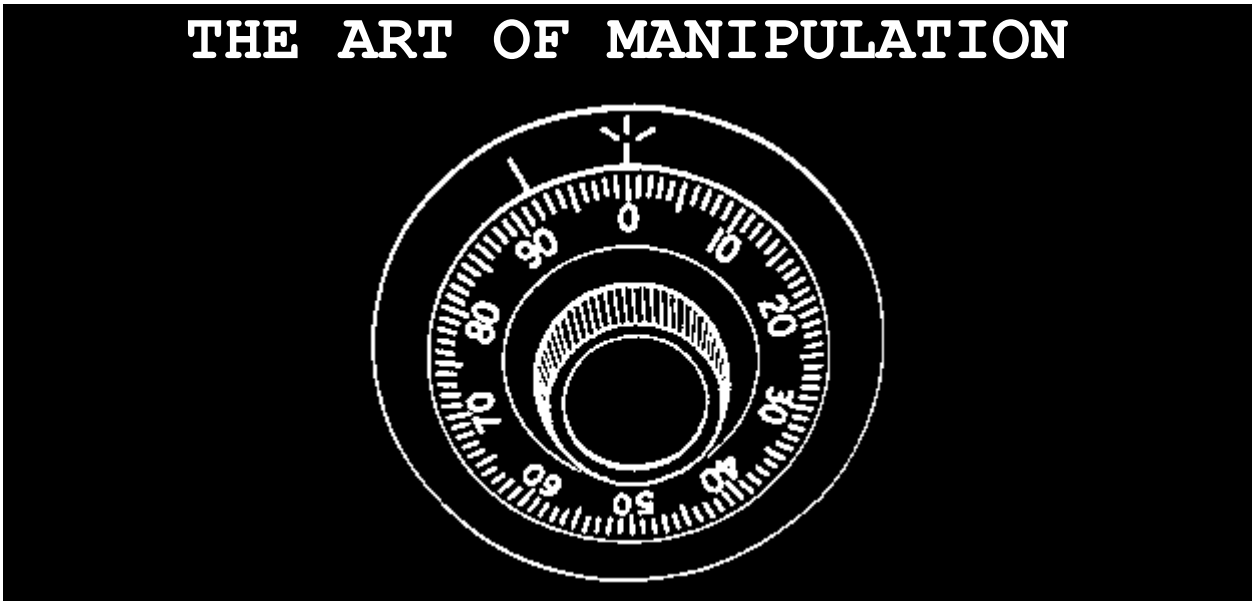
Aris's *Birmingham Gazette, November* 10th, 1856.

In closing this chapter, we would beg to draw especial attention to a little pamphlet by Mr. George Cruikshank entitled "Stop Thief," in which he suggests some most excellent and innexpensive concontrivances for securing doors and windows against burglars. The house-breakers' implements and method of breaking in are also explained, in order to give the house-keeper a through knowledge of the plan of attack, so that he may apply such fastenings as may frustrate the operation of the thief.



Clyde Lentz and Bill Kenton
First Edition, 1955

Introduction to Second Edition.

The original printing of ***The Art of Manipulation*** was in 1955. Although small in size, it was the first printed work to detail and describe the step by step theory and process of manipulation by practitioners in the trade. I think it is fair to say that the manual has been purchased by almost every safe and vault technician, since its original printing.

Because of its longevity and wide acceptance, it has been included within **LSS+**, as an added reference to the materials

presented in **Chapter 36.** The text and graphics have been edited and revised by the author to enhance understanding of the material. The basic concepts, however, have not changed, although the design of some Group 1 and Group 2 locks certainly have been altered and improved.

When Kenton and Lentz (referred to as "the authors") first published their manual, computer-based systems were not even a dream. Thus, the X-07, X-08, and competing products were not even contemplated. There were no robot dialers or other sophisticated forms of manipulation machines. Microprocessors had not been invented, nor the advanced devices that exist today to open combination locks.

It is hoped that the revision of the original edition provides an enhanced understanding of the subject, and offers another perspective to the Art of Manipulation.

MWT

MASTER EXHIBIT SUMMARY

CHAPTER ONE: Introduction to Manipulation

This chapter introduces the reader to manipulation, providing a summary of how and why locks can be opened by touch, feel, and sound. Specific definitions, the jargon of manipulation, are also presented. The reader is directed to Chapter 36 of Locks, Safes, and Security for a more thorough treatment of the subject.

DEFINITION of Manipulation

MANIPULATION is the art of opening combination locks:

- ***Without prior knowledge or information as to the present combination;***
- ***Does not require the use of force or tools;***
- ***Does not cause damage to any part or component;***

and leaves no evidence of entry.

The technician learns:

- **To move each wheel in order to indicate their position in relation to the fence;**
- **To determine the relationship between wheels, gates,**

and fence by sight, Sound, and feel;

- **To utilize electronic or mechanical devices as an aid to manipulation; however, they are not**

necessary but in some cases may be beneficial.

NOMENCLATURE OF COMPONENTS

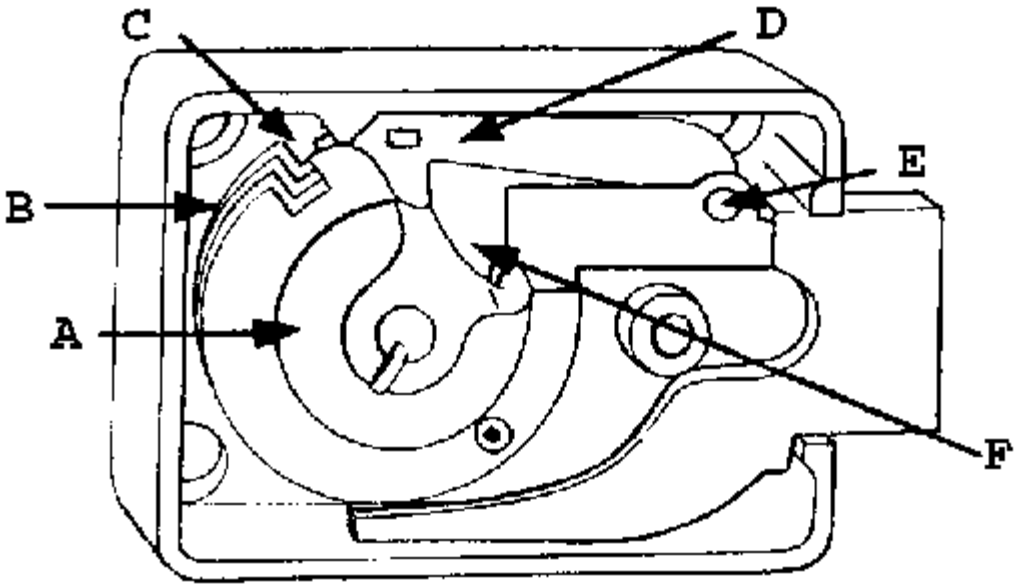


Figure M01 (A) drive cam, (B) tumblers or wheels, (C) wheel gatings, (D) lever fence, (E) lever screw or pin, (F) drive cam opening.

Why Manipulation Is Possible

There are eight primary conditions resulting from manufacturing tolerance errors that permit manipulation:

1.Differences in widths of gating in each individual wheel and in the drive cam;

2.Variations in the wheel post diameter for each wheel;

3.Eccentricity of each of the wheels;

4.General inaccuracy in and failure to maintain tolerances in the manufacturing process.

In machine-produced parts there must be a certain degree of tolerance or clearances for the proper movement and functioning of components. The same requirements exist for traditional key locks, and forms the basis of picking and impressioning theory. For example, the inside diameter of the wheels must be approximately .005” larger than the wheel post to allow free

rotation on the post.

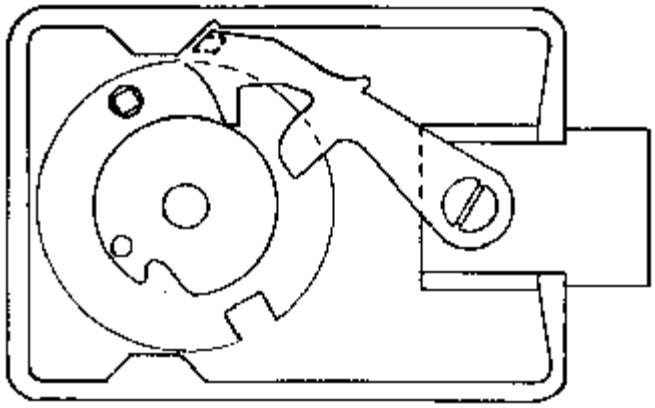
5.Differences in distance between nose of the lever and fence. The picking and decoding of lever locks closely parallels this parameter.

6.Differences in the diameter of the drive cam.

7.Squareness in wheel gatings and mating fence.

8.Tolerances in the lever Fence locks. The lever is secured to the bolt by a screw or pin, and in some locks is equipped with a lever spring, so that the lock can be mounted in different positions (Vertical up, Vertical down, Right or Left hand.) In order for the lever to work freely on the bolt screw or pin, the inside diameter of the hole in the lever must be considerably larger than the outside diameter of the actual bolt screw or pin.

The requirement for this tolerance can be understood from the illustration; Note how the play between lever and bolt creates a different position of the fence.



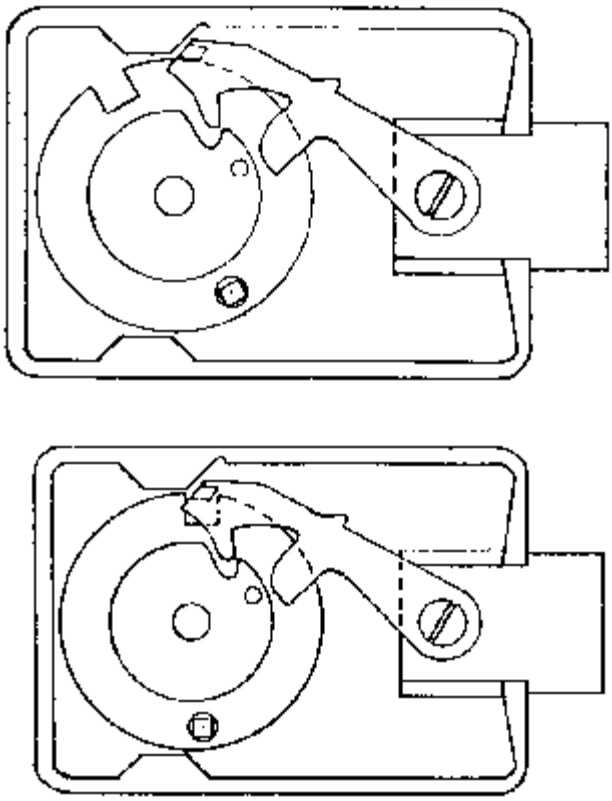


Figure M02. These diagrams demonstrate the different positions of the fence and nose of the lever during the manipulation process. In (top left), the fence and nose ride on the drive cam. In (top right) the fence is resting on the wheels with the nose of the lever in the drive cam opening. In (bottom), with No. 3 wheel-gating lined up with the fence and lever nose in the drive cam opening, the fence rests on No. 1 and No. 2 wheels, allowing the fence to tilt into the gating of No. 1 wheel and the nose of the lever to drop further into the drive cam opening.

A better understanding of the following procedures can be achieved by mounting a three-wheel lever fence lock, such as the S&G 6730, so that it may be manipulated throughout the remainder of this text. Cutaway locks may also be purchased from Lockmasters, MBA, and other vendors. After mastering the concepts to allow successful manipulation of the S&G lever fence design, it is suggested that similar products of different manufacturers and different basic designs be utilized.

Later in the text, variations upon the technique of manipulation will be explained, for different basic lock designs. Although there is a variance in procedures resulting from mechanical designs, the fundamental theory of all manipulation remains

constant.

Categories of Locks that are Subject to Manipulation

The authors have identified six primary classifications of combination locks that can be manipulated within the Group 2, or unlisted categories. Opening procedures vary according to each category, and are described in the chapters that follow.

- ***Gear-driven rotary fence***
- ***Rotary fence, spring-actuated***
- ***Lever fence***
- ***Straight tail-piece***
- ***Bottom drop***
- ***Off-set gear driven***

CHAPTER TWO: Manipulation Procedures for Lever Fence Lock

Introduction

The worldwide prevalence and acceptance of the lever fence combination lock makes this mechanical configuration the obvious choice for use as a model for teaching manipulation within this text. Variances in opening procedures for the other forms of locks previously identified are described in later chapters.

Manipulation Procedures for Lever Fence

There are two contact points in this mechanical configuration, and as with the Rotary fence lock, the sloping side of the drive cam provides a better indication of each wheel. Because the lever fence is so popular, detailed information will be provided as to the procedures that should be employed for a successful opening.

Overview of the Manipulation process

In order to determine the combination for a lever fence lock, the following critical actions must be accomplished:

Step 1: Determine the total number of wheels

Step 2: Determine the location of the contact points
Step 3: Find the low area of each wheel
Step 4: Determine which wheel is indicating

Detailed Manipulation Procedure

Each of the following steps must be successfully completed in sequence.

STEP 1: Determine the number of wheels in the Wheel Pack

It is critical to determine the number of wheels or tumblers within the lock to be opened. Obviously, if only three wheels of a four-wheel mechanism are tested, success can never be achieved. This information can also become invaluable for service calls where a mechanical malfunction has developed, such as stuck flys, tumblers sticking together, loose back plate screws, and other problems.

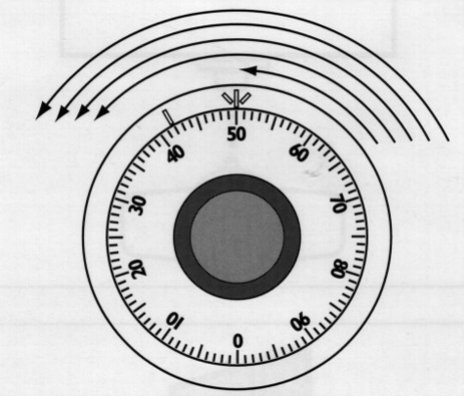


Figure M03. All wheels are rotated in one direction several complete revolutions, in order to insure th wheels are picked up.

In order to determine the number of wheels, all of the discs are rotated in one direction for several revolutions, so that all of the flys and drive pins are engaged, and all of the wheels within the wheel pack are rotated together. Direction of rotation is then reversed, so that an accurate count can be made as each wheel is picked up in succession.

Detailed Procedure for Counting Wheels

- **Turn the dial to the right (clockwise) six times stopping on 60;**

- **Turn left (counterclockwise) slowly to 50 then rapidly continue left past 60, listening and feeling as the wheel closest to drive cam is picked up. One wheel has now been counted;**

- **Continue turning left to 50 then rapidly past 60, listening and feeling as the next wheel is picked up. The count is now two wheels;**

- **Continue turning left to 50, then rapidly past 60, listening and feeling, as you pick up the next wheel. Three wheels have now been counted;**

- **Continue turning left to 50, then rapidly past 60, listening and feeling for an additional wheel. At this point, if there was no indication of another wheel, the lock only contains three discs.**

- **If an indication of a fourth wheel was received, then the lock must be tested for a fifth wheel;**

- **Continue turning left to 50 then rapidly past 60, listening and feeling as another wheel is tested. If so, then the lock contains five wheels within the wheel pack.**

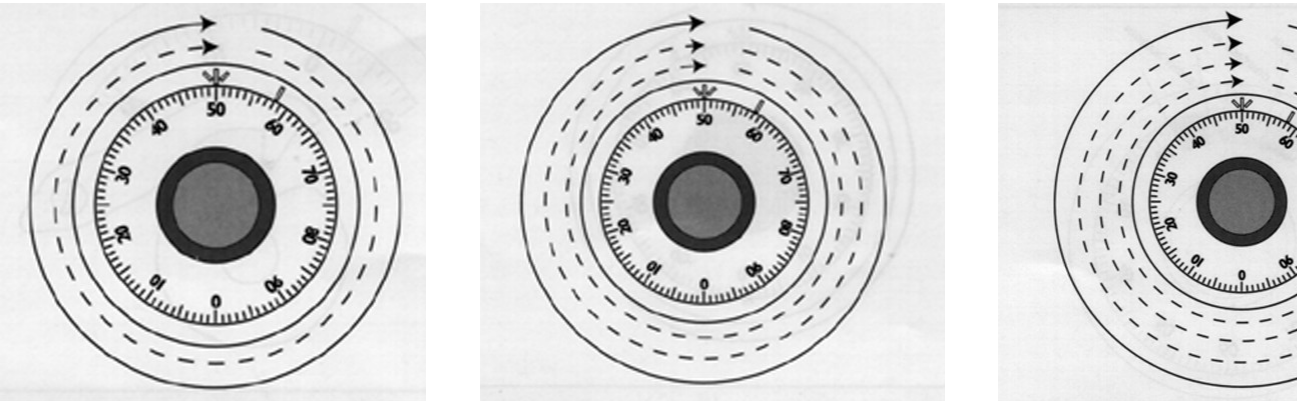


Figure M04. After parking, wheels are rotated so that each complete turn picks up another disc.

STEP 2: Determining the Location of the Contact Points

This is probably the most critical function to perform, because

it will provide you with the data (readings) from which all manipulation theory is based, and which is required to allow graphing of the geometry of each wheel. From the contact readings, the low areas for each disc can be determined, and ultimately, the gate position for each wheel is correlated.

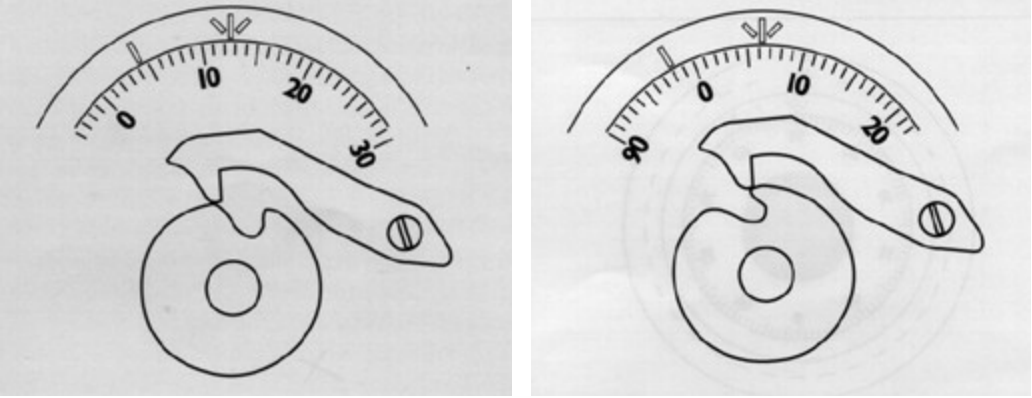


Figure M05. Contact points are shown for left (12.2) and right (8.1)

Detailed Procedure to Locate Contact Points for Lever Fence

Rotate the dial four times to Right, stopping at 60 (five times on a four wheel lock), turn left and attempt to feel and hear when the lever touches each side of the gateway of the drive cam.

Do this by oscillating over an area of approximately ten numbers at a time until you have determined the precise location of the two contact points. The **drop in area** is equivalent to locating each side of the drive cam opening or drop in point.

After finding the two contact points, lightly grasp the dial between thumb and forefinger and rotate the dial lightly between the contact points and note the exact location on the dial where the lever contacts the drive cam on the left and right side.

In the case of our test lock (using the sloping side on the drive cam), the contact point reads 12; the sharp side of the gate will provide a contact reading of 2. If the number-three wheel is lined up with the fence, and the **right** contact is read, then the fence reading improves as the nose of the lever drops further into the drive cam opening. In this event, the reading will be closer to 11.

Locating Contact Points for Spring Actuated Rotary Fence Lock

In the spring-actuated rotary fence lock, the fence is mounted on

a post secured to the lock case. In order for the fence to move freely on the post, it must have a considerable amount of tolerance. This type of mechanism will react in the same way as the lever fence, during manipulation.

Readings and contact indications can only be obtained when the dial is rotated to the left, because of the mechanical design of this category of lock. This results from a design that allows the fence to touch the drive cam only when it is rotated in the counterclockwise direction.

Locating Contact Points for Gear Driven Rotary Fence Lock

The fence in this lock works in conjunction with a gear, which in turn is actuated by the drive cam. This design differs from the spring-actuated mechanism because the fence only touches the drive cam when rotating the dial to the left; thus, there is only one contact point.

Determine which of the two contact points is to be used to obtain indications or readings on the dial. In some cases it is better to use the sloping side (right contact) of the drive cam opening because it will give a better indication when a wheel gating lines up with the fence. In other cases it makes no difference which contact point is selected, because the drive cam opening has the same contour on either side.

STEP 3: Finding Low Areas of each Wheel

The essence of successful manipulation is the determination of the lowest spot on each wheel, which must correlate to the position of the gating. Throughout the process, the goal is to cause the fence to drop further and further into the wheel pack. This is based upon the assumption that the lowest spot may be either a wheel gating or a dip in the edge of the wheel geometry that will allow the fence to contact the edge of the next lowest wheel. *The critical requirement, then, is to keep working toward the lowest spot within the wheel pack at all times.*

As the surface of each wheel is tested for each dial division or group of divisions, the contact readings are charted or graphed in order to provide a true representation of the geometry of the precise circumference of each disc. When all of the wheels have been graphed, a correlation can be made as to the location of each gate, and the combination is thus derived.

Documenting Contact Readings

Illustration graphs are provided for a three-wheel lever fence lock. Standard graph paper or preprinted forms from Lockmasters or other vendors can be utilized. Although some safe and vault technicians do not often chart their readings due to the time required, the practice is in large measure dependent upon the type of lock, and its tolerances. Students should chart all readings until proficiency is achieved.

Charting Procedure

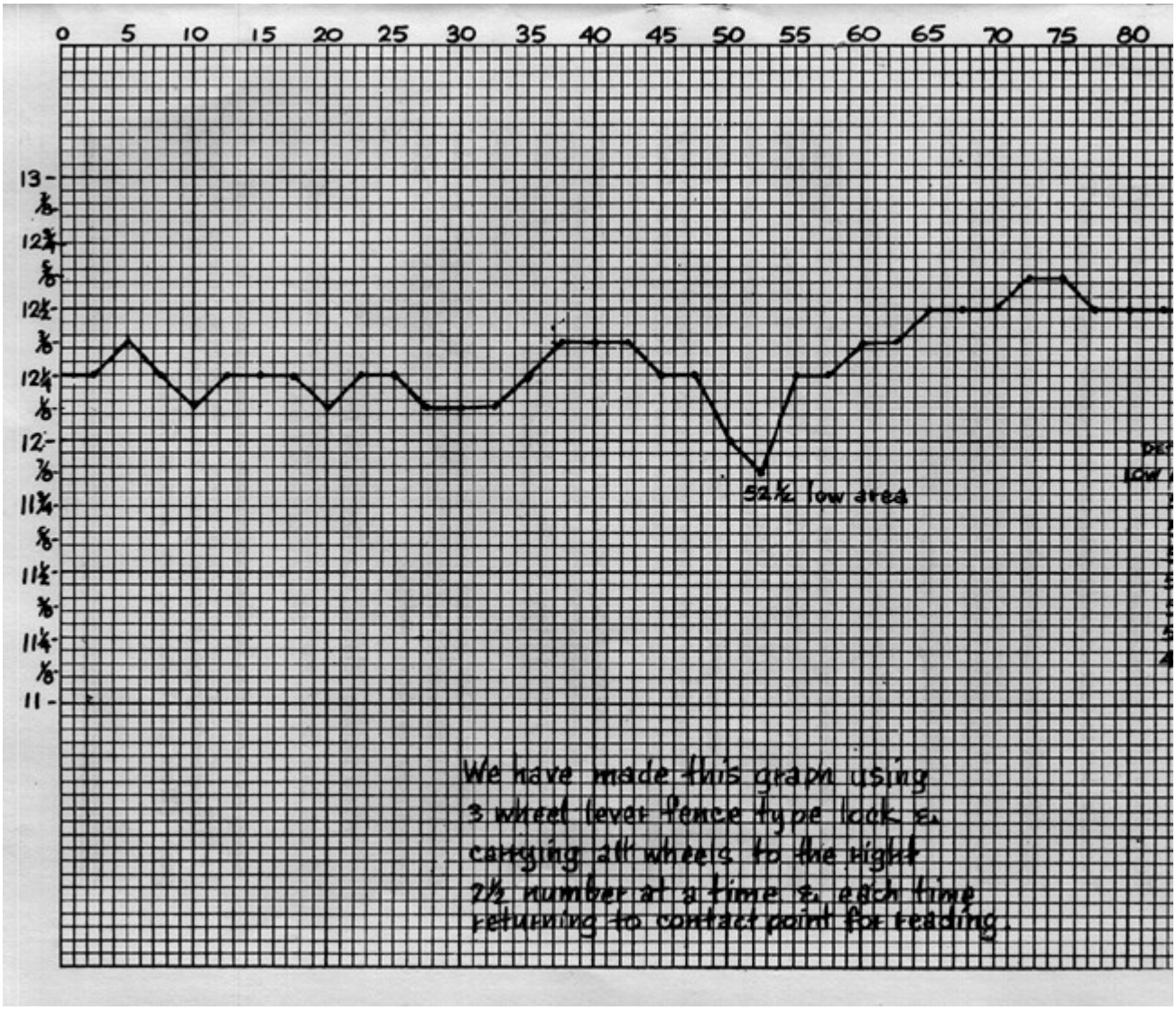


Figure M06. Graph #1

Turn the dial four times right, carrying all wheels to "0". Turn the dial left to the contact point. It is important to grasp the dial with a very light touch when turning to a contact point. This is a critical issue, because the validity of the reading depends upon the nose of the lever barely touching the gate area. If the nose is over-driven, then the reading will be skewed and in error. Remember, manipulation is based upon tolerance errors of a few thousandths of an inch. This correlates to an extremely minute change within the dial marker indication as the relative location of the nose within the lever changes.

- **Turn dial to the right, moving all wheels to 97 1/2;**
- **Turn dial to the left to contact point, take reading, and record on graph;**
- **Turn the dial to the right, moving all wheels to 95;**
- **Turn the dial left to contact point, take reading and record on graph;**
- **Turn the dial to the right, moving all wheels to 92 1/2;**
- **Turn the dial left to contact point, take reading and record on graph;**
- **Turn the dial to the right, moving all wheels to 90;**
- **Turn the dial left to contact point, take reading and record on graph;**
- **Turn the dial right, moving all wheels to 871/2,**
- **Turn dial left to contact point, take reading and record on graph.**
- **Before taking each reading at the contact point, oscillate the dial right and left over the drive cam opening, in order to float or work the fence to the lowest possible point. This will give you a closer reading.**

Follow the above procedure for every 2.5 number divisions, moving all wheels completely around the dial, taking readings and making

recordings on the graph.

The number of divisions for each sample is in part based upon the tolerance of the lock and the interaction of the gate and fence. A contact reading may be taken every number, if desired. This will provide more qualitative data from which to chart wheel geometry. However, every 2, or 2.5 division is sufficient for most Group 2 locks.

In the first edition of this manual, the authors did not address the issue of "parking" of each wheel during contact readings. This concept is important, and is addressed more fully in **Chapter 36** of Locks, Safes, and Security. Parking describes the practice of isolating each wheel, so that a determination can be made as to which is indicating. This is required in order to derive the correct combination sequence, and to insure that only one wheel is analyzed at any one time.

Parking simply requires that the first, second, or third wheel (in a three wheel lock) is rotated through the contact area, while the other wheels remain in one position. This is accomplished at the beginning of the reading sequence, when all wheels are rotated left or right to pick up all flys and drive pins. Depending upon which wheel is to be tested, the **first**, or **first and second** wheels are set to an imaginary number on the dial.

If the first wheel is to be tested, then after all wheels are rotated left for several revolutions, the dial is turned right, for example, to take contact readings. If the second wheel is to be tested, then after AWR or AWL, the first wheel is set to an imaginary number as if the combination were being entered. The rotation direction of the dial is reversed and the second wheel is moved through the contact area, division by division. If the third number is to be tested, then this process is repeated as if the first and second imaginary numbers were dialed; the third number being tested for contact readings. In this manner, each of the wheels can be tested individually.

Remember that as the wheels are moved to the right and pass the contact point, there is only a short rotational clearance remaining to the other contact point in order to take reading. Do not rotate completely around the dial. To illustrate, our contact point is approximately 12, so as we pass 12 and go to 10 with all wheels, we only turn back left two divisions to the contact point to obtain a reading.

When finished taking samples of each dial division group, examine graph for:

Sharp drops and rises
Gradual drops or rises

Identify all apparent low areas on the graph. These indications represent **potential** gate areas on each wheel, although they may also represent production errors in the stamping of each disc. It must also be understood that a failure to identify a low area may be due to a problem known as shadowing, whereby an adjacent wheel is blocking a reading of the next gate.

In our example graph, the *apparent* location of the gate is at 52. However, this is not a precise measurement but rather an approximation. The exact drop in point must now be determined.

Finding Exact Drop In Point

This is accomplished by first rotating the dial four times right, stopping at 56. Then,

- **Turn the dial left to contact point and record reading;**
- **Turn the dial right, moving all wheels from 56 to 55;**
- **Turn the dial left to contact point and record reading;**
- **Continue every number to 49, each time moving the wheels only one division at a time, and record the readings.**
- **By checking recordings, we find 52 gives the best reading or indication, so we assume 52 is one of the combination settings.**

The use of graphs in learning manipulation is most important, and the authors advise making a graph on every lock that is manipulated until proficiency is achieved. A graph will provide an overall picture of low areas of the wheel pack and in some cases will indicate two numbers of the combination setting.

Always study your graphs thoroughly, not only for sharp declines which likely indicate a gate, but also for gradual declines over

several numbers. Occasionally, a sharp decline will not be recorded; therefore the number-one and number-two wheels will have to be set in this gradual low area, and then attempt to obtain a better reading or indication of the number-three wheel.

To illustrate, assume that the gradual low area is between 37 and 52. The authors outline the following procedure to determine the precise location of the gate:

- **Turn the dial right four times, stopping at the center of the low area (approximately 43);**
- **Turn the dial left one complete revolution, picking up the number-three wheel at 43 and stop at 45;**
- **Turn the dial right to the contact point, take reading and record them on the graph;**
- **Turn the dial left to 45, picking up the number-three wheel and stop at 47;**
- **Turn the dial right to the contact point, take a reading and record it on the graph. Continue moving the number-three wheel every two divisions (numbers) completely around the dial; Determine which wheel is giving the lowest reading or best indication. By the process of elimination, find which wheel is giving the low or best indication;**
- **Turn the dial to the right four times, stopping at 52;**
- **Turn the dial left, causing only the drive cam to rotate. No discs are affected until reaching 52, where the number-three wheel (the one closest to the drive cam) is picked up. Stop at 62;**
- **Turn the dial right to the contact point and take a reading. At this time, the number-one and number-two wheels are at 52 the number-three wheel is on 62.**
- **If a good reading or indication is lost, it is likely that the number-three tumbler is the one that is giving the good reading. If there is still a good indication, then rotate the dial left to 62, picking up the number-three wheel; continue**

left and pick up number-two wheel at 52 and stop at 62.

- **Rotate the dial right to the contact point and take a reading. If a good reading or indication is lost, it is probable that the number-two tumbler is the one providing the good reading or indication. If there is still a good indication, then the number-one wheel must be the one being tested.**

This process is a modified form of "parking" which was noted earlier. Its purpose is to isolate and identify the indicating wheel, by eliminating the other two (or three) tumblers during the taking of readings.

We are actually moving one wheel at a time off the number that is giving the best indication, beginning with the disc that is nearest to the drive cam, or the number-three wheel in a three wheel lock (number-four wheel in a four wheel mechanism). Assuming that the number-three wheel was actually the one giving the good indication, we know that the third number of our combination is 52.

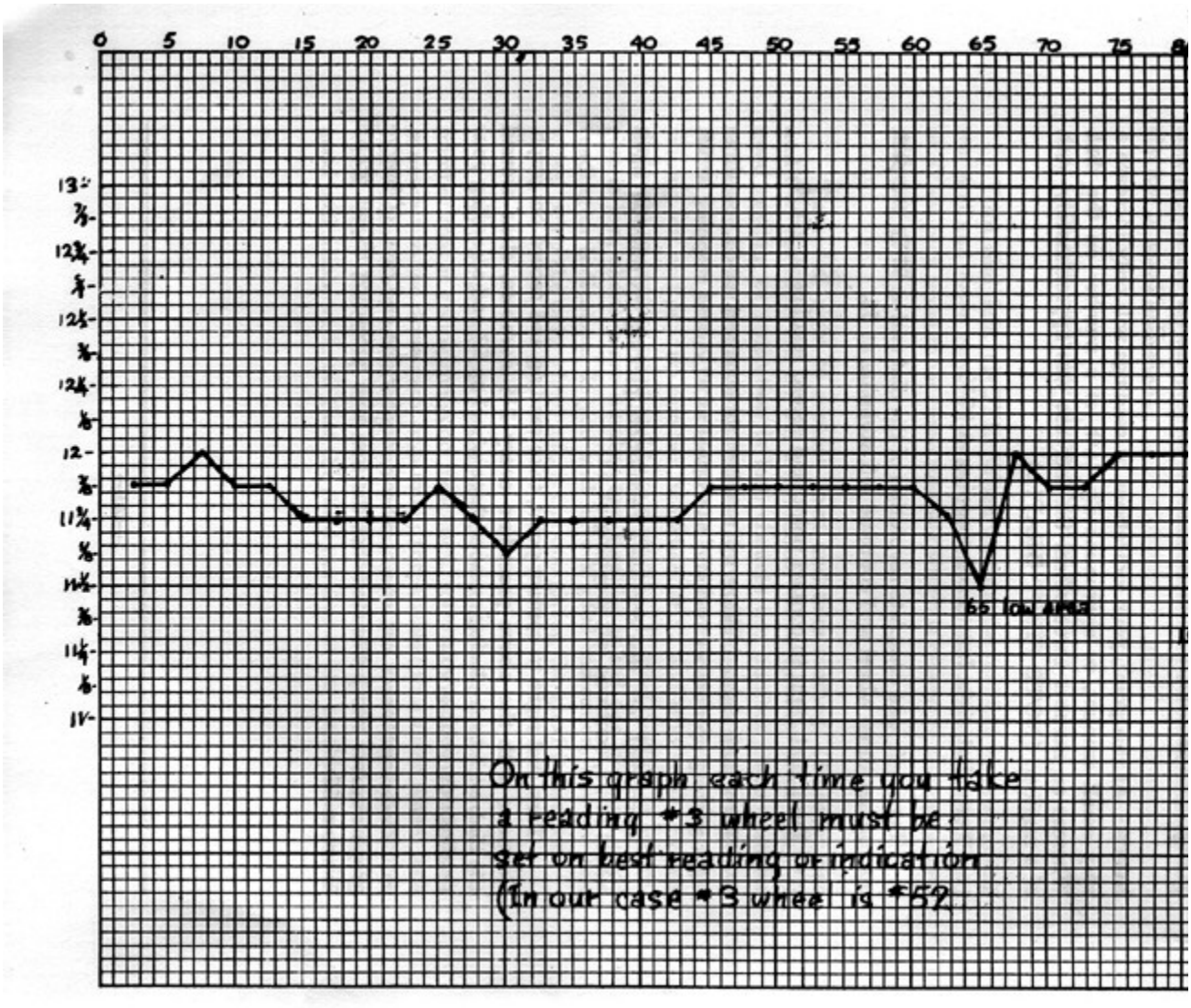


Figure M07. Graph #2.

- **Determine the low area or drop in point of tumblers number-one or two. A graph should be prepared for readings of these wheels;**

- **At this point, the indications or readings will increase a very small distance; approximately 1/8th of a dial marker division. In contrast, the change in the number-three wheel indication was approximately 1/4th of a marker division. Refer to the first graph;**

- **Turn the dial right four times, stopping at 97 1/2;**

- **Turn to the left one complete revolution, picking up the number-three wheel at 97 1/2,**

continuing left and stopping at 52;

- **Turn the dial right to the contact point and record the reading on the graph;**

- **Turn the dial right, picking up the number-three wheel at 52;**

- **Continue right while picking up the number-two and number-one wheel at 97 1/2 and stopping at 95;**

- **Turn the dial left for one complete revolution, picking up number-three wheel at 95. Continue left, stopping at 52;**

- **Turn the dial right to the contact point, take a reading and record on the graph. Continue to take samples for every 2 1/2 numbers, completely around the dial. For each reading, place the number-three wheel on 52 and record the readings;**

- **Determine the exact low area of wheel number-one and number-two, by examining the second**

graph. We find that it is probably at about 65;

- **Turn the dial right four times, stopping at 68;**

- **Turn the dial to the left one complete revolution, picking up number-three wheel at 68, and stopping at 52;**

- **Turn the dial right to the contact point, take a reading and record it;**

- **Turn the dial to the right and pick up the number-three wheel at 52, then continue right, picking up the number-one and number-two wheels at 68, stopping at 67;**

- **Turn to the left one complete revolution, picking up the number-three wheel at 67, continuing left and stopping at 52;**

- **Turn right to the contact point, take a reading and record the**

data Continue moving the number-one and number-two wheels to the right, one marker division at a time through 62, while placing the number-three wheel on 52 and returning to your contact point for a reading. From the graph we find that the exact low area of the number-one and number-two wheels is 64, and with number-three wheel on 52, we obtain the best indication or reading.

Isolating Individual Wheels

It can be seen from the first graph (number one) that when we were carrying all three wheels to the right and taking readings, that the position of the marker for number 52 read 11 7/8 on the dial. Now, on graph number two with the number-one and number-two wheels on 64 and number-three wheel on 52, our best reading was 11 1/2. So, how is it possible to determine which wheel is giving a good indication at 64, because it could be either the number-one or number-two wheel?

Isolating the Number-two wheel

- **Turn the dial right four times to 64. Turn the dial left for one complete revolution, picking up the number-three wheel at 64 and continuing left one more revolution to pick up the number-two wheel at 64 and stopping at 74;**

- **Turn the dial right one complete revolution, picking up the number-three wheel at 74 and stopping at 52;**

- **Turn left to the contact point, and take a reading. If a good indication has been lost, chances are that the number-two wheel, which is set on 64, was the one giving the good indication or reading. If a good indication remains, then the number-one wheel was providing the reading. In our case, the good indication was lost, thus demonstrating that 64 is the number-two wheel, or the second number of the combination.**

We have now derived what we believe to be two of the three numbers of the combination: those for the number-two wheel (at 64) and the number-three wheel (at 52). By the process of elimination we must now find the combination setting of wheel number-one.

- **Turn to the right four times stopping at 97 1/2;**

- **Turn to the left three times to 64;**

- **Turn to the right two times to 52, left to the drive cam opening, and oscillate the dial back and forth between contact points. Rapid oscillation after trying each combination setting will yield information from the sound and feel of the dial as the gate of the number one wheel is reached. If the true gate position is one or two divisions off from that shown on the graph, the fence can be worked into the gating by this method, thereby deriving the exact reading;**

- **Turn right four times stopping at 95.**

- **Turn left three times to 64. Turn right two times to 52.**

- **Turn left to the drive cam opening, and oscillate the dial back and forth between contact points. Continue moving the number-one wheel every 2 1/2 divisions, each time placing the number-two wheel on 64 and the number-three wheel on 52, until the lock is open. In most cases,the number-three wheel usually indicates first.**

Within the imperfect world of combination locks, **any** wheel can provide the initial indication. In the following example, the number-two wheel has been verified as giving the first positive reading. Now, the gate position of the number-three wheel should be determined, because it is usually the easiest to move.

Isolating the Number-Three Wheel

It is critical to correctly be able to isolate and identify each indicating wheel. Three examples are presented in the following pages to demonstrate the correct procedure. In these exercises, we wish to target wheel number-three.

Example 1

In our first example, we find that a good indication is at 36, which we have proven to be the number-two wheel. In the following exercise, the position of the number-one and number-two wheels will remain at 36, and they will not be disturbed.

- **Turn the dial right four times stopping at 36;**

- **Turn the dial to the left for one complete revolution, picking up the number-three wheel at 36 (leaving the number-one and number-two wheels at 36), and stop at 37 1/2;**

- **Turn the dial right to the contact point, take a reading, and record on the graph;**

- **Turn the dial to the left, picking up the number-three wheel at 37 1/2 and stopping at 40;**

- **Turn the dial right to the contact point, take a reading and record on the graph. Continue moving the number-three wheel every 2 1/2 numbers completely around the dial, each time taking a reading and recording it on the graph. Remember, as the number-three wheel is moved through the contact area, only a slight rotation of the dial will be required in order to take a reading;**

Example 2

Another example is provided, where the contact point is 3 1/4, with the number-one and number-two wheels on 36. The number-three wheel is moved left every 2 1/2 divisions past the contact point, stopping at 5.

- **Turn the dial to the right only 1 3/4 numbers to the contact point, which is at 3 1/4, and take a reading and record the information;**

- **Turn the dial to the left and at 5, pick up the number-three wheel and move it to 7 1/2;**

- **Turn the dial to the right only 4 1/4 numbers to the contact point, take a reading, and record the data. Continue moving the number-three wheel to 35;**

- **Check your graph for the lowest area and determine the exact low point of the number-three wheel by moving the number-three wheel over this area, one division at a time. What if you found the number-three wheel to be set on 82. You already**

have the combination setting of the number-two and number-three wheels. Follow the same procedure as before by moving the number-one wheel 2 1/2 divisions for each reading, and for each sample, set the number-two wheel on 36, and the number-three wheel on 82, until the lock is open.

Example 3

- **Turn right four times to 97 1/2;**
- **Turn left three times to 36;**
- **Turn right two times to 82;**
- **Turn left to the contact point or drive cam opening, and oscillate dial.**

Example 4: Number-One Wheel Indicates First

We will now explain what to do if the number-one wheel indicates first. In most cases when this occurs, the number-two wheel will indicate next.

In this example, you have determined the exact location of the low point for the number-one wheel from your graph, at 27. Proceed as follows to isolate the indicating wheel.

- **Turn the dial right four times, stopping at 27;**
- **Turn the dial to the left two complete revolutions, picking up the number-three wheel on the first revolution at 27, and the number-two wheel on the second revolution at 27, and moving them both to 30;**
- **Turn the dial to the right to the contact point, take a reading and graph the data;**
- **Turn the dial to the left, picking up the number-three and number-two wheels at 30, and stopping at 32 1/2;**
- **Turn the dial to the right to the contact point, take a reading and record the data;**
- **Continue moving the number-three and number-two wheels to the left every 2 1/2 divisions**

completely around the dial to 25, each time taking and recording the reading. These actions have been accomplished without moving the number-one wheel that we left set at 27;

- **Determine the exact low point of the number-two wheel (assuming it to be at 47), and use the process of elimination for the number-three wheel. This is quite simple, because the wheel is easily moved without disturbing the others;**
- **Turn the dial right four times to 27;**
- **Turn the dial left three times to 47;**
- **Turn the dial to the right one revolution, picking up the number-three wheel at 47 and stopping at 45;**
- **Turn the dial to the left to the contact point and oscillate back and forth over the drive cam opening;**
- **Turn the dial to the right, picking up the number-three wheel at 45, then move to 42 1/2;**
- **Turn the dial left to the contact point and oscillate back and forth over drive cam opening.**
- **Continue moving the number-three wheel to the right every 2 1/2 divisions until the lock is open.**

In this example, the number-three wheel has been moved around the dial without disturbing the position of the number-one or number-two wheels, which were left on 27 and 47 respectively.

CHAPTER THREE: Manipulation of Mechanisms other than the Lever Fence

Introduction

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In the preceding chapter, detailed procedures and examples demonstrated the methods to manipulate the lever fence lock. In the materials that follow, information will be presented regarding the techniques that are employed for the rotary fence gear-driven, rotary fence spring-loaded, straight-in tail piece, bottom-drop, and off-set gear driven mechanisms. Although the fundamental principles are the same, the methods required in obtaining accurate readings or indications will differ.

Manipulation(539) Procedures for Rotary Fence Gear-driven Locks

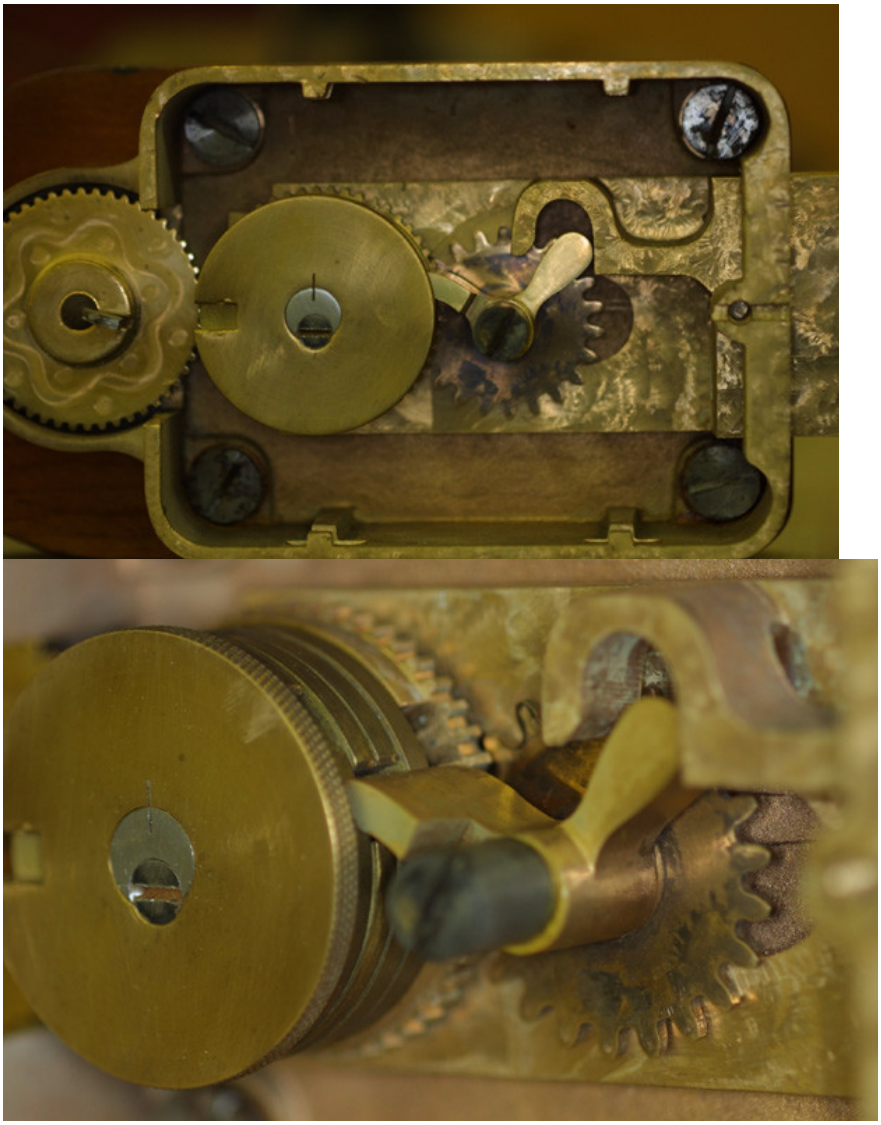


Figure M08. Rotary fence, gear driven lock.

It will be recalled that the lever fence mechanism offers two contact points that can provide data as to each wheel, although the sloping side of the fence offers more qualitative information. In the rotary fence gear-driven lock, readings can only be taken by rotating the dial counterclockwise. This is due to the mechanical design of the lock: as the dial is turned to the right, the friction between the gear and the fence moves the fence away from the drive cam and wheels.

If the dial is rotated to the left, however, the fence moves **toward** or against the drive cam and wheels, allowing the taking of readings at the drive cam opening.

Occasionally, due to variances in manufacturing, the drive cam is smaller than the wheels, thus allowing the fence to ride on the tumblers. By slowly and carefully turning the dial to the left, the gatings can sometimes be heard or felt as they rotate past the fence.

Manipulation Procedures for Spring-Loaded Rotary Fence

Figure M09. Yale OC9 spring roller fence lock.

This lock is manipulated in the same manner as the lever fence mechanism, described earlier.

Manipulation Procedure for Straight-in Tail Piece

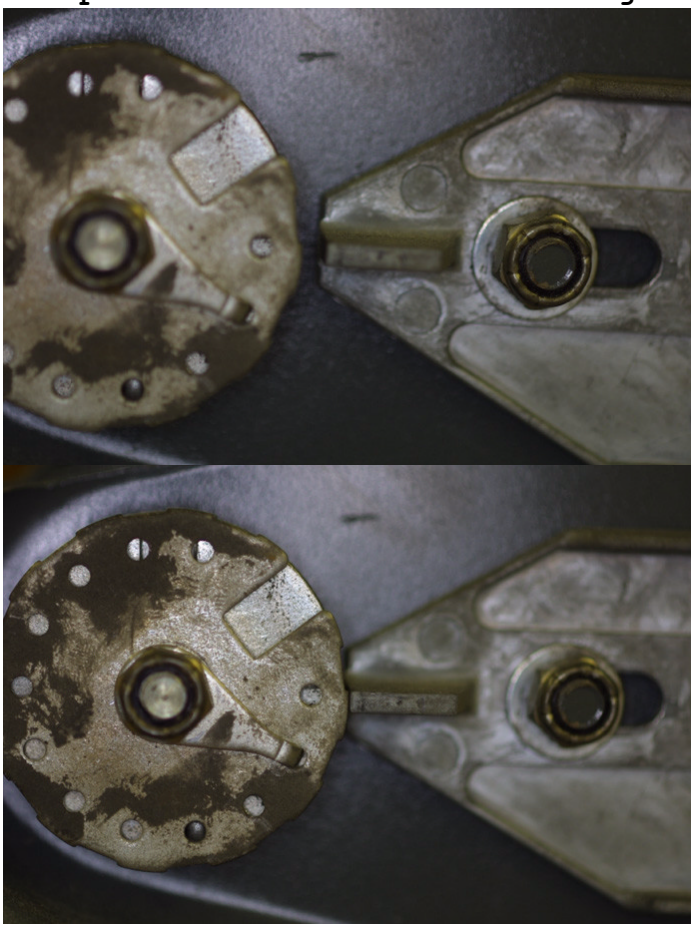


**Figure M10. Straight tail piece. Pressure can be applied directly against the wheel
pack to determine gate position.**

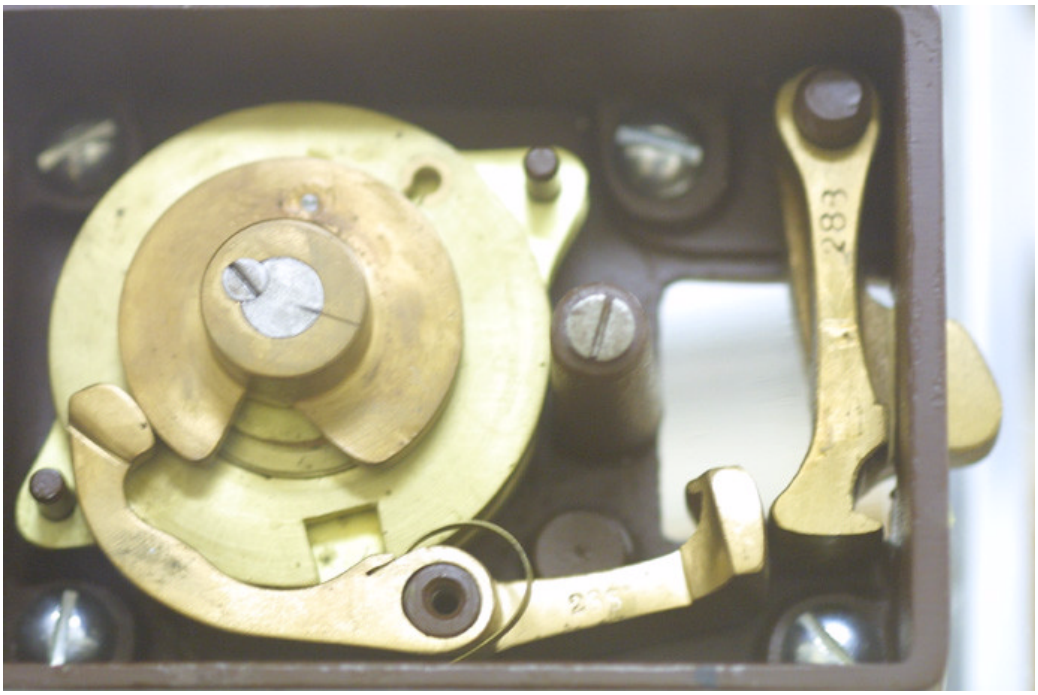
The mechanical design of this lock differs from all other types, and requires that contact indications and readings must be taken and charted from the **handle**, rather than from the dial.

To provide contact indications, a pointer must be constructed of approximately twelve and eighteen inches in length, and affixed to the handle of the safe. Located at the tip of this pointer, a sheet of paper is taped to the door and marked with graduations of 1/16”, to simulate the dial divisions for position data.

Once the pointer is in place, determine the drive cam opening. Often, there are false gatings in several places around the drive cam, although the true gating is usually narrower. By rotating the dial with pressure on the handle, a determination can usually be made as to which is the true gating or drive cam opening by the amount of play in the dial, when held by the handle tail-piece.

Once the location of the drive cam opening has been ascertained, follow the same procedure as described for the lever fence lock, with the exception that readings are derived from the pointer attached to the handle.

Manipulation Procedure for Bottom-Drop Mechanism



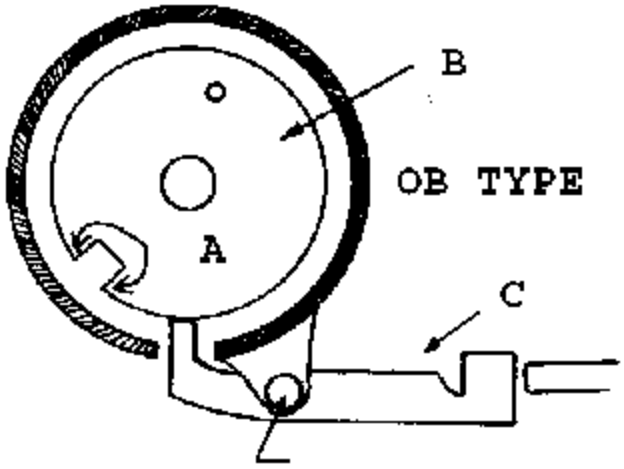


Figure M11. Bottom drop mechanism. In the diagram, (A) are the contact points, (B) is the drive wheel or cam, (C) is the lock dog or fence.

There are two different designs incorporated in this type of mechanism: **gravity fence,** and **handle pressure actuated fence.** These locks have two contact points; either will usually provide the same indications and readings.

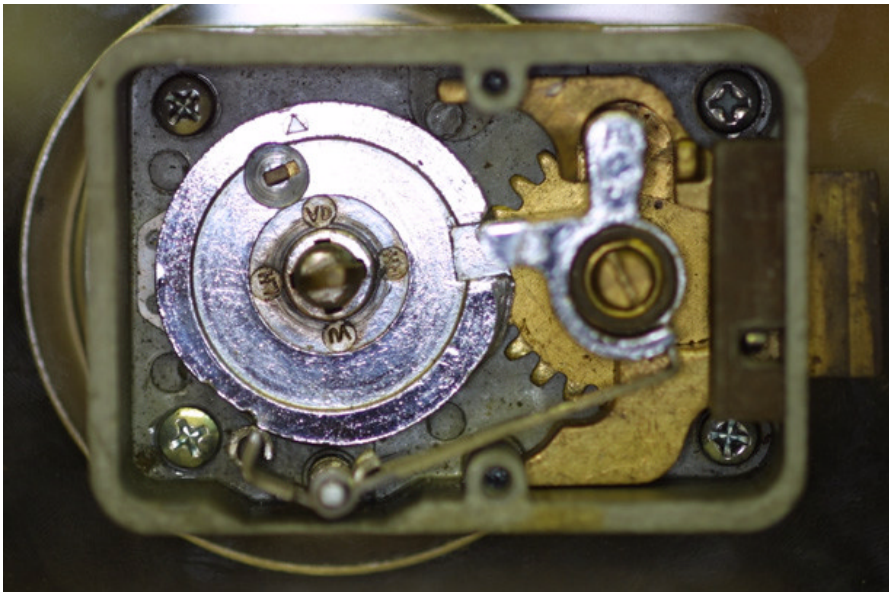
A. Gravity Fence

This lock is manipulated in the same manner as the lever Fence.

B. Fence Actuated by Handle Pressure

These devices are manipulated in the same manner as the lever fence, except that the handle must be turned to raise the fence so that it will contact the drive cam opening and wheels in order to take readings or indications.

Manipulation Procedures for Offset Gear-Driven Locks



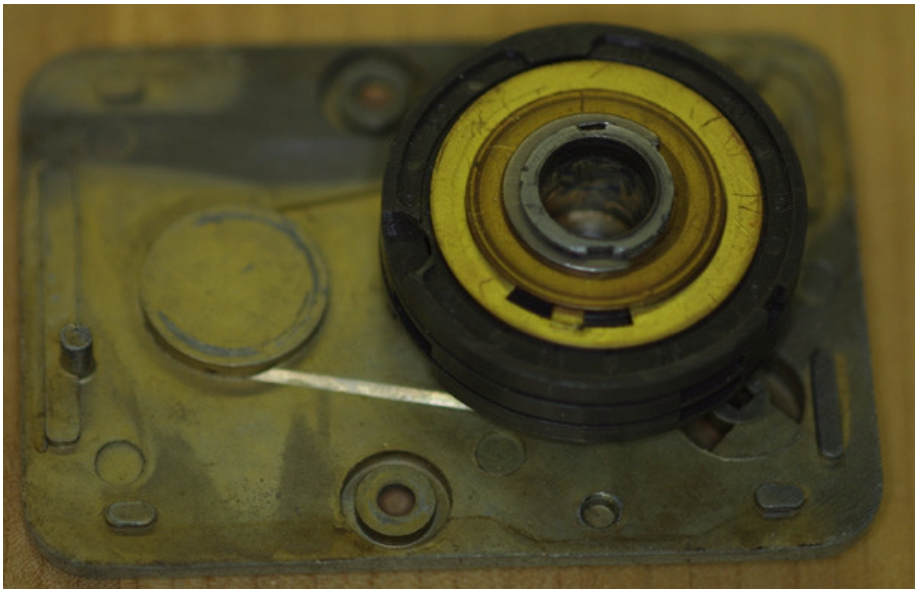
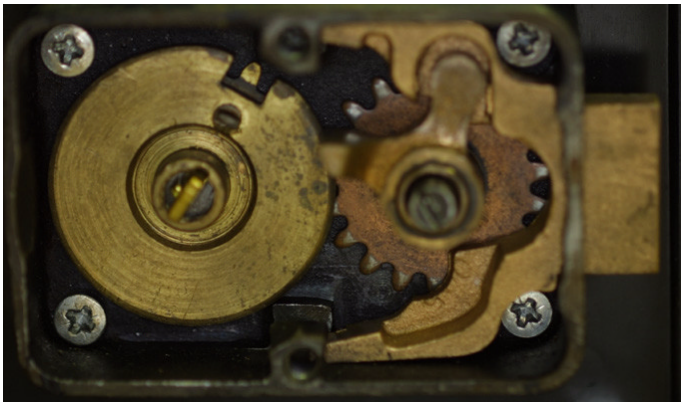
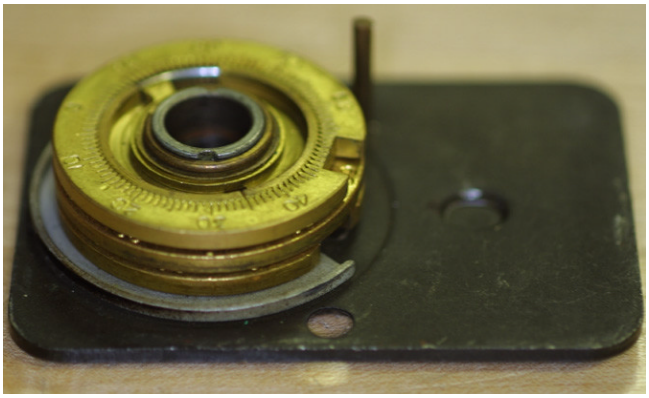


Figure M12. Yale B30 Manipulation resistant 1950 vintage UL 1R label.

Manipulation is accomplished in the same manner as with the direct drive locks described above; however, they are more difficult to read, due to the slack in the gears. The technique requires greater practice to become proficient.





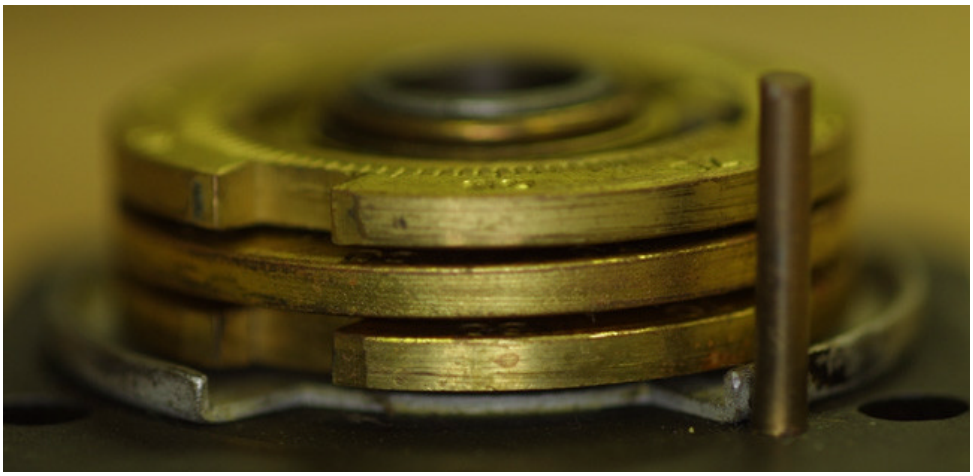


Figure M13. Yale OC5 geared roller fence. Only the left contact is read.

CHAPTER FOUR: Manipulation Resistant (MP) Locks

As with traditional key locks that boast that they are pick-proof, so also, there is a class of mechanical combination locks, designated as Group 1 devices, that are manipulation-resistant. Although most key and combination locks can be manipulated in one form of another: it is simply impractical with certain high-security and Group 1 designs. Since the original edition of this manual was written almost fifty years ago, the introduction of sophisticated microprocessors such as employed in the unique Mas-Hamilton X-07 and X-08, have created a class of locks that simply cannot be manipulated.

Mas-Hamilton has developed a highly sophisticated system called the Soft Drill, that actually performs manipulation on several popular combination locks, through the use of sound and mechanical feedback from the lock. The information from surface sensors is fed through a microprocessor and displayed on a laptop computer. The system will open many Group 2 locks. The reader is referred to **Chapter 36** for additional information.

Certain MP and MR Group 1 combination locks can theoretically be manipulated, and thus, information is presented here regarding the technique. The author utilizes the term “theoretically” to describe these manipulation processes because, although impractical, it is possible.

Rotary Fence Gear Driven MP Locks

This lock is almost identical to the older design, except for an additional lever that has been added to hold the fence away from the drive cam and tumblers until the proper combination has been run. It then drops into a narrow gating in all of the wheels, and allows the fence to contact the drive cam and open the lock.

This piece will be referred to as the manipulation-resistant lever. Instead of taking readings at the regular drive cam opening and fence, all of the indications will be derived from this lever, together with the small gatings in the tumblers and the slight depression in the drive cam into which this lever drops when the lock is opened.

The point of contact will be approximately 2 or 3 on the dial, where this manipulation-resistant lever contacts the edge of the depression on the drive cam, as the dial is rotated to the left. Although this lock has four tumblers, they often are only set on three numbers.

As an aid in obtaining readings or indications, it is usually necessary to mount a good magnifying glass or reading glass over the dial, in order to see the indications, as they are very slight. Also, a large pointer, twelve to eighteen inches long, may be attached to the dial, as in the case of the safe handle on the straight tail-piece.

This will increase the slight variations in indications to an extent that they will be more easily read. Otherwise, the lock is manipulated in the same manner as the regular rotary fence

gear driven device.

Lever Fence Mechanism

This lock is similar in outward appearance to the conventional version for the same manufacture. After dialing the combination setting, turn the dial to 100 and push in, allowing the lever to drop into the drive cam opening and rotate the dial to the right, retracting the bolt. The dial is spring loaded and can only be pushed in at 100.

In order to manipulate this lock, it is necessary to secure a machinist's dial indicator and mount it on the front of the safe, with the tip of the indicator touching the outermost point of the dial knob.

The manipulation procedure is the same as a regular lever fence lock, except that each time a reading is obtained the dial is set on 100, and pushed all the way in, allowing the lever and fence to drop down on the wheels. Then slowly let the dial come out until the lever contacts the beveled edge of the drive cam; take a reading on the dial indicator at this time. The lesser reading on the dial indicator will possibly be a combination setting. Although possible, this is a highly impractical procedure, due to the time required. It will be remembered that the applicable UL standards for manipulation-resistant locks require a minimum of 20 man-hours of manipulation resistance. See **Chapter 37**.

Conclusion

Manipulation requires a great deal of practice to become proficient. Attention to detail and perseverance, together with the technical understanding of the lock, and mechanical aptitude are prerequisite to mastering the Art of Manipulation.