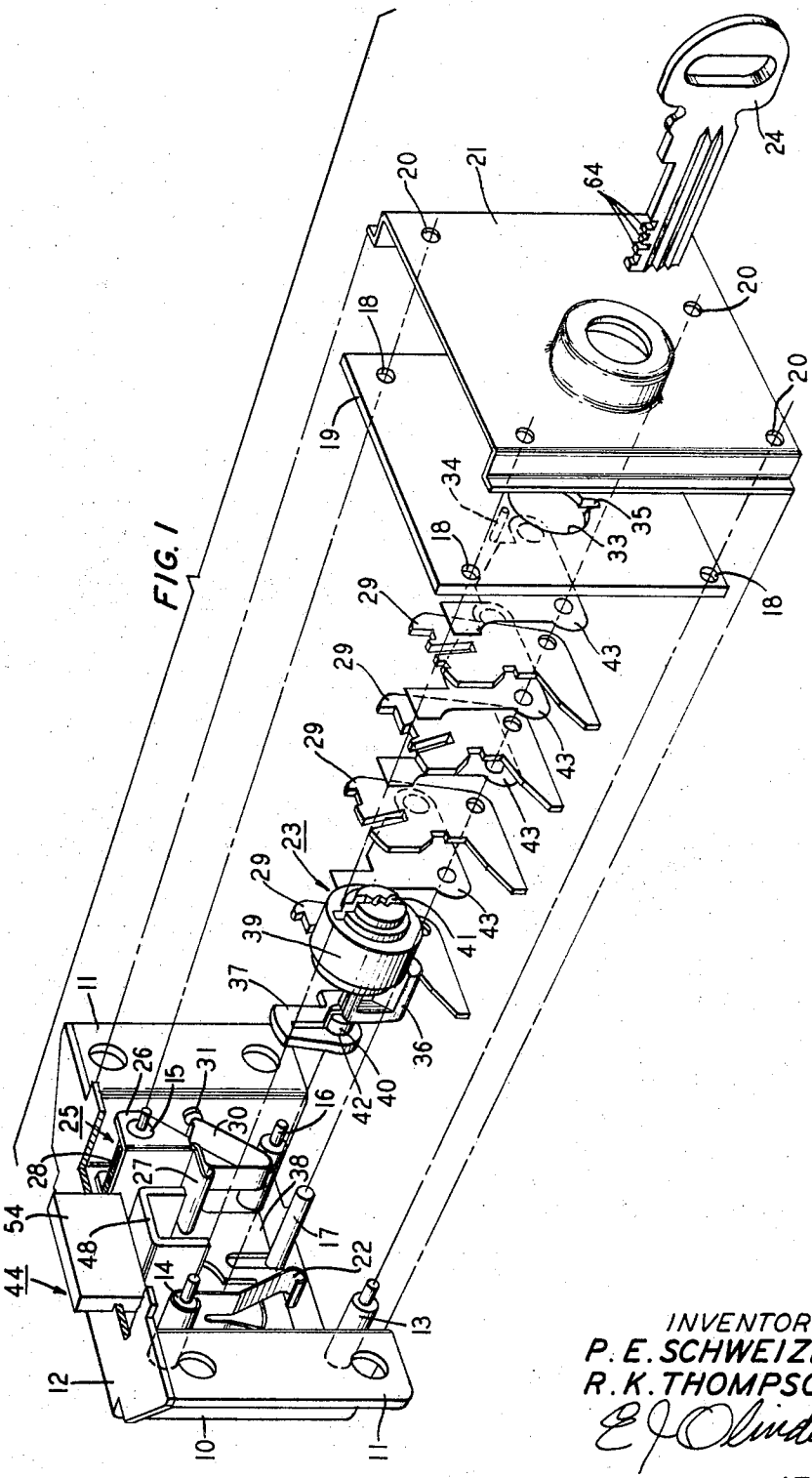
Sept. 24, 1968 P. E. SCHWEIZER ET AL 3,402,581

KEY OPERATED LOCK

Filed Sept. 20, 1966 3 Sheets-Sheet 1

FIG. 1



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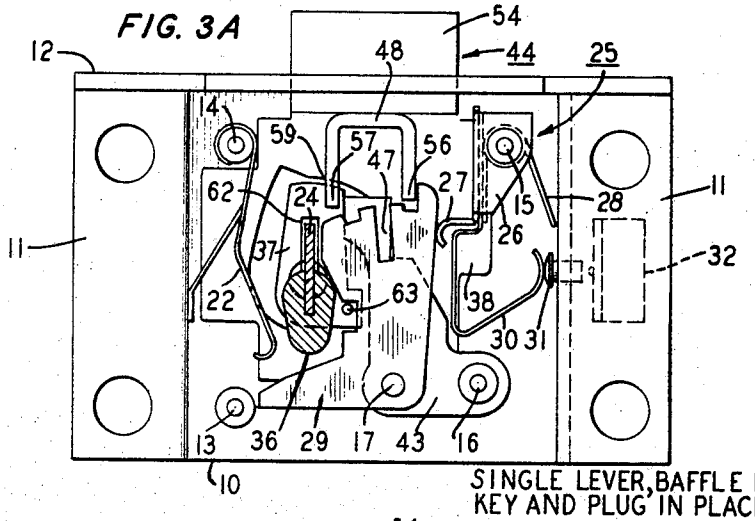
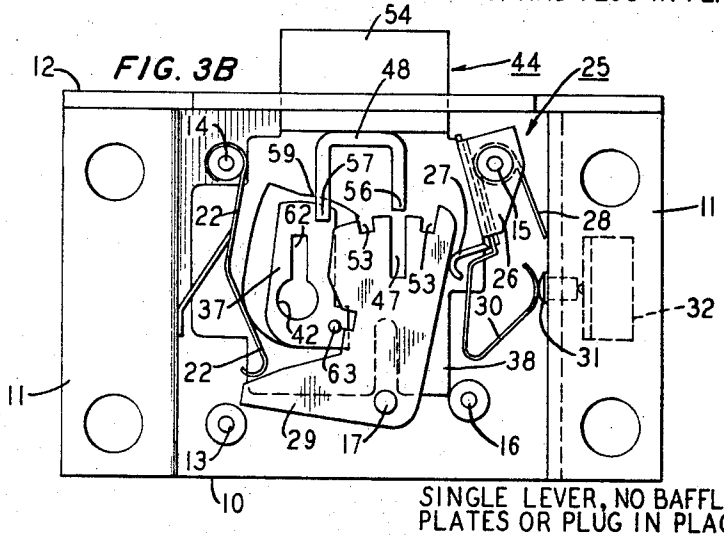
Filed Sept. 20, 1966 3 Sheets-Sheet 2

FIG. 3A



SINGLE LEVER, BAFFLE PLATE KEY AND PLUG IN PLACE

FIG. 3B



SINGLE LEVER, NO BAFFLE PLATES OR PLUG IN PLACE

FIG. 2

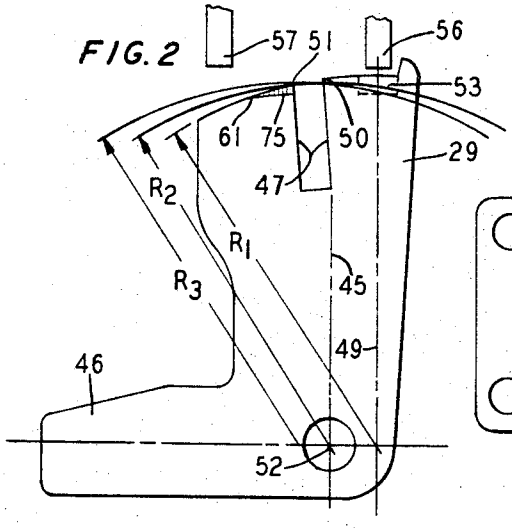


FIG. 5
PRIOR ART

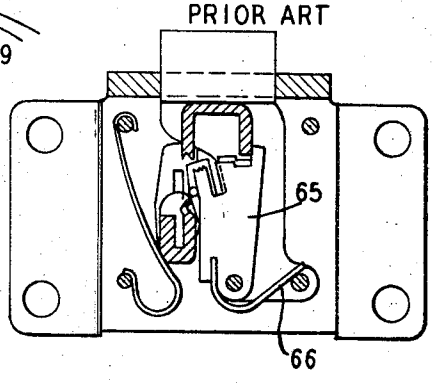


FIG. 4A

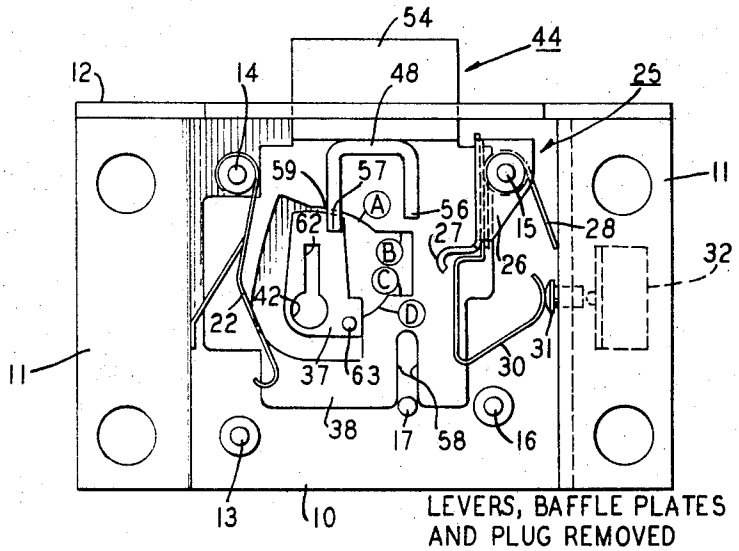
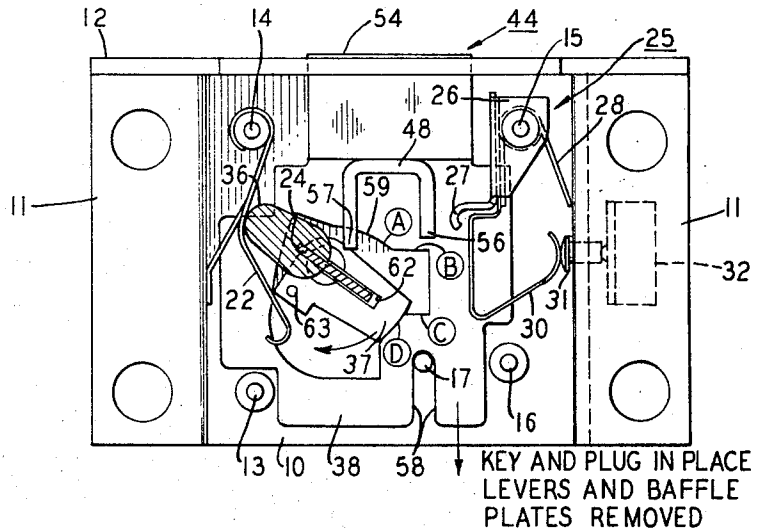

54
44
12
14
48
25
59
57
A
56
62
27
15
28
11
B
C
26
32
42
D
22
31
11
37
63
30
38
17
58
16
13
10
LEVERS, BAFFLE PLATES
AND PLUG REMOVED

FIG. 4B


12
14
54
44
15
25
26
28
48
36
24
57
59
27
11
A
11
56
62
B
32
22
9
31
63
C
30
37
D
17
16
13
10
38
58
KEY AND PLUG IN PLACE
LEVERS AND BAFFLE
PLATES REMOVED

United States Patent Office 3,402,581 Patented Sept. 24, 1968

3,402,581

KEY OPERATED LOCK

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Filed Sept. 20, 1966, Ser. No. 580,707
13 Claims. (Cl. 70—355)

This invention relates to key operated, lever type locks and its general object is to enhance the security of such locks against lock-picking and other forms of fraudulent entry.

A key operated, lever type lock typically employs a stack of pivotally mounted leaf-like levers or tumblers. Each lever has a deep notch or gate extending in more or less radially from its curved outer periphery. As the key is turned, each of the key notches engages the side edge of a corresponding one of the levers causing it to pivot through a related arc of travel until all of the lever gates are aligned in the path of a projection or fence portion of the bolt.

The key is accommodated by a roughly cylindrical lock-center or plug that rotates as the key is turned. The bottom of the plug conventionally terminates in an integral tongue-like cam. As the cam rotates, it engages a cam follower surface on a plate that in turn is integral with the lock bolt, withdrawing the bolt from the locked position as the fence slides into the accommodating opening provided by the aligned gates of the levers.

The basic problem of a lock-picker is to rotate each lever, without the benefit of a key, to a point at which each lever gate is in alignment with the fence portion of the bolt. This problem is readily solved by skilled lock-pickers by any one of a number of methods, most of which employ some combination of the following steps. First, pressure or tension is exerted on the movable locking members in a direction to open the lock. This step is typically accomplished by rotating the plug and its associated cam with some suitable tool. The tension thus applied takes up the clearances between the lever pivot pin and the pivot hole in the levers and between the fence and the top radius of the levers. Next, each individual lever is rotated with a picking tool. As the gate in each individual lever is aligned with the tool, the lever is moved further toward the fence by the amount of clearance between the pivot hole and the pivot pin under the urging force of an individual lever return spring that conventionally biases each lever toward its home or locked position. Each lever gate is aligned with the fence in the manner described and each is held in that position by the combined force of the tensioned bolt and the lever return spring associated with each of the levers.

While picking each lever to the desired position, the lock-picker must work almost entirely by his sense of touch and, for a skilled picker, the clues that are provided by the feel of the lever as the gate is aligned with the fence clearly mark the position of the lever. A particularly useful asset to the lock-picker is the spring tension that is uniformly exerted by each of the lever return springs that serves to maintain each picked lever in the open position as each succeeding lever is picked.

Various attempts have been made in the prior art to make locks of the type described more pick resistant. These attempts include the use of baffle plates sandwiched between adjacent pairs of levers which makes picking access to the levers more difficult. Additionally, it is common practice to employ levers with one or more randomly spaced false gates—a false gate being a relatively shallow notch adjacent to the true gate that tends to confuse the picker in his judgment as to the position of the true gate with respect to the fence. The skilled picker,

however, is generally able to circumvent such so-called pick-resistant features with little or no difficulty.

The fraudulent opening of key operated locks is by no means restricted to the use of lock-picking techniques. Assorted brute-force or refined force methods are employed that typically concentrate on the weak points of the particular lock. Various locks are available that have been made resistant to a broad range of possible forcible entry methods by employing very heavy, high strength materials for most or all lock parts. Such locks are inherently bulky, however, and far too costly to permit economical widespread use.

A completely secure key operated lock is of course an impossible goal and, accordingly, alarm systems are sometimes employed to provide either a local or distant warning signal to indicate that a lock has been fraudulently or forcibly opened. Generally, such warning systems are deficient in that they are actuated by the movement of the bolt and hence, more often than not, the alarm merely signals the completion of a fraudulent entry rather than signaling that an attempted and therefore preventable fraudulent entry is being made.

Each of the indicated prior art problems is either overcome or at least alleviated by a lock constructed in accordance with the principles of the invention. These principles are broadly directed to a philosophy of lock design that strikes a unique balance between the goal of a combined high resistance to both manipulative and forcible means of fraudulent entry and the goal of low cost and ease of manufacture. Insofar as pick resistance is concerned, the features of the invention are directed toward the elimination of those structural and operating aspects of conventional key locks upon which the picker typically relies to aid him in his task. For example, the ability of a picker to tension the lock merely by forcibly turning the plug is eliminated by the utilization of a floating or unattached cam that drives the bolt in response to engaging contact with the key. This floating cam is employed in lieu of the conventional plug-attached cam.

Another feature of the invention eliminates the individual lever springs that so conveniently assist the picker in holding each lever in position, after picking, with the gate aligned with the fence. Instead, a common spring assembly is employed. When picked to the open position, the lever with maximum throw removes or substantially reduces spring pressure from all of the other levers. There is a tendency to overpick an unbiased or floating lever and the plug must be rotated back to restore any "overpicked" lever to its locked or home position. Unfortunately, for the picker, plug rotation forces *all* levers including properly picked levers, back to the locked position through the action of a unique plug camming surface that rides against the leg of each lever as the plug is rotated.

Another feature of the invention involves the placement of the center of curvature for the top edge radius of each lever. By employing levers with different centers or curvature, the picker's "feel" for the position of each lever is largely destroyed.

A further feature relating to the lever common return spring assembly involves its use as a dual function device. In addition to its function as a lever biasing means, it also actuates an alarm switch in response to the movement of *any* lever, in contrast to prior art alarm switches that are bolt operated. It is thus possible to signal a warning that the lock is being picked rather than signaling that the lock has been picked.

The principles of the invention as well as additional objects and features thereof will be fully apprehended from the following detailed description of an illustrative embodiment and from the drawing in which:

FIG. 1 is an exploded view of a lock in accordance with the invention;

FIG. 2 is an enlarged plan view of one of the lock levers shown in FIG. 1;

FIG. 3A is a plan view of the interior of the lock with a lever in the locked position;

FIG. 3B is a plan view of the interior of the lock with a lever in the unlocked position;

FIG. 4A is a plan view of the interior of the lock with the bolt in the locked position;

FIG. 4B is a plan view of the interior of the lock with the bolt in the unlocked position; and

FIG. 5 is a partial plan view of a prior art lock illustrating the use of an individual lever return spring.

Construction and assembly

As shown in FIG. 1 a lock in accordance with the invention is housed in a steel case **10** which includes integral mounting flanges **11—11**, an integral top plate **12** and a lower plate (not shown). A total of five mounting studs **13–17** are suitably affixed to the bottom of the case **10**, by riveting for example. When the lock is assembled, the top portion of each of the mounting studs **13–17** is accommodated by a corresponding one of the mounting holes **18—18** in a protector plate **19** and by a corresponding one of the mounting holes **20—20** in a lock cover **21**. The stud **14** also serves as a mounting for a plug spring **22** which maintains a lock center or plug **23** in a neutral position to permit insertion of a key **24**. The stud **15** also serves as a pivot post for a lever spring assembly **25** which comprises a pivotally mounted bracket **26** with an integral lip **27** which is biased by a spring **28**. The lip **27** thus tends to maintain each of the levers **29** in a locked position, as shown in FIG. 3A. The return spring assembly **25** also includes a bent leaf spring **30** which drives a plunger **31** to actuate an alarm switch **32**, as shown in FIG. 3B, in response to the movement of any of the levers **29—29** from its locked or home position.

The protector plate **19** is preferably fabricated from hardened tool steel and provides substantial protection against penetration by drills. An off-center aperture **33** provides the upper bearing surfaces for the lock plug **23**. The plate **19** also acts as a force distribution member to counteract force attacks on the lock. The force of a frontal attack from a punch, for example, is transmitted through the protector plate **19** and the studs **13–17** to the case **10** and then on to the mounting screws (not shown). The protector plate **19** also includes a stop pin **34** which restricts clockwise rotation of the plug **23** and prevents the rear of the plug from coming into contact with the levers **29—29**. This arrangement prevents the cam portion **36** of the plug **23** from being utilized as an aid in aligning the levers for picking. The bearing hole **33** in the protector **19** is keyed to prevent pulling the plug **23** through it. The keying hole **35** in the protector plate **19** is located to the right of the plug cam **36**. Counterclockwise rotation of the plug **23** is restricted by the cam pin **63**, shown in FIG. 3A and by the bolt plate **38** so that it cannot be turned to the keying hole **35**.

The plug **23**, which includes a main cylindrical portion **39**, an integral cam **36** and an integral cylindrical nose **40**, is designed in accordance with the invention to provide a deep enclosed keyway **41** and to ensure separation from the bolt actuating member or cam **37**. It is of sufficient strength to resist punch and drill attacks. When assembled, the nose **40** of the plug **23** is accommodated by a hole **42** in the bolt actuating cam **37**. The nose **40** also protrudes into an aligned accommodating hole (not shown) in the bottom of the case **10**.

Each of the levers **29—29** is mounted for pivotal movement on the pivot stud **17**. Between each adjacent pair of levers **29—29** there is a baffle plate **43** secured against movement by the studs **16** and **17**. One of the baffle plates **43—43** is mounted on top of the uppermost one of the levers **29**. The baffle plates **43—43** prevent interacting friction between adjacent levers **29—29** and also prevent straight-through picking access from an upper lever to a lower lever.

Detailed construction of an illustrative lever **29** in accordance with the invention is shown in FIG. 2. The lever **29** includes a main body portion **45** and a mechanical return arm portion **46** so that it is substantially L-shaped. An open slot or gate **47** accommodates a fence leg **56** of the bolt assembly **44** when the lever is pivoted to its unlocked position by the turning of the key **24**. In accordance with the invention, the curved portion **61** of the lever **29** has a radius R_1 centered on the extended axis **49** of the fence leg **56**. This construction is particularly advantageous inasmuch as it ensures that the upper right corner **50** of the gate **47** and the upper left corner **51** of the gate **47** will be substantially equidistant from the fence leg **56** when the lever **29** is pivoted to its open position, as shown in FIG. 3B. If, as in many prior art locks, the center of curvature is instead located at the pivot point **52** of the lever **29** with a radius R_2, the upper left corner **51** of the gate opening is slightly higher than the right corner **50** which provides the lock-picker with a clue as to the lever position whenever the lever **29** is tensioned against the fence leg **56**.

In accordance with the principles of the invention it is possible to avoid the disadvantages of the "high corner" effect described above by modifying the circular contour of the lever slightly by removing the "high corner" material as shown by the hatched area **75** if a radius such as R_2 or R_3 is employed. Contact between the fence leg **56** and the lever **29** is thus held to a minimal level even when the bolt assembly **44** is placed under tension. As a result, it is possible, in accordance with the invention, to employ gates with varying radii of curvature, as indicated for example by the radii R_1, R_2 and R_3. Although a lever with a radius of curvature R_1, centered as shown in FIG. 2, appears to be theoretically ideal in that no modification of the circular contour is required, variations in lever curvature from lever to lever are employed in accordance with the invention because they are extremely frustrating to a lock-picker. Specifically, if levers different radii are used, some levers give the feel of a rising curvature as the lever is forced against the fence, other levers give the feel of a falling curvature under these same conditions, and levers with centers of curvature on the extended axis of the fence give a balanced feel when aligned.

In addition to its true gate **47**, each lever **29** includes one or more false gates **53** as shown in FIGS. 2, 3A and 3B. False gates are typically made slightly wider than true gates and are randomly positioned to enhance the possibility that a lock-picker may mistake the false gate for a true gate.

The bolt assembly **44**, best shown in FIG. 4A, includes a bolt proper **54**, which is accommodated by a strike aperture (not shown) to provide the basic locking connection, a fence **48** and a bolt plate **38**. The bolt fence **48**, the bolt plate **38** and the bolt **54** are integrally connected by brazing or welding. The fence **48** has a first leg **56** (which by itself may properly be identified as the fence) that is accommodated by the gates **47—47** of the levers **29—29** when the levers are moved to the unlocked positioned, and a second leg or lug portion **57** which limits picking access to the top radius portion of the levers. The bolt plate **38** is in sliding contact with the bottom of the case **10** and its positioning is controlled in part by the slot **58** that accommodates the lever pivot stud **17**. The bolt plate **38** has an open center portion with cam follower surfaces A, B, C and D that are engaged by the bolt actuating cam **37** in a manner described hereinbelow under "Operation". The cam **37** has a circulat aperture **42**, which, as indicated above, accommodates the nose **40** of the plug **23**, and a slot **62** which accommodates the key **24**. The pin **63** on the cam **37** is engaged by the cam **36** of the plug **23**. The purpose of this engagement

is to orient the key slot **62** of the cam **37** into alignment with the key slot **41** of the plug **23** when the plug **23** is turned to its vertical or locked position. Without this feature, tampering could misalign these two key slots **62** and **41** and thus prevent insertion of the key.

Operation

Assume that the lock is in the locked position and that the key **24** has been inserted in the plug slot **41**, as shown in FIG. 3A. As the key **24** is turned to the right or clockwise, each of the key notches **64** engages a corresponding one of the levers **29—29** on its left edge, causing it to pivot against the biasing force of the lever spring **28** of the spring assembly **25**. If instead, an attempt is made to pick the lock without the use of a proper key and each lever is successively moved to the right, the spring return effect of the spring assembly **25** will give a different feel to a picker, depending upon the sequence in which the various levers **29—29** are moved. If a "maximum travel" lever, for example, is picked first, pressure on the remaining levers **29—29** is removed, thus giving the effect of floating or friction levers. If a "minimum travel" lever is positioned first, then the "spring" or "friction" feel of the next lever will depend upon the angular distance through which that lever is moved. At first, no spring action is felt. As the lever is moved past the position of the first or "minimum travel" lever, however, spring bias is applied increasingly until the full spring force is brought to bear against the second lever. Spring force against successively positioned levers depends upon the angular throw of each. With a key, however, the varying spring forces exerted on each lever are of no consequence and each of the levers is pivoted so that all of the gates **47—47** are aligned with the fence leg. **56**. One lever **29** is shown positioned in this manner in FIG. 3B.

As the spring assembly **25** is pivoted, the leaf spring **30** is forced against the plunger **31** causing the switch **32** (FIG. 3B) to operate. To simplify the view presented in FIG. 4A, the switch **32** is shown mounted outside the case **10**. It is of course possible to employ a switch small enough to be positioned inside the case. Operation of the switch **32** is utilized to initiate a suitable warning signal which may be either local or which may be transmitted to a central point over a telephone line if, for example, the lock is used for a telephone coin box.

Continued turning of the key **24** after the gates **47—47** have been aligned with the fence leg **56**, forces the cam **37** to rotate clear of the cam locking surface A until it impinges against the cam follower driving surface C which drives the bolt assembly **44** and thus the bolt **54** inwardly to its unlocked position as shown in FIG. 4B. The final portion of travel of the cam **37** brings it into contact with the cam follower locking surface D, as shown in FIG. 4B.

In locking the lock, the key **24** is rotated counterclockwise so that the cam **37** clears the cam follower surface D of the bolt plate **38** and bears against the cam follower driving surface B which drives the bolt assembly **44** and thus the bolt **54** outwardly to the locked position, as shown in FIG. 4A. At the end of its travel, the cam **37** comes to rest against the cam follower locking surface A, as shown in FIG. 4A. At the same time, the combined action of the spring assembly **25** and the plug cam **36** impinging against the arms **46** of each of the levers **29—29** ensures that each lever is driven to its fully locked position, as shown in FIG. 3A. This action is in contrast to the lever return action of prior art locks, as shown in FIG. 5, where each lever **65** is individually biased to the locked position by a respective return spring **66**. Individual return springs, which have been eliminated in accordance with the invention, are an asset to the lock-picker because of the steady force they supply to hold each lever against the gate once the lever has been picked to its unlocked position. As previously explained, in a lock in accordance with the invention, spring tension is applied only against the levers of maximum travel when the levers are moved to their unlocked positions.

It is to be understood that the embodiment described herein is merely illustrative of the principles of the invention. Various modifications thereto may be effected by persons skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a key operated lock, in combination, a bolt including a fence portion, a plurality of pivotally mounted levers each having a gate for accommodating said fence portion when said bolt is in its unlocked position, the pivot of each lever being spaced from the extended axis of said fence portion, each of said levers having a substantially circularly curved edge portion adjacent to said gate, the center of curvature of said circularly curved portion for at least one of said levers being on the extended axis of said fence portion and differing from the center of curvature of said circularly curved portions of others of said levers.

2. Apparatus in accordance with claim **1** wherein the center of curvature of said circularly curved portion for at least one of said other levers coincides with the pivot point of said last named lever.

3. In a key operated lock, in combination, a bolt including a fence portion, a plurality of pivotally mounted levers each having a gate therein to accommodate said fence portion when said bolt is in its unlocked position, a spring loaded member normally urging all of said levers to a locked position, said member being tensioned by any one of said levers that is moved toward an unlocked position thereby removing spring tension from all the other of said levers, whereby said last named levers are free to move toward an unlocked position without spring bias.

4. Apparatus in accordance with claim **3** including an alarm switch responsive to the movement of any one of said levers to the unlocked position.

5. Apparatus in accordance with claim **3** including an alarm switch operatively responsive to said spring loaded member whenever said member is tensioned by the movement of any one of said levers toward its unlocked position.

6. In a key operated lock, in combination, a bolt including a fence portion, a plurality of pivotally mounted levers each having a gate therein to accommodate said fence portion when said bolt is in its unlocked position, spring loaded means normally biasing all of said levers in the locked position, the bias of said spring loaded means being removed from all but one of said levers when said last named lever is moved to the unlocked position, said spring loaded means tending to drive all of said levers back toward a locked position upon the withdrawal of said fence from said gates.

7. Apparatus in accordance with claim **6** wherein each of said levers includes a respective extended portion having a cam follower surface thereon, a plug member for accommodating a key, said plug member including a cam portion, said cam portion drivingly engaging said cam follower surface on each of said levers and driving said levers to the fully locked position in response to the turning of said key in said plug toward the locked position.

8. In a key operated lock, in combination, a bolt including a strike engageable tongue portion, a fence portion and a cam follower plate, a plurality of levers each including a gate for accommodating said fence portion when said lock is in the unlocked condition, a free floating cam having a slot therein for accommodating a key, a plug for accommodating said key, said cam drivingly engaging said cam follower plate to drive said bolt to a locked position or to an unlocked position in response to the turning of said key in the locked or unlocked direction, the end of said plug being freely rotatable in the center of said cam without drivingly engaging said cam.

9. Apparatus in accordance with claim **8** wherein said

cam includes an integral pin engageable with a cam portion of said plug to ensure proper orientation between the key slot of said plug and said slot in said floating cam.

10. Apparatus in accordance with claim **8** wherein said cam follower plate has an open center portion, the inside edge of said open center portion forming a plurality of cam follower surfaces engageable by said floating cam, said cam being positioned in said open center portion in a plane common with said plate.

11. Apparatus in accordance with claim **8** wherein said plug includes a cam portion for driving said levers to a fully locked position as said plug is turned to the locked position.

12. In a key operated lock, in combination, a bolt including a strike engageable tongue, a fence and a cam follower plate having an open center portion with a bounding interior cam follower surface, a plurality of pivotally mounted levers each including a first extended leg having a cam follower surface and a second extended leg having a substantially circularly curved end portion adjacent to said fence, the center of curvature of said end portion being on the extended axis of said fence for at least one of said levers and off the extended axis of said fence for at least another one of said levers, a spring assembly normally biasing all of said levers to a locked position, movement of one of said levers to the unlocked position removing the spring bias from all the locked ones of said levers, an alarm switch responsive to the compression of said spring assembly as any one of said levers is moved to the unlocked position, a key accommodating plug having a cam surface engageable with said cam follower surface of each of said levers whereby said levers are driven to the fully locked position by the turning of said plug, and a floating cam having a key engageable aperture positioned in said center portion of said plate and responsive to the turning of said key when engaged therein for driving contact with said cam follower surface, thereby extracting or extending said bolt in responsive to the direction in which said key is turned.

13. Apparatus in accordance with claim **12** wherein said center of curvature for said one of said levers that is off said extended axis is on the pivot point of said last named levers.

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