LOCK CONSTRUCTION

Filed Nov. 18, 1938 3 Sheets-Sheet 1

Fig. 1.

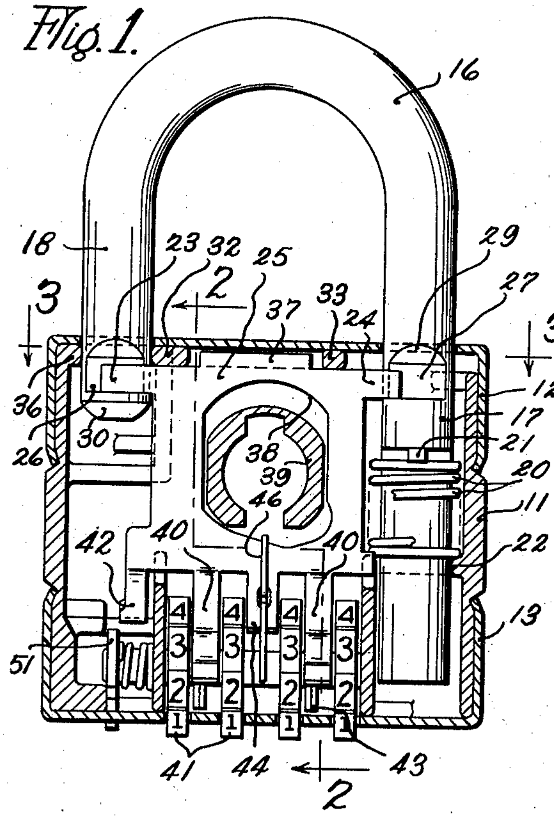

Fig. 2.

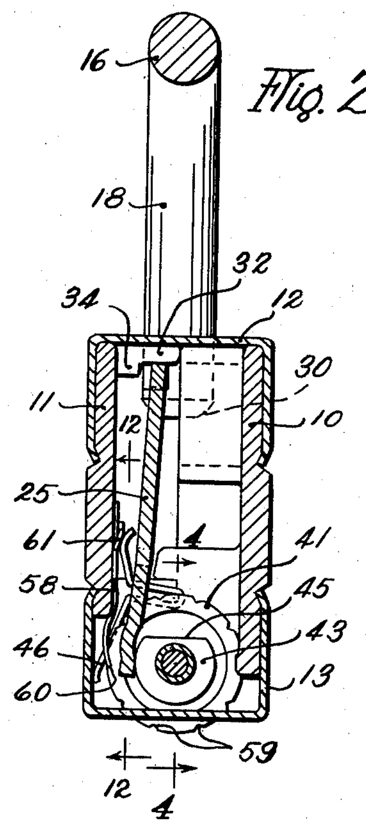

Fig. 4.

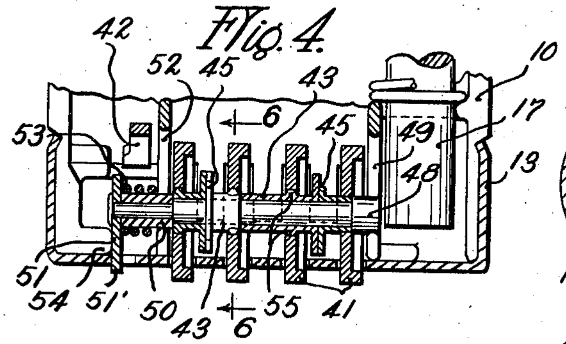

Fig. 3.

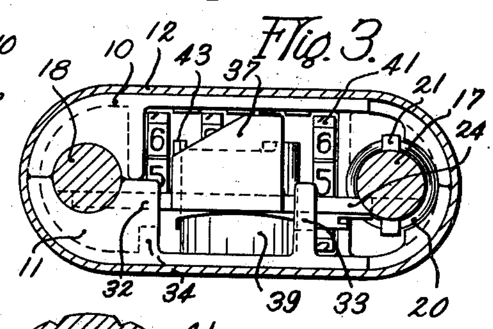

Fig. 5.

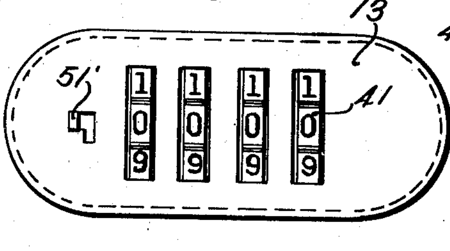

Fig. 6.

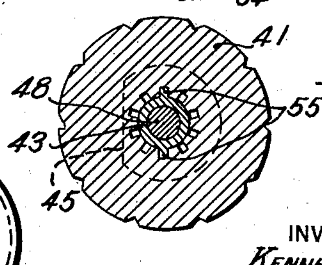

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Fig. 7.

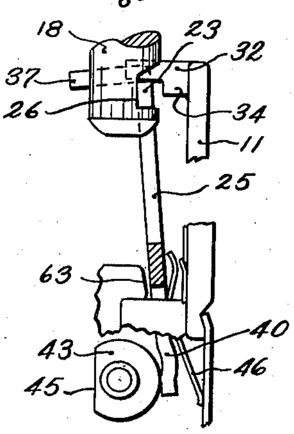

Fig. 8.

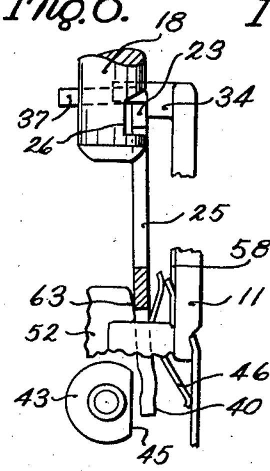

Fig. 9

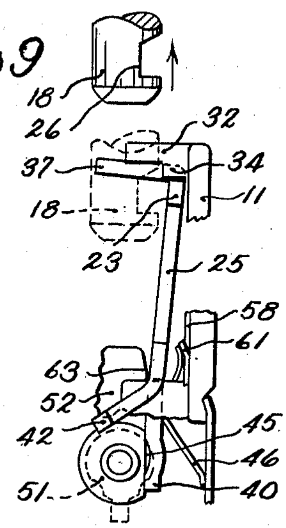

Fig. 10

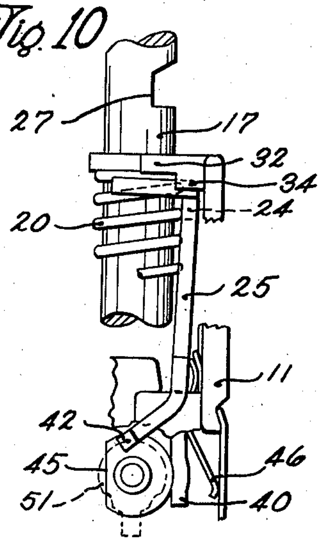

Fig. 11.

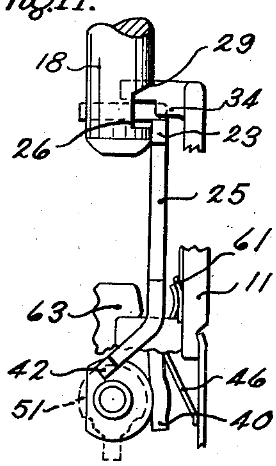

Fig. 20.

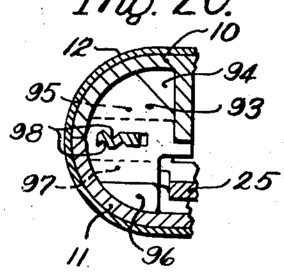

Fig. 21.

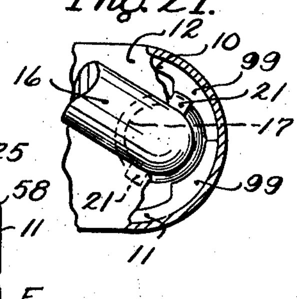

Fig. 12.

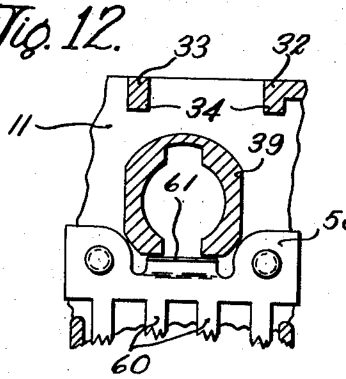

Fig. 13.

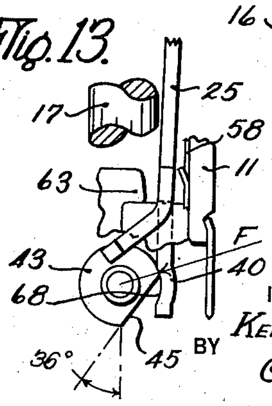

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Fig. 14.

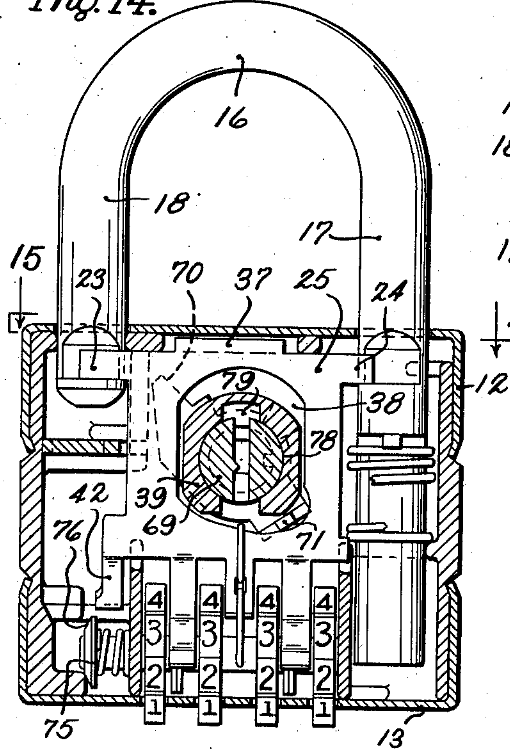


Fig. 15.

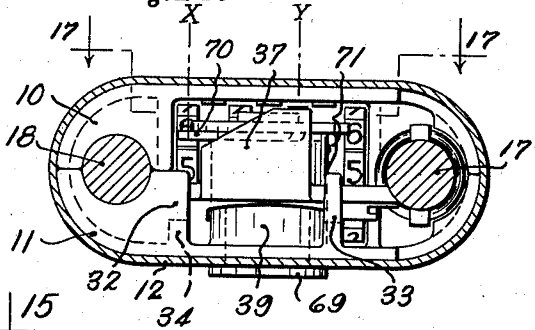


Fig. 16.

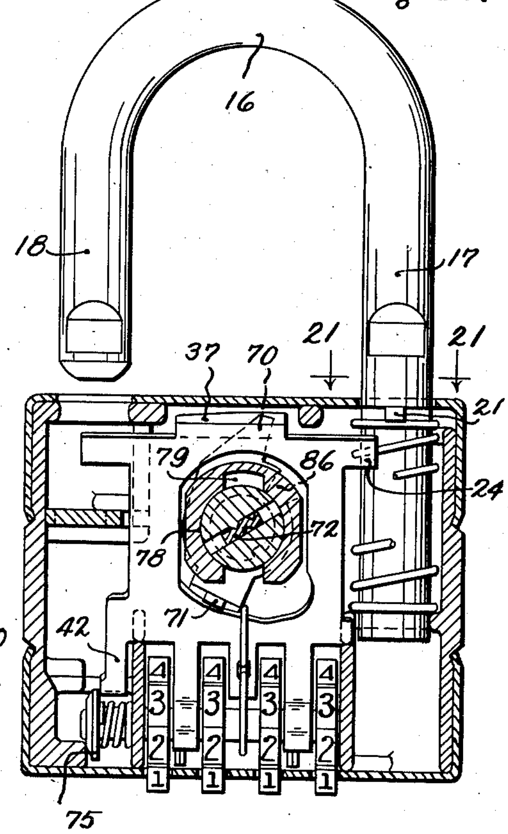


Fig. 19.

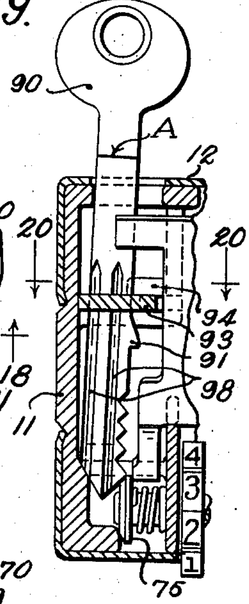


Fig. 17.

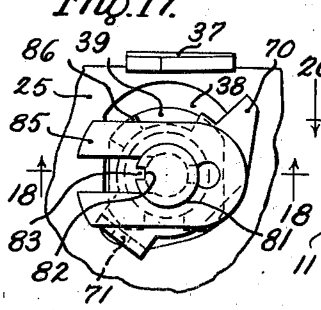
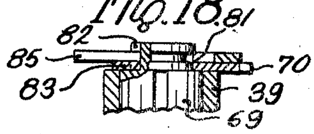


Fig. 18.



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Patented June 27, 1939

2,163,852

UNITED STATES PATENT OFFICE

2,163,852

LOCK CONSTRUCTION

Kenneth H. Pond, Longmeadow, Mass., assignor to Bemis and Call Company, Springfield, Mass., a corporation of Massachusetts

Application November 18, 1938, Serial No. 241,192

17 Claims. (Cl. 70—21)

This invention relates to improvements in permutation locks. It is particularly useful in that class used for padlocks, suit case, brief case, and other such small and relatively inexpensive locks, rather than in the high priced locks. An example of this type of lock is the structure disclosed in Patent No. 1,964,936 to Denerich, dated July 3, 1934.

One difficulty in the past manufacture of such locks has been to make them inexpensively enough to sell at a low price and yet function properly, not only when new, but through a long life of abuse.

Another difficulty has been to provide such a lock with many well known and desirable functions but without substantial cost increase.

The best way to understand the objects and the particular features of the invention is from the full description of the accompanying drawings which disclose the preferred manner of construction and operation.

In the drawings—

Fig. 1 is a substantially vertical longitudinal section of the lock taken in front of the bolt showing my structure arranged as a permutation lock with the parts arranged in locked position;

Fig. 2 is a vertical section on line 2—2 of Fig. 1;

Fig. 3 is a section on line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view on line 4—4 of Fig. 2 showing details of the mounting of the permutation wheels;

Fig. 5 is a bottom plan view of the lock;

Fig. 6 is an enlarged section on line 6—6 of Fig. 4 showing the interconnection of the permutation wheels and certain of the bolt controlling mechanism;

Figs. 7 to 11 are semi-diagrammatic views of the various positions assumed by the parts during the operations of unlocking and locking the mechanism;

Fig. 12 is a fragmentary sectional view on line 12—12 of Fig. 2 showing the method of mounting the detent spring;

Fig. 13 is a diagrammatic view of the parts of Figs. 7 to 11 showing the function of one feature of the bolt construction;

Fig. 14 is a view similar to Fig. 1 but showing how a key locking mechanism may be added to the structure;

Fig. 15 is a view taken on line 15—15 of Fig. 14;

Fig. 16 is a view of the parts in Fig. 14 in the unlocked position of the mechanism;

Fig. 17 is a detail view showing certain parts of the key locking mechanism and taken on line 17—17 of Fig. 15;

Fig. 18 is a fragmentary section on line 18—18 of Fig. 17;

Fig. 19 is a fragmentary view of the left-hand side of Fig. 16, showing the use of a key for the locking mechanism in changing the combination of the permutation lock;

Fig. 20 (Sheet 2) is a section on line 20—20 of Fig. 19; and

Fig. 21 is a section on line 21—21 of Fig. 16.

Referring to Figs. 1 to 3, the body of the lock consists, generally, of two halves, a base 10 and cover 11, secured together by top and bottom plates 12 and 13. The base 10 and cover 11 form the supporting structure for the rest of the elements providing the necessary strength to withstand the strains to which the mechanism is put while the top and bottom plates 12 and 13 primarily secure the two halves in position and serve as end closures.

The securing member in this embodiment takes the form of a shackle 16 having long and short legs 17 and 18 with the legs extending centrally down into the body through holes cut in the top plate 12. As is indicated the shackle is constantly urged upward by a shackle spring 20 threaded onto the long end 17 of the shackle and positioned between nubs 21 on the shackle and a shoulder or internal rib 22 formed in the body. The shackle is retained in its locked position by a pair of lugs 23 and 24 formed on the bolt 25 and engaging notches 26 and 27 cut in the legs of the shackle. These notches 26 and 27 have sloping upper edges as indicated at 29 and the short leg 18 a chamfered end 30 to aid in locking the mechanism as will be explained later.

The tension of spring 20 is sufficient to force the shackle 16 and bolt 25 bodily upward so that in the locked position the top edge of the bolt 25 rests against the bottom surfaces of a pair of legs 32 and 33 formed integral with the cover 11, see Figs. 1 and 2.

As appears in Figs. 2 and 3, each of the legs 32 and 33 has a shoulder 34 which overhangs the edge of the bolt 25. Likewise, see Fig. 1, a rib or shoulder 36 formed in the body encircles the shackle 16. This structure is provided to prevent a "forcing" of the lock by the exerting of a pull on the shackle with an accompanying rapping or jarring of the case and functions as follows: the direction tension on the lock shackle 16 is absorbed by the legs 32 and 33. If the bolt has any tendency to free itself by moving in a counterclockwise direction when viewed in Fig. 2, this movement is resisted by the shoulder 34 already referred to. However, as the area of contact between the recess 26 and lug 23 is much greater than that in the case of the corresponding recess 27 and lug 24, the greater part of the strain on the lock body will occur around the end of the short leg. Hence, the encircling shoulder 36 is necessary to provide strength.

As is indicated in Figs. 1 and 3, the upper edge of the bolt 25 has a toe 37 extending rearwardly between legs 32 and 33 and terminating with an irregular back edge. Also the bolt has a centrally located opening 38 encircling a hollow boss 39 formed integrally with the cover 11. As will be noted, there is clearance provided between the boss 39 and the opening 38 to allow the bolt a substantial vertical motion, which motion is necessary, as will later appear, when the bolt is passed from effective or locking to ineffective or unlocking position. Also the lower edge of the opening 38 is not symmetrical to the upper edge but it, along with the rear edge of toe 37, is used to form camming surfaces for a lock mechanism which is associated with boss 39 in a modified form of structure, as will be described later.

The lower edge of bolt 25 has a pair of control fingers 40 which extend downwardly between the permutation wheels 41 carried at the bottom of the lock body. Likewise, at the left edge of the bolt, Fig. 1, is a tail 42 extending downwardly and rearwardly towards the bottom plate 13 of the lock. The control fingers 40, as is well known in the art and fully explained in the Denerich patent referred to, ride on the peripheries of inner wheels 43 which turn with the permutation wheels 41. When the flats 45, see Fig. 2, on the inner wheels 43 are in the proper position as determined by the proper setting of the permutation wheels 41, the control fingers 40 will have been positioned to allow the shackle to be released as will be further explained. The tail 42 as will appear is provided to prevent a changing of the combination when the lock is unlocked but ready for the shackle to be locked in position again. A short leg 44 on the bolt 25 extends downwardly between the control fingers 40 to support a wire bolt spring 46 which is secured to the leg by a U-shaped portion of the spring passing through a slot cut in the leg 44, see Figs. 1 and 2.

Referring now to Figs. 4 to 6, the permutation wheels 41 are supported on the shanks of inner wheels 43 which pass through central openings in the permutation wheels and are themselves mounted on the shaft 48. There is an inner wheel 43 for each permutation wheel 41 and each inner wheel 43 abuts an adjacent inner wheel in such position that there are two flats 45 for each control finger 40. The shaft 48 has an enlarged head at one end which is journaled in webs 49 formed in the base and cover of the body. At the opposite end, the shaft is slightly reduced at the end of the first permutation wheel, a bushing 50 being slipped over the shaft at that reduced end and held in position by a finger piece 51 riveted as shown to the end of the shaft with a tip 51' extending through an opening in the bottom plate 13. This bushing 50 serves as a bearing for its end of the shaft, being journaled similarly to the enlarged end of the shaft in webs 52 formed in the body, and also keeps the inner wheels in tight abutment and against the enlarged head at the opposite end of the shaft. A spring 53 is provided between the web 52 and the finger piece 51 to constantly urge the whole assembly to the left against an abutment 54 formed integral with the body.

Referring particularly to Figs. 4 and 6, where each inner wheel 43 passes through each permutation wheel 41, the former has a pair of nubs 55 struck up on diametrically opposite sides of the periphery. The hole in the wheel 41 has a series of ten radial slots, cut in it, and the nubs 55 engage a pair of these slots. Thus, any motion imparted to the permutation wheel 41 is carried over to the inner wheel 43. Each permutation wheel has indicia from 0–9 cut on its periphery and when the indicia are set so that the combination appears on the set of permutation wheels the flats 45 will be in position to unlock the lock. As appears in Figs. 4 and 5, the permutation wheels extend through openings in the bottom plate and are read when the lock is viewed from the bottom.

Referring to Fig. 2, a separate detent spring 58 rides in a series of ten notches 59 cut in the periphery of each permutation wheel, the notches in the wheels being positioned so that when all the springs are in the notches of the various wheels the indicia of the wheels are in alignment. Also, one notch 60, in each wheel is cut so that when the wheel is rotated clockwise, the spring tip will abut the bottom of this notch 60 to arrest rotation. In each wheel this notch is positioned so that when the spring tip has stopped rotation the zero will be shown as indicated in Fig. 5. The other notches in each wheel, apart from 60, will permit rotation in either direction. This allows the user to rotate the wheels all to zero merely by the sense of touch and then set the combination by rotating the wheels and counting the number of notches as the detent spring slips over them.

As indicated in Figs. 2 and 12, the detent spring 58 is riveted in place on the inside wall of cover 11 and has a separate spring finger 60 for each permutation wheel. Also, what is termed an assister spring to facilitate the bolt action in a manner to be described is provided by the bent section 61 of spring 58.

Referring again to Figs. 4 and 5, the combination can be changed by merely shifting the finger piece 51 to the right against spring 53, to move shaft 48 and carry the nubs 55 on the inner wheels 43 out of the slots in the permutation wheels and then turning the permutation wheels to the new combination after which the finger piece 51 is released. A notch is provided in the bottom plate 13 to allow the tail 51' of finger piece 51 to be swung to one side and lock the shaft in its shifted position while the combination is being changed if it is so desired. It is to be noted, however, that this changing operation cannot be carried on when the lock is locked as the end of the long leg 17 of the shackle blocks sufficient motion of the shaft 48 for the purpose. Also, if the tail 42 of the bolt, already referred to, is positioned between the finger piece 51 and the web 52, the combination cannot be changed. As mentioned above, this blocking action can be accomplished when the lock is unlocked (the long end of leg 17 being raised out of the way), and provided the bolt 25 is then put in position, as will be later described, to secure the shackle when it is moved to its locked position. With the bolt 25 in such position, tail piece 42, instead of the long leg 17, prevents the combination from being changed, provided only the permutation wheels or one of them has been turned to move bolt 25 so as to locate tail piece 42 in blocking position when the shackle is up. Thus, the unlocking combination can be changed only when the user himself has unlocked the lock, and before setting it to be locked again, pushed finger piece 51 to the right and set the permutation wheels for the new unlocking combination and returned the finger piece to position of Fig. 5. To prevent others from improperly changing the combination without the owner's knowledge, the latter needs only to open the lock and move one or more permutation wheels off the combination setting, while the lock is in opened position.

The above method and general structure for changing the combination are well known in the art and fully explained in the patent to Denerich, as well as in Reissue Patent No. 16,833 to Hatch, dated December 27, 1927, the present invention in relation to the stated function of said patents being an improvement of structure and detailed mode of operation. Therefore, further explanation of this function per se is not believed necessary except as the detailed structure and its mode of operation will be later described with particular reference to Figs. 7 to 11.

I will now explain the operation of the locking elements during a complete operating cycle, that is from locked to unlocked position and again back to locked position. As described earlier in the specification in relation to Fig. 1, the bolt in the locked position bears against the bottom of legs 32 and 33 and is held in that position by spring 20 and the lift of shackle 16, exerted through the recesses 26 and 27. Referring to Fig. 7, which is a semi-diagrammatic view of the elements at the left end of the lock in the position of Fig. 1, this relation can be seen. It will be observed also in that figure that the bolt is urged into the recess 26 by the bolt spring 46, and that the control fingers 40 ride on the periphery of the inner wheels 43. Thus, the bolt is supported only by the inner wheels and the shackle.

With the parts thus arranged, the combination is set on the permutation wheels so that the flats 45 are positioned as indicated in Fig. 8. The shackle is then freed by pushing the shackle into the lock slightly and then releasing it, as will be described. Referring again to Fig. 8, as soon as the permutation wheels are set, the control fingers 40 no longer ride in the periphery of the inner wheels 43 but the bolt 25 is fulcrumed by having its forward edge bear against the shoulder 63 formed integrally with base 10 as part of the webs 49 and 52, in which the permutation mechanism is journaled, see Fig. 4. As soon as the shackle is slightly depressed the bolt 25 first is forced downwardly and then swings clockwise, due to the action of bolt spring 46, until shoulder 34 is contacted, Fig. 8. In this position the shackle still cannot be withdrawn. Continued pressure on the shackle will force the bolt 25 further downward until its upper edge clears the shoulder 34 when the bolt spring 46 will force it to the position shown in Fig. 9, where the shackle is free to be released and will rise to its open position under the pressure of the shackle spring 20, already referred to (see Fig. 1). The full line representation in Fig. 9 of the end 18 of the shackle shows the shackle moving to its final unlocked position while the dotted line position of the same part indicates the distance to which the shackle must be depressed to be released.

In Fig. 9 it will be observed that the bolt now rests with the control fingers 40 against the flats 45 and the bottom edge of the bolt, between the control fingers 40, fulcrumed on the top edge of the webs 49 and 52 formed integrally with cover 11, see Fig. 4. The bolt spring 46 of course is constantly urging the bolt against the flats 45.

Considering again Figs. 8 and 9, the function of the assister spring 61 formed with the detent spring 58 can be seen. As soon as the upper edge of the bolt clears shoulder 34 and swings clockwise the assister spring 61 contacts the upper end of the bolt spring and aids in forcing the lower edge of the bolt to its fulcrumed position on the top edge of web 52. This makes the bolt action much smoother and more reliable.

As long as the bolt 25 stays in the position of Fig. 9 the shackle cannot be locked. Therefore, to lock the mechanism the setting of the permutation wheels is changed and the control fingers 40 ride on the periphery of the inner wheels 43 as shown in Fig. 10. In this case, the fulcrum for bolt 25 is on the periphery of the inner wheels 43 and the bolt spring, therefore, forces the bolt constantly counterclockwise. This motion is limited by the lug 24 (on the opposite end of bolt 25) contacting the coils of the shackle spring 20 in the long leg 17 of the shackle. The assister spring 61 is still functioning to keep the lower edge of the bolt down on top of web 52. The locking operation is carried to completion by pushing the shackle downwardly until the lugs 23 and 24 of the bolt 25 snap into the recesses 26 and 27 and then releasing the shackle when the parts will reassume the position of Fig. 1. Fig. 11 indicates this final operation just before it is completed. There the short leg 18 has entered the body of the lock and the lug 23 is just about to enter the recess 26 under the urge of bolt spring 46. It is during this phase that the chamfer 30 functions, if necessary, to cam the bolt 25 slightly clockwise to make the lug 26 ride along the periphery of the short leg 18. Also, the sloping edge 29 of the recesses 26 and 27 aids the action of the parts during this operation in the following manner: As is clear in Figs. 1 and 2, the top plate 12 is of thin material and the holes provided for the shackle legs provide a close tolerance. Therefore, if due to wear in the parts, the shackle shifts slightly so that the top edge of the recesses 26 and 27 might catch on the top plate as the shackle legs are entering the body of the lock, the slope 29 serves to cam the shackle so that the entering action is smooth.

The above described feature of the mechanism requiring a turning of the permutation wheels off the unlocking combination before the shackle can be locked prevents the user from inadvertently leaving the combination set on the permutation wheels after locking the lock, and thereby allowing an unauthorized person to learn the combination.

Earlier in the specification in referring to the method of changing the combination for the permutation wheels it was stated that the tail 42 on the bolt, see Figs. 1 and 4, prevented a change in the combination when the shackle was in unlocked position but with the permutation wheels set at other than the unlocking combination. Referring to Figs. 9 to 11, where the finger piece 51 is shown by dotted lines, it will be seen that the tail 42 drops in back of the finger piece 51 in position to prevent a changing of the unlocking combination as soon as the permutation wheels are changed to allow locking of the shackle when it is reinserted.

At this point a further feature of the construction which makes the operation of the lock very smooth, will be explained. Referring to Figs. 2 and 13, it will be recalled that the permutation wheels have indicia from 0–9 on their peripheries and ten equally spaced notches cut on said peripheries to coact with the detent spring 58 to allow tend distinct settings of each wheel. Therefore, each wheel rotates 36° in going from one notch to the next. If a permutation wheel is turned in a clockwise direction from the position shown in Fig. 8 to the next notch, the flat 45 will be positioned as in Fig. 13. Then, the edge of the flat where it meets the periphery of the iner wheel will be just within the arcuate surface 68 in the tail of control finger 40. This surface 68, is formed on the same radius as the periphery of inner wheel 43. Therefore, the force F directed against the wheel by the bolt 25 will be radial as indicated in Fig. 13 and will have no tendency to turn the permutation wheel in either direction. If the tail of control finger 40 were flat, this pressure F would not be radial but would be in a direction to force the permutation wheel back to its original position.

The description so far has dealt entirely with my invention when constructed for use as a keyless lock. I will now describe a modified structure in which a key locking mechanism is associated with the locking elements already described to furnish a lock which may be operated either by manipulation of the permutation wheels or by use of the key locking structure.

In this embodiment the elements of the original form are kept essentially the same but the key locking mechanism is associated therewith in a manner to effect several novel results which will appear more fully as the description proceeds.

Referring now to Figs. 14 to 16, the locking elements are the same, that is, the bolt 25, the shackle 16, the top and bottom plates 12 and 13, the base and cover 10 and 11; however, the finger piece 51 of the other figures is replaced by a washer 75 which has a slanting cam surface as at 76 for a purpose to be described.

A lock center 69 is mounted in the hollow boss 39 extending from the cover 11. The lock center carries a cam 70 supported by the end of the lock center and having a toe 71 extending from the back of the lock center parallel to the axis thereof towards the front of the mechanism, the end of the toe protruding through the opening 38 at the bottom and to the right of the center of the hollow boss 39.

When the key 72, see Fig. 16, is inserted and the center 69 is turned from the locked position of Fig. 14 to the unlocked position of Fig. 16 the cam operates to move the bolt out of engagement with the shackle to thereby free the shackle and allow it to move to its disengaged position. In this operation no manual depressing of the shackle is necessary to free it as when the permutation lock is used nor is it necessary to adjust the permutation wheels.

The sequence of operation is as follows: as the lock center 69 begins to turn, the toe 71 acts as a cam to push the bolt downwardly sufficiently to clear the edge of shoulder 34, and as soon as the bolt is down far enough, cam 70 engages the slanting back edge of toe 37 on the bolt. Continued motion of the lock center 69 to the position of Fig. 16 causes the cam to push the bolt towards the front of the lock until the parts are in the position of Fig. 10 with the exception that bolt 25 is carried slightly more in a clockwise direction so that it clears the shackle legs 17 and 18, but not far enough for the toe 42 to clear the washer 75 which has replaced the finger piece 51. This operation releases the shackle 16 and allows it to spring to its freed position. In Fig. 15, the cam 70 moves from the position represented by line X to that represented by line Y in opening the lock.

If the lock center is now turned to its original position the elements will assume the exact position shown in Fig. 10, because neither portion of the cam 70 acts as a positive action cam. Of course, it will be understood that the lock can again be locked by merely depressing the shackle 16 as with the keyless lock structure, the parts cooperating as in Fig. 11 to return to the position indicated in Fig. 7.

Referring to Figs. 14, 17, and 18, the exact method in which the lock center 69 and cam 70 are mounted in the boss 39 is as follows: the center itself rotates in the inner cylindrical surface 78 of the boss 39. In the locked position of the center 69 the tumblers of the lock center 69 spring up into the recess 79. When the key 72 see Fig. 16, is inserted the tumblers are withdrawn from within the recess 79 and the center may be rotated. This particular method of mounting a locking center is well known and need not be further described.

At the back end of the boss 39, see Figs. 17 and 18, the center ends flush with the boss and has a reduced cylindrical portion 81 with a notch 82 cut therein. The cam 70 fits over the cylindrical portion 81 and has a lug 83 which cooperates with the notch 82 so that motion of the center is imparted to the cam. A keeper 85 fits over an annular groove cut in the cylindrical portion 81 and keeps the lock center 69 and cam 70 secured in the boss against the back face thereof.

The limits of motion of the cam 70 are determined by the locked position of the center 69 and contact of the cam 70 with the shoulder 86 formed on the back face of the boss 39.

It is to be noted particularly that as pointed out previously when the shackle has been freed by using the key lock, the tail 42, see Figs. 14 and 16, is in a position to block any lateral motion of the washer 75 to ecect a change in the combination. However, if the permutation wheels are used to set the prevailing combination, the parts cooperate as in the preferred form of lock and with the lock unlocked the tail 42 does clear the washer 75.

This arrangement allows me to make use of a master key system in which the master key is constructed to be used not only to operate the center 69 but also to change the combination to which the permutation wheels must be set to free the shackle, and this only when the lock has been opened by setting the combination on the permutation wheels.

Referring to Fig. 19, the master key 90 has a longer shank than the key normally used to unlock the center 69, the ordinary key having its head formed on the shank just above the abutment 91. That is, the portion of the key between abutment 91 and the lower end is the only part effective to unlock the center 69. In Fig. 19 the lock has already been unlocked by setting the prevailing combination on the permutation wheels. Then the master key 90 is inserted through the hole out of which the short leg 18 has passed, down through a slot in a concealed change plate 93 until its lower end abuts the body of the lock on one side and the cam surface 76 of washer 75 on the other. If the key is pushed downwardly further until the line A marked on the key is even with the top plate 12 of the lock, the wedging action of the key tip against the washer 75 will shift the permutation wheel mechanism to allow a change in the combination.

Referring to Figs. 19 and 20, it will be seen that the change plate 93 is held in position between a ledge and web 94 and 95 on the base 10 and a similar ledge and web 96 and 97 on the cover 11, the change plate 93 being inserted as the two halves 10 and 11 are assembled. Also, the slot in the change plate 93 is cut to accommodate only keys having the correct milled grooves 98.

By the above arrangement one group of persons can be informed of the combination and another given a set of keys to fit the lock center 69, with the master key remaining in the owner's possession. Either group can then unlock the lock. However, the group knowing the combination can be limited by using the master key to change the combination, but only by the owner since he alone has the master key and the ordinary keys will not fit. Again, since the master key can be used to change the combination only when the permutation wheels are set to unlock the shackle, the owner cannot embarrass himself by unlocking the center with the key without setting the combination and then using the master key to change the setting with the result that even the owner himself would not know the new combination.

Of course, when the combination is being changed or the lock shackle taken out of a hasp after being freed it is necessary to swing the shackle to one side, using the long leg 17 as a pivot. To prevent the shackle being depressed until the short leg 18 is again aligned with the hole in the top plate 12 I have provided the structure indicated in Fig. 21. When the shackle is in its uppermost position, see Fig. 16, the nubs 21 contact the under side of plate 12. In this position the nubs 21 lie above a pair of stubby ribs 99 formed in the halves 10 and 11, see Fig. 21. These ribs form an arcuate ledge which terminates in such a position that if the shackle is turned in either direction so that the short leg does not line up with the hole in the top plate, the nubs are supported by the ledge and will not allow the shackle to be depressed.

If the structure as described is considered from the standpoints of simplicity of manufacture and assembly as well as reliability of operation certain advantages in addition to those already pointed out will readily be apparent.

For instance, with the body formed in halves which cooperate to provide a frame for the elements of the lock, the permutation mechanism can be assembled as a unit outside the lock and then merely placed in position as part of an assembly operation. This is a distinct advantage over other structures where it is frequently necessary to assemble this mechanism piece by piece on a separate frame member which has been incorporated in the lock by being inserted through the top or bottom of the body.

The halves themselves may be conveniently made out of die castings and, as is evident, the mold for the keyless lock is the same as that used for a keyless lock with a cooperating locking center.

An important, practical feature from the standpoint of manufacture and use is the lack of close tolerances in fitting the bolt. In Figs. 7 to 11 where the semi-diagrammatic views show the operating cycle, it will be seen that the lug 23 on the bolt can be fitted loosely within the recesses in the shackle and not abut the shoulder 34, and the bolt will still perform its locking function entirely satisfactorily. This is so because in the first place in the locked position of the elements the shackle continually pulls the bolt upwardly against the leg 32 and whatever slack there is, arising because of the fit of lug 23 in the recess 26, is taken up. The bolt is constantly forced deeper into the recess by the bolt spring and all that shoulder 34 has to do is prevent a clockwise motion of the bolt from the locked position of Fig. 7 sufficient to allow lug 23 to get out of the recess 26. The effect of locating this shoulder 34 at the upper end of the bolt opposite the recess 26 is to confine lug 23 as though it were in a socket and it makes little difference how much play there is between the lug 23 and the recess provided the shoulder 34 keeps the lower edge of the lug 23 on the surface of recess 26. Thus, the shoulder can wear down substantially the thickness of the bolt itself before the lug will be freed from the recess. This is a distinct advantage over, for instance, locating the shoulder 34 between the fulcrum 63 and the end of the bolt in which case any wear of the shoulder would be magnified at the end of the bolt and less wear would be necessary to render the guarding action of shoulder 34 ineffective. Also, as has been pointed out, in the locked position of the parts, the bolt bears only on the peripheries of the inner wheels and the notches in the shackle, not touching the fulcrum 63. Therefore, the locked position of the parts is not affected by any adjustments necessary to fulcrum 63 in order to make the bolt function properly during the unlocking operation.

Another feature is the fact that the parts used in the keyless lock structure of the preferred form are adaptable by merely changing the finger piece on the permutation wheel shaft for use with the locking center.

The whole operation of assembly of this type of lock has by my structure been given a new aspect, so that now not only may mechanism be assembled more easily and without the employment of specially trained fitters but the finished product is more reliable under the type of rough usage to which it is put.

I claim:

1. In a permutation lock construction a bolt mounted for pivotal and longitudinal movements, means operable by permutation wheels of the lock construction to give pivotal movements to said bolt, a movable and lockable member having a notch engageable by one end of said bolt upon pivotal movement of the latter, said bolt being movable longitudinally by limited movement of the lockable member, guard means located opposite said notch when said lockable member is in locked position and adapted to maintain said bolt and lockable member engaged in locked position of said last-named member, and means for said bolt to pivot upon, which means are located near the opposite end of the bolt from that end which engages said notch.

2. In a permutation lock, permutation members each provided with a lock controlling element, a securing element having an effective position and an in effective position, a locking element controlled by said lock controlling elements and having at one end means to engage the securing element in effective position when the prevailing combination of the permutation members is disturbed, guard means located opposite said engaging means in a position to maintain said engaging means effective while the prevailing combination is disturbed and the securing element is in effective position, and spring means for urging said locking element into engagement with said securing element when the prevailing combination is disturbed.

3. In a permutation lock, permutation members each provided with a lock controlling ele-

ment, a securing element having an effective position and an ineffective position and provided with a pair of notches, a locking element controlled by said lock controlling element and having at one end lugs engaging said notches when the prevailing combination is disturbed, guard means located opposite said notches in the effective position of said securing member to hold said lugs in said notches while the prevailing combination is disturbed, and spring means for urging said locking element into locking position when the prevailing combination is disturbed.

4. In a permutation lock, permutation members each provided with a lock controlling element, a securing element having an effective position and an ineffective position, a locking element controlled by said lock controlling elements and having at one end means to be engaged by said securing element when the combination is disturbed, spring means for urging said locking element into engagement with said securing means when the prevailing combination is disturbed, an abutment on the body of said lock having a guard means closely adjacent said end of said locking element to maintain engagement between said securing and locking elements when the prevailing combination is disturbed, and additional spring means to urge said locking element against said abutment when the prevailing combination is disturbed.

5. In a permutation lock, permutation members each provided with a lock controlling element, a securing element having an effective position and an ineffective position, a locking element controlled by said lock controlling elements and having at one end means to be engaged by said securing element when the combination is disturbed, spring means for urging said locking element into engagement with said securing means when the prevailing combination is disturbed, an abutment on the body of said lock closely adjacent said end of said locking element and having a shoulder in position to maintain engagement between said securing and locking elements when the prevailing combination is disturbed and additional spring means to urge said locking element against said abutment when the prevailing combination is disturbed.

6. In a permutation lock, permutation members each having a lock controlling element, a securing element having an effective and an ineffective position, a locking element having means at one end to engage said securing element in its effective position, and means at the opposite end to bear on said lock controlling elements when the prevailing combination is disturbed, a fulcrum between said lock controlling elements and said engaging means on which said locking element bears when the prevailing combination is set, and the securing member is in effective position, but on which said element does not bear when the prevailing combination is disturbed and the securing element is in effective position, spring means for urging said locking element into engagement with the securing element when the prevailing combination is disturbed, and guard means closely adjacent said engaging means to maintain engagement between said locking and securing elements when the prevailing combination is disturbed.

7. A permutation lock consisting of the combination of a body comprising two complementary halves secured together by two oppositely disposed end plates, a securing member adapted for rectilinear motion with respect to the body through holes cut in one end plate from an effective to an ineffective position, permutation members each provided with a lock controlling element, a locking element engaged at one end by the lock controlling elements and controlled by said lock controlling elements to render the securing member effective or ineffective, and a spring constantly urging said locking member in a direction to maintain said securing member effective when the prevailing combination is disturbed, said body having integral webs forming a frame for said elements and provided with an integral guard in position to lie behind the other end of said locking element and maintain said locking element and securing member engaged with the securing element effective when the prevailing combination is disturbed.

8. In a permutation lock, a securing element having an ineffective position, an effective position, and a third position slightly beyond said effective position, a locking element adapted to engage said securing element in said third position and hold it in effective position when the securing element is moved to said effective position from said third position, permutation mechanism adapted to move said locking element to render the securing element ineffective when the prevailing combination is set, or into position to engage said securing element in said third position when the prevailing combination is disturbed, and a key lock center carrying a cam cooperating with camming surfaces on said locking element and having two positions to which it may be moved by a key, in the first of which said locking member is moved to render said securing member ineffective and in the second of which said locking member is held in said engaging position by the permutation mechanism when the prevailing combination is disturbed.

9. The structure of claim 8 in combination with means to change the prevailing combination to which the permutation mechanism is set only when the securing member has been rendered ineffective by setting the then prevailing combination on the permutation mechanism.

10. In a permutation lock, a securing element having an ineffective position and an effective position, a locking element adapted to engage said securing element to render it effective, permutation mechanism to move said locking element to render the securing element ineffective when the prevailing combination is set and into position to engage said securing element when the prevailing combination is afterwards disturbed, a key-operated lock center carrying a cam and cooperating with said locking element to move said locking element to render the securing element ineffective and back to the above-mentioned engaging position, means to change the prevailing combination to which the permutation mechanism is set only when the securing member has been rendered ineffective by setting the then prevailing combination on the permutation mechanism, said combination changing means being operable by a master key used with the key operated lock center.

11. The structure of claim 10 in combination with additional means to prevent the use of other devices than the master key for operating said combination changing mechanism.

12. In a permutation lock, a securing element having an ineffective position, an effective position, and a third position slightly beyond said effective position, a locking element engaged with said securing element in said effective position,

permutation mechanism controlling said locking element and adapted when set to the prevailing combination to allow said locking element to move out of engagement with said securing element when said element is moved to its third position from its effective position, and then when the prevailing combination is disturbed, position said locking element to engage said securing element when said last-named element is moved to its third position, and a key operated lock center carrying a cam and cooperating with said locking element and adapted to move said securing member from its effective to its third position, disengage said locking member and securing member and then allow the return of said locking member to the position to engage said securing element when it is moved to its third position, this position being the one determined by the permutation mechanism as described.

13. In a padlock construction, the combination of a hasp having a short and long leg and curved connecting portion all substantially of the same cross-sectional diameter, a casing having a top end closure through which said legs pass, permutation lock mechanism in the casing having a longitudinally movable shaft for the purpose of changing the unlocking combination of the mechanism, the long leg of the hasp being positioned when the lock is locked to prevent longitudinal movement of said shaft, an integral lug struck out from the metal of the long leg and a coiled spring around the end portion of the long leg with the upper end of said spring bearing against said integral lug and its lower end bearing against a stop inside the casing, said spring being wound so as to lift the hasp for the short leg to rise out of the casing, the integral lug being positioned on said long leg to bear against the under side of said end closure to arrest the motion of the hasp when the short leg is out of the casing far enough for opening purposes and the end of the long leg has moved far enough to permit longitudinal movement of the shaft of the permutation mechanism and means at the top of the casing to cooperate with said lug and prevent the hasp from being depressed until the short leg is aligned with its hole in the top closure.

14. In a permutation lock, a securing element having an ineffective position, an effective position, and a third position slightly beyond said effective position, a locking element adapted to engage said securing element in said third position and hold it in effective position when the securing element is moved to said effective position from said third position, guard means to maintain engagement between said locking and securing elements in said effective position, permutation mechanism adapted to move said locking element to render the securing element ineffective when the prevailing combination is set, or into position to engage said securing element in said third position when the prevailing combination is disturbed, and a key lock center carrying a cam cooperating with camming surfaces on said locking element and having two positions to which it may be moved by a key, in the first of which said locking member is moved to render said securing member ineffective and in the second of which said locking member is held in said engaging position by the permutation mechanism when the prevailing combination is disturbed.

15. In a permutation lock, a securing element having an ineffective position, an effective position and a third position slightly beyond said effective position, a locking element adapted to engage said securing element in said third position and hold it in effective position when the securing element is moved to said effective position from said third position, guard means located closely adjacent one end of said locking element and adapted to maintain engagement between said locking and securing elements in said effective position, permutation mechanism adapted to move said locking element to render the securing element ineffective when the prevailing combination is set, or into position to engage said securing element in said third position when the prevailing combination is disturbed, and a key lock center carrying a cam cooperating with camming surfaces on said locking element and having two positions to which it may be moved by a key, in the first of which said locking member is moved to render said securing member ineffective and in the second of which said locking member is held in said engaging position by the permutation mechanism when the prevailing combination is disturbed.

16. In a permutation lock, a securing element having an ineffective position, an effective position, and a third position slightly beyond said effective position, a locking element adapted to engage said securing element in said third position and hold it in effective position when the securing element is moved to said effective position from said third position, permutation mechanism adapted to move said locking element to render the securing element ineffective when the prevailing combination is set, or into position to engage said securing element in said third position when the prevailing combination is disturbed, and a key lock center adapted to control said locking element and having two positions to which it may be moved by a key, in the first of which said locking member is moved to render said securing member ineffective and in the second of which said locking member is held in said engaging position by the permutation mechanism when the prevailing combination is disturbed.

17. In a permutation lock, a securing element having an ineffective position, an effective position, and a third position slightly beyond said effective position, a locking element adapted to engage said securing element in said third position and hold it in effective position when the securing element is moved to said effective position from said third position, guard means to maintain engagement between said locking and securing elements in said effective position, permutation mechanism adapted to move said locking element to render the securing element ineffective when the prevailing combination is set, or into position to engage said securing element in said third position when the prevailing combination is disturbed, and a key lock center adapted to control said locking element and having two positions to which it may be moved by a key, in the first of which said locking member is moved to render said securing member ineffective and in the second of which said locking member is held in said engaging position by the permutation mechanism when the prevailing combination is disturbed.

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