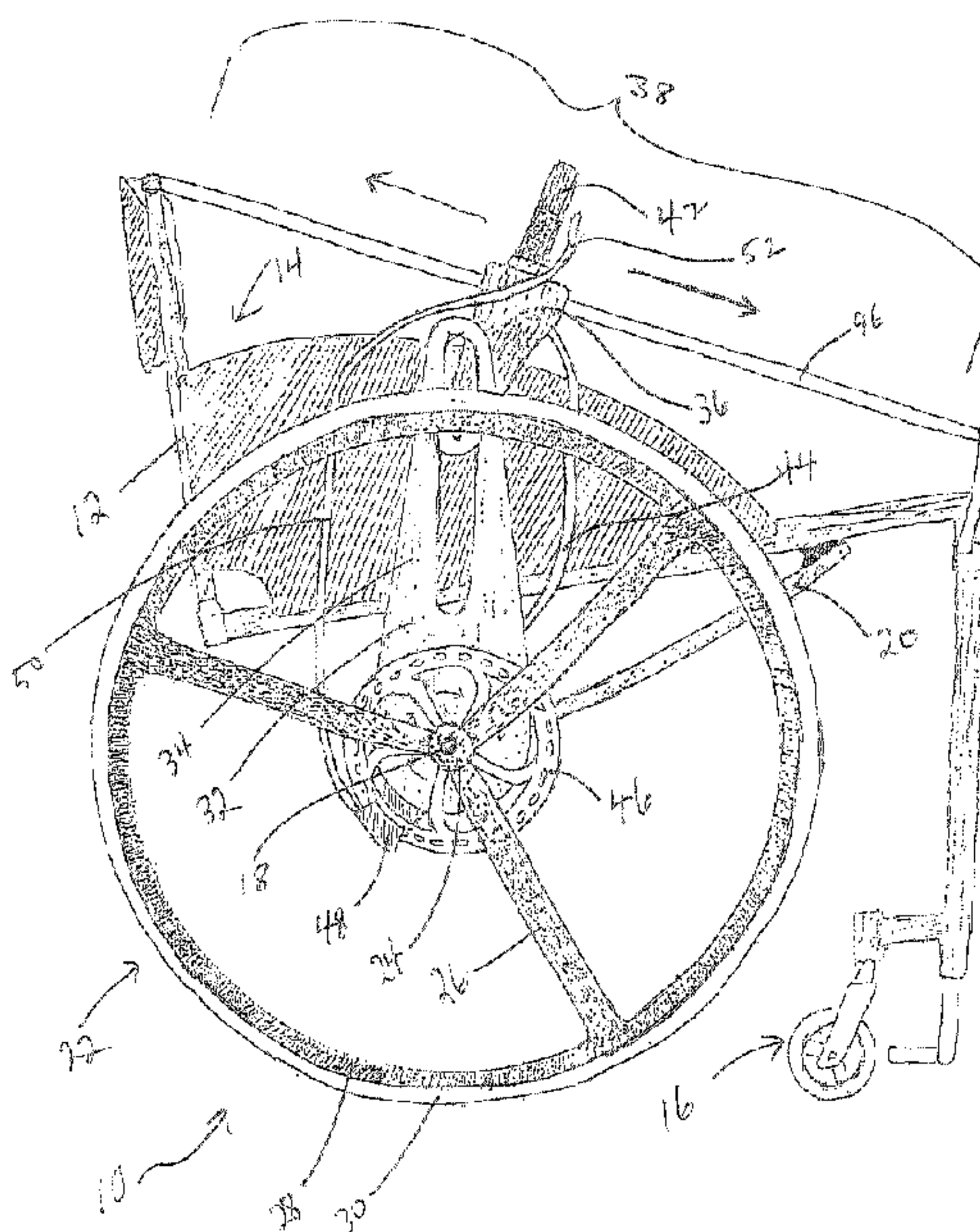
(71) Demandeurs/Applicants:
HARCOURT, MICHAEL, CA;
BAGG, CHRISTIAN, CA

(72) Inventeurs/Inventors:
HARCOURT, MICHAEL, CA;
BAGG, CHRISTIAN, CA

(74) Agent: BENNETT JONES LLP

(54) Titre : FAUTEUIL ROULANT

(54) Title: WHEELCHAIR



(57) **Abrégé/Abstract:**

A manually-propelled wheelchair having a frame having a forward-facing seat, two independently castered front wheels mounted to the frame, a rear axle suspended beneath the frame, and two rear driving wheels, each rotatably mounted upon an opposite end of the axle. Rotatably mounted upon an opposite ends of the axle are two lever arm assemblies, each comprised of a discrete lever arm ending in a handle and extending far enough from the axle to allow an occupant of the seat to grip the handle and a discrete one-way clutch connecting the lever arm to the wheel mounted upon the same end of the axle. When the occupant pushes the handles in a forward direction, the one-way clutches are engaged so that torque is applied to turn the wheels so as to propel the wheelchair in the forward direction, but when the occupant ceases to push the handles or pulls the handles rearward, the one-way clutches are disengaged, allowing the handles to be pulled freely rearward, and allowing the wheels to rotate forward freely. The one-way clutches may be disconnected by the occupant by operating twist grip handles mounted upon the lever arms. Occupant-operable disk brakes are provided for each driving wheel, the rotor of each disk brake connected to a driving wheel so as to rotate with the driving wheel and the caliper of the disk brake mounted upon corresponding lever arm.

ABSTRACT

A manually-propelled wheelchair having a frame having a forward-facing seat, two independently castored front wheels mounted to the frame, a rear axle suspended
5 beneath the frame, and two rear driving wheels, each rotatably mounted upon an opposite end of the axle. Rotatably mounted upon an opposite ends of the axle are two lever arm assemblies, each comprised of a discrete lever arm ending in a handle and extending far enough from the axle to allow an occupant of the seat to grip the handle and a discrete one-way clutch connecting the lever arm to the wheel mounted
10 upon the same end of the axle. When the occupant pushes the handles in a forward direction, the one-way clutches are engaged so that torque is applied to turn the wheels so as to propel the wheelchair in the forward direction, but when the occupant ceases to push the handles or pulls the handles rearward, the one-way clutches are disengaged, allowing the handles to be pulled freely rearward, and allowing the
15 wheels to rotate forward freely. The one-way clutches may be disconnected by the occupant by operating twist grip handles mounted upon the lever arms. Occupant-operable disk brakes are provided for each driving wheel, the rotor of each disk brake connected to a driving wheel so as to rotate with the driving wheel and the caliper of the disk brake mounted upon corresponding lever arm.

WHEELCHAIR

FIELD

5 This invention relates to the field of manually-propelled wheelchairs and in particular to a lever-operated wheelchair.

BACKGROUND

10 Manually-propelled wheelchairs are conventionally comprised of a frame having a seat. Typically, the frame is mounted upon two large rear wheels and two small castered front wheels. Many wheelchairs provide grip rings, which are wheel-like structures somewhat smaller than the rear wheels, that are attached outboard of the rear wheels so that an occupant of the seat can apply torque to a rear wheel by
15 gripping the corresponding grip ring and pushing it forward or pulling it back. Further, the occupant may slow or stop the wheelchair by using his or her hands (preferably gloved) to apply friction to the grip rings. The grip rings are advantageous as the occupant's hands can be kept cleaner than if the occupant gripped the rear wheels directly, but the occupant requires considerable upper body strength and
20 coordination to manipulate the wheels using the grip rings. Further, as the movement required to grip and push or pull the grip ring follows a circular arc as the wheel turns, the occupant is restricted to a fairly short stroke unless he or she can bend forward in a somewhat awkward manner to follow that arc.

25 A large number of other propulsion schemes for manually-propelled wheelchairs have been proposed, but those known to the inventor are either complicated or inefficient or require more strength and coordination than some wheelchair users are capable of providing. In particular, some wheelchair users may lack sufficient strength and coordination in their hands to grip a grip ring, but still
30 have enough strength in their upper arms to push and pull if their movements can be guided in some manner.

SUMMARY

The present invention is directed in one aspect to providing a manually-propelled wheelchair that includes a frame having a forward-facing seat, two
5 independently-castered front wheels mounted to the frame, and two rear driving wheels rotatably mounted upon opposite ends of a rear axle upon that is suspended beneath the frame. Two lever arm assemblies, each also rotatably mounted upon an opposite end of the axle are provided. Each is comprised of a discrete lever arm ending in a handle and extending far enough from the axle to allow an occupant of the
10 seat to grip the handle and a discrete one-way clutch connecting the lever arm to the wheel mounted upon the same end of the axle. When the occupant pushes the handles in a forward direction, the one-way clutches are engaged so that torque is applied to turn the wheels so as to propel the wheelchair in the forward direction, but when the occupant ceases to push the handles or pulls the handles rearward, the one-way
15 clutches are disengaged, allowing the handles to be pulled freely rearward, and allowing the wheels to rotate forward freely.

In another aspect of the present invention the lever arm assembly may also include an indexed drive ring fixedly attached to the one-way clutch between the one-
20 way clutch and the lever arm, a retractable drive pin coupled to the lever arm for engaging the indexed drive ring, and an actuator controllable by the occupant for extending and retracting the drive pin. When the pin is retracted, the lever arm is disconnected from the one-way clutch and when the pin is extended to engage the indexed drive ring, the lever arm is connected to the one-way clutch.

25 In another aspect of the present invention, a discrete occupant-operable disk brake may be included for each wheel. The rotor of the disk brake is connected to the wheel so as to rotate with the wheel. The caliper of the disk brake is mounted upon the lever arm, so that when the lever arm is disconnected from the one-way clutch, the
30 occupant may move a wheel forward or rearward by engaging the brake for that wheel and pushing forward or pulling rearward the handle of that lever arm.

In yet another aspect of the present invention, two guide bars may be fixedly attached to the frame, one upon each side of the frame and parallel to the plane of a wheel. The handle of each lever arm is then slidingly coupled to a discrete one of the guide bars so that handle is constrained to follow a discrete guide bar as it is pushed or pulled by the occupant.

In yet another aspect of the present invention, the axle is suspended by two carbon fiber leaves, each of which is only attached to the frame near the front of the frame.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic side elevation view of a wheelchair in accordance with the invention.

Figure 2 is a schematic side elevation view of the wheelchair of Figure 1 after the removal of the driving wheels.

Figure 3 is a schematic front elevation view of a portion of the wheelchair of Figure 1.

Figure 4 is a schematic front isometric view of the lower end of the lever arm assembly and portions of one driving wheel of the wheelchair of Figure 1.

Figure 5 is a schematic partially sectional side elevation view of the lower end of the lever arm assembly and portions of one driving wheel of the wheelchair of Figure 1 taken facing axial outward.

Figure 6 is a schematic partially sectional front elevation view of the lower end of the lever arm assembly and wheel of one driving wheel of the wheelchair of Figure 1 taken through the axle.

Figure 7 is a schematic front elevation section of the hub of one driving wheel of the wheelchair of Figure 1.

Figure 8 is a schematic outward axial view of the hub of Figure 7.

5

Figure 9 is a schematic front elevation section of the axle stub of one driving wheel of the wheelchair of Figure 1.

10 Figures 10A, 10B, and 10C are schematic side elevation, plan, and end views of the suspension arm bracket and a portion of one suspension arm of one driving wheel of the wheelchair of Figure 1.

15 Figures 11A and 11B are schematic side elevation and end views of the suspension arm mounting block and portions of one suspension arm and the frame of one driving wheel of the wheelchair of Figure 1.

20 Figures 12A, 12B, and 12C are, respectively, a schematic front elevation view and a partial sectional front elevation view of the upper portion of the lever arm assembly of one driving wheel of the wheelchair of Figure 1 and an isometric view of one of the spacers of those views.

Figure 13 is a schematic side elevation view of another wheelchair in accordance with the invention.

25 Figure 14 is a schematic partially sectional side elevation view of the lower end of the lever arm assembly and portions of one driving wheel of the wheelchair of Figure 13.

30 Figure 15 is a schematic partially sectional front elevation view of the lower end of the lever arm assembly and wheel of one driving wheel of the wheelchair of Figure 14 taken through the axle.

DETAILED DESCRIPTION

Figure 1 shows a preferred embodiment of a manually-powered wheelchair in accordance with the present invention. Figure 2 shows the same embodiment with its driving wheels removed. The wheelchair, generally indicated by reference numeral 10 in Figure 1, comprises a frame 12 that includes a forward-facing seat 14 for an occupant, two independently-castered front wheels mounted to the frame 12, the right one of which, from the viewpoint of an occupant of the wheelchair, is visible and is indicated in Figure 1 by reference numeral 16, a rear axle suspended beneath the frame 12, the rear axle including an axle pin 18 that is visible in Figure 1 and suspended by two suspension arms, the right one of which is indicated by reference numeral 20 in Figure 1, and two rear driving wheels, the right one of which is visible in Figure 1 and is indicated generally by reference numeral 22. In the following description, the right driving wheel 22 and the mechanism used to drive and control it will be described in detail. The left driving wheel, which is not shown in Figure 1, is identical except for the changes necessary to mount it on the left side of the wheelchair 10. Hence all references below are to components on the right side of the wheelchair 10, unless specifically stated to be otherwise. For example, the right driving wheel 22 will henceforth be referred to as "the driving wheel 22".

20

The driving wheel 22, which is shown in more detail in Figure 3, is conventional, comprising a hub 24, wheel spokes 26, a rim 28, and a tire 30. The hub 24 is shown in detail in Figures 7 and 8.

25

The driving wheel 22 is rotatably mounted upon the axle pin 18 in a manner that will be described in detail below. The foregoing description of the wheelchair 10, with the exception of the suspension arm 20, would generally apply to most wheelchairs currently in use. Such wheelchairs are normally also equipped with grip rings mounted beside each rear wheel and fixedly connected to the corresponding rear wheel. The occupant can manually grip the grip rings and use them to push the rear wheels forward or backward in order to propel and maneuver the wheelchair as well as to apply braking force to the rear wheels. As discussed above, this arrangement

30

requires considerable strength and coordination in the occupant's hands. Such strength and coordination may be lacking in some wheelchair users even though they may have sufficient upper arm strength to manually propel the wheelchair.

5 The wheelchair 10, in the place of grip rings uses two lever arm assemblies, one for each driving wheel. Optionally, grip rings (not shown in drawings) may be retained, if desired, in addition to the lever arm assemblies. The lever arm assembly for the driving wheel 22 is indicated generally by reference numeral 32 in the drawings and is comprised of a lever arm 34, the upper end of which is linked to a
10 handle assembly 36, and a one-way clutch, not visible in Figure 1, but indicated by reference numeral 40 in Figures 4, 5, and 6, for connecting the lever arm 34 to the driving wheel 22. Further details are provided below, but basically the occupant propels the wheelchair 10 forward by pushing the handle assembly 36 forward with sufficient force and speed to engage the one-way clutch 40 and apply a torque to the
15 driving wheel 22. When the occupant stops pushing forward with sufficient force and speed or pulls the handle assembly 36 rearward, then the one-way clutch 40 disengages (because the driving wheel 22 has overrun the clutch 40), allowing the occupant with little effort to return the handle assembly 36 to position it for another forward push. The lever arm assembly 32 extends far enough from the axle pin 18 to
20 allow an occupant of the seat 14 to grip the handle assembly 36 and move it through a range of motion approximately indicated by reference numeral 38 in Figure 1. Of course, to move straight forward, the occupant must push with relatively equal effort on both the handle assembly 36 and the left handle assembly, which is not shown in the drawings. By applying unequal effort the occupant may turn the wheelchair 10 as
25 it is moving.

The reader will note that the occupant cannot, using the handle assemblies of the wheelchair 10 as described above, rotate a wheel backwards or apply a braking force to a wheel. To provide such capabilities, the wheelchair 10 preferably includes a
30 braking system and a means for bypassing the one-way clutches so that movement of the handle assemblies can drive the wheels in either direction, not just the forward direction. Generally this is accomplished by providing means for disconnecting the

lever arms from the one-way clutches and providing brakes mounted on the lever arms so that when the lever arms are disconnected from the one-way clutches and the brakes applied, movement of the lever arms is transmitted to the wheels in a way that is essentially equivalent to the occupant manually gripping the wheels or grip rings and pushing or pulling on the wheels or grip rings directly. In effect, the lever arms and brakes take the place of the occupant's arms and hands, which as will become clear below allows occupants with impaired hand grip strength and control to effectively move about in the wheelchair 10 and also provides more effective use by occupants who have normal arm and hand strength and coordination.

10

One manner in which the one-way clutches may be made disconnectable by occupant and braking may be applied to the wheels is described in detail below in relation to the right wheel. As discussed above, the description applies equally to the left wheel.

15

In Figures 1, 2, and 3, the handle assembly 36 is shown as including a twist grip 42 of the type conventionally used on bicycles for shifting gears. Details of the twist grip 42 are not shown in the drawings or described further as such mechanisms are conventional and readily available. The twist grip 42 is connected to a grip cable 44 that runs from the handle assembly 36 to the lower end of the lever arm 34. Twisting the grip shift 42 in one direction pulls on the grip cable 44, which twisting it in the other direction releases it. The manner in which this motion is used to connect or disconnect the one-way clutch 40 from the lever arm 34 is described below in detail in relation to Figures 4, 5, and 6.

20

Also shown in Figures 1, 2, and 3 is a disk braking system comprised of a rotor 46, a caliper 48, a brake cable 50, and a brake lever 52. These components are readily available conventional bicycle brake components and are also not described in detail. The brake lever 52 is mounted on the handle assembly 36 in a conventional fashion. The rotor 46 is connected to the rear hub 24 so as to rotate with the rear hub 24 and the caliper 48 is fixedly secured to lower end of the lever arm 34, both in a manner that will be described in detail below in relation to Figures 4, 5, and 6.

25

Turning to Figures 4, 5, and 6, the rear axle as a whole comprises the axle pin 18, which is a conventional quick release pin, an axle stub 54, an axle tube 56, and the corresponding left axle pin and left axle stub, which are not shown in the drawings.

5 The axle stub 54 is shown in detail in Figure 9. The axle tube 56 extends between the wheels and is suspended by the suspension arm 20 and the left suspension arm (not shown in the drawings). Figures 10A – 10 C shown how a suspension arm bracket 60 is used to clamp the suspension arm 20 to axle tube 56. The inside end 58 of the axle stub 54 is welded to or press-fitted in place into the outboard end of the axle tube 56.

10 Alternatively, the axle tube and the right and left axle stubs may be machined in one piece. However, using tubular material for the axle tube 56 saves weight. The axle stub 54 has an axial bore 59 for receiving the axle pin 18. As mentioned above the axle pin 18 is a conventional quick release pin. Starting from the inside end 58 of the axle stub 54, the axle stub 54 is provided with a lever arm bearing mounting surface

15 62 for lever arm bearings 64 that support the lever arm 34 and a one-way clutch bearing mounting surface 66 for one-way clutch bearings 68 that support the one-way clutch 40.

As shown in Figure 6, the one-way clutch 40 comprises an outer race 70 and

20 an inner race 72. Fixedly connected to the outer race 70 is a drive ring 74, which is provided with a plurality of radially-outward facing drive ring cavities 76. Fixedly connected to the inner race 72 is a rotor mount 78. The rotor 46 is bolted to the rotor mount 78 with rotor attachment bolts 80 having heads 82 that protrude axially outward.

25

The grip cable 44 is connected to a drive pin 84 mounted in a radially inwardly directed drive pin cavity 86 near the lower end of the lever arm 34. A spring 88 is provided at the outer end of the cavity 86 to bias the drive pin 84 so that when the grip shift 42 is twisted so as to release tension on the grip cable 44, the drive pin 84 is

30 forced in a radially inward direction, and when the grip shift 42 is twisted so as to pull on the grip cable 44, the drive pin 84 is retracted into the drive pin cavity 86 against the spring 88.

The lever arm bearing mounting surface 62 is offset axially and radially inward from the drive pin cavity 86 so as to allow the lever arm 34 to be rotatably mounted upon the axle stub 54 by means of the lever arm bearings 64 with the drive pin cavity 86 in the same plane as the drive ring cavities 76. This allows the drive pin 84 to mesh with whichever of the drive ring cavities 76 is aligned with it when the grip shift 42 is twisted so as to release tension on the grip cable 44.

The one-way clutch 40 is rotatably mounted upon the axle stub 54 by means of the one-way clutch bearings 68. The one-way clutch 40 and the lever arm assembly may rotate independently of each other when the drive pin 84 is retracted.

The hub 24 is provided with axial bores 90 that match the pattern of the rotor attachment bolt heads 82 and a central axial bore 92 in which are mounted hub bearings 94. The hub 24 is mounted to the lever arm assembly 32 by aligning the axial bores 90 with the rotor attachment bolt heads 82 and inserting the axle pin 18 through the central axial bore 92 until the axle pin 18 locks the hub 24 to the lever arm assembly 32. The axle pin 18 is provided with a conventional release mechanism that need not be described in detail.

When assembled in the manner described above, the wheel 22, the brake rotor 46, the rotor mount 78, and the inner race 72 rotate together on the one-way clutch bearings 68 and hub bearings 94.

If the drive pin 84 is engaged, then the lever arm 34, the drive ring 74, and the outer race 70 rotate together on the lever arm bearings 64. Due to the action of the one-way clutch 40, the lever arm 34 may be pulled backward without appreciable resistance when the wheel 22 is rotating forward. However, if the occupant pushes forward hard enough on the handle assembly 36, the one-way clutch 40 engages to apply a torque to the wheel 22, driving the wheel 22 forward. It should be noted that if the wheel 22 is rotating backward, the lever arm 34 will be moved backward due to the action of the one-way clutch 40.

If the drive pin 84 is retracted, then the handle assembly 36 is disconnected from the one-way clutch 40 and may be pushed forward or pulled backward without applying a torque to the wheel 22 and without appreciable resistance. As well, rotation of the wheel 22 in either direction will not move the lever arm 34.

Because the brake caliper 48 is mounted upon the lever arm 34 rather than upon the frame 12, if braking is applied while the wheelchair 10 is stationary, then the occupant may move the wheel 22 in backward by simply continuing to apply the brake while pulling the handle assembly 36 backward. However, to move backward by more than one backward stroke of the handle assembly 36, the one-way clutch 40 must also be disconnected. Otherwise, if the occupant attempts to move the handle assembly 36 forward to prepare for another stroke, the wheel 22 will be moved forward. If the one-way clutch 40 is disconnected, then braking must be applied to move the wheel 22 forward. The result of applying braking with the one-way clutch 40 disconnected is effectively the same as if the occupant gripped the wheel 22 or a grip ring directly with his or her hand and allows similar low-speed maneuverability in restricted spaces.

The wheelchair 10 as described above provides no limitation upon how far forward or backward the handle assembly 36 may rotate. This might be acceptable to a strong and coordinated occupant, but could create difficulties for others if the wheelchair 10 were moving rapidly forward and the occupant applied braking too forcefully. In that situation, the handle assembly 36 would be pulled rapidly forward, perhaps causing dire consequences for the occupant. For that reason, it is preferable to provide a guide bar 96 as part of the frame 12. The guide bar 96 runs the length of the frame 12 parallel to the plane of the lever arm 34 and generally above the wheel 22 and slopping downward toward the front of the wheelchair 10. The handle assembly 36 is constrained to follow the guide bar 96 slides on a linear bearing. Since the motion of the handle is now constrained to be linear and the motion of the lever arm assembly 32 is rotary, a suitable linkage must be provided between the handle assembly 36 and the lever arm assembly 32. As shown in Figure 1, a slot 98 is

provided in the lever arm 34. As shown in more detail in Figures 12A, 12B, and 12C, the lower end of the handle assembly 36 ends in a fork 100. A bolt 102 passes through one tine of the fork 100, through the slot 98 and is screwed into the other tine. The bolt 102 rides in the slot 98 on bearings 104. Between each tine and the lever arm 34, a spacer 106 having a brass central section 108 and a Teflon™ outer section 110 is provided.

The length and orientation of the guide bar 96, the slot 98, and the handle assembly 36 are best chosen empirically so that when the bolt 102 is at the top of the slot 98 the handle assembly 36 has traveled to a position near the front or rear end of the guide bar 96 that is comfortable for the occupant. The extreme front and rear positions effectively act as stops to the maximum travel of the handle assembly 36. Providing stops is important in the situation discussed above in which the occupant has applied braking causing the handle assembly 36 to be pulled forward. The occupant can easily apply braking if he or she moves the handle assembly 36 to the extreme forward position and then applies braking. In this situation, the caliper 48 is effectively fixed in position relative to the frame 12, allowing controlled application of braking without the handle assembly 36 being pulled forward as braking is applied. Of course stops could also be attached to the guide bar 96 to directly restrain the movement of the handle assembly 36.

The suspension arm 20 is attached to the frame 12 in the manner shown in Figures 11A and 11B by a mounting block 112.

Figures 13, 14 and 15 show another embodiment of the invention, which is a second wheelchair generally indicated by reference numeral 114 suitable for someone who has good upper body strength and coordination. In those drawings, elements that correspond to elements of the wheelchair 10 shown in Figures 1 – 12 are labeled with corresponding reference numerals. The primary differences between the two wheelchairs 10, 114 is that the second wheelchair 114 does not include a guide bar corresponding to guide bar 96, the brake caliper 48 has been moved to the suspension arm 20, and a two-speed planetary gear system 116 that includes a one-way clutch

replaces the one-way clutch 40. Because there is no longer a guide bar 96, a one-piece lever arm 118 is provided.

5 The second wheelchair 114 is propelled forward by the same pushing movements, but as the brake caliper 48 is fixed to the suspension arm 20, which is connected to the frame 12, the second wheelchair 114 cannot be moved backward by shifting to neutral so as to disconnect the one-way clutch, engaging the brake and pulling back on the handle 42. Instead, the occupant must shift to neutral, manually grip the wheel 22 or a grip ring, and pull back directly on the wheel 22 or grip ring.

10

Other embodiments will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.

What is claimed is:

1. A manually-propelled wheelchair, comprising:

a frame having a forward-facing seat;

two independently castered front wheels mounted to the frame;

a rear axle suspended beneath the frame;

two rear driving wheels, each rotatably mounted upon an opposite end of the axle; and

two lever arm assemblies, each rotatably mounted upon an opposite end of the axle and each comprised of

a discrete lever arm ending in a handle and extending far enough from the axle to allow an occupant of the seat to grip the handle and

a discrete one-way clutch connecting the lever arm to the wheel mounted upon the same end of the axle,

whereby the occupant by pushing the handles in the forward direction with sufficient force may engage the one-way clutches so that torque is applied to the turn the driving wheels so as to propel the wheelchair in the forward direction, but when the occupant ceases to push the handles forward or pulls the handles rearward, the one-way clutches disengage, allowing the handles to be pulled freely rearward.

2. The manually-propelled wheelchair of claim 1, wherein the lever arm is rotatably mounted on the axle and is disconnectable by the occupant from the one-way clutch so that when the lever arm is disconnected from the one-way clutch the lever arm may be moved forward and rearward without engaging the one-way clutch.

3. The manually-propelled wheelchair of claim 2, wherein the lever arm assembly additionally comprises:

a drive ring fixedly attached to the one-way clutch between the one-way clutch and the lever arm;

a retractable drive pin coupled to the lever arm for engaging the drive ring; and

an actuator controllable by the occupant for extending and retracting the drive pin,

whereby when the pin is retracted, the lever arm is disconnected from the one-way clutch and when the pin is extended to engage the drive ring, the lever arm is fixedly connected to the one-way clutch.

4. The manually-propelled wheelchair of claim 2 or claim 3, additionally comprising a discrete occupant-operable disk brake for each driving wheel, the rotor of the disk brake connected to the driving wheel so as to rotate with the driving wheel and the caliper of the disk brake mounted upon the lever arm, whereby when the lever arm is disconnected from the one-way clutch, the occupant may move a driving wheel forward or rearward by engaging the brake for that driving wheel and pushing forward or pulling rearward the handle of that lever arm.

5. The manually-propelled wheelchair of any of claims 1 to 4, additionally comprising two guide bars fixedly attached to the frame, one upon each side of the frame and parallel to the plane of a driving wheel, the handle of each lever arm slidingly coupled to a discrete one of the guide bars so that handle is constrained to follow a discrete guide bar as it is pushed or pulled by the occupant.

6. The manually-propelled wheelchair of claim 5, wherein the guide bars are straight and each lever arm is comprised of a handle and a lower lever arm, the handle linked to the lower lever arm so as to allow the handle to follow the guide bar.

7. The manually-propelled wheelchair of claim 6, wherein a portion of the handle slides and rotates in a slot in the lower lever arm as the handle is moved forward and rearward.
8. The manually-propelled wheelchair of any of the preceding claims, additionally comprising two carbon fiber suspension arms, each only attached to the frame near the front of the frame and wherein the axle is suspended by the two suspension arms.
9. The manually-propelled wheelchair of claim 1, each lever arm assembly additionally comprising a discrete planetary gear system, that planetary gear system including the one-way clutch of that lever arm system, connecting the lever arm of that lever arm system to the corresponding driving wheel.
10. The manually-propelled wheelchair of claim 9, wherein each lever arm is rotatably mounted on the axle and is disconnectable by the occupant from the corresponding planetary gear system so that when that lever arm is disconnected from that planetary gear system that lever arm may be moved forward and rearward without engaging the one-way clutch.
11. The manually-propelled wheelchair of claim 9 or claim 10, additionally comprising two suspension arms and wherein the axle is suspended by the two suspension arms.
12. The manually-propelled wheelchair of claim 11, wherein the two suspension arms are carbon fiber suspension arms and are each only attached to the frame near the front of the frame.
13. The manually-propelled wheelchair of claim 11 or claim 12, additionally comprising a discrete occupant-operable disk brake for each driving wheel, the rotor of each disk brake connected to a discrete driving wheel so as to rotate with that

driving wheel and the caliper of that disk brake mounted upon a discrete suspension arm.

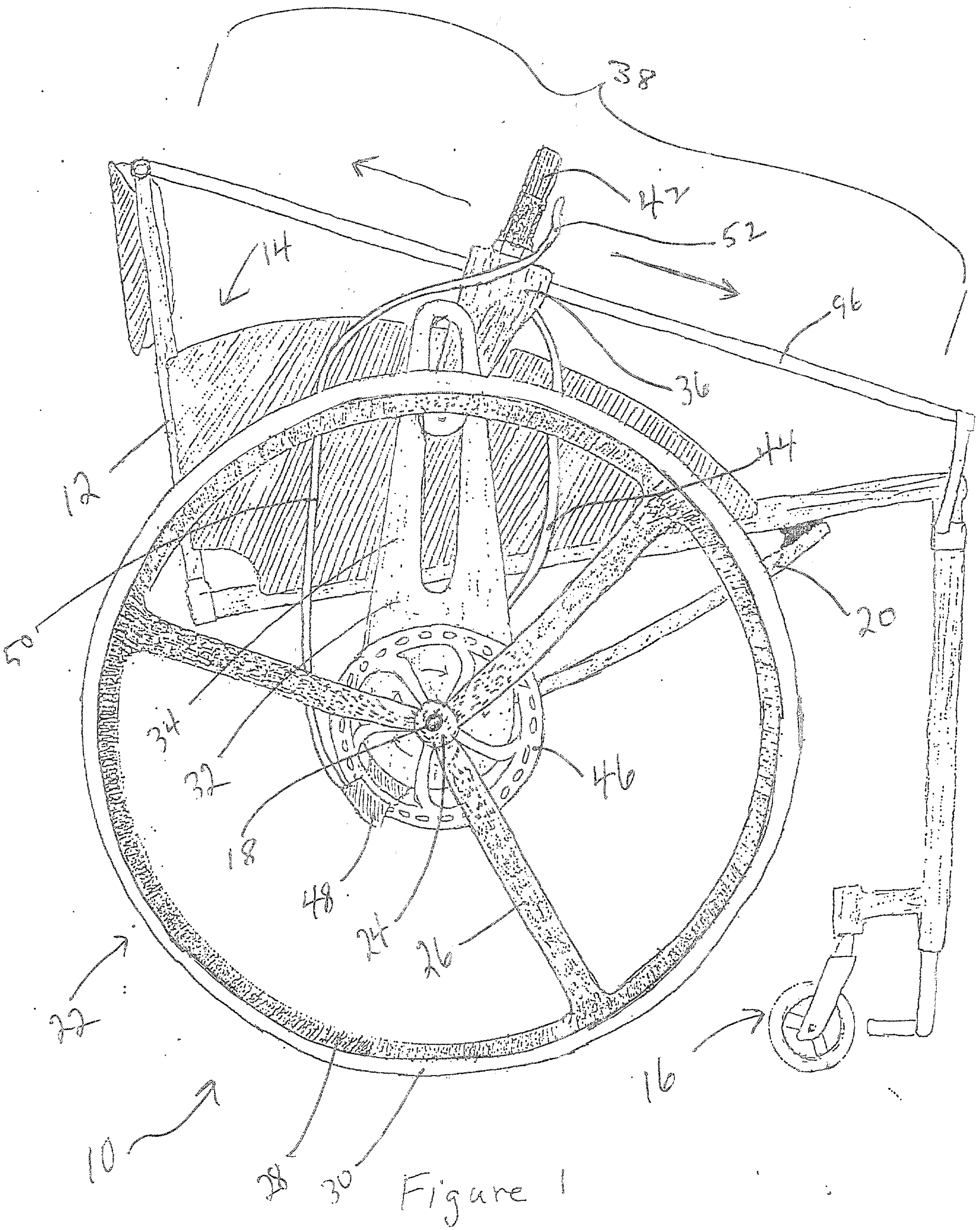
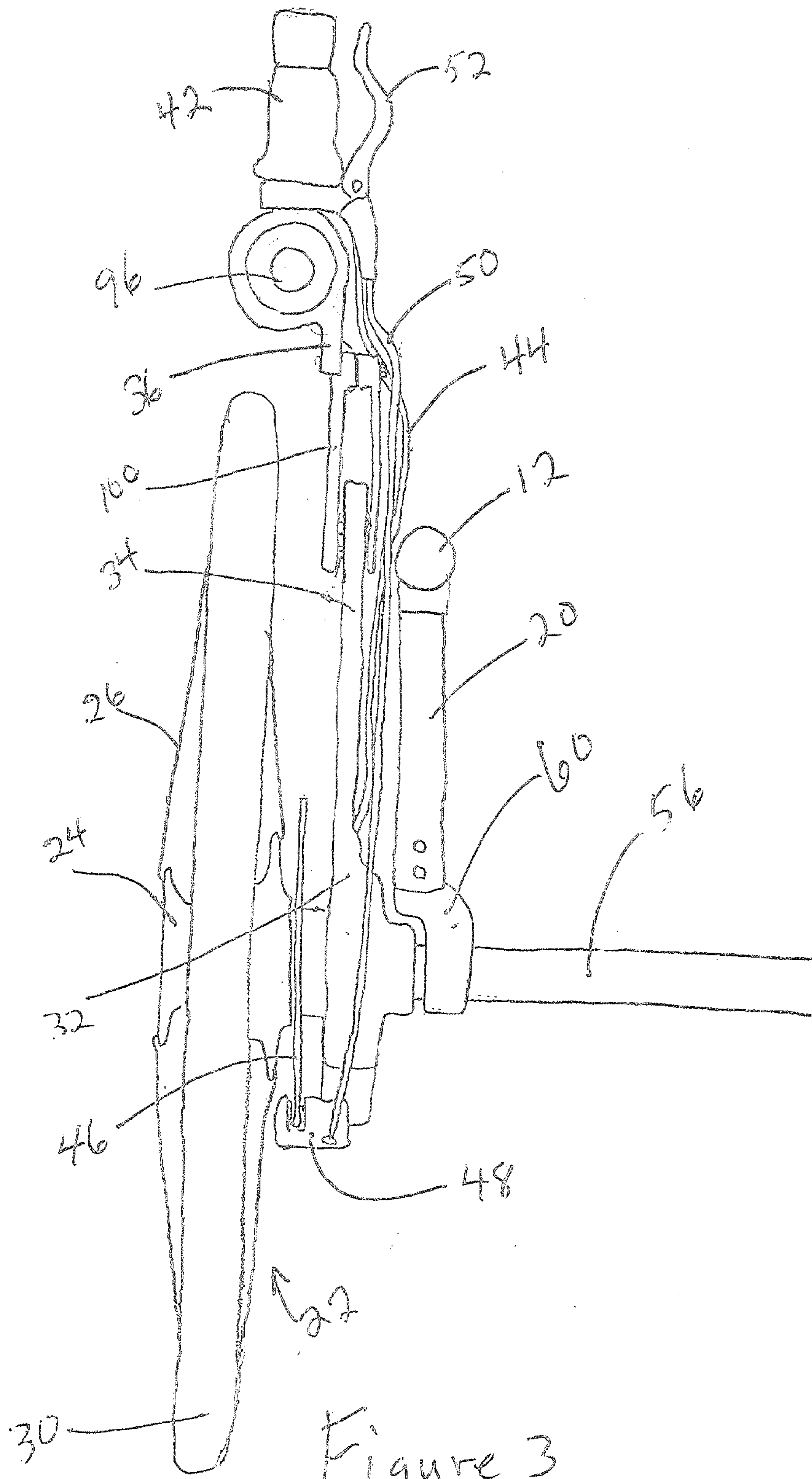


Figure 1



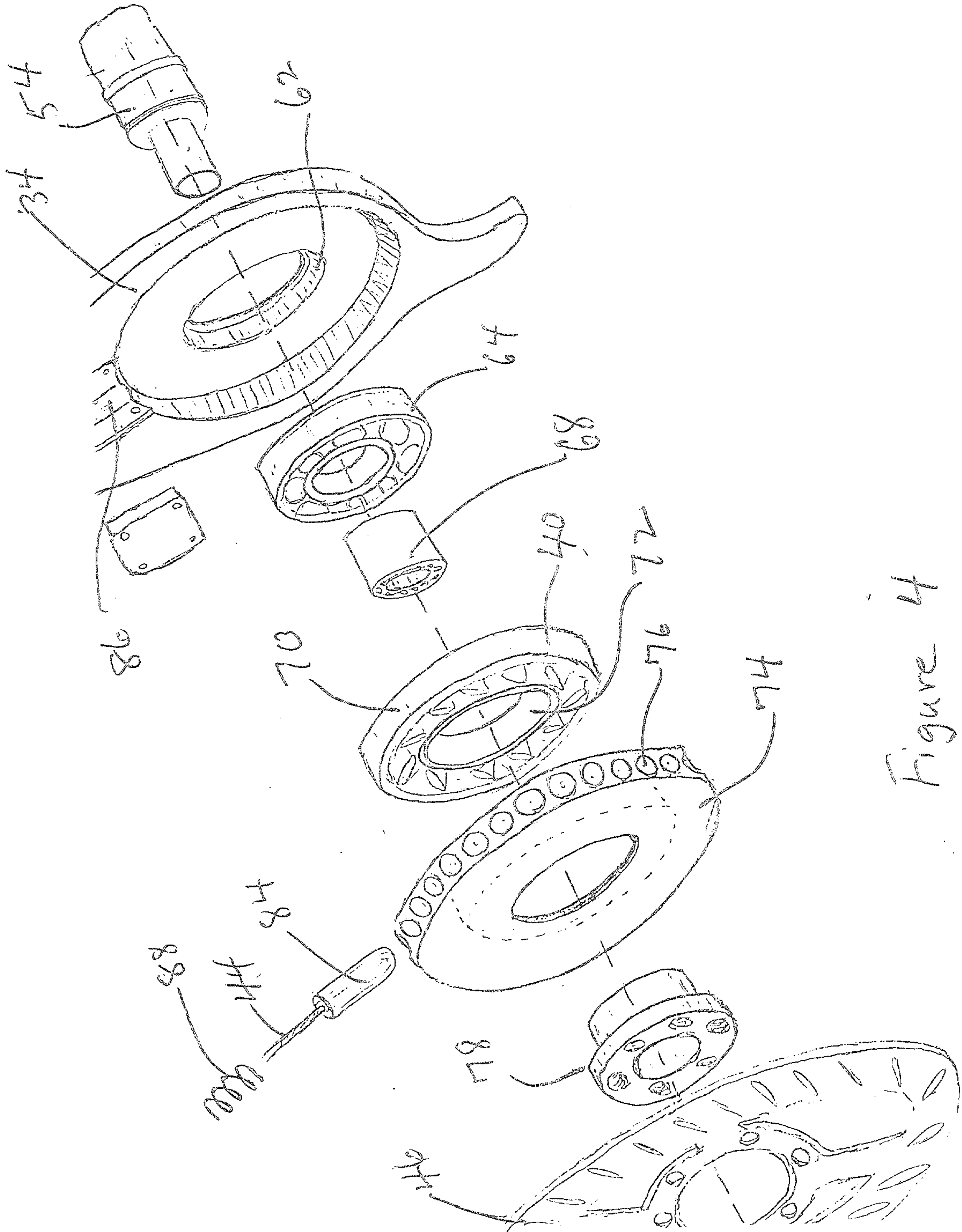


Figure 4

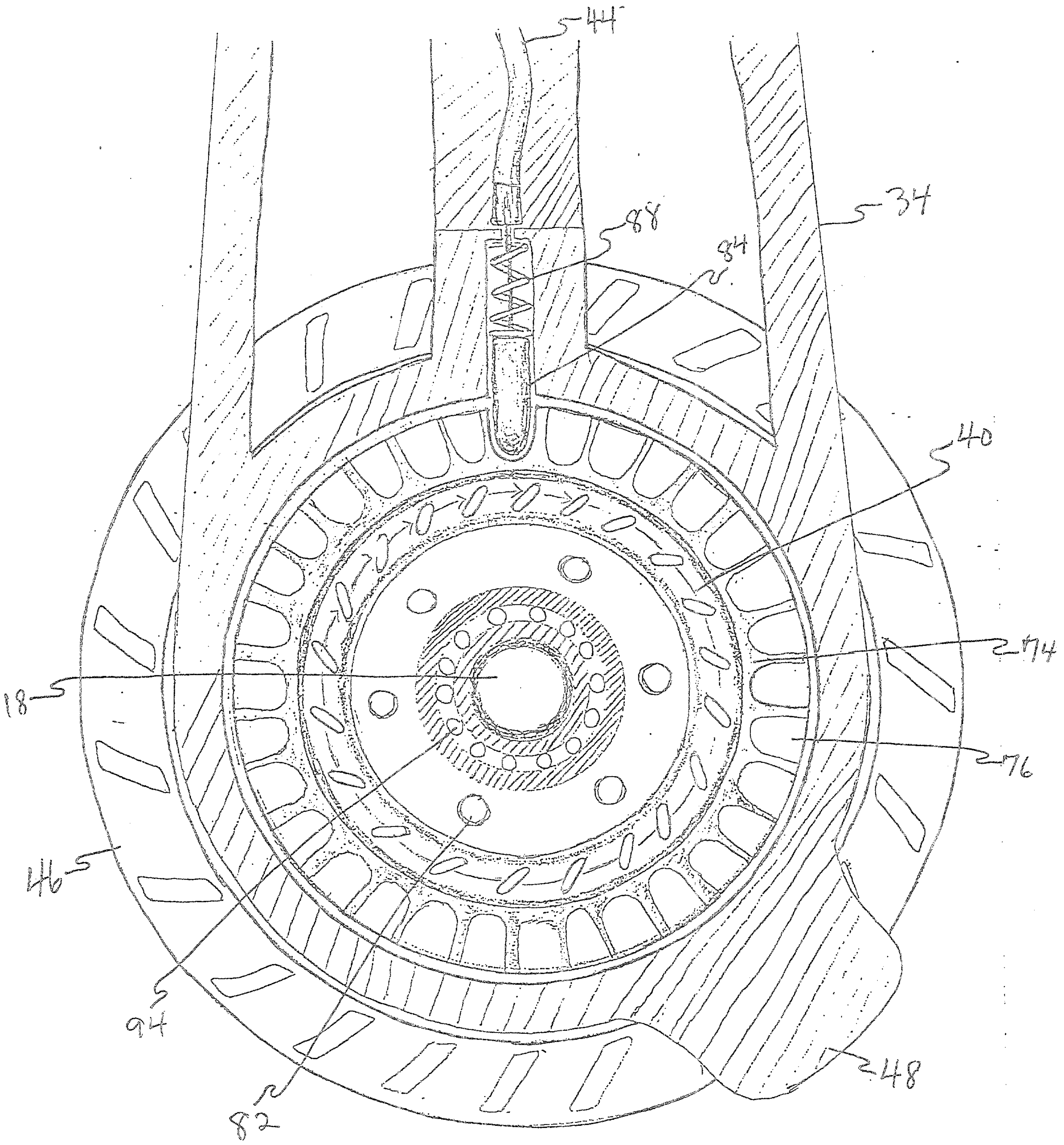


Figure 5

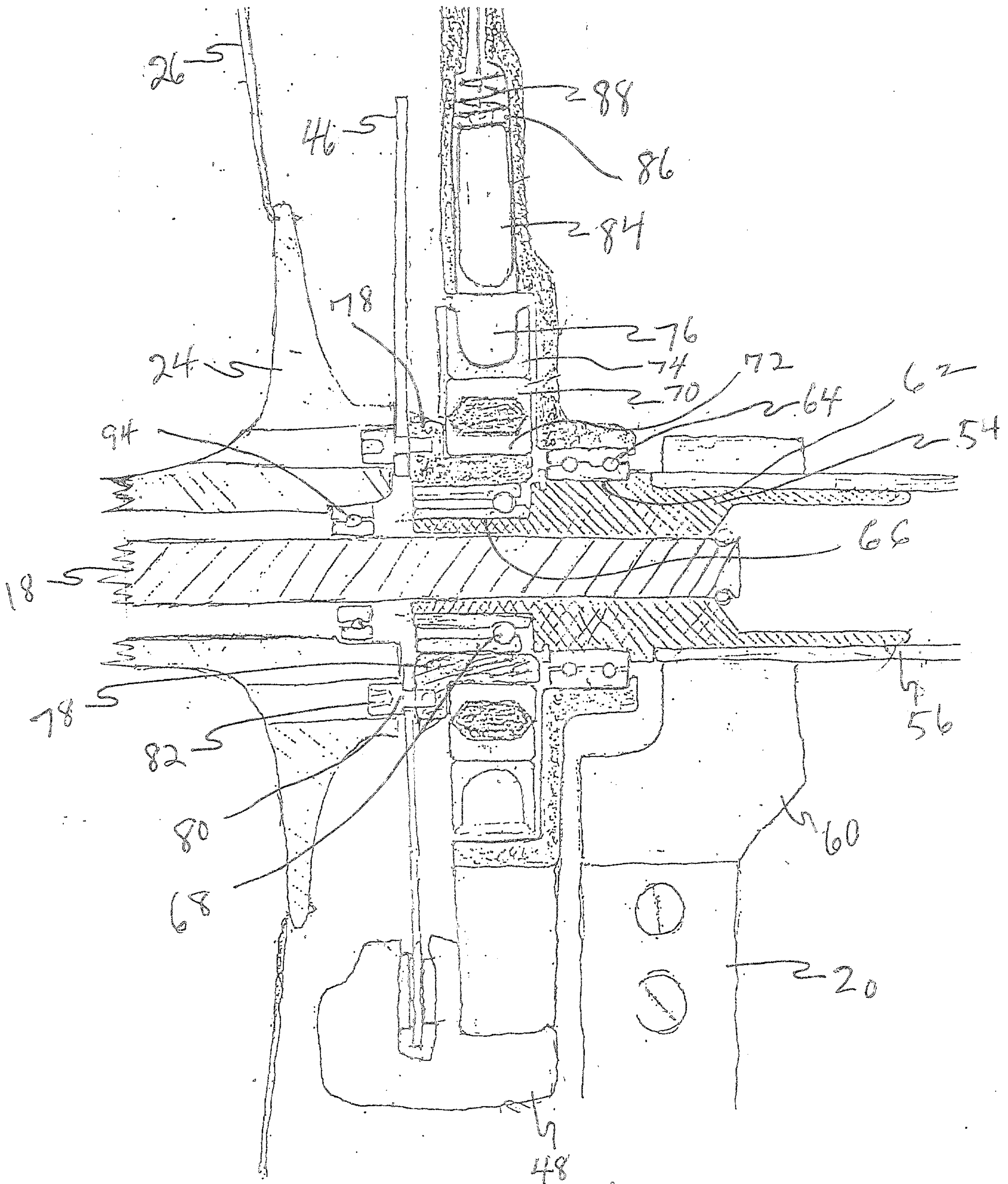


Figure 6

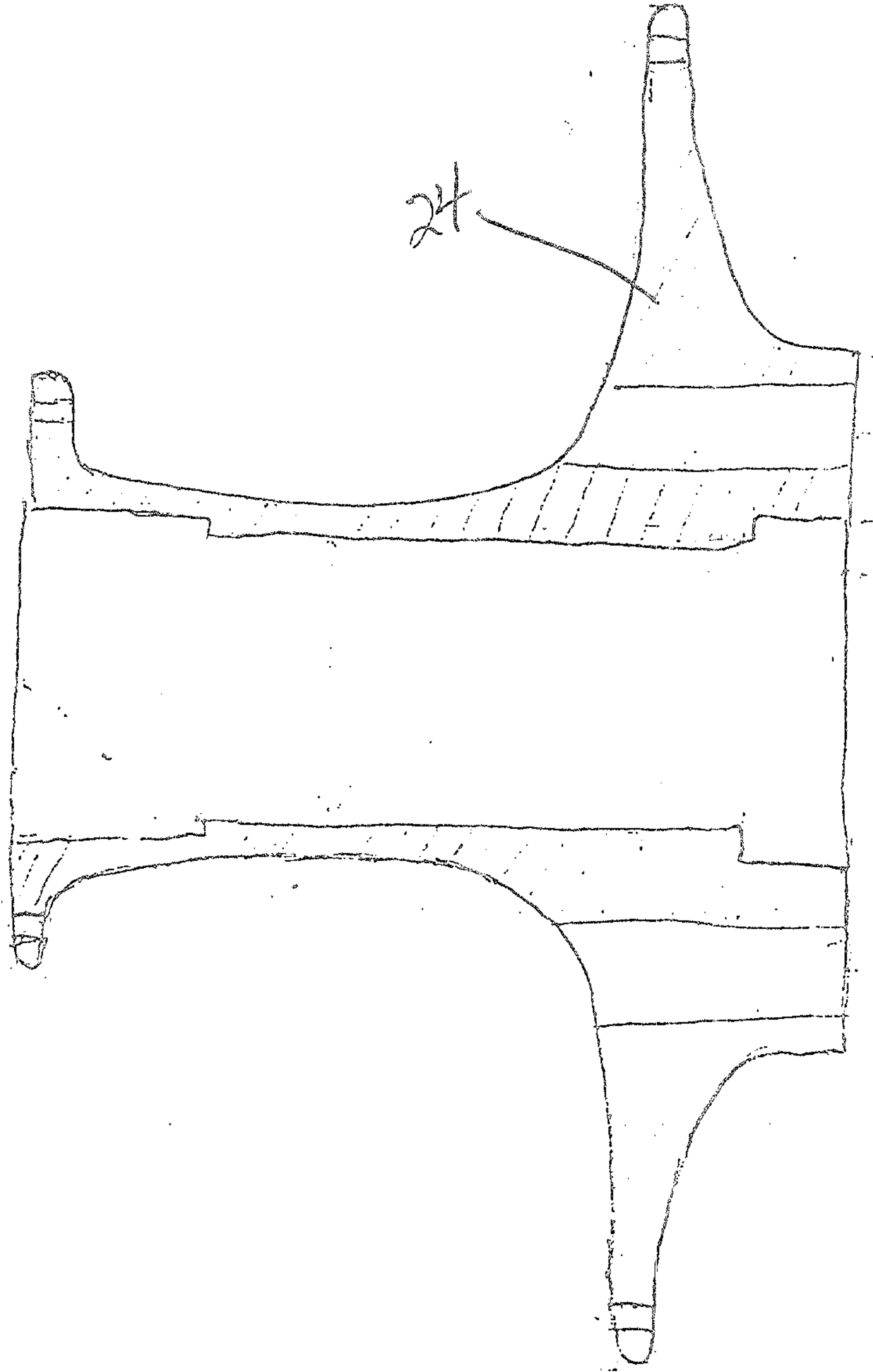


Figure 7

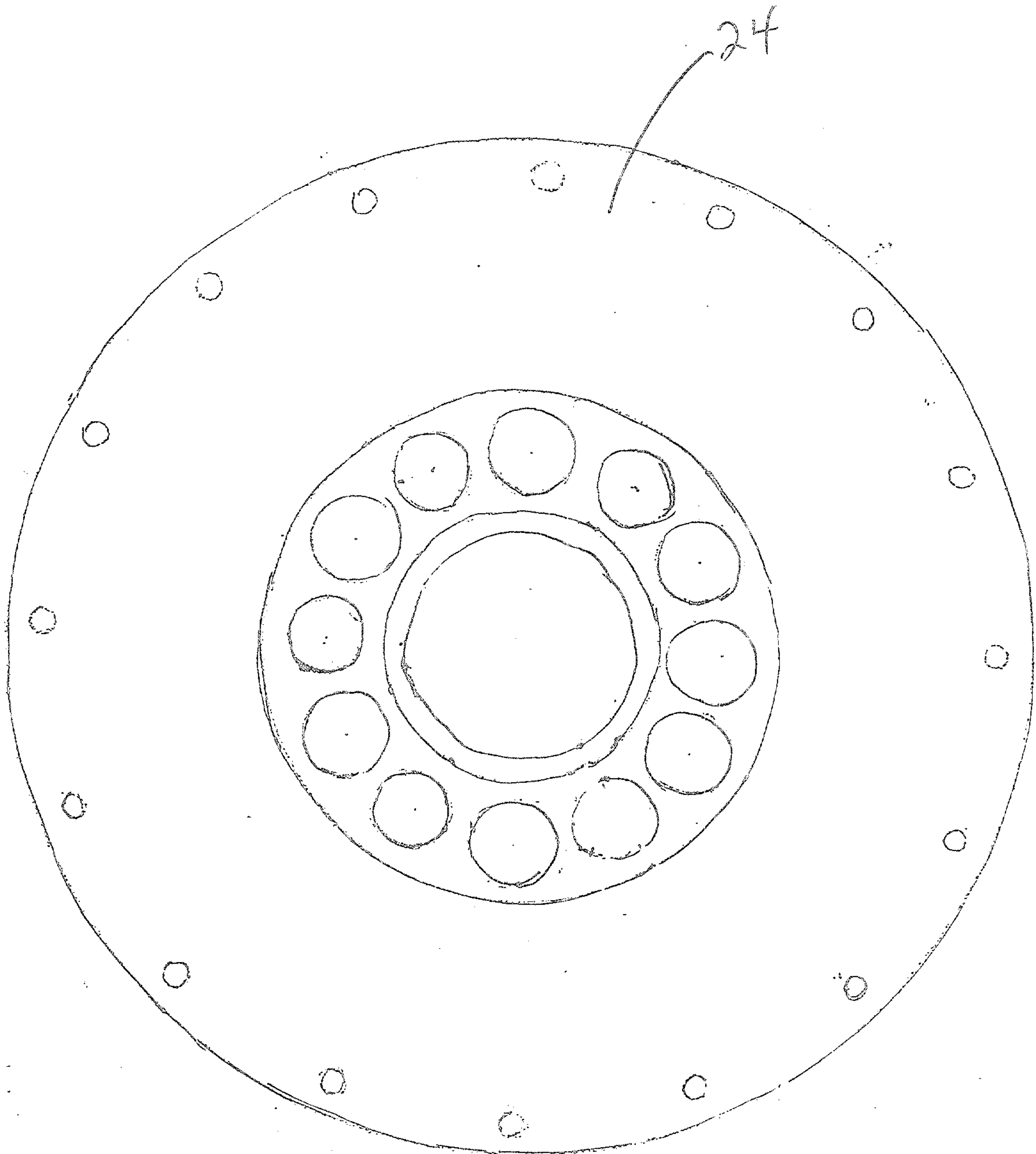


Figure 8

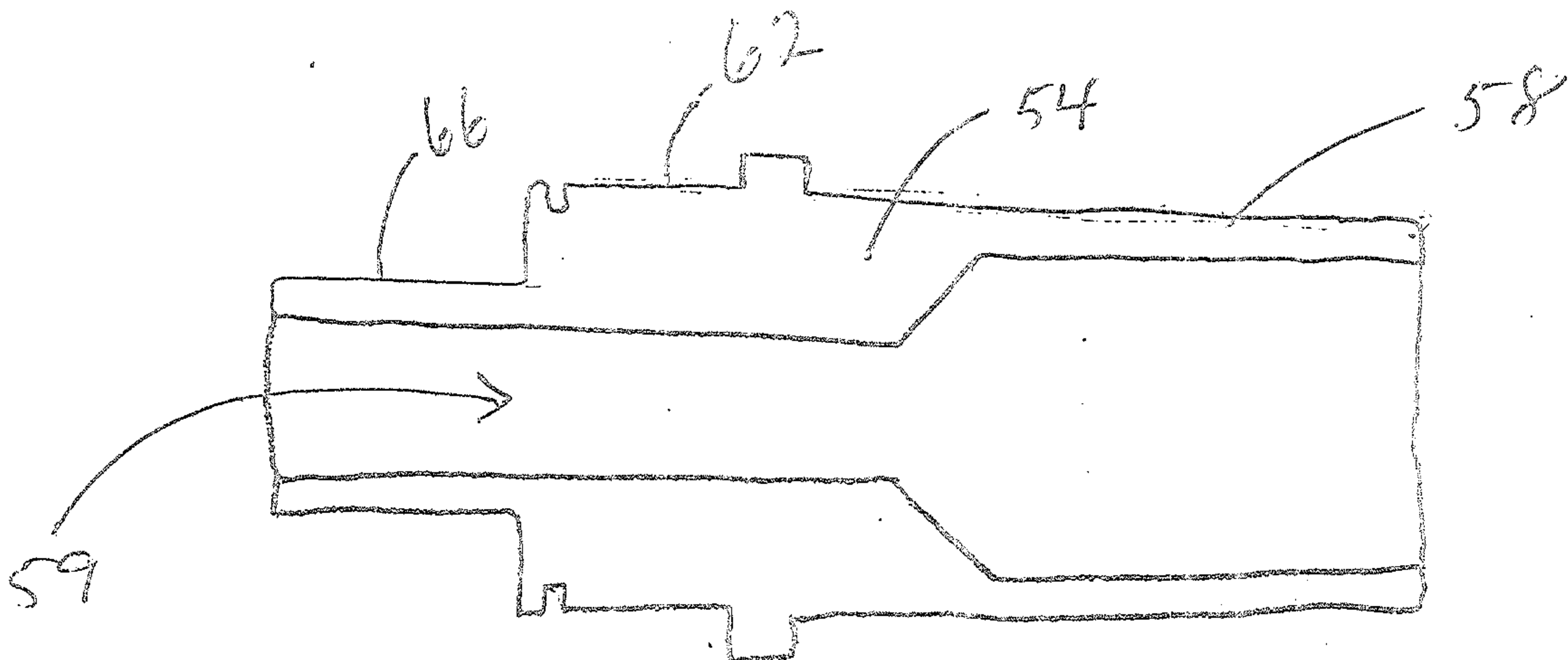


Figure 9

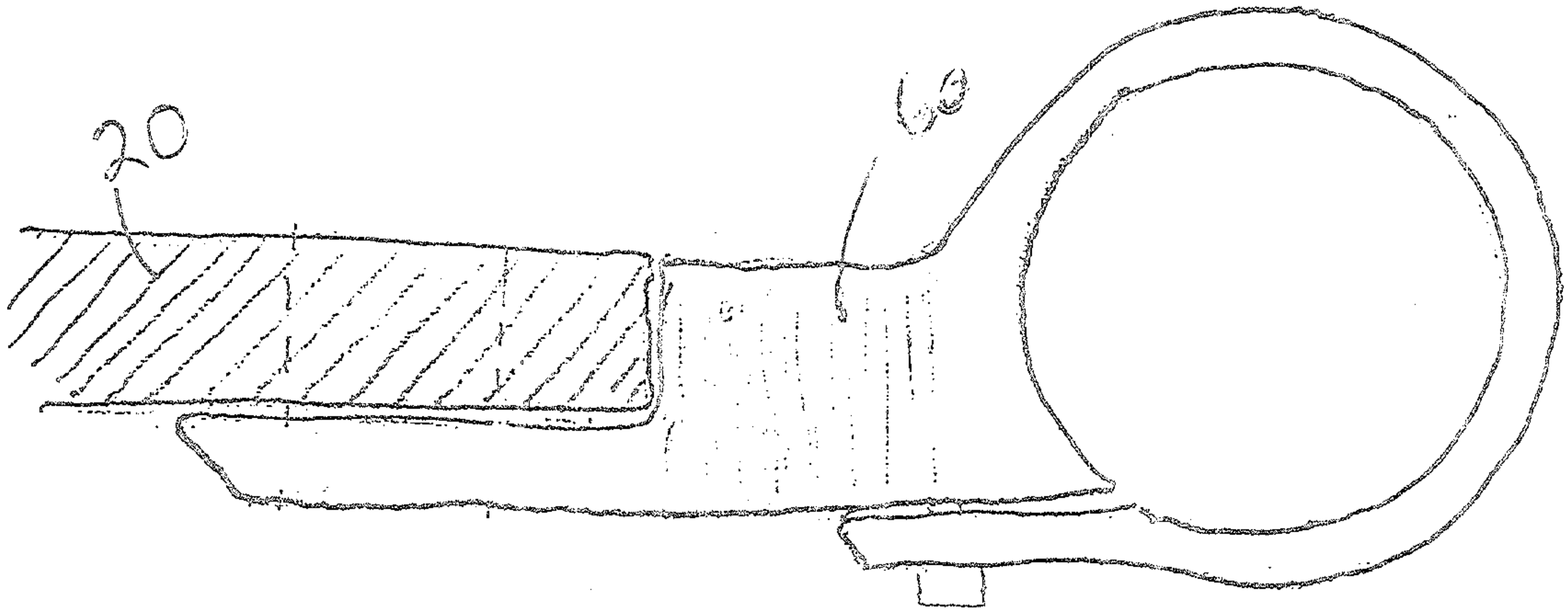


Figure 10A

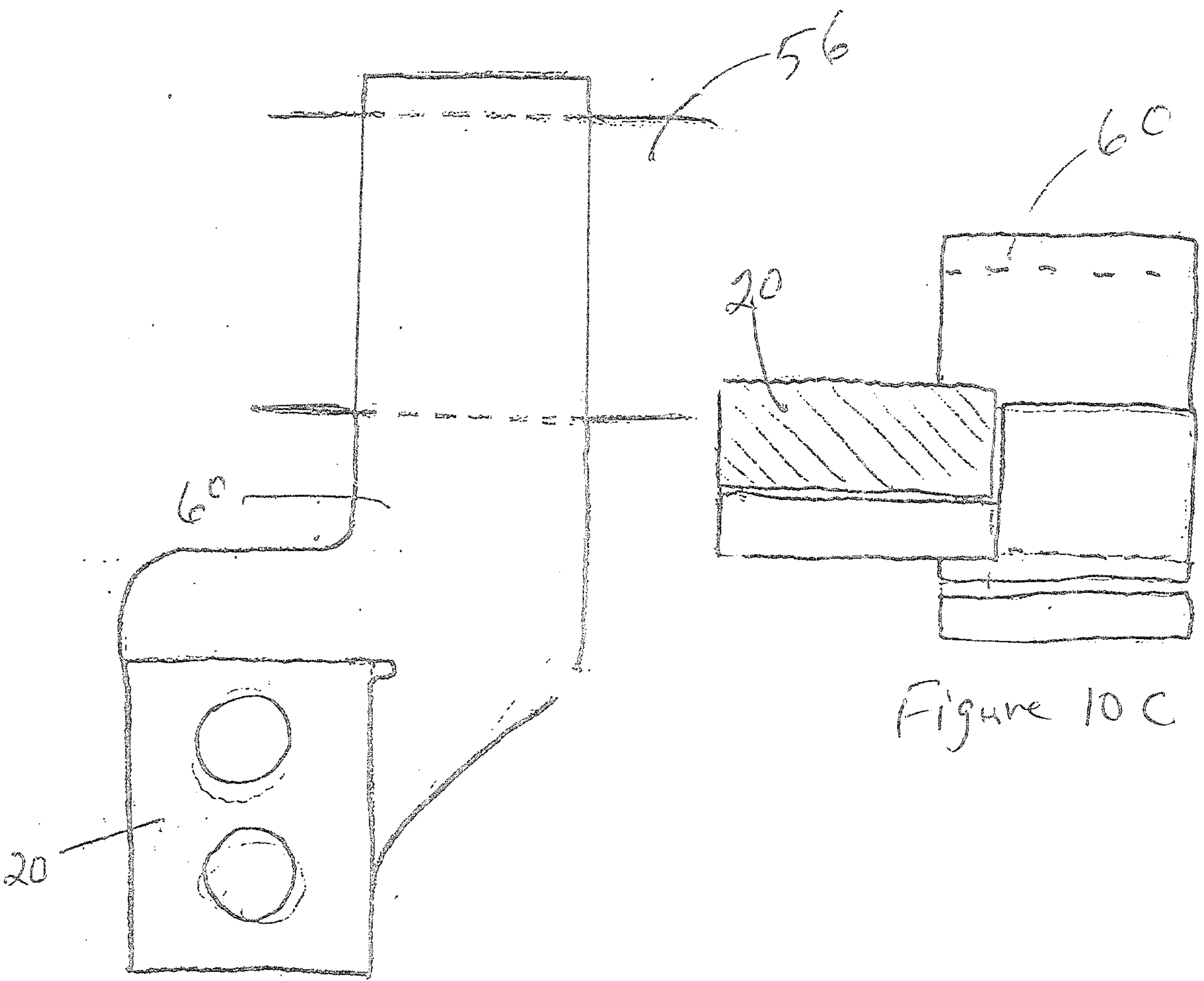


Figure 10 B

Figure 10 C

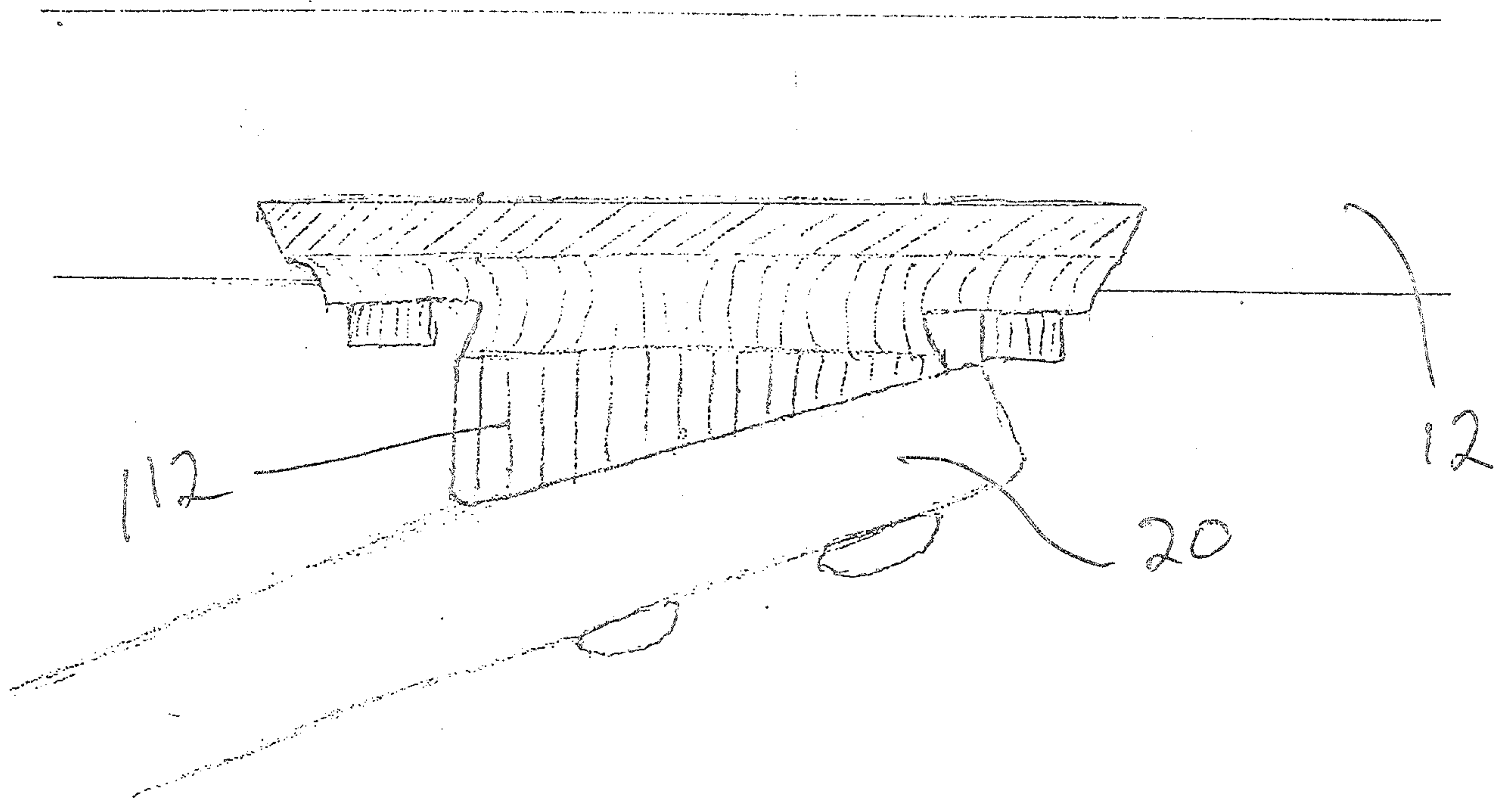


Figure 11 A

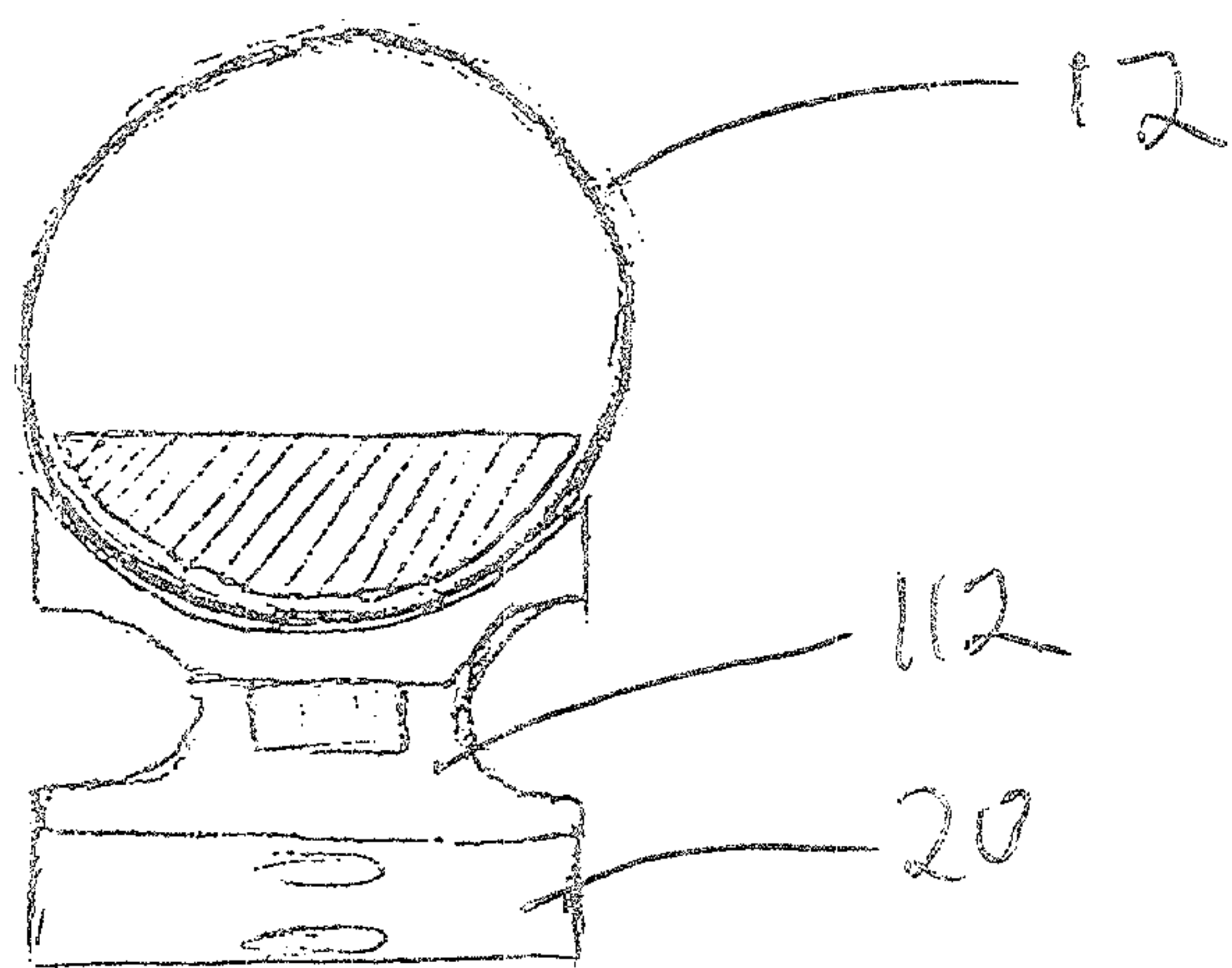


Figure 11 B

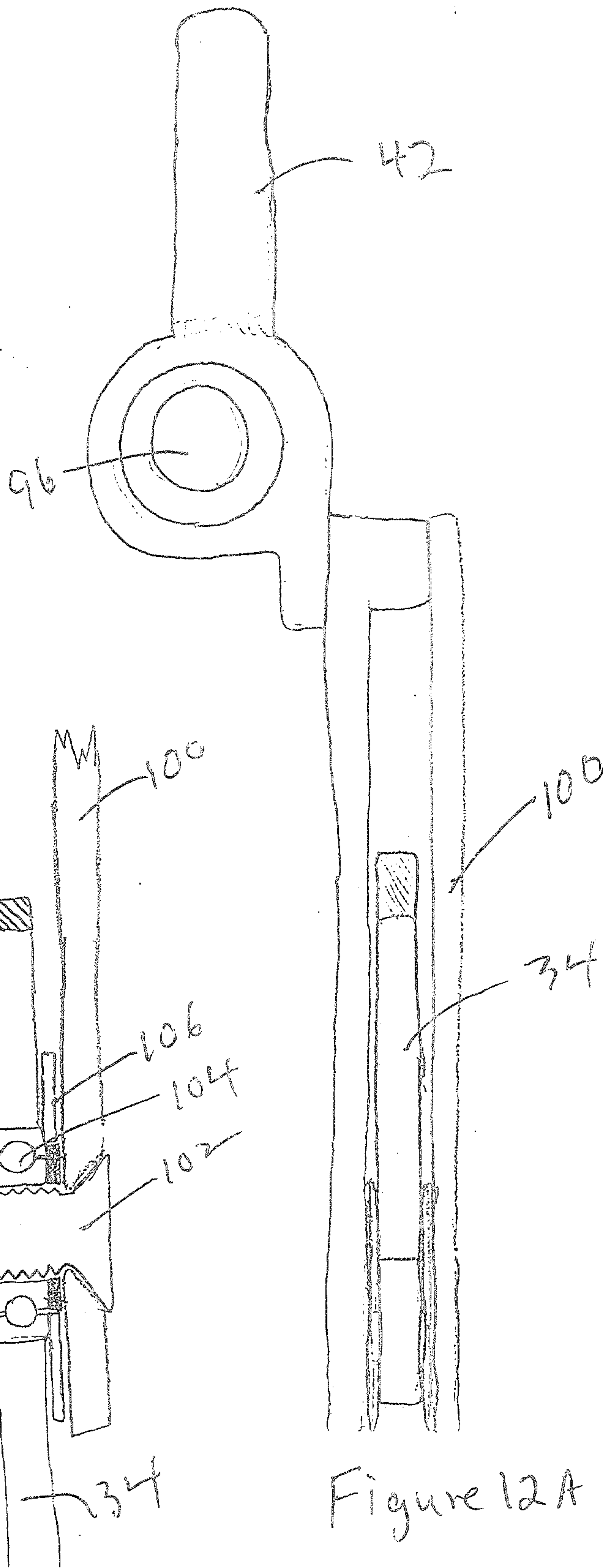


Figure 12A

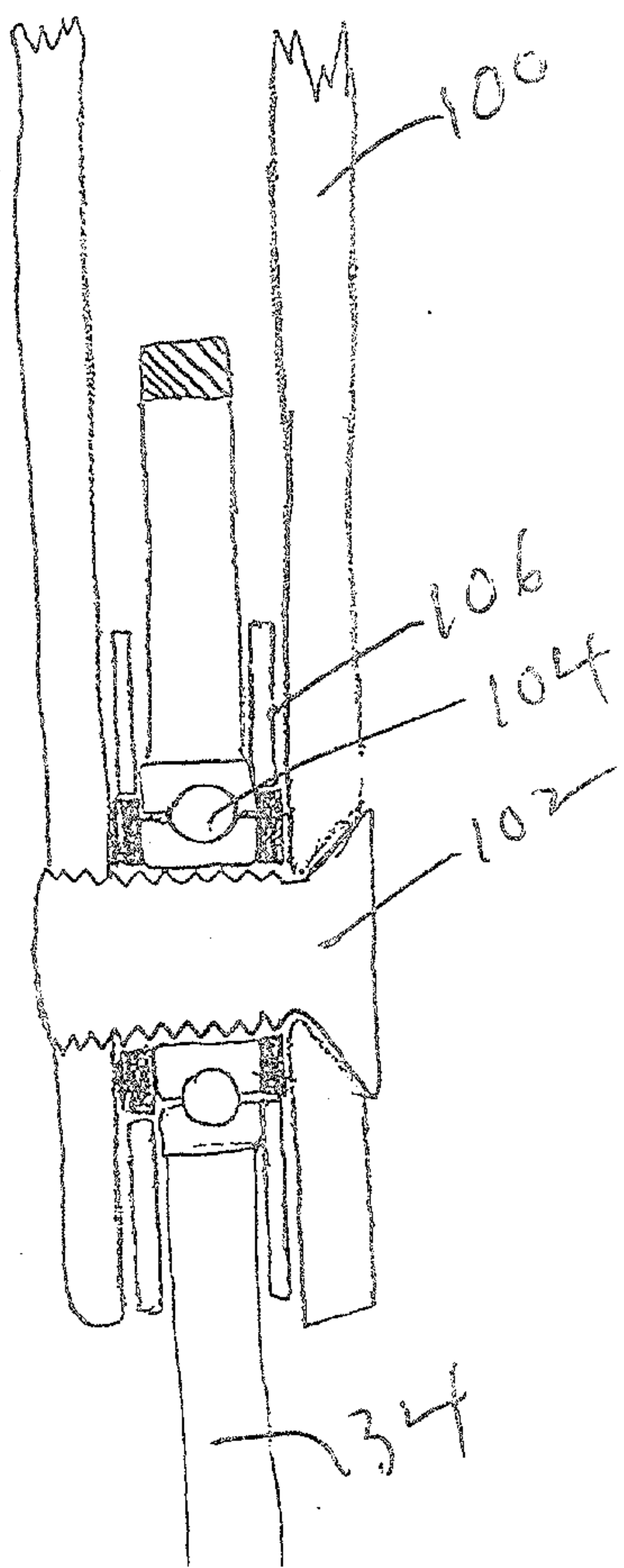


Figure 12B

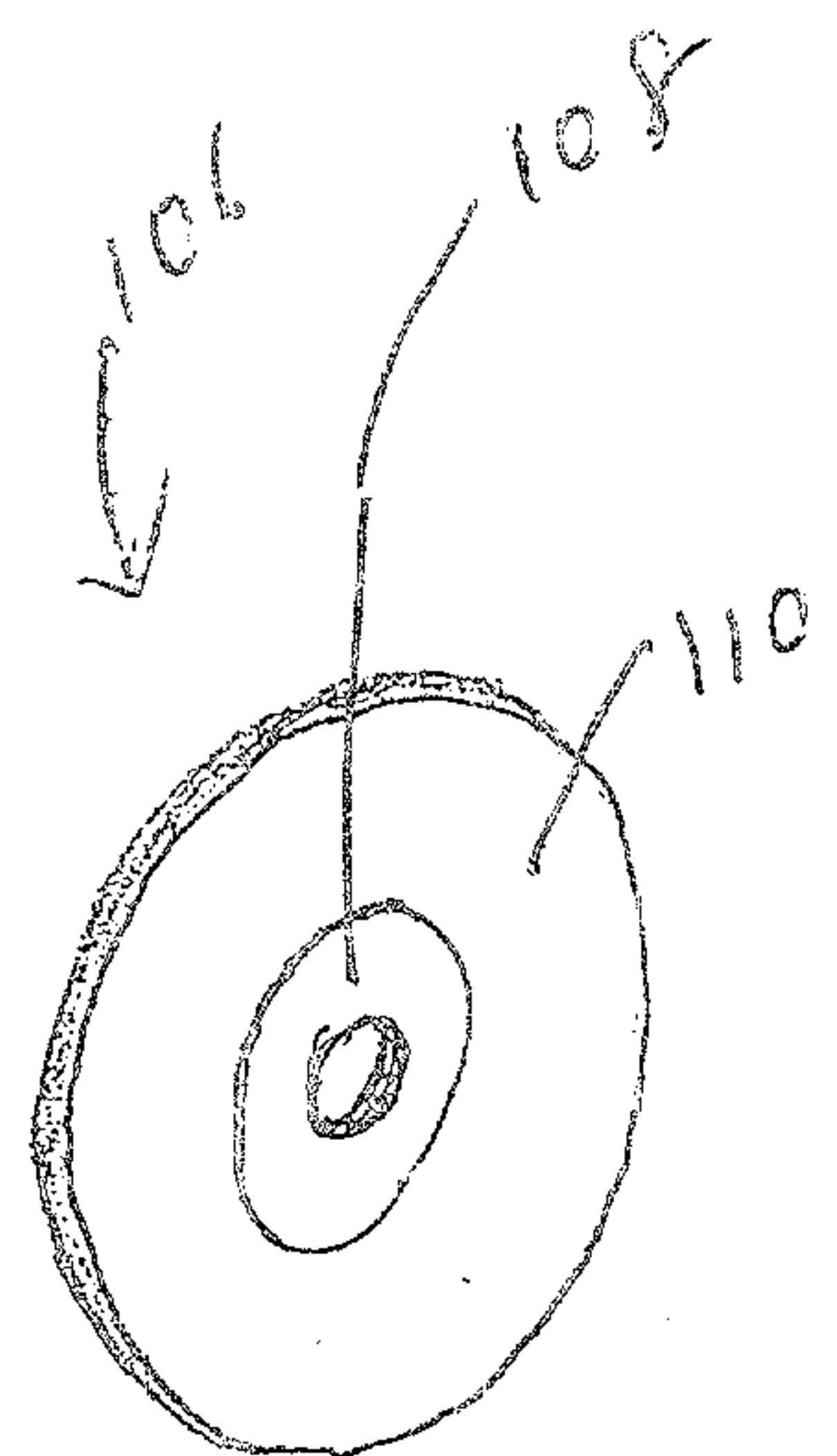


Figure 12C

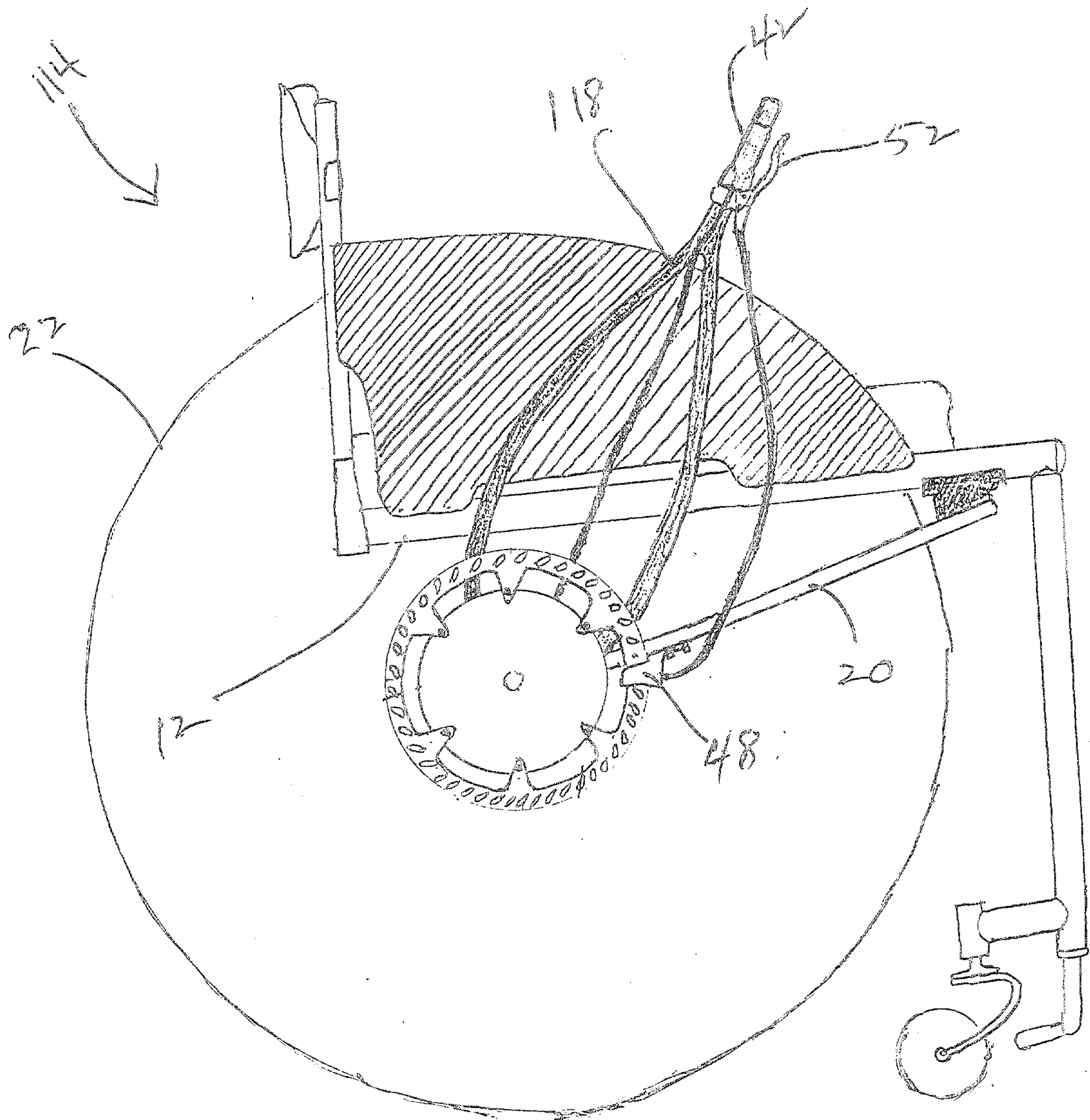


Figure 13

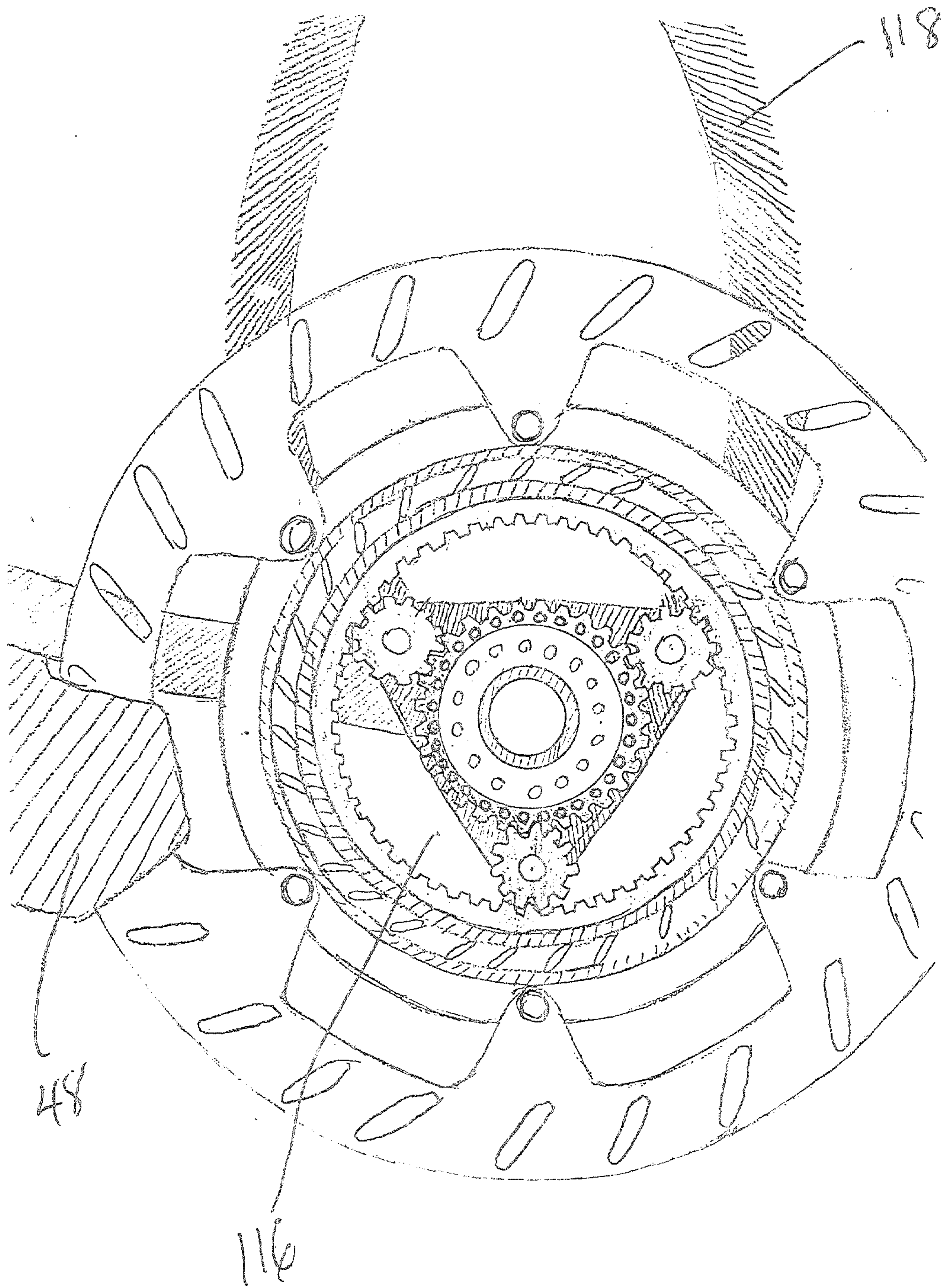


Figure 14

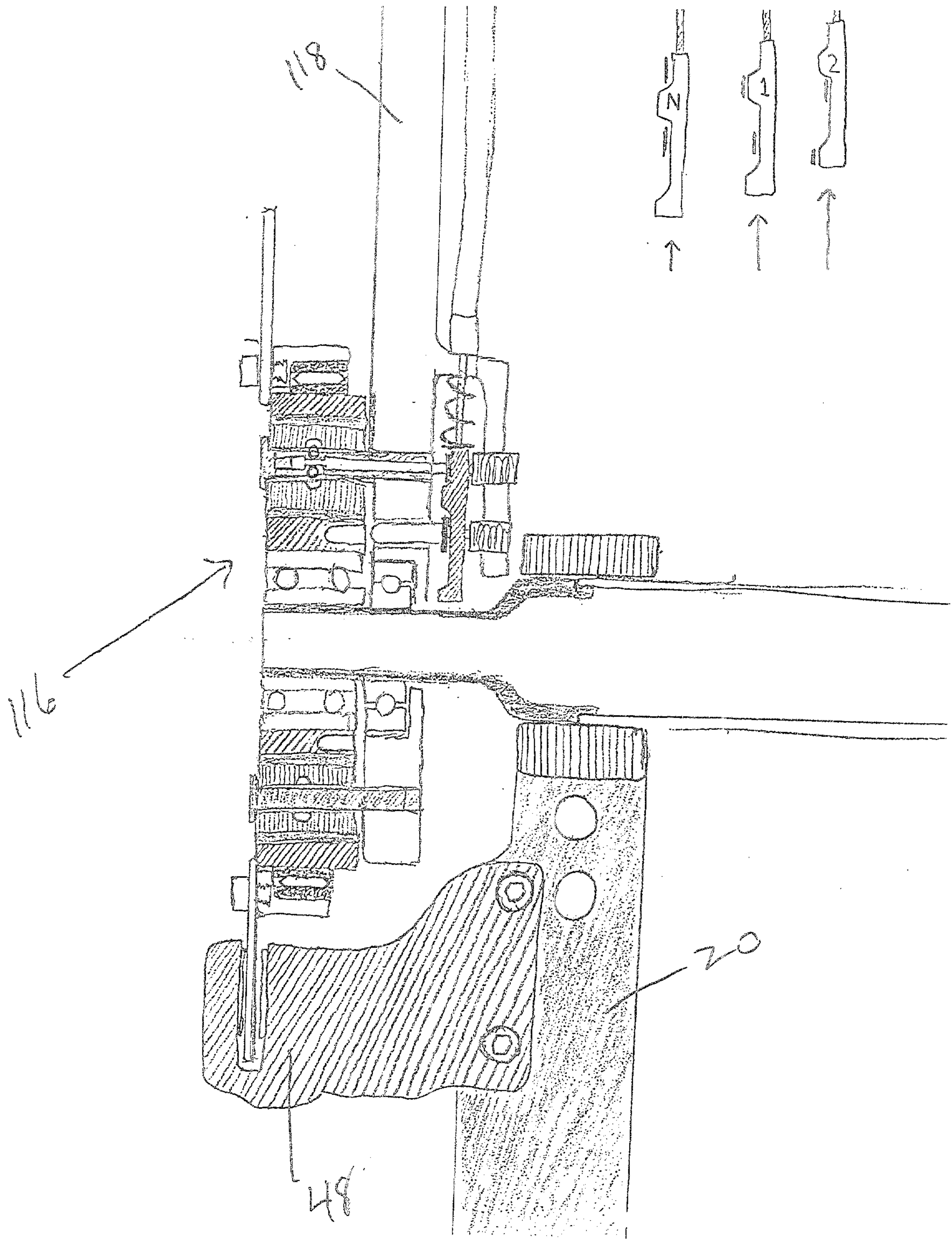


Figure 15

