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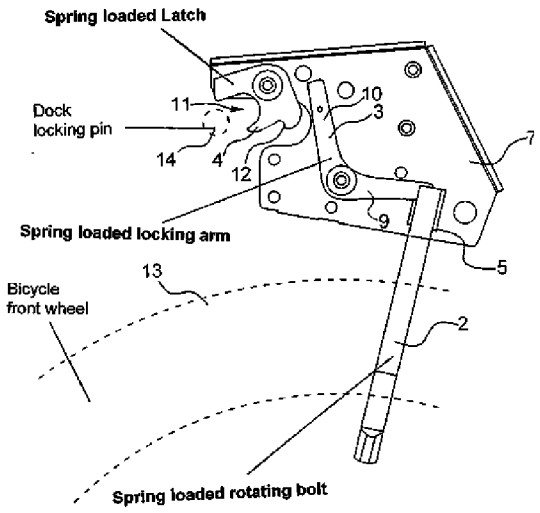
(54) Title **BICYCLE LOCKING SYSTEM**

(57) Abstract

A bicycle locking system comprising a bicycle lock attached to a bicycle, characterized in that the lock having a latch that is adapted to lock the bicycle to a docking station and a bolt that is adapted to block the wheel of the bicycle.



BICYCLE LOCKING SYSTEM

Technical Field

[0001] The present invention relates to a bicycle locking system, especially a locking system suitable for a bicycle rental service.

Background Art

[0002] Bicycle rental services have become an increasingly more important factor for the transport within cities and larger towns, especially due to imposed restrictions on automobiles due to congestions and environmental concerns.

[0003] With an increased number of users, ease of checking in and out bicycles, increased security against theft and increase of number of and distribution of rental stations is a great demand.

[0004] Some rental services meet these demands by providing cheap bicycles in great numbers and with a relatively low security against theft. The result is of course that a large proportion of the bicycle fleet is rendered useless due to non-return to the stations. Many bicycles end their working life in bushes, lakes or rivers, polluting the environment. Moreover, these cheap bicycles are often of very bad quality and are therefore susceptible to breakdown.

[0005] To encounter the disadvantages of the cheap bicycles, the quality and hence the cost of each bicycle will have to be increased. This also means that the security against theft and misplacement of the bicycle must be increased to avoid a too high degree of loss.

[0006] Increased security will often mean that the procedure for checking out and in a bicycle increases in complexity and time. The stations become more complex and expensive. With more expensive and sophisticated stations, the threshold for putting up a station in a certain area becomes higher, and hence the distance between stations will be larger. The farther a potential customer has to walk to or from a station, the more discouraged he will be to the rental of a bicycle. How far a person is willing to walk to get a bicycle, or from the return station to the destination, is of course varying from person to person and from place to place. A study made by Eindhoven University of Technology in 2011 (https://www.jtlu.org/index.php/jtlu/article/view/568/832) has revealed that most car

drivers are willing to walk only a few hundred meters from the parking lot to their place of work. This means that the bicycle stations have to be distributed with a fairly high density to attract people that would otherwise use a car.

[0007] There are many examples of prior art that provides security against theft of a bicycle from a station. One example is shown in FR2970933, which describes a secure storage system for bicycles comprising a securing wire and a lock controlled by a physical key. A locking housing is configured to cooperate with the wire for securing the bicycle to a parking terminal. The key is configured to be secured to the parking terminal by the wire.

[0008] This known locking system is depending on a physical key, and is therefore not very suitable for a large bicycle rental service, as the customer has to obtain a key before he is able to check out a bicycle. It will be practically impossible to recollect keys as customers resign from the service.

[0009] Another example is shown in WO2016048421, which describes a lock with a housing and a locking ring. The locking ring closes or opens a gap in the housing. The locking ring is moved by an electronic actuator (electric motor) between closed and open position. Communication electronics signals the actuator after receiving a wireless signal.

[0010] This known lock is depending on electric power to open or close. If the power is too low, the lock will not be able to open to release the bicycle or lock the bicycle after use.

[0011] Other examples of locks for bicycles, primarily in a bicycle rental service, are shown in US9024759, US 20150204112, FR2951852, GB2495138, WO2016190643, DK177237, EP2846315, WO2006021650, US9512649, EP1229193, EP2722825, WO2017041097, FR2988506, EP2874864, WO2016141948, WO2016075121, US8854207, US20160333611, EP3004495, US9260885, EP1558486, FR3008066, US20170109953, WO2016091319, EP2093718, EP3010791, WO2017041097 and EP2722825.

[0012] None of the prior art locks are sufficiently suitable for a flexible and secure bicycle rental system.

Summary of invention

[0013] The present invention therefore has as its main objective to provide a lock for a bicycle that is secure, easy to use, does not require a physical key and provides great flexibility with regard to establishing stations.

[0014] This objective is achieved by the features of the subsequent independent claim.

Brief description of drawings

[0015]

Figure 1 N/A,

Figure 2 shows a schematic view of the main components of a first embodiment of the locking mechanism in a side elevation view,

Figure 3 shows the locking mechanism of figure 3 in isometric view,

Figure 4 shows the locking mechanism in a side elevation view in a first state,

Figure 5 shows the locking mechanism in the first state in isometric view,

Figure 6 shows the locking mechanism in a side elevation view in a second state,

Figure 7 shows the locking mechanism in the second state in isometric view,

Figure 8 shows the locking mechanism in a side elevation view in a third state,

Figure 9 shows the locking mechanism in the fourth state in isometric view,

Figure 10 shows the locking mechanism in a side elevation view in a first state,

Figure 11 shows the locking mechanism in the fourth state in isometric view,

Figure 12 shows the locking mechanism in a side elevation view in a fifth state,

Figure 13 shows the locking mechanism in the fifth state in isometric view,

Figures 14 – 18 shows a second embodiment of the locking mechanism, where:

Figure 14 shows the locking mechanism in a first state,

Figure 15 shows the locking mechanism in a second state,

Figure 16 shows the locking mechanism in a third state,

Figure 17 shown the locking mechanism in a fourth state, and

Figure 18 shows the locking mechanism in a fifth state.

Detailed description of the invention

[0016] Figure 1 shows a lock of the present invention in an exploded view, showing the individual components.

[0017] Figures 2 and 3 show a schematic view of the locking mechanism and its main components. The locking mechanism comprises a basis 1 onto which are mounted a rotating bolt or bow 2, a double-sided arm or rocker 3 and a latch 4. The basis 1 can be fixed to the frame of a bicycle (not shown), though a bracket or similar (not shown).

[0018] The rotating bolt 2 extends through an opening or recess 5 in the basis 1, and is moveable through this opening 5 along the curvature of the bolt 2.

[0019] The bolt 2 has a groove 6 extending along a part of the length of the bolt. The groove has an outwardly extending opening 7 and an inwardly extending opening 8 close to one end of the bolt 2.

[0020] The bolt is spring loaded towards an open position, which will be explained later. The spring is not shown.

[0021] The rocker 3 has a first arm 9 and a second arm 10, which are set at an angle to one another. The angle is preferably about 90º. The rocker 3 is rotatably attached to the basis 1 at the joint of the first and second arms.

[0022] The double-sided arm 3 is spring loaded (spring not shown), which will be explained later.

[0023] The latch 4 is also rotatably attached to the basis 1. The latch is also spring loaded (spring not shown), which will be explained later.

[0024] The latch has a recess 11 and a shoulder 12. These will also be explained later.

[0025] The bolt 2 is adapted to extend around the rim of a bicycle wheel 13 (shown schematically.

[0026] The latch 4 is adapted to receive a docking pin 14 of a docking station (not shown) within the recess 11.

[0027] The functioning of the locking mechanism will not be explained, referring to figures 4 - 13.

[0028] Figures 4 and 5 show the lock in a first state, where the bicycle is in use and ready to be locked to a docking pin 14.

[0029] In this first state, the latch 4 has been rotated to an open position by the spring (not shown), so that the recess 11 faces outwardly. The latch 4 is out of contact with the rocker 3.

[0030] The outer end of the first arm 9 of the rocker 3 is situated within the outwardly extending opening 7 of the rotating bolt 2, thus preventing movement of the bolt 2 in either direction. The rocker 3 is held in this position by an actuator (not shown).

[0031] Figures 6 and 7 show the lock in a second state, where the lock, and hence the bicycle, is locket to the docking station.

[0032] The latch has been forced by the docking pin 14 to rotate anti-clockwise until it abuts the second arm 10 of the rocker 3. It has pushed the second arm past the shoulder 12, so that the second arm 10 has been caught under the shoulder 12 and the latch 4 is prevented from rotating back to an open position again.

[0033] Thereby the latch 4 prevents the pin 14 from escaping from the recess 11, and the bicycle is locked to the docking station.

[0034] After the locking to the station, the rocker 3 remains in the same position as in the previous state, preventing rotation of the rotating bolt 2.

[0035] Figures 8 and 9 show the lock in a third state, where the lock is ready to lock the wheel 13 of the bicycle.

[0036] The latch 4 is in the same position as in the first state, open, but ready to receive the docking pin 14. However, in this state the rocker 3 has been rotated slightly clockwise, so that the second arm 10 is to far away from the latch 4 to be able to be caught on the underside of the shoulder 12 of the latch 4. If an attempt is made

to lock to the docking pin, the latch will just rotate back and forth as it is pushed by the docking pin 14 and subsequently released.

[0037] The outer end of the first arm 9 of the rocker 3 has been brought (by a not shown actuator) inward so that the end of the arm 9 is fully within the groove 6. Thereby the rotating bolt 2 can be moved along its length to interfere with the wheel 13.

[0038] The moving of the bolt 2 is done manually by gripping a handle (not shown) extending radially outward from the bolt.

[0039] Figures 10 and 11 show the lock in a fourth state, after the bolt 2 has been moved to a locked state.

[0040] The bolt 2 has been rotated manually until the first arm 9 of the rocker 3 is aligned with the inwardly extending opening 8. Due to the spring action (spring not shown) on the rocker 3, the first arm 9 moves into the opening 8 and effectively prevents the bolt 2 from being moved either way. Hence the wheel of the bicycle is now locked.

[0041] Figures 12 ands 13 show the lock in a fifth state, which is identical to the first state. The rocker 3 has now been rotated to bring the outer end of the first arm 9 out of the opening 8 and into the groove 6. The rotating bolt 2 can now be manually moved towards the unlock position whereby the wheel is free to rotate. When the bolt 2 has been rotated so that the first arm 9 of the rocker 3 is aligned with the outwardly facing opening 7, the arm 9 moves into the opening. This is due to the spring biasing of the rocker 3. The rotating bolt 2 is now effectively locked in the open position.

[0042] The rocker 3 is rotated in the clockwise or the anti-clockwise direction by an actuator (not shown). A spring (not shown) is arranged between the actuator and the rocker 3.That the rocker 3 will be biased by the spring in the same direction as the actuator has moved the rocker 3. Thereby the first arm 9 of the rocker will move into the outwardly facing opening 7 or the inwardly facing opening 8 when the arm 9 is aligned with one of the openings, depending on which direction the rocker 3 is biased. The same applies for the second arm 10, which will catch the shoulder 12 of the latch 4 when this is rotated to the closed position or release the latch 4, depending on the direction the rocker 3 is biased.

[0043] The actuator is preferably an electric actuator, such as a solenoid or a step-motor. The actuator may be controlled by a signal from an internal processor in the lock. The processor will send a signal to the actuator depending on authorization provided by a user or a remote controller. This will be explained in further detail below.

[0044] A second embodiment of the lock mechanism will now be explained, referring to the schematic views in figures 14 – 18.

[0045] Referring first to figure 14, the various parts of the lock mechanism will be explained. Similar reference numbers will be used for parts corresponding with the first embodiment. As for the first embodiment, the locking mechanism comprises a basis 1. Onto the basis 1 is mounted a rotating bolt or bow 2., a rocker 3 and a latch 4. The basis 1 can be fixed to the frame of a bicycle (not shown), though a bracket or similar (not shown).

[0046] In addition to these part, the second embodiment shows an actuator 15, a pair of balls 16 and 17 and a slide 18.

[0047] The actuator 15 is a rotating actuator with an axle 19 and a cam 20 attached to the axle 19. The cam 20 acts on the pair of balls 16 and 17. The balls 16, 17 are positioned diametrically opposite of one another adjacent the cam 20.

[0048] The slide 18 has a conical portion 21 and a small diameter portion 22 joining the conical portion 21.

[0049] The slide 18 has a head 23, which is adapted to enter one of two notches 24, 25 in the rotating bolt 2 (only one of the notches 24 is clearly visible in the drawings. The head is situated within the other notch 25 in figure 14).

[0050] The latch 4 is almost identical to the latch of the first embodiment. It has a recess 11 to receive a docking pin (not shown).

[0051] The rocker 3 is shaped very differently from the rocker of the first embodiment. It has a semi-circular surface 26 (somewhat more than a quarter circle) and a lug 27 diametrically opposite of the semi-circular surface. Between the lug and a first end of the semi-circular surface 27 is a planar surface 28. The planar surface 28 and the semi-circular surface 27 form a corner 29 where these surfaces meet. The rocker 3 is rotatable about an axis 30. The axis 30 is positioned close to a lower

surface 31 extending between the lug 27 and a second end of the semi-circular surface 26.

[0052] Figure 14 shows the lock in a state corresponding to the second state of the first embodiment, where the latch grips a docking pin (not shown) inside the recess 11. The latch 3 is held in the gripping position by the corner 29 of the rocker 3 abutting the shoulder 12 of the latch 4. The rocker 3 is prevented from rotation by the lower surface 31 abutting one of the balls 16 and the ball 16 in turn abutting the cam portion 20 of the actuator.

[0053] In the state of figure 14, the rotating bolt 2is in the open position and is held in this position by the slide 18, which head 23 is within the notch 25 of the bolt 2. The slide 18 is biased by a spring (not shown) in the direction towards the bolt 2.

[0054] Figure 15 shows the lock in an open state, largely corresponding to the third state of the first embodiment, except that the rotating bolt 2 is still in a position preventing movement of the bolt 2.

[0055] The actuator has rotated the axle 19 so that the cam 20 lifts the ball 16. The ball 16, in turn, has lifted the rocker 3 so that the corner 29 is forced out of interference with the shoulder 12. Due to spring biasing (spring not shown) the latch 4 rotates clockwise and releases the docking pin 14 from the recess 11. The bicycle is ready to be ridden.

[0056] Figure 16 shows a state corresponding to the first stage of the first embodiment. The actuator has been rotated so that the cam 20 is no longer lifting the ball 16. The rocker 3 is thereby allowed to rotate anti-clockwise to its initial position. In this position the rocker is ready to receive and retain the shoulder 12 of the latch 4 if this is rotated back into the closed state. This rotation is effected by pushing a docking pin into the recess 11.

[0057] Figure 17 shows the lock in a state largely corresponding to the third state of the first embodiment, except that the rocker 3 is in a position to receive the shoulder 12 of the latch.

[0058] The actuator 15 has been rotated so that the cam 20 pushes on the lower ball 17. The ball 17 pushes in turn against the conical portion 21 and forces the slide 18 away from the bolt 2. The ball 17 is pushed into the portion 22 with the small

diameter. Thereby, the head 23 of the slide 18 is retracted from the notch 25 (not clearly visible).

[0059] Now the bolt 2 can be rotated to the blocking position, preventing the wheel (not shown) of the bicycle from rotating.

[0060] In figure 18, which shows the locking mechanism in perspective view, the bolt 2 has been rotated into the blocking position. The actuator 15 has been rotated, so that the cam 20 no longer pushes on the ball 17. Hence, the slide 18 is allowed to return to its position pressing against the bolt 2. When the bolt 2 has been rotated so that the notch 24 is aligned with the head 23 of the slide 18, the head will enter the notch 24 and lock the bolt 2 in position.

[0061] The actuator 15 is preferably controlled by a processor (not shown) within the lock. The processor rotates the actuator 15 as a response to commands from an electronic user operated key, remote controller or other types of input. This is the same for both embodiments of the lock.

[0062] The lock may contain an RFID reader, QR code reader or other type of reader, that senses the vicinity of an approved docking station for the bicycle. Only if the reader detects that the bicycle is about to be pushed against an authorized docking station, the actuator will set the rocker in a position ready to receive the shoulder 12 of the latch 4. If an authorized docking station is not detected, the latch will spring open again as soon as the latch is released by the pin 14.

[0063] A possible scenario of renting and returning a bicycle having a lock according to the invention will now be described.

[0064] When a user is intending to rent a bicycle, he sends a rental request to a remotely positioned server or to a cloud based rental system. The request can be sent from a smart phone through the Internet. The smart phone can contain software especially designed for the bicycle rental service, or the user can enter a web page of the rental service. The request contains an identification of the user and the position of the user.

[0065] When the server or rental system receives the request, it will check if the user is already registered in the system. If not, a registration procedure will be initiated. Such a procedure is well-known in the art.

[0066] When the user has been identified as a legitimate user, the system will check if there are any bicycles available close to the position of the user. The user will receive a confirmation containing information about the position and identification (e.g. number or name) of the closest available bicycle.

[0067] At the same time a message is sent to the closest bicycle ordering the processor in the lock of the bicycle to unlock the bicycle from the docking station.

[0068] If the bicycle is not locked to a docking station, but locked by blocking the wheel of the bicycle, the processor in the lock will be ordered to unlock the rotating bolt 2.

[0069] Then the user can retrieve the bicycle, optionally by first rotating the bolt 2 to the unblock position. The processor, which is coupled to sensors sensing the retrieval of the bicycle, e.g. by the reader sensing that it is no longer in immediate proximity to a docking station, confirms to the system that the user has retrieved the bicycle. Now the bicycle is assigned to the particular user.

[0070] If the user during the time of the rental, needs to leave the bicycle for a period of time, such as to enter a shop, he may lock the bicycle. This may be done either by directly communicating with the processor within the lock from his smart phone, or by communicating via the Internet with the server or cloud service. He sends a lock request to the processor, the processor signals the actuator, for the first embodiment to rotate the rocker 3 so that it unlocks the rotating bolt 2 and for the second embodiment to withdraw the slide 18 from the bolt 2. Then the user can manually rotate the bolt 2 to the blocking position. For the first embodiment, the rocker first arm 9 will enter the inwardly facing opening 8 by the spring bias and for the second embodiment, the processor will receive a sensor signal that the bolt has been rotated into the blocking position, and it will release the slide, so that it can enter the second notch 25.

[0071] When the user wants to pick up the bicycle again, the sends another coded signal to the bicycle to unlock. Then the processor performs the opposite procedure to release the bolt 2. The bolt 2 may be spring biased onto the open position or the bolt 2 may be moved manually until either the first arm 9 of the rocker 3 enters the outwardly facing opening 7 for the first embodiment, or the processor receives a

sensor signal indicating that the bolt has been moved to an unblock position and can release the slide 18.

[0072] When the user intends to return the bicycle, he can simply push the bicycle into a vacant position in a docking station. When the processor, through the reader, detects that it is an authorized docking station, the latch 4 will be caught by the rocker 3 and the docking pin 14 will be retained within the recess 11. A message will be sent to the service system confirming the return. and the user will be released from the assignment to the bicycle.

[0073] The system may debit the account of the user according to the duration of the rental.

[0074] The position of the bicycle will be updated, and it will be flagged as ready for rental.

[0075] Alternatively, the user may, if he is not in the vicinity of an authorized docking station, lock the bicycle by locking the wheel. He then checks out from the rental by choosing the appropriate option on his smart phone. A request to lock the bicycle is sent to the lock processor. The lock processor may check if the bicycle is in in an area authorized for leaving a bicycle. This may be done by the processor sending the GPS position of the bicycle to the service system, and the service system authorizing the bicycle to lock or denying the bicycle to lock.

[0076] When the bicycle has locked and the user is checked out from the system, the user cannot unlock the bicycle again without sending a new rental request. The bicycle is now ready for rental by another user, and the position of the bicycle is stored in the system.

Claims

1. A bicycle locking system comprising a bicycle lock attached to a bicycle, **characterized in** that the lock having a latch that is adapted to lock the bicycle to a docking station and a bolt that is adapted to block the wheel of the bicycle.

2. The bicycle locking system of claim 1, **characterized in** that it comprises an actuator adapted to set the lock in a selected one of multiple states, said states comprising a first state where the latch is releasing the lock from the docking station and the bolt is not blocking the wheel, a second state where the latch is ready to receive a docking pin of a docking station and retain said pin, a third state where the bolt is allowed to be moved into a blocking position with the wheel and a fourth state, where the bolt is retained in a blocking position of the wheel.

3. The bicycle locking system of claim 1 or 2, **characterized in** that it comprises a rocker that is capable of interfering with the latch and the bolt.

4. The bicycle locking system of claim 1 or 2 characterized that the actuator comprises a cam that is acting on a rocker.

5. The bicycle locking system of claim 4, characterized in that the cam is acting on a slide that in turn is capable of locking the bolt.

6. The bicycle locking system of claim 4 or 5, characterized in that the cam is acting on the rocker and the slide through a ball.

Lock mechanism / Main components

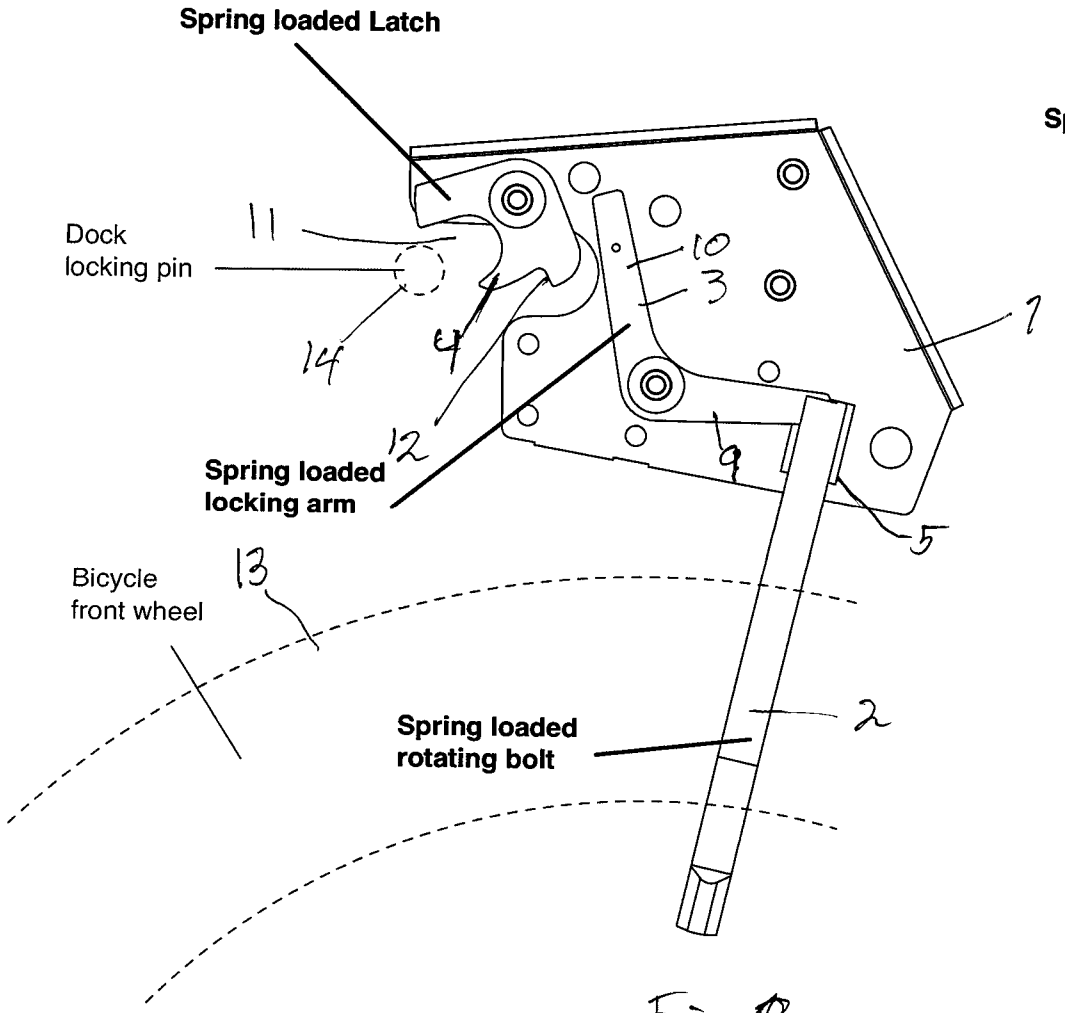


Fig. 2

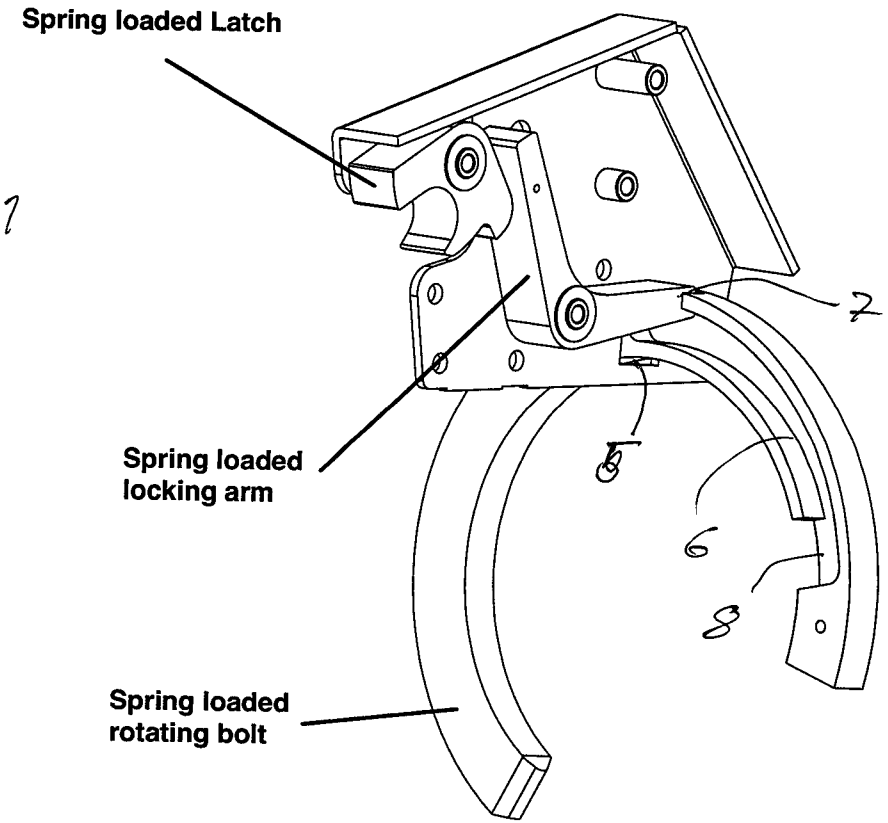


Fig. 3

State 1 : Bike is in use and is ready to be locked to a dock

Locking arm is ready to lock latch and blocking the rotating bolt

Latch is ready to be used, bike can be locked to dock

Rotating bolt is blocked

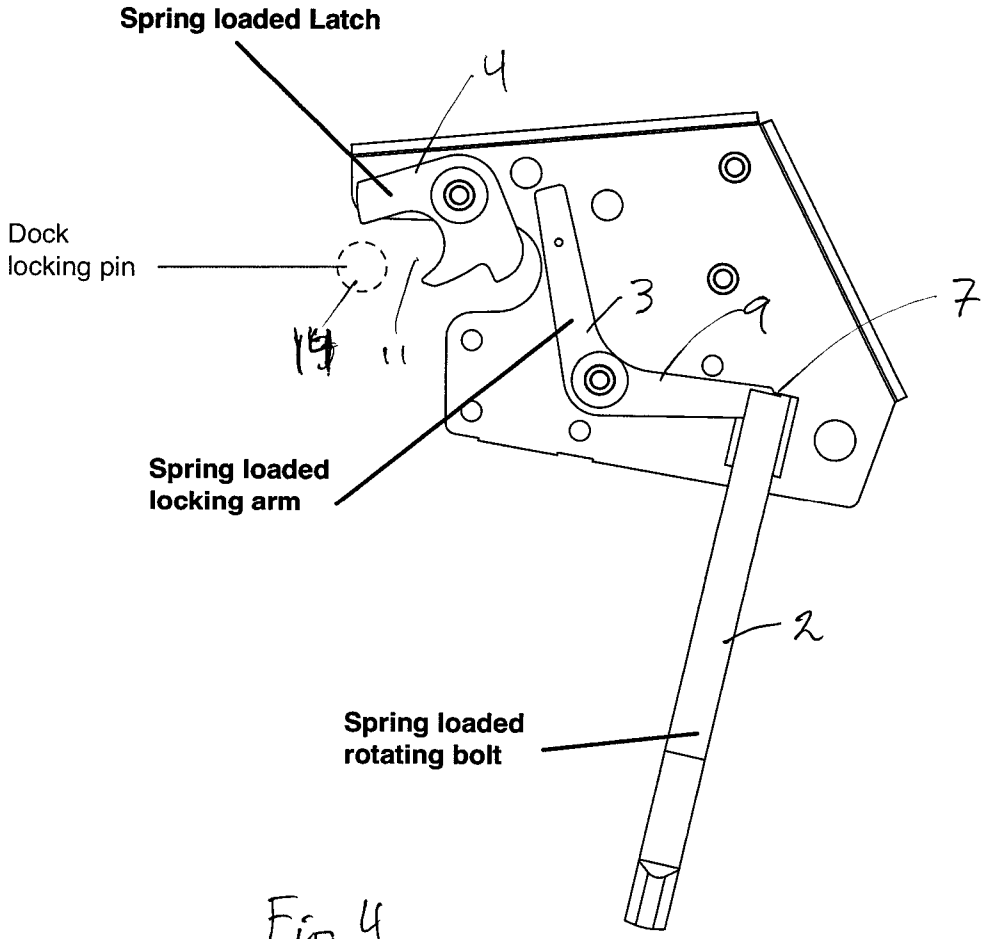


Fig. 4

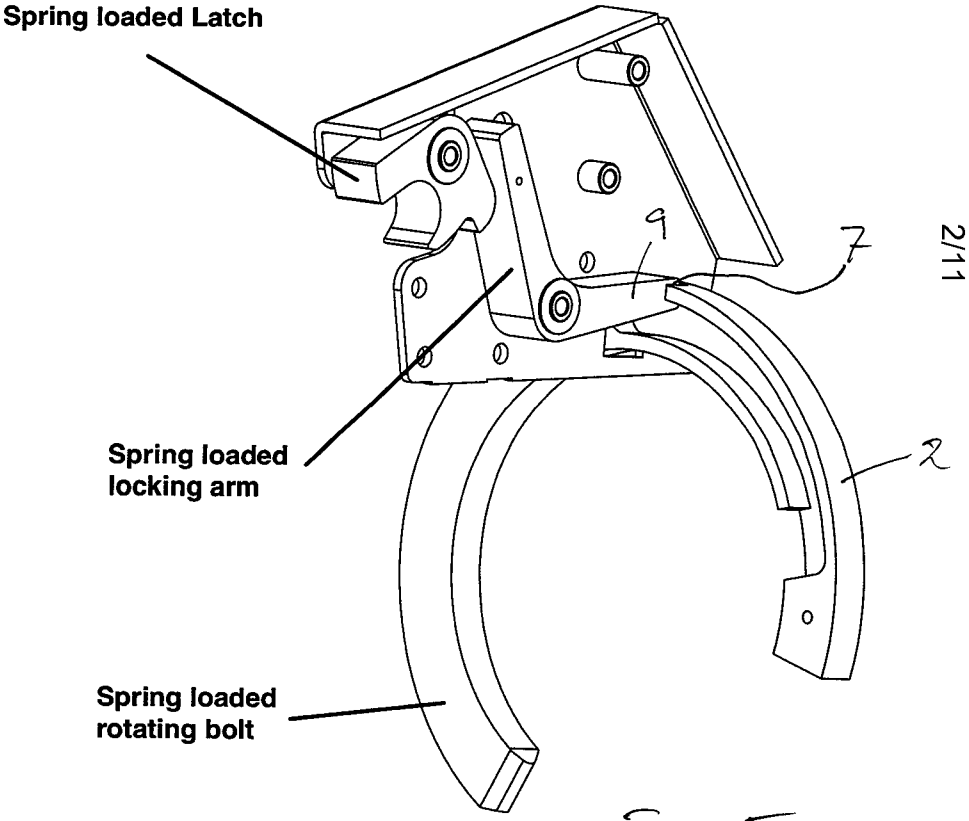


Fig. 5

State 2 : Bike is locked to the dock/system

Locking arm is locking the latch

Latch is locked and bike is locked to the dock

Rotating bolt is blocked

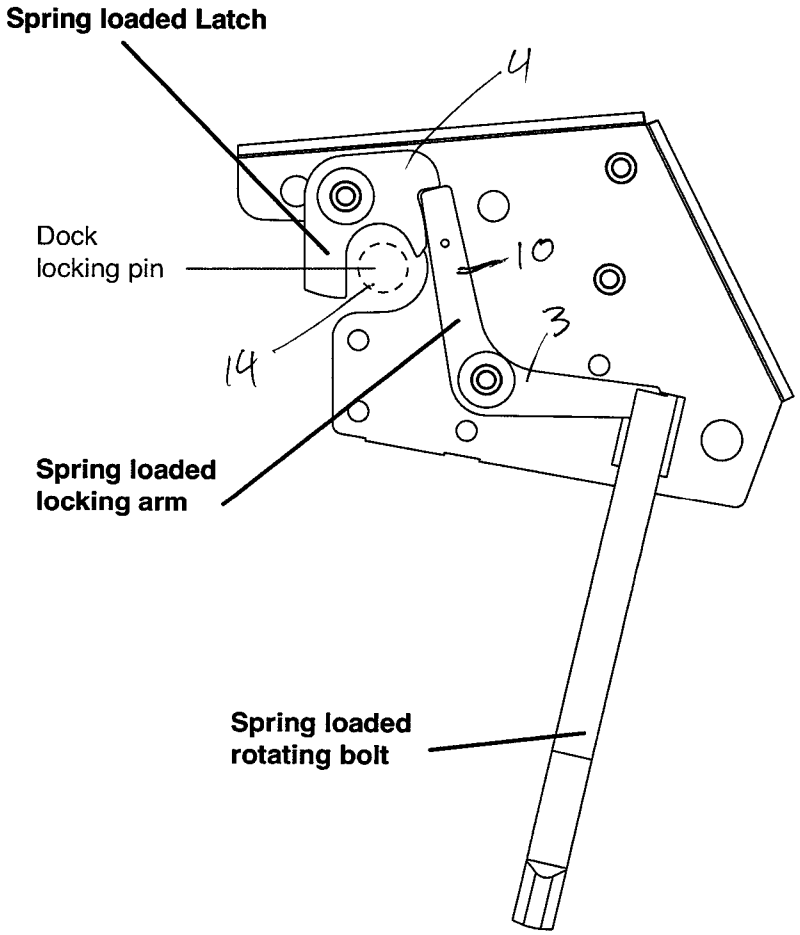


Fig. 6

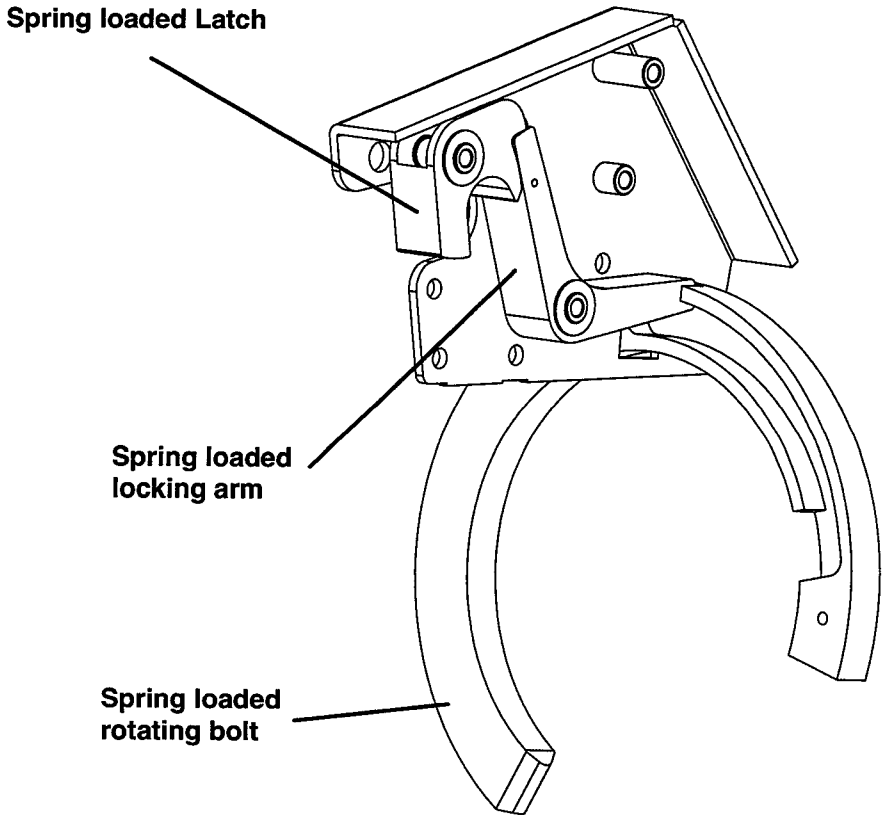


Fig. 7

State 3 : Bike is in use and is ready to be locked to itself

Locking arm has moved and enables the rotation bolt to be rotated

Latch is rotating freely

Rotating bolt can be moved using manual force and bike can be locked to itself

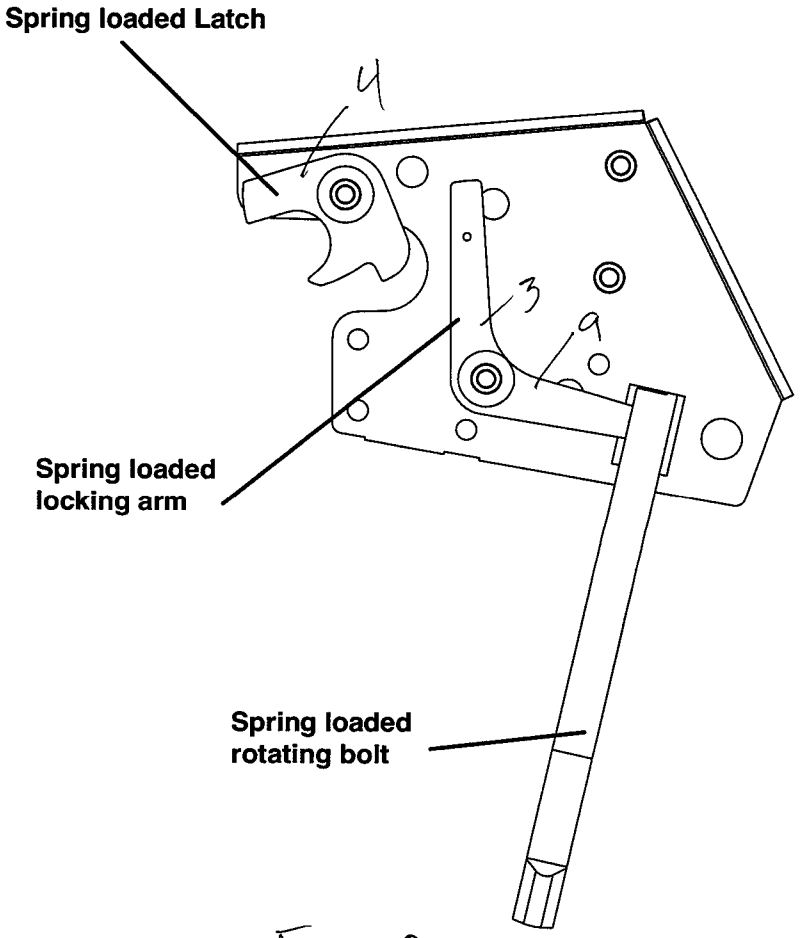


Fig. 8

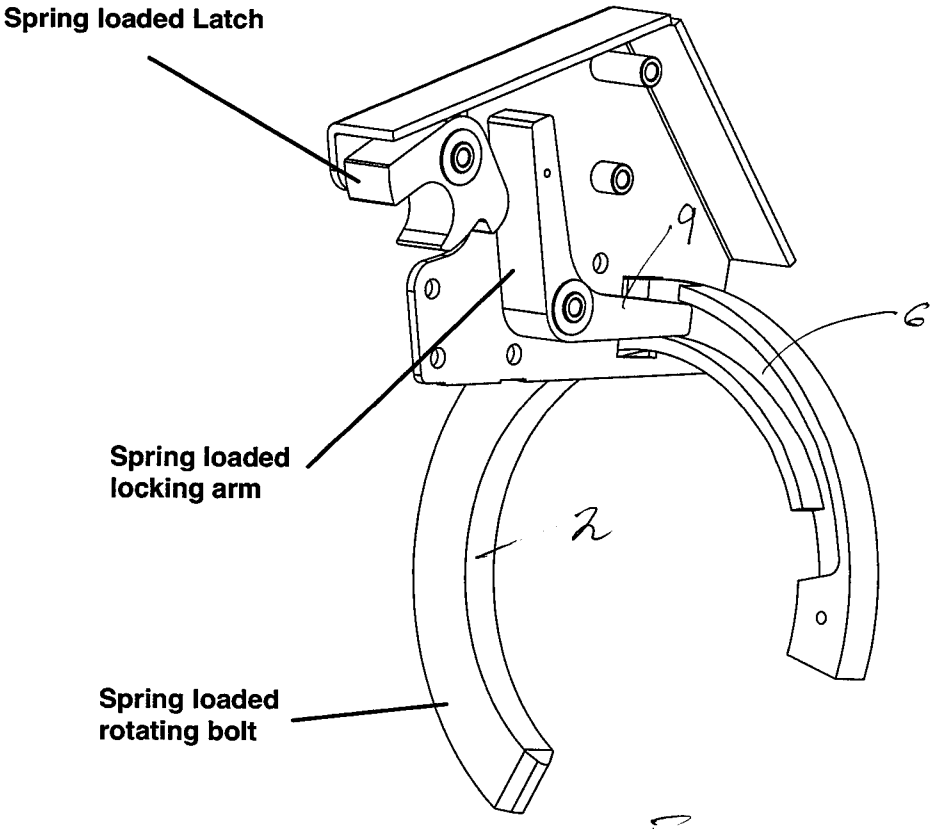


Fig. 9

State 4 : Bike is locked to itself

Locking arm has moved and locks the rotating bolt

Latch is rotating freely

Rotating bolt is locked in locked position

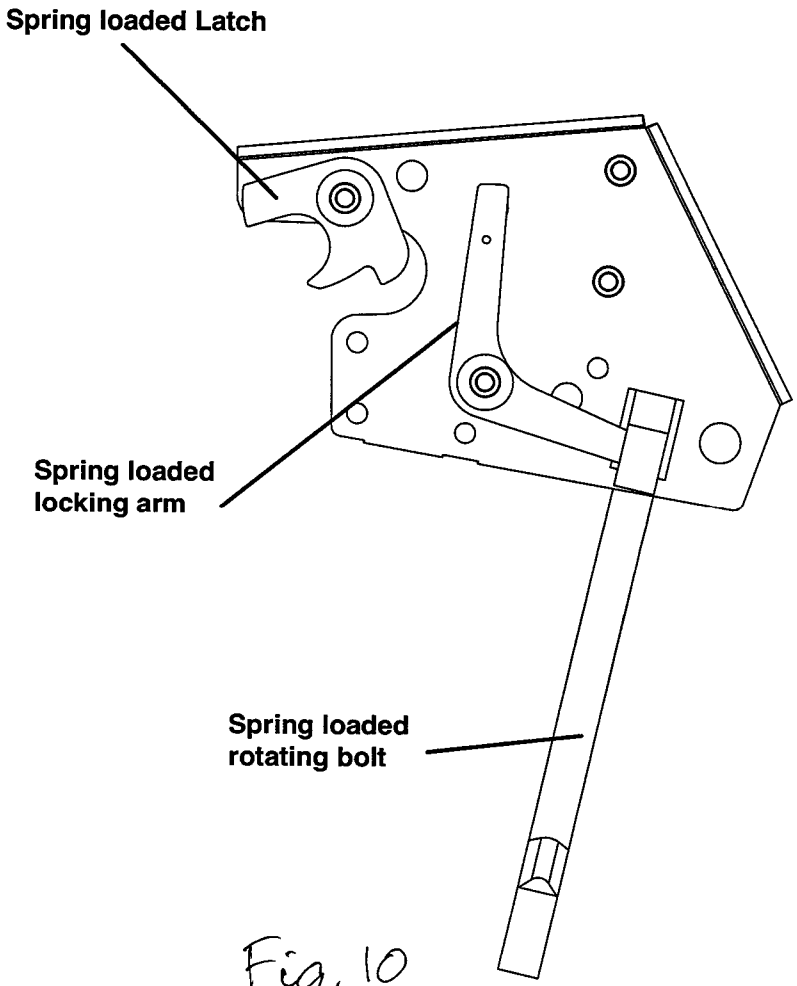


Fig. 10

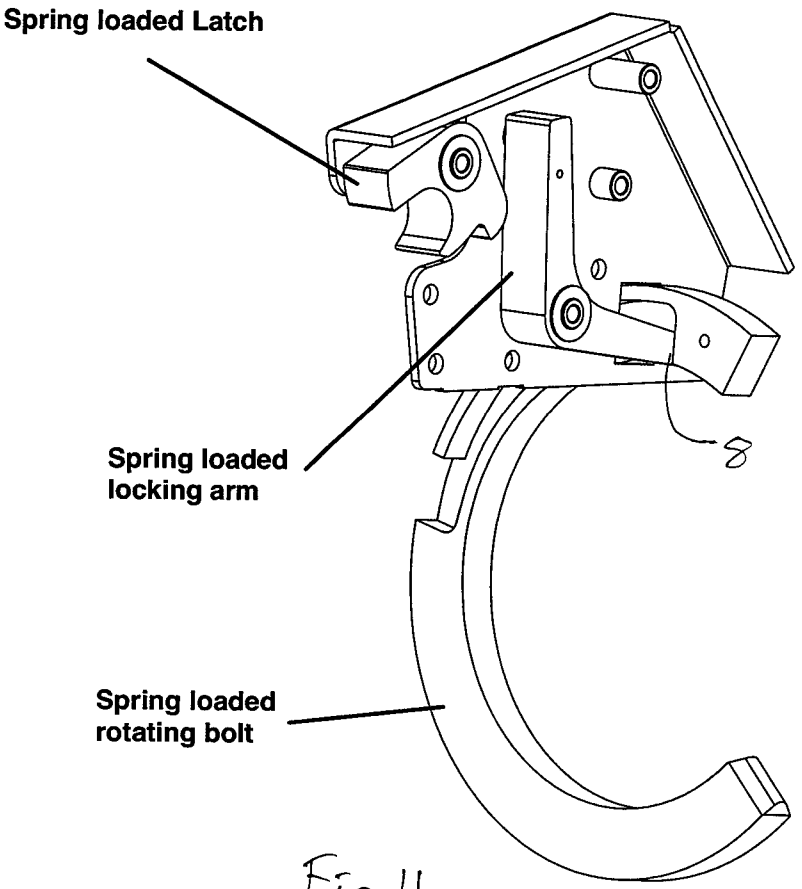


Fig. 11

State 5 : Bike is unlocked and in use

Locking arm moves and releases the spring loaded rotating bolt
Latch is ready to be used, bike is now ready to be docked
Rotating bolt is blocked

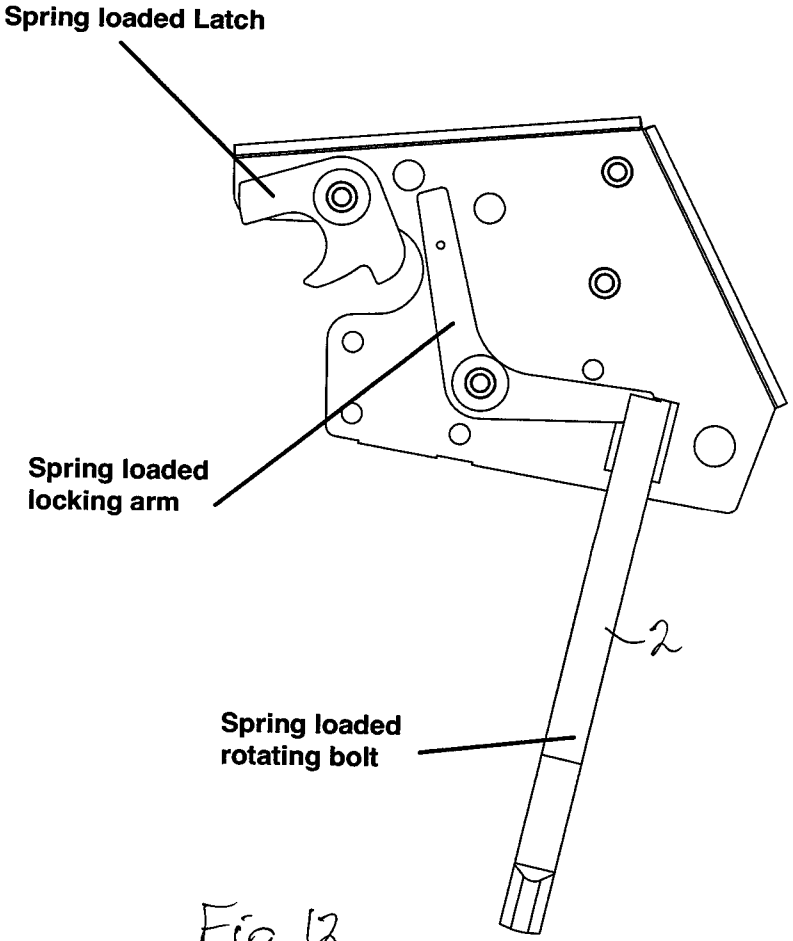


Fig. 12

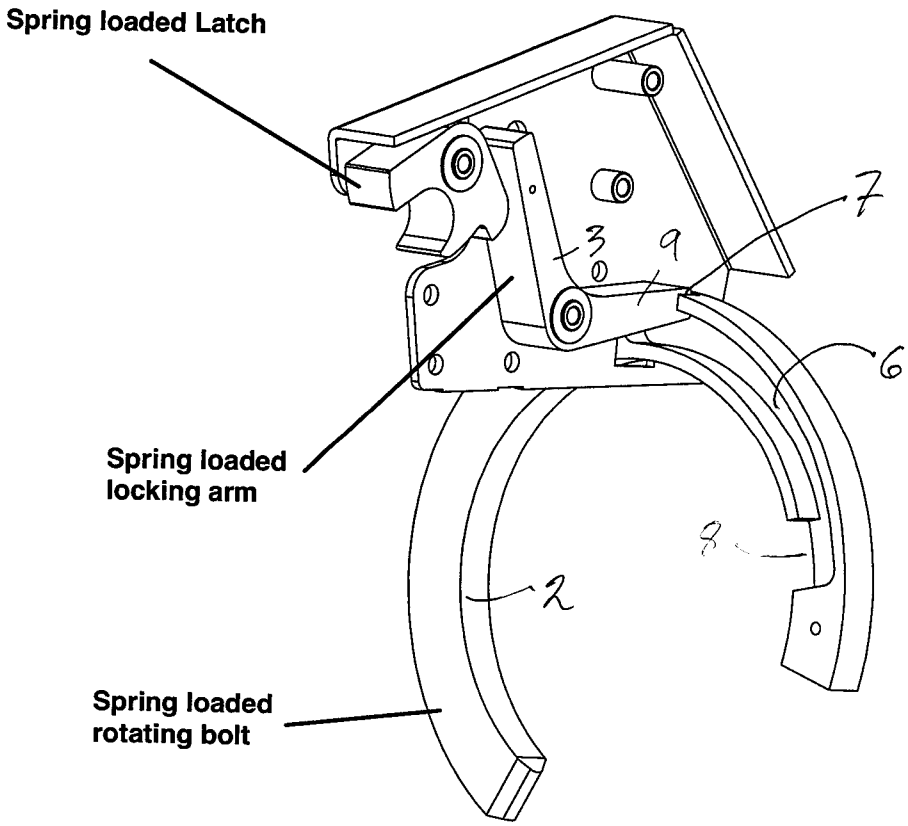


Fig. 13

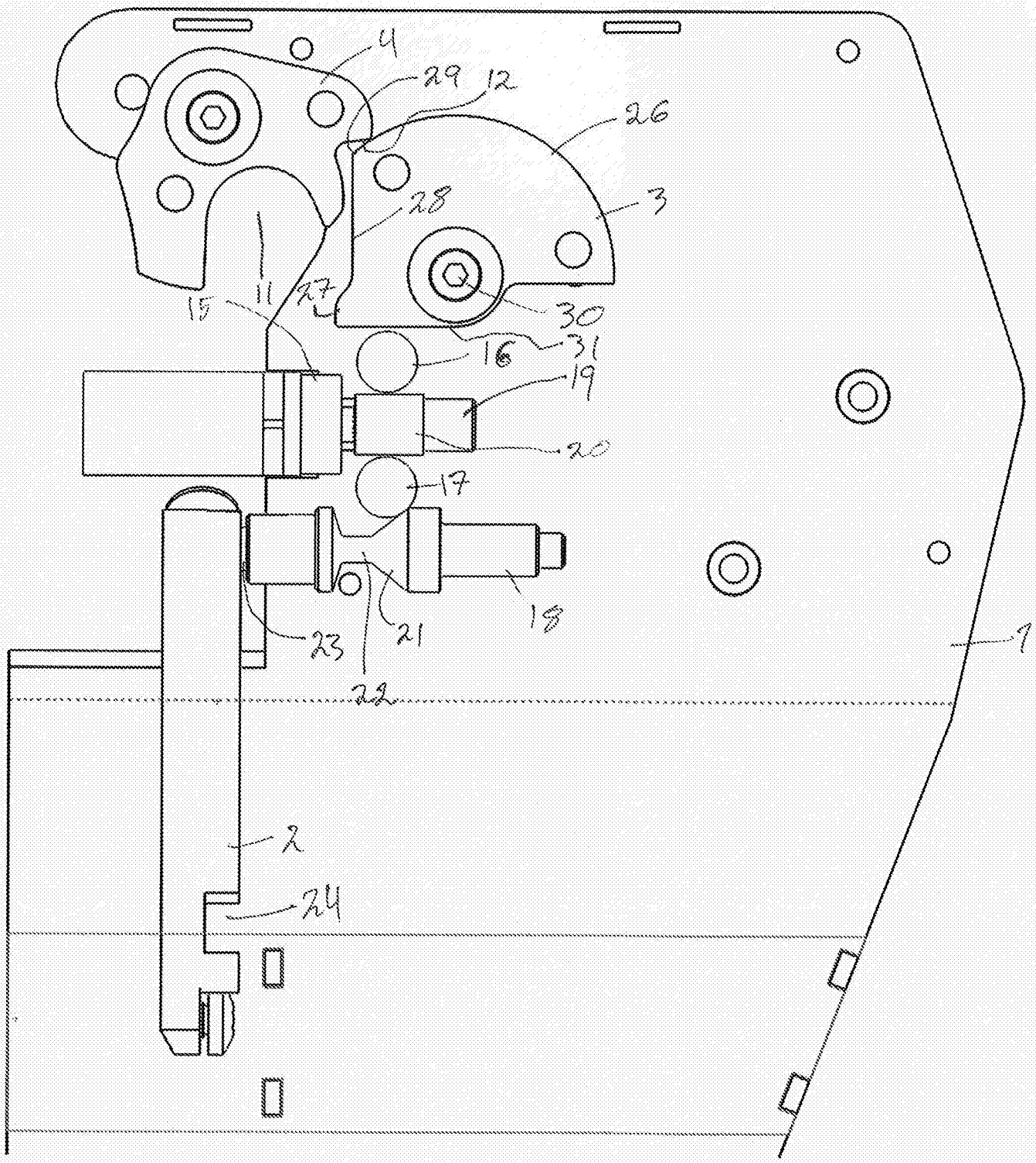


Fig. 14

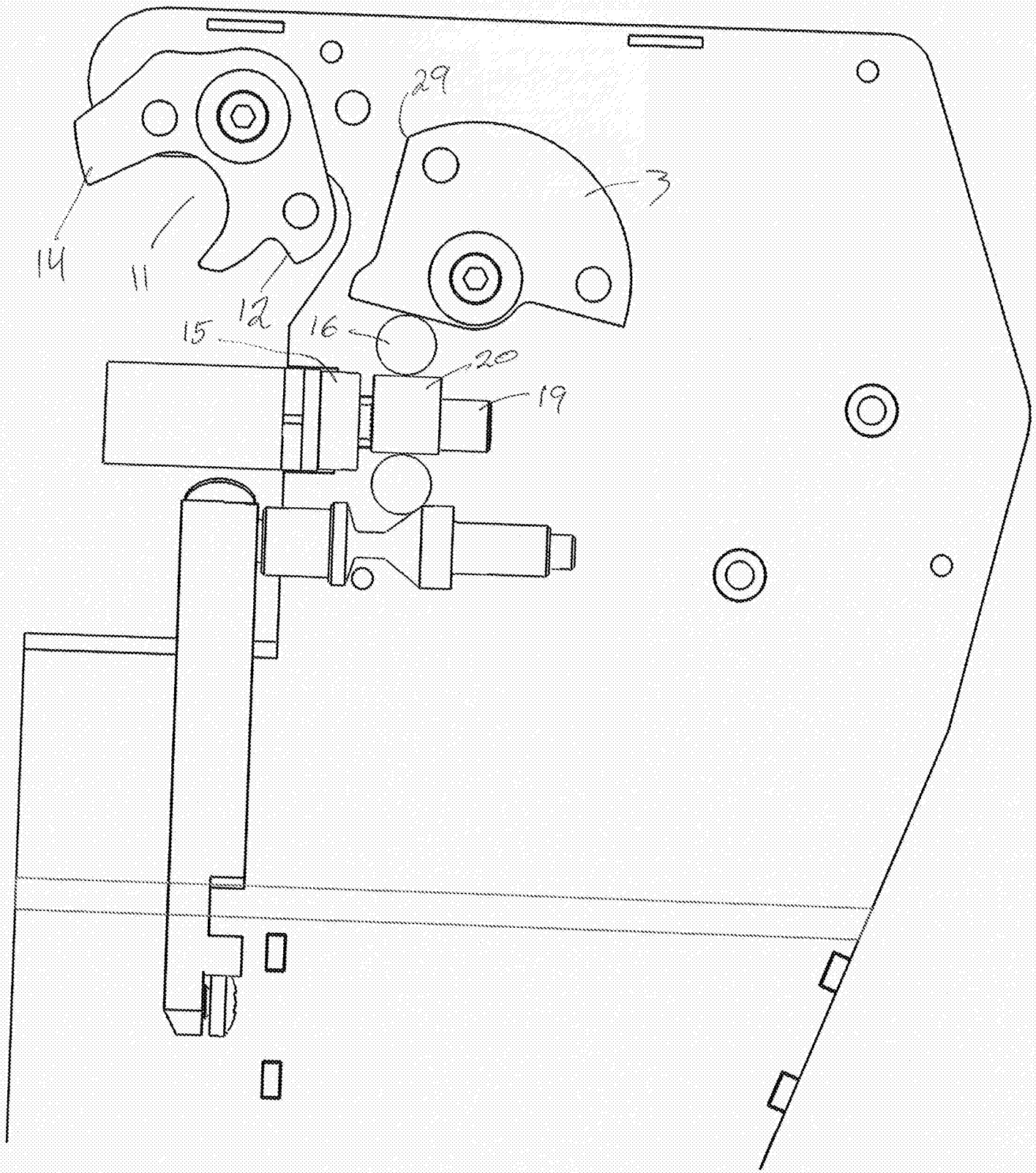


Fig. 15

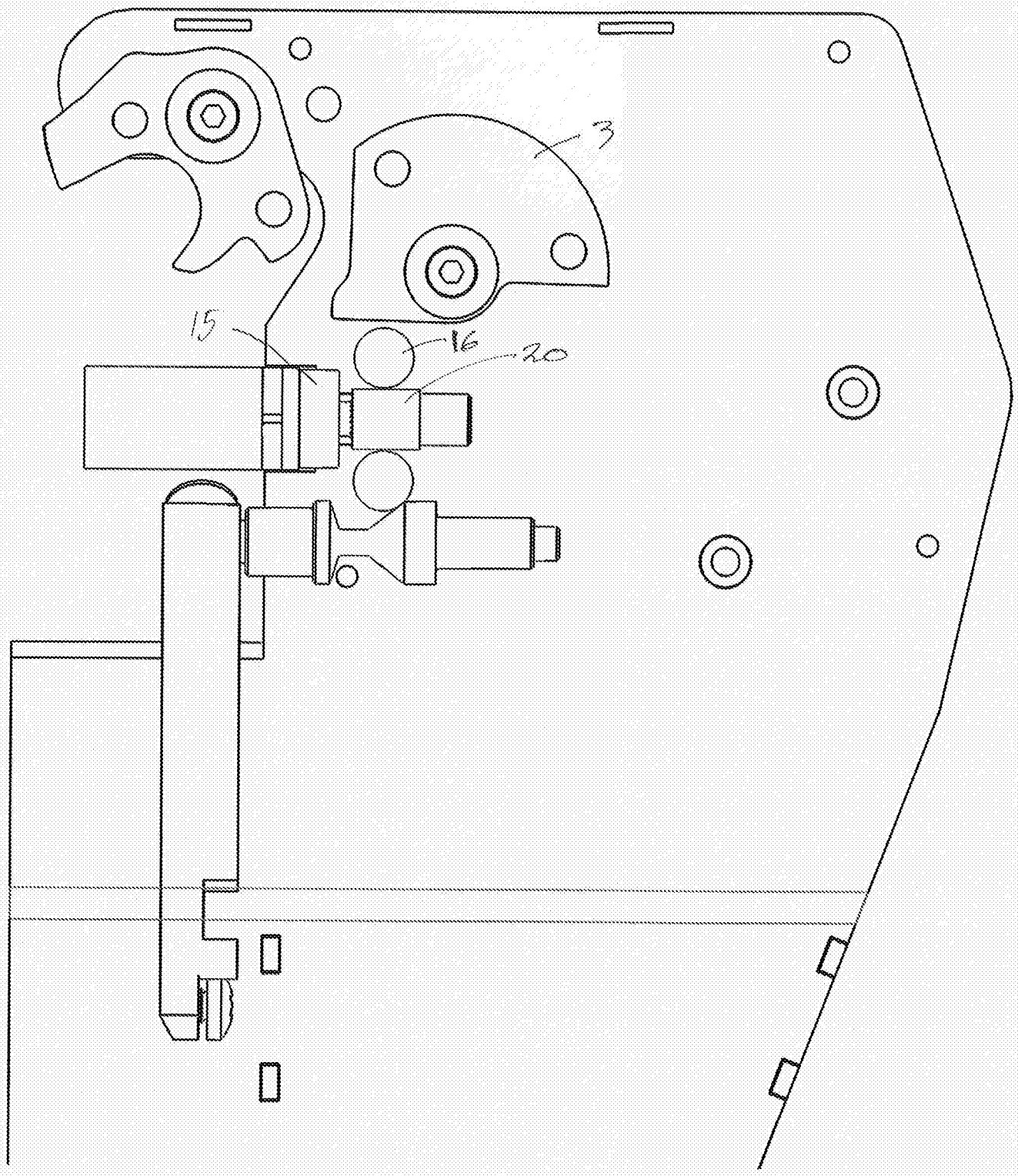


Fig. 16

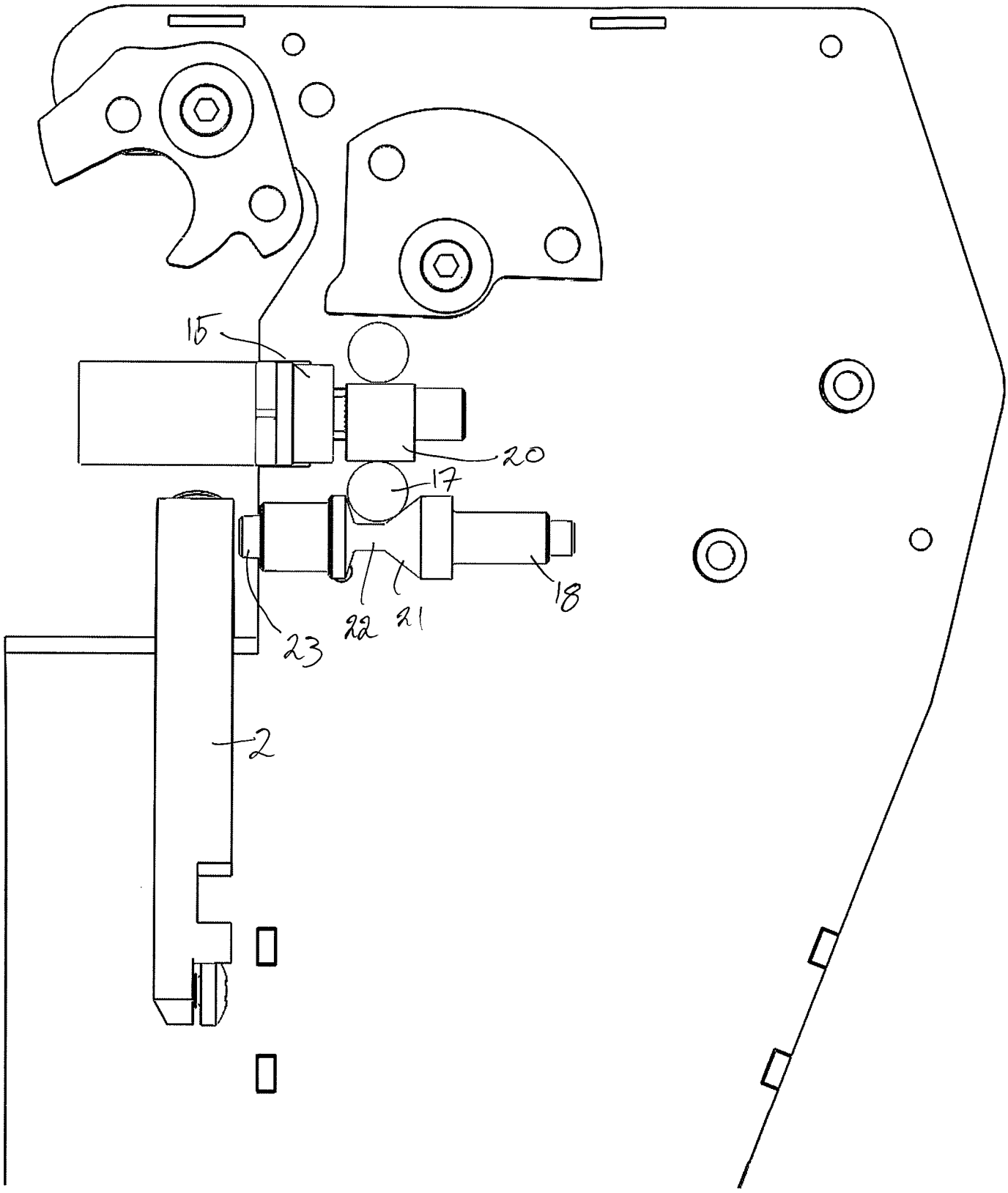


Fig. 17

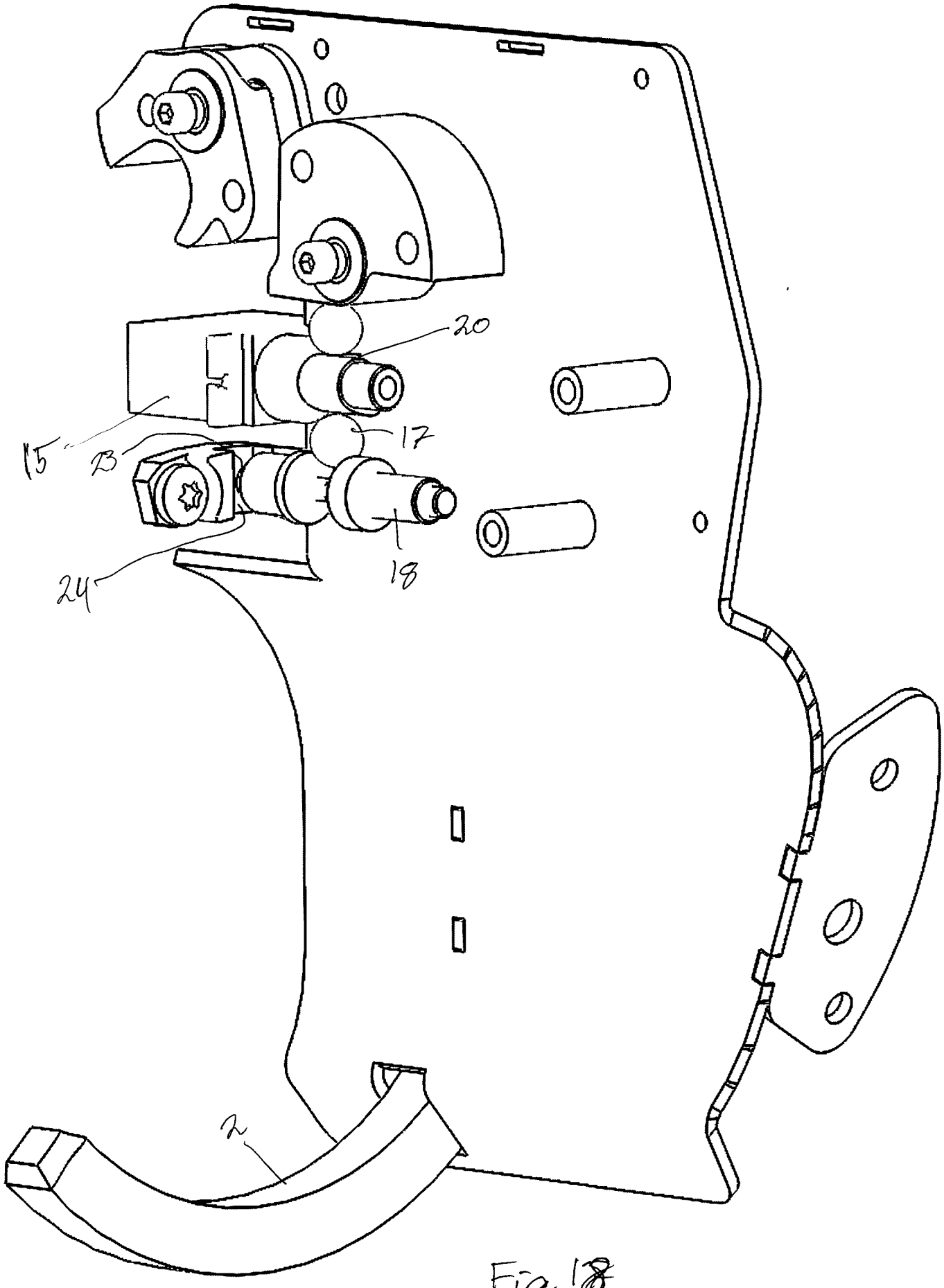


Fig. 18