Oct. 14, 1941. L. E. ZERBE ET AL 2,259,055

ROTARY MACHINE

Filed Oct. 3, 1939 2 Sheets-Sheet 1

Fig. 1

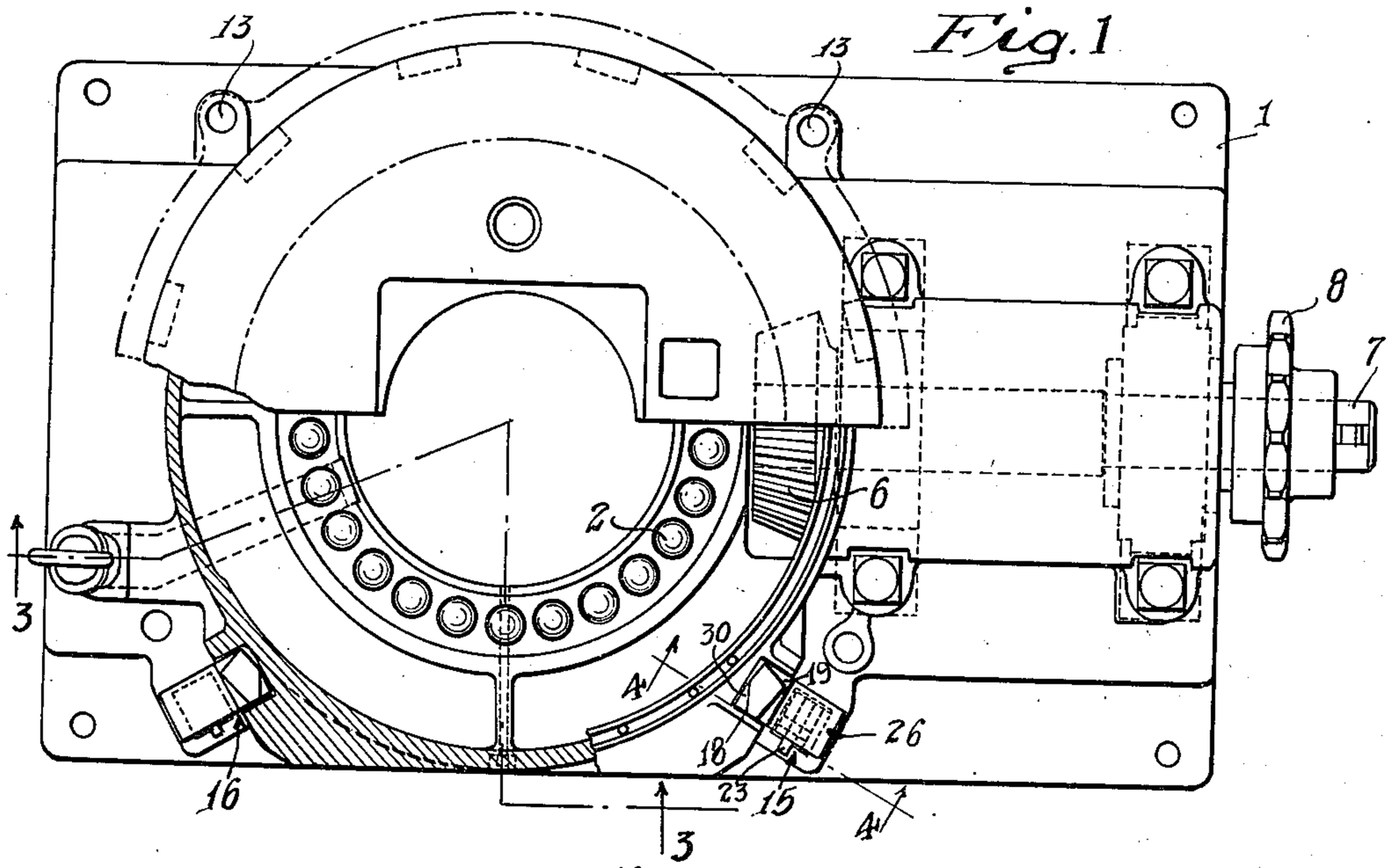


Fig. 2

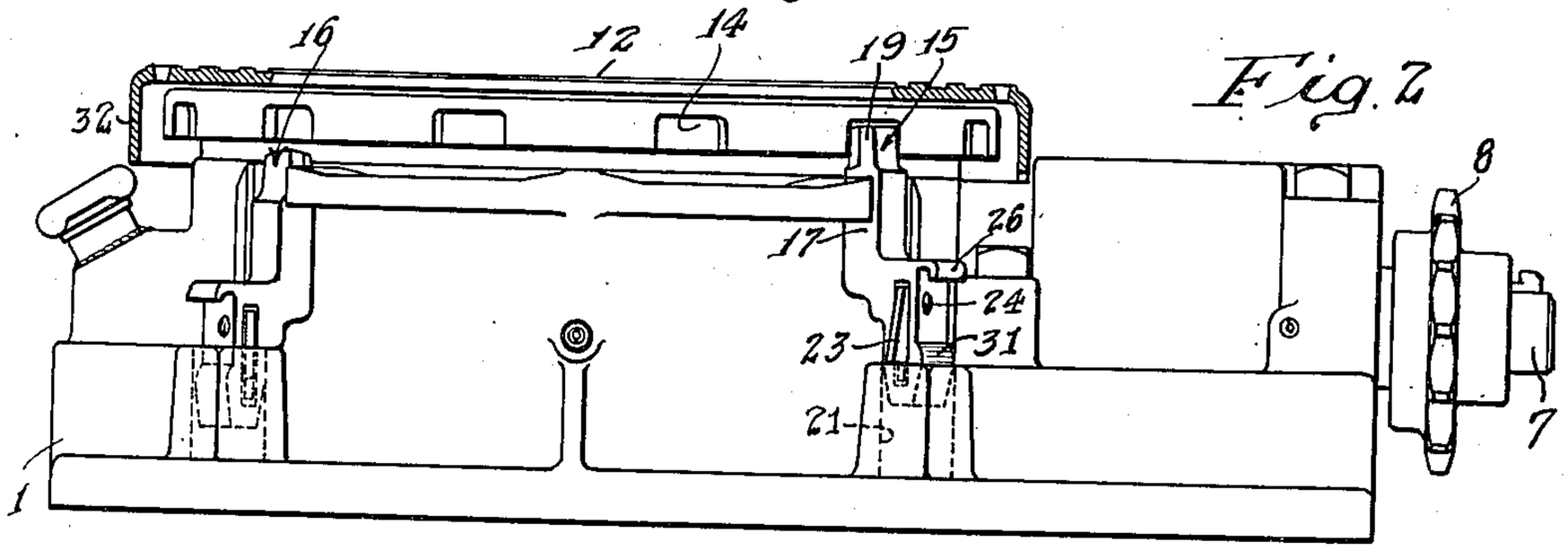
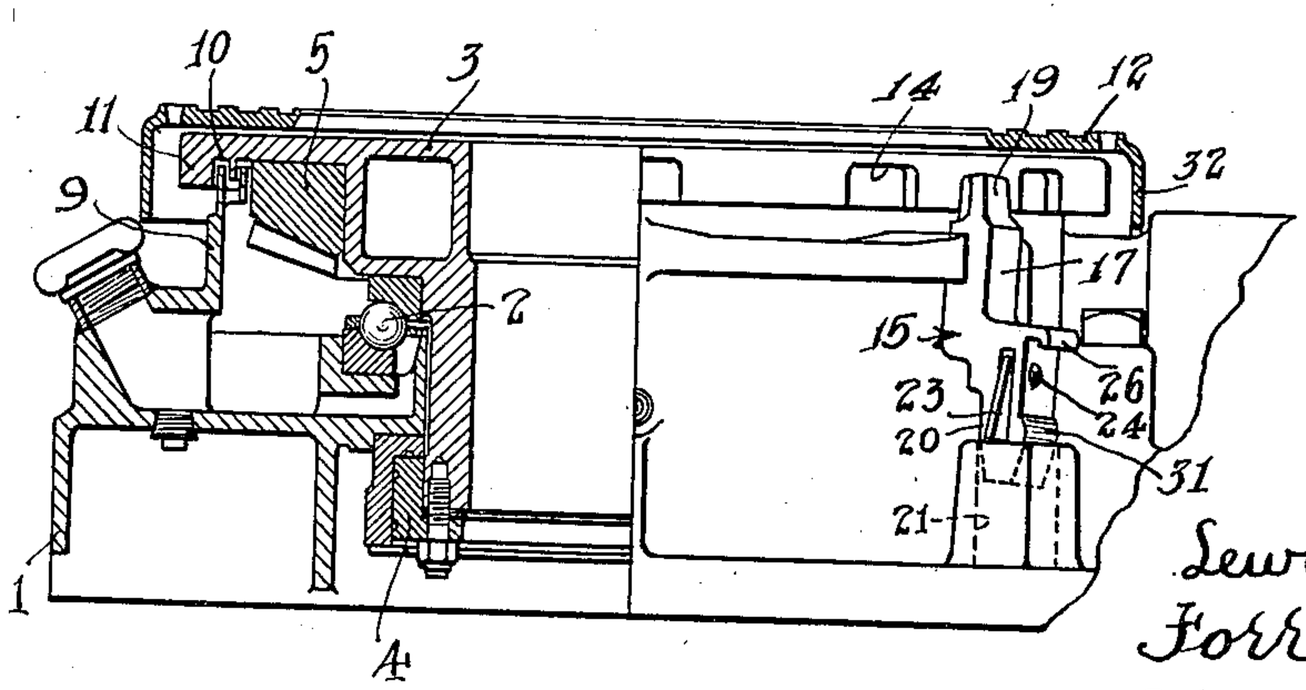


Fig. 3



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2 Sheets-Sheet 2

Fig. 6

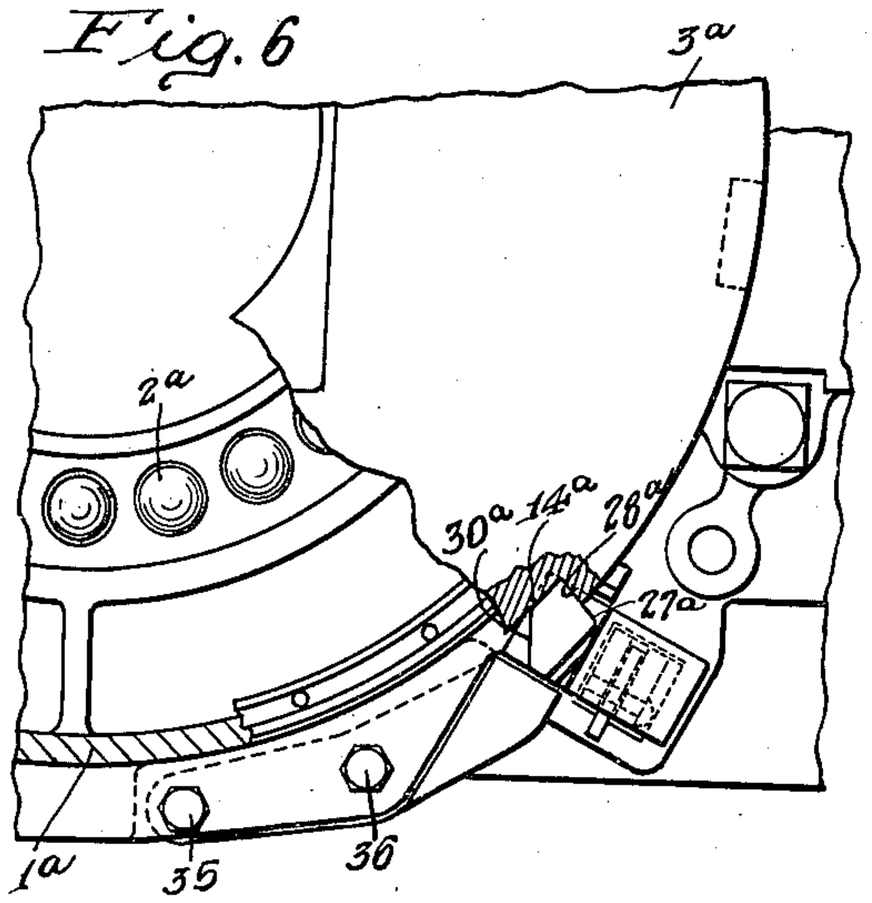


Fig. 8

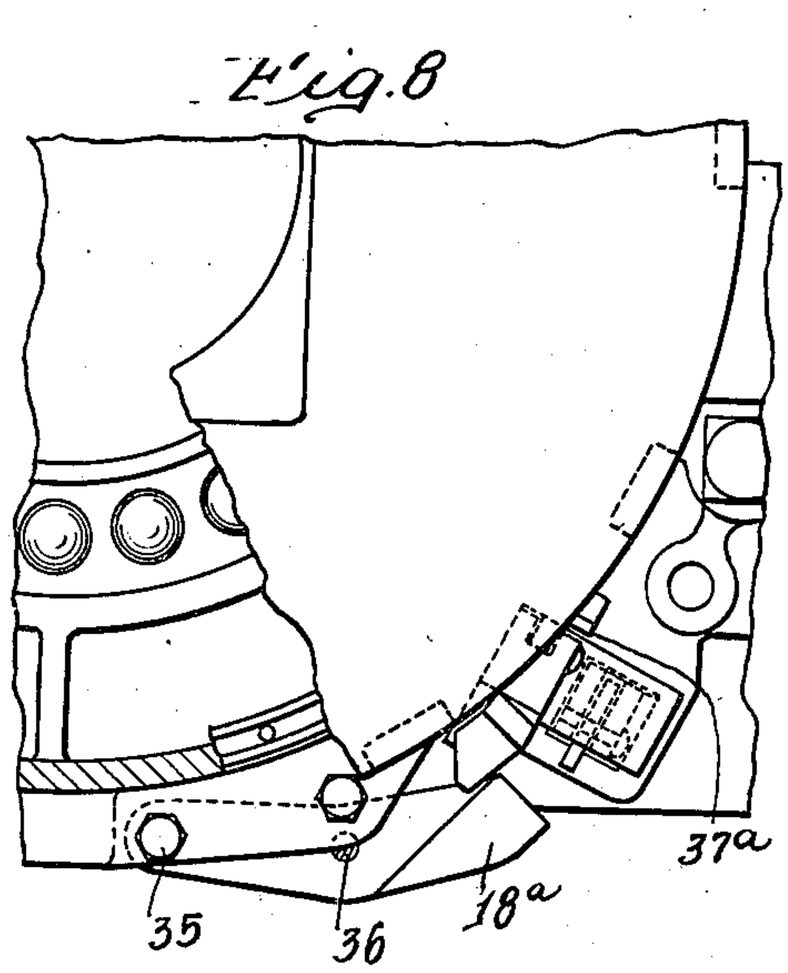


Fig. 7

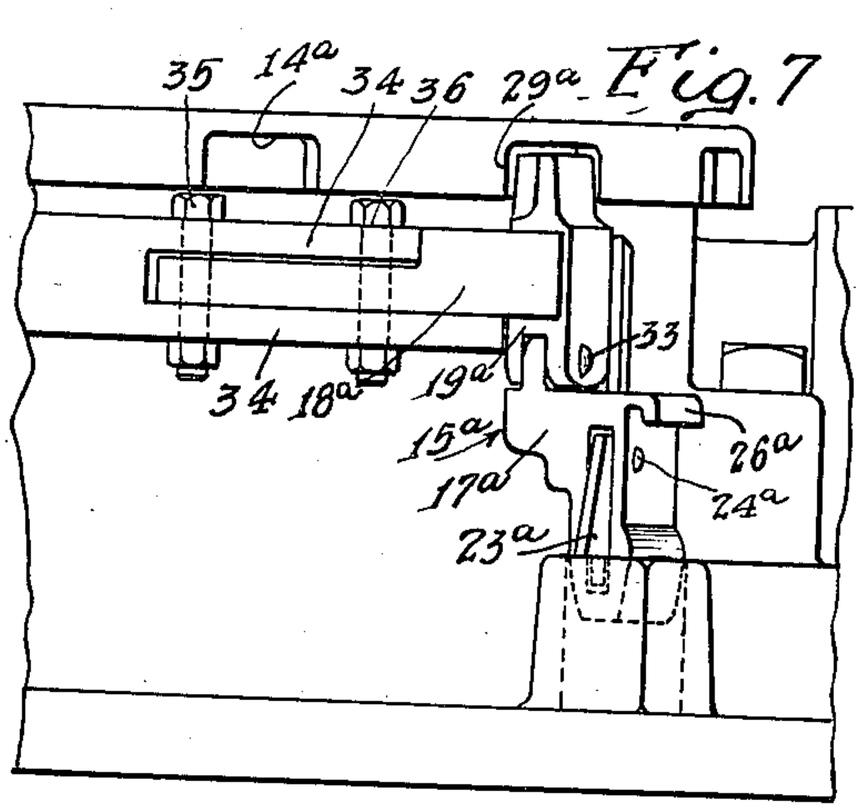


Fig. 9

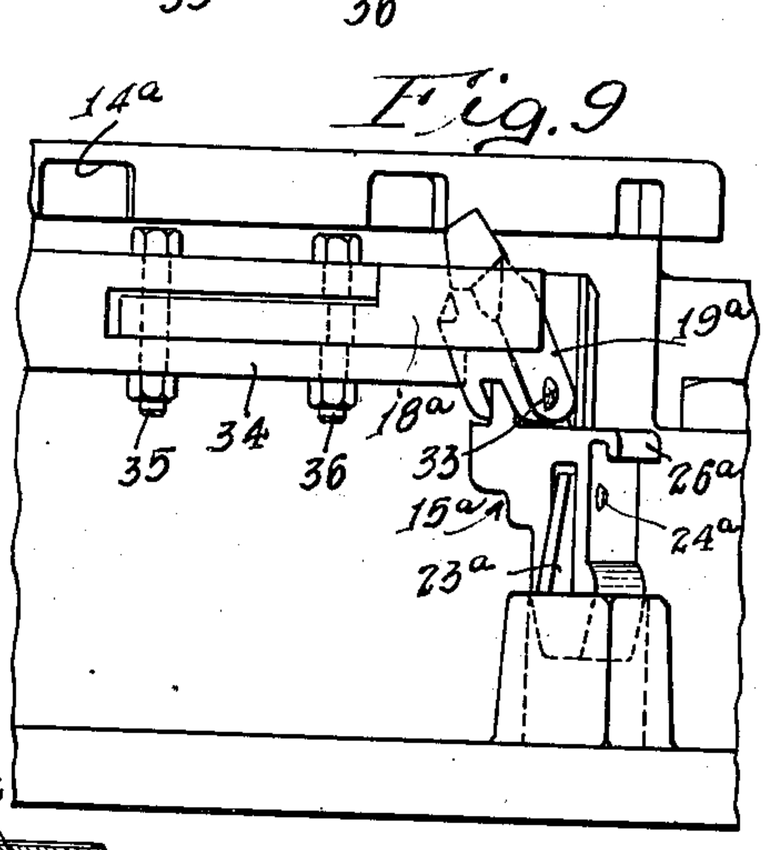


Fig. 4

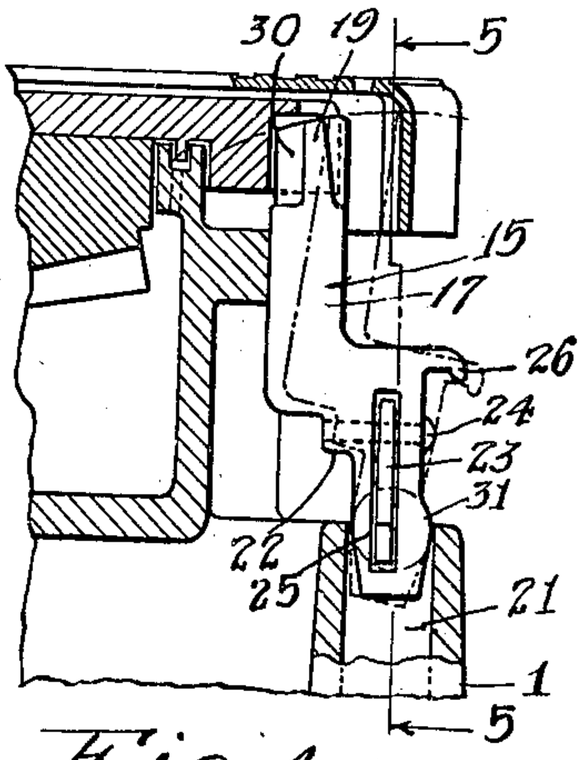
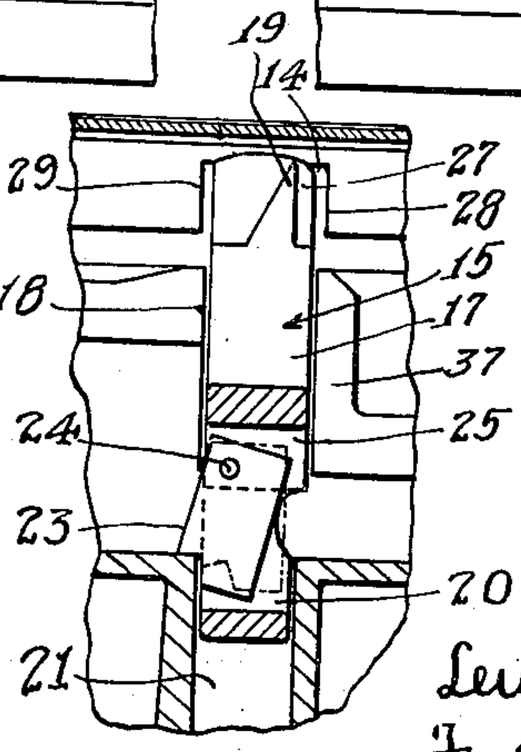


Fig. 5



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UNITED STATES PATENT OFFICE

2,259,055

ROTARY MACHINE

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Application October 3, 1939, Serial No. 297,688

12 Claims. (Cl. 255—23)

This invention relates to rotary drilling apparatus, and more particularly to an improvement in rotary machines as used in such apparatus for the drilling of wells. In the drilling of wells, a rotary machine is employed, the primary function of which is to rotate the drill string so that the bit carried thereby will bore into the formation. In addition to this primary function, the rotary machine also performs secondary functions, among which are that of assisting in the operations of coupling and uncoupling the sections of drill string.

In the operation of uncoupling the drill string, the rotary machine is required to hold the lower section of the string stationary while the upper section is turned by means such as tongs to break the joint. When the joint is broken, the rotary machine is used for the purpose of turning the lower section of pipe while the upper section is held stationary until the unthreading operation is completed. In the art this operation is known as "breaking out." Similarly in the making up of a drill string, the rotary machine is required to hold the lower section of the drill string stationary while the upper section is threaded in or, as known in the art, "spun in" through suitable means such as by the use of a manila line, after which final tightening is effected by use of tongs. This operation is known as "making up."

It will be apparent that during these two operations, means are required for maintaining the rotary machine stationary. Thus rotation locks are provided which may be selectively engaged to prevent rotation of the table in one direction while permitting rotation in the other direction.

During the "breaking out" operation the rotation lock must selectively prevent counter-clockwise rotation of the table while permitting clockwise rotation.

In the "making up" operation, the rotation lock must act to selectively prevent clockwise rotation of the table. Ordinarily in rotary machines these requirements are provided through the use of a ratchet and pawl rotation lock so that in the "breaking out" operation the ratchet and pawl prevents counter-clockwise rotation and in the "making up" operation the rotation lock prevents clockwise rotation.

The "making up" rotation lock is customarily formed as a ratchet and pawl because the ratchet action is necessary in case a drill string is employed which has left-hand threads. Such left-hand drill strings are employed for fishing jobs or at other times where it is desired to rotate the drill string in a counter-clockwise direction.

In the conventional structure of rotary machine, ratchets are fixed upon the pinion shaft of the rotary machine and the ratchets are selectively engaged by separate pawls pivotally mounted upon the rotary machine base. For example, such structure is illustrated in the patent to Faulkner, No. 1,875,430. In this type of structure the shock loads occasioned in the "breaking out" and "making up" of the joints are transmitted through the gears of the rotary table to the rotation lock. These shock loads are sometimes of such magnitude as to cause distortion or failure of the gear teeth.

It is therefore an object of this invention to provide a rotation lock for "break out" and "make up" operations which will lock the table directly to the base to avoid the transmission of shock loads through the gears.

Another object of this invention is to provide a rotation lock for a rotary machine which is so positioned as to engage the rotary table at its largest diameter.

Another object of this invention is to provide a rotary table locking means including a locking pawl which may be raised vertically between guides on the rotary table base into locking position with respect to the rotary table.

Another object of this invention is to provide a lock pawl adapted to engage a lock element on the table of a rotary machine, the lock pawl being mounted for pivotal motion in a plane disposed substantially at right angles to the plane of rotation of the lock element.

Another object of this invention is to provide a rotary machine rotation lock including a lock pawl having such pivotal motion and in which locking pawl the center of gravity lies radially inward from the point of support so that the weight of the pawl acts to automatically move the pawl toward locking position.

Another object of this invention is to provide a rotary table rotation lock which includes an overload releasing means.

Other objects and advantages of this invention it is believed will be apparent from the following detailed description of a preferred embodiment thereof as illustrated in the accompanying drawings.

In the drawings:

Figure 1 is a top plan view partly in horizontal section of the rotary machine embodying our invention.

Figure 2 is a side elevation of the rotary machine as illustrated in Figure 1 illustrating the "make up" rotation locking pawl in engaged position.

Figure 3 is a sectional elevation taken substantially on the line 3—3 of Figure 1 illustrating the "make up" rotation lock pawl out of engagement and in the position assumed when ratcheting.

Figure 4 is a fragmental sectional elevation taken substantially on the line 4—4 of Figure 1.

Figure 5 is a fragmental sectional elevation taken substantially on the line 5—5 of Figure 4.

Figure 6 is a fragmental plan principally in horizontal section of a modified form of rotary machine embodying our invention.

Figure 7 is a fragmental side elevation of the rotary machine as illustrated in Figure 6.

Figure 8 is a fragmental plan view of the structure illustrated in Figure 6 but illustrating the parts as moved to a different position.

Figure 9 is a fragmental elevation of the structure as illustrated in Figure 8.

In the preferred embodiment of our invention, particularly as illustrated in Figures 1 to 5, inclusive, the rotary machine is indicated as including a base 1, supporting bearings 2, upon which the rotary table 3 is mounted for rotation. As is customary in such structures, an upthrust bearing 4 is provided for maintaining the table 3 in position.

A gear ring 5 is suitably secured to the table 3 in position to mesh with a pinion 6 mounted upon the pinion shaft 7. The pinion shaft 7 is rotatably supported on the base 1. A drive sprocket 8 is secured to the shaft 7.

In the form of rotary machine as illustrated, the base 1 is provided with an annular upstanding wall 9 which cooperates with the table 3 to form a labyrinth seal as indicated at 10. The table 3 is provided with a depending flange 11 which overlaps the upstanding annular wall 9 in telescopic relation.

Disposed above and about the outer edge of the table 3 is a guard ring 12 which is supported in the base 1 on posts 13. Formed in the depending annular flange 11 are a series of lock recesses 14 which are adapted to receive the locking pawls 15 and 16. The pawls 15 and 16 are so constructed and mounted as to be of right and left-hand formation, that is, each functions to prevent rotation of the table 3 in the direction permitted by the other; except, however, in this factor, the pawls 15 and 16 are quite similar so that a detailed description of one serves as a description for the other. Accordingly, the pawl 15, which we will hereinafter refer to as the "make up" pawl has a body portion 17 which is adapted to lie flat against an abutment or stop shoulder 18 formed on the upstanding wall 9 of the base 1. The pawl 15 has a head portion 19 adapted to enter any one of the recesses 14. The body 17 of the pawl 15 is offset, as particularly illustrated in Figure 4 so that the lower end 20 is spaced outwardly from the position of the head portion 19.

Means are provided whereby the vertical position of the pawl 15 may be determined so that in the lower position the head 19 does not reach high enough to engage within the recesses 14 and therefore the table 3 is free to rotate. Thus the lower end 20 of the pawl 15 fits within an opening 21 formed within the base 1. The opening 21 is a vertical opening and its side walls function as a guide for the end 20 of the pawl 15 during its vertical movement. In its lowermost position the pawl 15 is supported by its shoulder 22 engaging the upper end of the wall forming the guide opening 21.

Means are provided for retaining the pawl 15 in its raised or operative position, which means is herein illustrated as including a latch member 23.

The "make up" pawl 15 is provided for holding the table 3 against clockwise rotation when the same is raised to the position where the head 19 engages within one of the recesses 14. In this position the latch 23 engages the upper surface of the wall forming the guide hole 21 (Figure 5) maintaining the said pawl 15 in raised position.

In order to provide for the automatic engagement of this latch to retain the latch member 23 in latching position, the same is pivotally mounted on a pivot pin 24 within a latch recess 25 formed in the pawl 15. The pin 24 is positioned in off-center relationship so that when free to do so, the latch member 23 swings outward into the latching position under the effect of gravity.

In order to provide for the convenient operation of the pawl 15, the lift lug 26 is formed thereon which the operator may grasp to raise the same vertically in the guide hole 21 to such position as to permit the latch member 23 to swing to latching position.

When in locking position, the "make up" pawl 15 has its abutment face 27 in engagement with the trailing wall 28 of one of the lock recesses 14. In this position the main force is transmitted from the table 3 through the lock pawl 15 to the stop shoulder 18 formed on the base 1, while the reaction force at the lower end of the pawl 15 is also received by the base 1.

Due to the offset construction of the body 17 of the pawl 15, the center of gravity of the pawl lies radially inward from its point of support and therefore the weight of the pawl 15 acts to maintain the head portion 19 within the recess 14. If for any reason the table 3 should be rotated in the reverse direction while the lock pawl 15 is engaged, the lock pawl 15 will not act to prevent this rotation but will be ratcheted back and forth. Thus the recess wall 29 will strike the tapered face 30 of the pawl head 19. This action results in the pawl head 19 being forced out of the recess 14. As the table 3 continues to rotate in this stated direction, the pawl 15 will be rocked back and forth and to accommodate this rocking action, the lower end of the pawl 15 is provided with rounded surfaces 31 which fit within the walls of the opening 21. Thus in Figure 3 the "make up" pawl 15 is indicated tilted back from its locking position with its head portion 19 out of contact. Excessive over-travel is prevented by the head 19 engaging the depending annular flange 32 of the guard 12.

When the operator desires to return the pawl 15 to non-engaging position, it is only necessary for him to strike or kick the latch member 23 to release the same from engagement with the upper edge of the wall forming the receiving hole 21, thereby letting the lock pawl 15 drop back into the opening 21.

The construction of the "break out" pawl 16 is entirely similar to that of the pawl 15 except that the surfaces 27 and 30 are in reversed position.

In the modified form of our invention as illustrated in Figures 6 to 9, inclusive, similar parts

are indicated with the same numeral with the addition of an exponent *a* thereto. Thus in this modification of our invention, the table **3***a* is mounted upon bearings **2***a* supported by a base **1***a*. In this modification we have chosen to indicate only the "make up" pawl **15***a*, although it is obvious that a similar "break out" pawl will also be provided.

In the structure of "make up" pawl of this modification, the body portion **17***a* is provided with a head portion **19***a* and the head portion is pivotally connected to the body portion on a pivot pin **33**. Also in this modification the member **18***a* which forms the stop shoulder is a separate member mounted between fins **34** on the base **1***a* by means of the spaced bolts **35** and **36**. Thus in this modification when the pawl **15***a* is supported in locking position by means of the latch member **23***a*, the abutment face **27***a* engages the trailing wall **28***a* of the recess **14***a* preventing clockwise rotation of the table **3***a*. However, should the table be rotated in a counterclockwise direction, the leading face **29***a* of the recess **14***a* strikes the tapered face **30***a* of the head **19***a* of the pawl **15***a*, causing the pawl **15***a* to ratchet back and forth, thereby permitting the said table **3***a* to rotate. If, however, an excessive load is applied to the abutment face **27***a*, the force transmitted by the head portion **19***a* to the abutment shoulder **18***a* is sufficient to shear the bolt **36** and move the abutment member **18***a* from the position indicated in Figure 6 to that indicated in Figure 8, and permitting the pawl head **19***a* to pivot about the pin **33** freeing the table **3***a* for rotation. The location of the bolts **35** and **36** is such that the bolt **36** receives the greatest proportion of the applied load and hence shears off before the bolt **35** is subjected to too great stress.

In this modification of our invention there is thus provided an over-load release which will effectively act to prevent breakage of the rotary machine parts. This becomes an important feature in the operation of such a rotary machine as it is obvious that the pawl **15***a* might be engaged by error while the table **3** is rotating. Such accidental engagement might result either through the error of the operator or by reason of one of the hoisting machines utilized in such drilling operations accidentally catching under the lifting lugs **26***a*. Also an excessive force might be applied to the table through the medium of the tongs (not shown) which are normally used to tighten the joints between the adjacent pipe sections. Through the medium of this over-load release excessive loading of the parts of the rotary machine is prevented. Excessive loading also does not unduly stress the pawl pivot **33** because the reaction force on the lower end of the head portion **19***a* is transmitted through the back face of the head **19***a* directly to the guide wall **37***a* formed on the base **1***a*.

There is also provided a similar guide wall **37** for the pawl **15** as indicated in Figure 5.

Having fully described our invention, it is to be understood that we do not wish to be limited to the details herein set forth, but our invention is of the full scope of the appended claims.

We claim:

1. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a locking element carried on the table, a pawl supported on the base and adapted to engage said locking element to prevent rotation of the table in one direction, said pawl being adapted for pivotal movement in a plane positioned substantially at right angles to the plane of rotation of the locking element, and cooperating means on the table and the pawl adapted to cause the pawl to pivot away from the table upon rotation of the table in the other direction.

2. In a rotary machine, the combination of a stationary base member, a rotary member rotatably mounted on the base member, a lock element on said rotary member, a lock member supported on the base member and adapted to engage said lock element to prevent rotation of the rotary member in one direction, said lock member being adapted for pivotal movement in a plane disposed at an angle to the path of said lock element, and means including a bevel surface on said lock member adapted to be engaged by said lock element to impart pivotal movement to said lock member upon rotation of the rotary member in the other direction.

3. In a rotary machine, the combination of a base, a table mounted upon the base for rotation about a vertical axis, a lock element on said table, a lock pawl supported on the base and adapted for pivotal movement in a vertical plane, the lock pawl being adapted to engage the lock element to prevent rotation of the table, the center of gravity of the lock pawl being at one side of its pivotal axis whereby the weight of said lock pawl normally acts to maintain it in locking position.

4. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a stationary annular guard supported on the base and having a depending skirt surrounding a portion of the table, a plurality of locking elements on the table within the depending skirt, a lock member supported on the base and adapted to extend within said depending skirt to engage said lock element, said lock member being adapted for pivotal movement in a plane disposed at an angle to the path of said lock elements, said pivotal movement being limited in one direction by engagement between the lock member and a lock element and limited in the other direction by contact between the lock member and the depending skirt of the annular guard.

5. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a locking element carried on the table, a pawl supported by the base and adapted to be moved upward into the path of said locking element to prevent rotation of the table in one direction, latch means automatically acting to maintain said pawl in its upper position, said pawl and locking element being so proportioned that turning movement of the table in the other direction causes the pawl to ratchet and allow the locking element to pass.

6. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a locking element carried on the table, a pawl movable upwardly into engagement with said locking element, a latch pivotally mounted on said pawl, a shoulder on said base adjacent said latch, said latch being adapted to turn automatically about its pivot and engage said shoulder, upon the pawl being raised to its locking position, the engagement of said latch and shoulder acting to maintain the pawl in its raised position.

7. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a locking element on the table, a pawl movable

upwardly into engagement with said locking element, an opening in the base in which the lower end of the pawl is adapted to slide, a recess within the pawl near its lower end, a latch pivoted to said pawl and mounted within said recess, said latch being adapted to turn automatically about its pivot to engage an element of the base, upon the pawl being raised to its operative position, the engagement of the latch and base acting to maintain the pawl in its raised position.

8. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a locking element carried on the table, a pawl comprising a head portion and a body portion pivotally connected, the pawl being adapted to be moved upwardly to a position in which the head portion engages the locking element to prevent rotation of the table, means including a frangible element adapted to maintain said head portion of the pawl in locking position, the frangible element being proportioned to withstand a normal load of predetermined magnitude but adapted to break in the event of an excessive load being transmitted by the locking element to said head portion, the breakage of the frangible element acting to allow the head portion of the pawl to pivot relative to the body portion and thereby allow the locking element to pass by.

9. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a locking element carried on the table, an abutment piece positioned on said base adjacent the path of said locking element, means including a frangible element adapted to secure the abutment piece upon the base, a pawl adapted to be operatively interposed between the locking element and the abutment piece to prevent rotation of the table, the frangible element being proportioned to withstand a normal load of predetermined magnitude but adapted to break in the event of an excessive load being transmitted by the table to the pawl, the abutment piece moving to an inoperative position upon breakage of the frangible element.

10. In a rotary machine, the combination of a base, a table rotatably mounted on the base, a locking element carried on the table, an abutment piece positioned on said base adjacent the path of said locking element, means including a frangible element adapted to secure the abutment piece upon the base, a pawl comprising a head portion and a body portion pivotally connected, said pawl being adapted to be moved upwardly to a position in which the head portion is operatively interposed between the locking element and the abutment piece to prevent rotation of the table, said frangible element being adapted to break in the event of an excessive load being transmitted by the table to the pawl, the abutment piece moving to an inoperative position upon breakage of the frangible element whereby the head portion of the pawl may pivot relative to the body portion to allow the locking element to pass by.

11. In a rotary machine, the combination of a stationary base member, a rotary member rotatably mounted on the base member, a lock element on said rotary member, stop means including a frangible element mounted on said base member adjacent the path of said lock element, a pawl adapted to be operatively interposed between the stop means and the lock element to prevent rotation of the rotary member, the frangible element being proportioned to withstand a normal load of predetermined magnitude but adapted to break in the event of an excessive load being transmitted by the lock element to the pawl.

12. In a rotary machine, the combination of a base having an upstanding wall, a table rotatably supported upon the base, a depending flange on the outer periphery of the table overlapping said upstanding wall in telescopic relation, a gear on said table within said upstanding wall, means carried by the base adapted to rotate said gear, a plurality of locking elements on said depending flange, and a lock pawl positioned outside said upstanding wall movable upwardly into the path of rotation of said locking elements.

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