July 11, 1961 R. S. EDWARDS ET AL 2,991,644

COMBINATION LOCK

Filed Aug. 29, 1958 6 Sheets-Sheet 1

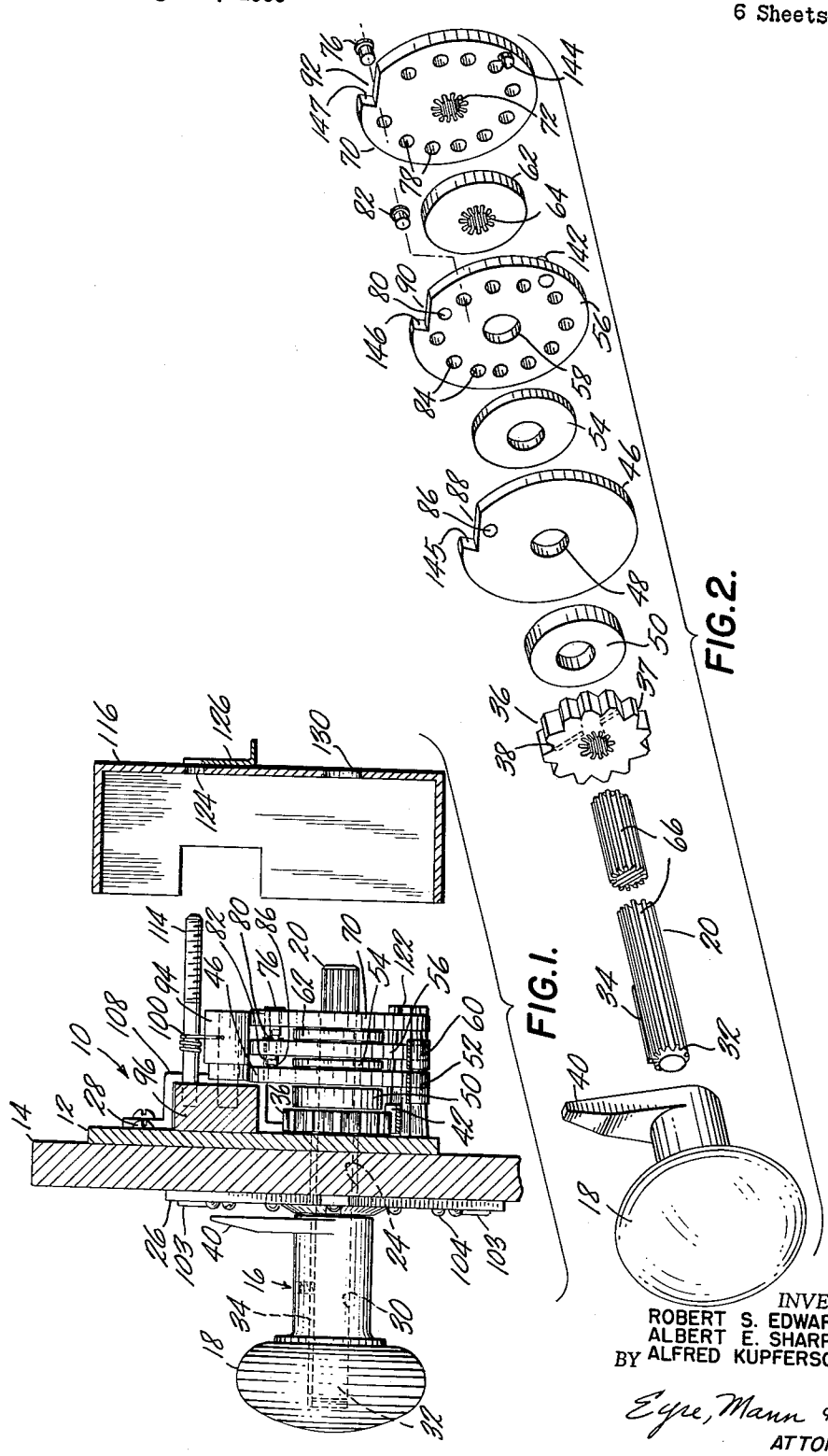


FIG. 1.

FIG. 2.

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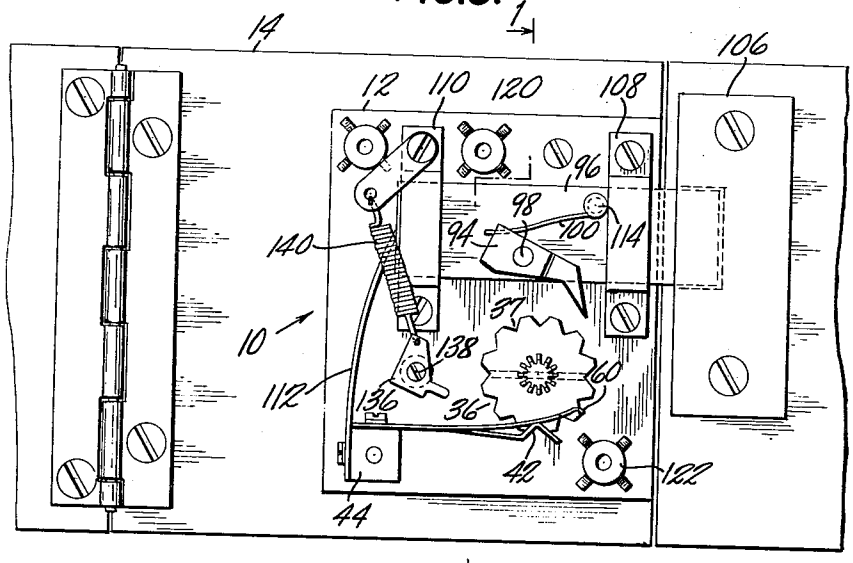
July 11, 1961 R. S. EDWARDS ET AL 2,991,644

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FIG.3.



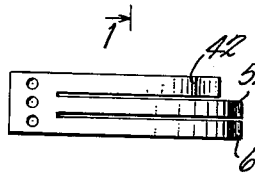


FIG.4.

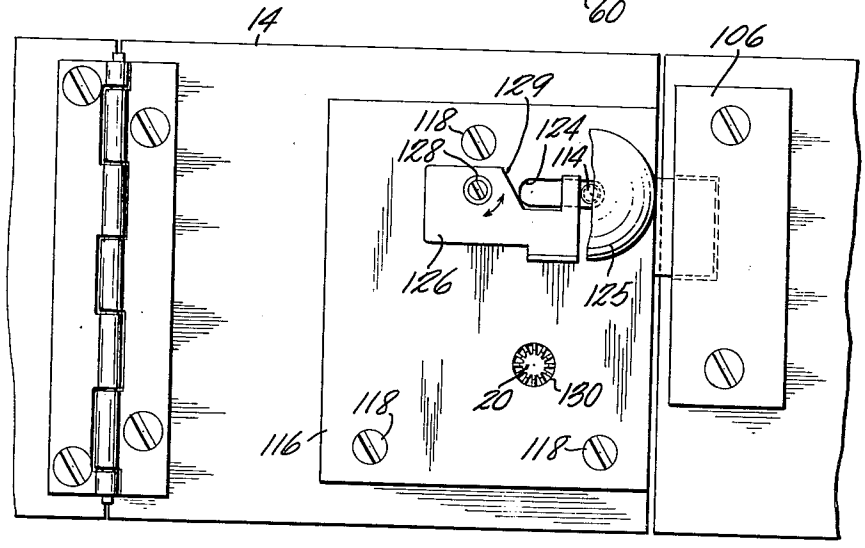


FIG.5.

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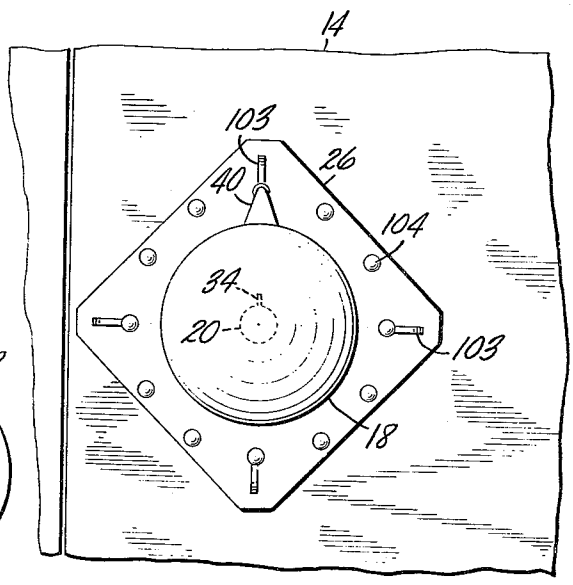


FIG. 6.

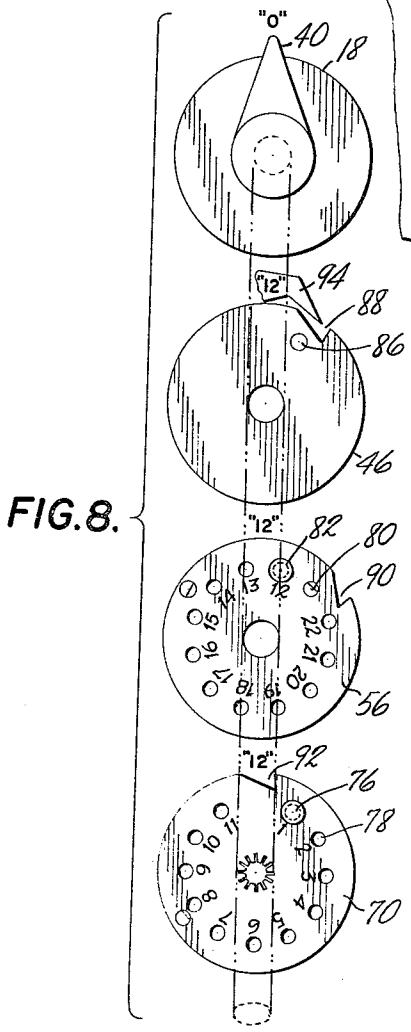


FIG. 8.

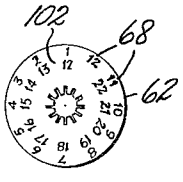


FIG. 7.

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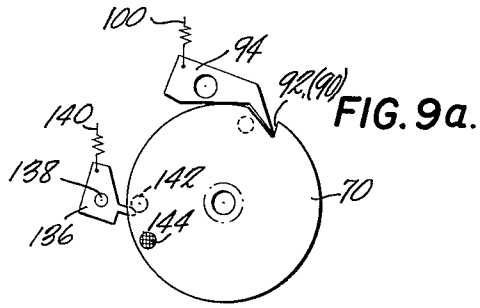


FIG. 9a.

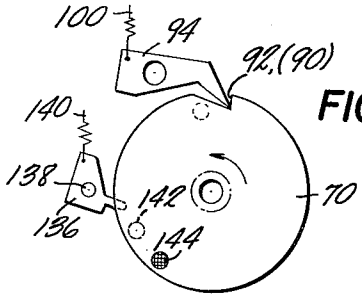


FIG. 9b.

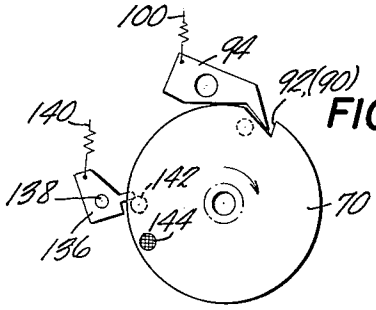


FIG. 9c.

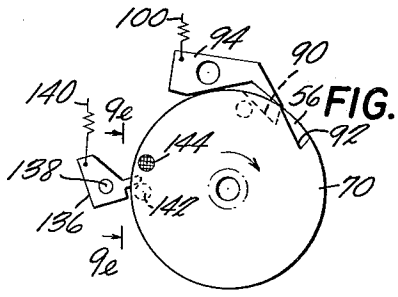


FIG. 9d.

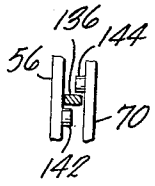


FIG. 9e.

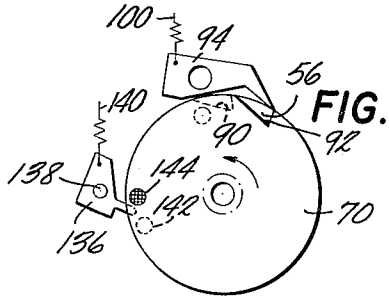


FIG. 9f.

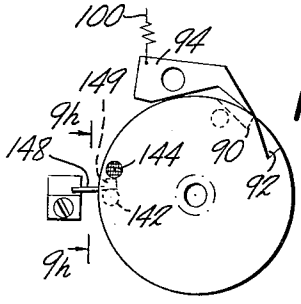


FIG. 9g.

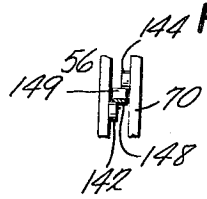


FIG. 9h.

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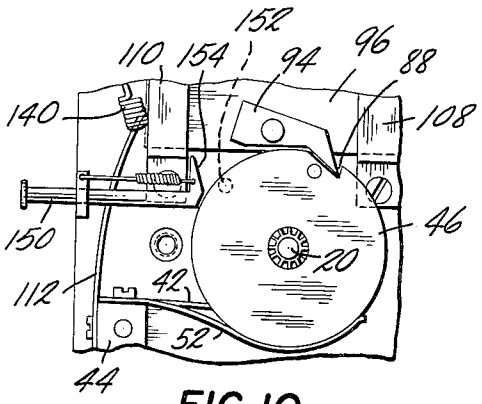


FIG. 10.

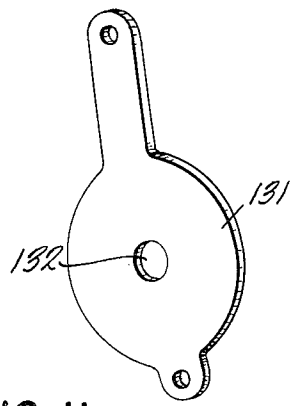


FIG. 11.

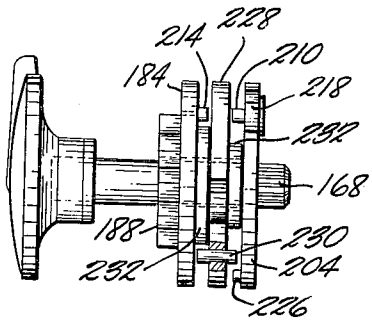


FIG. 17.

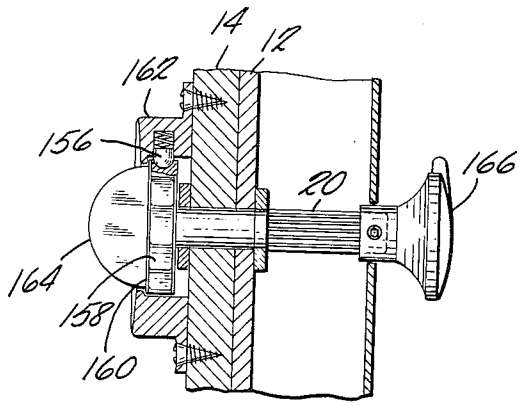


FIG. 18.

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Filed Aug. 29, 1958 6 Sheets-Sheet 6

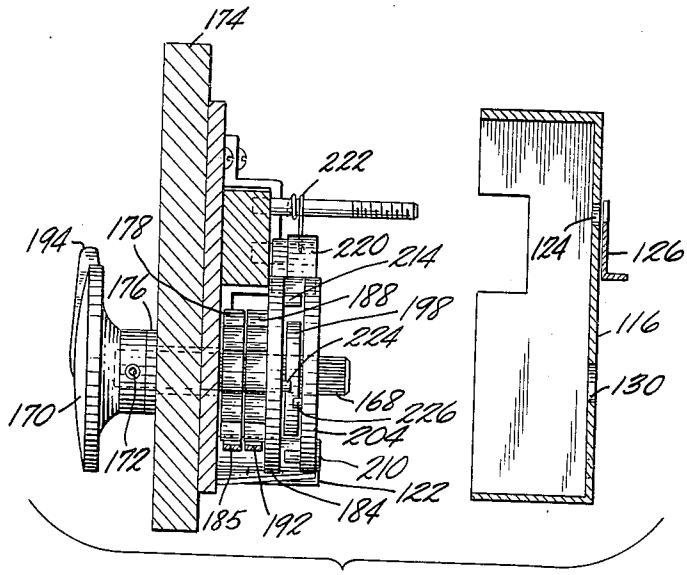


FIG. 12.

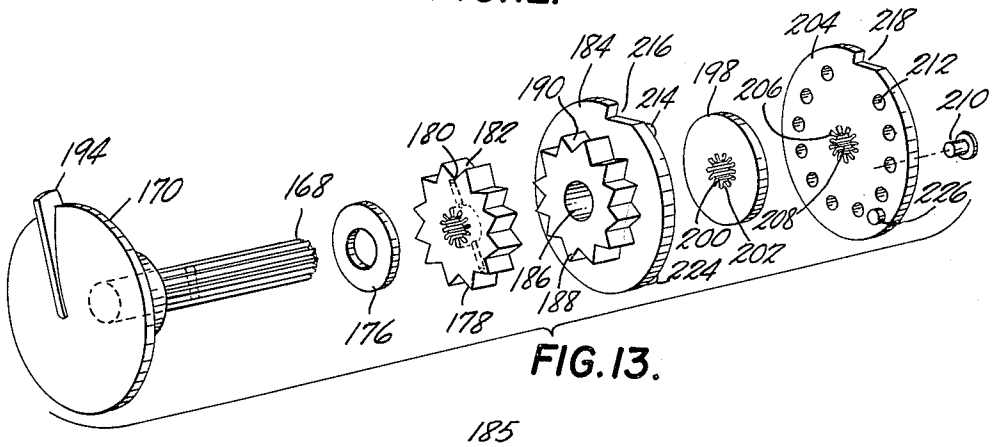


FIG. 13.

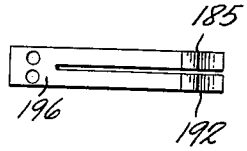


FIG. 14.

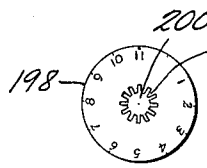


FIG. 15.

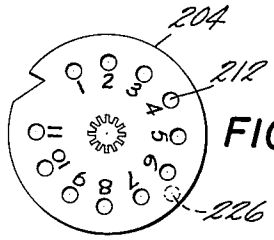


FIG. 16

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United States Patent Office 2,991,644 Patented July 11, 1961

2,991,644

COMBINATION LOCK

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Filed Aug. 29, 1958, Ser. No. 758,042
8 Claims. (Cl. 70—156)

This invention relates to a combination type lock in which a shaft attached to the operating dial is used for indexing code wheels against the dial in such a way that a highly effective lock of many different combinations is achieved with extremely simple and economical construction.

In a preferred form of structure the combination is based upon the face of a clock. To this end a click mechanism is arranged in the structure to provide the dial with twelve different click positions and each of the click positions correspond to one of the hours on the face of a clock. As a result the dial and its shaft may be clicked through each of the twelve hour positions and the combination worked out in the dark by touch alone.

The shaft of the operating dial serves as an index for correlating code wheels against the dial. This is done by providing the shaft with a plurality of indexing surfaces which control a driven code wheel so that it will move in step with the dial. Movement of the driven code wheel is transmitted to one or more idler code wheels by means of driving pins which may be set in any one of a plurality of holes positioned in the different code wheels and each hole is in turn indexed against the twelve predetermined clock positions of the dial.

By indexing the code wheels against the clock positions of the operating dial in this way, any hour may be used as the starting position for working out the combination and if desired the combination may be readily changed by merely removing the driven code wheel and changing the position of the driving pins relative to the indexing surfaces on the shaft.

If desired half hour clicks may be incorporated into the structure and by this simple expedient the number of combinations will be materially increased. For some applications it may be desirable to decrease the number of possible combinations and this may readily be done by setting the dial and shaft indexing surfaces to give ten, eight or even four clicks for each revolution of the dial.

The simplicity of the structure insures positive reliable action and when applied to doors it may be used either on a left or right hand door which may open in or out. This and other advantages of the present invention may be readily understood by reference to the accompanying drawings in which:

FIG. 1 is a side view of a preferred form of the combination lock of the present invention installed in a door with certain parts removed in order to illustrate construction of the lock;

FIG. 2 is an exploded isometric view of the knob, shaft and code wheel assembly of FIG. 1;

FIG. 3 is an end view of the mounting plate of the structure of FIG. 1 on the inside of a door with certain parts removed to illustrate the structure of the remaining parts;

FIG. 4 is a plan view of a preferred form of spring member;

FIG. 5 is an end view similar to that of FIG. 3 with a cover member in place over the mechanism;

FIG. 6 is an end view of the structure of FIG. 1 showing the knob in place on the outside of the door;

FIG. 7 illustrates the second side of the coordinating wheel of FIG. 2;

FIG. 8 illustrates the relationship of various parts during one step in working out the combination;

FIGS. 9*a* through 9*h* illustrate scramble devices for the lock;

FIG. 10 illustrates a modified form of scrambling device;

FIG. 11 illustrates a strap which may be employed for holding the lock assembly in place for shipment;

FIG. 12 illustrates a modified form of combination lock assembly;

FIG. 13 is an exploded isometric view of the knob, shaft and code wheel assembly of FIG. 12;

FIG. 14 illustrates a preferred form of spring for the structure of FIG. 12;

FIG. 15 illustrates the second side of a coordinating wheel of FIG. 12;

FIG. 16 illustrates the second side of a code wheel of FIG. 12;

FIG. 17 illustrates another modified form of structure;

FIG. 18 illustrates another form of knob for the structure of FIG. 1.

Turning now to FIG. 1, the working parts of the combination lock assembly **10** are mounted on the face of a single plate **12** and simplicity of construction is emphasized throughout to provide a "do it yourself unit" which the average home owner may readily mount on a door **14** or other suitable enclosing member. Mounting is very simply carried out by unscrewing set screw **16** which holds a dial or knob **18** in fixed position on an indexing shaft **20** and then the knob is removed from the shaft. A hole **24** large enough to rotatively accommodate shaft **20** is drilled through the door and a decorative escutcheon plate **26** may be mounted on the exterior of the door by suitable fasteners (not shown). The free end of the shaft is then inserted through the hole in the door and escutcheon plate until plate **12** fits snugly against the inside surface of the door. Plate **12** is held in position by suitable fasteners **28**. Thereafter knob **18** is replaced on the free end of shaft **20** and set screw **16** is tightened to anchor the knob in fixed position on the shaft. Viewed from the outside the single attractive knob enhances the appearance of the door and on the inside is a beautifully finished sturdy casing later described.

If desired the hole **30** in knob **18** which receives shaft **20** may be made long enough to extend into the knob about an inch or so beyond set screw **16** and the free end **32** of shaft **20** may be adjusted to extend throughout the full length of the hole in order to accommodate doors of different thicknesses. As best shown in FIG. 2 knob **18** is preferably keyed to shaft **20** by any suitable means as by indexing surfaces on the shaft (later described) or by an ordinary key as indicated at **34** to insure rotation of knob **18** with shaft **20**.

Referring now to FIGS. 1 and 2, the operating unit for the combination includes an indexing shaft **20** which is rotatively mounted in plate **12** by means of a suitable bearing (not shown) and the shaft carries a wheel **36** provided with channels, grooves, protuberances or other suitable indexing surfaces such as a plurality of V-shaped notches **37**. Wheel **36** is fixed on the shaft in the factory by any convenient means as by pinning the wheel to the shaft as at **38** and in the preferred form of structure shown the wheel **36** is provided with twelve V-shaped notches, each of which is arranged in the periphery of the wheel in position corresponding to each one of the twelve hour positions on the face of a clock.

When wheel **36** is mounted in fixed position on shaft **20** care is taken to orient the wheel on the shaft so that

one of the generally V-shaped notches 37 will be in position corresponding to that of a suitable indicator fin 40 on knob 18. Yieldable means adapted to cooperate with the V-shaped notches of wheel 36 to produce an audible click and temporary obstruction to rotation are provided such as the generally V-shaped spring detent 42 (FIGS. 3 and 4) which is mounted in the assembly as on post 44 in position to cooperate with the notches of wheel 36. The V-shaped spring detent is set at one of the twelve hour positions on the face of a clock and as a result wheel 36 with its spring detent provides a click mechanism giving fin 40 of knob 18 twelve different predetermined click positions each of which corresponds to one of the hours on the face of a clock.

The next element assembled on shaft 20 is a code wheel 46 which is slidably mounted to rotate freely on the shaft by means of hole 48 and the code wheel is separated from indexing wheel 36 by means of a spacer washer 50 which freely rotates on the shaft. Shaft 20 is free to rotate independently of code wheel 46 and in order to prevent the code wheel from turning with the shaft any convenient yieldable means such as the friction spring brake 52 (FIGS. 3 and 4) are arranged to bear against the periphery of the wheel. Code wheel 46 will only rotate when it is positively driven as later described. Friction spring brake 52 may be most conveniently mounted in the assembly on post 44 adjacent to the spring detent 42.

The next element assembled on shaft 20 is a spacer washer 54 which is free to rotate independently of the shaft. Following this is a second code wheel 56 which is slidably mounted to rotate freely on the shaft by means of hole 58. In order to prevent code wheel 56 from turning with shaft 20 any convenient yieldable means such as a second friction spring brake 60 is provided to bear against the periphery of the second code wheel. Spring brake 60 may also be mounted on post 44 adjacent the first friction spring brake 52. If desired spring detent 42 and the friction spring brakes 52 and 60 may be combined and made up in a single unit as illustrated in FIG. 4. As in the case of the first code wheel the second code wheel 56 will only rotate when it is positively driven as later described.

The next element on the shaft following code wheel 56 is a coordinating wheel 62 which is used for coordinating the code wheels with the clock positions of knob 18 as later described. Coordinating wheel 62 is mounted on shaft 20 by means of a plurality of notches, channels, protuberances or other suitable indexing surfaces such as ribs 64 which are adapted to mate with corresponding indexing surfaces such as grooves 66 on shaft 20 so that the coordinating wheel may be slidably mounted on the shaft to rotate therewith. Shaft 20 and wheel 62 are preferably provided with twelve grooves and twelve mating ribs respectively which are arranged on the shaft to correspond to the twelve hourly clock positions of the knob so that each of the twelve numbers positioned adjacent the periphery of the wheel (as shown in the outer circle of numbers 68 in FIG. 7) will turn in step with the dial as fin 40 is rotated into each one of its twelve hour click positions.

The last element on shaft 20 is a driven code wheel 70 which is mounted on the shaft by means of a plurality of notches, channels, protuberances or other indexing surfaces such as ribs 72. These indexing surfaces are arranged to mate with the indexing surfaces 66 on the shaft so that code wheel 70 will turn in step with the knob and transmit step by step drive to code wheel 56 by means of a driving pin 76 which is adapted to fit into any one of a plurality of holes 78 positioned adjacent the periphery of the code wheel. Holes 78 are indexed against the indexing surfaces on shaft 20 so that any one hole will correspond to one of the twelve hour clock positions of knob 18. As a result the hole and corresponding point of the hourly clock position on knob 18 will move in step around a circle even though the circles are of different diameter. The step by step movement of code wheel 70 is transmitted to code wheel 56 when pin 76 contacts and drives a cooperating pin 80 which projects out from the face of code wheel 56 into the path of pin 76. Pin 80 is mounted in fixed position on wheel 56.

As in the case of the driven code wheel 70, step by step rotation of code wheel 56 is transmitted to code wheel 46 by means of a driving pin 82 which is adapted to fit into any one of a plurality of holes 84 positioned adjacent the periphery of code wheel 56. Holes 84 are indexed against the hourly clock positions of knob 18 so that any one hole will turn in step with the dial as the dial is clicked through the twelve hourly clock positions. The step by step movement of code wheel 56 is transmitted to code wheel 46 when pin 82 contacts and drives a cooperating pin 86 mounted in fixed position on code wheel 46.

In operation knob 18 is rotated through the selected combination to bring notches 88, 90 and 92 positioned in the periphery of the respective code wheels 46, 56 and 70 into corresponding position under the tip of a spring loaded pawl 94 (FIG. 3) which is pivotally mounted on a sliding bolt 96 as at 98 and urged down against all three of the code wheels by spring 100. Details of operation may best be understood in connection with the steps taken to effect a change in the combination.

In order to change the combination it is only necessary to remove the driven code wheel 70 and the coordinating wheel 62 from shaft 20 which is readily done by sliding these wheels off the free end of the shaft to the right in FIG. 1.

The first step in setting up any particular combination is to select a zero point and any one of the twelve hour clock positions of knob 18 may be used. For the purpose of illustration we pick "twelve o'clock" for the zero point and knob 18 is clicked around until fin 40 is in the twelve o'clock position (FIG. 6).

Referring now to code wheel 56 which is in place on shaft 20 it will be seen that in the preferred form of structure shown this wheel is provided with eleven holes each of which is located in a clock position adjacent the periphery of the wheel and each hole is numbered in consecutive order from twelve to twenty-two. This code wheel controls the second code number which is set before the first code number is set on code wheel 46.

The next step in setting the desired combination is to remove pin 82 from its hole and reinsert it into the hole with the desired second code number. For the purpose of illustration the number "twelve" is selected as the second code number and pin 82 is inserted into hole number twelve. Since code wheel 56 rotates independently of shaft 20 the position of the twelve o'clock hole relative to the knob is unimportant. After this is done, coordinating wheel 62 is slipped on shaft 20. As best shown in FIG. 7 wheel 62 has an inner circle of numbers as at 102 arranged in consecutive order from twelve to twenty-two. Each of these numbers are located in a clock position corresponding to the clock position of one of the holes of code wheel 56. In placing wheel 62 on shaft 20 the number in the inner circle 102 that corresponds to the second code number of the combination is placed on top in the zero position (FIG. 6). Since twelve is the second code number the wheel is placed on shaft 20 with the number twelve on top. The first number or start position of the combination is now set by clicking knob 18 around in either direction through its clock positions until the desired first code number as shown in the outer circle 68 is on top in the zero position. For the purpose of illustration the number "twelve" is selected and knob 18 is clicked around until number twelve in outer circle 68 is on top. This completes the setting of the first code number of the combination.

The last code number is set by placing the driving pin **76** into one of the numbered holes positioned adjacent the periphery of the driven code wheel **70**. Code wheel **70** in the preferred form of structure has eleven holes which are numbered from one to eleven and as previously described each hole is located in a clock position. For the purpose of illustration the number "one" is selected as the last code number of the combination and pin **76** is inserted into the hole numbered one and then the code wheel is placed on shaft **20**, care being taken to position the pin on top in the zero position (FIG. 6). This completes the combination which is now set for twelve-twelve-one for a zero position of twelve o'clock.

In order to work the combination and open the door, knob **18** is rotated first through two complete turns in counter-clockwise direction (FIG. 6). This will bring pin **76** of the driven code wheel **70** into contact with pin **80** of code wheel **56** and pin **82** of code wheel **56** into contact with pin **86** of code wheel **46** so that each of the code wheels will be positively driven in step with knob **18**. Counter-clockwise rotation is then continued until fin **40** of knob **18** reaches the start point which in the illustration given is twelve o'clock. When fin **40** is clicked into the twelve o'clock start position notch **88** of code wheel **46** will be in proper position to receive the tip of pawl **94** which at this time is in contact with the periphery of both of the code wheels **56** and **70**. The arrangement of the code wheels relative to each other at the time fin **40** is clicked into the first combination number or start position is illustrated in FIG. 8.

As there shown when notch **88** is properly oriented under the pawl, pin **82** of code wheel **56** is on top approximately in the twelve o'clock position and pin **82** must always be in this particular set position in order to bring notch **88** under pawl **94** regardless of the number of the hole in which pin **82** is placed in code wheel **56**. At this time pin **76** is positioned one click space beyond (clockwise direction FIG. 8) the zero twelve o'clock position and the position of pin **80** relative to notch **90** is such that the notch is positioned one click space beyond (clockwise direction FIG. 8) its proper position under the pawl.

It is to be noted that when code wheel **70** was placed on shaft **20**, pin **76** was in the zero twelve o'clock position on top of the shaft so that at the time pin **76** was indexed against shaft **20** pin **76** was one click space away from proper drive relationship with pin **80** required for properly orienting notch **88** under pawl **94** for unlocking the bolt. This relationship between pins **76** and **80** may be readily understood by considering the inner and outer circles of numbers on coordinating wheel **62**. It will be recalled that in setting the combination pin **82** was positioned in hole number twelve of code wheel **56** and when wheel **62** was assembled on the shaft the number twelve in the inner circle **102** was positioned on top in the zero twelve o'clock position. Since the first code number of the selected combination was twelve the dial was rotated until the number twelve in the outer circle **68** was brought into the zero position on top. In order to do this it was necessary to move fin **40** of knob **18** one click space away from the zero position into the one o'clock position as viewed from the exterior of the door. Since the dial is rotated in opposite direction (counter-clockwise) in working out the combination this one click space setting of fin **40** resulted in bringing pin **76** into proper drive position with pin **80** for a twelve o'clock setting of the fin as viewed from the exterior of the door.

Referring again to the numbered circles on coordinating wheel **62** it will be readily seen that the one o'clock position of fin **40** will be achieved regardless of the direction in which the knob is rotated to set number twelve in the outer circle **68** in the zero position.

The next step in working the combination is to rotate knob **18** in clockwise direction (FIG. 6) to the clock position that corresponds to the second code number. In the example chosen this is twelve o'clock so that knob **18** is rotated clockwise one full revolution to bring fin **40** back again into the twelve o'clock position. When fin **40** reaches the twelve o'clock position pin **76** is right back in the position shown in FIG. 8. Since the combined space occupied by pins **76** and **80** equals one click space notch **90** will now be in proper position to received the pawl for unlocking the bolt.

Referring again to FIG. 8 it will be seen that when the pins are in drive relationship and notch **88** is in position under pawl **94** notch **92** is positioned one click space away (counter-clockwise direction FIG. 8) from the pawl. The setting of the combination is completed by again rotating knob **18** in counter-clockwise direction (FIG. 6) one click into the eleven o'clock position to bring notch **92** of code wheel **70** into proper position under the tip of the pawl. This brings all three notches **88, 90** and **92** into proper position under the tip of pawl **94** so that the tip of the pawl will move down into the notches under the influence of spring **100** as illustrated in FIG. 9*a*. Thereupon one additional click of the knob in clockwise direction will cause pawl **94** to slide bolt **96** to the left (FIGS. 3 and 9*b*) to release the bolt from its keeper **106**. The door may now be opened.

Referring again to FIG. 8, it will be understood that when notch **88** is in position under the pawl the other two notches **90** and **92** are each positioned one click space away from notch **88** so that in working out the combination only one notch at a time will be brought into proper position under the pawl as the combination is dialed.

Further details of the combination lock assembly will be understood in connection with the changes in relationship of the members of FIG. 8 which are required in setting up a different combination. For the purpose of illustration we pick the combination five-eighteen-eight for a zero position of twelve o'clock. The relationship of the members of the new combination will be described but not shown in the drawings.

The first step in setting the new combination is to remove code wheel **70** and coordinating wheel **62** from shaft **20** and then pin **82** is placed in hole number eighteen of code wheel **56**. The coordinating wheel **62** is now placed on the shaft with the number eighteen (inner circle **102**) on top and at this time fin **40** will be in the zero twelve o'clock position. It is to be kept in mind that regardless of the combination that is set up pin **82** must be on top approximately in the position of number 18 of coordinating wheel **62** in order to bring notch **88** under the pawl when the combination is worked out. In setting up the new combination pin **82** has been moved six holes (click spaces) in wheel **56** away from its drive position shown in FIG. 8 and as a result the fixed pin **80** will also be positioned six click spaces away (clockwise direction FIG. 8) from the position it has in FIG. 8 for the second code number of twelve.

As a result driving pin **76** and knob **18** will have to travel six click spaces beyond the zero twelve o'clock position before pin **82** will arrive in the proper position to bring notch **88** under pawl **94** when the first code number is dialed. These six click spaces have to be taken into account in setting up the first code number in the new combination and it is for this reason that the second code number of the combination is set up before the first code number.

The first code number of the new combination is five and knob **18** is now turned until the number five on coordinating wheel **62** is on top. Examination of the numbers on coordinating wheel **62** shows that in order to bring the number five on top fin **40** of knob **18** will always end up in the two o'clock position (FIG. 6) which is two click spaces away from the zero position of fin **40** and this results in indexing the two code wheels **46** and **56** against each other and in indexing both of these code wheels against shaft **20** and knob **18**.

One click space takes care of the extra click space introduced by setting the second code number in hole number eighteen which advances pin **80** six click spaces beyond the zero position (only five are required for the first code number or start point) and the other click space accounts for the one click space required to move pin **76** beyond the zero position in order to bring the pins into the proper drive relationship to position notch **88** under the pawl when fin **40** is advanced in counter-clockwise direction (FIG. 6) five click spaces beyond the zero position into a clock setting of seven o'clock (FIG. 6).

When the new combination is subsequently worked out it can be most conveniently done by using the clock position (FIG. 6) of fin **40** for the first code number as the start point for dialing the combination. In this way the zero position may be ignored and once positive drive is established by rotating knob **18** two complete revolutions counter-clockwise (FIG. 6) fin **40** may be moved directly into the seven o'clock position which will automatically provide the five click spaces beyond the twelve o'clock zero position which was selected for the first code number of the combination.

In dialing the second code number knob **18** is rotated through one complete revolution in clockwise direction (FIG. 6) which accounts for twelve of the eighteen click spaces required for working out the second code number of the combination and this again positions fin **40** in the seven o'clock position (FIG. 6). Fin **40** must then be advanced in clockwise direction an additional six clicks for the second code number eighteen and when this is done fin **40** will be in the one o'clock position (FIG. 6). At this time notch **90** will be properly oriented under pawl **94** for unlocking the bolt.

The last code number of the new combination is established by placing pin **76** in hole number eight of code wheel **70** and then this code wheel is placed on shaft **20** with pin **76** on top approximately in the twelve o'clock zero position.

Referring again to FIG. 8, it will be understood that pin **76** will always be in the same position when notch **90** is properly oriented under the pawl and this is so regardless of the clock position that knob **18** has when notch **90** is set under the pawl. The relationship of the numbered holes to notch **92** is such that rotation of code wheel **70** in clockwise direction (FIG. 8) for the number of click spaces set underneath the hole of pin **76** will bring notch **92** into proper position under the pawl for unlocking the bolt. In setting the notch **90** under the pawl we ended up with fin **40** in the one o'clock position (FIG. 6). Since pin **76** is in position in hole number eight knob **18** must now be rotated eight clicks in counter-clockwise direction (FIG. 6) in order to bring fin **40** into the five o'clock position (FIG. 6) and properly orient notch **92** under the pawl for unlocking the bolt. All three of the notches are now properly positioned under the pawl which drops down into the notches and the bolt may be unlocked as previously described hereinabove before. By using clock positions of the dial the combination may be worked out by touch alone and there is no need to position code numbers on the exterior of the door or escutcheon plate. As illustrated in the example for the combination of five-eighteen-eight the combination may be worked out by setting the knob fin in the seven-one and five o'clock positions as previously described. If desired the twelve, three, six and one o'clock positions may be marked on the door or escutcheon plate by means of ribs or raised protuberances **103** and small raised dimples **104** may be used for indicating the hour positions between the ribs to assist in manipulating the knob.

It will be understood that any clock position from one to twelve may be employed as the zero position for setting up the combination. In the preferred form of structure shown code wheel **46** may be used for any one of twelve different code numbers and wheels **56** and **70** are each set for eleven different code numbers. Eleven code numbers on wheels **56** and **70** is the maximum because any one set of driving pins (**76** and **88** or **82** and **86**) take up one click space. If desired the code numbers in the combination may be reduced by reducing the number of holes at the periphery of wheels **56** and **70** or the number of indexing surfaces in the mounting hole of code wheel **70** may be reduced. The same result can be achieved by reducing the number of click positions of wheel **36** or by reducing the number of indexing surfaces on shaft **20**. On the other hand the code numbers may be increased to twenty-four by setting up half hour click positions between each of the hour positions on wheel **36**. In such case shaft **20** and code wheels **56** and **70** may also be made to include the half hour positions.

As previously described the tip of pawl **94** is rotated down into notches **88**, **90** and **92** by spring **100** when all three notches are registered under the pawl and one click of knob **18** in clockwise direction (relative to the exterior of the door, FIG. 6) will cause bolt **96** to slide to the left (FIG. 3) and out of keeper **106** to unlock the door. Bolt **96** may be slidably mounted on plate **12** by any conventional means such as by two straps **108** and **110** respectively. When the latch bolt is moved to the left (FIG. 3) it overcomes the tension of leaf spring **112** which is so mounted on post **44** as to constantly urge the latch bolt into locked position. Leaf spring **112** is preferably made strong enough to automatically snap the tip of the bolt back into keeper **106** when the knob is released. Once pawl **94** is set in all three of the code wheel notches the latch bolt may be locked and unlocked at will provided the position of the code wheels relative to the pawl is not disturbed.

A rod **114** is positioned on bolt **96** so that the door may be opened from the inside without working the combination. When rod **114** slides to the left (FIG. 3) the tip of pawl **94** is free to slide along the periphery of the code wheels so that the door may be opened from the inside without working the combination. If desired plate **12** along with the other supporting members for the working parts may be die cast as a single unit. Suitable plastic materials such as the vinyl resins may be employed in place of metal which may be of special advantage in the case of the code wheels. If the code wheels are made of plastic material the periphery of the wheels is preferably sanded or otherwise made rough to provide a greater frictional grip between the wheels and the yieldable spring brakes that bear against the wheels.

After the combination lock assembly has been mounted on door **14** and the desired combination has been set cover plate **116** (FIGS. 1 and 5) is slipped over the operating mechanism and attached to plate **12** by means of suitable fasteners such as screws **118** which are inserted through the cover and screwed into posts **44**, **120** and **122** which all have threaded holes positioned therein for this purpose. Rod **114** projects out through a suitable slot **124** which is made large enough so as not to interfere with the sliding movement of the rod when the bolt is unlocked from the inside. A knob **125** is threaded on rod **114** for convenience of operation.

If desired the combination lock may be latched from the inside so that it can not be opened even if the combination is worked out. This is done by means of a lug **126** which is pivotally mounted on cover **116** as at **128** so that one end of the lug may be rotated into position against rod **114** to prevent it from sliding to the left in slot **124**. Lug **126** has a notch **129** adapted to receive rod **114** and the notch may be used as a keeper for the rod to hold the bolt in the unlocked position. Any other convenient means may be employed for the same purpose.

Cover **116** is also provided with a hole **130** which is adapted to receive one end of shaft **20** and provide a bearing at this end of the shaft without interfering with rotation thereof. By using the cover as a bearing

for shaft **20** it will be seen that the inside surface of the cover may be brought flush up against the right hand face (see FIG. 1) of code wheel **70** so that the cover will effectively hold the operating parts of the combination lock assembly in position on shaft **20** without special locking devices. In some cases it may be advantageous to sell the combination lock assembly without the cover in place thereon. This may readily be done by holding the working parts in place by means of a strap **131** (FIG. 11). Strap **131** is provided with a hole **132** adapted to fit on the end of shaft **20** and the strap is held in place by screws (not shown) that are threaded in holes **120** and **122**. In this way the home owner may work out the combination set in the factory and observe movement of the operating parts without danger of having them fall off the shaft.

Referring now to the drawings it will be seen that the combination lock way be used in connection with a door that opens from the left or right hand side. The door shown in the drawings opens from the right hand side (FIG. 3). In order to install the combination lock on a door that opens from the left hand side (FIG. 3) it is only necessary to turn plate **12** upside down and install the plate on the other side of the door.

The door shown in the drawings opens from the outside in but the lock may also be used in connection with a door that opens from the inside out.

The preferred form of structure shown in the drawings includes a device for scrambling the combination after the door has been unlocked. As illustrated in FIGS. 9*a* through 9*g* the scrambling device includes a lug **136** which is pivotally mounted on plate **12** as at **138** and held in the position shown in FIG. 9*b* by means of a spring **140**. One end of the lug **136** projects into the space between code wheels **56** and **70**. A pair of pins **142** and **144** mounted in fixed position on the code wheels **56** and **70** respectively project far enough out into the space between the wheels to hit the lug but the pins do not project out far enough to contact one another (see FIG. 1).

The pins **142** and **144** are arranged on the code wheels to occupy the position shown in FIG. 9*a* when notches **90** and **92** are brought into position under pawl **94**. When bolt **96** is unlocked by rotation of the code wheels, one click in counter-clockwise direction (FIGS. 9*a* and *b*), pins **142** and **144** are caused to move and pin **142** will pass lug **136** and move from its position on top (FIG. 9*a*) into position underneath the lug (FIG. 9*b*). It is to be noted that when code wheel **70** moves counter-clockwise (FIG. 9*b*) to unlock the bolt all three code wheels turn together even though driving pin **76** is not on contact with pin **80** because motion of the driving code wheel **70** is transmitted to code wheel **56** and **46** by pawl **94** which is held captive in the bottom of the notches by means of the camming surfaces **145**, **146** and **147** of notches **88**, **90** and **92** respectively (FIG. 2) which are adapted to overlie the tip of the pawl during this movement. As a result the three code wheels move in step to keep the notches together. In the preferred form of structure shown the camming faces **145**, **146** and **147** of the notches are undercut back of a radial line of the code wheel to assist in locking the pawl in place in the bottom of notches **88**, **90** and **92**.

When the bolt is again locked in keeper **106** by rotating the code wheels one click in clockwise direction into the position of (FIG. 9*a*) pin **142** tips lug **136** up into the position shown in FIG. 9*c* but the pin does not pass the lug and remains below it. On the next click turn of code wheel **70** in clockwise direction (FIG. 9*d*) pawl **94** rides up on the periphery of wheel **70** while code wheels **46** and **56** remain stationary held by the spring brakes **53** and **60** respectively and pin **144** of code wheel **70** moves past lug **136** into position over the top of the lug as shown in FIG. 9*d*. At this time notch **92** is out of alignment with notches **88** and **90** and when this occurs the combination is scrambled.

If code wheel **70** is rotated counter-clockwise (FIG. 9*f*) it will move down against the top of lug **136** which in turn contacts pin **142** so that pin **144** can not pass lug **136** without driving pin **142** ahead of it. As a result notches **90** and **92** remain separated (FIG. 9*f*) and can only be brought together again by working out the combination. Clockwise rotation of code wheel **70** from the position of FIG. 9*d* causes driving pin **76** to contact pin **80** but the notches **90** and **92** are always separated when this occurs.

A modified form of the scrambling device of FIG. 9*a* is illustrated in FIGS. 9*g* and 9*h*. As there shown the scrambling device comprises a leaf spring **148** which may be provided with a contact point **149** to increase its thickness. As in the case of lug **136**, spring **149** projects into the space between the two code wheels in position to be contacted by both pins **142** and **144**. Operation of the spring is identical with that described for lug **136**.

A second modified form of scrambling device is shown in FIG. 10. As there shown a spring loaded plunger **150** is slidably mounted in the side wall of casing **116** in position to move into the casing adjacent the left face (FIG. 1) of code wheel **46** to contact a fixed pin **152** which projects out from the left face of code wheel **46**. Spring loaded plunger **150** carries a camming surface **154** at the front thereof which upon contact with pin **152** is adapted to rotate code wheel **46** in clockwise direction (FIG. 10) and move notch **88** out from under the tip of pawl **94**. This causes the tip of pawl **94** to ride up on the periphery of code wheel **46** and once this is done the combination is scrambled. Rotation of knob **18** in either direction, clockwise or counter-clockwise, will not cause code wheel **46** to rotate until the driving pins of all of the code wheels make contact and when this occurs the three notches are separated from each other as illustrated in FIG. 8.

While indexing wheel **36** and spring detent **42** are employed in the preferred form of structure for setting up the twelve predetermined positions of knob **18**, any other convenient form of click mechanism may be employed for such purpose, such as a spring-loaded ball **156** shown in FIG. 18. Spring-loaded ball **156** is adapted to click into and out of the depressions **158** positioned in the surface of an inner annular ring **160** which is rotatively mounted in an outer annular ring **162** which mounts the spring-loaded ball. In such case the two rings **160** and **162** would be used in place of knob **18** and indexing wheel **36**. A web **164** provides a convenient means for rotating the inner ring **160**. In some cases it may prove desirable to be able to work the combination from the inside as well as from the outside. This is very simply done by merely mounting a second knob **166** (FIG. 18) similar to knob **18** on the second end of shaft **20**. Other modifications will be obvious to those skilled in the art.

For example, the number of idler code wheels on shaft **20** may be increased or reduced without departing from the spirt and scope of the present invention. A modified form of actuating mechanism for the combination lock assembly is illustrated in FIGS. 12 through 16. In this form of device the structure is identical to that of FIG. 1 with the exception that the operating unit on the shaft includes a single loose idler code wheel which takes the place of the two loose code wheels **46** and **56** shown in the preferred form of structure of FIG. 1.

Referring to FIGS. 12 through 16 and in particular to FIG. 12 it will be seen that the modified form of structure includes an indexing shaft **168** having an operating knob **170** slidably mounted but held in fixed position on the shaft by means of a set screw **172**. The knob is separated from the exterior surface of the door **174** by means of a washer **176** which is slidably mounted on the shaft to rotate independently thereof.

As in the case of the preferred form of structure of FIG. 1 a click mechanism is provided which is used to establish a plurality of predetermined positions for the knob so that as the knob is rotated from one position

to another there will be a different click and temporary interruption of movement for each of the click positions. This is achieved by means of an indexing wheel **178** that is slidably mounted on the shaft and held in fixed position by any convenient means as by pinning the wheel to the shaft as at **180**. The periphery of indexing wheel **178** is provided with a plurality of indexing surfaces such as notches **182** which cooperate with a spring detent **185** and as in the case of the preferred form of structure code wheel **178** is preferably provided with twelve notches each of which is arranged to correspond to one of the hour positions on the face of a clock.

The next element assembled on the shaft is a code wheel **184** which is slidably mounted on the shaft by means of hole **186** so that the shaft can rotate independently of the code wheel. To insure independent rotation of the shaft yieldable means are provided which frictionally grip the periphery of the wheel to prevent its rotation with the shaft except when this code wheel is positively driven (later described). The yieldable means shown in the drawings include a notched wheel **188** having notches **190** arranged around the periphery of the wheel in position corresponding to the position of the notches in wheel **178**. The notched wheel **188** is mounted in fixed position on one surface of code wheel **184** by any convenient means and a second spring detent **192** is adapted to cooperate with the notches **190** so that when wheel **184** is positively driven it will move in step with knob **170** as the fin **194** on the knob is turned from one hour click position to another.

In the preferred form of modified structure shown twelve notches are positioned in the periphery of wheel **188** corresponding to the twelve click positions of knob **170**. The spring detents **185** and **192** are preferably made out of a single piece of spring metal as best shown in FIG. 14 and each spring detent constitutes one leg of the U shaped member **196** which is most conveniently mounted on post **44** (FIG. 3) so that the spring detents will fit into and cooperate with the notches on wheels **178** and **188**. Since the notches in both wheels are arranged around the circumference in corresponding position code wheel **184** will move in step with the indexing wheel **178** as the spring detents move from one notch to another.

The next element on shaft **168** is a coordinating wheel **198** but this is not essential and it is put there as a convenient aid to help change the combination as later described. Coordinating wheel **198** is adapted to rotate with shaft **168** and this is achieved by providing the mounting hole **200** with a plurality of notches, grooves or other indexing surfaces **202** that correspond to the indexing surfaces on shaft **168**. In the structure shown shaft **168** is a spline shaft having twelve lands and twelve grooves positioned lengthwise along the periphery of the shaft to correspond with the notches in wheel **178**. Preferably there are twelve grooves positioned in shaft **168** and each one of the grooves corresponds to one of the notches in wheel **178**. The coordinating wheel is readily assembled by merely sliding it on shaft **168**.

The last element on shaft **168** is a driven code wheel **204** which is indexed against the shaft by means of a plurality of notches, grooves or other indexing surfaces **206** positioned on the periphery of mounting hole **208**. These indexing surfaces are arranged to correspond and mate with the indexing surfaces on the shaft so that the code wheel will turn in step with wheel **178** and transmit step by step drive to code wheel **184** by means of a driving pin **210** which is adapted to fit into any one of a plurality of holes **212** positioned adjacent the periphery of the code wheel. Holes **212** are indexed against the indexing surface of the shaft **168** so that any one hole will have a corresponding point on wheel **178** and the point and hole will move in step around a circle together even though the circles are of different diameter. The step by step movement of code wheel **204** is transmitted to code wheel **184** when pin **210** contacts and drives a corresponding pin **214** mounted in fixed position on code wheel **184**.

Operation of the modified form of structure shown in FIGS. 12 through 16 employs the same principles used in the preferred form of structure shown in FIG. 1. In operating the modified form of structure knob **170** is rotated first in one direction and then in a second direction to bring notch **216** of code wheel **184** and notch **218** of code wheel **204** into corresponding position under the pawl **220** which corresponds to pawl **94** of the preferred form of structure of FIG. 1.

Details of operation may best be understood in connection with the steps taken to effect a change in the combination.

In order to change the combination it is only necessary to remove code wheel **204** and coordinating wheel **198** from the shaft by sliding them off the free end of the shaft to the right in FIG. 12. The first step in setting up any particular combination is to select a zero point for the start and any position from one to twelve may be used for this purpose. For the purpose of illustration we picked four o'clock for the zero point and knob **170** is then clicked through the hours until fin **194** is at the four o'clock position. The zero point of the combination is now set for four o'clock. After this is done the coordinating wheel **198** is replaced on the shaft. Referring to FIG. 15 it will be seen that the coordinating wheel **198** is marked with numbers from one through eleven and the number eleven is marked in red so that it may be placed on the shaft on top in the twelve o'clock position. If desired a red indexing line (not shown) may be positioned on pawl **220** to mark the exact position for the number eleven of the coordinating wheel **198**. While we have picked the twelve o'clock position as the index line for numeral eleven this is not necessary and any position will do provided wheel **198** is marked to function in accordance with the chosen position. Once the coordinating wheel **198** is in position on shaft **168** it will be indexed against knob **170** and move in step with the knob clicks. After wheel **198** is in position on the shaft with the number eleven in the twelve o'clock position knob **170** is now clicked in clockwise direction (relative to the exterior of the door) until the number selected for the second code number of the combination is brought into position under the red index line on pawl **220**. For the purpose of illustration we picked the number three and when this number on coordinating wheel **198** appears under the index line fin **194** will be set in the eight o'clock position (as viewed from the exterior of the door) but the setting of the second number of the combination is not yet complete.

To complete the setting of the second number of the combination it is necessary to position code wheel **204** on the shaft with its driving pin **210** on top under the index line of pawl **220**. Any one of the plurality of holes **212** may be selected for driving pin **210** and the particular hole selected will in turn set the third and last number of the combination.

Referring to FIG. 16 it will be seen that code wheel **204** is provided with eleven holes **212** and each hole is numbered from one to eleven. For example we picked the number five as the last number of the combination. This number is very simply set by inserting the removable pin **210** into the hole marked number five and then driven code wheel **204** is mounted on shaft **168** with pin **210** positioned under the red index line (not shown) on pawl **220**. This completes the combination which is now set for the numbers four-three-five.

To operate the combination and open the door fin **194** on knob **170** is first rotated clockwise (relative to the exterior of the door) through the first number of the combination, four, and rotation is continued until fin **194**

again arrives at the four o'clock position. This is the first number or zero position for the combination. Knob **170** is rotated through more than 360° in setting up the first number in order to insure contact between pin **210** and pin **214** so that code wheel **184** will be positively driven upon further clockwise rotation of knob **170**.

The second number is arrived at by continuing to click knob **170** in clockwise direction three clicks away from the zero position to bring fin **194** into the seven o'clock position. This sets the second number of the selected combination and at this time notch **216** of code wheel **184** will be in position under the tip of pawl **220**. The pawl as best shown in FIG. 12 is pressed down against the periphery of code wheel **204** by means of spring **222**.

The last number of the combination is set by reversing the rotation of knob **170** and the knob is clicked counterclockwise five click spaces to bring fin **194** into the two o'clock position. This brings notch **218** of code wheel **204** into position under the tip of the pawl **220** and thereupon the tip of the pawl will move down into both of the notches **216** and **218** under the influence of spring **222**. One additional click of the knob in clockwise direction (relative to the exterior of the door) will cause pawl **220** to slide the bolt out of its keeper to unlock the door, as described in connection with the structure of FIG. 1.

It will be understood that the twelve indexing surfaces on shaft **168** which correspond to the twelve click positions of knob **170** correlate rotation of the two code wheels and knob. Code wheel **184** is indexed against the predetermined settings of knob **170** by so positioning pin **214** on code wheel **184** that notch **216** will fall under the tip of pawl **220** when driving pin **210** arrives at a certain set position relative to the tip of the pawl for the selected clock position of knob **170**. Once notch **216** is in position under the pawl it is only necessary to rotate knob **170** counterclockwise (relative to the exterior of the door) for the number of clicks shown under the hole in which pin **210** is positioned to bring notch **218** into proper position under the pawl. When the two pins **210** and **214** are in driving position to rotate code wheels **184**, the pins occupy one click space and for this reason the maximum combination numbers for wheels **184** and **204** is one less than the total number of clicks of knob **170**. In the preferred form of structure shown knob **170** is set for twelve clicks and each of the code wheels **184** and **204** are set for eleven. This gives a maximum of **1452** possible combination settings.

In the modified form of structure of FIGS. 12 through 16 each of the code wheels **184** and **204** are provided with a pin **224** and **226** respectively which are adapted to cooperate with a lug (not shown) to scramble the combination as previously described in connection with the preferred form of structure of FIG. 1.

To those having knowledge in the art it will be appreciated that the maximum number of different combinations may be increased by positioning a second idler code wheel **228** on shaft **168** similar to code wheel **184** (see FIG. 17). As illustrated in FIG. 17 the drive for the second idler code wheel **228** may be conventionally arranged by positioning a pin **230** through the wheel so that portions of the pin project out from both faces of the wheel into the path of pins **210** and **214** respectively for transmitting the drive of pin **210** to pin **214** in conventional manner for a plurality of idler code wheels. Washers **232** may be positioned between the code wheels in order to separate them and any suitable yieldable means (not shown) may be used for holding the idler code wheels **184** and **204** stationary when the wheels are not being positively driven.

In the structure shown in FIG. 17 it will be understood that pin **210** of code wheel **204** during the first revolution of the knob will make contact and start to drive pin **230** and pin **230** will in turn during the second revolution make contact and drive pin **214** of code wheel **184**. Rotation is continued to bring the knob into the zero or starting position for working the combination. Thereafter all wheels are positively driven and rotation is continued until pin **214** is set in the proper position to bring notch **216** under the pawl (not shown). Code wheel **204** is then rotated in reverse direction through one revolution so that pin **210** will again contact pin **230** and turn it away from its drive position against pin **214**. Rotation in this direction is continued until pin **230** is set in the proper position to bring the notch (not shown) in idler code wheel **228** into position under the pawl. This must occur before code wheel **204** completes its second revolution in this direction in order to avoid disturbing the setting of code wheel **184**. Thereafter code wheel **204** is again rotated in opposite direction to bring notch **218** into position under the pawl. It being understood that such position is reached before pin **210** again contacts pin **230**. The bolt may then be unlocked as described for the structure of FIG. 1.

It will be understood that if it is intended to cover all modifications and changes of the preferred form of structure herein chosen for the purpose of illustration which do not constitute departures from the spirit and scope of the invention.

What we claim is:

1. In a combination lock assembly of the type which includes a shaft rotated by an operating knob into a plurality of positions each of which are operable positions capable of being used to move a code wheel in the assembly into position for moving a bolt to a retracted position, a driven code wheel which rotates with the shaft having a plurality of holes therein positioned in spaced relationship to correspond to the operable positions of the knob, a removable drive pin positioned in one of said holes and at least one idler code wheel rotatively mounted on the shaft, said idler code wheel having a driving pin thereon which projects out from the idler code wheel toward the driven code wheel to contact the removable drive pin positioned in one of said holes in the driven code wheel to transmit rotation from the shaft to the idler code wheel, the improvement which comprises a plurality of indexing surfaces on said shaft which surfaces are arranged in spaced relationship to correspond to the operable positions of the knob, one of such indexing surfaces being provided for each one of the operable positions of the knob, at least one indexing surface carried by the driven code wheel in position to correspond to one of said operable positions of the knob, said indexing surface on the driven code wheel being adapted to cooperate with the indexing surfaces on the shaft to mount the driven code wheel on the shaft with any one of said holes in the driven code wheel in position corresponding to any one of the operable positions of the knob and to position the pin of the driven code wheel in an indexed relationship to the position of the operating knob in order to set at least two code numbers of the combination.

2. In a combination lock assembly of the type which includes a shaft rotated by an operating knob into a plurality of positions each of which are operable positions capable of being used to move a code wheel in the assembly into position for moving a bolt to a retracted position, a driven code wheel which rotates with the shaft having a plurality of holes therein positioned in spaced relationship to correspond to the operable positions of the knob, a removable drive pin positioned in one of said holes and at least one idler code wheel rotatively mounted on the shaft, said idler code wheel having a driving pin thereon which projects out from the idler code wheel toward the driven code wheel to contact the removable drive pin positioned in one of said holes in the driven code wheel to transmit rotation from the shaft to the idler code wheel, the improvement which comprises at least one indexing surface on said shaft located in a position which corresponds to one of said operable positions of the

knob, a plurality of indexing surfaces carried by the driven code wheel which surfaces are arranged in spaced relationship to correspond to the operable positions of the knob, one of such indexing surfaces on the driven code wheel being provided for each one of the operable positions of the knob, said indexing surface on the shaft being adapted to cooperate with the indexing surfaces of the driven code wheel to mount the driven code wheel in position on the shaft with any one of said holes in the driven code wheel in position corresponding to any one of the operable positions of the knob and to position the removable pin of the driven code wheel in an indexed relationship to the position of the operating knob in order to set the first and last numbers of the combination.

3. A structure as specified in claim 2 which includes a member adapted to click each time the operating knob moves into one of the plurality of positions for the knob.

4. A structure as specified in claim 2 in which the operating knob is provided with twelve operable positions and in which the driven code wheel is provided with twelve corresponding indexing surfaces.

5. A structure as specified in claim 2 which includes a third pin mounted in fixed position on said idler code wheel to project out from the face thereof toward the driven code wheel, a fourth pin mounted on said driven code wheel in position to project out from the face thereof toward the idler code wheel, a yieldable member pivotally mounted in fixed position with a portion of said member projecting into the space between the two wheels, said member being adapted to be contacted by each of said third and fourth pins and pivoted out of the path of the pin without interfering with rotation thereof, said pins being adapted to pass by each other without interfering with rotation of the wheels, whereby when one of the third and fourth pins is positioned on one side of the yieldable member and the second of such pins is positioned on the second side of the yieldable member, further rotation of one of said wheels will cause its pin to drive the other pin by means of contact with the yieldable member to cause the second wheel to rotate even though the said first and second driving pins of the two code wheels are separated.

6. A structure as specified in claim 2 in which the indexing surfaces on the shaft are formed by a plurality of grooves and in which the indexing surface on the driven code wheel is formed by a tooth adapted to fit into such grooves.

7. A structure as specified in claim 2 which includes a rod mounted on the bolt for sliding the bolt to retracted position independently of the said first mentioned code wheel.

8. A structure as specified in claim 2 in which there are two idler code wheels which are loosely mounted on said shaft, the first such idler code wheel being located nearest the driven code wheel having a pin mounted thereon as previously specified which projects out toward the face of the driven code wheel in position to be contacted by the drive pin of the driven code wheel and also having a plurality of holes positioned therein, said holes being positioned in spaced relationship circumferentially in position corresponding to the predetermined position of said operating knob and a removable pin constructed and arranged to fit into one of the holes of said first idler code wheel to project out from the face thereof toward the second idler code wheel, said second idler code wheel having a driving pin mounted thereon which projects out from the face thereof in position to be contacted by said removable pin of the first idler code wheel whereby the respective driving pins cooperate to rotate the idler code wheels when the driven code wheel is caused to rotate.

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