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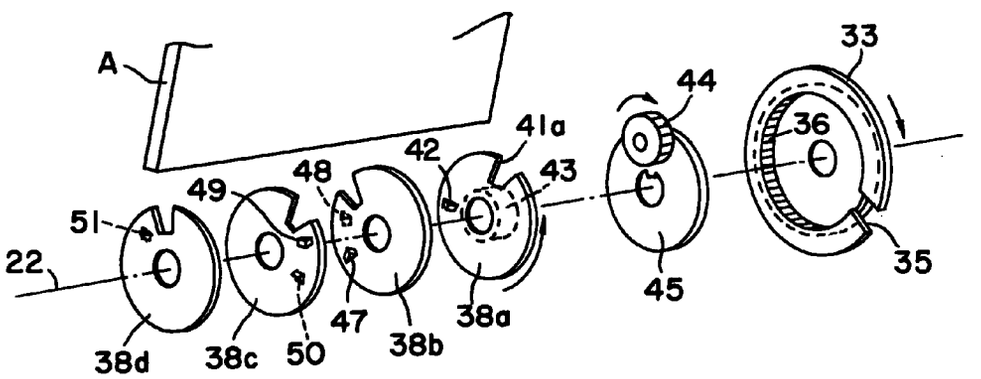
(54) Combination lock

(57) A combination lock includes a dial shaft (22) adapted to be rotated with a user's hand, a fore lock plate (38a), at least one intermediate lock plate (38b,c) and a rear lock plate (38d) arranged in parallel with each other, and a driving plate (33) integrally fitted to the rear end of the dial shaft (22). A plurality of unlocking cutouts (35,41a,b,c,d) are formed on the outer peripheries of the driving plate (33) and all the lock plates (38a-d) so as to allow a lock pawl (A) to be received in the unlocking cutouts when the latter are located in alignment with each other. A driving gear (36) having a large diameter is formed in the driving plate (33), and a follower gear (43) having a small diameter is formed on the fore lock plate (38a). Both the gears mesh with each other at a gear ratio via an idle gear (44) so as to allow both the gears (36,43) to be rotated in the opposite direction. The gear ratio is determined such that all the lock plates (38a-d) are followably rotated as a dial knob is turned with a user's hand. Usually, the number of lock plates is four, and the gear ratio of the driving gear (36) to the follower gear (43) is set 3 : 1.

Fig. 20



EP 0 757 144 A1

Description

The present invention relates generally to a combination lock for storably holding various items. More particularly, the present invention relates to a combination lock which assures that unlocking can easily be achieved with substantial reduction of rotation of dial plates.

To facilitate understanding of the present invention, a conventional combination lock will be described below with reference to Fig. 26 to Fig. 32.

A shown in Fig. 26, a dial knob 1 includes a dial shaft 2 to which rear end a fore lock plats 3a is fastened by tightening a lock nut 4 in such a manner that it is rotated together with the dial knob 1. First and second intermediate lock plates 3b and 3c and a rear lock plate 3d are rotatably fitted onto the dial shaft 2. Reference numeral 5 denotes a spacer which is interposed between adjacent lock plates among the lock plates 3a, 3b, 3c and 3d, and reference numeral 6 denotes a compression spring. Unlocking cutout 7a, 7b, 7c and 7d are formed on the outer peripheries of the lock plates 3a, 3b, 3c and 3d for receiving lock pawl A when they are located in alignment with the lock pawl A so as to allow the combination lock to be unlocked. In addition, engagement projections 8 to 13 are formed on side surface of each lock plate in the following manner.

An engagement projection 8 is formed on the rear side surface of the lock plate 3a, an engagement projection 9 is formed on the fore side surface of the lock plate 3d, two engagement projections 10 and 11 are formed on the fore side surface of the lock plate 3b and two engagement projections 12 an 13 are formed on the opposite side surfaces of the lock plate 3c. It is obvious that each of the projections 8 to 13 is formed at a predetermined position with each of the unlocking cutouts 7a to 7d as a reference position for unlocking. Reference numeral 14 denotes a plane plate fixed to an opening/closing door of a safe, and reference numerals 15 and 16 denote first and second shaft bearing of the dial shaft 2.

Fig. 27 is a perspective view which shows the lock plates 3a to 3d in the disassembled state. When unlocking is effected, first, the fore lock plate 3a is rotated in the clockwise direction by an angle of 360 degrees so that engagement projection 8 is engaged with a rear engagement projection 11 of the first intermediate lock plate 3b.

Next, as shown in Fig. 28, the lock plate 3a is rotated in the same direction by an angle of 360 degrees so that the fore engagement projection 10 of the first intermediate lock plate 3c is engaged with a rear engagement projection 13 of the second intermediate lock plate 3c.

Subsequently, as shown in Fig. 29, the lock plate 3a is rotated in the same direction by an angle of 360 degrees so that the fore engagement projection 12 of the second intermediate lock plate 3c is engaged with a rear engagement projection 9 of the lock plate 3d, and moreover, the lock plate 3a is rotated by an angle less than 360 degrees until a predetermined memory value (e.g., 33) is assumed. Thereafter, the unlocking cutout 7d of the lock plate 3d is kept immovable at a predetermined position where it is oriented in the upward direction.

In detail, when the fore lock plate 3a is rotated by the dial knob 1 at three times, the first intermediate lock plate 3b is rotated at two times and the second intermediate lock plate 3c is rotated by one revolution so that the rear lock pate 3d starts to be rotated. In addition, by rotating the fore lock plate 3a by a predetermined angle less than 360 degrees to assume a predetermined memory numeral, the unlocking cutout 7d of the rear lock plate 3d can be held at a predetermined position.

Next, as shown in Fig. 30, the fore lock plate 3a is rotated in the anticlockwise direction by an angle of 360 degrees (one revolution) so that the fore engagement projection 8 is engaged with a rear engagement projection 11 of the first intermediate lock plate 3b. Subsequently, the fore lock plate 3a is rotated in the same direction by an angle of 360 degrees so that the fore engagement projection 10 of the first intermediate lock plate 3b is engaged with a rear engagement projection 13 of the second intermediate lock plate 3c. Thereafter, the second intermediate lock plate 3c is rotated by a predetermined angle less than 360 degrees corresponding to a predetermined memory numeral (e.g., 97) so that the unlocking cutout 7c is located in alignment with the unlocking cutout 7d of the rear lock plate 3d which has been kept immovable.

Next, as shown in Fig. 31, the fore lock plate 3a is rotated in the clockwise direction by an angle of 360 degrees so that the engagement projection 8 is engaged with a rear engagement projection 11 of the first intermediate lock plate 3b. Additionally, the first intermediate lock plate 3b is rotated by a predetermined angle less than 360 degrees until a predetermined memory numeral (e.g., 64) is assumed so that the unlocking cutout 7b is located in alignment with those of the second intermediate lock plate 3c and the rear lock plate 3d which have been kept immovable.

Finally, as shown in Fig. 32, the fore lock plate 3a is rotated in the anticlockwise direction by a predetermined angle less than 360 degrees until a predetermined numeral (e.g., 84) is assumed so that the unlocking cutout 7a is located in alignment with those of the first and second intermediate lock plates 3b and 3c and the rear lock plate 3d which have been kept immovable. Thus, a lock pawl A is received in the unlocking cutouts 7a to 7b of the lock plates 3a to 3d, whereby the combination lock is brought in an unlocked state.

As is apparent from the above-described procedure of unlocking, a conventional combination lock is typically unlocked by rotating the knob from a reference numeral (e.g. zero) in the normal direction by three revolutions, next, rotating the knob in the reveres direction to assume predetermined memory numeral by two revolution, further rotating the knob in the normal direction

to assume to predetermined memory numeral, finally rotating the knob in the reverse direction to reach a predetermined memory numeral.

The above procedure of unlocking is only to applicable to the combination lock comprising four lock plates but things are same with the combination lock including three or five lock plates. For example, in the case of the combination lock including three locking plates, in accordance with the operational principle, first, the dial knob is rotated from a reference numeral in the normal direction by two revolutions, next, the dial knob is rotated in the reveres direction by one revolution plus a fraction corresponding to a predetermined memory numeral. Similarly, in the case of the combination lock including five locking plates, first, the dial knob is rotated in the normal direction by four revolutions, next, the dial knob is rotated in the reveres direction by three revolutions plus a fraction corresponding to a predetermined memory numeral, further, the dial knob is rotated again in the normal direction by two revolutions plus a fraction corresponding a predetermined memory numeral, subsequently, the dial knob is rotated in the reveres direction by one revolution plus a fraction corresponding to a predetermined memory numeral, finally, the dial knob is rotated in the normal direction to the position corresponding a predetermined memory numeral.

At any rate, with respect to the conventional combination lock, the number of revolutions of the dial knob and a plurality of memory values should be exactly memorized. For this reason, it is complicated for an unskilled user to unlock the conventional combination lock in spite of excellent locking ability.

Accordingly, the conventional combination lock is not widely put in practical use.

The present invention has been made in consideration of the aforementioned background.

An aim of the present invention is to provide a combination lock which assure that the combination lock can simply be unlocked.

Another aim of the present invention is to provide a combination lock which assures that the combination lock can be unlocked for a short time.

According to the present invention, there is provided a combination lock which is characterized in that the combination lock includes a dial shaft adapted to be rotated with a user's hand, a fore lock plate, at least one intermediate lock plate and a rear lock plate arranged in parallel with each other so as to allow them to be followably rotated via a plurality of engagement projections projected from the opposite side surfaces of the lock plates, and a driving plate integrally fitted to the rear end of the dial shaft, that a plurality of unlocking cutouts are formed on the outer peripheries of the driving plate and the lock plates so as to allow a lock pawl to be received in the unlocking cutouts when the latter are located in alignment with each other, and that a driving gear having a large diameter is formed in the driving plate, and a follower gear having a small diameter is formed on the fore lock plate located adjacent to the driving plate, the driving gear and the follower gear meshing with each other at a gear ratio via an idle gear so as to allow both the gears to be rotated in the opposite direction, the gear ratio being determined such that all the lock plates are followably rotated as the dial knob is turned with a user's hand.

It is preferable that the number of lock plates is four, and the gear ratio of the driving gear to the follower gear is set to 3 : 1.

The follower gear is preferably formed around the outer periphery of a hub portion of the fore lock plate, the whole driving plate is formed in a silk hat-like contour so as to allow the hub portion to be received in the silk hat-like contour, the driving gear is formed around the inner periphery of the silk hat-like contour, and the idle gear is interposed between the driving gear and the follower gear facing to each other.

A preferred embodiment of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

Fig. 1 is vertical sectional view of a combination lock constructed in accordance with an embodiment of the present invention.
Fig. 2 is a front view of a second bearing sleeve.
Fig. 3 is a vertical sectional view of the second bearing sleeve taken along line 3 - 3 in Fig. 2.
Fig. 4 is a front view of a driving plate.
Fig. 5 is a sectional view of the driving plate taken across line 5 - 5 in Fig. 4,
Fig. 6 is a front view of a fore lock plate.
Fig. 7 is a sectional view of the fore lock plate taken along line 7 - 7 in Fig. 6.
Fig. 8 is a front view of a hub portion.
Fig. 9 is a sectional view of the hub portion taken along line 9 - 9 in Fig. 8.
Fig. 10 is a front view of an idle gear.
Fig. 11 is a sectional view of the idle gear taken along line 11 - 11 in Fig. 10.
Fig. 12 is a front view of a first intermediate lock plate.
Fig. 13 is a side view of the first intermediate lock plate.
Fig. 14 is a side view of the first intermediate lock plate taken along line 14 - 14.
Fig. 15 is a front view of a second intermediate lock plate.
Fig. 16 is a side view of the second intermediate lock plate.
Fig. 17 is a sectional view of the second intermediate lock plate taken along line 17 - 17 in Fig. 15.
Fig. 18 is a front view of a rear lock plate.
Fig. 19 is a sectional view of the rear lock plate taken along line 19 - 19 in Fig. 18.
Fig. 20 is a perspective view which shows a step of unlocking the combination lock of the present invention while main components are disassembled

and some ones are not illustrated wherein the fore lock plate 38a is engaged with a first intermediate lock plate 38b.

Fig. 21 is a perspective view which shows a step of unlocking the combination lock of the present invention while main components are disassembled and some ones are not illustrated wherein the first intermediate lock plate rotating integrally with the fore lock plate 38a is engaged with a second intermediate lock plate 38c.

Fig. 22 is a perspective view which shows a step of unlocking the combination lock of the present invention while main components are disassembled and some ones are not illustrated while the second intermediate lock plate 38c rotating integrally with the fore lock plate 38a and the first intermediate lock plate 38b is engaged with a rear lock plate 38b of which unlocking cutout 41d is located at a predetermined angular position.

Fig. 23 is a perspective view which shows a step of unlocking the combination lock of the present invention while main components are disassembled and some ones are not illustrated wherein the dial knob is turned in the opposite direction such that an unlocking cutout 41c of the second intermediate lock plate 38c is located at a predetermined position and the unlocking cutout 41d of the rear lock plate is held at the predetermined position.

Fig. 24 is a perspective view similar to Fig. 23 which shows that the dial knob is turned in the opposite direction to that in Fig. 23 and an unlocking cutout 41b is located at a predetermined angular position.

Fig. 25 is a perspective view similar to Fig. 24 which shows that unlocking cutouts of all lock plates are located at predetermined angular positions.

Fig. 26 is a vertical sectional view which shows by way of example the structure of a conventional combination lock.

Fig. 27 is a perspective view which shows a step of unlocking the conventional combination lock while main components are disassembled and some ones are not illustrated wherein the shown state corresponds to that shown in Fig. 20.

Fig. 28 is a perspective view which shows a step of unlocking the conventional combination lock while main components are disassembled and some one are not illustrated wherein the shown state corresponds to that shown in Fig. 21.

Fig. 29 is a perspective view which shows a step of unlocking the conventional combination lock while main components are disassembled and some one are not illustrated wherein the shown state corresponds to that shown in Fig. 22.

Fig. 30 is a perspective view which shows a step of unlocking the conventional combination lock while main components are disassembled and some one are not illustrated wherein the shown state corresponds to that shown in Fig. 23.

Fig. 31 is a perspective view which shows a step of unlocking the conventional combination lock while main components are disassembled and some ones are not illustrated wherein the shown state corresponds to that shown in Fig. 24.

Fig. 32 is a perspective view which shows a step of unlocking the conventional combination lock while main components are disassembled and some ones are not illustrated wherein the shown state corresponds to that shown in Fig. 25.

The present invention will be described in detail hereinafter with reference to the accompanying drawings which illustrates a preferred embodiment thereof.

Fig. 1 is a vertical sectional view which shows that a combination lock for a safe composed of lock plates is assembled for the convenience of comparison with the conventional combination lock. Reference numeral 21 denoted a dial knob, and reference numeral 22 denotes a dial shaft which is made integral with the knob 21 by striking a knock pin 23. The rear end part of the dial shaft 22 is machined to form a stepped part having a small diameter.

Reference numeral 25 denotes a first bearing sleeve for supporting the fore part of the dial shaft 22. The first bearing sleeve 25 extends through an opening/closing door M for a safe (not shown), and a plane plate 26 integrated with the first bearing sleeve 25 is fixed to the front surface of the opening/closing door by tightening screws 27. Reference numeral 28 denotes a leaf spring which is expanded against the plane plate 26 while imparting rotational braking force to a knob 21.

Reference numeral 29 denotes a second bearing sleeve which is fixed to the rear end of the first bearing sleeve 25 with the aid of a key 30 and fitted onto the small diameter portion 24 of the dial shaft 22. As shown in Fig. 2 and Fig. 3, the rear end part of the second bearing sleeve 29 is machined to provide a small diameter sleeve portion 31 corresponding to the small diameter shaft portion 24 of the dial shaft 22. The fore end part of the second bearing sleeve 29 is expanded to serve as a spring retainer.

Reference numeral 33 denotes a driving plate which is fitted onto the small diameter shaft portion 24 so as to rotate together with the dial shaft 22. The driving plate 33 is molded of a hard synthetic resin in a silk hat-like contour. The driving plate 33 includes a flange portion 34 on which outer periphery an unlocking cutout 35 is formed. In addition, a driving gear 36 is generated along an inner peripheral surface of the barrel portion of the driving plate 33. Reference numeral 37 denotes a ring which prevents the driving plate 33 from being undesirably disengaged from the dial shaft 22.

To assure that the driving plate 33 is firmly connected to the dial shaft 22, non-circular hole is formed at the central part of the driving plate 33 as shown in Fig. 4. The rear end of the dial shaft 22 having the same non-circular sectional shape is fitted into the non-circular hole of the driving pate 33.

Reference numeral 38a denotes a fore lock plate

which faces to the driving plate 33. As shown in Fig. 6 to Fig. 9, the fore lock plate 38a is provided as an assembly comprising a flange portion 39 having the same diameter as that of flange portion 34 of the driving plate 33 and a hub portion 40 molded of a hard synthetic resin coaxially fitted to the driving plate 33. The hub portion 40 is rotatably supported on the small diameter sleeve portion 31 of the second bearing sleeve 29.

Reference numeral 41a denotes an unlocking cutout formed on the outer peripheral part of the flange portion of the fore lock plate 38a, and reference numeral 42 denoted an engagement projection raised from the plate surface of the flange portion 39. The engagement projection 42 is engaged with a rear engagement projection of a first intermediate lock plate which will be described later.

As shown in Fig. 1, the hub portion 40 of the fore lock plate 38a is dimensioned to have a diameter smaller than that of the driving plate 33, and a follower gear 43 is generated along the outer peripheral surface of the hub portion 40.

The follower gear 43 associated with the fore lock plate 38a is accommodated in the driving plate 33, and an idle gear 44 is disposed between the driving gear 36 and the follower gear 43 so that both the gears 36 and 43 are rotated in the opposite direction. Since a gear ratio of the driving gear 36 and the follower gear 43 is set to 3 : 1, when the driving plate 33 is rotated by the dial knob 21 by an angle of 360 degrees (one revolution), the fore lock plate 38a is rotated by three times.

Reference numeral 45 denotes a stationary plate which is located between the hub portion 40 of the fore lock plate 38a and the driving plate 33, and reference numeral 46 denotes an idle gear shaft which is axially projected from the stationary plate 45 so as to rotatably support the idle gear 44.

Reference numerals 38b and 38c denote a first intermediate lock plate and a second intermediate lock plate which are successively arranged forward of the fore lock plate 38a, and reference numeral 38d denotes a rear lock plate which is arranged forward of the second intermediate lock plate 38c. Each of three lock plates, i.e., the lock plates 38b, 38c and 38d is made of a circular metallic plate and has the same diameter as that of the flange porion 39 of the fore lock plate 38a. Unlocking cutouts 41b, 41c and 41d are formed on the outer periphery of each lock plate, and three lock plates are rotatably supported on the second bearing sleeve 29.

On receipt of the rotational force from the fore lock plate 38a, the remaining three lock plates are followably rotated from the rear side. Specifically, as shown in Fig. 12 to Fig. 14, a fore engagement projection 47 and a rear engagement projection 48 are projected from the opposite side surfaces of the first intermediate lock plate 38b so that the rear engagement projection 48 is engaged with the fore engagement projection of the fore lock plate 38a.

As shown in Fig. 15 to Fig. 17, a fore engagement projection 49 and a rear engagement projection 50 are projected from the opposite side surfaces of the second intermediate lock plate 38c so that the rear engagement projection 50 is engaged with the fore engagement projection 47 of the first intermediate lock plate 38b.

Reference numeral 51 denotes a rear engagement projection which is projected from the side surface of the rear lock plate 38d as shown in Figs. 18 and 19. The rear engagement projection 51 is engaged with the fore engagement projection 49 of the second intermediate lock plate 38c. With such construction, when the dial knob 21 is rotated by an angle of 360 degrees (one revolution), all the lock plates till the rear lock plate 38d are rotated based on the gear ratio of the driving gear 36 of the driving plate 33 and the follower gear 43 of the fore lock plate 38a.

In this case, rotational angular positions of the engagement projections 42, 47, 48, 49, 80 and 51 projected from the four lock plates 38a to 38d as measured from the respective unlocking recesses 41a to 41d are adequately determined corresponding to an identification code number of the combination lock. Thus, it of course is obvious that memory numerals available for unlocking are preliminarily determined corresponding to the rotational angular positions. When the positions where the engagement projections 42, 47 to 51 are projected vary, the memory numeral of the combination lock varies correspondingly, whereby the combination lock having a different actuation key is finished in spite of the same type thereof.

Reference numeral 52 denotes three spacers which are interposed between adjacent lock plates among the lock plates 38a to 38d. The spacers 52 are unrotatably fitted on the second bearing sleeve 29. Reference numeral 53 denotes a compression spring which is disposed between the spring retainer 32 of the second bearing sleeve 29 and the rear lock plate 38d so as to impart an adequate intensity of thrusting force to all the lock plates 38a to 38d.

The combination lock constructed in the above-described manner is unlocked by way of the following steps. Fig. 20 shows by way of a disassembled view the locked state of the combination lock. When the locked combination lock is unlocked, first, the dial knob 21 is rotated from a predetermined reference numeral in the clockwise direction by an angle of 1/3 revolution so that the fore lock plate 38a is rotated by an angle of 360 degrees (one revolution) via gear meshing of the driving gear 36 with the follower gear 43, whereby the fore engagement projection 42 on the fore lock plate 38 is brought in engagement with the rear engagement projection 48 on the first intermediate lock plate 38b.

Next, as shown in Fig. 21, the dial knob 21 is rotated in the same direction by an angle of 1/3 revolution so that the fore lock plate 38a and the first intermediate lock plate 38b are rotated together by an angle of 360 degrees. Thus, the fore engagement projection 47 on the first intermediate lock plate 38b is engaged with the rear engagement projection 50 on the second inter-

mediate lock plate 38c.

Thereafter, as shown in Fig. 22, the dial knob 21 is further rotated in the same direction by an angle of 1/3 revolution so that the fore lock plate 38a and the first and second intermediate lock plates 38b and 38c are rotated together by an angle of 360 degrees (one revolution) so as to allow a fore engagement projection 49 on the second intermediate lock plate 38c to be engaged with a rear engagement projection 51 on the rear lock plate 38d. Then, the second intermediate lock plate 38c is further rotated by a predetermined angle less than 360 degrees to reach a preliminarily determined memory numeral. At this time. the unlocking recess 41d on the rear lock plate 38d is oriented in the upward direction.

Next, as shown in Fig. 23, when the fore lock plate 38a is rotated at two times and the first intermediate lock plate 38 is turned by one revolution by rotating the dial knob 21 in the anticlockwise direction, the fore engagement projection 47 on the first intermediate lock plate 38b is engaged with the rear engagement projection 50 on the second intermediate lock plate 38c. While the foregoing state is maintained, the first and second intermediate lock plates 38b and 38c are further rotated by an angle less than 360 degrees until a preliminarily determined memory numeral is reached. At this time, the unlocking recess 41c on the second intermediate lock plate 38c is located in alignment with the unlocking recess 41d on the rear lock plate 38d which has been kept immovable.

At this time, since the second intermediate lock plate 38C is held integral with the dial shaft 22, it is rotated together with the dial knob 21 while the rear lock plate is left at the preset angular position.

Next, when the fore lock plate 38a is rotated by one revolution by turning the dial knob 21 in the clockwise direction as shown in Fig. 24, the fore engagement projection 42 on the fore lock plate 38a is engaged with the rear engagement projection 48 on the first intermediate lock plate 38b. While the foregoing state is maintained, the fore lock plate 38a is further rotated by a predetermined angle less than 360 degrees until a preliminarily determined memory numeral is reached so that the unlocking recess 41b on the first intermediate lock plate 38b is located in alignment with those on the rear lock plate 38d and the second intermediate lock plate 38c which have been kept immovable. At this time, the unlocking recesses 41b, 41c and 41d are oriented in the upward direction, respectively.

Again, when the dial knob 21 is rotated in the anticlockwise direction by a predetermined angle less than 360 degrees until a preliminarily determined memory value is reached so that the unlocking cutout 41a on the fore lock plate 38a is located in alignment with those on the rear lock plate 38d and the first and second intermediate lock plates 38b and 38c, the combination lock is brought in the unlocked state that the lock pawl A can be received in the engagement recesses 41a to 41d formed on all the lock plates 38a to 38d as shown in Fig. 25.

In other words, four lock plates 38a to 38d are located in parallel to each other in such a manner that one lock plate can followably be rotated by adjacent one, and since the driving gear 36 associated with the driving plate 33 adapted to be rotated together with the dial knob 21 meshes with the follower gear 43 associated with the fore lock plate 38a, it is sufficient that the dial knob 21 is turned by one revolution (360 degrees). Thus, provided that a user memorizes predetermined memory numerals, an unlocking operation can lightly be achieved at a high efficiency.

The shown embodiment has been described above with respect to the combination lock including four lock plates 38a to 38d. However, since it is sufficient that a single intermediate lock plate is used, in the case that a combination lock is produced using three lock plates inclusive of the foregoing intermediate lock plate, a gear ratio of the driving gear 36 to the follower gear 43 is set to 2 : 1. In addition, in the case that five lock plates in total is employed to build a combination lock, it is acceptable that the gear ratio is set to 4 : 1. Thus, a desired object of the present invention can be accomplished by suitably modifying the aforementioned rule.

It is obvious that when at least one of the unlocking recess 41a to 41d formed on the lock plates 38a to 38d is dislocated from the remaining ones, the combination lock is brought in the locked state.

As described above, the combination lock of the present invention is composed of the dial shaft 2 rotationally actuated by the dial knob 21, the fore lock plate 38a rotatably supported on the dial shaft 22 at the position in the vicinity of the rearmost end of the dial shaft 22, at least one of the intermediate lock plates 38b and 38c, the rear lock plate 38d, and the driving plate 33 integrally rotatably fitted to the rear end of the dial shaft 22 and located adjacent to the fore lock plate 38a.

The unlocking recesses 35, 41a, 41b, 41c and 41d are formed along the outer periphery of the lock plates 38a to 38d and the driving plate 33 so as to receive the lock pawl A. The driving gear 36 having a large diameter is formed in the driving plate 33, the follower gear 43 having a small diameter is disposed at the fore lock plate 38a located adjacent to the driving plate 33, and the idle gear 44 is interposed between the driving gear 36 and the follower gear 43 so as to allow both the gears 36 and 43 to be rotated in the opposite direction. The gear ratio is determined such that all the lock plates 38a to 38d are followably rotated by one revolution of the dial knob 21. With such construction, the technical problems described above with reference to Fig. 26 to Fig. 32 have been solved with the result that a combination lock which can very simply be unlocked has been provided.

Specifically, with construction as defined in claim 1 and claim 2 of the claim clause, the dial knob 21 is rotated from a preliminarily determined reference numeral, e.g., by an angle of 360 degrees (one revolution) in the clockwise direction to locate the unlocking recess 41d on the rear lock plate 38d, next, the dial

knob 21 is rotated by a predetermined angle less than 360 degrees in the anticlockwise direction to reach a preliminarily determined memory numeral so that the unlocking recesses 41b and 41c on the intermediate lock plates 38b and 38c are located in alignment with that on the rear lock plate 38d, and the dial knob 21 is rotated by a predetermined angle less than 360 degrees in the clockwise direction to reach a preliminarily determined memory numeral so that the unlocking recess 41a on the fore lock plate (38a) is located in alignment with those on the rear lock plate 38d and the intermediate lock plates 38b and 38c, whereby the combination lock can be unlocked.

In other words, since all the lock plates 38a to 38d are successively followably rotated by the turning movement of the dial knob 21 by one revolution, provided that a user memorizes memory numerals corresponding to the lock plates 38a to 38d so as to allow the lock plates 38a to 38d to be alternately rotated by an angle less than 360 degrees in the normal/opposite direction, the combination lock can quickly be unlocked.

With the combination lock of the present invention, since each of the lock plates 38a to 38d is rotated by a rotational angle three times of that of the dial shaft 22, there is increased a probability that the unlocking recesses 41a to 41d are located in alignment with each other. Since the unlocking recess 35 is formed on the driving plate 33, an unlocked state is established unless all unlocking recess 35 and 41a to 41d are located in alignment with each other. Consequently, there does not arise a malfunction that safety as a lock is reduced.

Especially, with construction as defined by claim 3 of the claim clause, the driving plate 33 is made in a silk hat-like contour adapted to surround the hub portion 40 of the fore lock plate 38a, and since the driving gear 36 having a large diameter and generated around the inner peripheral surface of the barrel portion of the driving plate 33 and the follower gear 43 having a small diameter and generated around the outer peripheral surface of the hub portion 40 mesh with each other via a single idle gear 44 at the aforementioned gear ratio, the combination lock can compactly be incorporated in a commercial safe, a holding chamber for various items or the like without any necessity for modifying the safe, the holding chamber or the like.

While the present invention has been described above with respect to a single preferred embodiment, it should be understood that the present invention should not be limited only to this embodiment but various change or modification may be made without departure from the scope of the present invention as defined by the appended claim.

Claims

1. A combination lock characterized in

that said combination lock includes a dial shaft adapted to be rotated with a user's hand, a fore lock plate, at least one intermediate lock plate and a rear lock plate arranged in parallel with each other so as to allow them to be followably rotated via a plurality of engagement projections projected from the opposite side surfaces of said lock plates, and a driving plate integrally fitted to the rear end of said dial shaft,

that a plurality of unlocking cutouts are formed on the outer peripheries of said driving plate and said lock plates so as to allow a lock pawl to be received in said unlocking cutouts when the latter are located in alignment with each other, and

that a driving gear having a large diameter is formed in said driving plate, and a follower gear having a small diameter is formed on said fore lock plate located adjacent to said driving plate, said driving gear and said follower gear meshing with each other at a gear ratio via an idle gear so as to allow both the gears to be rotated in the opposite direction, said gear ratio being determined such that all the lock plates are followably rotated as said dial knob is rotated with a user's hand.

2. The combination lock as claimed in claim 1, wherein the number of lock plates is four, and said gear ratio of said driving gear to said follower gear is set to 3 : 1.

3. The combination lock as claimed in claim 1 or 2, wherein said follower gear is formed around the outer periphery of a hub portion of said fore lock plate, the whole driving plate is formed in a silk hat-like contour so as to allow said hub portion to be received in said silk hat-like contour, said driving gear is formed around the inner periphery of said silk hat-like contour, and said idle gear is interposed between said driving gear and said follower gear facing to each other.

Fig. 1

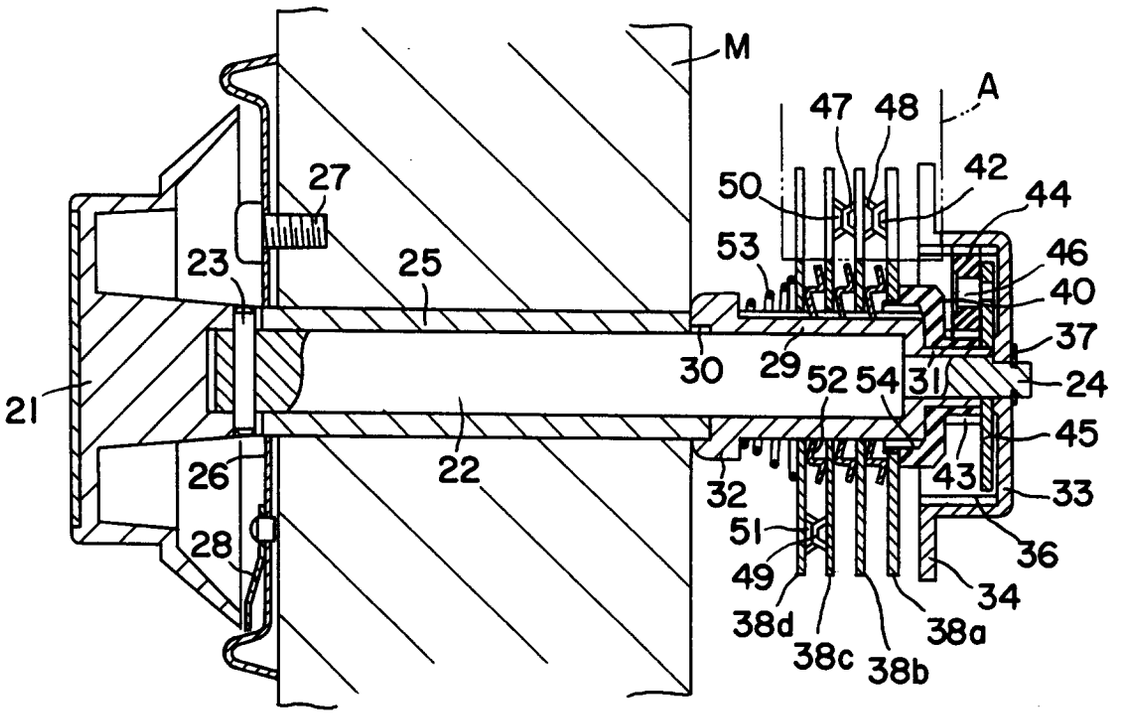


Fig. 2

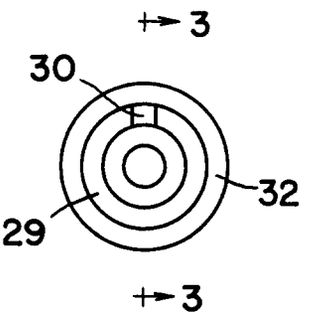
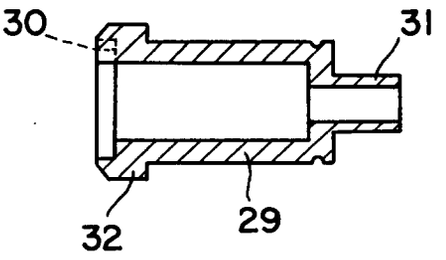


Fig. 3



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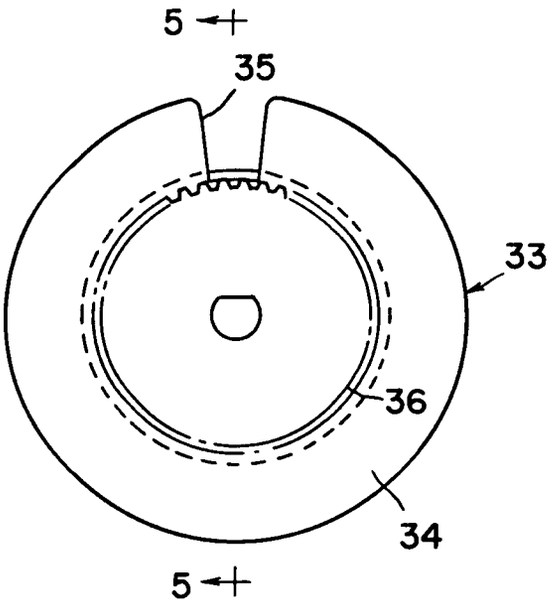

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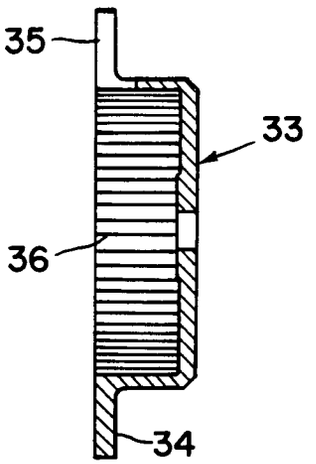

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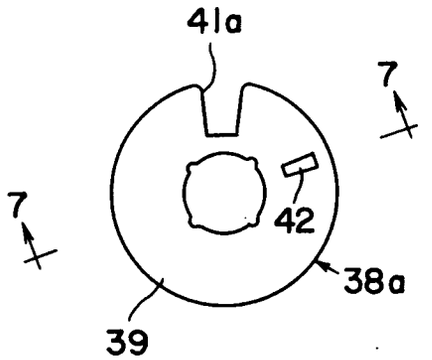

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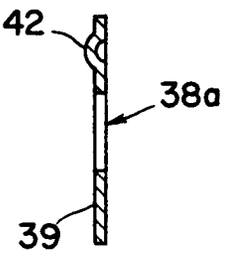

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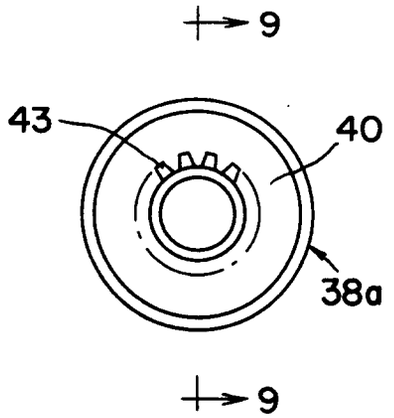
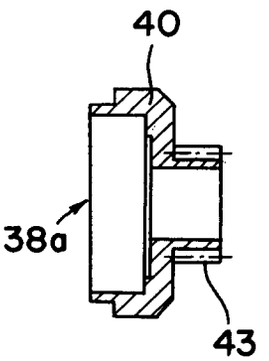


Fig. 9



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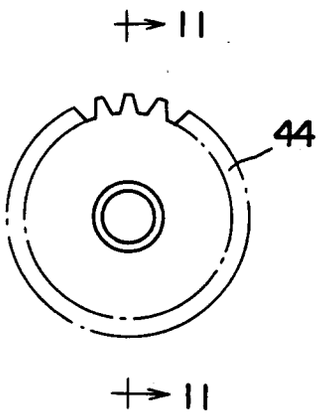

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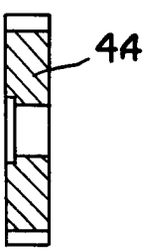

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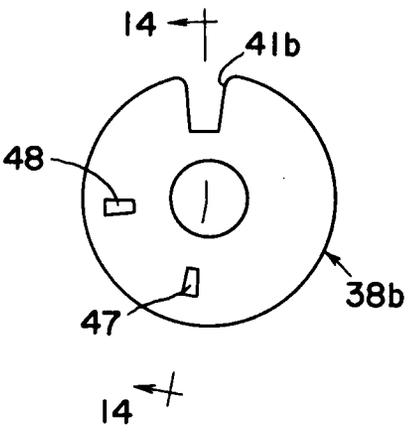


Fig. 13

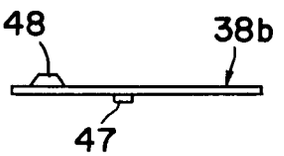


Fig. 14

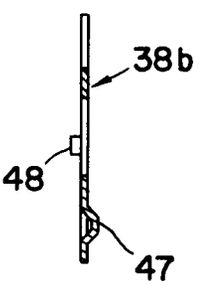


Fig. 15

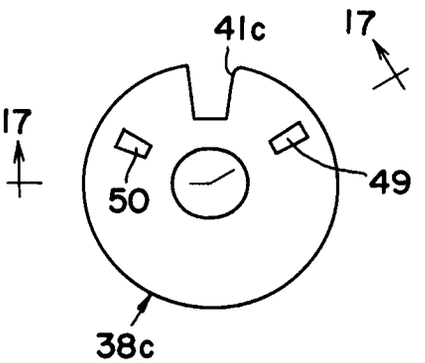


Fig. 16

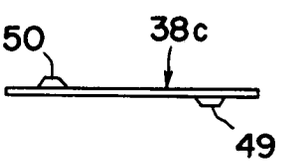
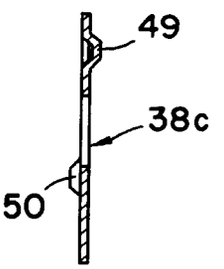


Fig. 17



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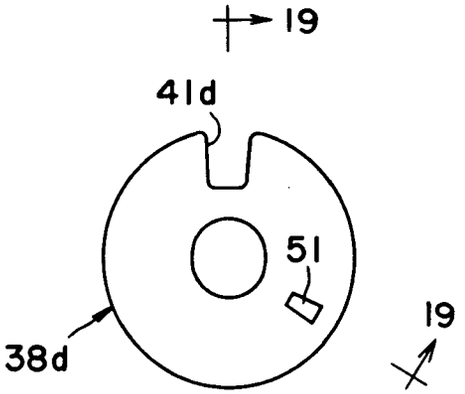

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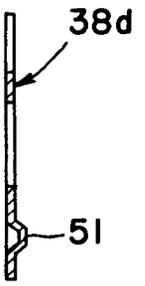


Fig. 20

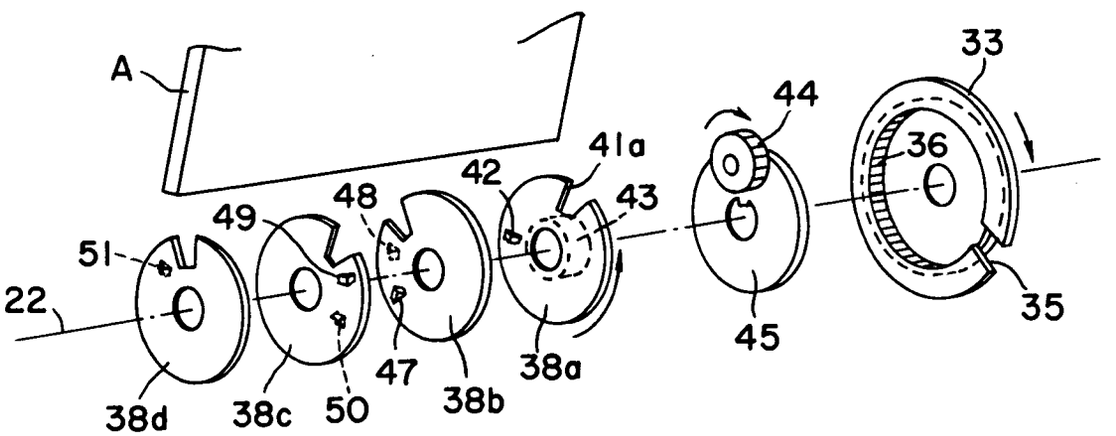
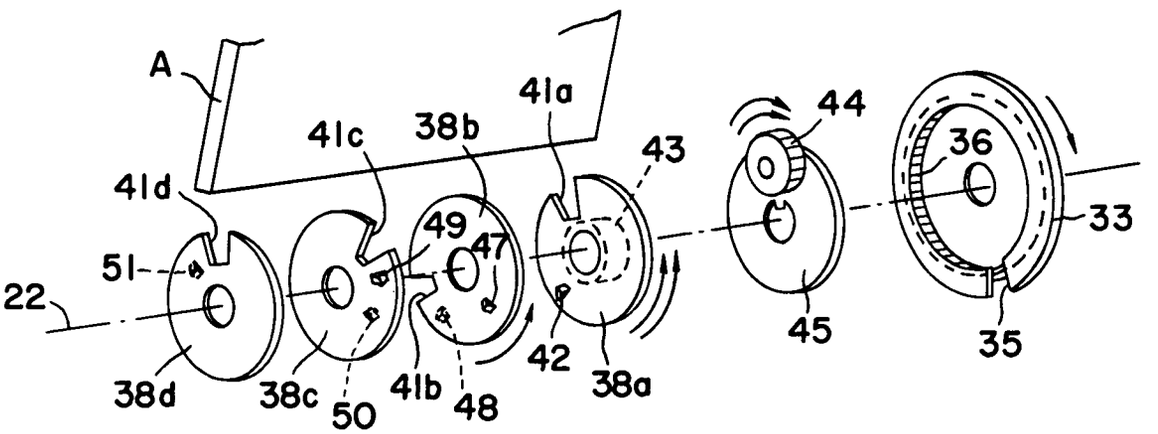


Fig. 21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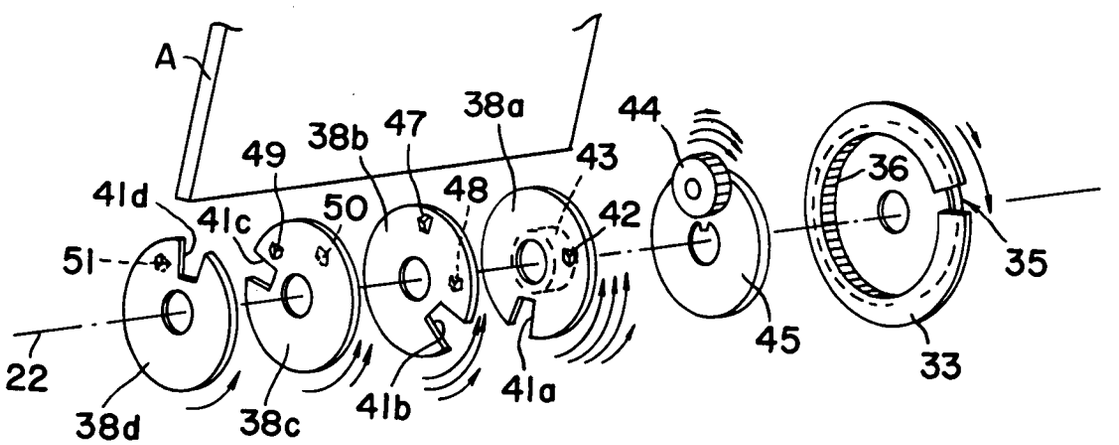
38b
43
44
36
41d
49
47
33
51
22
45
35
42
38a
38d
38c
50
41b
48

Fig. 22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41c
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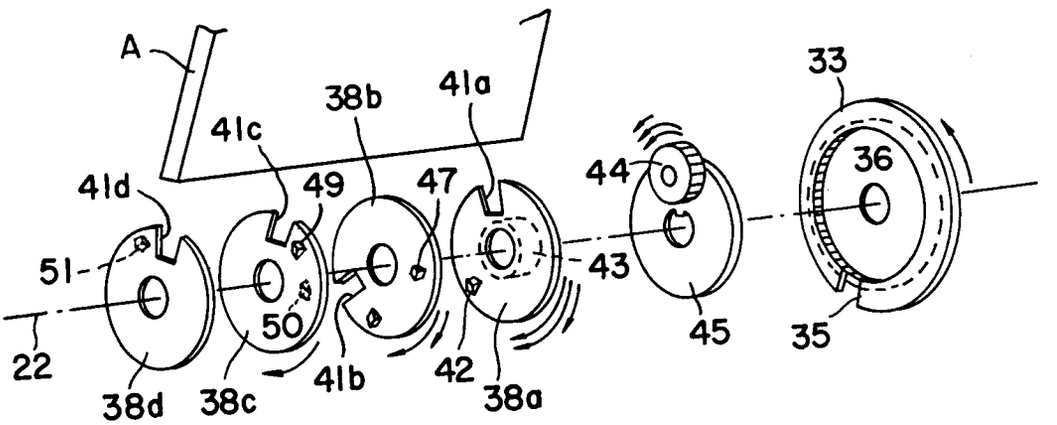
22
33
41b
41a
38d
38c

Fig. 23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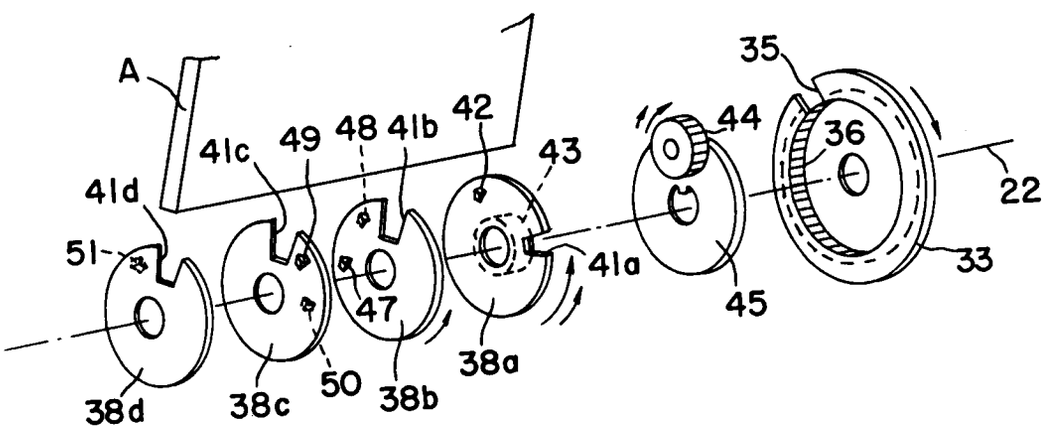
41b
38d
38c
38a

Fig. 24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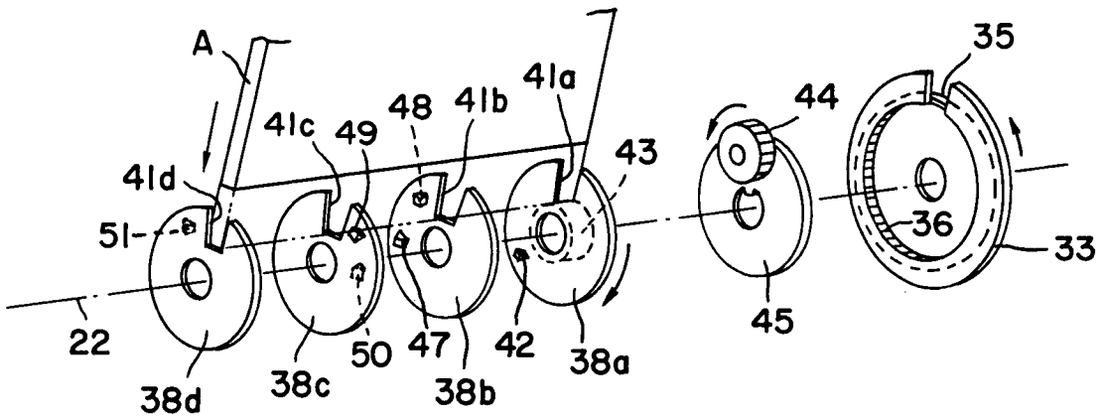
38a
50
38b
38d
38c

Fig. 25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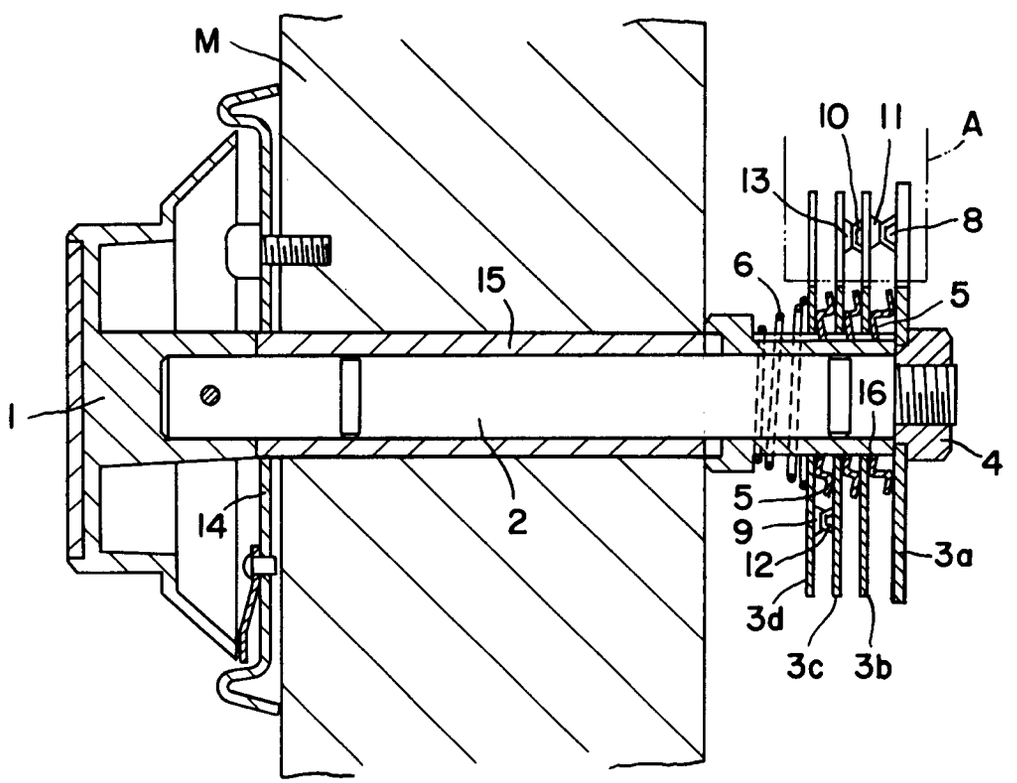
38d
38c
38b

Fig. 26


M
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16
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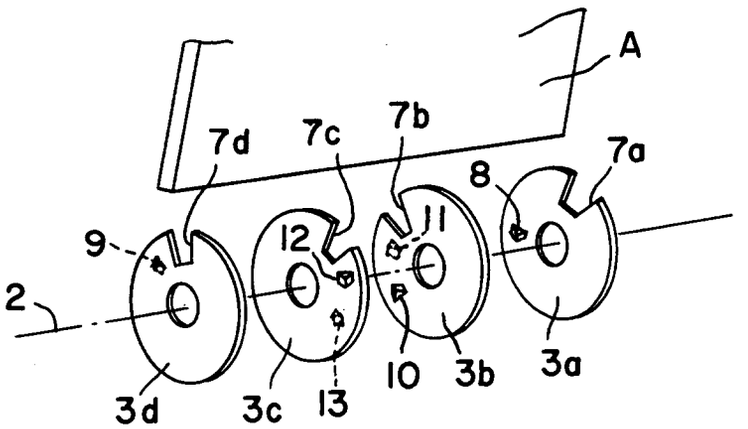
9
12
3a
3d
3c
3b

Fig. 27


A
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7b
8
7a
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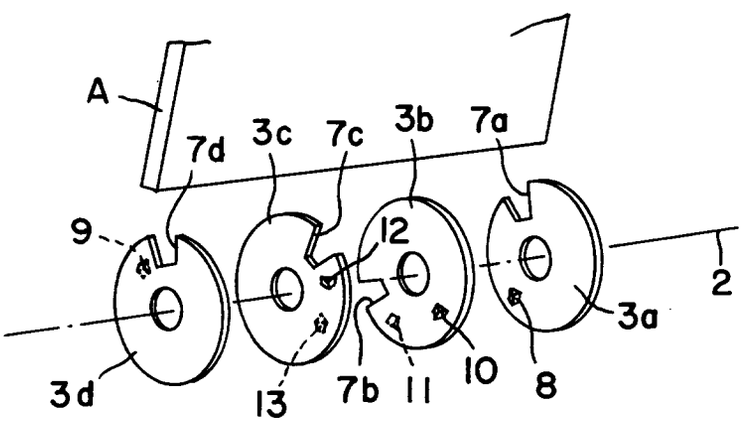
12
11
2
10
3b
3a
3d
3c
13

Fig. 28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3d
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7b
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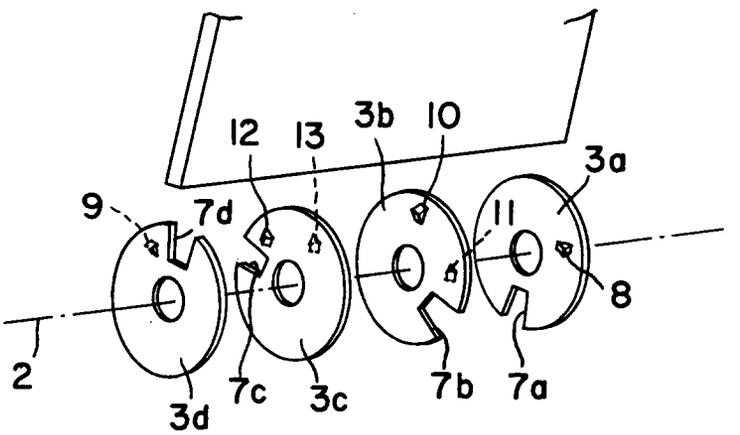
8

Fig. 29


12
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3a
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11
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2
7c
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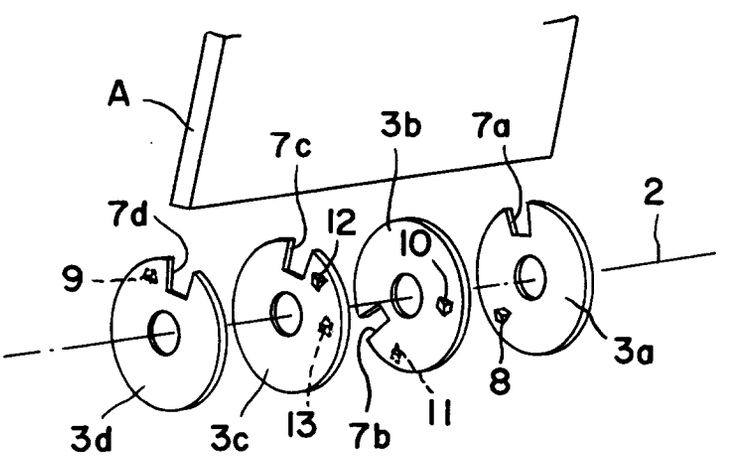
7a
3d

Fig. 30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7b
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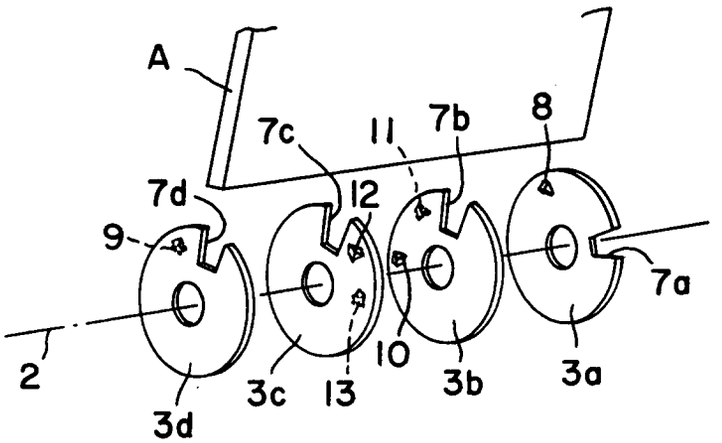
Fig. 31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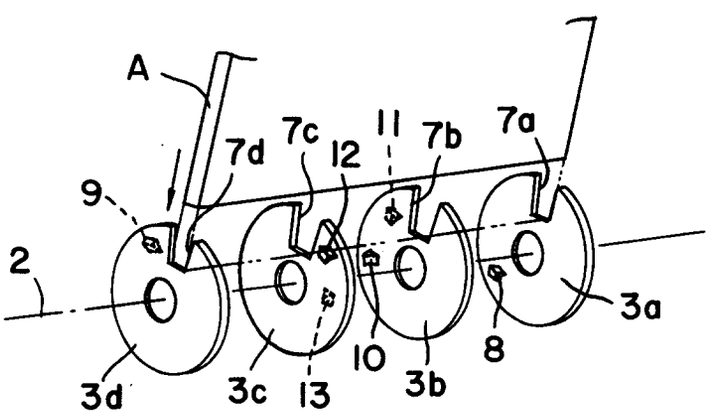
3b
3a
3d

Fig. 32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3b

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 5501

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-1 513 230 (DONOHUE) * the whole document *	1	E05B37/08
A	US-A-1 366 868 (BRAUN AND HOFFMAN) * the whole document *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 14 no. 583 (M-1064) ,26 December 1990 & JP-A-02 252873 (FUJI SEIKO HONSHA : KK) 11 October 1990, * abstract *	1	
A	DE-C-667 249 (BODE) * the whole document *	1	
A	FR-A-1 226 470 (CARMINE) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) E05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 January 1996	Westin, K

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