Nov. 7, 1950 E. S. GIFFIN 2,528,746

CAM-OPERATED LATCH MECHANISM

Filed May 19, 1947 3 Sheets-Sheet 1

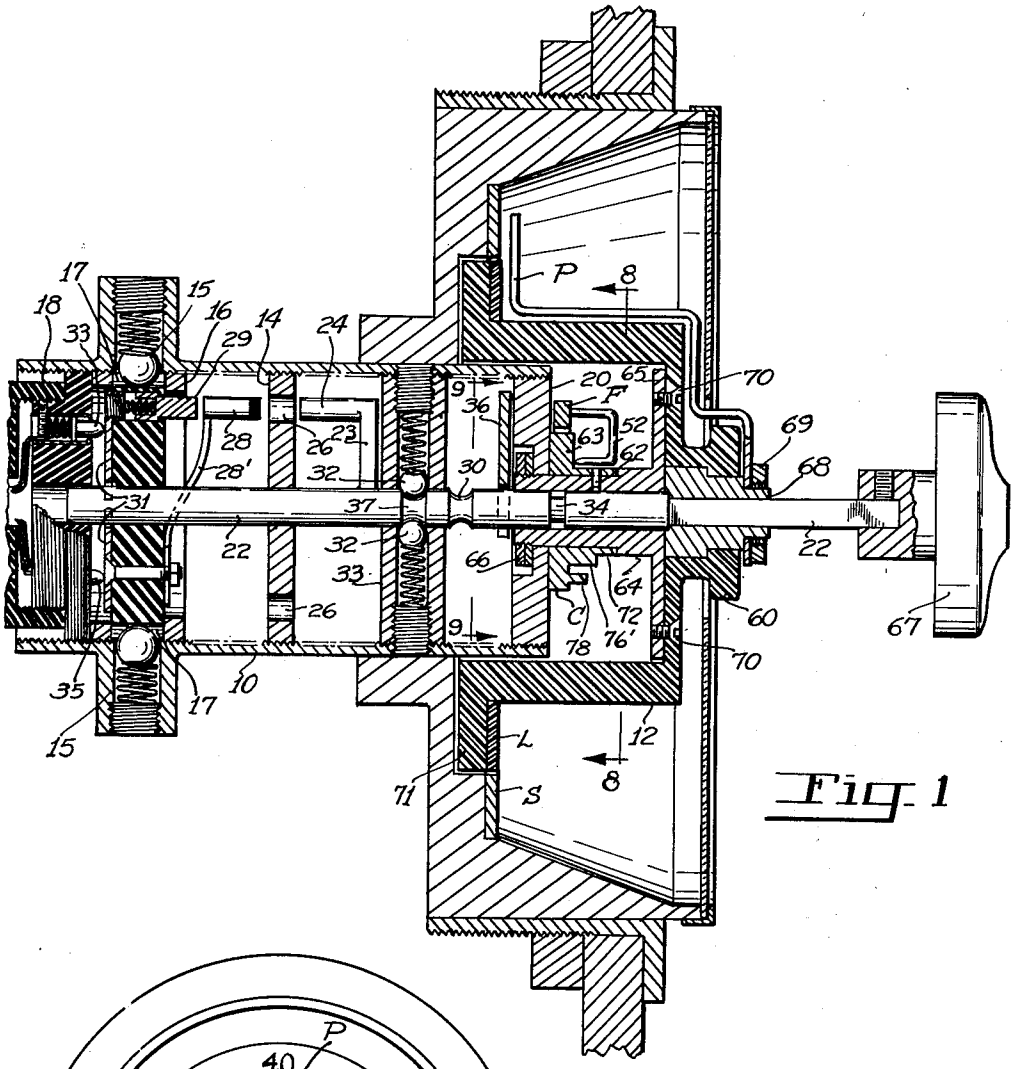


Fig. 1

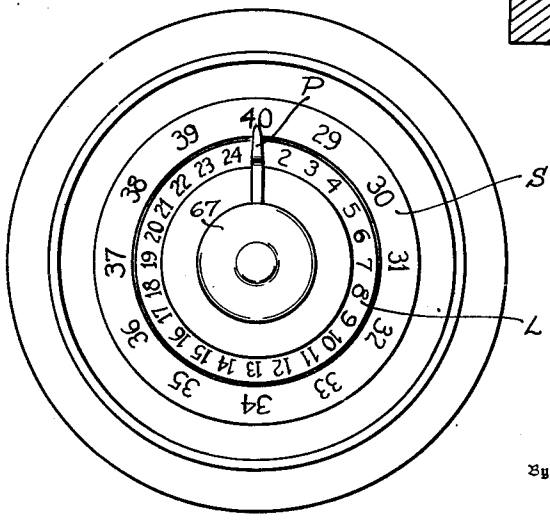


Fig. 3

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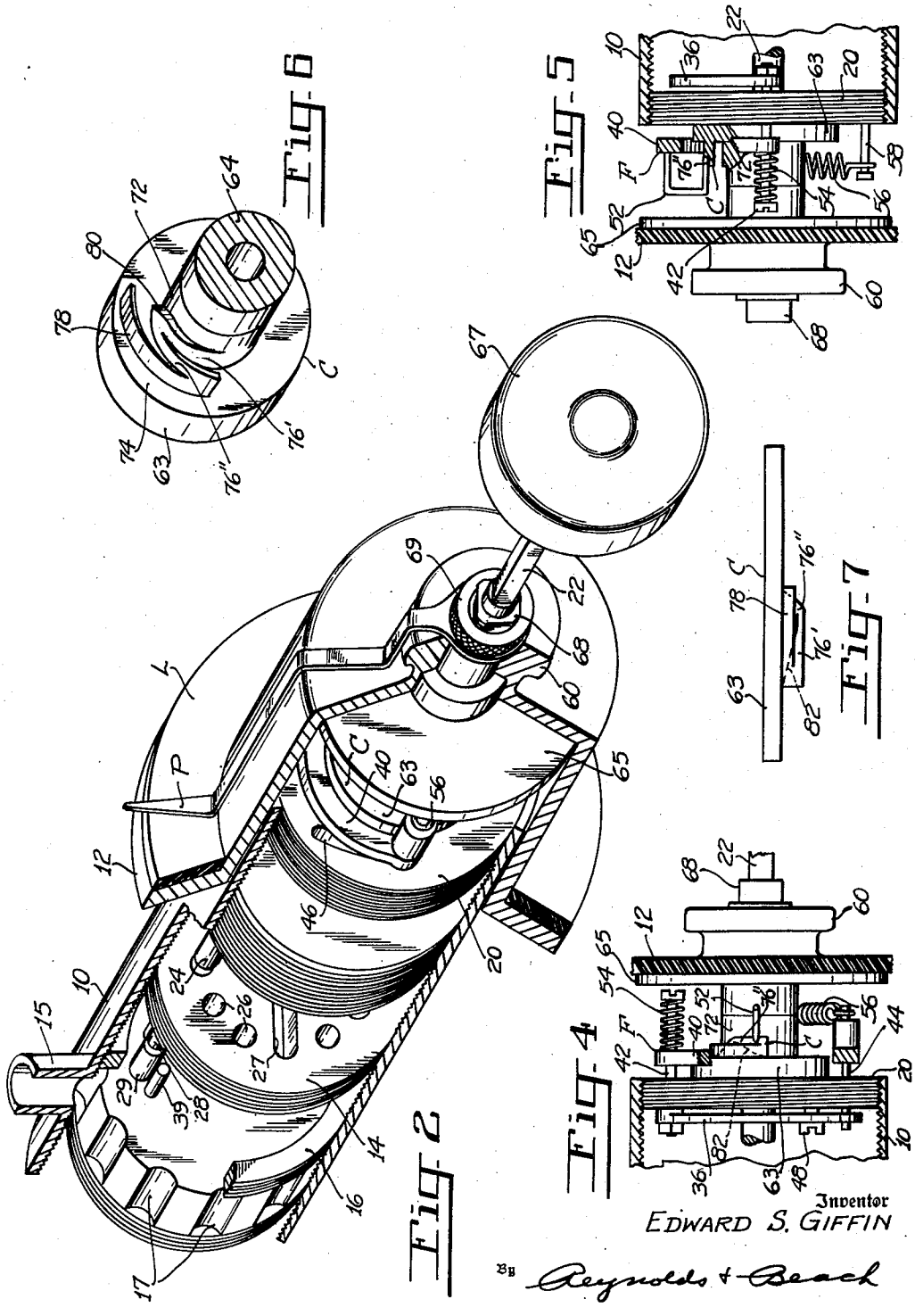
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CAM-OPERATED LATCH MECHANISM

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CAM-OPERATED LATCH MECHANISM

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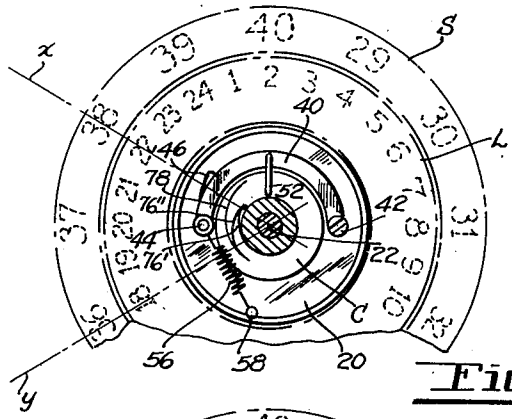


Fig. 8-A

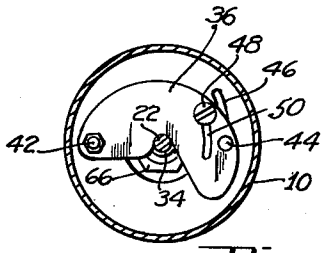


Fig. 9-A

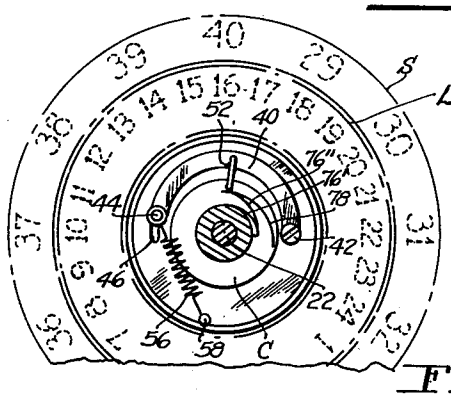


Fig. 8-B

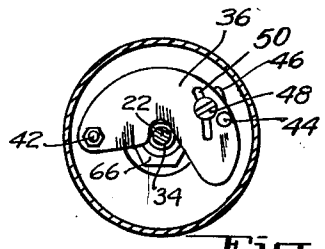


Fig. 9-B

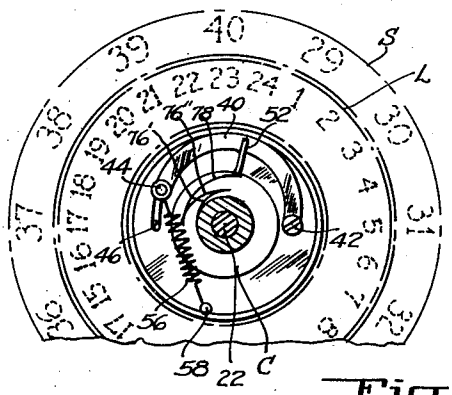


Fig. 8-C

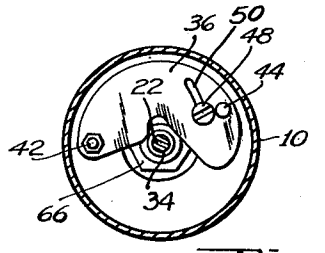


Fig. 9-C

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UNITED STATES PATENT OFFICE

2,528,746

CAM-OPERATED LATCH MECHANISM

Edward Stanley Giffin, Auburn, Wash.

Application May 19, 1947, Serial No. 749,028

11 Claims. (Cl. 70—290)

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The present invention relates to a combination lock of the type adapted to be operated by manipulation of a control member or handle in accordance with a predetermined plan, such as by moving it from a starting point back and forth through a predetermined sequence of motions terminating at a lock-release or control point. It is a primary object of the invention to provide an improved lock of this general type, characterized particularly by its positiveness of operation and its simplicity and ruggedness of construction. Because of its relatively small number of moving parts and their manner of construction, the lock may be operated an indefinite number of times without altering its combination through wear or rendering it less dependable for release each time it is properly manipulated.

A more specific object of my invention is to provide a combination lock particularly adapted for use in a self-contained switching unit for an electrical circuit, such as is described in my copending application Serial No. 572,339, filed January 11, 1945, now Patent No. 2,484,991, issued October 18, 1949, entitled Switch Mechanism. The purpose of a lock in such a unit is to prevent unauthorized persons from tampering with the device to operate or control the electrical circuit associated with it. The lock forming the present invention is illustratively described by reference to its application to such a switching unit because it illustrates one of the preferred uses to which the lock may be put, although the lock may readily be adapted for various other uses.

As a principal feature, my invention includes a displaceable element which can be moved from a base position to a control position to effect release or opening of the lock, such movement being produced by manipulating or moving a single actuating cam or guiding member in accordance with the lock combination. The combination of the lock is determined by the structural formation of the cam, and more particularly by a cam track or principal guiding surface, composed of a series of sections or ledges in switch-back arrangement which lead from a point representing the lock combination starting point, on a base or reference surface, to a combination terminal point or control point on a remote surface on the cam. Thus, the displaceable element may itself comprise a cam follower, mounted for reciprocation in the lock casing and engageable with the cam track, or it may be operated by a cam follower, thereby to be displaced progressively in one direction as it is caused to traverse the track when the cam is rotated in the

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manner dictated by the lock combination. The length of the different successive sections of track over which the follower travels will thereby determine the extent of the successive angular movements, respectively, making up the lock combination, and the number of track sections will determine the number of such movements. In the illustrated case, three ledges or track sections are employed, comprising the outer face of the remote surface previously mentioned, and the outer surfaces of two intermediate projecting ledges extending between the hub or base surface of the cam and the remote surface.

Even if the displaceable element or follower is successfully started onto the track from the base surface by a person who does not know the combination, if any one of the prescribed movements of the combination is exceeded, the corresponding ledge carrying the follower will pass beyond the follower so that it will be constrained to drop off and return immediately to the base surface. Conversely, by reversal of the cam before fully carrying out any movement of the combination, the follower will retrace its path and fail to gain access to the next section of track, eventually being returned to the base surface.

The follower may be constrained by suitable spring means which will insure that it return to the base position whenever the lock is operated incorrectly. Furthermore, the end walls of the ledges making up the different sections of track, are abrupt, pitching steeply and directly downward onto the underlying base surface in the illustrated case, thereby giving full clearance for return of the follower when it moves over an edge by a miscalculation of the operator or at his volition in reclosing the lock after opening.

As an additional feature of construction, collateral guiding surfaces of track sides forming part of the cam structure, integral with the ledge formation, are provided, and these serve to direct the follower from one section of track to another, coacting with the principal surfaces or track in this respect. In addition, spring means are employed to maintain engagement of the follower with its principal and collateral guiding surfaces and to return the follower to the base surface when the lock is improperly operated as aforesaid. The displacement of the follower between its starting and final operating points, therefore, takes place in incremental steps, one step for each succeeding increment of the cam.

These and other objects and features of the invention will now be more fully described by reference to the accompanying drawings, which

illustrate one form of the lock as it is incorporated in a switching unit of the type referred to in my said copending application.

Figure 1 is a longitudinal vertical sectional view of the switching unit, as a whole.

Figure 2 is a perspective view of the principal elements of the same unit, with parts broken away.

Figure 3 is a front elevation view of the indicator dials for the switching mechanism and for the combination lock.

Figure 4 is a plan view, and Figure 5 is a right side elevation view of the lock with parts broken away, shown as a fragment of the switching unit of Figure 1.

Figure 6 is a top perspective view of the cam employed in the lock, and Figure 7 is a development of the cam, made by representing circumferential lengths as linear lengths.

Figures 8A, B, and C are transverse sectional views looking rearward on line 8—8 of Figure 1, illustrating the mode of operation of the lock by showing the relative position of the lock elements at three stages during the working of the lock combination, and

Figures 9A, B, and C are transverse sectional views looking forward on line 9—9 of Figure 1, showing the corresponding positions of the latching member for the three operating stages illustrated in Figures 8A, B, and C.

Before entering into a description of the lock itself, it will be expedient first to describe generally the entire electrical switching unit in which the lock is shown incorporated, and to point out the salient features of the construction and operation of the switching mechanism involved, for complete detail concerning which reference is made to my said copending patent application, Serial No. 572,339.

The switch unit is housed within a tubular casing 10 over the front end of which is fitted an indicia bearing rotary head 12, enclosing parts of the lock. The casing is partitioned transversely by a fixed partition 14 having holes 26 through it, arranged in a circle. A rotor 16, carrying elements of the switching mechanism, is received in the tube 10 rearwardly of the partition 14, and is held in any selected one of a plurality of possible rotative positions by spring-pressed ball detents 15 extending radially outward from the tube and arranged around it in spaced relation. These detents engage cooperating notches 17 formed in the periphery of the rotor 16. A partition 18 is lodged in tube 10 behind rotor 16, and carries contacts 33 and 35 of the switching mechanism, engaging contact segments 31 on the back of the rotor. A front partition 20 forms part of the structure of the lock. All of the partitions 14, 18 and 20 have threaded peripheries and screw into a thread on the inside of the casing 10.

The switching mechanism is controlled primarily by a longitudinal rod 22 extending axially of the casing through bores in the several partitions and the rotor 16. The rotary head 12 is carried by the outer end of the rod and is rotatable with it. The rod 22 is guided for rotation and for reciprocation axially of the unit by such bores, the former movement being employed in positioning a switch control member in the form of an arm 23 projecting radially from such rod and carrying a head 24 which may be brought into registry with any one of the several circumferentially arranged apertures 26 in the partition 14. By the second type of manipulation the head

may be reciprocated rearwardly and passed through the registering aperture to engage a cooperating contact element 28 of the switch mechanism mounted resiliently on rotor 16 by a spring leaf arm 28' connected to one of the contact segments 31. By projection of head 24 through the aperture 26 behind which is located the contact 28, such contact will be pressed inwardly into engagement with its cooperating contact 29 mounted yieldably for axial, overtravel movement in rotor 16, and connected to the other contact segment. By such contact engagement the arcuate plates 31, and hence the switch terminals 33 and 35 contacting these plates, will be connected, to energize the electric circuit in which the switching mechanism is connected.

However, as will appear from my copending application mentioned above, if the actuating head 24 is pushed through an aperture 26 other than that in registry with contact 28, as by an unauthorized person attempting to operate the device, the switching mechanism will not be actuated when the rod 22 is thrust inwardly. Moreover, it will then become locked by the mechanism described below, to prevent further tampering. If the unit is used to control the ignition circuit of an automobile, it can be incorporated as another feature in the dashboard of the vehicle, where the switch indicia dial S and pointer P may be readily visible to the operator. Each number "29," "30," "31," etc. on the dial corresponds to a different aperture 26 of the partition 14.

As explained in greater detail in my copending application, the switch contact member 28 may be shifted at the will of the operator into registry with any aperture 26 of the partition 14, thus to establish any of the numbers on the dial S as the switch-closing number, with the exception of that corresponding to the slot 27 in partition 14. Such shifting of the contact member 28 is effected by turning the pointer P until it registers with the number on dial S corresponding to such slot, and then pressing rod 22 inwardly to move the actuating head 24 and its supporting arm 23 completely through the slot. To complete such inward movement it may be necessary to release the locking mechanism described hereinafter.

After thus being moved axially inward rod 22 is rotated in one direction or the other to bring the actuating head 24 into engagement with one or the other of the pins 39 located alongside the contact elements 28 and 29, as shown in Figure 2. Pressure of the actuating head laterally against one of these pins will rotate the rotor in the corresponding direction, the detent 15 snapping from one groove 17 into an adjacent groove, so that the rotor will always be brought to rest in a position to locate the contact element 28 in registry with an aperture 26 of partition 14. When the contact has thus been aligned with the desired aperture the rod 24 is rotated in the reverse direction, again to dispose its arm 23 in registry with slot 27, so that by drawing rod 22 outwardly the arm and head again may be disposed at the side of partition 14 opposite that adjacent to contact member 28.

The lock dial L is carried by the margin of the rotary head 12, so that it is rotated with such head. Any one of the numbers of dial S, such as "40," may serve as an index for this lock dial.

The device is shown in its switch-open position in Figure 1. In that position spring-pressed ball detents 32 mounted in a partition 33 are engaged in an annular groove 37 formed in rod 22,

to hold the rod against inadvertent axial displacement. The actuating head **24** is moved axially into its switch-closed position by inward reciprocation of rod **22**, which movement engages the detents **32** with a second annular groove **30** in the rod. By such detents the rod **22** is thus held either in switch-open or in switch-closed position until it is shifted intentionally toward the other position. The distance between the grooves **30** and **37** determining the extent of movement of rod **22** between such positions.

Whenever rod **22** is moved inward so that groove **30** passes beyond detents **32**, whether actuating head **24** has been disposed in registry with an aperture other than that in registry with contact element **28** or in registry with slot **27**, my locking mechanism, if conditioned for operation, will act to lock the rod against outward movement until the lock has been released. To render such locking action effective, precautions should be taken in the design of the mechanism to prevent detents 32 engaging too securely in groove **30**. Thus the springs of these detents should be very light, or groove **30** should be quite shallow, or both, to prevent an unauthorized operator detecting engagement of such detents in that groove, while at the same time the detents will afford sufficient holding engagement with the groove to prevent inadvertent lengthwise shifting of the rod.

If the correct aperture for engaging actuating head **24** with contact element **28** is not known to the operator, and the rod **22** is reciprocated to move such head into some other aperture, its inward movement will not be limited by engagement with the switch member **28**. Because movement of the head is not thus interrupted, the tendency is for the unauthorized operator to press the rod **22** inward sufficiently to move its groove **30** well beyond the detents **32**, and to the point where an abrupt annular groove **34** in the rod is brought into registry with a latch plate **36**. Normally this latch plate rests slidably on the rod, but it is urged against the rod by spring pressure, so that upon registry of notch **34** with it, it drops into the notch and prevents outward withdrawal of the rod for another operation trial by the unauthorized operator.

Therefore, only an authorized person having the information necessary to operate the switching mechanism, by knowing the relative positional relationship of the actuating element **28** and of the apertured partition **14**, as indicated by the numbers on dial S, can hope reasonably to close the switch. This relationship, which may be changed by the owner in the manner described above, may easily be altered from time to time as a means of obtaining security against unauthorized operation. Once the mechanism has been locked by improper manipulation it cannot again be operated unless the combination of the lock is known to the operator so that it can be opened, lifting the latch **36** from the notch **34**, whereupon the rod **22** may be withdrawn by the operator.

The lock, of which the latch **36** forms a part, will now be described, along with the manner in which it operates to raise the latch out of the notch **34** to allow withdrawal of the rod **22**. The lock includes, as its principal elements, a rotary cam element designated generally as C, and a cam follower designated generally as F, engageable with the cam. The cam follower includes a swingable arcuate arm **40**, preferably semicircular, one end of which is pivotally and slidably mounted on a fixed pin **42** projecting from the front face of partition **20**. The opposite end of the pin may extend through the partition and serve as a pivotal support for the latch plate **36**. Thus the latch and arm are disposed on opposite sides of the partition. Interconnecting the latch and cam follower arm for conjoint movement is a coupling pin **44** carried by the latch plate, which pin passes through an arcuate slot **46** in the partition **20**, swinging the latch about the axis of the supporting pin **42** as the cam follower is displaced by the cam.

To support the latch against tilting or axial displacement, thus preventing breakage, in case the lock is forced, I have provided a headed stud **48** threaded in or otherwise anchored to the partition **20**, which holds the latch against an inward thrust of the rod **22** when the latch is engaged in the notch **34**. Further, to allow the latch to be swung about its supporting pin **42**, the stud **48** extends through an arcuate slot **50** formed in the latch plate. The latch itself is preferably of crescent shape, its concave edge being notched or recessed to embrace closely the reduced portion of rod **22** at the bottom of notch **34**, so that with the latch engaged in the notch **34** there is a line of contact around a large fraction of the periphery of the rod to form a contact zone of substantial area. The inner end of a reversely bent or U-shaped pin **52** acts as the cam contacting member of the cam follower. The outer end of the pin away from the cam is secured to the follower arm **40** at a point approximately midway between its ends. The cam follower is acted upon by two forces, to urge pin **52** always rearwardly and radially inwardly into contact with the cam, produced conveniently by two spring members **54** and **56**, respectively. The first spring encircles the end of the supporting pin **42** projecting forward from partition **20** and is compressed between the head of such pin and the outside of the arm **40** to urge the arm rearwardly toward the partition. The second spring **56** is a tension spring having one end connected to the swinging end of arm **40** and its other end to an anchor pin **58** secured in and projecting from the front side of the partition **20**, tending to swing arm **40** inwardly.

In order to raise and lower the cam follower to operate the latch correspondingly, the cam is rotated or oscillated about the central axis of the unit in a predetermined manner, in accordance with the lock combination. This is accomplished by turning a control knob **60** integral with and forming a central projection of the the rotary head **12**. Preferably the body of the cam is a separate element fitted over a shouldered sleeve **64** which is received loosely on rod **22** and has a flange **65** bolted to the inner face of the end of the rotary head **12**. The cam element is secured to sleeve **64** by a readily removable pin or screw **62** so it can easily be removed from the sleeve so that a cam element having a cam track of different shape may easily be substituted for that shown. The inner end of sleeve **64** projects through a central aperture of partition **20** and is threaded to receive retaining nuts **66** which abut the rearward side of the partition to secure the cam and rotor sleeve assembly in the unit.

The projecting end of rod **22** which carries the knob **67** is of noncircular shape, being represented as square, although it may be splined, keyed, or of any other noncircular shape in cross section. A sleeve **68** fitted over this end of the rod **22** has a bore shaped complementally, so that

while the rod may be reciprocated lengthwise through this sleeve, rotation of the rod will turn such sleeve. This sleeve is held against endwise movement by being shouldered to engage with a complemental annular shoulder within the knob 60. The inner end of sleeve 68 abuts the forward face of flange 65 formed on the end of sleeve 64. Consequently sleeve 68 cannot be moved endwise with respect to the rotary head 12, although it may be turned relative to it by rotation of rod 22.

Sleeve 68 carries the pointer P, which is secured to it by the nut 69 threaded on the end of such sleeve. As rod 22 is turned, therefore, the pointer P will be turned in synchronism with it, to register with the various numbers on the dial S corresponding to the several holes 26 in partition 14, as explained previously. Conversely, rotation of the knob 60, and hence of the cam C, may be effected independently of the angular position of the rod 22 and of the pointer P.

The flange 71 of head 12 bears the dial L having the lock combination numbers arranged circumferentially around its outer edge, so that as the cam is rotated relative to the cam follower in working the lock combination, its exact position will be made known to the operator by the relationship of the dial numbers to the indicator number of dial S. The numbers or critical points of the lock combination may readily be altered or shifted through an angle relative to the casing by repositioning the cam C rotationally on the sleeve 64, such as by inserting pin 62 in any one of a series of holes arranged circumferentially around the sleeve, or by securing the flange 65 of sleeve 64 in different circumferentially adjusted positions relative to rotary head 12 by the arrangement of the threaded holes for the screws 70 holding together the rotary head 12 and the flanged sleeve 64 and alternatively engageable for the purpose.

Generally, in the construction of the particular cam illustrated, there is a base or reference surface on which the cam follower, when groove 34 is in registry with latch plate 36, rests with the lock closed. Continuing from this surface and leading therefrom to a remote surface, is a discontinuous or switchback track over which the follower will be displaced, by oscillation of the cam in accordance with the combination, in moving between the surfaces to raise the latch and open the lock. In order that the cam follower, being in fixed angular position, may traverse the length of the cam track of switch-back conformation, it is necessary to reverse the direction of rotation of the cam each time an intersection between connected track sections reaches the follower. The lengths of the track sections thereby determine the directions of rotation of the knob 60 and the spaces between consecutive numbers of the lock combination.

In the particular type illustrated, the cam element is generally circular, having a hub 72 the surface of which acts as the base or reference surface of the cam. The cam track leads generally outwardly from the hub up the side of the cam sleeve flange 63 as a ledge formation projecting outwardly from the face of such flange, as shown best in Figures 6 and 7. The side or face of the cam element flange carried by the hub 72, from which the switchback cam ledge formation projects, is labelled 74. The switchback track over which the cam follower travels defines a path comprising a series or flight of track sections 76', 76'', of generally spiral arcuate shape, which ascend gradually from the base surface 72 to the remote track section surface 78. The surface 78 is nominally designated by the term "remote" to impart the idea of displacement, since when the cam follower is moved up or over the track it becomes displaced radially by an amount sufficient to raise the latch 36 out of its notch 34 when the follower reaches the end of this surface. In the illustrated case, two intermediate sections of track have been employed, in addition to the remote track section 78, thereby requiring a lock combination manipulated by three oscillatory movements of the cam.

If the cam is rotated continuously in a clockwise direction, the follower 52 can not ascend even the first track section 76' but will simply traverse the periphery of the base surface or hub of the cam. During such movement the follower will be pressed against the forward surface 74 of the flange 63 by spring 54, being shifted outwardly therefrom by engagement with it of the collateral guiding surface 80, forming the side of the ledge beneath the first section of track 76'. For this reason, the collateral or side surface 80 is curved and faired smoothly into the face of the surface 74 at the end which first encounters the follower, to offer the minimum resistance to continuous clockwise rotation of the cam. As rotation of the cam clockwise is continued, the height of the collateral guiding surface 80 diminishes to the point where the track 76' becomes substantially tangential to or flush with the base surface, at which point the follower pin slips over the surface 76' and is thrust rearwardly by the spring 54 into contact with the surface 74 beneath the overhanging ledge forming the section of track 76''. This point of rotation may constitute the starting point of the combination.

In order to bring the first section of track 76' into engagement with the cam follower the cam must be rotated counterclockwise by turning knob 60, and the continued movement of the track beneath the follower will press it outwardly against the resilience of spring 56 acting on arm 40, because of the spiral conformation of the track section. As the track thus moves beneath the follower the vertical collateral guiding surface beneath the track section 76'' will wedge the follower forwardly against the resilience of spring 54 acting on arm 40, until it reaches the junction between track sections 76' and 76''.

To release the lock successfully the cam must not be rotated so far in the counterclockwise direction that the follower will drop off the junction of the track sections 76' and 76'', shown in Figure 6, to be returned to the base surface 72 by the force of spring 56 acting on follower arm 40. If, after the junction of the track sections 76' and 76'' has been engaged with the follower, so that it will be shifted rearwardly again by spring 54 into engagement with the flange surface 74, rotation of the cam is reversed, the track section 76'' will be moved beneath the cam follower to urge it still farther away from the base surface 72 in opposition to the force of spring 56.

As the cam track section 76'' continues to move beneath the follower pin 52 during such rotation of the cam, again it will be wedged forwardly, as well as outwardly, by engagement with it of a vertical collateral guiding surface beneath the remote track section 78 and inclined away from surface 74, until the junction between track sections 76'' and 78 is engaged with the cam follower. At this point the spring 54 again will shift the arm 40 and follower 52 rearwardly, until the follower once more engages the surface 74.

If rotation of the cam is continued in the clockwise direction too far by one unfamiliar with the combination, the follower will drop from the intersection of track sections 76' and 76'', to be returned to the base surface 72 by spring 56 acting on arm 40, just as would occur by excessive rotation of the cam when the follower is engaged with the junction of track sections 76' and 76''. If the cam rotation is reversed from clockwise to counterclockwise in time, however, the remote track section 78 will be moved beneath the cam follower, to shift it still further outward, so that when it approaches the outer end of this track section the lock will be released.

As has been mentioned previously, the cam follower 52 is carried by the arm 40 pivoted on the pin 42, and this arm in turn is connected to the latch plate 36 by the interconnecting pin 44. The progressive outward displacement of follower 52, arm 40, and latch plate 36, as the several cam track sections are moved beneath the cam follower in the manner described, is illustrated in Figures 8A to 8C and 9A to 9C inclusive. Thus in Figure 8A the cam follower 52 is engaged with the base surface 72 of the cam C, at which time the latch plate 36 is engaged in latched position in the groove 34 of rod 22. As the cam follower is moved outward by oscillation of the cam until the junction between track sections 76'' and 78 contacts the cam follower, the latter is moved progressively into the position of Figure 8B. By such movement the arm 40, and the latch plate 36 connected with it, are swung outward about the axis of pin 42 into the respective positions shown in Figures 8B and 9B. It will be noted that such swinging has not completely released the latch plate 36 from the shoulders of the rod groove 34, because of the considerable depth of the rod-engaging notch in that plate made possible by its crescent shape.

Actually when the junction of cam track 76'' and 78 is engaged with cam follower 52, as shown in Figure 8B, the latch plate 36 has been swung outwardly only about half as far as necessary for it to clear the rod notch 34. In order to free the latch bar completely from the notch, therefore, the remote track section 78 is of a length approximately equal to the combined lengths of track sections 76' and 76''. Consequently movement of the track section 78 beneath the cam follower will wedge it outwardly from the position of Figure 8B to that of Figure 8C, so that the bar 40 and latch plate 36 will be swung outward sufficiently far, as shown in Figures 8C and 9C, respectively, to raise the latch plate completely out of the rod notch 34.

If the switch actuating head 24 has been pushed into an aperture 26 other than the one in registry with contact element 28, therefore, or if it has been moved in one direction or the other part way through slot 27 in partition 14, the latch plate in that released position will not interfere with movement of the rod either inward or outward from the position in which its groove 34 is in registry with latch plate 36. After such movement, even though the knob 60 is rotated so that the cam track passes out of engagement with the cam follower, and it is returned toward the base section, inward movement of the latch plate will be interrupted by the edges of its notch striking the outer surface of the rod so that the latch plate will merely ride along the rod as it is reciprocated, until once again the notch 34 has been brought into registry with the latch plate. At that time spring 56 will swing arm 40 and the latch plate inward into latched position without any rotation of the cam element C being required.

It is not necessary to employ the particular cam track formation herein shown, in which each outer section is positioned directly over the inner section or sections; however, to do so makes it possible conveniently to limit the expansion and contraction necessary in the operation of the spring 54 to an amount equal to the greatest projection of the cam track beyond surface 74.

It has been stated that the entrance to the track section 76' may be defined by the point at which the cam follower pin clears the side 80 of the first ledge and moves rearwardly onto the track as the cam is turned clockwise, which point may correspond to the first number of the lock combination. It will be apparent, however, that this number is not critical, inasmuch as any number of several may be selected as a starting point if the cam is first rotated counterclockwise from that point to the number corresponding to the location of the first switchback point in the track at the junction of track sections 76' and 76''.

Thus, in Figure 8A, assuming the numeral 40 of the fixed dial S to be the index point for the lock combination dial L, the starting point of the combination may be any number from 1 to 18, the latter number being aligned radially with the beginning of the track section 76' as indicated by the line *y* of Figure 8A. In order to bring the first track section 76' under the follower pin 52 up to the first switchback point, which pin is shown positioned in line radially with the numeral 40, the cam may be rotated counterclockwise to the number 22 which is aligned with this point radially, along line *x* of Figure 8A.

Thereafter, the combination is determined by the length of the track sections 76'' and 78, the dial L being next rotated clockwise from number 22 to the number 16, at which the follower shifts onto the remote track surface 78, and finally counterclockwise to number 23, corresponding to the outer end of the remote surface. At this point the cam follower is elevated to its extreme position, and with it the latch 36, which is then released from the notch 34.

The combination may be made very critical by reducing the length of the track section junctions to approximately the width of the pin 52. The angular movement of the dial L during the elevation of the cam follower by the cam may be taken into account by adding to or subtracting from the length of the track sections in their design, in order that the switch-back points may be made to register exactly with selected numbers or marks of the combination dial.

In order to return the cam follower to the base surface, when the pin 52 is perched at the end of the remote surface 78, the cam may be rotated counterclockwise a slight distance further to drop the pin over the edge, or it may be rotated clockwise the length of the remote surface and beyond, to the same end. It is not possible to return the follower otherwise because of the action of the spring 54 in forcing the follower rearwardly against the side of the cam, because of which it cannot drop directly to the adjoining track section 76''.

It will now be apparent that the same results may be achieved by cams and cam followers of different forms. For example, instead of em-

ploying a direct connection between the follower 52 and the latch 36 to cause the latch to move always conjointly with the follower as the latter is displaced by the cam, a lost-motion type of connection may be employed, whereby, during the initial lifting of the follower by the cam track, there will be no effect on the latch. In this case, the latch could be tripped during the last increment of outward displacement of the cam follower by the action of suitable means interengaged between the latch and the follower.

Furthermore, an alternative form of cam may be employed whereby the cam follower becomes displaced, not radially, but in a direction generally parallel to the axis of rotation of the cam. Accordingly, the collateral or side guiding surfaces of the present track sections can be modified appropriately to act as the principal guiding surfaces which, in a practical application, will define a track progressing in successively reversed stages lengthwise of the cam, instead of radially of the cam. The manner of designing a cam capable of operating in this way may be based on the same principles, namely, to provide a track with suitably located switchback points which are bordered by follower-return points so that incorrect manipulation of the lock will return the follower to a base surface or point.

I claim as my invention:

1. A lock comprising a tubular casing, a rotatable and reciprocable rod lockable against reciprocation and supported and guided in said casing for rotation and reciprocation axially thereof, handle means to reciprocate and rotate said rod in said casing, a latch carried in said casing and mounted for reciprocation toward and away from said rod, latch-engaging means on said rod movable with said rod axially of said casing into latch-engageable position, cam means rotatably mounted in said casing and having a bore through which extends said rod in slidable relation thereto, means for rotating said cam means, and cam-follower means coacting with said cam means, mounted in said casing for radial movement, and operable to effect movement of said latch by predetermined rotational movement of said cam means.

2. A lock comprising a tubular casing, a rotatable and reciprocable rod lockable against reciprocation and supported and guided in said casing for rotation and reciprocation axially thereof, handle means to reciprocate and rotate said rod in said casing, a latch carried in said casing and mounted for reciprocation toward and away from said rod, latch-engaging means on said rod movable with said rod axially of said casing into latch-engageable position, cam means rotatably mounted in said casing and having a bore through which extends said rod in slidable relation thereto, means for rotating said cam means, and cam-follower means coacting with said cam means, mounted in said casing for axial and radial movement, and operable to effect movement of said latch by predetermined reversed angular rotational movements of said cam means, said cam means having a switchback track engageable by said cam follower and which progresses from a peripheral base surface to a remote surface.

3. A lock as defined in claim 2, in which the cam-follower means comprises spring means operable to return the cam-follower means to the base surface each time the limits of the track are exceeded by angular movement of the cam means.

4. Locking mechanism comprising latch-secured means, a latching element mounted for movement reciprocably relative to said latch-secured means, and cam mechanism operable to effect movement of said latching element out of securing position including a cam member, a cam follower engageable with said cam member and operatively connected to said latching element to effect its releasing movement by movement of said cam member, a cam supporting member, and means normally interconnecting said cam supporting member and said cam member, readily removable for replacement of said cam member by another cam member.

5. Locking mechanism comprising latch-secured means, a latching element mounted for movement reciprocably relative to said latch-secured means, and cam mechanism operable to effect movement of said latching element out of securing position including a cam member, a cam follower engageable with said cam member and operatively connected to said latching element to effect its releasing movement by movement of said cam member, and a recessed head receiving said cam member and cam follower in the recess thereof, and secured to said cam member for rotation therewith, said recessed head carrying an indicator dial bearing marks adapted to indicate lock operating positions of said cam member.

6. Locking mechanism as defined in claim 5, and connecting means interconnecting the recessed head and cam member in a selected one of a plurality of selectable relatively rotated positions.

7. In locking mechanism of the cam operated type, including a rotatable cam member incorporating a cam track, the combination comprising a notched rod, a latch plate, a cam follower coacting with the cam track and operatively connected to said latch plate, and means jointly supporting said cam-follower and said latch plate for conjoint swinging movement relative to said notched rod, to effect engagement and disengagement of said latch plate with the notch in said rod when said cam follower is displaced by predetermined rotational movement of the cam member.

8. Locking mechanism as defined in claim 7, in which the latch plate is generally of crescent shape with a deep notch in its concave side approximately mid-way between its ends which is engageable with the notched portion of the rod.

9. A lock as defined in claim 2, in which the switch-back track comprises arcuate peripheral sections inclined successively reversely of a circular line drawn about the axis of the shaft as center, and additionally comprises collateral surfaces respectively adjacent said sections on one side of the cam block, and means operable to effect engagement of the cam-follower means and the cam means including spring means urging the cam-follower means radially into contact with said peripheral sections of track and axially of the cam against said collateral surfaces, successively, upon predetermined rotational movements imparted to the cam.

10. Locking mechanism adapted to perform a control function, comprising a rotatable, lengthwise reciprocable rod having a groove therein, a latch plate, means supporting said latch plate for swinging about an axis generally parallel to said rod, between a locked position engaged in said groove and an unlocked position withdrawn from such groove, and rotatable lock mechanism in-

cluding a cam concentric with said rod, and cam follower means operatively connected to said latch plate and operable by rotation of said cam to swing such latch plate about its pivot from its locked position in said groove to its unlocked position withdrawn from such groove thereby to release said rod for lengthwise reciprocation to perform a control function.

11. The locking mechanism defined in claim 10, wherein the cam follower means comprises a cam follower element operatively engageable with said cam, and supporting means for said cam follower element, rotatable about the axis of swing of the latch plate by operative movement of said cam follower element, and means operatively interconnecting the latch plate and said supporting means for conjoint swinging about said axis to effect disengagement of the latch plate from the rod's groove.

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The following references are of record in the file of this patent:

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