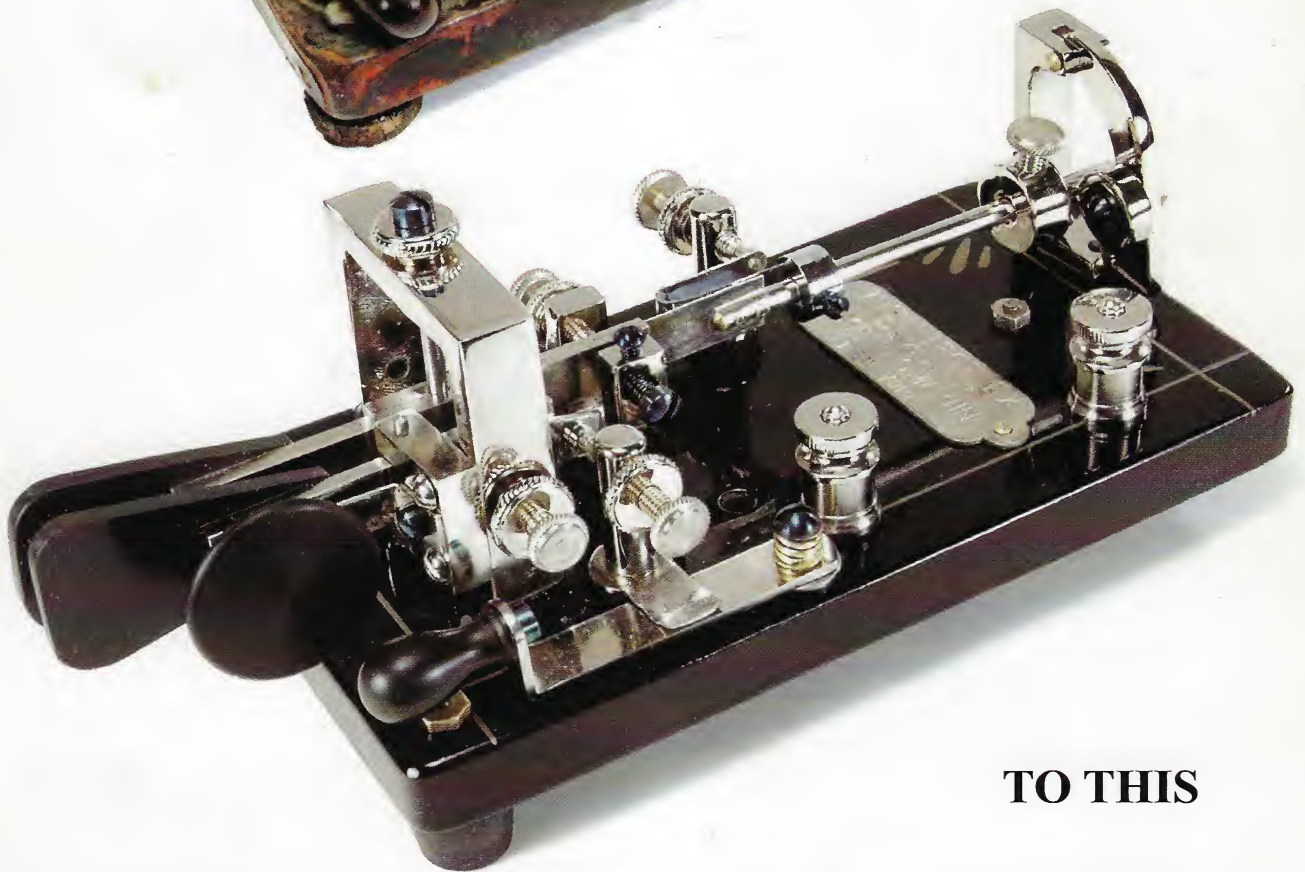


HOW TO RESTORE TELEGRAPH KEYS

FROM THIS



TO THIS

W. R. SMITH, BSME, FBHI, FNAWCC, CMC, CMW, CMEW, W4PAL.

How To Restore Telegraph Keys

By. W. R. Smith

**Second Edition
2006**

Text and Graphics
By W. R. Smith (W4PAL)

How To Restore Telegraph Keys

Every telegraph key collector has come across a key that seemed like a hopeless basket case. Other keys are missing parts or have broken parts that look unrepairable. Some are just plain dirty and need a good cleaning.

W. R. Smith, W4PAL has authored a book that addresses all of the above problems in a clear and profusely-illustrated manner. The 107 pages and 254 photographs provide the reader with a complete 'tool kit' of skills and techniques for every procedure.

Taking into account the collectors who do not want to do anything other than clean their keys, WR describes safe and effective techniques for removing dirt and rust. Calling upon his widely respected watch making skills, he describes the application of special clock-cleaning techniques and materials to the cleaning of keys. His strong emphasis on the importance of drying keys and using special rust inhibiting liquids will help readers avoid doing serious damage to keys in their well-meaning attempts to clean them. The book then presents information and techniques for japanning key bases and plating key bases and parts. His procedures for baking and plating bases read like recipes for fine French cooking. He describes several wonderful ways of removing rust that include electrolysis. He also provides an innovative solution to the common problem of a broken-off steel screw in a brass key part. His solution is to dissolve the steel screw leaving a nice clean hole.

Recognizing the desire of most collectors to take good photographs of their keys, he shows and describes lighting and background techniques that ensure excellent pictures.

The book then gives dozens of shop techniques and methods of fixing common key problems. This is followed by a section on how to make virtually every part of a bug. Techniques for punching holes in tempered steel, making missing bug weights, winding springs, and the mysteries of knurling are covered in a clear and expert fashion. The book then shows the use of these techniques in the complete reconstruction of basket case Vibroplex double-lever, model "X" and other bugs. Before and after photographs of Vibroplex Original and Blue Racer bugs and a McElroy teardrop bug are then presented. After reading the preceding sections, the reader recognizes that he now has all of the information necessary for every one of these procedures.

At the end of the book, WR shows some of his original designs for keys. These include the Monovert, a vertical bug, the Magnevert, a vertical bug with magnetic contacts, and the incredible Duover, a fully automatic speed key with a magnetic dash contact.

These extraordinary bugs provide a fitting ending for a book that will be an indispensable part of every collector's library and a classic for many years to come.

Tom Perera Ph. D. - W1TP
Professor Emeritus
Telegraph Museum: www.w1tp.com

How To Restore Telegraph Keys

Our little corner of the collecting world is blessed to have garnered the attention of W. R. Smith, a world renowned horologist (clockmaker), and the author of **How to Restore Telegraphic Keys**.

Raised on a farm in Atoka, Tennessee, WR became a competent watchmaker long before graduating high school. WR served in the Pacific during WWII, earning a Legion of Merit for his work on aircraft instrumentation, and finished his tour of duty in New Guinea flying for a year as a radio operator. He then went on to earn his degree in Mechanical Engineering and, amongst other accomplishments, served for 15 years as Chief Engineer of the world's first sector-focusing cyclotron at Oak Ridge, Tennessee.

WR has published numerous works, articles and instructional videos on clock building and repair, and has won several medals and awards in international competition in recognition of his clock building skills. WR has been involved in ham radio since 1930, has been a licensed ham radio operator, W4PAL, since 1946, and remains active on the air. This book is the fortuitous confluence of WR's many skills, his radio background, an insatiable desire to master mechanical devices and make them better, and to pass on all that he has learned.

Several of the lost causes depicted in the book were hulks in my junk pile awaiting cannibalization. Improvising and learning as he went along, WR created the fine specimens shown in the "after" pictures. And while he was at it, after a glimpse of the Vibroplex vertical, WR created the magnificent Monovert, Duovert and Magnevert "speed keys" featured in the final chapter of the book.

Is the book a work of art unto itself? I believe so, finding it to be a worthy addition to any telegraphic key and instrument collection. The book plumbs the secrets of WR's prolific workshop and mind. In it, this Modern-day Merlin imparts knowledge and skills in ways which will prove quite useful over time, from the simpler tasks of disassembly and cleaning, through refinishing surfaces, and, finally, through repairing and making replacement parts. WR has laid it all out with excellent photographic support.

I highly recommend reading the book cover to cover. You will find useful nuggets on every page, and will refer to it often as the bible of repair of semiautomatic keys ("bugs"). In fact, many of the techniques will also be applicable to the restoration of straight keys and telegraphic instruments (and watches and clocks if you are so inclined).

WR is a gifted craftsman and a natural teacher. Kudos to him for dedicating so much of his time and effort to this project, and for funding it out of his own pocket. The result would be a truly amazing achievement for someone half WR's age.

I am honored to know WR, and to have been chosen to write a foreword to his book. Many thanks to Shelby Rye, "Coach", AD4WQ, another Tennessean and bug aficionado, for having introduced me to this special gentleman.

Warren E. Berbit, K2UVV
BSEE, MSEE, JD

How To Restore Telegraph Keys

Many may wonder why anyone would wish to write a book on the restoration of speed keys, when so many collectors hold the word in such utter contempt. Some wish their keys to remain completely untouched. But others wish to be able to clean them without doing harm. Still others may wish to have them in good operating condition. Also, there are keys with missing parts that need to be made, broken mainsprings that need to be replaced, dot springs to be made, silver contacts to be machined, bent parts to be straightened, etc.

My association with Ham Radio began 74 years ago. In 1930 at the age of 10 I built my first speed key from a Ham magazine article. It was mounted on a wooden board and used a spring from my mother's corset. Two years later, I built a fully metal speed key. Sixty years ago, while a mechanical engineering student at The University of Tennessee, I made my first paddle to key one of the new electronic keyer circuits.

Following a recent return to Ham Radio, a friend, Shelby Rye (AD4WQ), learned of these keys and that I still had the paddle. He drove across Tennessee to see it and encouraged me to build another speed key. This aroused my interests again and I built the first new vertical speed key design in about 80 years—The Monovert. Following this, I designed and built the world's first fully automatic mechanical, vertical speed key—The Duovert. This was followed by the world's first combined vertical speed key/paddle using rare earth magnets—The Magnevert.

In checking the literature, I was amazed that I could find no book on the proper cleaning and repair of telegraph keys. Since such techniques are commonly practiced in the field of clockmaking, I decided to put the camera to work and write this, my eleventh book.

Despite the fact that I had a number of photographs from work I had already done on speed keys, many more were needed for the book. The additional keys were provided by my friends, Shelby Rye (AD4WQ), Warren Berbit (K2UVV) and Tom Perera (W1TP). I am grateful to them for allowing me to do whatever I wished to keys from their collections.

In reviewing the text, I discovered that I had not mentioned the use of Kroil. This is an excellent penetrant for loosening rusted screws. It is available from Kano Laboratories, PO Box 110098, Nashville, TN 37222. Phone:615-833-4102.

More keys have been destroyed by owners washing them in the kitchen sink than ever imagined. The trapped water rusts the screws, which twist off during removal.

The reader may wonder why I use an ammoniated, water based, clock cleaning solution, which requires thorough drying, when there are non-water based solutions available. There are several reasons for this. It is excellent for brightening dirty parts, dissolving solidified oil and removing corrosion. It is also a very good conditioner for bare metal that needs to be chemically cleaned before being plated. Thus, it eliminates the need for an additional cleaning agent when plating parts. Lastly, I have used the same water based solution successfully for 70 years and am very familiar with how to manage its use.

If the cleaning and drying techniques offered here help avoid the destruction of only a few valuable keys, the book will have served its purpose. I hope the high cost of color printing does not limit its distribution among collectors.

W. R. Smith (W4PAL) 2005

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CHAPTER 1

CLEANING AND MINOR REPAIRS

PHILOSOPHY

Aware of the strong feeling of many in the field of telegraph key collecting, I approach the writing of this book with considerable trepidation. It is not the intention here to encourage anyone to do any of the things described. Rather, it is the intent that those wishing to do such things be given ways to do them that will result in no harm to the key.

I come to key collecting from many years of watch repair, the design and building of clocks, an association with countless clock collectors and a mechanical engineering degree. Thus, I am very aware of the various approaches to the preservation of collectibles and these influences will be noted throughout the book.

The majority of clock collectors want their clocks to run. Thus, if a part has to be replaced, the original part is retained, the date of its replacement is noted and by whom and the part is returned to the owner along with the clock. This preserves the history of the piece and is a practice that is accepted by most collectors. There are exceptions, where the history of the piece is more important than its ability to run and it is never touched. I view telegraph keys in much the same light.

IDENTIFICATION OF PARTS

The significant parts of a typical key are identified in **Figure 1**.

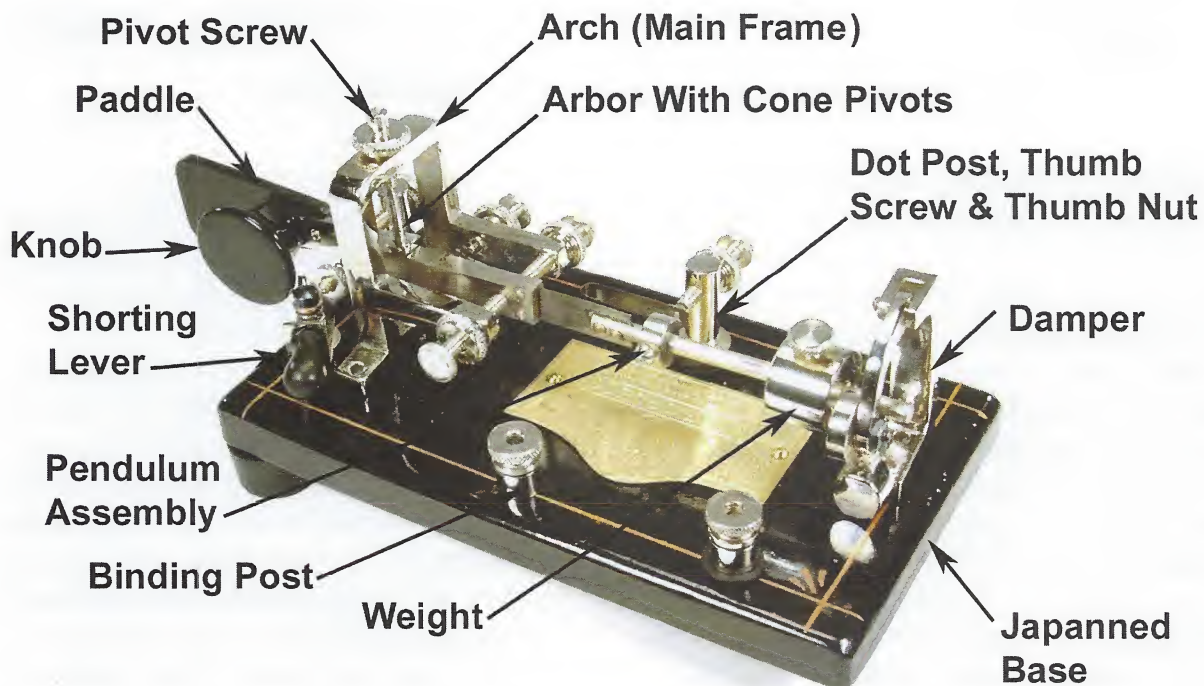


Fig. 1. A Typical Key With Parts Identification

It will be noted that I have broken step with some writers in the naming of parts. It is my belief that every part name should be descriptive enough that the reader can locate the

part by its name. The term pendulum comes from timekeepers, which predate speed keys by several hundred years. Key collectors usually refer only to the weight rod as the pendulum, but watch and clockmakers would consider the entire moving structure as the pendulum. Thus, I have named it "pendulum assembly." The "Dot Bar" is the bar portion of that assembly associated with making dots. The "Dash Bar," is that portion involved with making dashes. The "Weight Rod" is that rod on which the weights mount.

Another departure has to do with the names thumbnut and thumbscrew. A thumbnut has a knurled circumference and is for manipulation by the fingers. As such, it can be a nut that locks, but a hex nut, which is often a lock nut, can never be a thumbnut. Thus, I prefer the more correct use of thumbnut and thumbscrew for these rope-knurled parts.

Figure 2 shows a complete pendulum assembly, along with call-outs for its parts. These names will be used throughout this book.

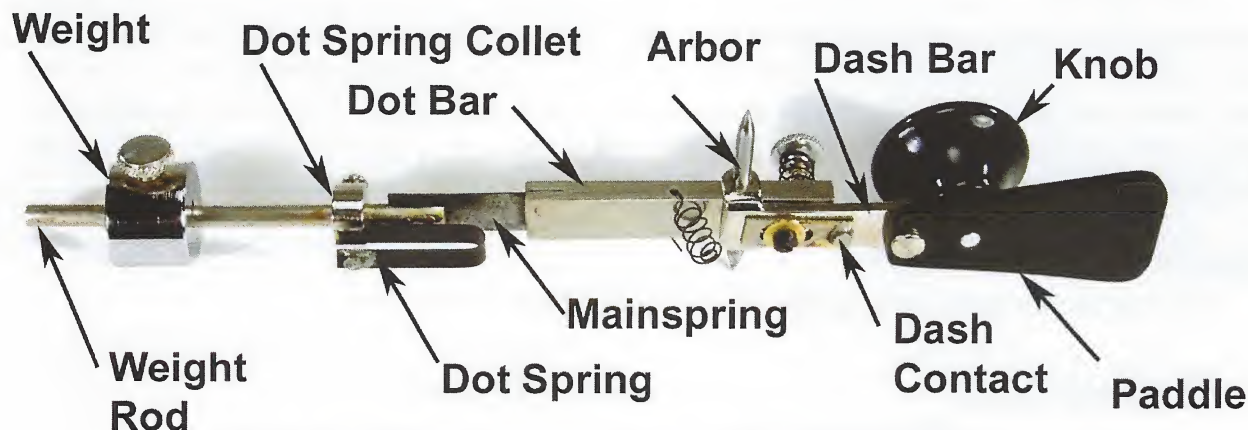


Fig. 2. Pendulum Assembly With Parts Identification

REPAIRS, CLEANING AND DRYING

Improper Cleaning Damage— Far too many collectors believe that cleaning a speed key requires very little thought. Put it in the kitchen sink, give it a bath and set in the sun to dry. Far too many do this to the detriment of their keys. Unfortunately, the sun will not drive out the trapped water, which will later cause rust and damage the key.

Let's examine some of the damage done to a key by this method. At a very minimum, water will reach the screw threads and the void behind the screws holding the feet in place. Rust will then freeze the screw so tightly that it will twist off flush with the base during attempts to remove it. Often one finds a key where the knob and paddle screws have been wet, rusted and locked in their holes. Quite often the knob must be shattered to remove its screw. Or the paddle screw, which usually twists off, must be drilled out and the hole re-threaded. These are very serious problems that will forever prevent the key from being in original condition. There is no simple way to remove the screw and preserve the original threads. The only hope is to try to drill as closely to the center of the screw as possible and enlarge the hole so it can be tapped for a larger screw.

As if this were not enough of a problem, there are usually others. The steel screws when wet can rust and freeze in the brass parts and later twist off flush with their surfaces. Later in the book I will be showing how to dissolve the steel screws without damage to the brass parts. However, the process is a long and involved one that should be avoided.

The attempt here will be to show how to clean a speed key without doing damage to it.

A typical 1922 Martin Junior key that is dirty and in need a few very minor repairs is shown in **Figure 3**. For the benefit of those who would like to do nothing to their key except remove the dirt, I will show a way to do this without disturbing the patina of the key. For those who would like to brighten the parts of the key, I will show how to do that.

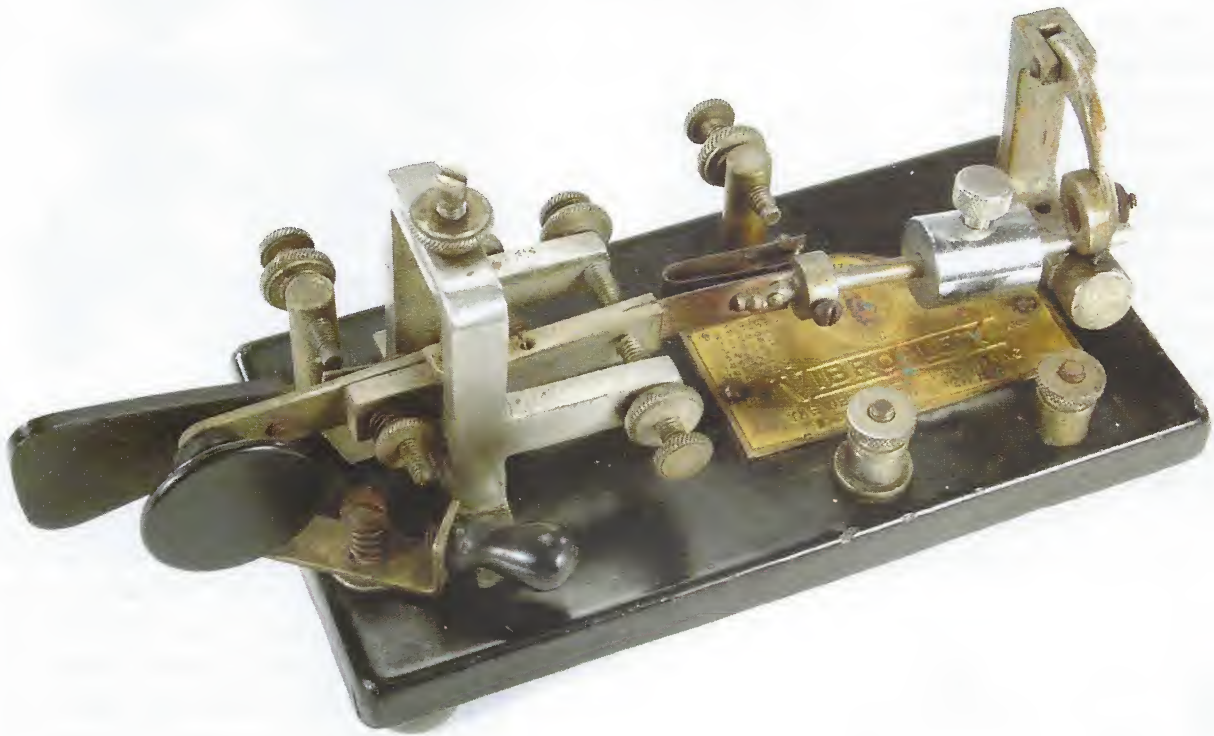


Fig. 3. A 1922 Martin Jr. In Need Of Cleaning & Minor Repairs

Examination And Repair Of Parts— On examination of the key, several minor problems were noted, including a severely bent mainspring. This is shown in **Figure 4**, where the damper has been swung out of the way to allow the weight rod to assume its unusual position. This must be corrected.

Fig. 4. Showing The Bent Mainspring

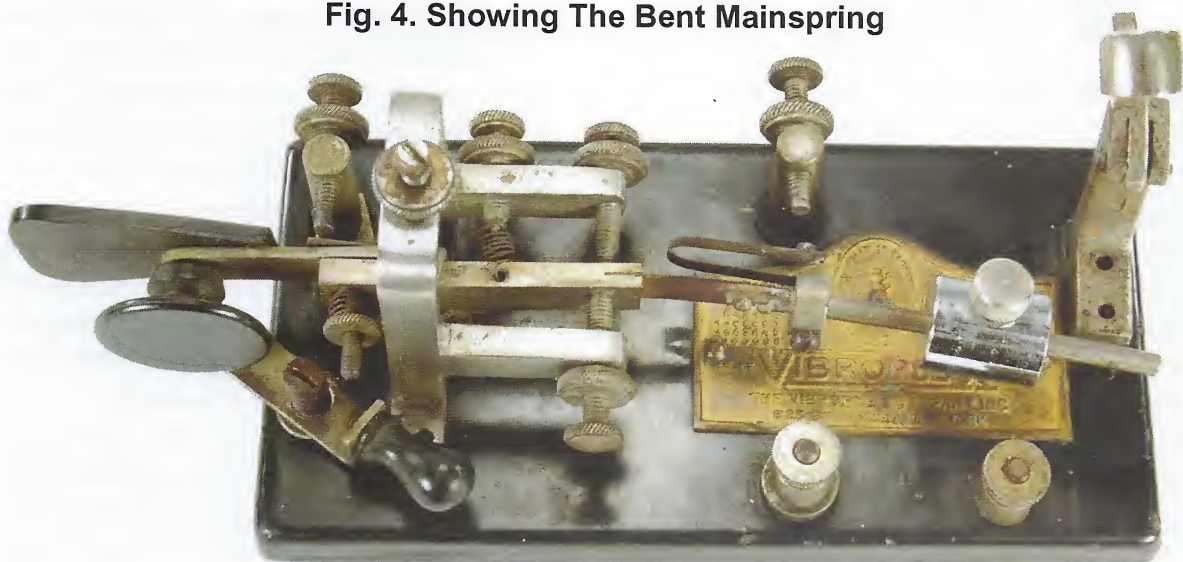


Figure 5 shows the disassembled key so all the parts can be carefully examined and problems corrected **before** cleaning. It was discovered during disassembly that someone in the past had installed an arbor that was much too long for the main frame, making removal of the pendulum assembly extremely difficult.



Fig. 5. The Disassembled Key

Figure 6 shows this condition. The first step must be the removal and shortening the arbor to a normal length.

How Arbors Are Secured In Dot Bars—To date, I have seen only four ways to lock arbors in dot bars. In the most common way, the manufacturer reams the hole in the dot bar and uses an arbor stock that is 0.001" larger in diameter. The arbor holes in the dash bar ears are made slightly larger in diameter than that of the arbor to provide clearance for the hinge action. The arbor is then pressed into the dot bar. This results in a very nice press fit that keeps the arbor well positioned without the need for screws or other fasteners.

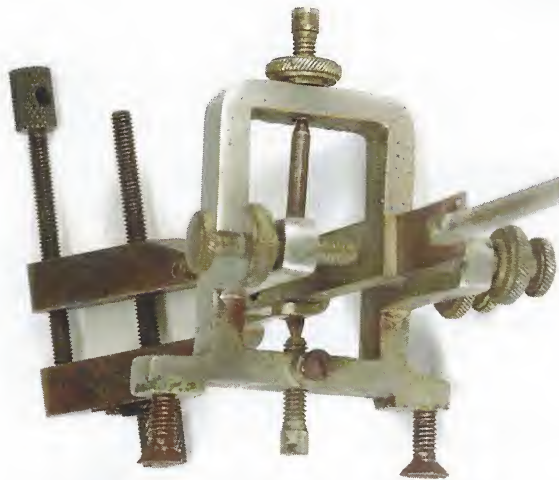


Fig. 6. The Main Frame Showing The Excessively Long Arbor

A second method of securing the arbor is to ream the hole in the dot bar to the same diameter as that of the arbor. A round-nose punch is then used to indent the side of the dot bar directly over the hole. This closes the hole slightly in the region of the dimple and allows the dot bar to grip the arbor when it is inserted. This solution is mechanically unsound, because the region of interference by the dimple is only a very small area.

The third way of securing the arbor in the dot bar is by the use of a cross-drilled screw hole. This hole is drilled through the side of the dot bar at 90 degrees to the arbor hole and almost touching it. The hole is threaded and countersunk to receive a screw and its head. With the arbor in place and the screw tightened, the screw head presses against the side of the arbor and captures it. To remove the arbor, one simply backs off the screw.

In every type of arbor installation, it is always possible to move the dot and dash bars up and down on the arbor so they can be correctly positioned to match the height of the damper and the contact thumbscrews in their mounting posts. In most cases, this requires the use of pry-bars and a protective brass washer to prevent scarring of the parts.

Removing Arbors— Simple miniature pry-bars are used in watchmaking and clockmaking to remove hands, pressed on wheels, and other friction fitted parts. **Figure 7A** shows a pair of such pry bars that I made from two 20-penny nails 70 years ago. The same technique can be used to safely remove friction fit speed key arbors.

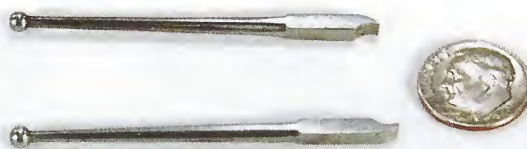


Fig. 7A. Miniature Pry-Bars



Fig. 7B. Pry-Bars Made From Screwdrivers



Fig. 8. Arbor Removal

To make them, I purchased two 10-inch screwdrivers, and removed the plastic handle without cutting the metal. Then the blades were heated red hot with a Butane torch and the ends were forged over a rod to curve them. There is no need for hardening and tempering. If concerned about harming the arbor, use brass chops. **Figure 7B** shows these pry-bars and a brass washer with a hole slightly larger than the OD of most arbors.

In use, one clamps the arbor upside down in the vise with the washer in place and the two pry-bars beneath it, as shown in **Figure 8**. One simply presses down equally on the two pry-bars to easily remove the arbor.

Often one finds a key with the dot bar positioned too high or too low on the arbor. The pry-bars also can be used to reposition the dot bar to the proper location with ease. In those cases where the arbor does not protrude enough for gripping in the vise, clamp it upside

down and use a wooden block with a hole in it and tap the pendulum to the desired location. This will be shown during replacement of the dot bar on the arbor.

Shortening An Arbor— My choice for shortening the arbor would be in a clockmaker's lathe, using a hand held graver to shorten and turn the new cone pivot. I would follow this by burnishing the pivot. However, since most who need to do this operation will not have a lathe, I am also showing a clockmaking trick that will allow it to be done completely by hand.



Fig. 9. Filing The Arbor Pivot

Figure 9 shows a wooden filing block with a slight "V" groove filed into the top corner. Place the arbor in a hand chuck and grind away the excess metal, leaving a rough conical pivot. Smooth the pivot cone to final shape with a clockmaker's fine cut file. As each file stroke is made, rotate the arbor toward the file. This will result in a cone pivot with a very smooth surface and without flats from the filing.

Such arbors are usually quite hard and an ordinary file may not cut them. Thus, the need for a clockmaker's # 6 cut pillar file, which will cut much harder metal. Such a pillar

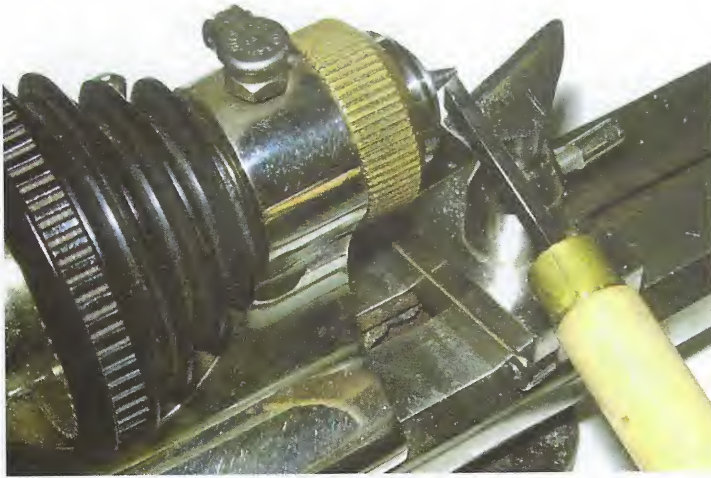


Fig. 10. Turning A New Arbor Pivot

GRAVER MAKING AND HAND TURNING (Ref. 3).

Since the graver has a polished cutting edge, it cuts a polished surface. Thus, no further finishing of the cone pivot is required. The new cone pivot is shown in **Figure 11**. The other pivot has also been dressed. One must be very careful not to polish the area of the arbor OD that presses into the dot bar or the arbor will not be a press fit.

Replacing The Arbor— To replace the arbor in the dot bar, determine the area of the arbor where the dot bar was positioned before being removed. Clamp the arbor in a bench vise with this portion upward. Place the dash bar on the dot bar and align the arbor holes. After making certain that the dot and dash bars are upside down, drop the assembly over the arbor. Place a wooden block with a hole in it slightly larger than the arbor over the assembly. Tap lightly with a hammer, **Fig. 12**. Never drive the dash bar ear into the top of the vise. This would close the ears and cause them to grip the dot bar and be a source of unwanted friction.



Fig. 12. Arbor Reinsertion

file is available from Cas-Ker (**Ref. 1**). If an arbor is found that is still too hard to be cut with the above file, heat the pivot until it turns blue. This should lower the temper enough to allow filing.

Figure 10 shows the normal turning that I do with a hand held graver at the clockmaker's lathe. This graver is made from a Mo Max, Super Cobalt, M-46, lathe bit from Tru-Kut Inc. (**Ref. 2**). A cutter this hard is required when turning tempered steel. For those interested in hand turning, see my 2 hour video,



Fig. 11. Refinished Arbor

When there is a need to replace an arbor completely, go to the local hobby shop and purchase a straight length of 1/8" music wire. This material is already hardened and drawn to a bright surface. All that is required is to cut it to length and turn a new cone pivot on each end. However, the material is extremely hard and the turning will require the use of the M-46 steel mentioned above.

Place the pendulum assembly in the main frame and determine if the adjusting screw in the arm of the main frame is centered on the dot bar. If not, adjust the position of the pendulum assembly on the arbor and recheck its position

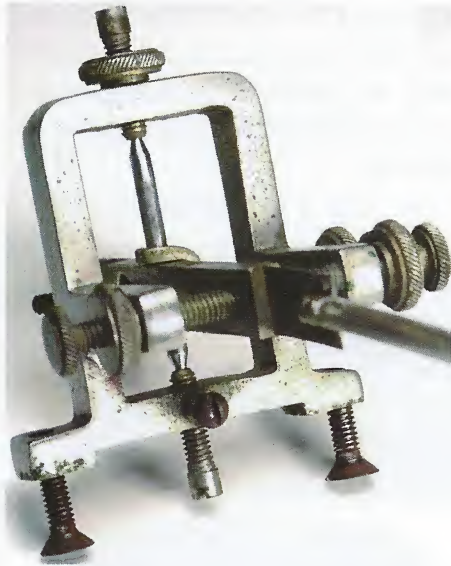


Fig. 13. Arbor Adjustment

with regard to the adjusting screw. Note how the dot bar is properly centered on the adjusting screw in **Figure 13**. Also, note that the arbor has been positioned such that there is roughly the same amount of each pivot screw projecting into the main frame. This arbor is now the correct length and the pendulum assembly can be easily removed from the main frame by backing out only the top pivot screw. Before shortening the arbor, the top pivot screw had to be removed completely to free the pendulum assembly.

Cleaning The Parts—I usually clean a key in three groups, the superstructure, the base and the pendulum assembly. Those who only want to remove dirt from the key without brightening the metal parts should simply scrub the parts in soap or detergent and water with a fingernail brush and then dry them as discussed later.

Figure 14 shows all the parts except the base and the pendulum assembly strung in groups on # 22 gage wire for cleaning in a solution that will brighten the parts. The pendulum structure and base are not shown here because they require different cleaning treatments.

For this type of cleaning, I use a special clock-cleaning bath in a one-gallon pickle jar with a wide mouth. Pour one pint of ammoniated watch and clock cleaning concentrate in the jar and add enough tap water to fill it. This product is available as Catalog # 231.0251 from Cas-Ker (Ref. 4). **Figure 15** shows the parts on wires hanging in the solution. This bath cuts dirt, brightens the metal parts and loosens rust.



Fig. 14. Parts For Cleaning



Fig. 15. Cleaning Parts

Never leave the parts immersed for more than about a minute before examining them. Too long in the solution may cause it to attack the plating. Less time may be required for a very old key with thin plating. After the bath, rinse in running water, immerse in denatured alcohol and then dry with heat or sawdust as described in a later section.

Never contaminate this solution with key parts that have been sprayed with WD-40. It can only be cut with more WD-40, or other products such as carburetor cleaner, and will ruin the cleaning solution. The WD-40 always must be removed from the key before placing the components into the clock cleaning solution.

The Ultrasonic Cleaner— For the cleaning of very stubborn parts, I often use a soap and water solution in a



Fig. 16. Ultrasonic Cleaner

small ultrasonic cleaner such as shown in **Figure 16**. This unit has a built in heater and a capacity that is nice for small objects. However, ultrasonic cleaners must be used with considerable skill, because they work very fast and extremely vigorously. This unit is available from Cas-Ker (**Ref. 5**).

The Base— This particular key has a japanned base that needs little more than a good bath. About all that one needs for this cleaning job is soap and water and a hand brush, **Figure 17**.

Since the base is not being refinished, the label should remain in place. If work were to be done on the base, the brads would have to be removed as well as the lacquer from the label so it could be cleaned. Then, it would need to be re-lacquered and reinstalled. That is not the intent of this chapter on simple cleaning and will be dealt with later.

After scrubbing, it is essential that the base be carefully rinsed in water. Dry it on a towel and place it in a toaster oven at 150 degrees F for thirty minutes to be certain that all of the moisture has been driven from the screw holes. This temperature will not harm it.

The Pendulum Assembly— It is now time to tackle the pendulum assembly. First, the mainspring must be straightened. There is no solution to this problem but a very judicious bending of the spring. Only those of us capable of replacing such a spring are



Fig. 18. The Straightened Mainspring

ever very comfortable doing this bending, because the spring must be bent beyond its elastic limit in order to be straightened. The breaking point is just beyond this limit, but you have no other choice. **Figure 18** shows the spring after being straightened. Should the spring break while it is being straightened, it will require replacement. The technique for this will be discussed later in the book. The weight rod was also bent and had to be straightened. Weight rods are usually made of soft brass and are easily straightened.

Although the attempt here is to show a way to clean a key without harm, I do not consider dirt or rust to be patina. Rust is so destructive that it must always be removed from some portions of the key and the part treated to avoid further rusting. For this simple cleaning, I will not refinish the screws but will coat them with oil for added protection. However, the mainspring and the dot spring are another story. I have seen keys with them so badly rusted that they could no longer make the required number of dots. Thus, the rust must be removed and the springs treated to prevent further rust.

The Glass Bristle Brush— One of the most important tools for those who work on keys is a brush having glass fiber bristles. These brushes appear to be used only in the watchmaking and clockmaking fields. The ends of the glass fibers are very sharp and cut



Fig. 17. Hand Brush For Cleaning

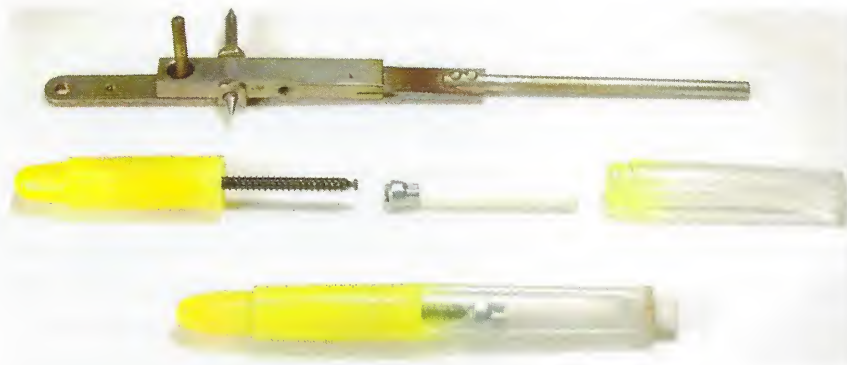


Fig. 19. Glass Fiber Rust Removal Brushes

rust faster than anything I have ever found. **Figure 19** shows the excessive mainspring rust and two of the brushes. Refills are available for the brushes; however, they require a bit of preparation before they can be inserted. The refill elements are supplied round with the fibers bonded with something

that makes them quite rigid. The opening through which the bristles must emerge is flat, narrow and rectangular. Thus, the inserts must first be placed in the jaws of a vise and squeezed flat before installation, or the holder will self-destruct while trying to force the bristles through the end of the tool. As the glass fibers break during use, one turns the knob at the rear of the brush to expose new material. The brushes are absolutely essential for key work. They are available from Cas-Ker Co., as Fiberglass Scratch Brush and refills (**Ref. 6**).

Rust Preventative— After removing the rust with the brush, clean the part in the clock cleaning solution, rinse it in water, then in denatured alcohol, and dry it for about 15 minutes in a toaster oven at 150 degrees F. My bench has a swinging arm lamp with a 100 Watt bulb in its reflector. I often turn the reflector upside down and lay such a part in it touching the bulb.

The spring must next be protected from further rust. Mix a few drops of boiled linseed oil with a few drops of paint thinner, dip a pipe cleaner in the mixture and coat the bare spring as shown in **Figure 20**. I have seen keys from the 1920's with bare springs protected in this manner, which showed no signs of rust.

Drying— Complete and absolute drying of the parts is the most important step in the entire cleaning process. The parts must be dried before rust sets in. The literature states that a steel part will begin to rust within ten minutes after exposure to moisture. Thus, every effort must be used to avoid that possibility. The surest way to avoid the problem is to quickly dry the parts with a towel while still on the wire after the water rinse. Then immerse them immediately in denatured alcohol to rid them of the remaining moisture. Follow with oven drying to achieve complete drying.

From this point, there are two ways to go and both are useful—heat or sawdust. But each must be used selectively. Heating the part in an oven, as described above, is by far the surest and best way to dry the parts after they are removed from the alcohol.

Boxwood Sawdust— Watch and clockmaker's have used warm boxwood sawdust for generations for drying watch and clock parts. Both the large and small dust size particles have been removed from the sawdust, leaving grains about half the size of ground coffee. This is kept warm and as soon as the parts come out of the alcohol, they are quickly dried



Fig. 20. Treating Mainspring



Fig. 21. Sawdust Drying

on a towel and dumped into the box of warm sawdust. One of my boxes with some key parts in it, is shown in **Figure 21**. After shaking them well, they are removed and any excess sawdust captured in the parts is removed with a brush or toothpick. This boxwood sawdust is available from Cas-Ker Inc., (Ref. 7). The sawdust drying is adequate for any part that does not have a small cavity in which the rinse water or alcohol can be trapped touching steel. This method should not be used for drying pendulum assemblies because water can be trapped in the slots where the mainspring is riveted.

remaining part to be cleaned. These are usually quite rusty. We will use a new material that very few are familiar with, to remove the rust,—abrasive blocks. These rubbing blocks contain very fine abrasive particles and are available in various sizes and shapes in coarse, medium and fine grit. A fine grit block (Ref. 8), **Figure 22**, is absolutely essential when dealing with telegraph keys of all sorts. They can be cut with a pocketknife, are flexible and are excellent for refinishing parts.

Abrasive Polishing Blocks— The dot spring is the



Fig. 22. Abrasive Block

This material will be used to clean the rust

from the inside of the dot



Fig. 23. Rust Removal

spring. The glass fiber brush cannot reach inside the spring well enough to do the job. However, a piece of abrasive block can be cut to enter this area easily and will quickly remove the offensive rust, as shown in **Figure 23**. For cleaning rust from the outside of the spring, place a thin piece of wood inside the spring and use the glass bristle brush. After the rust is removed, coat the spring, but not the contact, with the linseed oil mixture to prevent rusting.

the knob. During assembly, a small piece of the neck broke free. This was re-bonded with 5 Minute Epoxy and left overnight. The next morning the knob was chucked in the clockmaker's lathe and machined with a round, hand-held graver, as shown in **Figure 24**. This is another example of how hand turning can often do a job easily and without the need for form tools, as normally practiced in machine shop work.

Repairing The Knob— It was noted that rust on the knob screw had caused it to swell and crack the Bakelite neck of



Fig. 24. Turning The Knob

Silicone Grease— A machined surface on a molded plastic item, like the knob, usually leaves a

frosted appearance. A nice satin finish was produced on the knob by rubbing it with the abrasive block material and then coating it with Silicon Grease. This grease, often called stopcock grease, can be purchased at automotive stores as a dielectric coating for ignition wires and other waterproofing needs. A tube of this is illustrated in **Figure 25**.

Old English Furniture Polish— A very useful agent for brightening old key bases is Old English, Red Oil Furniture Polish. This is available in most stores and has been used for many years on black crackle electronic equipment, speed keys, etc. Just rub on a coat and wipe with a cloth.



Fig. 25. Silicone Waterproofing Grease

Adjusting The Key— After cleaning and making any needed repairs, give the key base a coating of silicone grease and rub away the excess. Assemble the parts and make the necessary adjustments.

Use the dot bar thumbscrew to make the weight rod touch the damper and lock it. Set the motion of the dot bar at the thumbscrew to about 1/16 inch and lock the thumbnut. Attach a code oscillator and adjust the dot contact screw for good dots and lock its thumbnut. Set the dash screw for about 0.020" gap and lock its thumbnut. Use a relay contact file to brighten the surfaces of the dot and dash contacts. This completes all work on the key.

Choice Of Key— Many may wonder why a far dirtier key was not used to illustrate the cleaning process. Such a key would have offered a more impressive result. However, experience has shown that keys in that condition, more often than not, require extensive repairs that would have distracted from what I wanted to address in this chapter. These will be treated more fully later during the restoration of basket case keys, those in such poor shape that most would consider them to be a virtually hopeless task.

The speed key is now clean, the dot spring and mainspring have been treated to prevent future rust, giving the key many more years of useful life. The arbor is now the correct length, which allows easy removal of the pendulum assembly, and the key performs nicely. It is shown in its final form in **Figure 26**. The large weight is as received.

Fig. 26. The 1922 Martin Jr. After Cleaning & Making Minor Repairs



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1. Regular Pillar File, 6" length, # 6 cut, Catalog # 311.249, available from Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH. Phone: 1-800-487-0408.
2. Mo Max Super Cobalt lathe tool bits, EDP #C44567, available from Tru-Kut Inc., 1121 Spring Street, N. W. Atlanta, GA 30309. Phone: 800-282-4061.
3. Graver Making And Hand Turning, 2-hour video available from W. R. Smith, 8049 Camberley Dr, Powell, TN 37849, Ph. 865-947-9671.
4. Ammoniated Clock Cleaning Solution, Cat. # 231.0251 from Cas-Ker Inc., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 1-800-487-0408.
5. Ultrasonic Cleaner, Cat. # 230.091, from Cas-Ker Inc. 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 1-800-487-0408.
6. Scratch Brush, Cat. # 160.330. Refills # 161.331 from Cas-Ker Inc., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 1-800-487-0408.
7. Sawdust, 1 Lb., Cat. # 231.0530. Cas-Ker Inc. 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 1-800-487-0408.
8. Bergeon Polishing Block, Fine, Cat. # 100.742. Cas-Ker Inc. 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 1-800-487-0408.

CHAPTER 2 JAPANNING A KEY BASE

To Refinish Or Not To Refinish— Again I feel the need to remind the reader that it is not the intent of this book to encourage anyone to do any of the operations described. Rather, the purpose is to offer successful ways to accomplish those tasks if the reader wishes to perform them. The object of this chapter is to illustrate how to refinish the badly

damaged japanning of a speed key base such as shown in Fig. 1.



Fig. 1. The Base To Be Japanned

Speed Key Base Finishes— Before the advent of modern paints, japanning was used very often as a treatment for the protection of metal surfaces. Ford used it on the Model T and Singer used it on the foot-pedaled sewing machines. Many speed key bases also were

japanned. The slightly more expensive key bases were nickel-plated.

The japanning varnish formed a very hard, jet-back coating that was durable and had a most attractive high gloss surface. The fact that keys can be found today that are 100 years old and still have a good finish is a testament to its durability. The history of japanning and its major component, asphaltum, is a rather interesting story.

Asphaltum— This material is said to have formed in vertical veins about one million years ago when a viscous hydrocarbon lost its volatile constituents and solidified into a glossy, black, solid hydrocarbon. Its appearance is similar to coal. It is brittle, lightweight, can be crushed and, depending on the grade, melts at between 300 and 400 degrees F.

A vein of it was discovered in Utah by Samuel Gilson in 1885 and he named it Gilsonite. Its first uses were for painting buggies, lining beer vats and waterproofing lumber for docks. Since then, its uses have grown amazingly. However, other more modern materials have replaced its use as a metal coating.

The Varnish— Some of the earlier formulas for japanning varnish required the melting of asphaltum at 350 to 400 degrees F during the mixing with turpentine—a rather dangerous exercise. It is likely that this was needed because, at that time, the asphaltum came in lumps like coal. However, it can now be purchased in powder form that has been processed to remove rock and other contaminants. This allows cold mixing in the home workshop. I know of no reliable source for true japanning varnish.

The literature offers a confusing number of formulas for japanning varnish. The one that has proven to be the easiest to mix and use is a cold mix, consisting of 2 parts of boiled linseed oil, 5 parts of turpentine, 3 parts of asphaltum powder and 3 parts of rosin. Lamp black or carbon black is sometimes added but they are not needed for key base use and usually cause more problems than they solve. It is wise to mix the varnish outdoors

because the smell is a lingering one. Containers of asphaltum and rosin are shown in **Fig. 2**.

At the time of writing, one of the firms from which the asphaltum and rosin can be purchased is Rembrandt Graphic Arts Company (**Ref. 1**).

Some users of home-mixed varnish have reported that a smoother finish results if no rosin is added to the mixture. Numerous tests in my own shop have shown this to be quite true.

To avoid clumps while mixing the varnish, add very small amounts of asphaltum to the turpentine while stirring. Add rosin in small amounts after all asphaltum has been dissolved.

It has been suggested that warming the mixing bowl over boiling water shortens the mixing time considerably. However, it will be found that to obtain a smooth consistency, a considerable amount of mixing time is required.

After mixing, it is wise to strain the varnish through a couple of layers of reasonably close-knit, lint free, cotton cloth to remove grit and any undissolved components. Be extremely cautious handling items wet with linseed oil. This material is spontaneously combustible and could easily start a fire. Never put waste saturated with it in a wastebasket. Straighten the pieces of cloth or paper and lay them outside to



Fig. 2. Containers Of Asphaltum & Rosin



Fig. 3. Japanning Varnish & Brush

dry before disposing of them.

Figure 3 shows a small jar of home-mixed japanning varnish and a soft bristle (camel's-hair), brush for applying it. These brushes are available at most art supply stores. If unavailable, most any soft bristle brush can be used. Clean with paint thinner.

Preparing The Base— The old japanning varnish on speed key bases can be removed easily in fifteen to thirty minutes with most commercial paint removers. Prepare the base for this as follows. After the hardware and feet have been removed, straighten the brads and remove the label. These are simple dome-head, brass brads that have been annealed by the factory for easy bending. On the bottom of the base, slip a wood chisel under the bent end of the brad and lift it enough to be gripped with a pair of flat nose pliers. Do not allow the chisel to mark the wall of the brad. Straighten it as much as possible and drive it free of the base.

If the wall of the brad has not been scored with the chisel, and does not crack while being lifted, it may be possible to anneal and reuse it later when reinstalling the label.

Figure 4 illustrates the lifting of a brad with a small wood chisel. Some brads are not bent but are large in diameter and have their ends bradged on the underside of the base. Most, however, are of the brad type and are bent on the underside of the base. All I have seen are brass.

Removal of the old japanning is best done outdoors near a water faucet. Place a bent wire in the bottom of a loaf pan, to space the base from the pan so the paint remover can easily reach the underside of the base, **Fig. 5**. Place a wire through one of the holes in the base for ease of handling.



Fig. 5. A Loaf Pan with Bent Wire

Lay the base on the bent wire in the bottom of the loaf pan, **Fig. 6**, cover it with paint remover and allow it to stand for 15 to 30 minutes. By then the varnish should be free enough to be pushed off the surface with a brush. In stubborn cases, it may be necessary to discard the old paint remover and apply a fresh coating for a longer time.

When all the old varnish has been removed, rinse the base thoroughly in tap water and use a toothpick, or other object, to clear the dead paint from inside the holes. Dry in a toaster oven at 150 degrees F for 30 minutes. The base stripped of the japanning is shown in **Fig. 7**.



Fig. 7. The Stripped Base

to prevent it from moving. Paper the surface with an orbital sander and 100-grit emery paper. This is only to remove the sharp points that could stick through the varnish. It would be unreasonable to try to remove all of the sand mold marks. Key makers seldom made any serious attempt to remove the marks before japanning their bases.

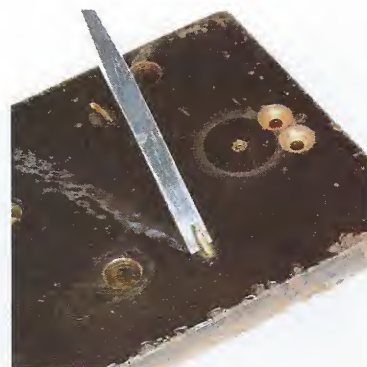


Fig. 4. Brad Removal

Be certain to wear eye protection. There is a great danger of the base slipping during handling and causing the paint remover to splatter. For this reason, the handling wire is an added protection. Wear rubber gloves and avoid all skin contact with the paint remover. It is a very offensive material, burns the skin almost instantly and could cause blindness



Fig. 6. The Base In The Pan

Smoothing— Key bases are usually cast iron that has been poured in a sand mold. This often leaves sharp pips in the surface. These cause problems by sticking through the various coats of japanning varnish and they should be removed. A very simple way to do this is to lay the base on a board and drive finishing nails around it

to prevent it from moving. Paper the surface with an orbital sander and 100-grit emery paper. This is only to remove the sharp points that could stick through the varnish. It would be unreasonable to try to remove all of the sand mold marks. Key makers seldom made any serious attempt to remove the marks before japanning their bases.

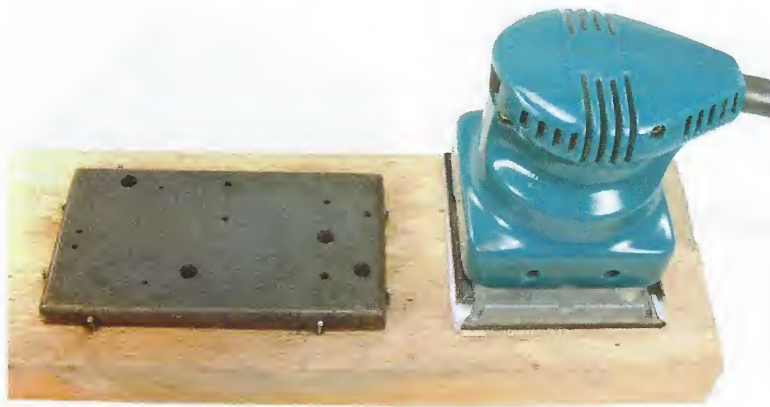


Fig. 8. Papering The Base

The setup for papering a base is shown in **Fig. 8**. Using wet or dry paper and water speeds up the process but is very harmful to the orbital sander.

At times, one encounters a base with cavities in the casting. These can be filled with Lab-metal before jpanning . This material will withstand the baking temperature and comes in two temperature versions, 350 degrees F and 1000 degrees F,

and has a very short shelf life. A can of each type is shown in **Fig. 9**. It can be purchased from Alvin Products (**Ref. 2**).

Rust Removal— By far the best rust removal method for a cast iron key base or steel base is by electrolysis. This is a simple process and can be done by anyone. Purchase a typical wall-wart having an output voltage of 6 or 12 volts DC and at least 1/2 ampere current capacity. Also, a container will be required to hold the electrolyte solution.

Since the electrolysis action does not affect 18-10 stainless steel, I purchased such a bowl from Wal-Mart. Iron plates could be used in a plastic container but it is difficult to arrange such plates to completely surround the base for the line-of-sight action desired for electrolysis. Thus, I prefer the solid container of stainless steel.



Fig. 10. Rust Removal From The Base



Fig. 9. For Patching Casting Holes

Suspend the base on two wires from a wooden rod laid across the top of the container. Connect the negative lead from the wall-wart to one of these wires. (A red alligator clip is the only color I had.) Attach the positive lead either to the iron plates submerged in the solution and spaced around the base or to the stainless bowl. A base arranged for de-rusting by electrolysis action is shown in **Fig. 10**.

The Electrolyte— Mix a solution of one tablespoon of washing soda (sodium carbonate), not baking

soda (sodium bicarbonate) to one gallon of water. Cover the base with this, plug in the wall-wart and look for bubbles rising from the base. If none are seen, check for a poor connection. The action is self-limiting and can be left unattended for extended periods.

Drying— After de-rusting, ferrous metal will begin to rust in about ten to fifteen minutes. It is imperative that it be dried properly and quickly. Remove the base from the washing soda solution and rinse it thoroughly in water. Dry it on a towel and rinse it in denatured alcohol, dry with a towel again and place it in a toaster oven at 150 degrees F for about 30-minutes. When cool, the base is ready for the application of the japanning varnish.

Japanning The Base— In each of the foot screw holes, install a screw that protrudes about 3/4" from the bottom of the key base. Lay the base upside down on a piece of clean paper. Using a 1" or 3/4" wide camel's-hair brush, apply a uniform coat of japanning varnish to the bottom of the base. (It is best not to stir the varnish before use. Some of the offensive material, missed by the straining and settled to the bottom, could cause bumps in the varnish if stirred.) Do not try to apply excessive varnish or it will form droplets on the bottom side of the base that must be removed with a knife after baking. Turn the base over, stand it on the screws and apply varnish to the edges and then to the top surface.



Fig. 11. The Toaster Oven & Key Base

There are two choices before starting the baking cycle. The base can rest in a dust free place for two days or it can be taken directly to the toaster oven, **Fig. 11**, at 125 degrees for 2-1/2-hours. I prefer to go directly to the oven and allow the low heat to do the same job of evaporating the volatiles that resting at room temperature for two days does.

Set the base on a 1/16" thick sheet of steel and place it in a toaster oven. This first stage cannot be rushed. If too high a temperature is applied to the base before the remaining volatiles have had time to evaporate, large bare spots or brush-like streaks will appear in the varnish. **Figure 12** shows a large bare spot on the base caused by this.

Most instructions for japanning state a baking process with a cooling period between bakes. My experience has shown that cooling between bakes is not required. Thus, I go directly from one baking temperature to the next. This avoids a great loss of shop time.

After the 2-1/2-hours in the 125 degrees F oven, it is time to start the baking cycle. Set the oven at 150 degrees F and bake for 1-hour, then at 200 degrees F and bake for 30-minutes. Next, bake at 250 degrees F for 30-minutes. Follow this at 300 degrees F for 30-minutes, and finally 350 F degrees for 1-1/2 hours. When cool, it should not be possible to mark the japanning with the



Fig. 12. Temp Too High Too Quickly



Fig. 13. The Support Screws

varnishing and baking process.

Quite often, small inclusions appear in the varnish as minute grains after a baking cycle. When they occur, they must be removed. Wrap a small patch of 600 grit, wet or dry emery paper around a half wine cork (sawed axially), **Fig. 14**. Wet this and rub the surface to remove them. This should be done following each baking cycle.

At times, varnish will be stripped off the brush as it crosses the holes in the base. This excess varnish will collect as a drop on the bottom of the base and will not cure during baking. Cut these off smooth with the surface with a pocket knife before each baking cycle.



Fig. 15. A Buff, Arbor & Dressing

The Pin Stripes— There are a number of ways to pin stripe a base. I have used a draftsman's ruling pen and gold paint and also a commercial gold paint pen from an art supply store. Each of these work but I prefer the latter.

To simplify the pin striping effort, a homemade ruling guide must be made to guide the pen while drawing the stripes. It must rest against the side of the base to provide a straightedge that stands above the surface

fingernail. If it can be marked, return it to the oven for a longer bake at 350 degrees F.

Experience has shown that a minimum of five coats of varnish will be needed for a good finish. Each coat requires the same complete baking cycle.

Figure 13 shows temporary feet (tapered screws) for handling and supporting the base during the

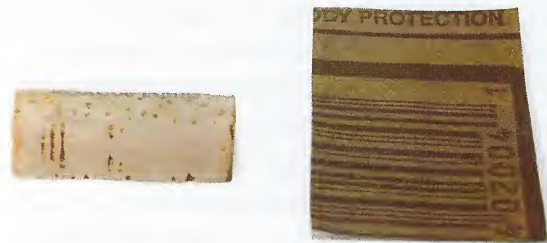


Fig. 14. Emery Paper & 1/2 Cork

Figure 15 shows a muslin buff, an arbor for chucking it in a drill motor, and tripoli and red rouge polishing compounds. Clamp the drill motor in a bench vise to simulate a buffing machine and use the polishing compounds on the buff to produce a highly polished surface.

After buffing, thoroughly wash the base with detergent and water to remove the polishing compounds and dry it in a toaster oven at 150 degrees F for 30-minutes. **Figure 16** shows the japanned base.



Fig. 16. The Japanned Base



Fig. 17. Top View Of Straightedge

touching the paint. For the same reason, the spacer must be shortened to a dimension less than the distance between the pin stripes on the ends of the base. This will allow the guide to be put in position for drawing the long stripes without smearing the freshly drawn end stripes. **Figure 18** shows the underside of the ruling guide, as described above.

The pen used for the pin striping is called a paint pen. It is available from art supply

of the base and serves as a guide for the pen. **Figure 17** shows such a device. It is composed of a wooden base, a 1/16" thick brass spacer and a 1/32" thick brass top strip. This top strip can be positioned and locked from 3/8" to 1/2" inward from the edge of the base to guide the pen. The spacer positions the straightedge above the surface of the base to prevent the guide from



Fig. 18. Straightedge, Bottom View

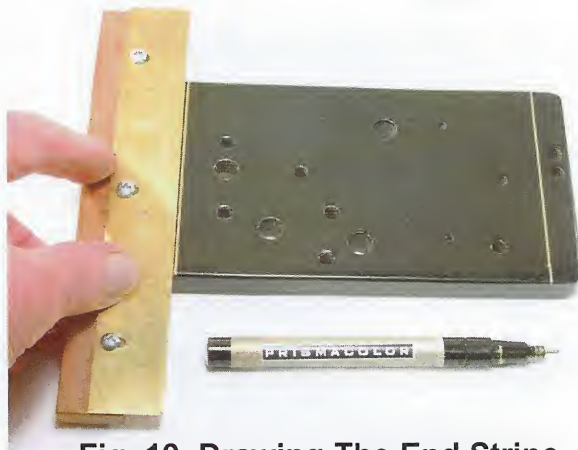


Fig. 19. Drawing The End Stripe

end of the base, as shown in **Fig. 19**. Shake the paint pen vigorously to mix the paint, place it against the straightedge and draw the gold line. Move the guide to the other side of the base and draw the other line there.

While the end stripes are still wet, lay the straight edge against the long edge of the base, **Fig. 20**, being careful to center it so the spacer will not touch either of the freshly drawn end stripes. Also, do not let the guide tip over and touch the wet end lines. Draw the pin stripe on one side of the base and then the other. Allow these stripes to dry for about 30-minutes. Use the paint pen to draw the tick marks inside the stripes.

stores in larger cities or from Sandford Company (**Ref. 3**). It contains a gold liquid, which is probably a lacquer.

Adjust the top strip to position the guide at the desired distance inward from the edge of the base. Position the guide across the



Fig. 20. Drawing The Long Stripes



Fig. 21. The Japanned Base

oven and bake it at 350 F for 1-hour to set the stripes. I have learned that both gold paint and the paint from paint pins are prone to smear if touched with hydrocarbons such as gasoline, lighter fluid, etc. The baking at 350 makes the stripes more resistant to these things. This concludes the work on the base and all that remains to be done is to clean and install the label. **Figure 21** shows the japanned base with the pin stripes and tick marks added.

Installing The Label— Clean the label in clock cleaning solution, rinse it in water, dry it and dip it in clear lacquer. Shorten the brads, polish and dip them in lacquer. Mix 5 minute epoxy and apply a small dab in each hole with a toothpick and place the brads in their holes. This does not harm the base because the brads and epoxy can be drilled out if there is a ever need to remove the label.

Figure 22 shows the newly japanned and pin striped base with the label attached.

Fig. 22. The Completed Base



REFERENCES

1. Asphaltum and rosin available from Rembrandt Graphics, PO Box 13, Rosemont, NJ 08556-0666. Phone: 800-622-1887, Fax: 609-397-0666. The current prices are:

Pt. #	Mat'l.	Cost
4003	Asphaltum	\$2.40/lb.
4120	Rosin, Fine Powdered	\$5.35/lb.

2. Lab Metal, 350 degree F and 1000 degree F, available from Alvin Products, 350 Merrimac Street, MA 01843. Phone: 978-975-4580.

3. Paint Pins, item No. 03532 (PM 120) Fine, available from Sanford, Bellwood, IL 60104.

CHAPTER 3 THE PLATING OF KEY PARTS

To Plate Or Not To Plate— Because I will be dealing with plating in detail in this chapter, some may say that I **advocate** the re-plating of keys just to make them pretty. Nothing could be further from the truth. During the repair of speed keys, one often becomes backed into a corner. The color of a new part made of brass, no matter how well made, doesn't match the other plated parts of the key. Thus, the new part needs to be plated. However, new plating will then not match old plating of the key. Thus, if one is to have a key with a uniform appearance, it usually means that the key must be re-plated.

There are also other reasons for plating key parts. Often one encounters a key having been mutilated in one way or another—a double lever converted to a single lever, main frames sawed apart that must be silver brazed together, missing dampers, a large hole drilled in the base to mount a contact post to convert the key to a paddle, etc. Returning a base to normal by plugging the hole and refinishing it, produces a very crazy looking key—a beautiful base and terribly old looking hardware.

Occasionally, the owner of a basket case wishes the key returned to usefulness. This book shows how to do what he wishes to do, but certainly not to persuade him to do it.

Metal Finishes— For hundreds of years, man has been using noble metal as an attractive and/or protective coating for base metals. Most likely, the first instance of this was gilding. In this process, a gold/mercury amalgam was used to coat brass and other base metals. The object was then heated to vaporize the mercury, leaving a beautiful gold coating on the surface. This protected it from the elements and resulted in a very attractive appearance. The gilding on pocket watch movements from

250 years ago is still attractive today. The process also had the advantage over early electroplating in that gold of any carat could be deposited. Unfortunately, gilding was a very dangerous process in that the mercury used entered the body of the gilder and caused terrible health problems.

Figure 1 is the gilded back plate of a handmade watch movement from 200 years ago. Note the amount of work lavished on the four pillars. This is a testament to the pride of the craftsman who made it. However, in this instance, the gilding appears to have been done for appearance only. There is a bright ring just inside the edge of the back surface, **Fig. 2**. This indicates that the gilder overlapped the back of the plate only enough to be certain that the visible edge was adequately gilded. No gold was wasted on this area of the plate, later to be covered by the watch dial.



Fig. 2. Back Of The Plate



Fig. 1. Gilded Watch Plate

the edge of the back surface, **Fig. 2**. This indicates that the gilder overlapped the back of the plate only enough to be certain that the visible edge was adequately gilded. No gold was wasted on this area of the plate, later to be covered by the watch dial.

Electroplating—With the advent of electricity, electroplating became popular. It and cladding are the coatings of choice. Scientific instruments were once flashed with gold.

Nickel-plating was done first in Germany in 1842 and later in the US in 1869, and held sway for many years until chrome plating became available. Both nickel and chrome found their way into telegraph key manufacturing and remain popular today.

Unfortunately, both chrome and nickel plating are somewhat porous and in time, corrosive agents can penetrate the layer and cause rust and corrosion. This often results in a loss of plating in large areas and severe pitting of the underlying metal.

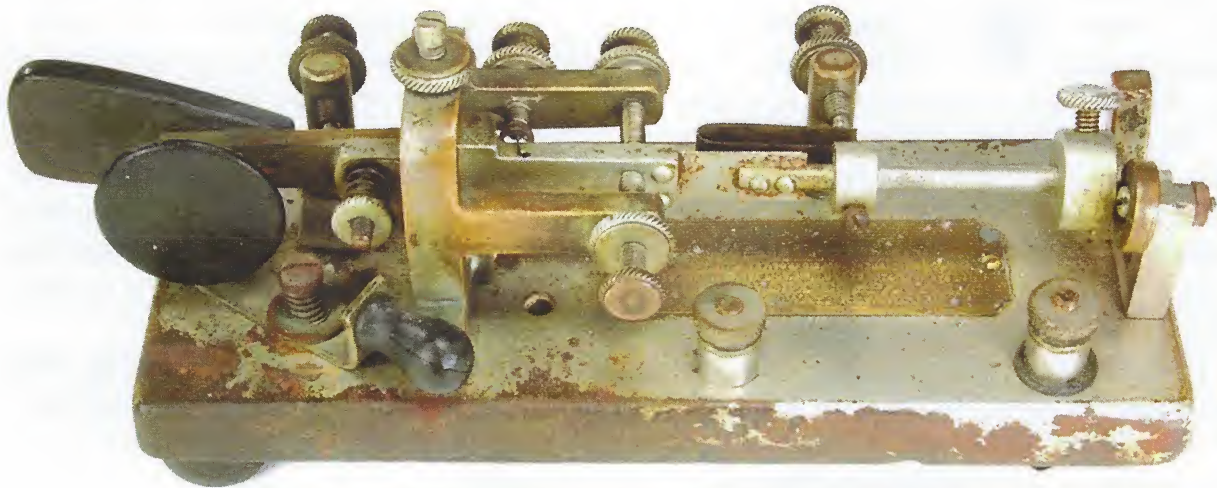


Fig. 3. A Vibroplex Blue Racer With Poor Plating

Key Bases— Occasionally, a collector, having keys with plating as poor as in **Figs. 3** and **4**, may wish to have the plating redone. Chapter 2 offered a way to redo a japanned

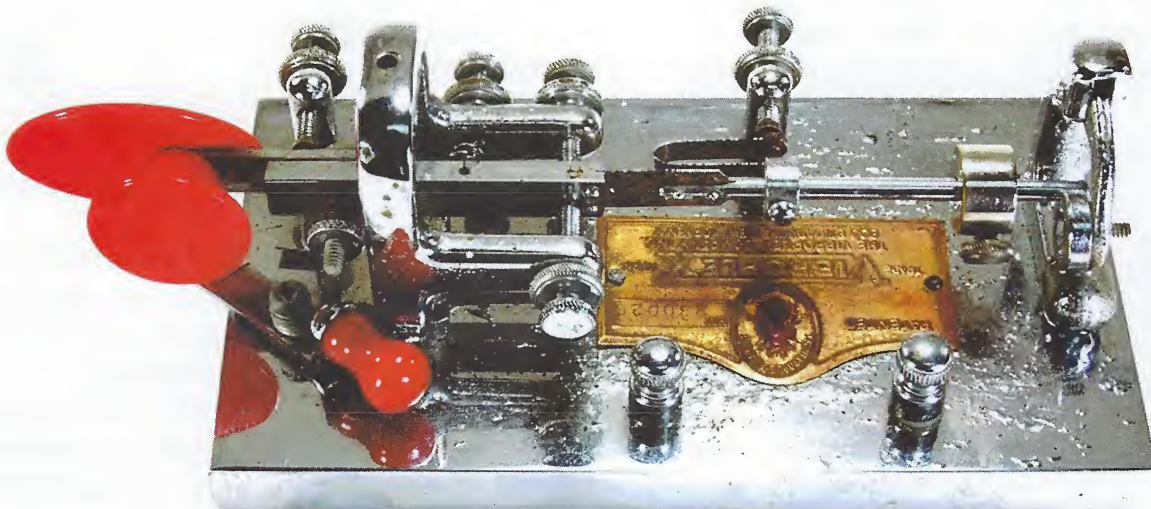


Fig. 4. A Modern Vibroplex With Poor Plating

base, but the re-plating a base may not be as easy as managing the re-japanning of one. If the base is not pitted, it can be stripped and plated with nickel or chrome without problems by most plating shops. However, if the base has severe pitting from rust or corrosion, the situation becomes far more complex and may not have a simple solution..

For smoothing surfaces, plating shops use motorized belt sanders having various grit

emery belts, 4" to 6" wide and 15 or more feet long. The use of these sanders requires considerable skill to avoid rolling the surfaces. Experience has shown that most plating shop workers do not strive to maintain flat surfaces. If a base has severe pitting, the worker will likely do one of two things. He will remove the pits but roll the flat surfaces of the base into a cushion or he will create a cushion, give up on the pit removal and plate it with some pits remaining. Neither is a happy ending. The plated base will have pits and its surface will no longer be flat.

It seems that the only solution to deeply pitted bases is to locate a machine shop having a surface grinder and have them grind away the pits. This will keep the surfaces flat. The plating shop will need only to do a minimum of polishing and will likely produce a good plating job with a reasonably flat surface. Before delivery to the plating shop, everything must be stripped off the base. They seldom will disassemble items to be plated.

Plating Key Parts— Plating shops often plate chrome over nickel and can do all key parts except for the pendulum assembly and screws. They do not like to work with parts having a combination of brass and steel parts. Also, their plating is usually too heavy for screws, making them too large for their threaded holes. Thus, pendulum assemblies and screws should not be sent to a plating shop and must be done in the home shop.

The parts above the base of most speed keys are cast brass. Most plating shops have a special bath in which they put the parts to dissolve the old plating. This is a rather slow process, often requiring several days. The parts are then buffed lightly before being plated.

Plating In The Home Shop—During the repair of telegraph keys, I have found it absolutely necessary to do nickel plating of small parts in my shop. So how does one setup to do this? The first thought would be to purchase one of the little kits containing a solution, a wand and a wall-wart, **Fig. 5**. This is not the best approach to the problem because to do plating, one needs to immerse the object in the plating bath.

Many have tried to place the wand in the bath and then immerse the part. However, when the part is removed from the solution for inspection, the plating is usually burned when it is returned to the bath. This is very annoying and demands a re-polishing of the part to remove the burned plating.

However, there is a solution to the problem. The wall-wart usually has a simple diode charging a capacitor but no load resistor. When the part is removed from the bath for inspection, the diode charges the capacitor to peak voltage. This stored higher voltage burns the part before the load of the plating bath returns the voltage to normal. Solve the problem by placing a 2 Watt, 500 Ohm resistor across the wall-wart leads to prevent the voltage from soaring when the part is removed from the plating bath for inspection.

A Better Home Plating Rig—There is a much better approach to home shop plating. At Wal-Mart purchase a wall-wart having a variable DC output voltage, with at least 1/2 ampere current rating. Put a 500 Ohm, 2 Watt shunt resistor across the DC leads,



Fig. 5. A Wand Type Plating Kit



Fig. 6. Wall-Wart & Load Resistor



Fig. 7. The Nickel Anode



Fig. 8. Plating Solution

Fig. 6. Place a red banana plug on the positive lead and a black alligator clip on the negative lead. Set the voltage for 3 volts.

The Anode— Make your own nickel anode. From your local plating shop, purchase two or three of the nickel slugs they use in their system. These are usually 1-1/4" squares sheared from 5/16" thick sheet stock. Join the nickel pieces together with a press fit as follows. Drill a hole in the corner of one slug and machine a spigot on the other. Press the spigot into the hole. This will prevent contamination of the plating solution by anything entering it, other than nickel metal.

At one end of the assembly, drill and tap a hole and install a stainless steel strip and a banana jack to accept the banana plug on the wall-wart lead. Rig this addition so it can be hung over, and remain against, the wall of the jar, **Fig. 7**. Note that the stainless steel screw attaching the strip for the banana jack never enters the plating bath.

On the Internet, locate and purchase a quantity of standard Watts nickel-plating solution. If the quantities offered are much too large for your needs, have your local plating shop sell you a gallon of their plating bath. They use hundreds of gallons of it and likely will be more than willing to help you.

Fill a 1-pint, wide mouth, Mason jar with the electrolyte, **Fig. 8**. This size container is large enough for most of the parts encountered. A larger container could be used but speed key parts are usually quite small and it will be very seldom that one will be needed.

The part to be plated must have a bright, chemically clean surface, free of oil, grease or finger marks. Rub it with an abrasive block, clean it in clock cleaning solution and rinse it in water.

Also, remember the first rule of plating. The finish of the part will be only as smooth as the surface on which it is applied—dull surface, dull finish. If a

brilliant finish is required, the part must be buffed to a high polish. (Believe it or not, plating shops put saccharine in their solution to brighten the nickel plate.)

Place the nickel anode in the solution as shown in **Figure 9**, insert the banana plug of the wall-wart lead into the jack, plug in the wall-wart, place a wire on the part to be plated and grip it with the alligator clip on the other wall-wart lead. Immerse the part in the solution but never allow the part to touch the anode. This will likely blow the fuse in the wall wart.

Plating is a line-of-sight thing, thus, be sure to rotate the part so as many portions of it face the anode as possible. Except for losses due to the wetting of parts, the plating solution will last forever. As nickel is removed from it by plating, more nickel enters the solution. Your gallon of plating solution will likely last you a lifetime.

Thumbscrews— Let's examine the actual plating of a newly machined brass thumbscrew. Wrap about three turns of # 24 copper wire around the screw such that it lies in the threads.



Fig. 10. Screw, Ready To Plate

Also, if using a plating bath with saccharine in it, this tends to lessen the brightness of the plating. Because the part will always be so very near the anode in the small jar, the voltage required will be lower than that for a larger bath. The amount of time required to add a good thickness of plating will also be much shorter than when using a larger bath.

The arrangement for plating is shown in **Fig. 11**. Immerse the screw in the solution and rotate it from time to time so all of it faces the anode. The total plating time can range from about 5 to 10-minutes. Midway in the process, remove it from the solution, rotate the screw in the wire turns to expose a new surface to be plated. If this is not done, there will be a spot where the wire has prevented the nickel from reaching the screw. When completed, rinse the screw in tap water and dry on a towel.



Fig. 9. The Solution & Anode

The wire must be tight but must also allow the screw to be revolved within the wire turns, as will be required later during the plating process. See **Fig. 10**. Clean the screw in clock cleaning solution, rinse in tap water and dry it on a towel. Avoid finger marks. Grip the wire in the alligator clip on the wall-wart negative lead.

Place the jar of plating solution in the microwave and heat it for 45-seconds. This will greatly speed up the plating process.



Fig. 11. Plating A Screw

Thumbnuts— The arrangement for plating thumbnuts is shown in **Fig. 12**. These are plated in much the same way as the thumbscrew except that the wire must pass through the threaded hole to allow the nut to be rotated during the plating process. To avoid blank spots in the plating, make it a practice to lift the part from the solution and rotate it on the wire every minute or so. When plated, rinse in water and dry on a towel.

Two thumbscrews and thumbnuts are shown in **Fig. 13**. The upper screw has been deliberately chosen to show what happens when one forgets to rotate the screw in its wire during the plating process. Note the dark, un-plated spot about 12 threads from the right-hand end of the screw. Also, note that the other screw, which was turned properly in its wire, has no evidence that it was ever supported by a wire during the plating process.

Pendulum Assemblies— Often, there is a need to plate the dash bar, the dot bar and the weight



Fig. 13. Plated Screws & Nuts

future rusting. As previously illustrated, this is easily done with a pipe cleaner.

The plating example being illustrated here is that of the dot bar, mainspring and weight rod portion of a pendulum assembly. Clean the part as needed with the glass fiber brush, the abrasive block and clock cleaning solution and rinse it in tap water. Note in **Fig. 14** how this has produced the required bright metal surfaces.

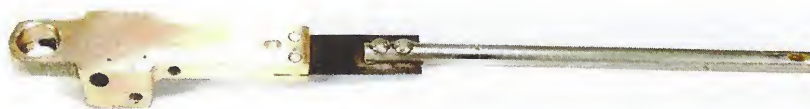


Fig. 14. The Part Ready For Plating

Place the alligator clip of the wall-wart negative lead on the dot bar and immerse the weight rod in the plating bath to cover the spring. As mentioned, never let the part touch the anode or it is likely to blow the fuse of the wall-wart. If this happens, the wall-wart can be taken apart and the fuse replaced. However, this is a tedious task.

It is also a good idea to have a voltmeter available with which to check the wall-wart voltage. Otherwise, if the leads have been touched together and the internal fuse of the wall-wart has been blown, there will be no way of knowing that it has happened. Rotate the part in the plating bath, keeping the mainspring immersed in the liquid. When completed,



Fig. 12. Plating A Thumbnut

rod of a pendulum assembly. If the key is old, the mainspring has likely suffered from rust. There is simply no reasonable way to clean a heavily rusted mainspring well enough for it to accept plating. Thus, it must be ignored and later treated to prevent rusting. A spring that can be cleaned of all rust will accept plating. However, because plating is porous, they should always be coated with a mixture of equal parts of linseed oil and paint thinner as an insurance against

reverse the part, place the alligator clip on the weight rod, immerse the dot bar enough to bring the liquid over the spring and plate it, as illustrated in **Fig. 15**.

After the part has been plated, rinse thoroughly in tap water to be certain there is no plating solution remaining in the joints. Rinse in denatured alcohol and dry with heat to be certain that no moisture remains trapped in the dot bar and weight rod slots with the spring. **Figure 16** shows the results of the plating effort.



Fig. 16. The Plated Part

If ever there is a time when you wish to block the plating from some portion of a part, coat that portion of the part with Dykem layout blue. This will prevent the plating from reaching any area covered by it.

Plating More Key Parts— The part in **Figs 15** and **16** was taken from the key used in Chapter 2 to illustrate the re-japaning of the base of a 1919 Vibroplex original speed key. When work was begun on this key, there was no intention of doing other than using a few of its parts to illustrate various fabrication techniques for this book. However, having done so much work on the key, it seemed only reasonable to complete the job. Thus the hardware, except for the thumb screws and pendulum assembly, was taken to a plating shop. While waiting for them to be plated, parts that should not be taken there were plated in my own shop. With time still available, work was started on the strip conductors.

The Conductors— **Figure 17** shows a sheet of 1/32" thick, 1/2 hard, leaded brass, that has been coated with layout blue and the strip conductor widths scribed on it. After sawing to shape, the edges were smoothed with files, papered and holes for the screws were punched in each end of the strips.



Fig. 17. Laying Out The Strip Conductors

In an attempt to match the black insulation strips used in early keys, two layers of heavy, black paper were coated with epoxy and bonded under pressure. When cured, 3/8" wide strips were cut from this stock, coated with linseed oil and allowed to dry.



Fig. 18. Strip Conductors & Insulators

Figure 18 shows two of the insulator strips and the two brass strip conductors. The short one is still coated with layout blue. The insulator strips were cut to length and holes punched in each end. The brass conductor strips were cleaned with the abrasive block, clock cleaning solution, rinsed in water and they, and the stationary part for the shorting



Fig. 15. Dot Bar Plating

mechanism, were nickel plated. The completed parts are shown in **Fig. 19**.

Rust was removed from the dot spring. Its collet was cleaned and plated and the dot spring was coated with a linseed oil mixture. Rust was removed from the steel screws, using the glass fiber brush, and all were coated with oil.

A break in the paddle was mended with epoxy and its surfaces smoothed to remove all traces of the repair.

The Knob— When the key was disassembled, it was discovered that someone had given it a bath and had failed to dry it properly. Rust had frozen the threads of the knob in the dash bar. The knob could not be turned and had to be shattered to reach the screw on which it was molded. This was clamped in the jaws of a bench vise, and was finally worked loose.

The dash knobs of keys this old have a very thin lip, a narrow waist and a slightly larger boss at the screw. Modern knobs are usually much more robust and are lacking these delicate features. Thus, they are not well suited as replacements. To match the original knob, a modern one was mounted in the lathe and turned with a hand held graver to obtain the desired shape. It was then papered and coated with silicone grease to give it a



Fig. 19. Insulators & Plated Parts

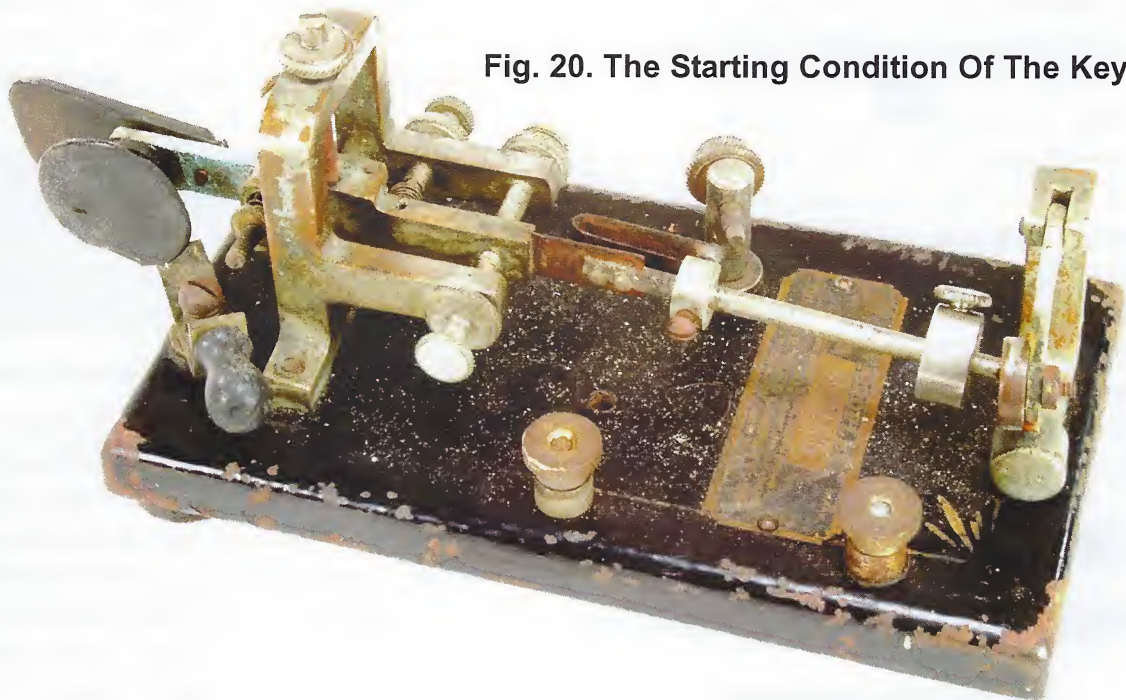


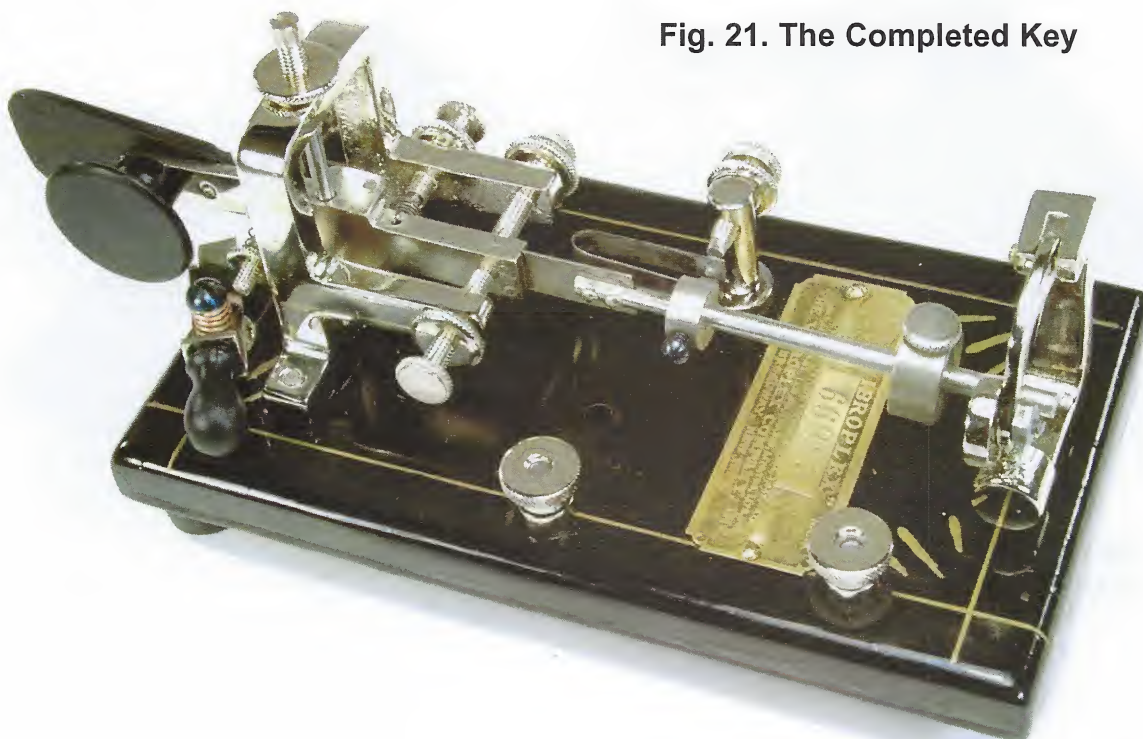
Fig. 20. The Starting Condition Of The Key

nice luster and installed. The key was assembled, the contacts dressed with a relay contact file and adjustments were made. During tests on a code oscillator, it performed well.

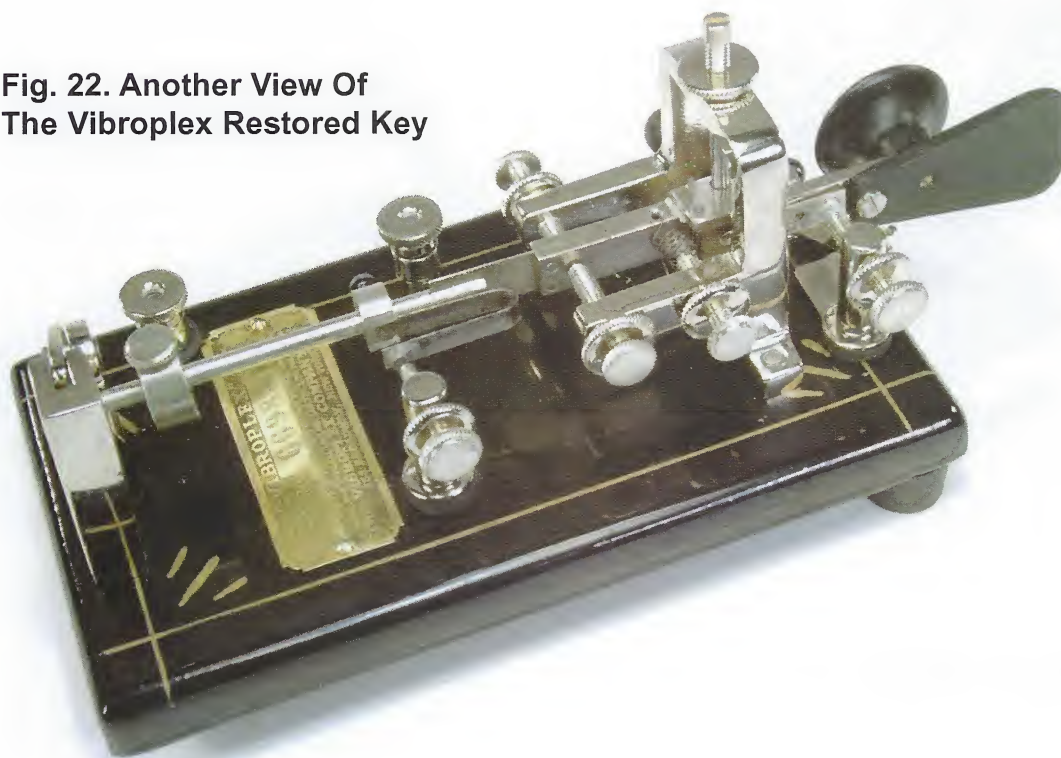
The “Before” and “After” Photos— **Figure 20** shows the condition of the 1919 Vibroplex when work was begun on it. As can be seen, it was in very poor condition.

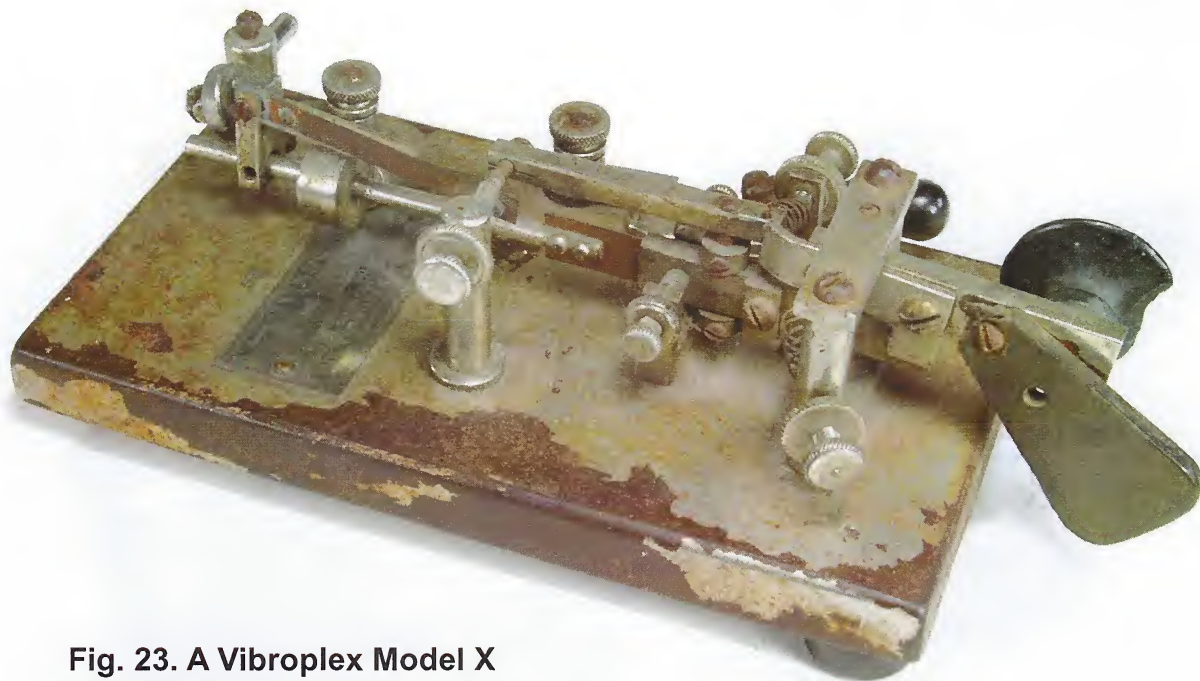
Figure 21 shows the key after restoration. All parts are original but the knob.

Fig. 21. The Completed Key



**Fig. 22. Another View Of
The Vibroplex Restored Key**





**Fig. 23. A Vibroplex Model X
In Need Of Re-plating**

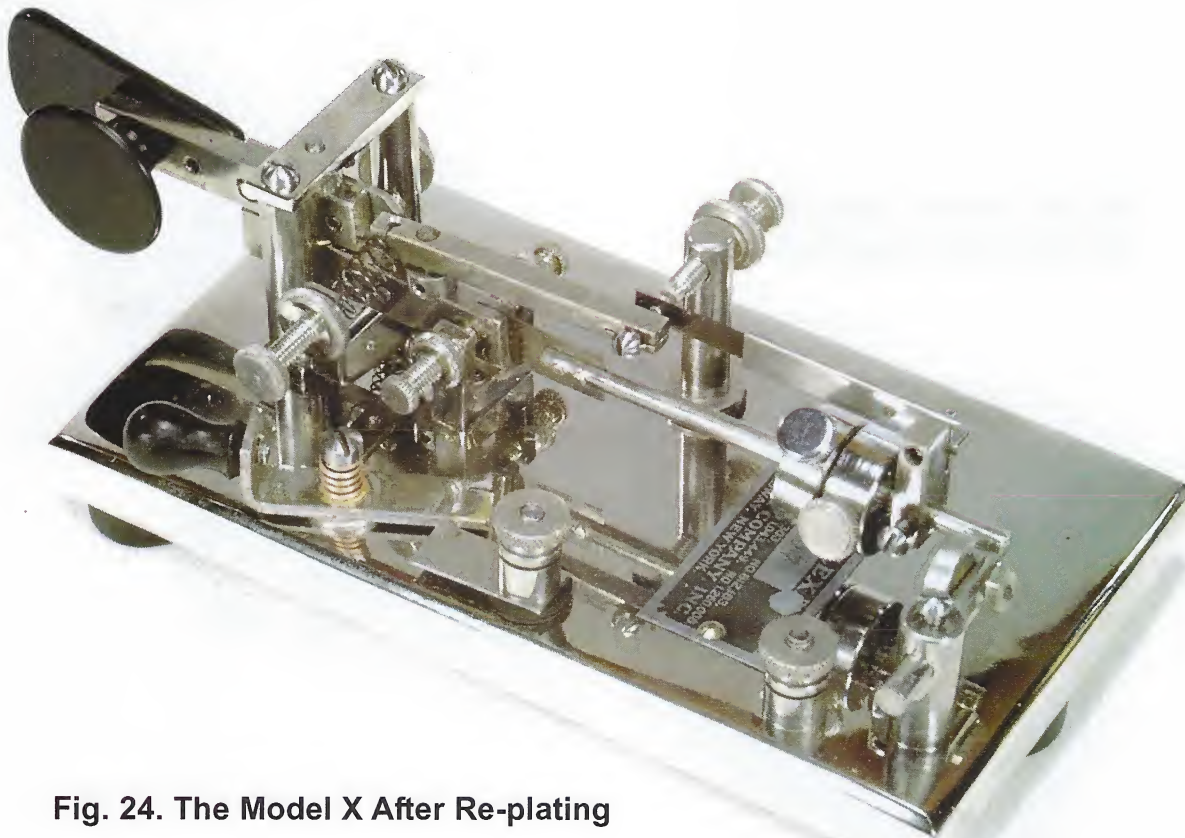


Fig. 24. The Model X After Re-plating

CHAPTER 4 HINTS, TIPS AND TOOLING

PHOTOGRAPHY

The intent of this chapter is to offer tips on tooling and techniques that will help a key owner to work on his key. However, a number of collectors familiar with my efforts in preparing this book have requested that I also include information on the photography.



Fig. 1. The Photo Stage

When a backdrop is employed, one or two additional lights are used to brighten the background, as shown in the figure.

For shots in various parts of the shop where it is difficult to bring all of the equipment shown, I use a little vest pocket, 5.1 Megapixel, Nikon Coolpix 5200, digital camera with built in flash, **Fig. 2.**

All of the photographs are processed in Photoshop 7 in CYMK color. The book is being prepared in Adobe PageMaker 7 for printing on both digital, color offset presses or on color laser printers.

SHOP TOOLING AND TECHNIQUES

Some work can be done in a simple shop having only a bench vise, a hand drill, a hack saw, a piercing saw and some hand tools. However, the addition of a bench lathe, a bandsaw, and a few power tools makes the shop work a great deal more effective. I am by no means suggesting that the reader needs to duplicate my equipment to do limited key work. The tooling and techniques shown are being drawn on from a lifetime of work in the watch and clockmaking fields.

The Lathe— It would be virtually impossible to do all of the work illustrated in this book without the use of a good lathe. A large assortment of lathes are currently available from numerous sources. A simple and inexpensive, small lathe, made by Sherline Products

For 25 years I have had my own darkroom, process camera, film cameras, and for many years, an offset press, but recently I have switched to digital equipment. The main camera is a Nikon D-70, SLR, 6.1 Megapixel, with a Nikon 24 to 85 mm zoom lens. For good depth of field, I always shoot with the iris locked at $f/16$. Close-up work is done with a Nikon 60 mm Micro lens. A darkroom table, **Fig. 1**, covered with white backdrop paper is used as the stage for most photographs.

The basic stage always involves three 250 Watt blue floodlights in reflectors—one boom light, one left, high (and down at the object), and one right (high and down at the



Fig. 2. Nikon Coolpix Camera

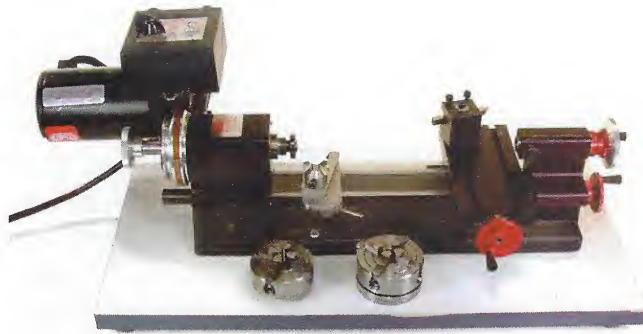


Fig. 3. The Sherline Lathe

(Ref. 1), is shown in Fig. 3. Because it can be adapted for use with collets and a “T” rest, it is also capable of being used as a watchmaker’s lathe. Although a larger lathe is desirable, much work can be done on the little Sherline.

The W. R. Smith “T” rest shown mounted on the lathe bed, is being produced by Sherline and allows the lathe to be used for hand turning with hand-held gravers. This greatly extends the usefulness of the lathe. Sherline

also offers many inexpensive accessories for their equipment.

A six-inch bench lathe is more desirable for key work, and since no gears or pinions are to be cut, almost any make lathe of acceptable quality would be worth having in the shop. Figure 4 shows my Myford Super 7B, modelmaker’s lathe from England. I am not suggesting that the reader purchase one for key work and am showing it for general interest. The present price for such a lathe, complete with tooling, would cost about \$12,000.00.

The appendage seen behind the lathe is a McDuffie drive unit that has been added to the lathe table. It is a 1/2 Hp, 1000 rpm motor on rails that allow it to slide to any location opposite the lathe bed for driving live spindles and other lathe-mounted equipment.



Fig. 4. The Myford Super 7 B Lathe

Magnification And Lighting— I have often been asked, “What is the secret of good filing?” If there is a secret, it is magnification and lighting.

Figure 5 shows the standard of magnification for those doing close work--the OptiVISOR (Ref. 2). This unit has a rigid, adjustable head band and can be worn all day without discomfort if the proper plate has been chosen. Be certain to purchase it with a # 5 plate. Some may think that more magnification is needed but a unit with a stronger plate cannot be worn all day without discomfort. This unit can be worn over spectacles, pushed up out of the way when not needed and pulled down when magnification is desired.



Fig. 5. The OptiVISOR

The other part of the secret to good workmanship is a swinging arm lamp. Strangely, one would think that the four tube, 48” fluorescent light, directly over a workbench would be more than adequate lighting. It is not. Without the



Fig. 6. A Swinging Arm Light

When working with them or making replacement brass parts, special fiber jaws must be used in the bench vise to prevent scarring of the parts. One cannot use aluminum, brass or copper jaw liners for this. Each of these materials is capable of pressing filing dust into the surface of the brass part being made. This will require much work with files and emery paper to remove the marks. Rubber jaws are not good because they are not rigid enough. Years of clockmaking have taught me that the only solution to the problem is fiber jaws, **Fig. 7**. These jaws are made in England and are available from S. E. Bate (**Ref. 3**).

The jaw in front shows how the fiber face of each jaw, as received from the factory, are riveted to the metal body. When placed in the vise, the jaws would tilt on these rivets and be unstable. To avoid this problem, make a metal spacer thicker than the height of the rivet and with two holes in it to clear the rivets. Bond one into each jaw with epoxy.

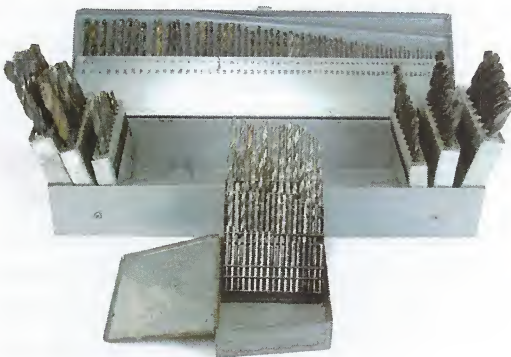


Fig. 8. High Speed Twist Drills

swinging arm lamp, **Fig. 6**, with its single incandescent bulb, no accurate filing can be done in the vise shown in the low, right-hand corner of the photograph. The reason for this is that one needs a point source of light that will lay down a bright, reflected pattern on the surface of the work. It is the only way to determine where the file has made its last cut. Those who cheat themselves with poor light and a lack of magnification will more often than not do poor shop work.

Fiber Jaws For The Vise— Most speed key parts are made of brass.



Fig. 7. Fiber Bench Vise Jaws

These jaws are available for vises having different jaw widths and the tabs on them can be shaped to hold them in place. They should never be used for excessive gripping of small objects or the fiber faces are likely to be harmed.

Twist Drills— A good set of numbered drills is required in any shop working with metal. **Fig. 8** shows two typical drill sets. The one in the rear is an inexpensive set that is made in China and has proven to be most useful. The back row is numbered drills from 1 through 60. The left bank is fractional drills and the right bank is letter drills. The little drill set in front contains



Fig. 9. Blunting The Drill

emery stone can be held with pressure against the cutting edge of a twist drill and pushed to blunt it. Make a very narrow, bright, flat cut with the stone. Treat each lip in this manner, and the drill will never grab in brass.

The Dremel Tool— Figure 10 shows a simple Dremel tool set that is very useful in any workshop, especially for working with a speed key base having holes that have been plugged. The tool shown has a spindle with a rubber face to accept stick-on emery paper disks. A stack of these is shown to the left of the tool. Although it comes with many accessories, the most useful ones for my work are



Fig. 11. Dressing The Plugs

numbered drills from 1 to 60 and is very useful. Be sure to purchase only high-speed drills.

Drills For Brass— Those who work with brass are aware that the rake angle of any cutting tool used for brass must be zero or negative. The rake angle of a twist drill is very positive and if not modified, the drill will function like a screw and screw itself into the work with disastrous results. To avoid this, any drill used for drilling brass must have its cutting edge blunted. Figure 9 shows how a flat



Fig. 10. The Dremel Tool

the cutoff disk and the arbor with the flat rubber face for accepting stick-on emery disks.

Figure 11 illustrates the Dremel being used to smooth away the excess metal of two plugs that needed to be added in the base of a mutilated, double lever Vibroplex speed key. The plugs were machined to fit the holes, the holes were chamfered and the plugs riveted in place.

Since japanning varnish does not adhere well on smooth surfaces, it is wise to texture the plugs with a sharp pointed scribe, or the corner of a file, after they have been smoothed level with the base.

Clockmaker's Broaches— A most useful group of tools for key work is a set of five-sided clockmaker's broaches. These are slightly tapered reamers and are used mostly for reaming brass. Broaches of this type range from about 0.005"

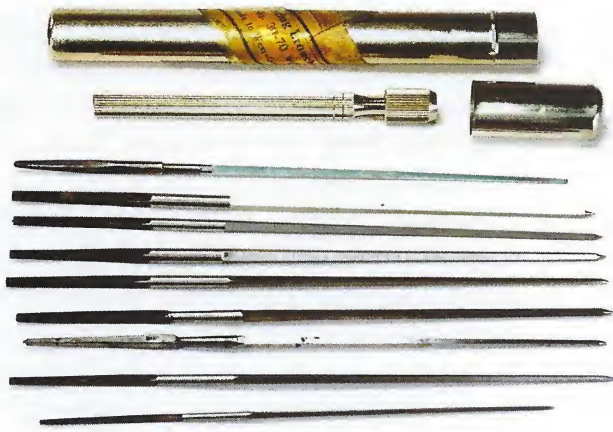


Fig. 12. Clockmaker's Broaches

member will allow freedom in the hinge.

Diamond Setter's Burr— A very useful tool for small work is a 7 mm diamond setter's burr, available from Cas-Ker (Ref. 5), and shown in a pin vise in Fig. 13. The punching or drilling of most holes leaves a sharp ridge around the hole, also called a burr. This tool is very good for removing these offending ridges. A twist drill larger than the hole is also useful for removing such burrs. However, a diamond's setter's burr has many fine cutting edges and will leave a very

diameter for watchmaking use to about 1/2" for clockmaking use. An assortment of medium size broaches is shown in Fig. 12. These and other sizes are available from Cas-Ker (Ref. 4).

For example, using a broach, it is possible to make a hinge with ease. Drill a hole through the two members and turn a tapered pin for a fit in the hole. Remove the middle section of the hinge, ream its hole larger for clearance, reassemble the hinge and drive in the pin. The taper will wedge the pin in place and the clearance in the moving



Fig. 13. Diamond Setter's Burr



Fig. 14. A Homemade Split Nut

much smoother surface than a twist drill. The screw in the split nut and grip the nut in the lathe chuck. The slit in the wall of the nut will cause it to spring enough to grip the screw and allow the needed machining operation. With a number of these nuts in the toolbox, there is never a problem chucking a screw.

Dykem Layout Fluid— Dykem layout fluid is the standard coating for laying out the shape of parts on metal surfaces. It comes with a built-in brush and paints a quick drying, dark blue layer. The scribe cuts through this layer and leaves an easily seen, bright metal line against a dark blue background. Dykem can also be used as a plating stop to avoid plating in areas of an object where no plating is wanted. This is especially useful for preventing the plating of the silver contacts in thumbscrews or dot springs being plated.

much smoother surface than a twist drill.

The Split Nut— When working with keys, one often needs to chuck a screw so its end can be drilled or machined. This is usually not possible because the diameter of the head prevents gripping the body of the screw in a lathe chuck. The problem can be solved by machining a split nut to hold the screw.

Choose a brass rod larger in diameter than the head of the screw to be chucked. Drill down its axis and tap it to receive the threads of the screw. Part it about 1/2" long and saw into it from the side as shown in Fig. 14. Place



Fig. 15. Dykem, A Scribe & Brass

bushing rod, available from S. LaRose (Ref. 7), and face the ends. This is a small OD brass rod with a hole through its center.

Slightly flatten the end of a piece of 1/16" diameter, straight music wire and stone a spade drill cutting edge on the flattened end. Use the wire as a long drill to open the hole in the bushing wire. Cut a piece of the same diameter music wire 3-1/2" long and give it a very slight bend. Insert the wire in the hole of the body. The bend in the wire will provide the friction required to maintain the measurement the tool picks up. A tool of this type is shown in Fig. 16.



Fig. 16. Length Transfer Gage

For use, tap one end of the gage on the table top to expose the center wire at the other end. Press the end of the wire against the bottom of a hole or the shoulder of a part and the body of the tool against the other surface. This allows the tool to pick up the desired depth or shoulder length. The dimension can then be measured with a dial gage or scale.

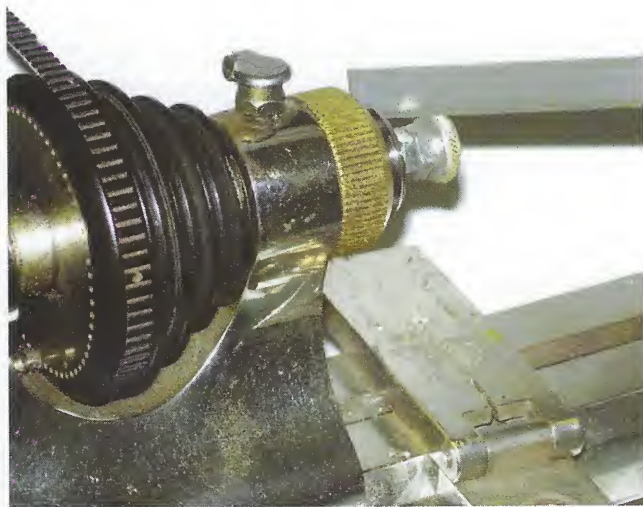


Fig. 17. Correcting A Rope Knurl

There are two special files from watchmaking and clockmaking that are most useful in key work. One is a very short and thin one with no tang for cutting slots in the heads of watch screws (Ref. 8). This file is very useful for reshaping the ridges of rope knurled thumbnuts and thumbscrews that have been mashed with pliers. Figure 17 illustrates such a file being used for this purpose. In this example, the thumbnut is mounted on a length of screw stock held in the lathe collet. The file has a knife-shape that will get between the ridges of the knurl. The nut cannot be made like new, but it makes the problem less noticeable after the part has been plated.

The other screw head file is a much larger one, about 5/8" wide and considerably thicker but of the same general cross sectional shape and is intended for making the slots in larger screws. It is extremely useful for removing rust from the slot of larger screws. The secret of its use is to place the screw in the collet, not gripped by it. The screw will then position itself

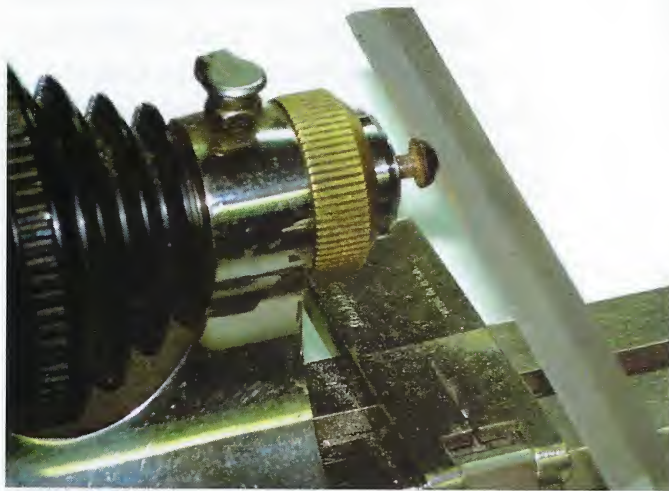


Fig. 18. Brightening A Screw Slot

correctly against the walls of the slot. This operation is illustrated in **Fig. 18**; however, for photographic reasons, I have gripped the screw and extended it to show the head. This file can also be had from Cas-Ker (**Ref. 9**).

The Piercing Saw— One of the most useful tools for small work is the piercing saw. These are offered with 2-1/2", 5", and 6" deep throats. The 5" is by far the most useful for speed key work. There is a third saw of this general type called a fret saw. However, it has a 12" deep throat and is of little use for general shop work. Blades for these saws are 5-1/4" long and come in a range of sizes from number 8/0 to 14.

They are very inexpensive and all sizes are available from Cas-Ker (**Ref. 10**).

Figure 19 shows a saw with a 5" throat, a gross of blades and a saw board. Use a fine tooth blade for thin stock and coarse teeth for thick stock.

Clamp the saw board into the jaws of a bench vise with its top surface in a horizontal plane and with the "V" notch facing the worker. If the sawing is to be inside the body of a part, drill a small hole to accept the blade. Clamp the blade in the far end of the frame securely and with the teeth pointing toward the handle. Adjust the frame length so that the other end of the blade lacks about 1/8" of reaching the clamp at the handle end. Lock the frame adjusting wing nut and never release it again—never ever! Thread the blade through the hole in the work, place the clamp of the far end against the workbench, the handle against the chest and push on the saw to spring the frame. When the free end of the blade reaches about 1/4" into the jaws at the handle, lock the blade clamp. If installed properly, the blade will make a musical note when plucked. Place the work on the saw board and saw. Use of the saw will be illustrated in future chapters.



Fig. 19. A Piercing Saw, Blades & Saw Board

Sheet Metal Drill— Although this drill does not have many uses for key work, I am showing it for completeness, **Fig. 20**. It is a drill that cuts a true circle in thin sheet metal.

An ordinary twist drill makes a three cornered hole in such metal. The center point of this drill prevents it from walking, thus the hole it cuts is truly circular. This is not the common wood bit that looks very similar to it. Grind it with the same



Fig. 20. A Sheet Metal Drill

Grind it with the same



Fig. 21. A Clockmaker's Lathe

larger work. The lathe is powered by an AC/DC motor with a foot-feed speed control. The full motor speed is 5,000 rpm; however, this is far too fast for hand turning and the torque is much too low. Thus, a countershaft is used to slow the motor approximately 10 to 1. This also increases the torque by the same ratio. The rheostat foot-feed then gives a useful range of about 250 to 500 rpm at the lathe headstock.

The world is full of used watchmaker's lathes at seemingly bargain prices. However, the accessories are extremely expensive and not very effective. A far better choice is the little Sherline lathe equipped with an 8 mm collet adapter, draw bar, W. R. Smith "T" rest and a set of 8 mm collets. Used collets are usually available from watch and clock collectors.

Figure 22 shows a hand held graver being used at the lathe to turn a nickel silver rivet for attaching the mainspring to the dot bar or the weight rod of a speed key. This is a typical turning operation for which such lathes have no equal. The hand held tool allows one to turn various shapes without the need to grind a form tool. This greatly speeds up the work.

Such rivets could be made from brass; however, I use nickel silver because it matches the nickel plating of most speed keys without the need to plate the rivets after they have been installed. I drill the end of the rivet to provide an attractive appearance after being upset. The drilling will be shown later.

Gravers— Gravers, such as shown in **Fig. 23**, are the hand held tools that are used on a "T" rest when doing hand turning at a watchmaker's or clockmaker's lathe. They can have various shapes—round, slitting, hook, beveled to avoid grabbing in brass, etc. However, the typical graver is made from a 1/8" square stock and is ground at 60 degrees

to provide a diamond face. Unfortunately, the best quality gravers must be made by the user; most commercial ones are simply not good enough. Purchase a 1/8" x 2-1/2" Cleveland Twist Drill, Mo Max, super cobalt M-46 lathe bit from



Fig. 22. Turning With A Graver



Fig. 23. A Homemade Graver

Tru Kut (Ref. 11). Mount it in a 1/2" OD x 3-1/2" long piece of dowel rod. Use hobby shop, 7/16" OD x 1/32" wall, brass tubing as a ferrule. Such a graver will cut un-annealed music wire and hardened and tempered steels.

Watchmaker's Spade Drills— A set of watchmaker's spade drills and a bottle of tapping lubricant is shown in Fig. 24. Drills of this type are extremely useful in a shop that does work on small parts. They are very short and very stiff. Thus, they act somewhat like a center drill, in that they do not walk like the longer and more flexible twist drills. They are also quite hard and capable of drilling many tempered metals. They can be sharpened when dulled,



Fig. 24. Safe Tap & Spade Drills

When it is very important that a hole be placed at an exact location, use a sharp, prick punch and spot the exact location for the hole. Place a small spade drill in a pump drill body and use it to start the hole. A larger twist drill will then follow the starting hole made with the spade drill.



Fig. 25. Drilling A Rivet

The set shown has drills ranging from 0.028" to 0.050" OD. A similar set, with sizes from 0.004" to 0.026" is also available but not very useful for key work. These drill sets are quite expensive and can be purchased from Cas-Ker (Ref. 12).

Drilling A Nickel Silver Rivet— The rivet being turned in the Fig. 22 must be drilled in order to gain an attractive end when riveted. Nickel silver is used to match the plating of the dot bar. This is available from K & G Finishing Supplies (Ref. 13).

However, it is a tenacious metal that is difficult to drill. Use the short, stiff, spade drills shown or a miniature center drill. Either drill will cut better if it is flooded with a tapping fluid such as the Safe Tap shown in the figure. This can be purchased at most machine shop supply firms or from MSC Industrial Supply Company (Ref. 14). The drill being used in Fig. 25 is a 0.044" OD spade drill from the above Mascot drill set.

For this work, run the lathe at a low speed and avoid excessive pressure on the drill. Keep the point flooded with tapping fluid. A good way to do this is to place the finger under the work and touch the fluid to the junction of the finger and the work. Carbide drills should be avoided for such work. They are far too brittle and the nickel silver is too prone to grab. Once a carbide drill has been broken in a part, the dance is over. The part must be discarded. There is nothing available to cut carbide but diamond.

Managing Plated Screws— It is often difficult to locate a plain steel screw when needed in a hurry. Most of those offered in the local stores are zinc plated and not suitable for speed key work. Solve the problem by using an acid to remove the zinc coating so the screws can be refinished to bright steel or blued. Muriatic acid is most often offered in gallon jugs, but people are reluctant to have that much acid around the house or shop. However, LIME-A-WAY contains hydrochloric acid and is kept in most households. Thus,



Fig. 26. Lime-A-Way, Screws & Chopsticks

it is readily available for treating the screws to remove the zinc. Place them in a beaker, add a enough LIME-A-WAY to cover them and allow it to dissolve the zinc plating. No water is required; just use the liquid as it comes from the bottle.

Figure 26 shows a container of LIME-A-WAY, some zinc-plated screws, a pair of chopsticks and a beaker. There was trouble photographing the empty beaker so I added colored water. Chopsticks are used to manipulate the screws in the acid, but all precautions regarding the use of acids must be followed when doing this.

After the plating has been removed, neutralize the residual acid on them with baking soda in water and dry the screws with heat. If the heads are not properly shaped, reshape them with a graver, brighten the slot with a screw head file, brighten the head with emery paper and brighten the

threads with the glass bristle brush. The bright screws can then be coated with oil to lessen rust or blued with heat. However, after bluing, the screws should be coated with oil.

Heat Bluing— Years of rust have obliterated the finish of the steel screws of most speed keys. However, when examining disassembled keys, it is quite evident that the factories often used blued screws. Most any low carbon steel can be blued with heat. To properly blue a screw or any other piece of low carbon steel, brighten the surface and clean it with cigarette lighter fluid to remove any traces of oil or grease. Do not handle it with the fingers.

Place it in a piece of brass mounted on a handle and hold it over the flame of an alcohol lamp, **Fig. 27**. Heat the part slowly and watch the color changes. From bright steel, it will first turn a pale straw color, then a darker straw. As it darkens more it will go to a brown and then begin to show a touch of pale blue. With more heat, the blue will darken. Just before it reaches the desired deep, royal blue there will be a tinge of reddish purple in the color. As soon as the red leaves, you have reached the blue and must quench it in water or oil to stop the bluing process. If heated to too high a temperature, the color will go through the desired royal blue and will fade away to a dull silver. The part must then be refinished to bright steel and the bluing process tried again. If the part being blued is large, to avoid the need for most polishing, soak the part in a heated solution of water and boric acid (roach powder). This will dissolve the blue coating. Roach powder is available at grocery and hardware stores.



Fig. 27. Heat Bluing A Screw

The Weight Rod Jig— One of the most difficult tasks in speed key work is drilling the two weight rod rivet holes parallel to each other and through the center of the rod. This is a task too difficult to be done satisfactorily by eye. Despite the best efforts, the holes simply never come out parallel to each other. However, the problem can be solved quite

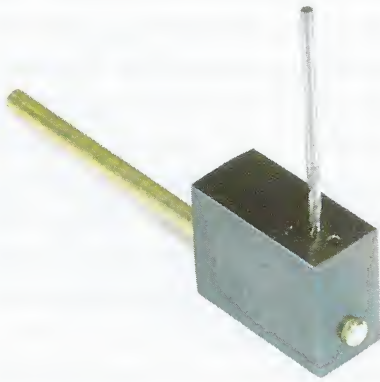


Fig. 28. The Weight Rod Jig

simply by the use of a homemade jig. **Figure 28** shows a jig of this type made from a piece of mild steel block. It guides the drill through brass and there is really no need to harden it. It has been heat blued to help avoid rust.

True the walls of a block of steel 1/2" x 1" x 7/8". Place it in a 4-jaw chuck and adjust the chuck jaws so a tailstock center touches the end of the work centered in the 1/2" dimension, and 1/4" in from a long wall. Make a center with a center drill, drill through the block with a 9/64" drill and ream 5/32" ID. Remove from the lathe.

Place a 5/32" OD rod in the hole and establish a true centerline over the hole on the wall of the body nearest the rod. With a center punch, mark the centerline at 1/8" and 1/4" inch in from the end of the jig. Drill through at these locations with a # 48 drill.

For use, place the 5/32" brass weight rod blank in the hole about 3/4 of the way through the jig. Near the jig, coat the rod with a dab of super glue and rapidly push the rod into the jig until the far end becomes flush with that of the jig. The super glue will lock the rod in place. Drill the holes with the drill entering the jig from the top, as shown in the figure. This will put the holes through the rod parallel to each other and through the center of the rod.

To break the super glue bond, heat the assembly. Do not overheat. The fumes are a health hazard. When cool, wash away the residual super glue with acetone. Be careful to avoid sparks or flame around acetone. It is quite dangerous. Avoid wintertime static sparks.

Sawing The Mainspring Slot— Now that the holes have been correctly drilled in the weight rod, a slot must be cut to accept the mainspring. A simple way to do this is to mount a Sherline, 3" x 0.010" thick, 280 tooth, circular saw in a Sherline arbor (**Ref. 15**) and place it in a Sherline lathe.

Make a very simple saw table, for use in the W. R. Smith "T" rest available from Sherline, by screwing a portion of a 5/16" diameter bolt into a 3/16" thick, flat plate, and sawing a slot in it to accept the saw. Remove the "T" from the rest and replace it with the saw table. Position the table height so the axis of the rod passes through the centerline of the saw arbor and lock it.

A circular saw mounted in a Sherline lathe and the homemade saw table are shown in **Fig. 29**. This is an extremely useful set up for any workshop doing key work.

It is imperative that the mainspring slot in the weight rod be perpendicular to the rivet holes in that rod. To accomplish this, an indication of the orientation of the holes must be provided. This is readily accomplished by placing a wire in the rivet hole nearest the operator and positioning the weight rod so the wire is parallel to the saw table when starting the cut. Once a correct slot orientation has been started, remove the wire and saw the remainder of the cut without it. The saw will follow the initial cut. For those wishing to make the W. R. Smith "T" rest, the plans, originally published in *The Home Shop Machinist* are available in my book, *Workshop Techniques For Clockmakers & Modelmakers* (**Ref. 16**).



Fig. 29. Slitting The Weight Rod

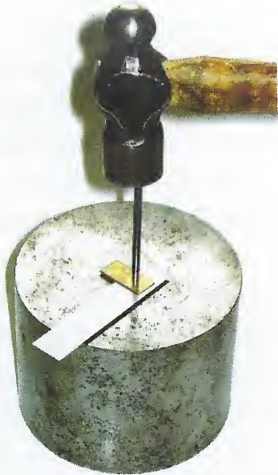


Fig. 30. Punching A Hole In A Steel Spring

Making Holes In Tempered Steel—Tempered steel, such as the feeler gage stock I use for speed key mainsprings and dot springs, is too hard to be drilled except with special drills. A typical clockmaking trick is to make a simple jig of brass for punching the holes. Cut a small strip from a sheet of 1/32" thick brass and anneal it by heating it red hot. When cool, fold the strip at the center over the stock to be punched to make a "U". Place the feeler gage stock in the "U" and squeeze the brass against the feeler gage with a bench vise. Remove the feeler gage and drill a hole of the desired diameter through both walls of the U. Turn a piece of tempered steel rod or straight music wire to the diameter of the hole. Prick mark the feeler stock where the desired hole is required and place it in the U. Center the prick mark in the hole of the jig and place the punch in the hole against the shim stock. With the assembly on a bench anvil, strike the punch with one hard hammer blow, **Fig. 30**. Pull the punch from the part and the shim stock from the jig and you will have a perfectly circular hole

in the shim stock the exact diameter of the punch—a simple solution to a difficult problem.

Dissolving Broken Steel Screws In Brass Parts— Quite often one encounters a key that someone has given a bath in the kitchen sink and failed to dry it properly. The moisture trapped around the steel screws then creates rust. This rust increases the diameter of the screw until it can no longer be turned in its hole and it twists off flush with the brass part. There is only one known way to remove such a screw without harm to the part—dissolve the screw! Although this seems to be a very strange statement, clockmakers and watchmakers have been doing it for hundreds of years. The secret is alum.

Figure 31 shows a container of alum and a part from a double lever key with the steel screw twisted off flush with the surface of the nickel plated brass part.

This screw will be completely dissolved with a solution of alum in water.

If the screw is large enough that a hole can be drilled through it without touching the threads in the part, this should be done as it will speed up the process. If the screw is too small for that, do not worry. Scrub the part with cigarette lighter fluid followed by detergent and water to remove any traces of grease or oil that might prevent the alum solution from touching the steel screw. In enough water to cover the part several times over, dissolve as much alum as possible. Place the part in the liquid and begin the waiting period.

This is not a fast process; after several days you will begin to notice that the screw appears to be receding back into the hole. It is now time to be very careful how the part is placed in the solution. There must be no air trapped in the hole to prevent the solution from reaching the screw. Thus, each time the part is examined and replaced in the solution,



Fig. 31. Alum To Dissolve Steel Screws

make sure the end of the hole is last to enter the solution so any trapped air will escape. In a week, or maybe two or more, you will finally discover that the alum solution has completely dissolved the screw and has in no way harmed the brass part.

Leaded Brass— Never use ordinary 70-30 brass when making parts for keys. It will break drills, is terrible to saw, difficult to file, will dull all of your cutting tools and greatly increase your quotient of profanity. Always use leaded brass. The Copper Development Association has three designations for leaded brass. Rod it is identified as—CDA-360, sheet and plate—CDA-353, and tubing—CDA-260. These materials contain 1 to 3% lead, which makes them free machining. They will do much to save your sanity. Such brass is often very difficult to locate. However, McMurray Metals (**Ref. 17**), keeps a large stock of it in all sizes and shapes. They usually make no charge for cutting to size.

Pivot File-Burnisher— When making a new arbor, a very useful tool is a combined pivot file and burnisher, **Fig. 32**. Available from Cas-Ker (**Ref. 18**). The file portion of this

tool is one of the finest cut files available today. As such, it will cut extremely hard metals that other



Fig. 32. A Pivot File & Burnisher

files cannot. The burnisher is of fully hardened steel and must be prepared for use as follows. Lay it flat on a piece of 320 grit emery paper. Apply pressure and move it at 90 degrees to its length. The emery will put skillions of saw-tooth ridges in the surface. Each ridge will come to a sharp crest. When this surface of the burnisher is applied with pressure to the cone pivot of a rotating arbor, if the arbor is rotating very slowly, these ridges will act like a super fine cut file and will remove small amounts of metal. However, when the work is speeded up and pressure is applied, the ridges will slip on the surface. This work hardens the surface, makes it much harder than the parent metal and yields a very bright surface. I use the tool to burnish the cone pivots of arbors that I make for speed keys. The file is excellent for removing wear marks in old arbors before burnishing.

Drill Press And Bandsaw— I have a simple, Taiwanese bench type drill press and a bench type bandsaw, **Fig. 33**. The drill press has a Jacobs chuck that accepts drills from about 1/32" to 1/2" OD and has the usual speed ranges. It seems quite adequate for work on the small items that I normally deal with. The bandsaw is a three wheel version, made in England. Unfortunately, the company has never been agreeable to shipping them to the U.S. It has a constant speed motor but the saw can be set up for two speeds, 1500 feet/minute and 300 feet/minute. I do no woodwork and keep it set for 300 feet/minute. With a blade having 32 teeth/inch, it will cut brass, steel, plastic and wood. One should not cut un-hardened tool steels with such a saw blade. Such steels are prone to work harden and destroy the saw blade. Hacksaw blades work well for these materials.



Fig. 33. Band Saw & Drill Press

Draw Filing— A filing trick not well known to many is draw filing. Even when striving for a flat surface, the typical approach by most workers is to push the file across the work in a sawing motion. Unfortunately, this is almost guaranteed to roll the surface that one is striving to keep flat. Avoid this problem by use of a draw filing technique.

To do this, one grasps the tang of the file in the left hand and the tail of the file in the right hand and “draws” it along the length of the work and toward the body, **Fig. 34**.

Actually, my technique should be called “push” filing. I reverse the grips and push the file away from

the body. By sitting in a position that allows one to look down the length of the part, it is very easy to keep the file level and the resulting surface is a very flat one and even smoother than that obtained when using a a milling machine. However, be certain to bounce light off the filed surface from a single bulb, swinging arm lamp.



Fig. 35. A Rope Knurl

the body. By sitting in a position that allows one to look down the length of the part, it is very easy to keep the file level and the resulting surface is a very flat one and even smoother than that obtained when using a a milling machine. However, be certain to bounce light off the filed surface from a single bulb, swinging arm lamp.

Rope Knurling Rollers— Much of the work done on telegraph keys requires the use of a rope knurling roller. These are quite unique items and are very expensive. A flat face roller, with straight or helical pattern usually costs \$10.00 each, a rope knurling roller is special made and can cost up to \$250.00 each. Not only that, each one can have a different helical pitch and each can have a different curvature of the rope portion. Thus, it can be very expensive to tool the shop for making rope knurled parts. One of the main suppliers of these rollers is Accu Trak Tool Corp (**Ref. 19**). A typical rope knurling roller is shown in **Fig. 35**.

Lathe Spindle Crank— There are a number of machining operations that require hand turning of the lathe headstock spindle. The threading of lathe drilled holes is a need that occurs quite frequently. The



Fig. 36. Bench Lathe Hand Crank

Figure 37 shows the Myford hand crank installed in the Myford bench lathe. Of course, the crank is not just a Myford accessory. Many lathe users have been making their own hand cranks for about as long as there have been bench lathes.

Speed Key Feet— One often needs to replace the feet on a speed key. An excellent source of supply for these feet is MSC Industrial Supply Co. (**Ref. 20**). They offer rubber bumpers in a number of sizes but the most useful one is 5/8" OD. A second one of 3/4" OD has some limited use.

Often, the 5/8" OD bumper is a bit too tall. However, it is very easy to reduce the height. Mount the bumper on a screw and lock it with a nut. Chuck it in the clockmaker's lathe and use an Exacto knife that has been modified

for use as a cutoff tool to shorten it to the desired length. The raw cut can then be smoothed with a Dremel motor and an adhesive sanding disk. Coat the surface with silicone grease and it will have a nice appearance. A group of the 3/4" and 5/8" OD bumpers is shown in **Fig. 38**.



Fig. 38. Rubber Bumpers

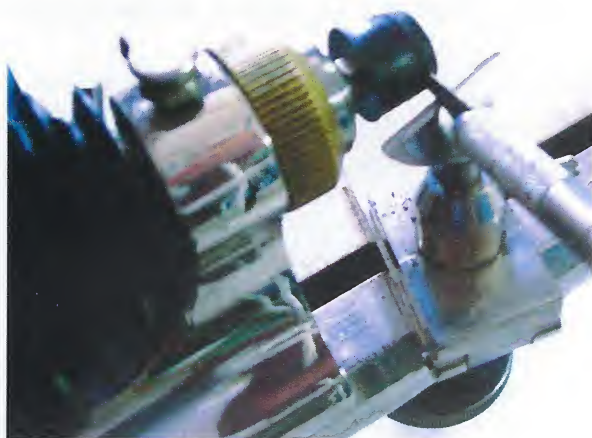


Fig. 39. Shortening The Bumper



Fig. 37. The Crank Installed

for use as a cutoff tool to shorten it to the desired length. The raw cut can then be smoothed with a Dremel motor and an adhesive sanding disk. Coat the surface with silicone grease and it will have a nice appearance. A group of the 3/4" and 5/8" OD bumpers is shown in **Fig. 38**. **Figure 39** shows the shortening of a bumper with an Exacto knife and **Fig. 40** shows the bumper after the cut end has been dressed with a Dremel and sanding disk. It is obvious how the silicone grease has improved the appearance of the foot.



Fig. 40. The Shortened Bumper

REFERENCES

1. Sherline, 3" x 15" Lathe, Model 4000. Sherline Produces Inc. 2350 Oak Ridge Way, Vista, CA 92083. Phone: 800-541-0735.
2. OptiVISOR with # 5 Plate, 8" Focal Length. Cat. # 290.473. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
3. Python Fiber Grips (State Size). S. E. Bate (Hawthorne) Ltd., New John Street, Halesowen, United Kingdom.
4. Cutting Broach Set, Cat. # 151.505 and 151.506. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
5. Burr, 7 mm, Cat. # 180.028. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
6. Dykem Layout Fluid, Blue, Cat. # 00264036. MSC Industrial Supply Co. Phone: 800-645-7270.
7. Bushing Rod, Cat. # 086129. S. LaRose, Inc. 3223 Yanceyville Street, PO Box 21208, Greensboro, NC 27420. Phone: 888-752-7673.
8. Screw Head File, 4" x 15/32". Cat. # 311.338. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
9. Screw Head File, 19/32" x 1/8". Cat. # 311.343. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
10. Piercing Saw Frame, 5" Throat, Cat. # 491.705. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
11. Cleveland Twist Drill Lathe Tool, 1/8" x 1/8" x 2-1/2", Mo Max, Super Cobalt, M-46, EDP # C44567. Tru Kut Inc., 1121 Spring Street N. W. Atlanta, GA 30309.
12. Mascot Flat Pivot Drill Assortment, 0.028" to 0.050", Cat. # 281.352. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
13. Nickel Silver Rod, 1/8" x 12". Cat. # HMJA1. K & G Finishing Supplies, PO Box 458, Lakeside, AZ 85929. Phone: 800-972-1192.
14. SafeTap Fluid, 4 Oz. Bottle. Cat. # 00259606. MSC Industrial Supply Co. Phone: 800-645-7270.
15. Circular Saw, 3" x 0.010" x 1/2" hole, 280 Teeth. Available from Sherline Produces Inc. 2350 Oak Ridge Way, Vista, CA 92083. Phone: 800-541-0735.
16. **Workshop Techniques For Clockmakers & Modelmakers**, 2-hour video available from W. R. Smith, 8049 Camberley Drive, Powell, TN 37849. Phone: 865-947-9671. E-mail, WRSmith2@AOL.COM.
17. Leaded Brass. McMurray Metals, PO Box 710040, Dallas, TX 75371. Phone: 800-658-5655.
18. Combination Pivot File & Burnisher. Cat. # 311.01720. Cas-Ker Co., 2550 Civic Center Drive, PO Box 31167, Cincinnati, OH 45231. Phone: 800-487-0408.
19. Accu Trak Tool Corp., 490 Stafford Street, Cherry Valley, MA 01611. Phone: 800-433-4933.
20. Rubber Recessed Bumpers, 5/8" OD, Cat. #, 32827883 & 3/4" OD # 37827891. MSC Industrial Supply Co. Phone: 800-645-7270.

CHAPTER 5 MAKING SPEED KEY PARTS

In Chapter 1, we covered the cleaning of a key. In Chapter 2, we worked with how to manage a japped base in poor condition. In Chapter 3 we discussed various plating methods for home and commercial plating, and in Chapter 4 we examined tooling, techniques, sources, etc. That has prepared us for the making of key parts, which will be the topic of this chapter.

The Dot Spring Assembly— The first part of this assembly to be made is the dot spring collet. Place a 1/2" OD, 1/2 hard, leaded brass rod (**Ref. 1**) in the lathe chuck, face it and turn it to 7/16" OD. Use a center drill to make a center and follow this with a

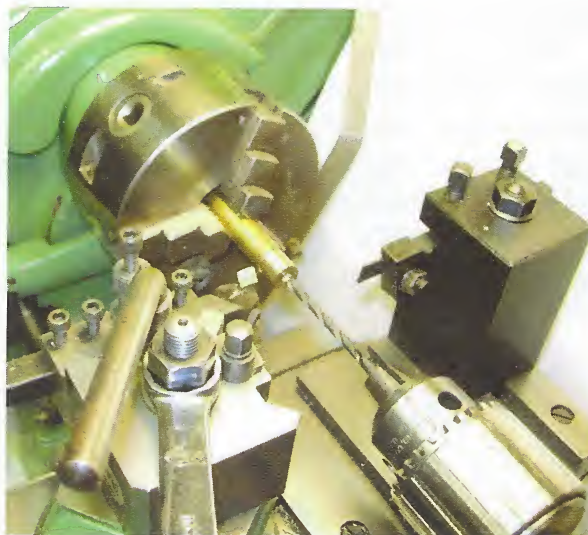


Fig. 1. Drilling The Dot Spring Collet



Fig. 2. Parting The Collet

3/16" drill, **Fig. 1**. Move in a back-post cutoff tool and part the work 1/4" long, **Fig. 2**. This is the body of the new dot spring collet. A

groove must now be cut into it, into which the dot spring can be swaged.

Mount the collet body in the vise of a milling machine. In the mill spindle, chuck a 3/16" OD milling cutter. Center the cutter on the collet, bring it against the top surface, zero the mill spindle dial and cut a groove in the collet 1/16" deep. This is being done on a little Sherline milling machine. The resulting cut is shown in **Fig. 3**.

Remove the collet from the milling machine vise and mount it in a machinist vise



Fig. 3. Milling The Collet Spring Slot

with the groove downward. At the top center of the collet, drill through the wall opposite the slot with a # 43 drill and tap the hole 4- 40. This completes the work on the collet.

The dot spring must next be made. Coat a length of 0.010" thick carbon steel feeler gage stock (Ref. 2) with Dykem layout blue and scribe a line the width of the 3/16" mill cut +1/64". Cut along this line with tin snips, Fig. 4. Using a fine cut file, smooth the cut edge to remove any trace of roughness and finish the edge with 600 grit emery paper.



Fig. 4. The Feeler Gage Stock And Snips



Fig. 5. Punching The Spring

of the contact to ensure an attractive riveting operation. For parting soft materials during hand turning operations, an Exacto knife can be modified to do the job nicely and avoid a waste of material. Grind the end of a normal Exacto knife to the shape of a cutoff tool. Use this as a hand-held cutoff tool, and part the contact to length, Fig. 7.

Measure the length of spring stock required for the dot spring and cut the stock to length. Place the silver contact in the hole of the spring and rivet it with the special punch that expands the rivet equally in all directions. Make

With a sharp prick punch, mark the location where the silver contact must be mounted and slip the feeler gage strip into one of the homemade punch jigs described in Chapter 4. Center the punch mark in the hole of the jig, place the punch in the hole and strike it a firm blow with a hammer, Fig. 5. Remove the punch and pull the feeler stock from the jig. Use a diamond setter's burr to smooth the edge of the punched hole and lay the spring aside.

Place a 1/8" OD silver rod, Fig. 6, (Ref. 3) in a collet of the clockmaker's lathe, and turn a spigot

Fig. 6. A Silver Rod For Making Contacts

on the end that is a slip fit in the hole punched in the feeler gage stock. Drill a small, short depth hole in the end of the spigot

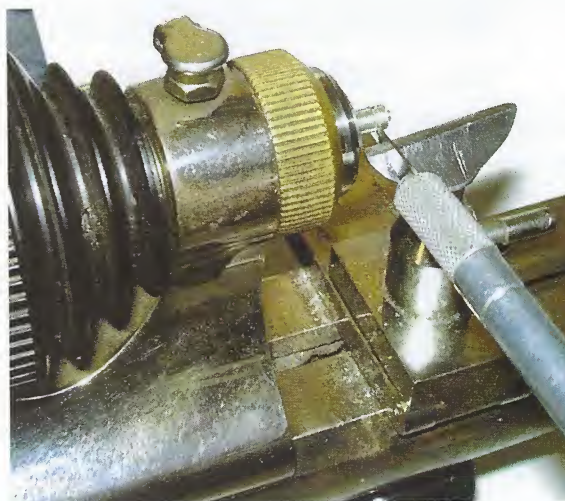


Fig. 7. Parting The Contact

certain that the body of the contact is firmly against the spring during riveting. If this is not done, there will be an unwanted gap between the spring and the contact.

Place the collet in a vise with the soft jaws installed. Using a three cornered, fine-cut file, gradually widen the walls at the base of the milled slot until the spring will just slide into the slot. Place it in the slot with the end flush and with the contact on the collet side of the spring. Position the collet on a bench anvil with the milled groove upward and using a hammer, swage the two walls of the milled groove over the dot spring. Check to make certain that the spring is firmly gripped by the walls of the milled slot by the swagging. Using round nose pliers, bend the spring to form the typical "U" of a dot spring shape.

Turn the OD of a 4 - 40 pan head, steel screw to make a filister of it. Clean the screw carefully and blue it with heat. This completes all fabrication work on the dot spring assembly and it is now ready for plating.

Add a piece of # 24 copper wire to the part, clean it with cigarette lighter fluid to remove all traces of oil and grease and place it in clock cleaning solution for about three minutes. Rinse it in tap water, dry it on a towel and then with heat. Without touching it with the hands, coat the silver contact with Dykem to act as a plating stop and nickel plate the entire unit in the workshop plating bath using 3 volts DC from a wall-wart, as described in the chapter on plating. The completed dot spring assembly, totally handmade in the shop is shown in **Fig. 8**.

Making Speed Key Weights— The fabrication of cylindrical weights for speed keys is about the simplest of machining operations. However, many people are constantly asking how to go about making such weights. So, we will make a couple of them next to illustrate the entire process, including the making of one of the many types of the weight screws.

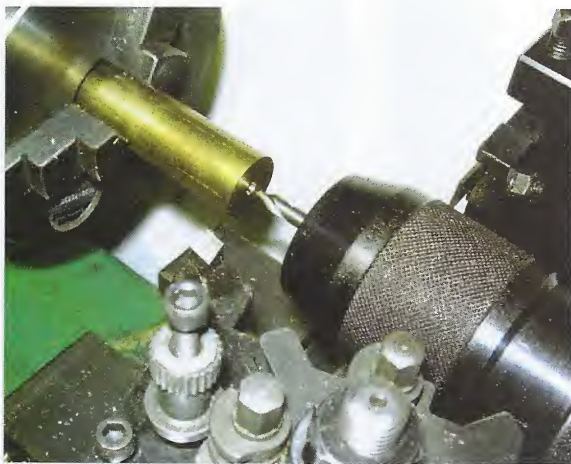


Fig. 9. Center Drilling The Weight Blank

Different speed keys have different diameter weight rods and require weights with different size center holes. For instance, McElroy speed keys have a larger weight rod than those used on Vibroplex keys. Of course making the weights for speed keys having a flat weight bar is a completely different ball game. For drilling the central hole for Vibroplex



Fig. 8. The Completed Dot Assembly

Place a 3/4" OD, 1/2 hard, leaded brass rod in the bench lathe and face it. Use a center drill to form a center as illustrated in **Fig. 9**. Twist drills habitually run off center if the length of a hole is repeatedly extended from an initial hole. To avoid this problem, drill the stock only one drill depth before parting the weights. Face the work anew, center drill the stock and start a new drill hole for each group of weights.

Different speed keys have different diameter weight rods and require weights with different

keys, use a # 18 drill, **Fig. 10**. For McElroy keys, use a # 10 drill. For this machining operation, the weight will be a heavy one and could be parted now; however, there would be no easy way to finish the exterior surface of the weight. Thus, it is advisable to do the tapering of it before it is parted. If the surface of the brass rod has scars or blemishes of any sort, it is wise to take a light cut on the OD. If there are no objectionable surface marks, a simple tapering will be adequate. Use 320 emery paper first and follow this with 600 paper. Running the lathe at a relative high speed will greatly shorten the required tapering



Fig. 10. Drilling The Weight Hole

operation. Also, with a fine cut file, break the sharp edge on the end of the work.

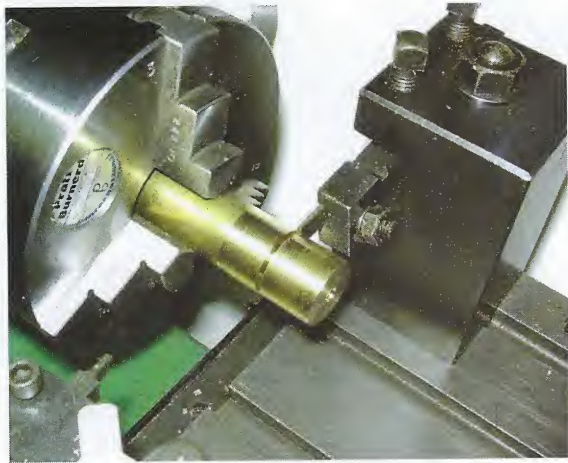


Fig. 11. Parting The Key Weight

When satisfied with the finish, bring in the back-post cutoff tool and start parting the work. However, before parting it completely, use a fine cut file to break the sharp edge of the cut. Part the work at 5/8" from the end, **Fig. 11**. For a second and lighter weight, set the cutoff tool at 5/16" from the end and part a second weight.

Mark the location of the screw hole on the OD of the blank using a center punch and place the part in a machinist vise. Carefully rotate the part in the vise until the punch mark is exactly at the top. Mount a #29 drill in the drill press chuck and drill through to the center hole as illustrated in, **Fig. 12**. Without releasing the part, replace the drill

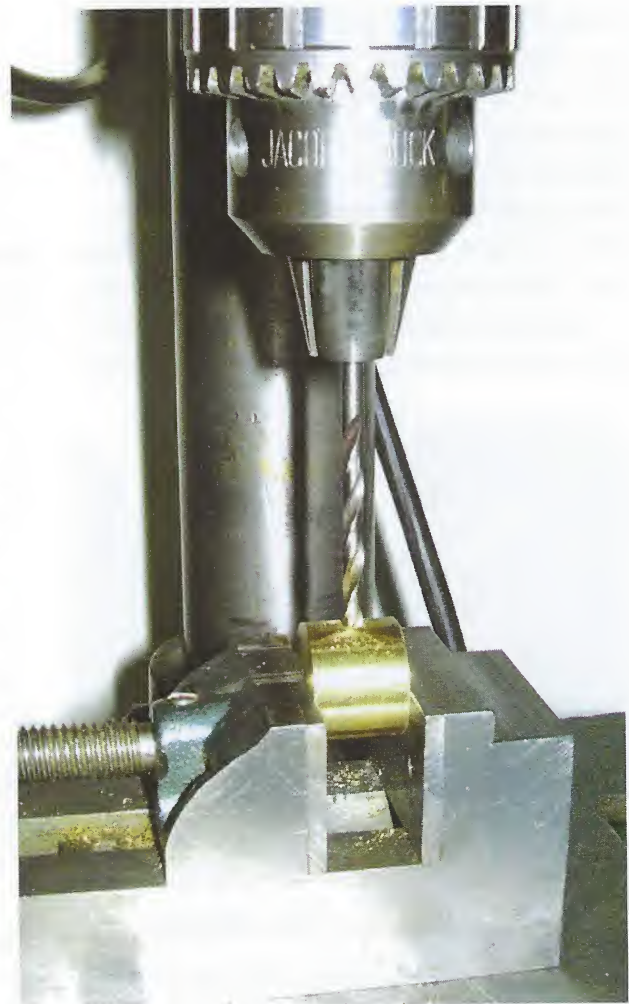


Fig. 12. Drilling The Weight Screw Hole

with an 8 - 32 tap and start threading the hole in the weight by rotating the drill press spindle by hand. This will ensure that the tap starts axial in the hole. After several threads have been cut, release the tap from the drill chuck and add a "T" handle to complete the threading of the hole. The machined parts are shown in **Fig. 13** and are ready to be plated.



Fig. 13. Machined Weights



Fig. 14. The Plated Weights

To remove the machining marks, rub the ends of the weights on 320 grit emery paper and then on 600 grit paper. If it is desired that the weight have a dull nickel finish, leave a 600 grit a 320 grit surface and plate them with nickel. If a very bright finish is desired, the weight blanks should be polished with a muslin buff coated with tripoli, followed by red rouge.

Mount the parts on a # 24 copper wire and plate them in the workshop nickel plating bath. However, if many are to be made, take them to a commercial plating shop. The home shop nickel plated, 600 grit emery finish weights, are shown in **Fig. 14**. As can be seen by the illustrations making weights is quite a simple matter.

The Weight Screw— As is well known, weight screws have many different shaped heads--cylindrical with straight knurls or diamond knurls, rope knurls, etc. The example to be made here will be a simple cylindrical head with straight knurling. If rope knurling is desired, it can be added as described later during the making of thumbscrews and thumbnuts.

Place a 3/8" OD, 1/2 hard, leaded brass rod in the lathe chuck and machine it to 0.155" OD x 7/16" long, **Fig. 15**. This is the diameter required for an 8 - 32 screw that is to be nickel plated. If the screw is not made undersize in this manner, the increase in diameter during plating will make it oversize and it will be too large for an 8 - 32 threaded hole.

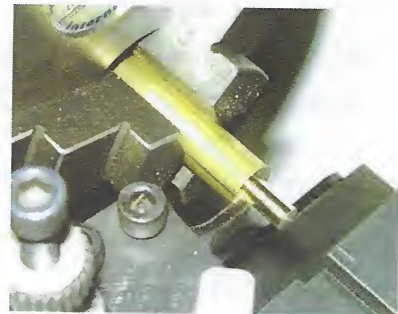


Fig. 15. The Screw Blank

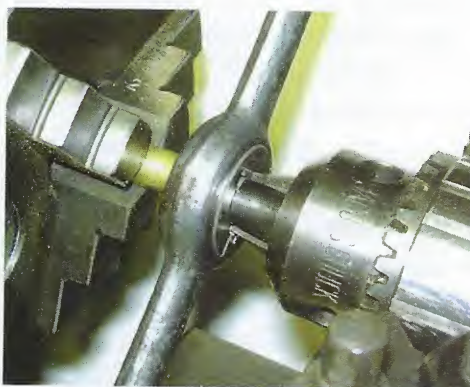


Fig. 16. Threading The Screw

Set an adjustable die for this diameter 8 - 32 threads and thread the part as shown in **Fig. 16**. The end of the partly opened Jacobs tailstock pressing against the die helps to keep it at right angles to the screw blank. An expandable handle mounted in the Myford lathe spindle allows it to be turned easily during the threading operation.

Bring in the back post cutoff tool and score the work for the correct head thickness but do not part the screw blank completely. Back the cutoff tool away and choose a knurling tool. I have a number of different knurling rollers in individual holders. These can be mounted in a normal Myford tool holder that drops into the quick change tool post. Since this screw is to have a cylindrical head, a fine pitch, straight knurl roller will be used (**Ref. 4**). Mount the knurling roller in the tool post and bring it against the head of the screw

blank, as shown in **Fig. 17**. It requires considerable pressure to knurl a part, so don't be shy with the cross slide crank. When satisfied with the resulting knurl, move the back post cutoff tool back into play and part the work as shown in **Fig. 18**.

Cutoff tools are notorious for leaving unwanted

machining patterns on work that has been parted. Thus, it is always wise to remove these by rubbing the flat, parted surface on 320 grit emery paper and then 600 grit paper.

There is not really much more that can be done to improve the surface of such a screw before plating. Buffing would harm the knurling and is not an option. The completed screw is shown in **Fig. 19**.



Fig. 18. Parting The Screw

Making Thumbnuts— Two of the most difficult problems faced when working with speed keys are the making of thumbnuts and thumbscrews. This is not because either is difficult to make but because the rope knurling rollers are special

made items. They are very expensive and several of them are required. Here is why. A rope knurl has a helix angle. Thus, there can be several of them. In addition, the helix can be either left hand or right hand. Lastly, each can have a different pitch. Multiply this roller quantity by a cost of up \$250.00 each and you can see why tooling to make something as simple as a thumbnut or thumbscrew is very costly.

The thumbnut is the simplest to make and will be made first. However, much preparation is required before any machining can be started. The most difficult part of the entire task is the making of a form tool for shaping the OD. **Figure 20** shows such a form tool from the bottom side. It is a normal 1/4" lathe tool that has its face ground square on the end and with a 20 degree relief angle. Into this angular face must be ground a half cylinder. Not only that, it must be positioned at the correct distance from one edge of the face. This must be done so when the cutoff tool is positioned against the shoulder cut by the tool, it will part the thumb nut



Fig. 20. Thumbnut Form Tool

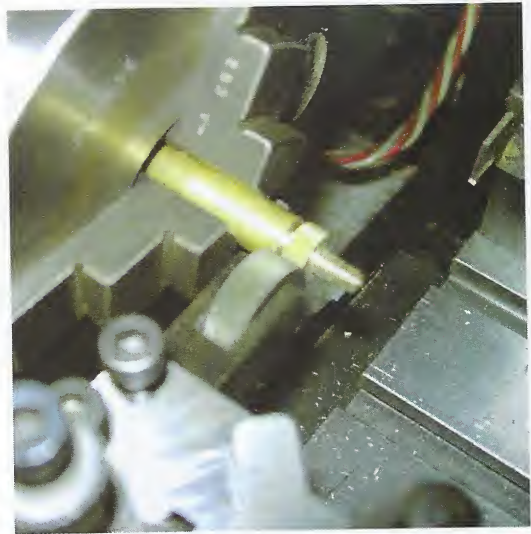


Fig. 17. Knurling The Screw



Fig. 19. The Screw

and leave the correct amount of boss typical of these nuts. This half cylinder groove must be hand ground into the face of the form tool and a Dremel will be used.

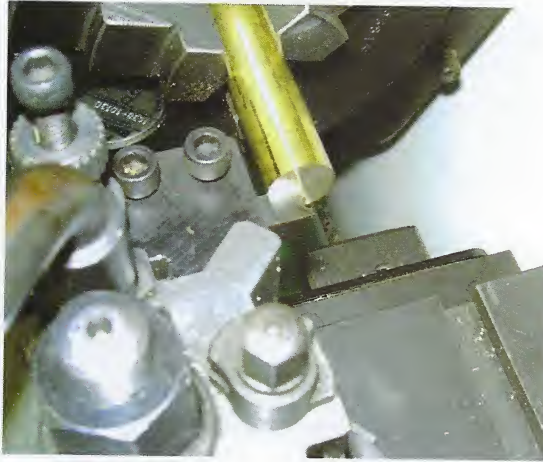


Fig. 22. Facing The Stock

with the shaping stone. Because this is hand held grinding, it is very difficult to do properly. When satisfied that the groove has been ground to the correct shape, mount the tool in a tool holder and then on the lathe tool post. Position it so its face is tangent to the OD of a 1/2", half hard, leaded brass rod and use its left corner to face the end of the rod, **Fig. 22**.

Reposition the form tool against the OD of the rod, and with its left corner, turn the required 1/4" x 1/32" shoulder, **Fig. 23**.

With the face of the form tool tangent



Fig. 24. Forming The Nut OD



Fig. 21. A Dremel, Stones, & A Shaper

Figure 21 shows two arbor mounted stones, a Dremel motor and a dressing stone. Each grindstone has been thinned to a proper thickness and a radius has been formed on the periphery

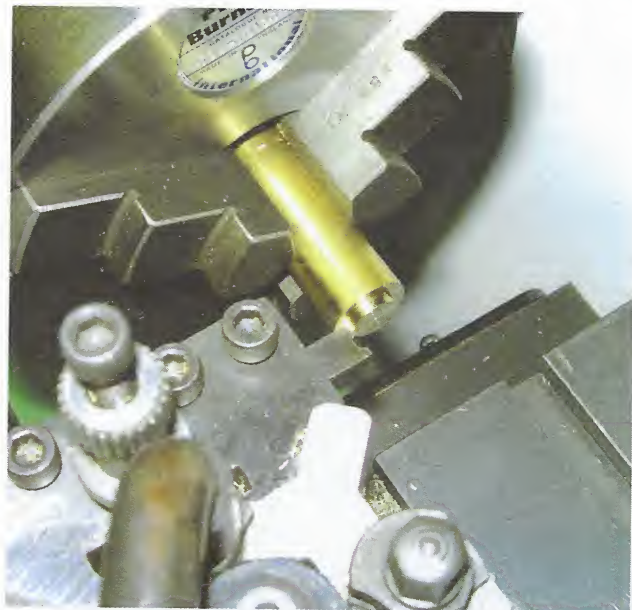


Fig. 23. Forming The Boss

to the OD of the rod, position the right edge of the tool flush with large diameter face of the work. Now, turn the cross slide crank. With the lathe running at about 600 rpm, watch for the instant that the half donut for the rope knurl has finally been correctly formed by the tool, **Fig. 24**. There are two tricks to this operation. To avoid chatter, the overhang of the stock must be kept to a minimum. Secondly, the instant the half donut is formed, quickly back the tool away from the work. If these things are not done, the form tool will cause chatter marks on the OD of the part.

Bring in the back post cutoff tool and place

its blade against the left wall cut by the form tool. Its thickness must reduce the left hand cylinder length to that correct for a thumbnut boss. The width of this groove is why it is so difficult to grind the form tool correctly. Without it, much additional machining must be done.

Choose the correct rope knurling tool (Ref. 5) and mount it on the lathe. Center it on the half donut of the part and set the lathe speed for about 300 rpm. Force the knurling roller against the half donut of the part with considerable pressure and note the formation of the knurl. If it appears poorly centered on the half donut, correct the lathe saddle position. Leaving the roller engaged, stop the lathe and examine the knurl to see if each ridge has come to a full crest. This operation is shown in Fig. 25. It is now time to drill and tap the hole in the nut. Mount a center drill in a tailstock chuck and form a center with a center drill as shown in Fig. 26. This is to give the twist drill a starting hole in the exact center of the part and prevent it from walking on the surface to a point off center. Follow this with a tailstock mounted

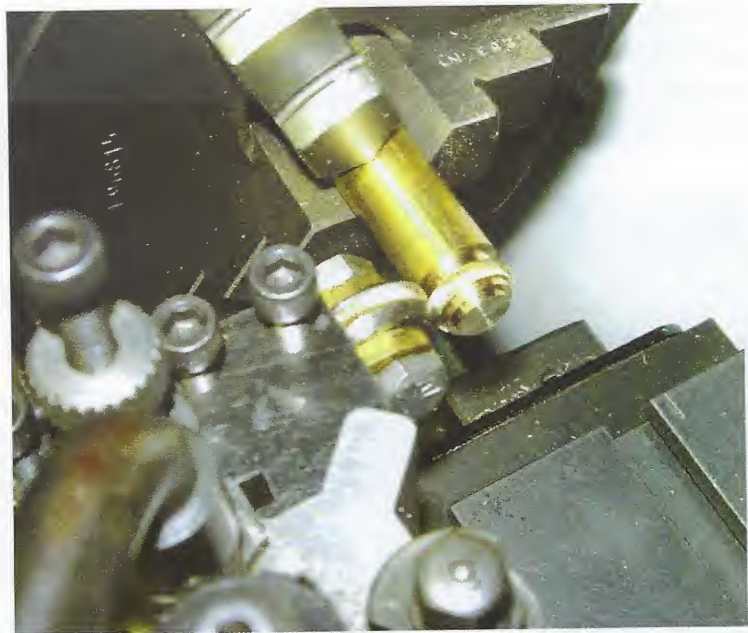


Fig. 25. Rope Knurling The Thumbnut

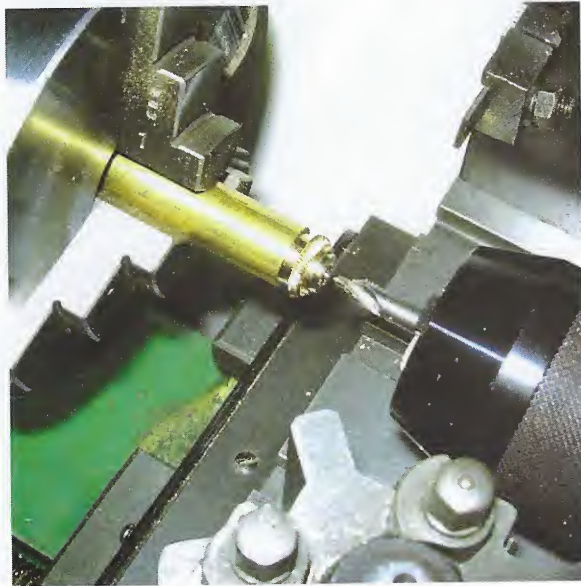


Fig. 26. Center Drilling The Stock

29 twist drill, as shown in Fig. 27. As mentioned, never attempt to machine more thumbnuts than one drill length of stock. Leaded brass is a free machining material and no lubrication is needed for drilling the hole or later when tapping it. Replace the drill with an 8 - 32 tap, mount a crank handle in the lathe headstock spindle. Although



Fig. 27. Drilling The Thumbnut

Myford offers a hand-crank for their lathes, many craftsmen make their own. Bring in the tap and thread the hole, **Fig. 28**.

Move in the back post cutoff tool and position its blade against the extreme left-hand wall of the cut made by the form tool. At this position, the cutoff tool performs two tasks. Its thickness removes excess thumbnut thickness to leave the desired boss and it parts the work, **Fig. 29**.

Before being plated, mount the thumbnut on a length of screw stock and use a slotting graver to clean-cut the wall on each side of the knurl. This will remove the excess metal moved outward from the



Fig. 28. Tapping The Thumbnut

half donut by the knurling roller during the knurling operation.

Mount a circular wire brush in the clockmaker's lathe and brush the ridges of the knurl to remove brass particles that might get trapped by the plating. Use the diamond setter's burr to de-burr each end of the threaded hole.

Finally, rub



Fig. 30. The Thumbnut

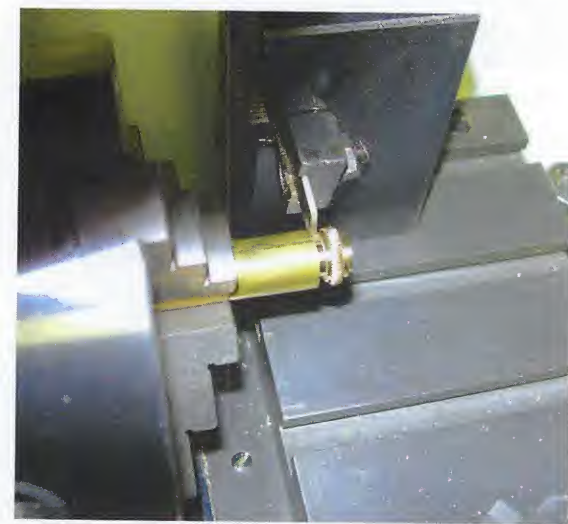


Fig. 29. Parting The Thumbnut

both sides of the thumbnut on 320 and then 600 grit emery paper. The completed thumbnut, ready for plating, is shown in **Fig. 30**. Add a #24 copper wire and plate the nut as described in Chapter 3.

Making Thumbscrews— There are two ways to make a thumbscrew and I will show both of them. One method involves joining a small diameter thumbnut to a length of 8 - 32 threaded brass stock. Since the making of a thumbnut has just been demonstrated, this method will be demonstrated first, although it is not the best of the two methods.

Set an adjustable 8 - 32 die to cut a thread 0.155" OD. Chuck a length of threaded brass stock (**Ref. 6**) in the clockmaker's lathe, start the die and use the lathe motor to run it down the length of the stock, **Fig. 31**. This is to reduce the OD so that it

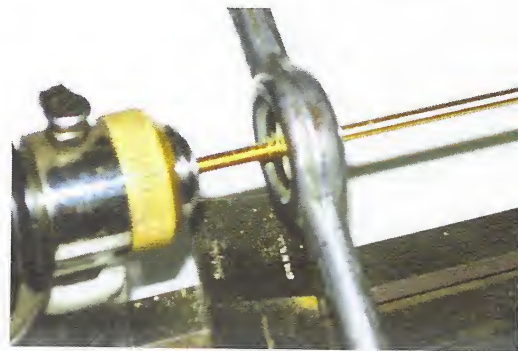


Fig. 31. Reducing The Thread OD

will not be too large for the 8 - 32 threaded holes after plating. If the thumbscrew is to be used as a spring adjusting screw, turn a small diameter spigot on the end of the stock to enter the spring. If it is to be used as a contact screw, drill a center hole to receive the silver contact. If to be used as an ordinary thumbscrew, use a round graver and form the end to the typical shape of such screws. Finally, extend the work and part it at a length of 1-1/8", as shown in **Fig. 32**.

Using the same tooling and techniques just used for making the 1/2" diameter thumbnut, make a batch of thumbnuts using 3/8" OD, 1/2 hard, leaded brass rod. These and a number of threaded screw bodies are

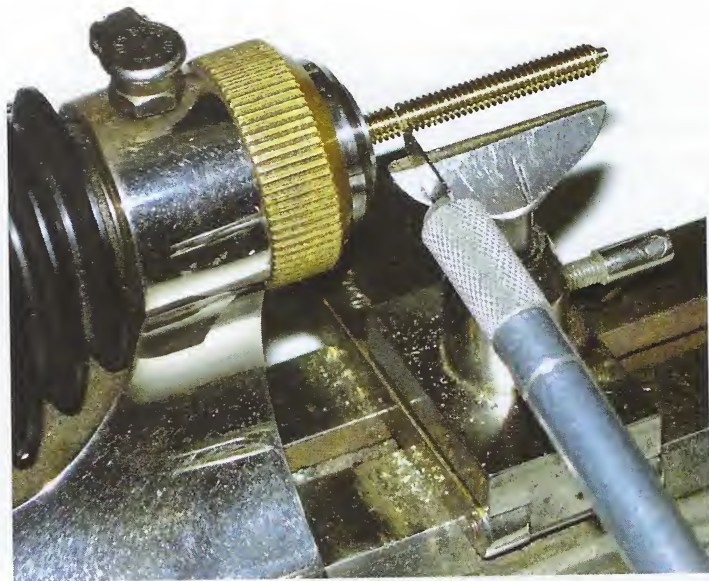


Fig. 32. Parting The 8 - 32 Stock To Length



Fig. 33. Thumbscrew Heads & Bodies

der when the part is hot enough. To be certain that the solder has flowed all the way through the joint, use something to rotate the head a few degrees clockwise and back again but leave a slight amount of the threaded stock protruding. This will be turned away later. **Figure 34** shows the screw after being soldered, a package of Tix solder, a length of the solder, a bottle of the flux and the Blazer torch used. These torches are available from S. LaRose, Inc. (**Ref. 8**). They have an excellent, pin point blue flame from their refillable butane gas supply. Tix also offers a bottle of stop-off fluid that can be painted on parts to prevent the solder from wetting the surface. I use the Tix solder quite often but have never had a need for the stop-off.

Mount the screw in the clockmaker's

shown in **Fig. 33**. These parts are now ready to be joined by the use of Tix solder, available from S. LaRose (**Ref. 7**). Tix solder has the lowest melting point of any of the soft solders, is by far the strongest and always remains bright.

Mount the screw body in a machinist vise and screw the head on it. Flood the joint with the Tix solder flux, heat the part with a torch and apply the sol-



Fig. 34. Soldering The Head

lathe and use a hand held graver to make a clean cut across the top of the head, as shown in **Fig. 35**.

As was true for the thumbnut, the ridges of the knurl must be brushed with a rotary wire brush to remove brass particles. It will also be noted that a slight ring is evident at the top of the screw where the screw stock meets the head. It seems that no matter how carefully the head is faced, there will always be evidence of the junction of the two parts. It is for this reason that I do not consider this to be the best method for making the screws. The completed thumb screw is shown in **Fig. 36**.

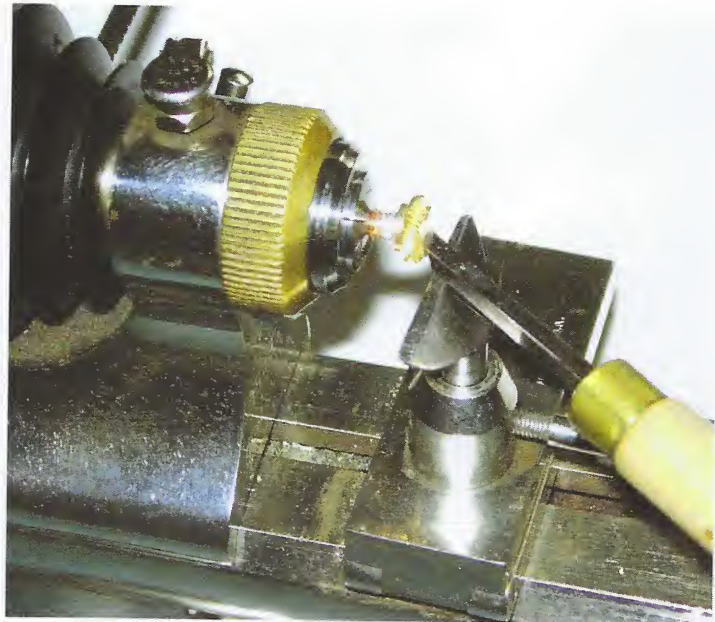


Fig. 35. Facing The Head Of The Screw

Since the flux used is of the acid type, the screw must be washed in a solution of baking soda and water to neutralize the flux. Clean it further in clock cleaning solution and it will then be ready for plating as described in Chapter 3.

The Best Way To Make A Thumbscrew— Compared to the way screw machines spit out screws, making any sort of a screw in the home shop is a labor intensive undertaking. The method to be described now for making one is a far simpler operation than the one just described. However, it requires a machining trick that must not be ignored.

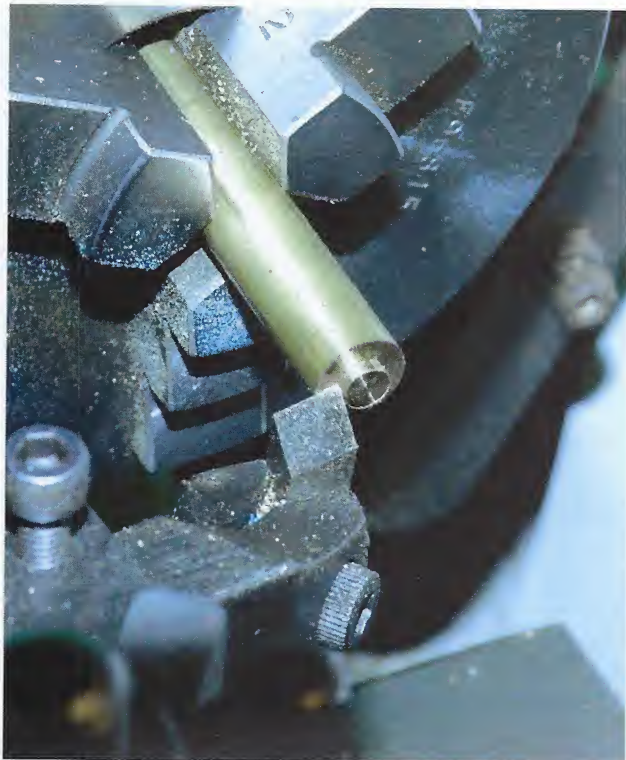


Fig. 37. Turning A Spigot



Fig. 36. The Thumbscrew

Trying to turn the entire length of the screw by gradually reducing the diameter of the stock by multiple cuts is very likely to fail because of the small diameter of the work and the long overhang. However, it is entirely possible to reduce the OD of the work to the required diameter in a single pass and without a problem.

Place a 3/8" OD, 1/2 hard, leaded brass rod in the lathe chuck and face the end. Turn a spigot 5/32" long, **Fig. 37**.

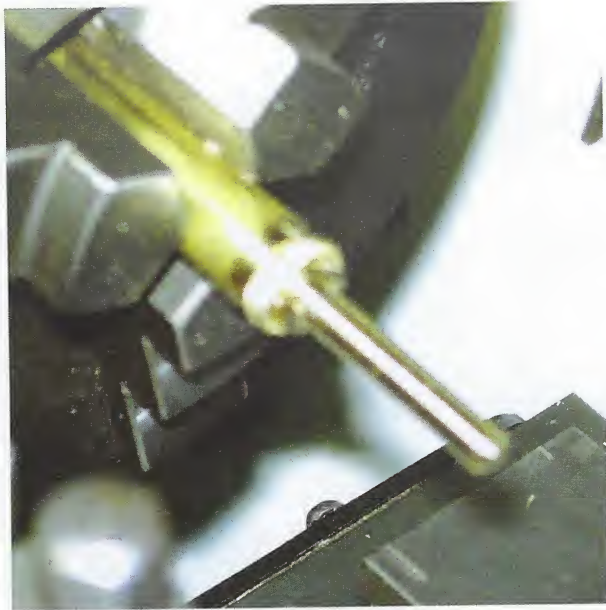


Fig. 38. The Machined & Knurled Part

The amount of work required to make thumb screws by this method is considerably less than by the first method. In addition, there will be no juncture on top of the head.

Mount the screw in the clockmaker's lathe and clean-cut the wall at each side of the knurl using a slotting graver. This will remove the metal pushed there by the knurling operation. Brush the knurls to remove brass particles from the grooves, clean it in clock cleaning solution and it is ready to be nickel plated. The completed screw is shown in **Fig. 39**.

Making Cubical Weights— The making of cylindrical weights has already been discussed and it is now time to deal with the more difficult to make, cubical type weights, for

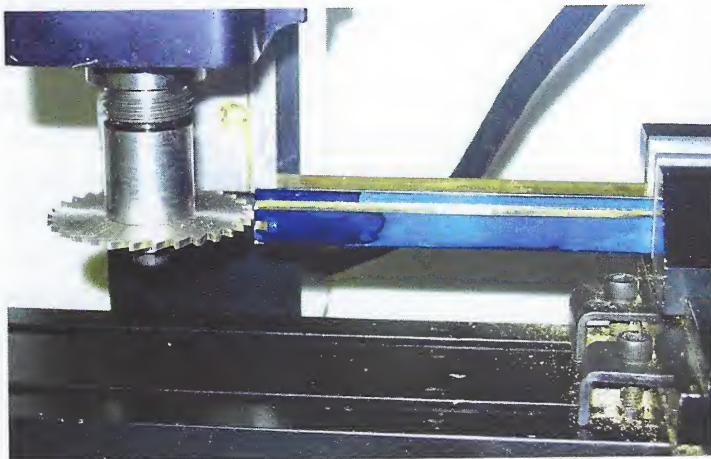


Fig. 40. Slotting The Brass Bar

keys having a flat weight bar. This will require the use of a Sherline milling machine and a length of 1/2" square, 1/2 hard, leaded brass bar (**Ref. 9**).

Place the bar in the milling vise and lock it parallel to the base of the milling machine. Mount a 1/16" thick circular saw on an arbor in the mill and position it to cut a groove 1/8" below the top edge of the rod and make a long cut 1/4" deep, as shown in **Fig. 40**. Back the cutter out of the work, lower it 0.010" and make a



Fig. 39. The Completed Thumbscrew

second cut to widen the total groove to 0.070". The weight bar of the key is 1/16" thick and this additional width is to ensure that the plating will not make the groove too small to mount on the key.

At the band saw, cut a 5/8" length from the slotted bar, as shown in Fig 41.

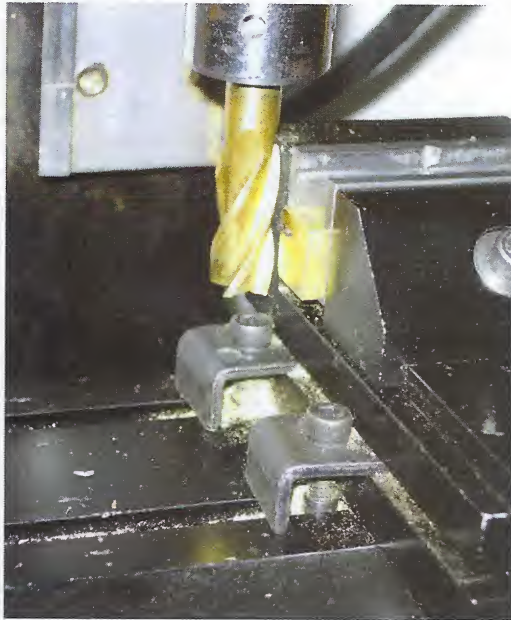


Fig. 42. Smoothing The Saw Cut

Mount the freshly cut part in the milling machine vise, being very careful to

keep its top surface parallel to the table of the milling machine. This will keep the cut square to the body of the part. Use a four flute end mill to smooth the saw cut surface on each end of the part, as shown in Fig. 42.

On the Dykem coated top surface of the part, mark the screw hole location with a center punch. This punch mark should be centered on the length of the part and 5/32" away from the near wall of the slot.

Mount the part in a machinist vise and drill through at the punch mark with a # 29 drill. Replace the drill with an 8 - 32 tap and use the drill spindle to start threading the hole in the weight, as shown in Fig. 43.

This will keep the axis of the tap coincident with the axis of the hole.

Use the diamond setter's burr to deburr each end of the threaded hole. Rub the walls of the cube and its edges on 320 and 600 grit emery paper laid flat on a workbench top. The resulting part, Fig. 44, is now ready to be nickel plated.

Although I have shown the individual steps for making one cubical weight, if many of them are to be made, multiple operations would be done at each of the various machining steps. This would save time and greatly speed up the production process.

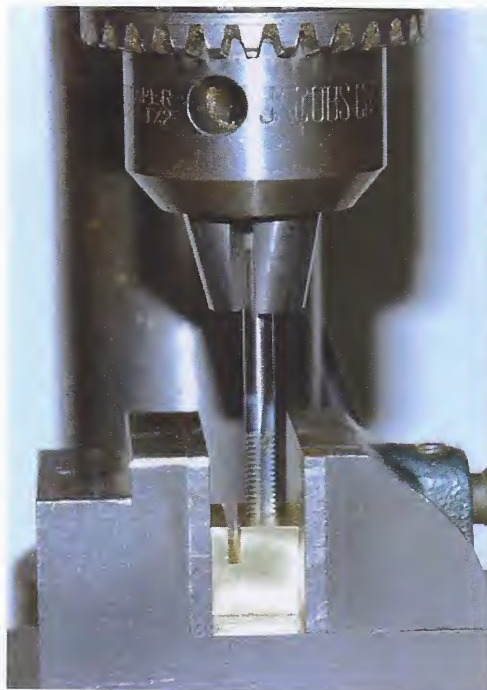


Fig. 43. Tapping The Hole



Fig. 41. The Weight Blank



Fig. 44. The Weight

A group of machined and nickel plated weights are shown in **Fig. 45**. Since I made a large number of these weights, they were taken to a local plating shop for plating.

The nickel plated, shouldered thumb screws, used with these weights are available from Small Parts Inc. (**Ref. 10**).

The “BUG KILLER”— After listening to a number of operators complaining about flat weight bar speed keys being too fast for them, I decided to see what might be done to solve the problem. As it turned out, a simple modification of my design for the cubical weight offered a very simple solution to the problem—The Bug Killer. Instructions for making this device will be given next.



Fig. 46. Slotting The End Of The Stock

At the band saw, cut a 5/8” length from the slotted stock, mount it in the milling vise and dress the ends with a four flute end mill, as was done for the cubical weights. Center punch the screw hole location in the same position as for the cubical weight and thread the screw hole.

On a 1/16” thick sheet of 1/2 hard, leaded brass, lay out a bar 1/4” wide x 2-1/8” long. Saw this from the stock, dress the edges with files and paper them. Make a clamp from a coat hanger by forming a circle, then a vertical run and finally an arm extending over the circle. Slide the circle under a fire brick and grip the brass cube against the brick with the spring tension from the clothes hanger clamp. Coat the end of the brass bar with silver brazing flux and put it in the slot of the cube. This arrangement and the Mapp torch with a Turner Whirlwind torch head is shown in **Fig. 47**.



Fig. 47. The Rig For Brazing & The Torch

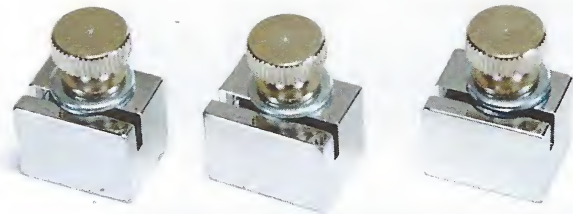


Fig. 45. Completed Flat Bar Weights

It is possible to install the bar in the slot on the wrong side of the cube. This would result in a unit that is not usable. To position the bar properly, the cube must be positioned on the fire brick as shown **Fig 48**, with the slot to the left of center. Also, make certain that the bar is firmly against the back of the slot and the top the of the fire brick. This will result in the bottom of the bar being in the same plane as the bottom of the cube, a very necessary geometry.

Use the Mapp torch to heat the cube and blade red hot and touch a bit of silver solder wire into the slot above junction of the two parts. (Mapp gas and Whirlwind Torch Heads are available at most plumbing supply companies.) If

the parts were clean and free of oil and grease, the silver braze metal should fill the gap around the blade quickly and evenly. Avoid overheating, which can melt the brass.

Run hot water over the part to dissolve the brazing flux and then scrub the part with a

brass bristle brush to remove discolorations. It may also be necessary to use emery paper and a glass bristle brush to complete the cleaning job. LIME-AWAY will also do an excellent job. The completed part that has been thoroughly cleaned and is ready for nickel plating is shown in **Fig. 49**.

Since I made a large number of these items, mostly to give to friends, the entire batch was taken to a local plating shop to be nickel plated.

The shouldered thumb screw used with this device is the same commercial



Fig. 49. The Completed Bug Killer

screw that was used with the cube weights made earlier. They are available from Small Parts Inc. A group of completed and plated Bug Killers are shown in **Fig. 50**.

To use the Bug Killer, replace the cube weight of the speed key with the Bug Killer. Mount the cube weight of the speed key on the bar of the Bug Killer and position both for maximum key

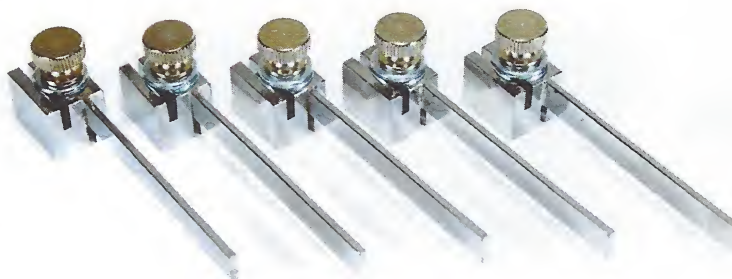


Fig. 50. A Group Of Completed Bug Killers



Fig. 48. The Silver Brazed Part

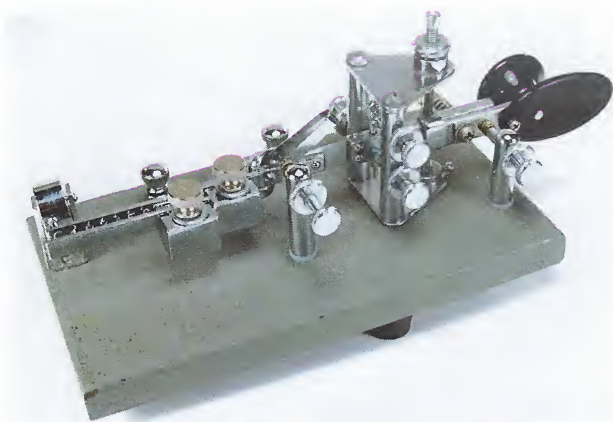


Fig. 51. Bug Killer's Fastest Position

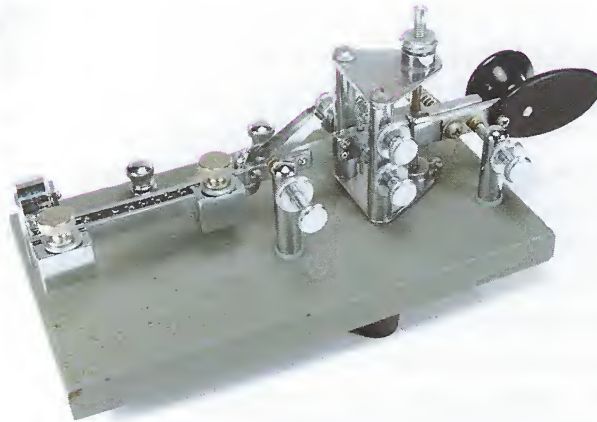


Fig. 52. The First Speed Range

speed, as shown in **Fig. 51**. This should yield a bug speed considerably slower than the maximum speed of the key before the Bug Killer was installed.

From this starting position, the weight on the Bug Killer can be moved forward along its bar to the end of the unit, as illustrated in **Fig. 52**. This is the first of the three speed ranges offered by the unit, almost the same range as the standard key but all speeds slightly slower.

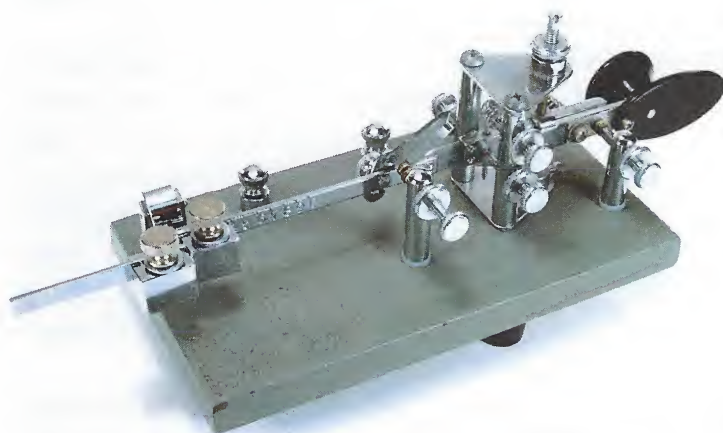


Fig. 53. The Second Speed Range

If a slower speed range is desired, start as in **Fig. 51**, with the key weight against the Bug Killer and move the Bug Killer in steps to the end of the key's bar, as shown in **Fig. 53**.

From this position, the Bug Killer is available for its third range of speeds. Moving the speed key weight from this starting position to the end of the Bug Killer bar offers the last and slowest range possible with the unit. This is shown in **Fig. 54**.



Fig. 54. The Third Speed Range

When attached to the weight bar of a standard key, the Bug Killer slows the speed of the key from its normal 25 wpm to about 10 to 12 wpm.

Since the Bug Killer attaches to the weight bar of the speed key in the same manner as the key's weight, it in no way damages the key or alters it in any way. It is always available for use if needed and can be laid aside at any time.

Those who have used it seem very pleased with its performance.

Making Thumbscrew Posts— When working with speed keys, one very often has a need for thumbscrew posts. These are a very simple machining exercise and will be illustrated next.

Place a 5/16" OD, 1/2 hard, leaded brass rod in the lathe chuck. Grind a form tool that will both face the end of the rod and machine the dome shape at the same time. With the tool mounted on the tool post of the lathe, face the end of the rod. The form cutter and a rod that has just been shaped is shown in **Fig. 55**.

Now is the best possible time to dress the surface of the part. Use 320 and 600 grit emery paper on the cylindrical portion of the part to give it a very nice finish. Use a very fine cut file on the dome portion to smooth away any tool marks and follow it with emery papering. Bring in the back post cutoff tool, position it at 1-5/32" from the faced end of the rod and part the post from the parent stock. Make as many post blanks as desired before going to the next machining step. (The English are noted for their use of the back post cutoff tool. As can be seen in **Fig. 56**, it is mounted upside down and is always used on the back side of the work.)



Fig. 56. Parting The Post

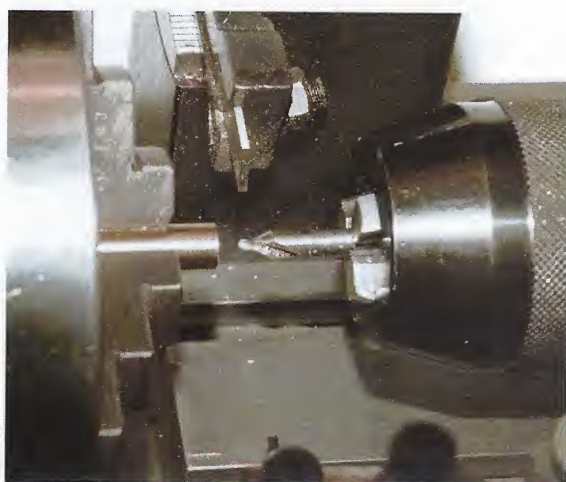


Fig. 57. Center Drilling The Post

Mount a post in the lathe with the parted end exposed and use a center drill to form a center for starting the hole to be threaded for mounting the part. Because I do multiple parts, I use three tailstock chucks. In one is mounted the center drill, in the second one is mounted the twist drill and in the third one is mounted the tap for threading the hole. Instead of replacing the objects in the chuck, I simply replace the total tailstock chuck, which is much faster. Of course, a turret lathe would be much faster but I don't have one. The center drilling of the part is shown in **Fig. 57**.

Mount the chuck holding a # 29 twist drill, in the tailstock and drill 3/4" into the end of the part.

A simple trick is to mark the 3/4" hole depth on the twist drill with a Sharpie pen so the desired depth can be easily determined during the drilling operation.

As the drill loads with brass, it is wise to

back it out from time to time and tap it with the handle of a chuck key to dislodge accumulated brass shavings. The drilling operation is shown in **Fig. 58**. Unlike taps which often require lubrication during tapping operations, drilling in leaded brass seldom requires a lubricant.

When the required depth has been reached, replace the chuck holding the drill with one holding an 8 - 32 tap. Install a hand crank in the lathe headstock spindle and begin the threading of the hole.

Although this is free machining brass, quite often a small amount of Safe-Tap will greatly lessen the force required to rotate the tap in the work. Base the use of it on the loading experienced during the tapping operation.

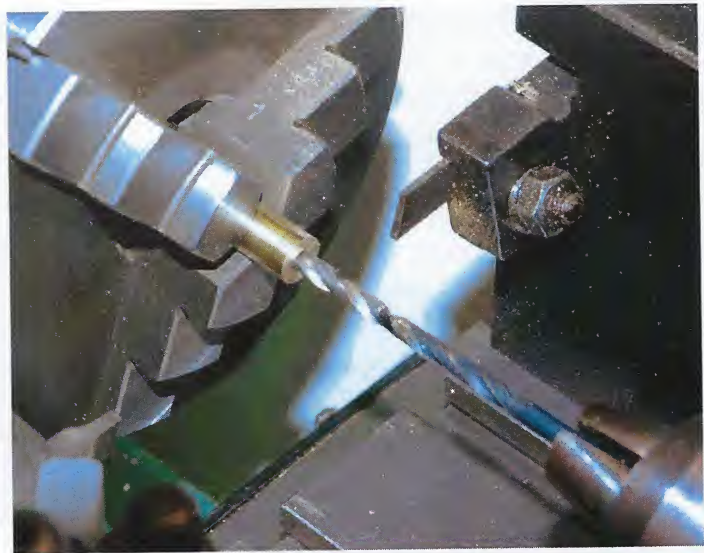


Fig. 58. Drilling The Post

Some taps cut better than others. As was true with the twist drill, one often has to back a tap out of the work and tap it with the handle of a chuck key or other metal object to dislodge the build up of brass accumulated by the threading operation. Be sure not to break the tap when it bottoms in the hole.

Following the threading operation, coat the dome end of the post with Dykem. Set a dial gage to 13/16" and use it to scribe the Dykem at that distance from the flat end.

Lay the post in a "V" block and use a sharp punch to make a small mark at the required location. Replace this punch with a typical center punch and make a good size center in the part. The "V" block, the post, the center punch and a bench anvil are shown in **Fig. 59**. The post is now ready to be cross drilled and threaded to receive the thumb-screw.

Place the post against the base of a machinist vise and positioned so the center mark is above and over the void in the base of the vise. Press the part firmly against the base of the vise and rotate it until the punch mark is

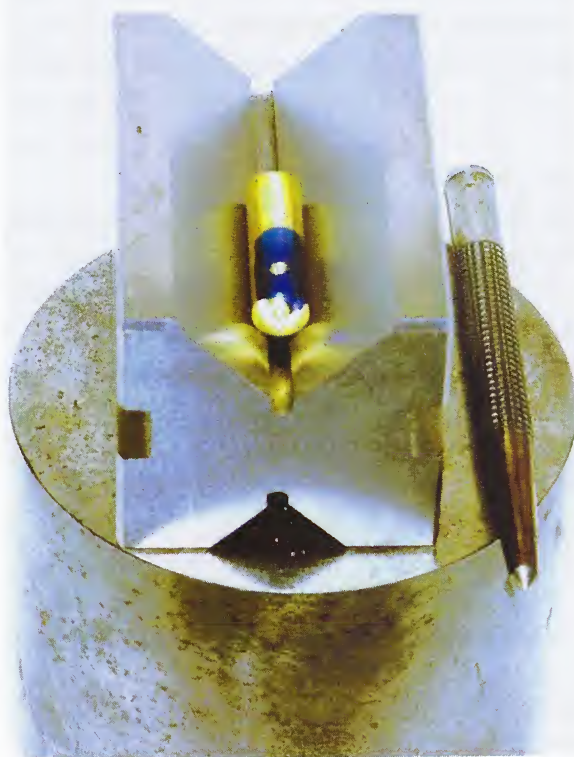


Fig. 59. Center Punching Post

midway between the jaws when the vise is tightened. This will ensure that the drill passes through the exact center of the part. It is a critical operation and must be done carefully.

Mount a # 29 twist drill in the drill press chuck and drill through the post at the center marked location. Be sure the cutting edge of the drill has been blunted, as described

previously for drilling brass. The drilling operation is shown in **Fig. 60**. If all has been done properly, the drill will pass through the center of the post and will also pass into the void in the middle of the machinist vise.

There is simply no better way to start a tap in a drilled hole than by leaving the part undisturbed and using the drill press with which the hole has been drilled. If the part is removed from the vise and the hole is tapped, it is quite certain that the tap will be started at an angle to the axis of the hole and threading the hole will be a problem. Avoid this by tapping the hole using the drill press while the part is still clamped in the machinist vise or against the table of the drill press after drilling.

Replace the drill with an 8 - 32 tap, coat it with Safe-Tap. Start threading the hole by rotating the drill press spindle by hand and with considerable downward pressure. When certain that several threads have been started, release the tap from the drill chuck and place a "T" handle tap wrench on it to complete the tapping operation, as shown in **Fig. 61**. When threaded, remove the tap, and wash the part in detergent and water to remove the Safe-Tap and shavings.

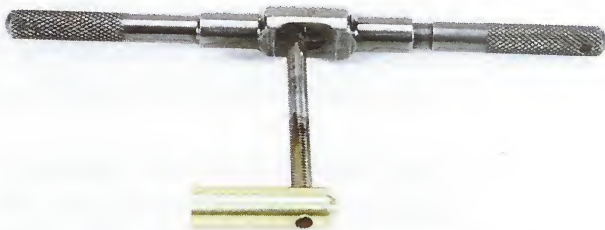


Fig. 61. Threading The Hole 8 - 32

For this exercise, it will be assumed that the completed post will require a bright nickel finish.



Fig. 62. The Buffed Posts Ready For Plating



Fig. 60. Cross Drilling The Post

Use the diamond setter's burr to deburr the ends of the holes and emery paper to smooth the part. If a dull nickel finish is required, leave the part with a 600 grit paper finish. For a bright finish, the post must be buffed to a high gloss.

Use the diamond setter's burr to deburr the ends of the holes and emery paper to smooth the part. If a dull nickel finish is required, leave the part with a 600 grit paper finish. For a bright finish, the post must be buffed to a high gloss. Thus, it is necessary that they be given a high polish with a buffer. I do this with my drill motor/muslin buff rig. The completed parts are shown in **Fig. 62**.

A standard buffing machine is usually a double ended, 3000 rpm motor, with a threaded conical adapter mounted on each shaft. This "screws" into the buffs and other

wheels used on the buffer. They are usually quite large and have a dust collector. I do not have such a system but have done very well using an ordinary drill motor and a hardware store arbor for mounting muslin buffs. Although not quite as good for buffing metal as the 3000 rpm buffing systems, it has the advantage that it can be used to buff plastics. Its slower speed avoids the melting of the plastic surfaces. My polishing drill motor and buff are shown in the bench vise in **Fig. 63**.



Fig. 63. A Drill Motor Buff

As previously shown, the buffing compounds used are tripoli and red rouge. Tripoli is a white material that cuts faster than red rouge. However, it does not produce as high a polish as the rouge.

During polishing, it will be noted that the base of the polishing materials (probably a wax) tends to build up on the surface of the work and prevent buffing in the spots covered by it. A touch of cigarette lighter fluid will remove these accumulations and allow

a more complete buffing of the surface. Strangely, the English call these buffs "Grease Mops."

Using the one pint, shop plating rig, previously described, the thumbscrew posts were plated, rinsed and dried. As usual, I made many posts and the completed group is shown in **Fig. 64**.



Fig. 64. The Completed & Plated Posts

These are the standard length thumbscrew posts, found on Vibroplex speed keys. If posts of different lengths or diameters are required, the machining operations will likely be the same as those described.

Making A Shorting Lever— Quite often a key comes through the shop missing a

shorting lever. These levers are quite easy to make and the process will be illustrated next by making one for a 1921, standard type, Vibroplex key. I will not be giving dimensions or drawings because different keys require different levers. However, the techniques are the same.



Fig. 65. The Shorting Lever Blank

Dykem. Draw in the required shape of the shorting lever, its hole locations, the bend mark and the location of the finger to be bent upward to act as a stop. While still a part of the sheet, drill the holes and tap the one for the knob. This avoids the need to hold small pieces while drilling and threading them. Saw the part from the parent stock, **Fig. 65**.

While the stock is still in the flat state, use a 0.010" circular saw to cut the slit in the end where the finger will later be bent up to serve as a stop. This is shown in **Fig. 66**. Not all shorting levers have this finger but the 1921 key does.

File and paper the edges of the stock to smooth them. Also, while still flat, paper the each side of the part to remove surface imperfections.

The part must next be heated red hot in the area of the bend line, thus, any remaining Dykem must be removed or it will be baked on and will be very difficult to remove later. Using denatured alcohol and a Kleenex, wipe the part clean.

Stand the part vertically, clamp the bottom end in the bench vise and heat the area of the bend line red hot. When cool, clamp it in the vise jaws exactly at the bend line. Place a square against the side of

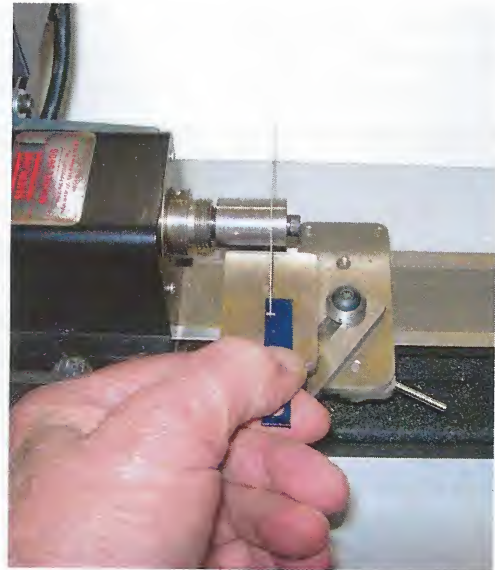


Fig. 66. Sawing The Finger



Fig. 67. Bending The Lever

the part to be certain that the bend will be at 90 degrees to the length of the part. Use a fiber block and a hammer to bend it, as shown in **Fig. 67**.

Grip the finger portion of the lever in the vise jaws and bend it up in the same direction as the part of the lever where the knob mounts.

This model lever has a bevel, which is, the same length as, and opposite the stop finger. This should be filed into the body opposite the finger.

Scrub the part with a brush and clock cleaning solution to remove any discoloration from the heating. Use 600 grit emery if necessary. Finally, buff the part to a high polish. Scrub with soap and water to remove the polishing compounds, clean it in clock cleaning fluid, rinse in water and nickel plate it. The finished lever is



Fig. 68. The Lever

shown in **Fig. 68**. Note the raised finger stop and the beveled edge opposite the finger.

It is now time to make the knob for the shorting lever. This will be a hand turning job using a clockmaker's lathe and a hand held graver. There is no simpler and faster way to do the work. Mainly, because it avoids the need for grinding a form tool or the making of casting molds. A standard graver shape will be used.

Mount a 1/2" OD, black plastic rod (**Ref. 11**) in the bench lathe chuck, drill an axial hole 1/2" deep with a # 29 drill and tap it 8 - 32. Part it 7/8" long with the back post cutoff tool. To ready the part for hand turning, screw a length of 8 - 32 threaded stock into the threaded

hole and mount the stock in a collet of the clockmaker's lathe, as shown in **Fig. 69**.

There should be no problems encountered during this turning exercise. Use a typical graver with a 60 degree face ground to the normal diamond shape but it must be kept very sharp. A few strokes on a fine cut India bench stone now and then should be adequate. However, with the graver recommended earlier, re-shaping at the bench grinder can be done without fear of damaging the graver. From that shape, only about four strokes on each cutting edge with the India stone will produce a razor sharp edge.

Start the turning by rounding the end portion first. Work on the waist portion next. The

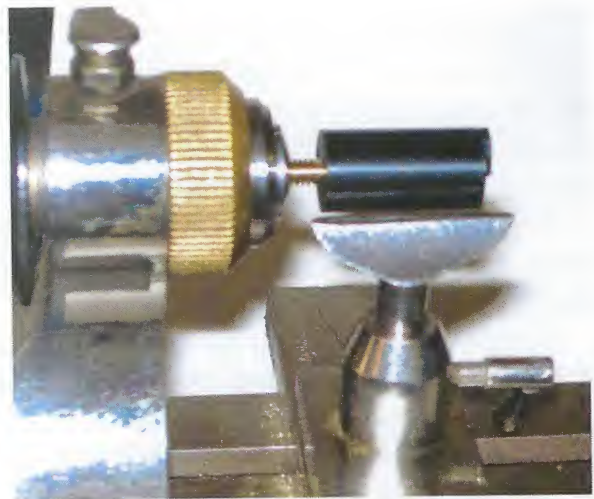


Fig. 69. The Stock For Turning.

plastic will come off in long strands that will wrap around the work and must be cleaned away from time to time,

Measurements can be made if desired but I have a lifelong habit of working by sight when doing such turning operations.

I should mention a few tips that might be helpful for those not accustomed to doing hand turning. Be certain to keep the "T" rest close to the work. With too much distance between it and the work, there can be a tendency for the work to grab the graver and try to carry its point under the work. This can result in the scoring of a soft part. Also, keep the cutting edge at an angle with respect to the work. Avoid hav-

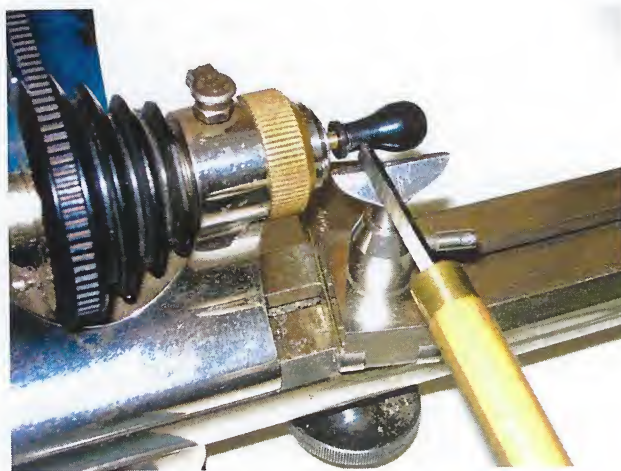


Fig. 70. The Turning Operation

ing the cutting edge in a plane parallel to the axis of rotation of the work when turning soft materials. Raise and lower the end of the graver handle to find the best cutting angle.

When satisfied with the shape of the knob, screw a length of 8 - 32 threaded stock into it and screw this stock into the threaded hole of the shorting lever. Using a small screw head file, score the thread root where the rod should be cut to length for the knob. Remove the knob and the screw from the lever. Mount the threaded stock in a clockmaker's lathe collet and use a modified Exacto knife as a cutoff tool for parting the unwanted stock. Follow this with a hand held graver to flatten the end and then bevel it for a nice appearance.

Plate the threaded stock with nickel and install it in the knob. Mount the knob in the shorting lever. This completes the job and the finished lever is shown in **Fig. 71**.



Fig. 71. The Completed Lever

Making Bearing Screws— Often there is a need to make a new bearing screw for a speed key. These require a small diameter, a long head and a hole in the threaded end. The cone of the key's arbor is captured by this hole in the screw and serves as a bearing for the rotation of the arbor during use of the key. A simple solution to this problem is to obtain a filister head screw and reduce the diameter of its head. This produces the "long" head required. It is then only a matter of cutting the screw to length and drilling a hole in the end to serve as the bearing.

Let's assume that a commercial screw has been obtained from a local hardware store and is zinc coated. The coating must be removed with acid and the screw neutralized as described earlier, so we end up with a plain steel screw. Place it in the collet of a clockmaker's lathe or the chuck of a bench lathe and turn the head to the desired diameter. This turning operation using a clockmaker's lathe and a hand held graver is shown in **Fig. 72**. This can be done equally well on a bench lathe.

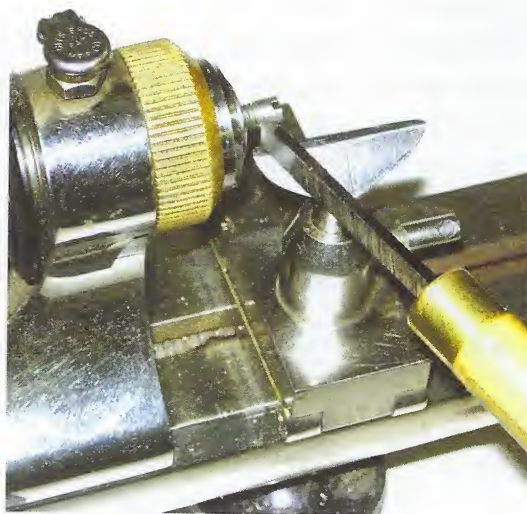


Fig. 72. Turning The Screw Head



Fig. 73. Center Drilling The Screw

The hole diameter used as a bearing for most keys is in the neighborhood of 0.070". Thus, replace the center drill with a # 51 twist drill and drill into the screw for about 5/32".

Many screws are quite hard and require a very sharp twist drill. If the drill fails to cut easily when tried, examine the point. If you can see the cutting edge, that means it is rounded and the drill is dull. you will need to reshape it on a grinder. A 2" OD grind stone moulded on a 1/4" OD arbor for mounting in the clockmaker's lathe is adequate for reshaping such drills. When the drill is sharp, drill the hole as shown in **Fig. 74**.

After the hole has been drilled, brush the screw with a glass bristle brush and emery paper until a bright surface is obtained. The screw is now ready

the desired diameter. This turning operation using a clockmaker's lathe and a hand held graver is shown in **Fig. 72**. This can be done equally well on a bench lathe.

The next problem is the chucking of the screw. With the head reduced in diameter, the screw will easily pass into a 10 mm chuck of a clockmaker's lathe. If one is not available, the split nut described earlier can be used to chuck it in a bench lathe. Cut the screw to length (many Vibroplex keys use one 25/32" long) and make a center with a very small diameter (0.045" OD) center drill, as shown in **73** at the clockmaker's lathe.

The hole diameter used as a bearing for most keys is in

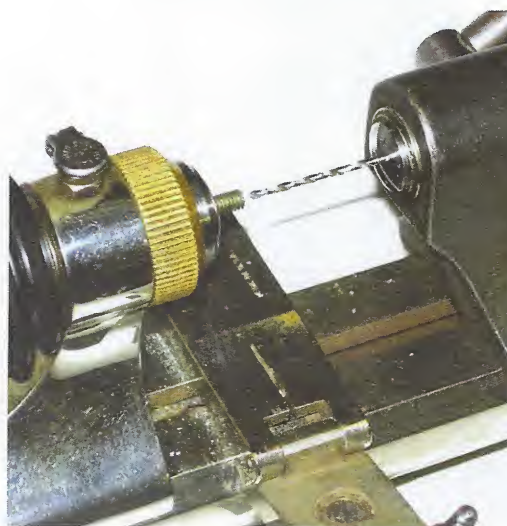


Fig. 74. Drilling The Screw

for bluing or for being plated. The completed bearing screw is shown in **Fig. 75**.

Winding Cylindrical Springs— To many, making coil springs appears to be somewhat of a mystery, when in fact, it is one of the simplest operations imaginable. Suppose there is a need for a dash lever return spring. These are usually 1/4" OD and wound from 0.020" diameter music wire (**Ref. 12**). On some of the older keys, phosbronze was used.

If there is a secret to winding springs, it is in the choice of the arbor diameter on which to wind them.



Fig. 76 The Setup For Spring Winding



Fig. 77. A Newly Wound Spring



Fig. 75. The Completed Screw

Spring stock always snaps back partly when bent, thus, the arbor on which the spring is to be wound must always be smaller than the desired spring. Trial and error is the best method for finding the required diameter of the arbor. Wrap a few turns of wire around a given rod and observe the resulting spring OD. When satisfied with the arbor's diameter, wind the spring.

For our example spring, a 3/16" OD rod proved to be a good arbor size. Make a short 90 degree bend on the end of a length of 0.020" diameter music wire. Choose a collet for the watchmaker's lathe or bench lathe that is a good fit on the rod plus one diameter of the wire. Place the

arbor in the collet and capture the bent end of the wire in the collet also, as shown in **Fig. 76**.

While holding considerable tension on the end of the wire with a Visegrip, turn the lathe headstock spindle by pulling on the drive belt while winding the spring wire on the arbor.

As you stand facing the lathe, the wire must be held to the left slightly to force it to "almost" climb over the last turn. Thus, the angle between the wire and the axis of the arbor must be less than 90 degrees. The desired angle will vary with the wire diameter and must be determined by experiment. If the wire climbs the last turn, the angle is too great but it must constantly be made to "almost" climb the last turn. This will produce a close wound spring, as is shown in **Fig. 77**.

If done properly, when tension on the wire is

released, the spring will unwind a few turns, grow slightly larger in diameter and all turns will be close together. This is the desired beginning spring. If the wire has not been made to "almost" climb the last turn during winding, the spring will be faulty.

Figure 78 shows the 3/16" OD rod on which the spring was wound. In the lower right-hand corner is a length of properly wound spring. In the lower left-hand corner is a standard Vibroplex dash bar return spring and the long spring is a length of close wound spring that has been stretched to space the coils as desired. Lengths of spring can now be cut from this stock as required. Also, the amount of stretch can be altered to match the requirements.

Winding Conical Springs— I have not fully explored the winding of conical springs yet and still have a couple of more ideas to try. However, here are the results of my first effort. On a 1/4" OD brass rod, I turned a long taper, terminating in a small diameter cylinder. A short length of the end of a length of .020" OD music wire was bent to 90 degrees. This bent end and the small diameter cylindrical portion of the arbor were captured in the lathe collet, **Fig. 79**. The wire was held by hand with considerable tension as the clockmaker's lathe headstock was rotated by pulling on the lathe belt. As was the true for the winding of cylindrical springs, to ensure a close wound spring, it "almost" climbed the last turn of the spring

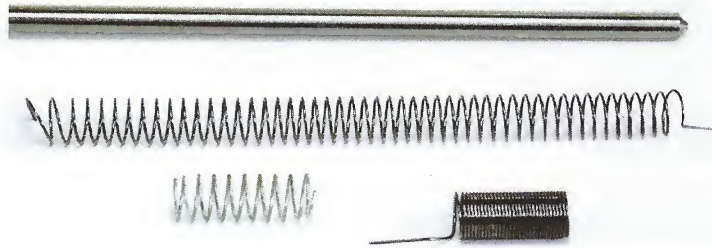


Fig. 78. The Arbor, Two Wound Springs & A Vibroplex Spring

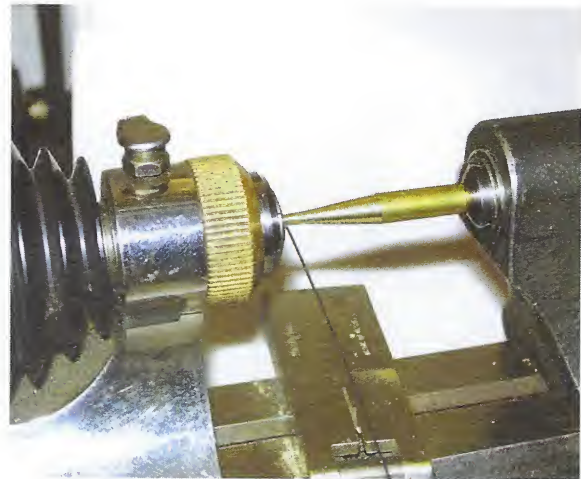


Fig. 79. Winding Conical Spring



Fig. 80. Winding A Conical Spring

the feed wire was held at a slight angle so during winding. The wire wound on the conical arbor is shown in **Fig. 80**.

A number of different cone shapes were tried and it soon became apparent that the resulting cone of the spring was a trial and error thing. Also, unlike a cylindrical spring, a conical spring cannot be stretched to provide uniform coil spacing. The larger diameter turns will always end up with more space between turns when the spring is stretched, than the small diameter turns. The best way I found to get equal turn spacing was to first stretch the spring to get the approximately correct spacing between the large diameter turns and then to work the spacing between the individual turns with the finger nails.

Figure 81 shows a 1/4" OD, conical arbor and several close wound springs that have been wound on the same arbor but with cone ends having a different included angle.

I tried spacing the turns by forcing different diameter rods between the turns. It didn't work very well. The spring in the lower right-hand corner is one that has been expanded by use of the fingernails. At a later date, I may devote more time to the winding of conical springs on a threaded, conical arbor. This should result in a more uniform spacing of the turns.

Making An Arbor— It is seldom that there is a need to make a new arbor. Although it is about the simplest of all machining efforts; the technique needs to be included for completeness. It can also help someone avoid trying to use an improper material such a drill rod.

An ideal material for a new arbor is straight music wire (**Ref. 13**). This is a hardened and tempered material and its use avoids the need for heat treatment of steels like drill rod. Most arbors are 1/8" OD and this size rod is readily available.

Measure the length of rod needed and cut it to length. Music wire is so hard it is likely that a hack-saw will not cut it. However, the graver detailed earlier will cut it readily, as will most high speed steel lathe tool bits.

Although I know of no engineering principle that calls for a certain cone angle for such pivots, most arbors that I have seen have a pivot that is a cone

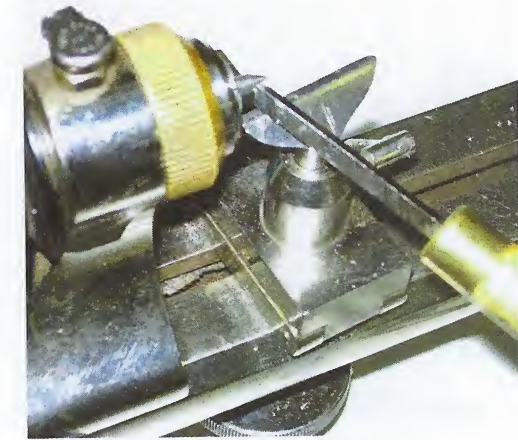


Fig. 82. Turning A Pivot

with a 60 degree included angle. Since I have spent a lifetime working at a clockmaker's lathe, I prefer to turn such cones by hand with a graver, as shown in **Fig. 82**.

As previously mentioned, hard steel becomes much harder when burnished. Thus, these pivots should be burnished. This work hardening also produces a mirror finish surface, which offers far less friction during use. During burnishing, run the lathe very slowly at first. This allows the saw tooth ridges of the burnisher to act as a super fine cut file. The surface will be seen to brightened considerably as the surface becomes smoother. Finally, speed up the lathe motor so the knife edge ridges of the burnish can no longer cut but must slip on the surface of the part. It is this slipping action that work hardens the surface, making it much harder than the parent metal.

Figure 83 shows the completed arbor. I hope the mirror finish of the burnished cones will be visible to the reader.

This arbor needs no heat treatment.

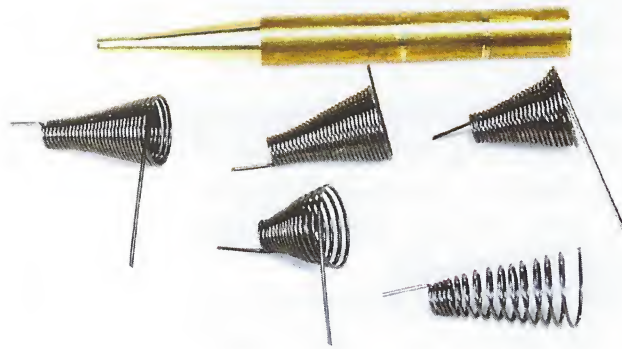


Fig. 81. An Arbor & Some Springs

with a more uniform spacing of the turns.

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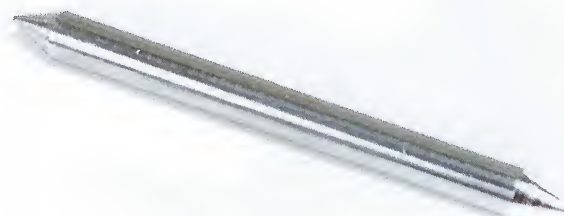


Fig. 83. The Completed Arbor

Replacing A Mainspring— Occasionally, one finds a key with a broken mainspring or one that is so heavily rusted that the key is no longer capable of making the required minimum number of dots. I replace the defective spring as follows. File the heads of the weight rod rivets flush with the weight rod. However, nothing needs to be done to the rivets holding the spring in the dot bar.

Since I have complete watchmaking equipment, I have available a watchmaker's staking tool set. This consists of a stake and approximately 120 punches of various types. However, no punch is proper for driving out the rivets of the pendulum and one must improvise. Cut a piece of 0.075" OD music wire to 1" length. This wire is hardened and tempered. Select a flat face hollow punch the wire fits into nicely. The stake, a punch and the wire are shown in **Fig. 84**. This length of wire when in the bore of the punch will protrude about 3/8", making it a punch of the required type, as shown in **Fig. 85**.

Select a hole in the stake that will just clear the rivet and center it with a conical end punch. Place the punch in the stake and position it carefully over one of the rivets as shown in **Fig. 86**. A firm blow from a medium weight hammer will drive the rivet free of the pendulum. Drive the rivets from the weight rod in the same manner.



Fig. 86. Driving The Rivet From The Dot Bar

been cut lightly by the file. Thus, it is wise to carefully clean the parts and plate both the weight rod and the spring. This will cover the file marks and discourage future rusting of the spring. The repair will hardly be noticed.



Fig. 84. The Stake, Punch & Wire



Fig. 85. The Staking Punch With Wire Installed

No jigs are required for punching the spring holes. Cut the spring to shape, position it in the dot bar and touch it with a bit of super glue. Turn a piece of music wire to the diameter of the rivet hole in the dot bar and use it to punch the two rivet holes. Treat the weight rod holes in the same manner.

This will usually leave the holes in the spring slightly smaller than the holes in the dot bar and weight rod. Use a small round file to open each of these holes to the same diameter.

Machinist rivets from nickel silver as previously described, making sure to drill a small hole in the end of each to ensure that the rivet will expand equally in all directions when a riveting punch with a center pip is used.

Since no filing has been done on the dot bar, the nickel silver rivets will match the old plating well enough. However, the weight rod likely will have

REFERENCES

1. One half hard, leaded brass available in all shapes and sizes from: McMurray Metals, Inc., PO Box 710040, Dallas TX 75371. Phone: 800-658-5655.
2. Carbon Steel Feeler Gage Stock, 0.010" x 1/2", Cat. # 01563881. MSC Industrial Supply Co. Phone: 800-645-7270.
3. Sterling Silver Rod, 0.162" OD x 12". Available from Stuller Inc. PO Box. 87777, Lafayette, Louisiana. 70598. Phone: 800-444-4741.
- 4 & 5. Plain And Rope Knurling Rollers, available from Accu Trak Tool Corp. 490 Stafford Street, Cherry Valley, MA 01611. Phone: 800-433-4933.
6. Threaded Brass Rod, 8 - 32 x 24", Cat. # 04355491. MSC Industrial Supply Co. Phone: 800-645-7270.
- 7 & 8. Tix Solder, Flux and Blazer Torches, available from S. LaRose, 3223 Yanceyville Street, Greensboro NC 27405. Phone: 800-752-7673.
9. Half hard, Leaded Brass 1/2" Square, McMurray Metals, Inc., PO Box 710040, Dallas TX 75371. Phone: 800-658-5655.
10. Nickel Plated Brass Thumbscrews, 8 - 32 X 3/8", Cat. # B-TSB-832-6. Small Parts Inc. 13980 NW 58th Court, Miami Lakes, FL 33014. Phone: 800-220-4242.
11. Black Plastic Rod, 1/2" OD x 12" Delrin, Cat. # B-ZRB-8. Small Parts Inc., 13980 NW 58th Court, Miami Lakes, FL 33014. Phone: 800-220-4242.
12. Carbon Steel Music Wire, 0.020" x 1# roll (Approximately. 937 ft.), Cat # 31890840. MSC Industrial Supply Co. Phone: 800-645-7270.
13. Straightened Music Wire, 0.125" OD x 18", Cat. # B-SMW-125. Small Parts Inc. 13980 NW 58th Court, Miami Lakes, FL 33014. Phone: 800-220-4242.

CHAPTER 6

REBUILDING A DOUBLE LEVER VIBROPLEX

In **Fig. 1**, we have what is left of a double lever Vibroplex that someone, in years past, has tried to convert to a standard speed key. In doing so he has reduced a part of history



Fig. 1. A Double Lever Vibroplex Someone Converted To A Normal Key

to a piece of rubble. Nothing short of making each of the missing parts can ever allow the world to see how this key once appeared. That is the task to be addressed in this chapter.

For this exercise, I am going to assume that this key belongs to you and that I have taught you to use my shop equipment. You have brought the key here, and by the use of my shop and guidance, you are going to make the parts required to bring it back from the dead. By no stretch of the imagination are you doing it so the key can later be offered to

someone as a rare and near mint condition collector's item to be bought at a high price.

Fortunately, there is at hand in my shop an identical dual lever Vibroplex from which all of the required measurements can be



Fig. 2. The Pendulum To Discard

taken. However, since the parts of various keys differ in size and shape, I will be leading you by techniques rather than by dimensions.

The pendulum assembly, **Fig. 2**, was cobbled together using old key parts and must be discarded. It will also pain many collectors to learn that the person who did



Fig. 3. The Work Begins Here

in it much is much too large for the normal brad used to secure this portion of the paddle for a key of this period. Thus, there will be no choice but to make a new paddle.

Figure 3 shows how, during the conversion to a normal bug, a hole was drilled that must be plugged. This was done so the dash contact post could be moved from its original location on the right side of the key to the left front of the main frame. Also, an additional hole has been drilled for mounting the shorting lever, which is also a nonstandard item. This lever rotates about its center and the correct lever must be longer and rotate about its end. However, the shorting lever knob and its mounting screw can be saved for later use. The two added holes must be plugged and the base stripped and re-japaned. If the dash post were returned to its original location and the shorting lever were discarded, the picture would represent all there is to work with when starting the rebuilding effort.

The Dash Bar Bracket— The first part to be made will be the dash bar bracket. Select a piece of 1/4" thick, half hard, leaded brass plate and coat it with Dykem. Scribe the outline of the part on it and center punch the location of the mounting holes, **Fig. 4**. At the bandsaw, part this from the parent stock and saw the two side walls of the notch.

To cut the back wall of the notch, mount a saw board in the bench vise with its surface horizontal and install a # 0 saw blade in a piercing saw frame.

Although discussed in Chapter 4, more needs to be said about the management of this saw. It has a frame length adjustment that is locked with a thumb screw. Most beginners view this as a blade tensioning device. It is not. Lock the blade in the far clamp, adjust the frame length so the free end of the blade reaches to within about 1/8" of the clamp at the handle, lock the frame length screw and never release it again. Spring the frame to make the blade reach into the clamp at the handle. Use this springing of the frame to tension the blade, not the frame length adjustment. The blade must be under enough tension from the sprung frame to sound a musical note when plucked. An un-tensioned blade will break almost immediately. Also, its tension must be great enough that the frame never springs on the up stroke of the saw. If this happens, the blade will pucker and break. Never allow the saw to lift the work off the saw

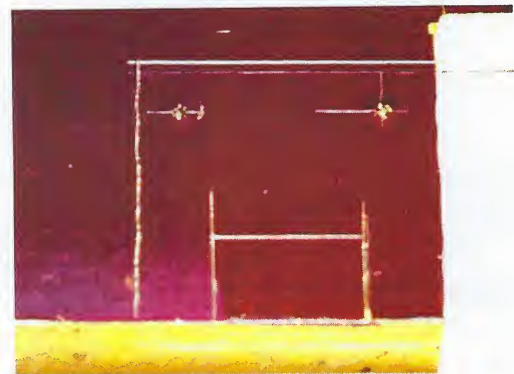


Fig. 4. The Dot Bar Bracket

board. This will also break the blade. Although these blades are small and appear very fragile, it is not unusual to dull one before breaking it. Use the piercing saw to cut the back wall of the notch, as shown in Fig. 5.

Finishing The Bracket— After sawing the bracket to shape, clamp it in the bench vise with the fiber jaws in place. Position the swinging arm lamp to bounce light off the top surface of the part to show where the file has cut last and file the part to shape.

After the surfaces are filed smooth, lay a sheet of 320 grit emery paper on a flat surface of the workbench and rub the walls of the part on it until they are free of all file marks.

Do the same on 600 grit emery paper. Rather than buffing the brass part, leave a 600 grit emery paper finish on it to avoid a bright nickel finish when plated.

The Hinge Pin— The hinge will be made using a clockmaking technique to avoid bradding the hinge pin. Drill the hinge pin hole in the dash bar bracket with a #56 drill. Then ream it from the top of the bracket with a clockmakers five-sided broach until both portions of the hole are tapered by the broach. Match-mark the top of the bracket with a sharp prick punch so it can always be mounted with the match-mark up. Turn, or file, a pin to the same taper for a good fit in the reamed hole. The completed parts are shown in Fig. 6. Nickel plating of all parts will be done later.



Fig. 6. Bracket & Pin

The Dash Bar— The dash bar of the Vibroplex double lever key was made from 3/8" wide x 1/8" thick brass stock. To duplicate this, coat a piece of 1/8" thick, half hard, leaded brass, with layout blue. Draw the outline of the dash bar, locate the holes and mark them with a center punch, as shown in Fig. 7. Drill and thread the holes as required and part the bar from the sheet. File and paper to final form and drill the required holes.

The Dash Knob— Modern dash knobs are much too bulky to match those used on the earlier keys. Thus, if a modern knob is to be used, it must be hand turned for a thinner lip and a waisted body. Mount the knob on a piece of threaded stock and chuck it in the clockmaker's lathe. Turn it to shape using a very sharp, round, hand held graver.

The Paddle— Scribe the shape of a paddle on a sheet of 1/8" thick, black plastic and saw it to shape with the band saw. Dress the edges with files and emery paper. To dull the shine of the surface, rub it on 1800 grit emery paper and give it a sheen by coating it with silicone grease. Install the paddle and knob on the dash bar but do not add the brad. It must be added only during final assembly after the dash bar has been plated.

Orient the dash bar so the paddle and knob are in the normal sending position and ream the hinge pin hole from the top of the dash bar. When the bar is installed in the



Fig. 5. Using The Piercing Saw



Fig. 7. Layout Of The Dash Bar



Fig. 8. The Dash Bar

a flat, brass sheet with a long adjustment slot and a hole in the end to receive a riveted silver contact. The contact can be easily hand turned from silver rod.

Coat a piece of 0.052" thick, half hard, leaded brass, with layout blue. Mark the location of three holes—one for the silver contact and one at each end of the slot. Drill the holes and use a piercing saw to cut the walls of the slot. The resulting part is shown in **Fig. 9**. Saw the part from the stock, and file and paper it to final form.

The Silver Contact— Place a silver rod in the clockmaker's lathe and turn a spigot on the end for a slip fit in the hole of the contact body. Drill a small hole in the end of the spigot to

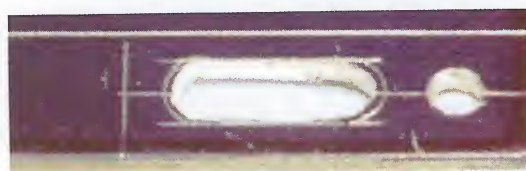


Fig. 9. The Contact Plate

make a nice rivet when upset with the special riveting punch that expands the metal equally in all directions. As mentioned in Chapter 4, tapping fluid will ease the drilling of the short depth hole. Part the work to contact thickness, re-chuck it on the spigot and turn a dome face on the parted side with a hand held graver. Turning the face with a sharp graver avoids the need to load the surface with emery by papering it. The completed part is shown in **Fig. 10**. It is really bright brass but the lighting has made it

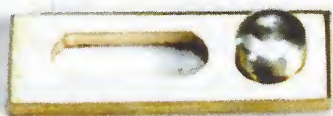


Fig. 10. The Contact

white in the photo.

The Dash Bar Assembly— Make a stop tab for adjusting the rest position of the dash bar using 0.052" thick, half hard, leaded brass sheet and mount it on the dash bar bracket with a 6-32 filister head screw. During assembly, this tab will be bent to position the dash bar parallel to the side of the key base.

Place a washer on the dash bar contact mounting screw and mount the contact. Place the dash bar assembly in its bracket and install the hinge pin with a bit of



Fig. 11. The Dash Bar Assembly

force. Check to make certain that the dash bar is free to rotate. Wind and mount a return spring from 0.020" OD wire music wire. The completed assembly is shown in **Fig. 11**.

Move the dash contact post from the left, front of the key to its correct location on the right side of the base just beyond the main frame. Remove and discard the shorting lever, but retain its knob. Mount the dash bar assembly on the main frame and bend the rest position stop to position the dash bar parallel to the edge of

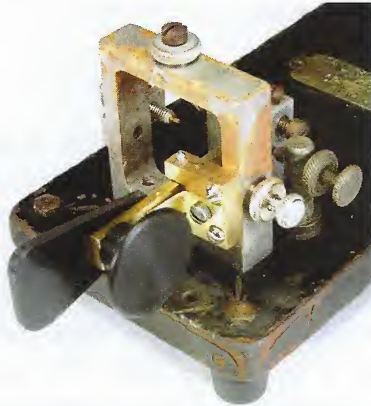


Fig. 12. The Dash Lever

the key base. Position the dash contact opposite the dash post contact and lock it. Check to see that all dimensions of the parts appear proper and that the dash bar has ample freedom of motion and has a good feel. The completed unit is shown in **Figs. 12 and 13**.

The Dot Bar— Like the dash bar, the dot bar of the double lever Vibroplex key was made from 3/8" x 1/8"

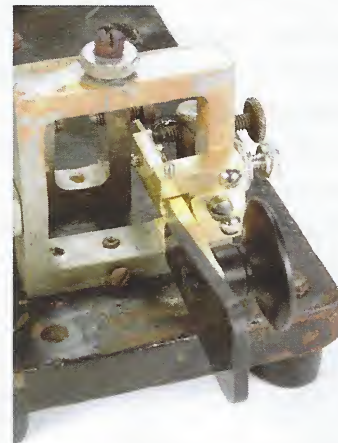


Fig. 13. The Dash Lever

brass. The dot bars of these keys were made in at least two versions. One of the early models had a thin dot bar with the arbor sandwiched between it and a short brass plate, clamped in place by two screws. A later version had the arbor pressed into a thicker dot bar. The base configuration of the above key indicates that it is the type with the arbor sandwiched on the side of the dot bar rather than being pressed into place.

Fortunately, we have an identical key from this period from which to get all needed measurements. Coat a 1/8" thick sheet of,



Fig. 14. The Dash Bar Blank

half hard, leaded brass with Dykem. Lay out the bar, draw in a centerline, drill the various diameter holes, tap those required and part it from the parent stock, as shown in **Fig. 14**.

The dash bar blank is in front and a portion of the large sheet from which it was cut is behind it. The blued portion at the right hand end of the part shows the thickness of the part. Unfortunately, the thickness of the remainder of the part has disappeared into the white background on which the part is lying. It would have been better to have blued the total wall to show the thickness of its full length. File and paper the part to its final form.

Lay out, saw, drill, file and paper the clamping plate from 1/8" thick, half hard, leaded brass and lock it in place on the dot bar. (Remember, brass that is half hard does not mean that it is leaded and the fact that it is leaded does not mean that it is half hard. Both designations are required.) With the clamping plate clamped firmly against the dot bar, the top surface of the two objects form a plane. On this plane, center punch where the wall of the dash bar touches the wall of the clamping plate and at a point midway between the two clamping screws. Drill a 7/64" hole at this location perpendicular to the plane formed by these two surfaces and ream it 1/8" ID. Turn an arbor from 1/8" OD straight music wire. This wire is already hardened and tempered and needs no further heat treatment; however, a better cone pivot will result if each one is burnished.

The dash bar and its screws, the arbor clamp and the arbor are shown in **Fig. 15**. The plate stock from which the brass parts came is in the background. The papering of the surfaces of the parts during the final finishing operation will remove enough metal to let the bracket grip the arbor firmly.

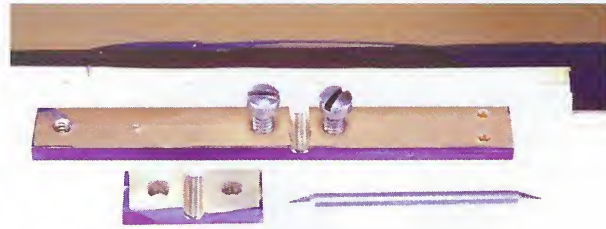


Fig. 15. The Dot Bar & Arbor

Now that the dot bar has been brought to final shape, the slit for the mainspring must be cut. For such work, a Sherline lathe set up with a 3" OD x 0.010" thick, 280 tooth, circular saw is ideal. These saws and the arbor on which they mount are available from Sherline (**Ref. 1**). However, the saw table to drop into the "T" rest body must be made.

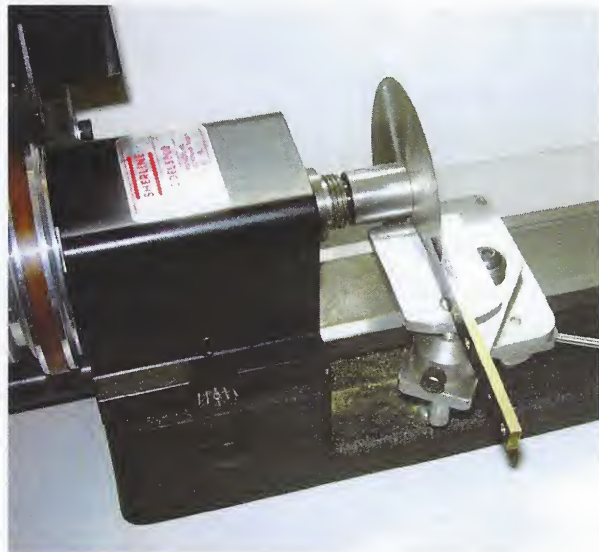


Fig. 16. Sawing The Dot Bar

Make the table by threading a portion of a 5/16" OD bolt into a piece of 3/16" thick steel plate with a slit in it for the saw. Drop this table into a W. R. Smith "T" rest manufactured by Sherline. As previously mentioned, Sherline has never decided to produce a simple saw table. I consider one to be most useful of workshop tools. Position and lock the table so the centerline of the dot bar passes through the axis of the saw arbor. Coat the end of the dot bar with layout blue, mark the required depth of cut, carefully center the saw and make the cut, **Fig. 16**.

The Weight Rod—One of the most difficult jobs in key work is the proper drilling of the rivet holes in the weight rod for attaching the mainspring. However, as described in Chapter 4, the solution to the problem is the use of a homemade jig, **Fig. 17**.

Bond the rod in the jig with super glue so its end is flush with the jig at the end where the holes are located. Set the jig on the flat surface of the drill press and pass the drill through the rod from the top of the jig. This places the holes parallel to each other and through the exact center of the rod. Break the super glue bond with heat, but do not heat the parts hot enough to make a vapor. When cool, remove the residual super glue with acetone. Keep sparks and flame away from the acetone; it is very dangerous stuff.

The slit for the mainspring must now be cut. Again, good use will be made of the Sherline saw. Coat the end of the rod with layout blue and mark the depth of the cut. Set the saw table height so the axis of the rod passes through the axis of the saw arbor and lock it. As suggested in Chapter 4, place a piece of wire in the hole nearest the operator and position the weight rod so the wire is parallel to the surface of the saw table. Carefully center the saw on the end of the rod and begin the cut,

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Fig. 17. The Weight Rod Jig

as shown in **Fig. 18**. Once the cut has been established, the wire can be removed and the saw will follow the cut. This rig makes life a pleasure.

The Mainspring— The mainsprings of Vibroplex speed keys are made of 3/8" wide by 0.010" thick tempered steel. For many years I have found feeler gage stock to be a good source of material for such springs. Fortunately, it comes in all thicknesses and obtaining the 0.010" thickness is no problem. I have also considered using feeler gage stock made from stainless steel, which would not rust. However, the same thickness of tempered stainless steel stock is considerably weaker than the tempered steel stock. Also, tempered steel matches what the factory used. This is available from MSC Industrial Supply Company (**Ref. 2**).

Coat a length of 0.010" thick, steel feeler gage stock with layout blue and scribe a line for a 3/8" width, **Fig. 19**. Use tin snips to scissor this to width.



Fig. 19. The Mainspring Stock

would be very difficult to drill. The easiest way to make holes in it is to punch them. In Chapter 4, I showed how to make a simple jig of 1/32" thick brass for punching such holes. However, for punching these holes, the dot bar can be used as a jig and avoid the need to make one.

Turn the end of a piece of music wire or other hardened and tempered steel for a slip fit in the rivet holes of the dot bar. Position the spring properly and touch a dab of super glue to the junction of the spring and the dot bar body. Place the punch in a hole and strike it with a firm hammer blow. This will shear a nice, circular hole in the steel mainspring. Turn a second punch for a slip fit but slightly longer than the first punch and use it to punch the second hole, leaving the first punch in place, **Fig. 20**. Usually, the punched holes will be slightly smaller in diameter than the holes in the brass part. Open these slightly with a small, fine cut, round file.

The Nickel Silver Rivets— When replacing the mainspring in a speed key, there is always a rivet problem. At the factory, they plated the rivets after completion of the dot pendulum assembly. This made everything look the same. A steel rivet is too difficult to upset, will rust and

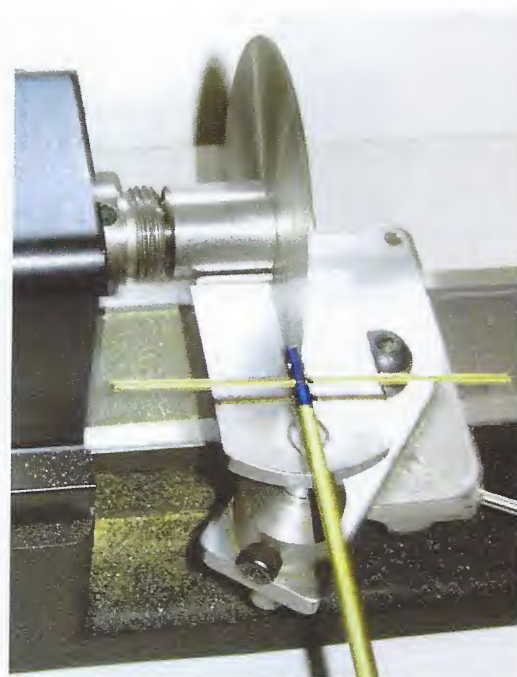


Fig. 18. Slitting The Rod

Dress the cut edge with a fine cut file and paper it with 600 grit emery to ensure that there are no cracks in the cut edge. Cut it to the proper length for the mainspring.

Punching The Rivet Holes—Feeler gage stock is hardened and tempered steel and



Fig. 20. Punching The Mainspring

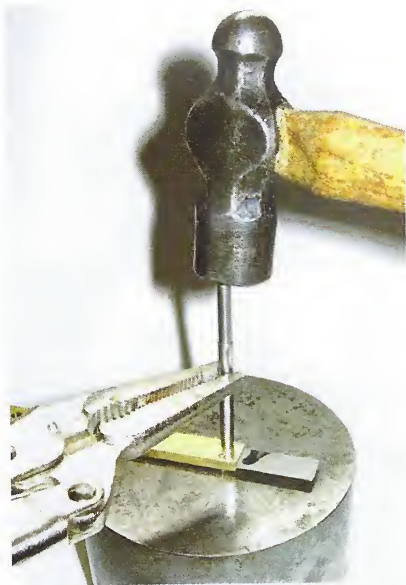


Fig. 21. Riveting

The Dot Pendulum— Figure 22 shows the mainspring riveted in the dot bar, the weight rod, two nickel silver, hand turned rivets and a small, fine cut file for opening the punched holes in the mainspring. A file for this use must be a good one and a Grobet is probably one of the best ones available on today's market. These can be purchased from Cas-Ker (Ref. 4).

Punch the holes in the mainspring for the weight rod by using the rod as a jig as was done for the dot bar. Before punching the holes in the spring, position it carefully in the rod and bond it with a dab of super glue. Break the bond with heat and, when cool, remove the residual super glue with acetone. Keep acetone away from sparks or flame.



Fig. 23. The Completed Dot Pendulum

were made in the early days of key manufacture. They appear to have been formed by bonding multiple layers of a thin black paper together with some unknown bonding agent.

The mounting of the paddles in keys of the early period is also unusual. Instead of having one large screw and one small screw attaching the paddle, in these keys, they have no small screw beside the large one. They have a small brad pushed through a hole in the paddle and the dot bar and bent on the far side. This makes it very difficult to remove a paddle without doing harm to it in some manner. Note how the arbor is clamped to the dot bar. Mount the dot pendulum assembly and the dash bar assembly on the main

does not match the plating of the dot bars. Brass is an ideal material that will rivet well, and is easy to work. However, it looks terrible against the plated dot bar and will eventually turn green. Although these rivets will later be plated, I always turn them from nickel silver rod (Ref. 3), as described in Chapter 4. This matches the plating of keys well enough that they are seldom noticed.

With the rivets in place, use a punch with a specially shaped end to rivet them Fig. 21. The end of this punch is shaped like the old brake shoe rivet punches. Its center pip forces the hollow rivet outward equally in all directions that results in a very attractive mushrooming of the rivet. Nickel silver is difficult to turn and even more difficult to drill. However, by use of a very sharp graver and tapping fluid on the drill, the job can be managed nicely. Very few people would ever notice a nickel silver rivet in a nickel plated or chrome plated dot pendulum assembly.

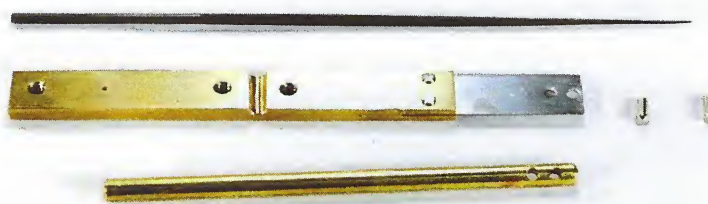


Fig. 22. Dot Bar, Weight Rod, Rivets & File

Figure 23 shows the completed dot pendulum assembly. The paddle is of modern sheet plastic. I have never been able to locate a source for the sheet stock identical to that from which the key paddles

frame of the key, **Fig. 24**, and make the dot and dash bars parallel to each other.

The hole in the base can be seen just beyond the nut attaching the foot. This was drilled to allow the dash post to be moved there when the key was changed from a double lever to a normal speed key. The other hole drilled for the shorting lever mounting screw is hidden by the paddles.

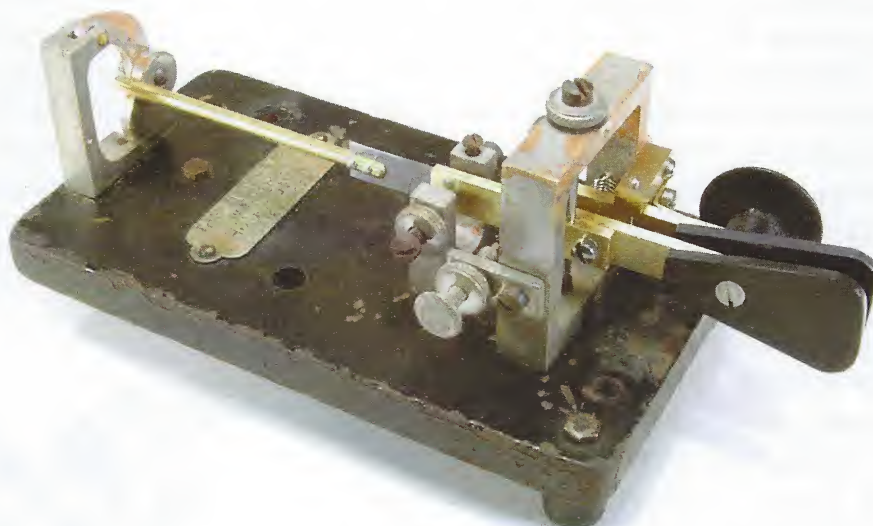


Fig. 24. The New Parts Mounted In The Key

Before the base can be re-japanned, both of these holes must be plugged.

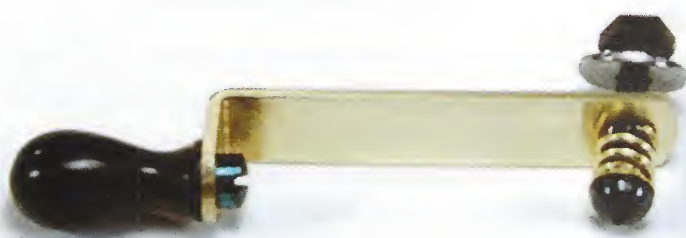


Fig. 25. The Shorting Lever

The Shorting Lever— The shorting lever used when the key was altered was of 1/2 hard brass, cut to shape, bent and finished. There is a trick to making such a lever, **Fig. 25**. Most available brass is approximately half hard. That is, it has not been annealed following the last rolling operation. As such, it is likely to crack when given the sharp, 90 degree

bend required for a shorting lever. Thus, a very wise practice is to anneal the part by heating to a red temperature at the bend point. There is no need for re-hardening. Brass only hardens by having its cross section reduced by rolling or hammering.

The knob from the old lever and its mounting screw are usable. Mount the knob on a piece of threaded stock and chuck it in the lathe. Smooth the surface with emery paper and coat it with silicone grease to give a nice black luster. Refinish the knob screw with a screw head file, emery paper and a glass bristle brush. When bright, clean with cigarette lighter fluid and heat blue it, as described in Chapter 4. The original screws were blue.

The Base Plugs— Holes in a key base are very difficult to plug. Note that one of these holes has a double diameter. Machine steel plugs for a slip fit in the unwanted holes of the base and make them slightly longer than the thickness of the base, **Fig. 26**. Chamfer the end of each hole and rivet the plugs in place, spreading the riveted material out into the chamfers of the holes. Use a Dremel motor with an arbor having a



Fig. 26. Plugs For The Base Holes

flat rubber face to receive a stick-on emery paper disk. Using very careful motions, smooth the plugs flush with the surface of the base, as was illustrated in Chapter 4.

There is a trick to the management of such plugs. Japanning varnish does not adhere well to the smooth surface made by the emery disk of the Dremel tool. Thus, score the surface of each plug with the point of a sharp scribe or the corner of a file to give it a rough texture. If this is not done, the japanning varnish will pull away from the slick surfaces and require additional applications before a good cover of the plugs can be obtained.

The Dot Spring And Collet— Rust on the dot spring has weakened the old one far too much to be used on the rebuilt key and a new one must be made, **Fig. 27**. I have seen them so rusty a key could not make enough dots for a five.

The making of a dot spring assembly was detailed in Chapter 5. It involves the following steps: machining the collet, scissoring the spring from feeler gage stock, punching a hole for mounting the silver contact, machining the contact from silver rod, riveting it in place, swaging the spring in the collet and bending it into a “U” and plating. To avoid rust, nickel plate the spring. Coat the silver contact with Dykem to serve as a plating stop.



Fig. 27. Dot Spring Assembly

The making of a dot spring assembly was detailed in Chapter 5. It involves the following steps: machining the collet, scissoring the spring from feeler gage stock, punching a hole for mounting the silver contact, machining the contact from silver rod, riveting it in place, swaging the spring in the collet and bending it into a “U” and plating. To avoid rust, nickel plate the spring. Coat the silver contact with Dykem to serve as a plating stop.

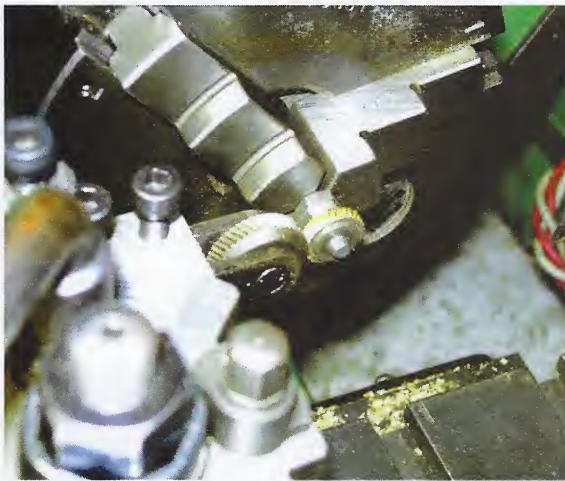


Fig. 28. Re-knurling A Nut

Correcting A Knurl— Two of the thumbnuts have bruised knurls and must be corrected. So the original nuts can be retained, mount each one on a screw, choose a matching knurling tool and use it to restore the knurl, **Fig. 28**. It is never possible to fully restore such a nut. However, it can be improved and after plating the flaws will seldom be noticed.

Completing The Key— To complete the work on the key, strip the base, de-rust it and re-japan it as described in Chapter 2, and address all of the plating problems.

Unfortunately, plating shops do not always do a good job on some items and a number of them must be plated in the home shop. These items include the pendulum assembly, the dash bar assembly and the thumbscrews. Good shops do well with the remaining parts, except for pitted bases, as has been discussed in detail in Chapter 2.

An examination of the steel screws of this key during disassembly indicated that they had originally been blued. Restore them by removing the rust with screw slot files, emery paper, and glass bristle brushes and re-blue them with heat, as described in Chapter 4.

Has your rebuilding of this little junk key ruined history? In my opinion, this rebuilt key and the restored pile of rubble that was once the Chinese wall, have something in common. Both have been restored so those of the present can see into the past.

After the parts have been assembled and adjusted as described in Chapter 1, the rebuilt key appears as in **Figs. 29** and **30**. What was once a piece of junk, that could speak no key history to anyone, is now a useful and attractive double lever speed key.

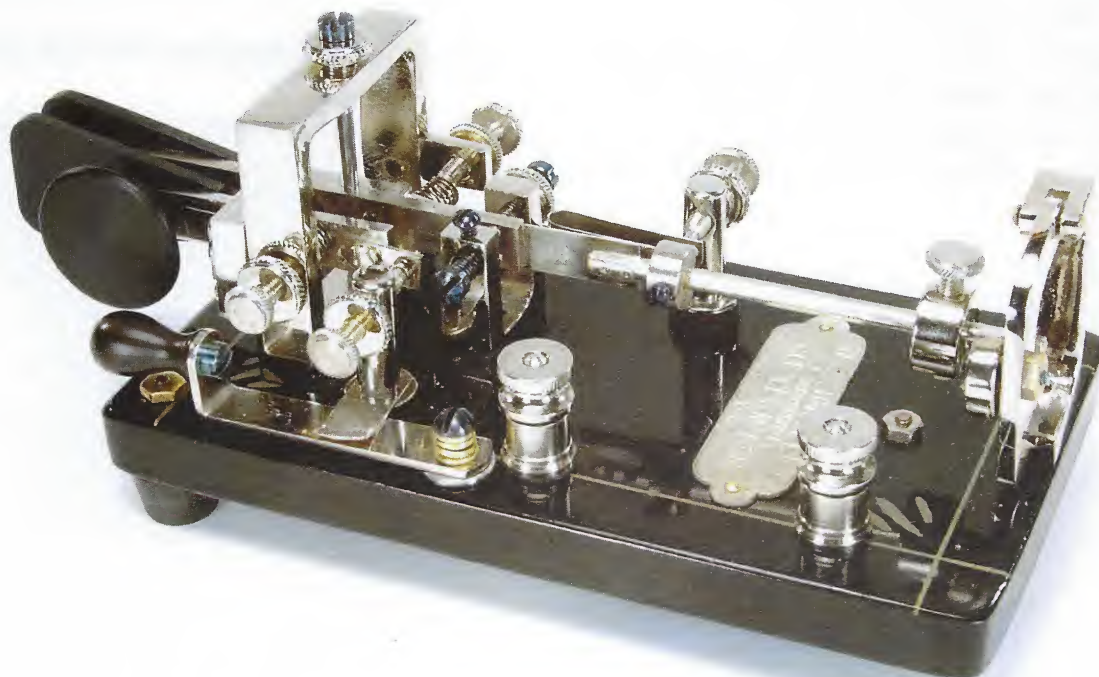


Fig. 29. The Rebuilt Vibroplex Double Lever Speed Key

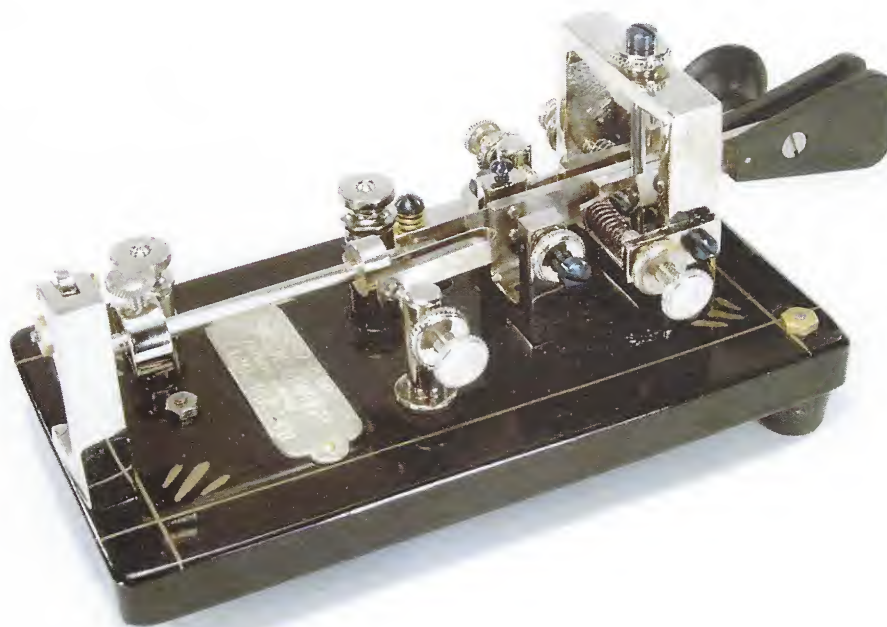


Fig. 30. Another View Of The Completed Key

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1. Slitting Saw, 3" OD, 1/2" Hole. Saw arbor for 1/2" ID saw hole. Sherline Products Inc. 2350 Oak Ridge Way, Vista, CA 92083. Phone: 800-541-0735.
2. Starrett Feeler Gage Stock, 0.010" x 12" x 1/2". Cat. # 01563881. MSC Industrial Supply Co., Phone: 800-645-7270.
3. Nickel Silver Rod, 1/8" x 12", Cat. # HMJA1. K & G Finishing Supplies, PO Box 458, Lakeside, AZ 85929. Phone: 800-972-1192.
4. Round Escapement File, Diamond, Round, Cat. # 331.956. Cas-Ker Co. 2550 Civic Center Drive, PO Box 31167 Cincinnati, OH 45231-0167.

CHAPTER 7 RESTORATION OF SPEED KEYS

The Vibroplex Model X— Using the techniques described in this book, I have chosen a number of keys for restoration. They are in extremely poor condition because of age, mistreatment, accidents, etc. The first of these is a 1919 Vibroplex Model X, **Fig. 1**.

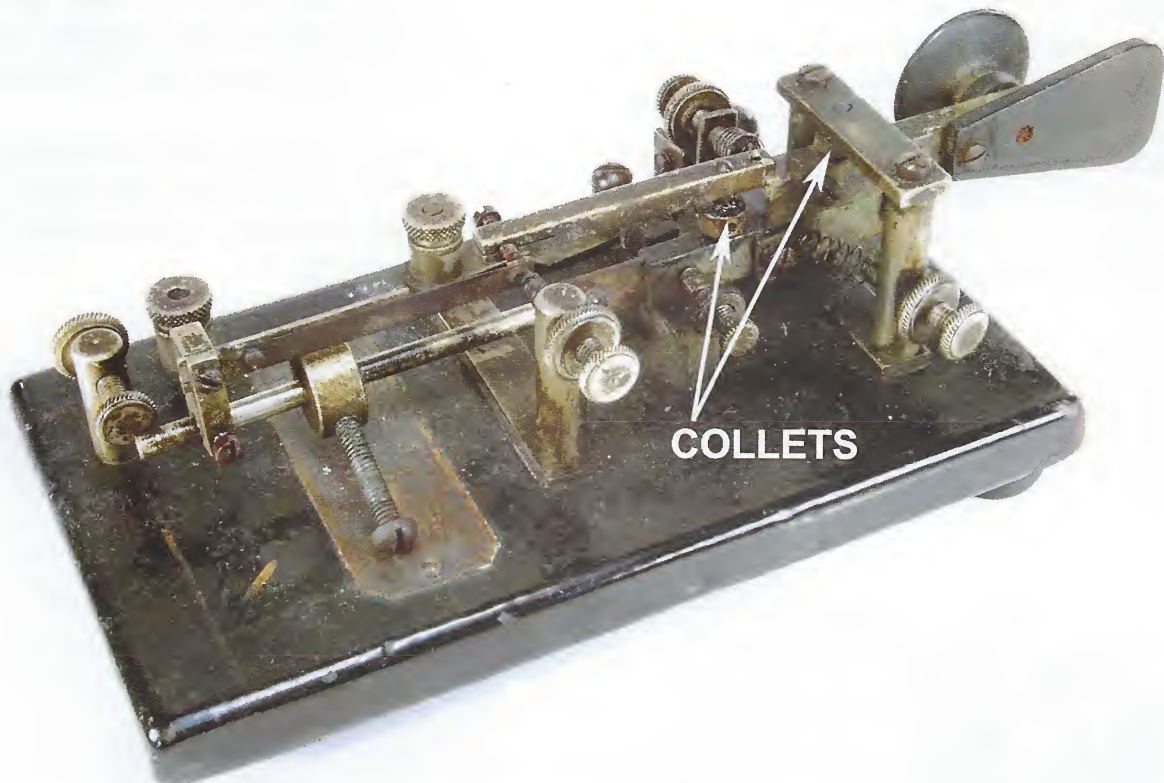


Fig. 1. A 1919 Vibroplex Model X Speed Key

Aside from the ravages of age, this key has been mistreated in many ways. As shown, I have indicated two of the four collets required for the key. The left most one has a screw head twisted off. This must be drilled out and the collet discarded. Two other collets are missing. Thus, three collets must be machined from scratch.

When received, all moving parts were completely frozen. This is typical of a mechanism which has been sprayed with WD-40 and presents a real cleaning problem that ruins the clockmaker's cleaning solution. To dissolve the old WD-40 requires the use of automotive carburetor cleaner. The key is also missing a weight and its thumbscrew, which will have to be machined. The plating is poor, the base japanning is chipped and in poor condition and the dash knob is cracked. To show what it is possible to do to such a key, it was decided to patch the knob, re-japan the base, strip the nickel and re-plate the hardware, install new feet and make the missing collets and weight parts.

The first order of business was to disassemble the key and start an attack on the dried WD-40. All of the key parts were removed and strung on wires. These were first given a cleaning in an ultrasonic cleaner to remove the dirt and oil. After that, the parts were

soaked in carburetor cleaner (available at any automotive store) to break down the dried WD-40. After this was removed, the parts were then cleaned in clock cleaning solution and examined. Three collets and a weight were machined and



Fig. 2. The Newly Machined Collets

they and all other hardware were taken to the plating shop. The three new collets, after plating, are shown in **Fig. 2**. Old japanning was stripped from the base and it was re-japanned and pin striped. A crack in the dash knob was repaired with super glue and it and the paddle were cleaned with an abrasive pad and coated with silicone grease. Rust was removed from all steel screws, each was blued with heat and coated with oil to lessen the possibility of future rusting.

The label was cleaned, dipped in lacquer and mounted on the base. While mounting it, the brads fractured. Thus, each was cut shorter and bonded in their holes with epoxy.

The key was assembled, adjusted and tested on a code oscillator. It functioned well and the final result of the restoration effort is shown below in **Fig. 3**.

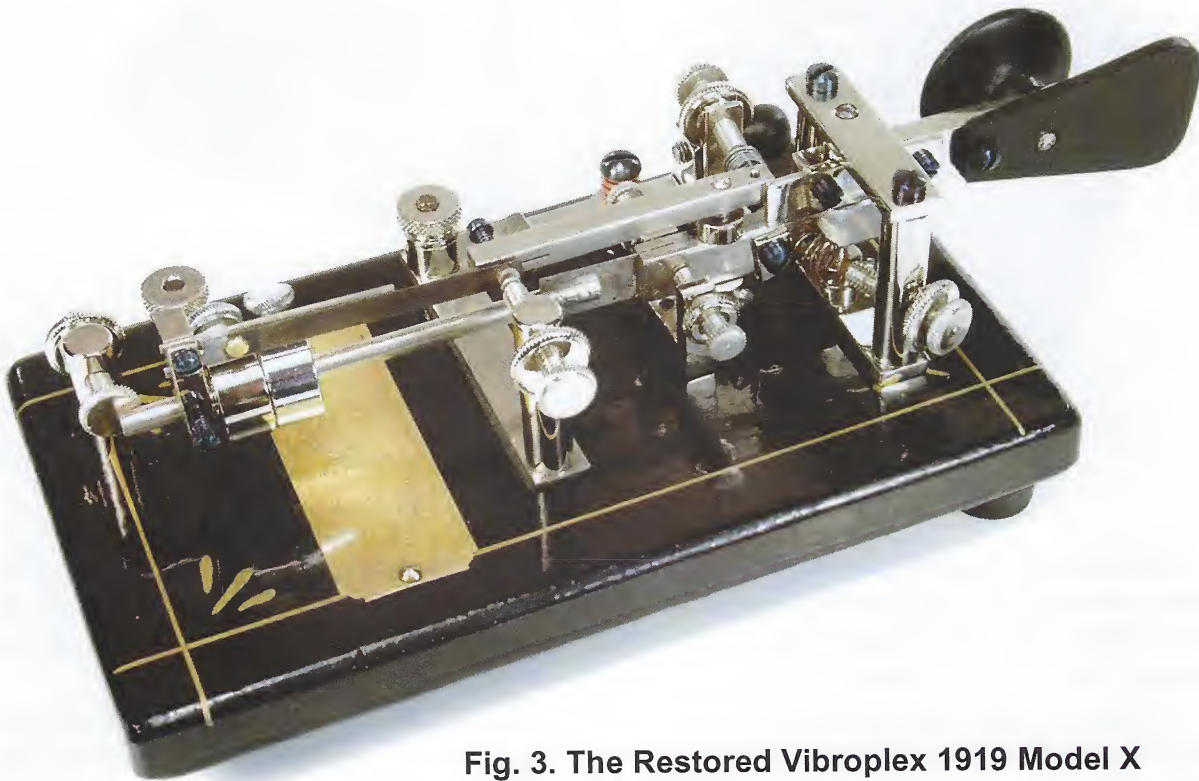


Fig. 3. The Restored Vibroplex 1919 Model X

Except for the two missing collets and the one with a broken screw, which had to be replaced, all other parts of this key are original, including the terminal strips and its flat insulators. This is unusual because almost every key I have seen of this age requires new terminal strips and a new insulators.

The rubber feet were so old that they had lost all their gripping power and would not allow the key to be used without holding it with the other hand. Thus, I replaced all four of the feet with new rubber bumpers from MSC.

A Norcross, GA 1908 Vibroplex—

I apologize to the reader for not having a starting photograph of this key. It came to me when I was just starting to collect keys and was in the process of switching from a film camera to a digital camera. Thus, I was only able to start the series of photographs after disassembling the key and doing much work on it. However, it was a true basket case and I will try to describe the starting condition.

The key had been completely mutilated. Someone had taken a standard 1908 Vibroplex speed key and attempted to make it into a double lever.

They needed room inside the main frame for the dash lever and sawed through the main frame at points at **A** and **C**, **Fig. 4**.



Fig. 5. The Rebuilt Main Frame



Fig. 6. All That Remains Of The Norcross Key

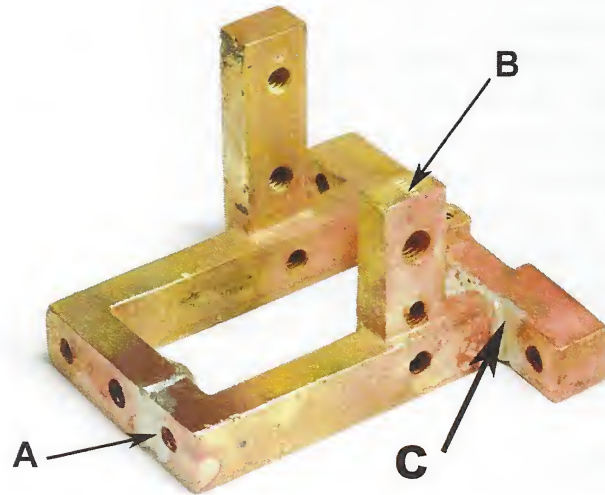


Fig. 4. The Mutilated Main Frame

They moved this freed member out to the very edge of the bottom of the frame, drilled and tapped two holes in the top of the main frame and mounted a flat bar (scab) across the top of the frame and captured it with three screws. Then, they sawed off the arm at **B**, because it was in the way of the dash thumbscrew and its post. In all, they drilled and tapped 10 new holes in the main frame.

To rebuild the key, I had to first restore the main frame. The wall that was sawed free, was moved back into position and silver brazed at **A** and **C**. New brass was added to the arm at **B** and each of the 10 unwanted holes were plugged with brass and silver brazed in place. The surfaces were worked with files and papered with 320 and 600 grit emery paper. The result of this effort is shown in **Fig. 5**. The frame is now ready to be re-plated with nickel.

No parts of the pendulum assembly or the separate dash lever were useful for restoring the key. Once the main frame had been restored, all that I had to work with is shown in **Fig. 6**. The damper and the main frame of the original key appeared to have been flashed with gold. The base was neither japanned nor plated but had a coating of something that prevented it from rusting.

The dash lever and dot pendulum were discarded and new ones made from scratch. These parts, before assembly, are shown in **Fig. 7**. All except the dash knob are hand made.

Note that the dash bar box hinge joint is typical of all Vibroplex keys made before Martin filed for a folded ear dash lever hinge patent in 1920.

The completed pendulum assembly, shown in **Fig. 8**, is ready to be nickel plated.



Fig. 8. The Completed Pendulum Assembly

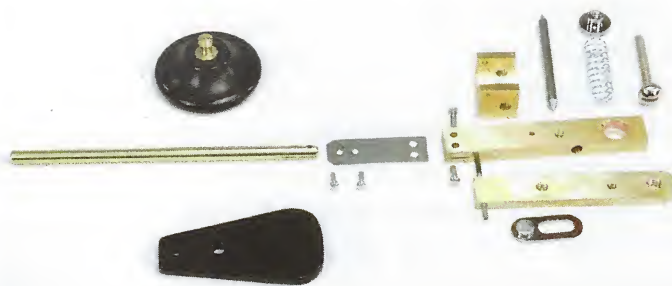


Fig. 7. The Pendulum Assembly Parts

After it and the remainder of the hardware were plated, the key was assembled, adjusted and tested on a code oscillator. I was very pleased with the restoration and the way the rebuilt key functioned. It is shown in its final form in **Fig. 9**.

Although it has no label, the number on the damper determines it to have been made in Norcross GA in 1908.

A famous key now lives again!

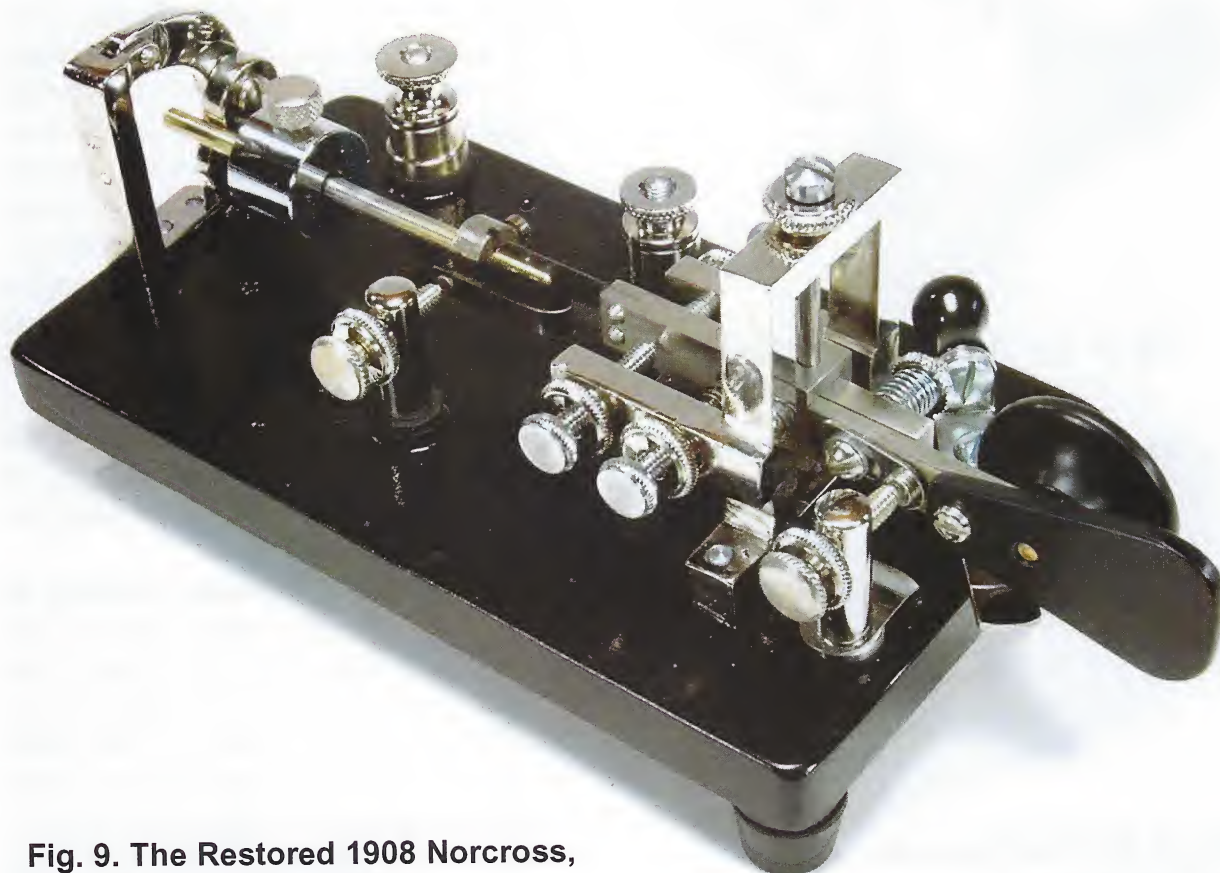


Fig. 9. The Restored 1908 Norcross, GA. Vibroplex Speed Key

Restored Keys— The following photographs are of additional restored speed keys.

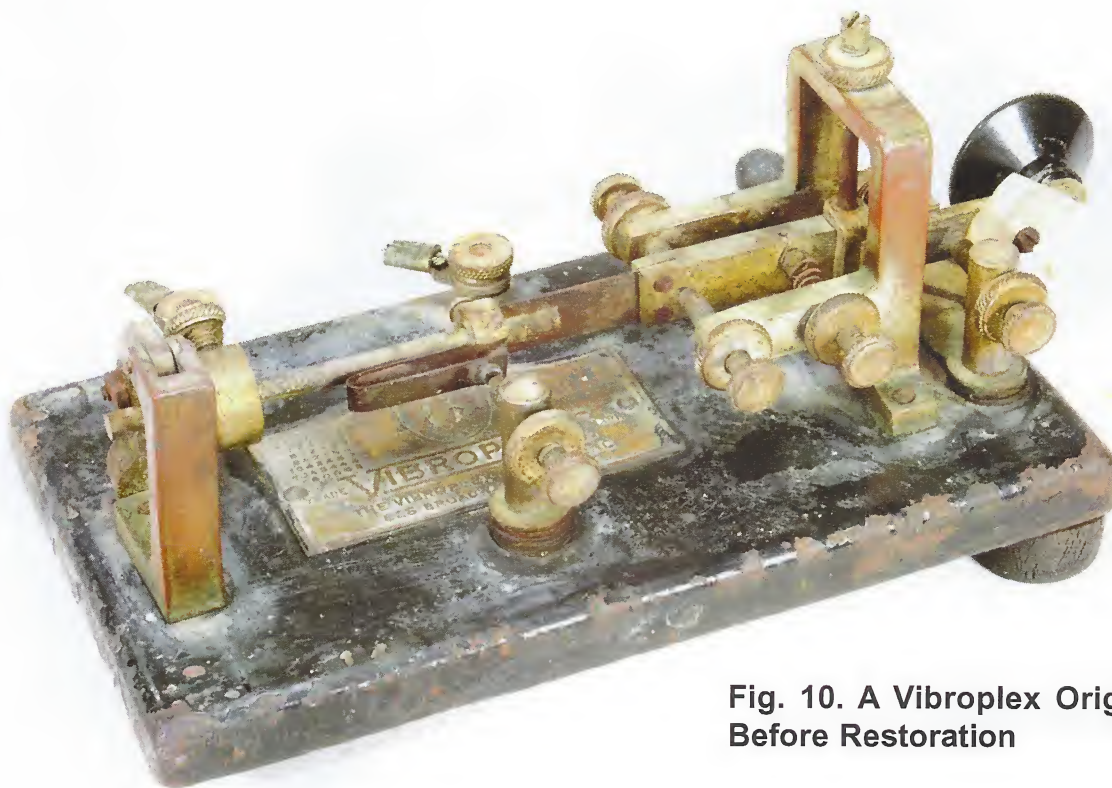


Fig. 10. A Vibroplex Original Before Restoration

Fig. 11. The Vibroplex Original After Restoration.



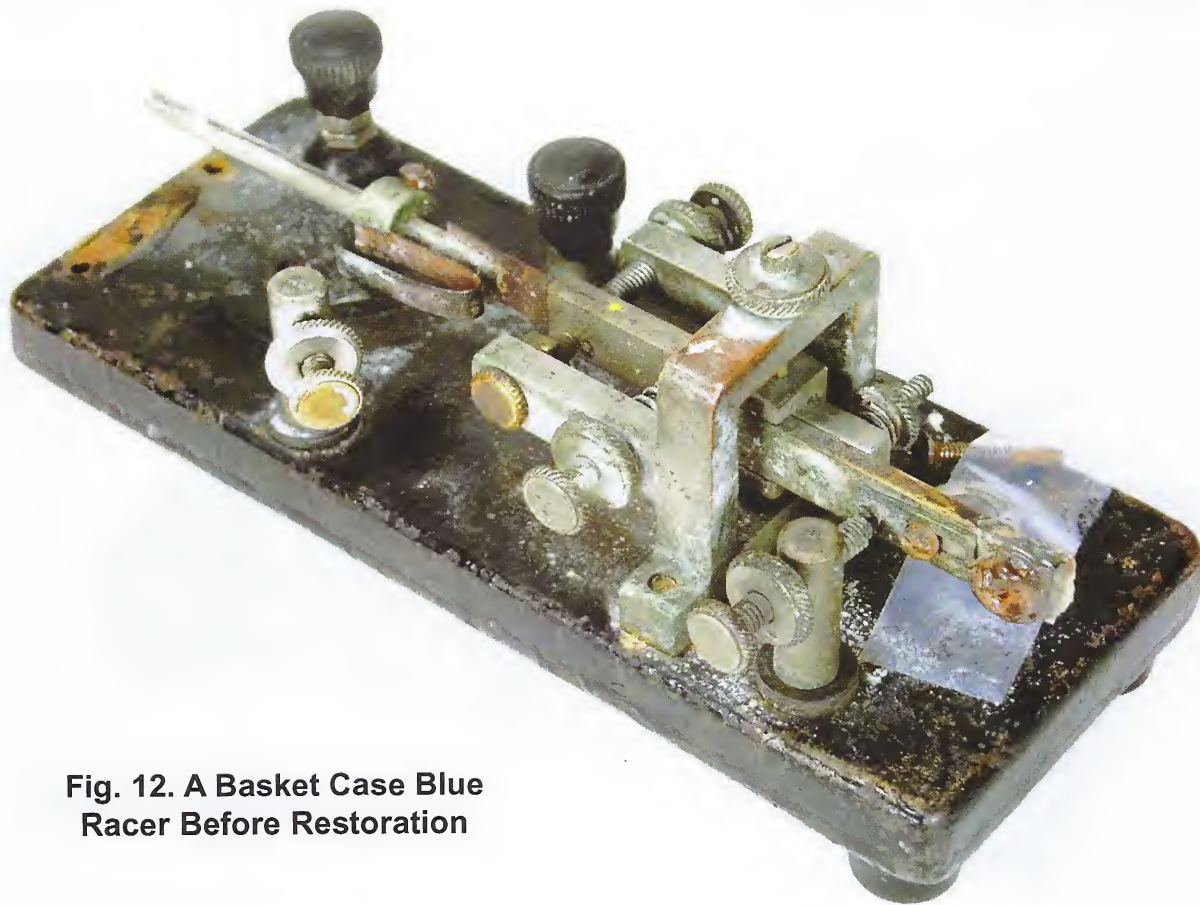


Fig. 12. A Basket Case Blue Racer Before Restoration

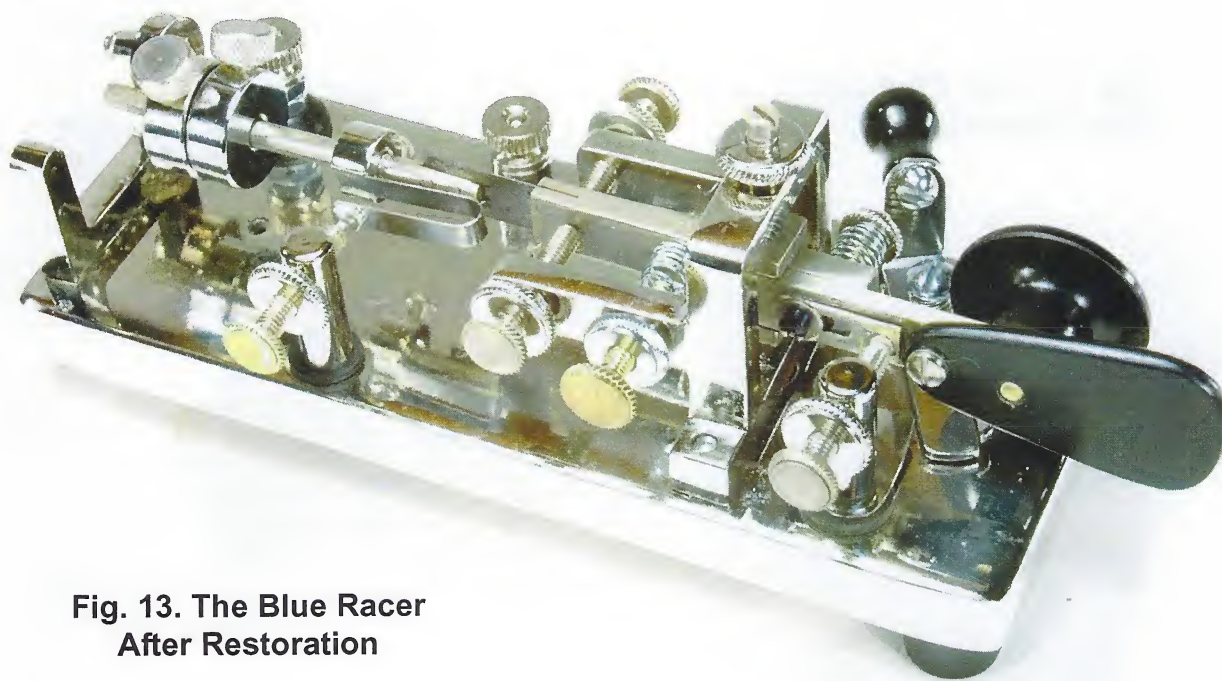


Fig. 13. The Blue Racer After Restoration

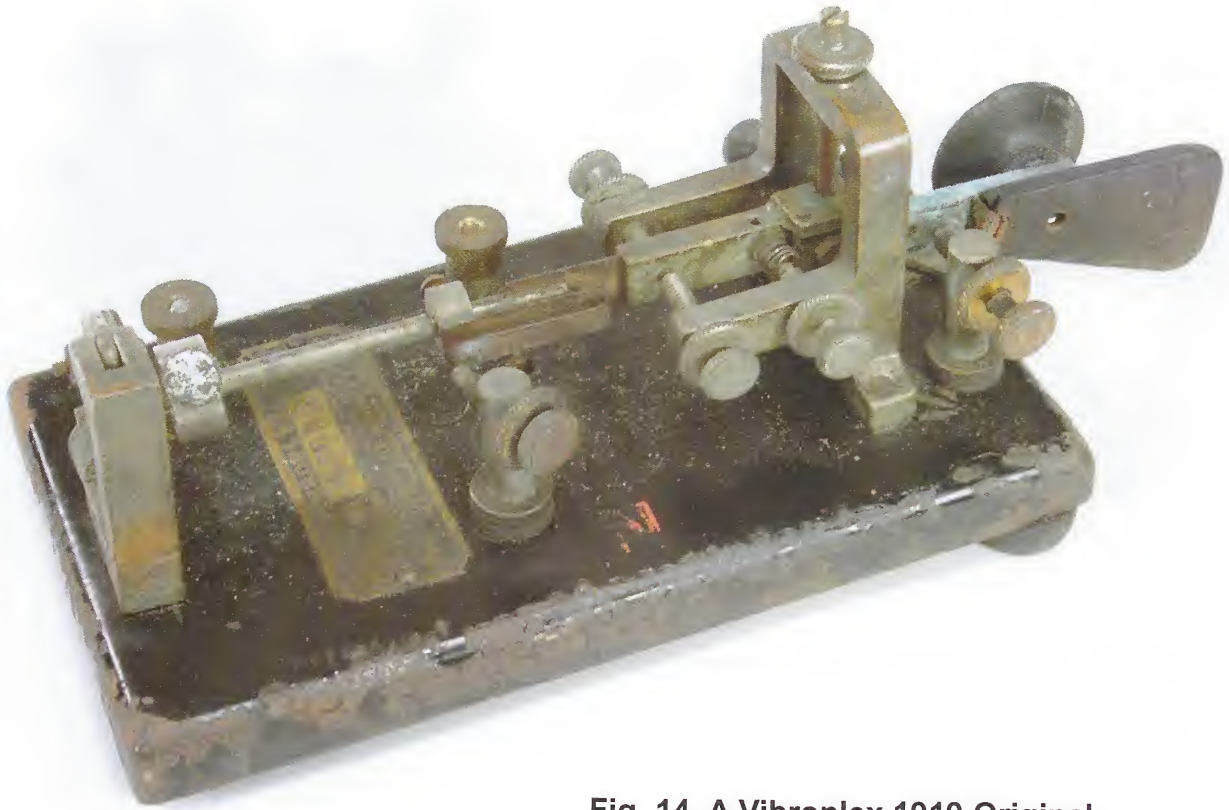


Fig. 14. A Vibroplex 1919 Original

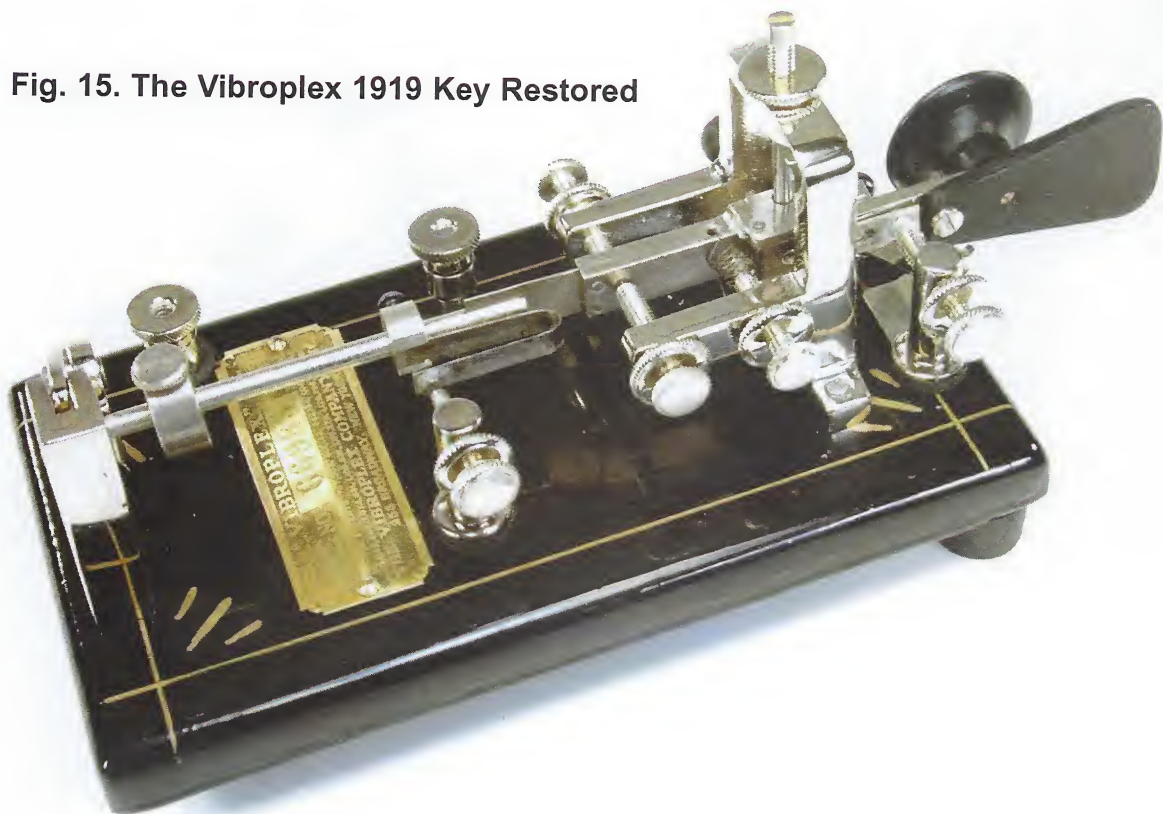


Fig. 15. The Vibroplex 1919 Key Restored

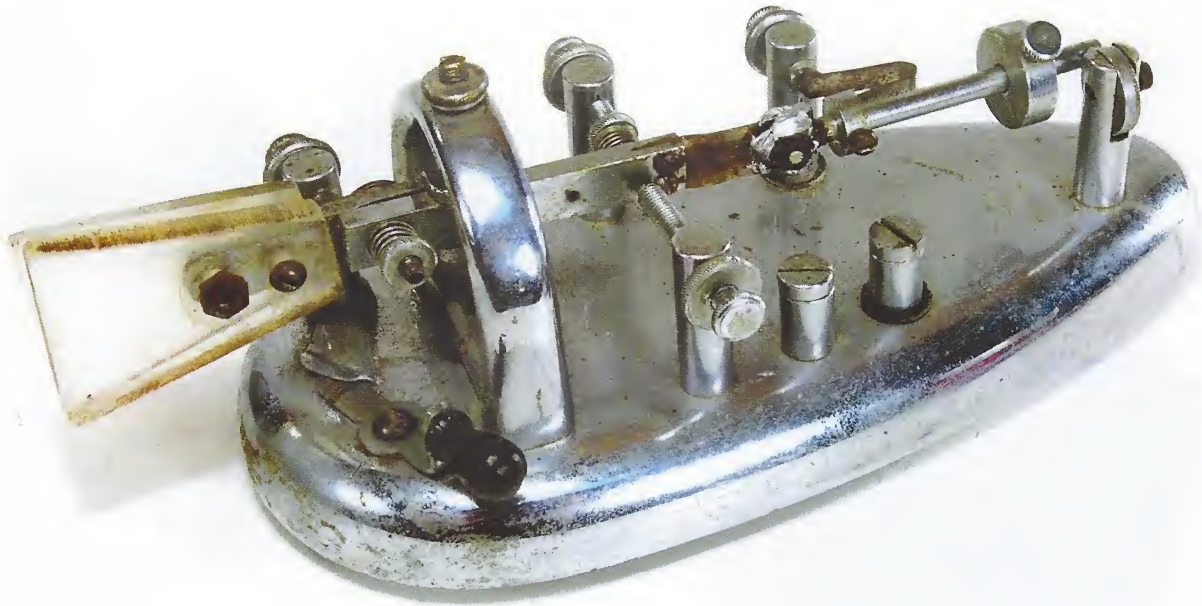


Fig. 16. A McElroy S-600 Super Stream Speed Key Before Restoration



Fig. 17. The S-600 After Restoration

CHAPTER 8

The W. R. Smith Telegraph Keys

THE MONOVERT, VERTICAL, SEMIAUTOMATIC SPEED KEY

Why New Speed Keys— After a sixteen year silence, I returned to ham radio and became acquainted with a CW operator, Shelby Rye (AD4WQ). An avid key collector, he was quite interested to learn that I had made a speed key at age ten and another at age twelve. When I mentioned that I had a paddle, **Fig. 1**, that was made as a University of Tennessee course project almost sixty years ago, he drove across Tennessee to see it. From that point on, he encouraged me repeatedly to put my lifetime of engineering, watchmaking and clockmaking skills to use designing and building another speed key. I had just finished work on my eighth clock and decided to think it over.

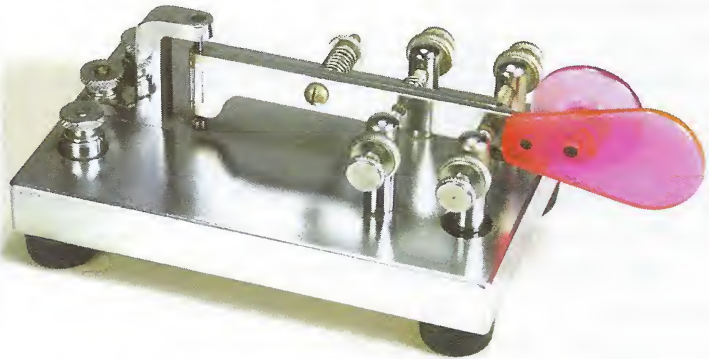


Fig. 1. A Paddle From 60 Years Ago

A new key seemed like a very interesting project and I began toying with ideas of what might be built that would be unusual and interesting enough to justify the effort. With the

thousands of ordinary speed keys in the world, making a copy of one made by others would be a waste of time. It was decided that an acceptable solution would be a vertical speed key and of a design unlike any ever built.

The Design— Some thought was given to the problem and a mental picture of the key began to take form. One of the main difficulties when designing a vertical speed key is how to get the paddle and dash knob above the dot pendulum assembly arbor. If a solution for this problem is not found, the key becomes unreasonably tall.

Fortunately, while designing the CW paddle of **Fig. 1** many years ago I happened on a solution to the problem. Fold the dash lever upward against the dot lever and allow the dot bar stop screw to reach the dot bar through a hole in the dash bar. With this in mind, I built the key and when completed, drew the sketch, **Fig. 2**, to show others how it works.

The Dash Bar— The most difficult to build portion of a speed key is the dash bar. In the early days, the dot bar had a cast brass hinge. However, in 1920, Horace Martin patented a dash bar hinge having two ears folded from sheet metal. Most speed keys use this design.

The required shape was laid out on a sheet of 3/32" thick, 1/2 hard, leaded brass and sawed to shape. The area where the ears were to be formed was heated red

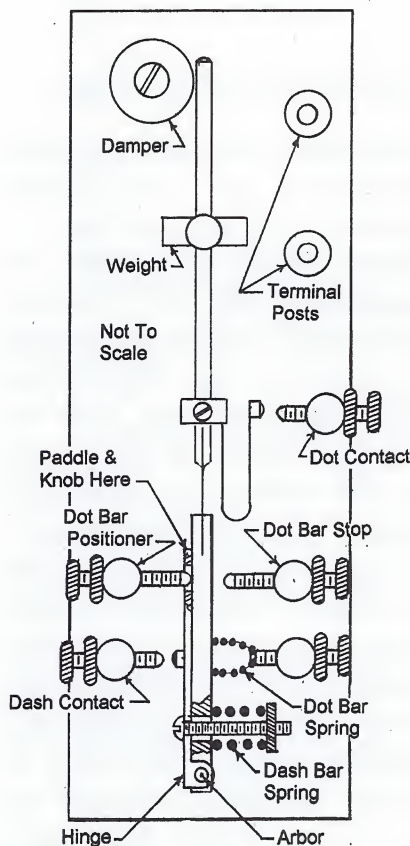


Fig. 2. The Monovert Sketch



Fig. 3. The Start Of The Dash Bar

drilled to accept a 1/8" OD arbor and cross drilled and threaded for a screw head to grip the arbor. The dot bar and the weight rod were drilled to accept rivets and each was slotted with a 0.010" thick circular saw. Feeler gage stock, 0.010" thick, was cut for the mainspring and holes were punched in it using the dot bar and the weight rod as punching jigs. The weight rod was nickel plated and hand turned rivets were used to attach it and the dot bar to the mainspring.

The Pendulum Assembly— An arbor was hand turned from 1/8" OD, straight music wire. A contact plate was sawed to shape using a piercing saw, drilled and a silver contact turned and riveted on. The dash bar return spring was wound from 0.020" OD music wire and nickel plated. The dash bar and dot bar were mated, the arbor installed and the dash contact and dash bar return spring were installed, **Fig. 4**.

In the upper left corner of the figure, note the hole in the dash bar, through which the dot bar stop screw will reach the dot bar. It is this hole, which I believe I am the first to have used,



Fig. 5. The Pendulum Assembly

was made and added to the weight rod. The completed pendulum is shown in **Fig. 5**.

The Main Frame— The next item made was the main frame. The shape was laid out on a sheet of 3/8" thick, 1/2 hard, leaded brass and sawed on a band saw. The edges were filed to shape and smoothed with 320 and 600 grit emery paper. The mounting screw

hot with a torch to anneal it and the ears were successfully folded over a bar of steel. The part at this stage of fabrication is shown in **Fig. 3**. Having solved the ear folding problem, the remainder of the work seemed simple enough.

The Dot Bar— A pendulum dot bar was laid out and sawed from 3/16" thick, 1/2 hard, leaded brass plate stock. The end of the dot bar was



Fig. 4. The Dash/Dot Bar Hinge

that allows the paddle and dash knob to be positioned above the arbor and greatly reduce the height of a vertical speed key.

The Pendulum, Knob & Paddle— A signet paddle was laid out with an "S" in it on a sheet of 1/8" thick, black plastic and sawed to shape using a piercing saw. The edges were smoothed with files, papered, and the holes drilled. The gloss finish of the plastic sheet was dulled with 1800 emery paper and the surface coated with silicone grease.

Unable to locate machinable black stock, with which to turn a dash knob, I used one from Vibroplex. It and the paddle were mounted on the dash bar. A weight was made as per Chapter 5 and a dot contact assembly

holes and the hole in the top of the frame that receives the bearing screw were drilled and tapped 8 - 32. The completed main frame is shown in **Fig. 6**. Plating was done later.

The Base And Hardware— A base was laid out on 3/16" thick, 1/2 hard, leaded brass and sawed to shape. Locations were marked for mounting the thumbscrew posts, the main frame, the damper and the binding posts.

These parts were machined and mounted on the base. The dot contact assembly, made here in the shop, is of the type used on flat weight bar Vibroplex keys and allows good contact alignment. However, this key has a round weight rod instead of the Vibroplex type flat bar. A cylindrical collet, having a stud and a thumbnut, solved the mounting problem.



Fig. 6. The Main Frame

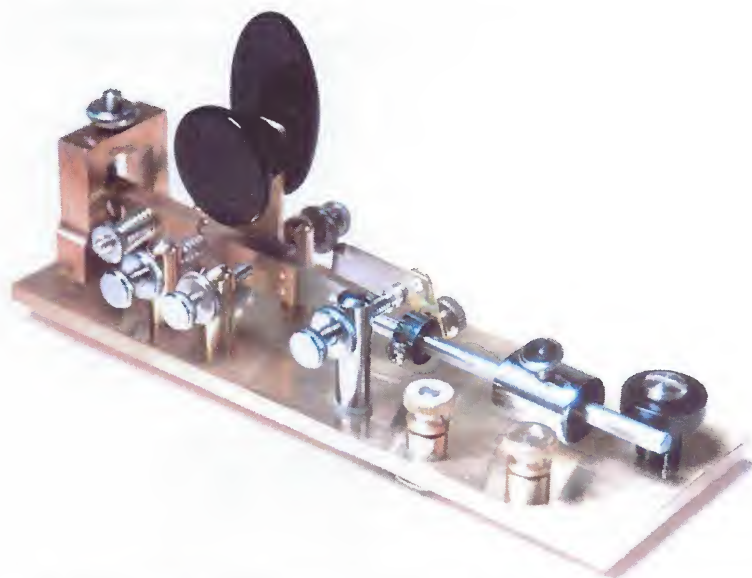


Fig. 7. The Monovert Key, Less Its Foot And Plating

the parts requiring plating were taken to a local plating shop and were plated with both nickel and chrome. I decided for aesthetic reasons to leave the dot bar and dash bar in their native brass color and lacquered them. The damper and its support column were blued with heat, as was the dot spring mounting collet.

The Foot— It was intended that this key be heavy enough that it could be used on a desktop without the need to be held down by hand. Thus, I settled on a "U" shaped foot sawed from a plate of 1" thick brass, believing that its weight and that of the key would be adequate. It was estimated that the resulting key would weigh about 3-1/2 pounds. This has proven to be true and the key sits very still when being used.

The completed key has a speed range of approximately 15 to 40 wpm, is easy to adjust and holds its adjustment well. Months of "on the air" tests in the hands of an avid CW operator have proven it to be a very good speed key.

Silver for the contacts was hand turned in a clockmaker's lathe. The damper is a simple, thick, steel washer mounted freely on a post. At that time, I did not have rope knurling rollers, with which to knurl the thumb screws and thumbnuts, and used those made by Vibroplex. I have since added these tools and now make my own thumbscrews and thumbnuts. The pivot bearing screws were made from ordinary screws by drilling a hole in their ends to receive the cone pivots of the pendulum arbor.

When satisfied that the base layout was acceptable, **Fig. 7**,

The completed Monovert vertical speed key is shown in **Figs. 8, 9 & 10**. It stands 7-1/2" high and weighs 3-1/2 pounds. The paddle and knob are at standard speed key height and all adjustments of the key are made in the same manner as for a normal, semiautomatic speed key. The damper does not swing out of the way but that is not needed since normal diameter weights readily pass it when being added to the weight rod.

The dot bar stop screw, that passes through a hole in the dash bar, can be seen in **Fig. 8**. The hole and the stop screw are just below the two rivets at the end of the dot bar. It is this feature that allows the paddle and knob to be swung above the arbor and lessen the height of the key. It has four rubber feet and is quite stable on a table top. Users have reported that the key has an excellent "feel," and is a pleasure to use.

As far as is known, this is the first vertical, semi-automatic, mechanical speed key to be designed and built in the last eighty years. I am pleased to have made it.

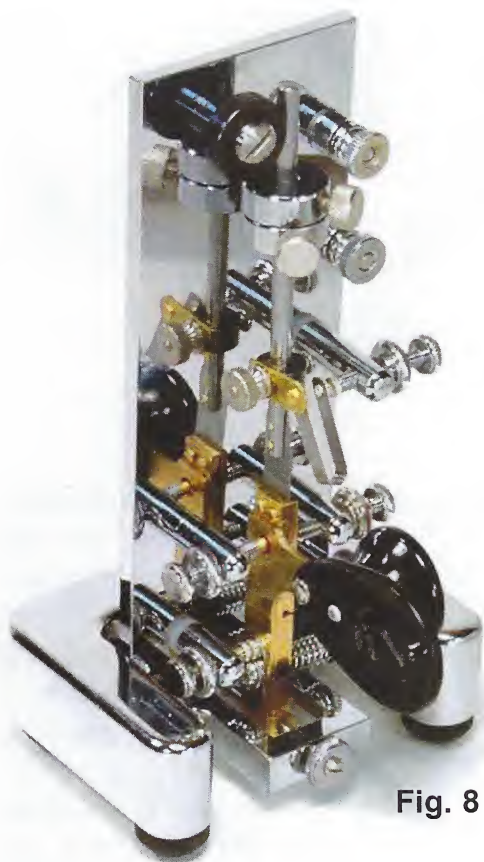


Fig. 8



Fig. 9.
98



Fig. 10

THE DUOVERT, VERTICAL, FULLY AUTOMATIC SPEED KEY

The World's First And Only Vertical, Fully Automatic, Mechanical Speed Key

The Duover Design— After having successfully built the Monovert key, I began to think about what sort of key could be made that had never been made by anyone before.

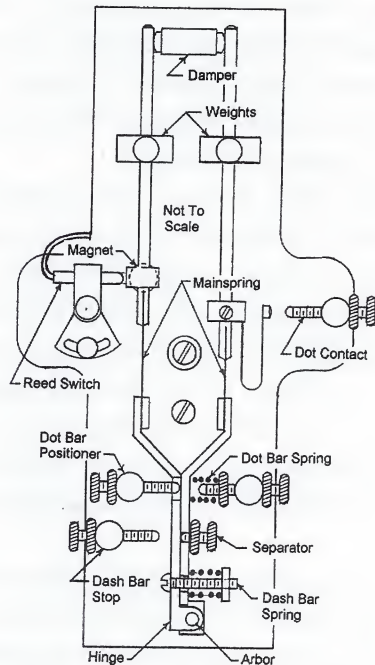


Fig. 11. The Duover

separating the dash and dot bars. Thus, a separator screw has been added.

A normal dot spring assembly was used for the dot side of the key. However, tests indicated that such a spring system for the dash side would not produce good dashes. Thus, a rare earth magnet was mounted on a collet and positioned on the dash weight rod just above a reed switch. This switch was mounted on the key base in a small brass tube



Fig. 12. The Combined Dash & Dot Pendulums

I was aware that fully automatic, mechanical speed keys had been built but had never heard of a vertical one. Thus, I began puzzling over how to build such a key. Further, since all of the horizontal, fully automatic speed keys I was aware of, had three arbors, I decided to try to design one with only one arbor. The design that satisfied these conditions is shown in **Fig. 11**.

The Pendulum Assemblies— Using the same techniques employed when making the Monovert key, I made a dot/dash bar assembly, except this time it was in the form of a “Y.” On both the dot bar and the dash bar I mounted a mainspring. A normal length spring for the dot side and a 2-1/2 times longer spring for the dash side. On the end of each spring, I mounted a 5/32” diameter, brass weight rod. This was later changed to stainless when a rare earth magnet was mounted on one of these rods.

If you study the drawing, it is evident that, except for the bifurcated dot and dash bars, the layout of the key is pretty much normal. However, there is one added part that is unusual. A means had to be included for

clamped in a fantailed holder, the tail of which can be rotated for fine adjustments and locked. The reed switch tube can also be repositioned in its clamp.

A signet paddle, dash knob and weights were added to complete the pendulum assembly, **Fig. 12**.

The rare earth magnet can barely be seen mounted under its collet on the dash weight rod. Also, note the separator screw just to the right of the dot bar return spring.

The screw head seen in the extreme left-hand end of the assembly captures the arbor and

allows vertical height adjustment. Because of the uncertainty regarding possible main-spring lengths, the springs were clamped to the dot and dash bars with 0 - 80 screws rather than being riveted.

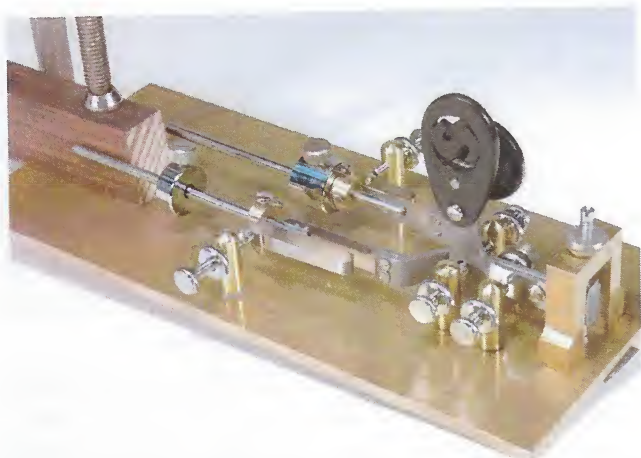


Fig. 13. The Duvert During Construction

a conventional type contact spring was being tried on the dash side. However, tests showed that it could not produce adequate length dashes and it was abandoned and replaced with a rare earth magnet and a reed switch. With these in place, the key is capable of producing about 50 proper length dashes.

The Foot— As was true with the Monovert key, I wanted this key to remain still on the table without the need to be held down. Thus, I again resorted to a “U” shaped foot from 1” thick brass plate. The base was mounted on the foot and the key was finally capable of standing vertically, **Fig. 14.**



Fig. 14. The Key On Its Foot

A typical main frame was laid out on 3/8”, half hard, leaded brass plate and cut to shape. Thumbscrew posts, thumbscrews and thumbnuts were made and some were plated. These parts were mounted on a sheet of 3/16” thick brass. **Figure 13** shows the key during this stage.

In this state, the key was clamped vertically in a bench vise and a few tests were made. Note the piece of wood clamped to the base to serve as a temporary damper. Also, note that at this stage in the development,

The Damper— Tests showed that damping of the key from the solid brass “T” was inadequate and I set about solving that problem. Rubber and plastics were both tried but were not suitable. Of all the material tried, leather appeared to be the best. However, most of the leather being used was too soft. It was finally discovered that the leather in pool stick cue tips was just right and inlays of it were placed in each wing of the “T.”

As noted in **Fig. 14**, there is no fine adjustment for the reed switch tube. Thus, the holder was redesigned and a fan shaped tail was added to allow very precise movements and locking of the of the switch position.

When convinced that the key was performing properly, it was disassembled, the base cut to shape and the parts plated. However, to add contrast to the key, I polished the dash and dot levers and blued them with heat. They were then lacquered to prevent rusting.

The key was then reassembled and tested. This showed that it is easy to adjust, it holds

its setting well and performed as expected. The key has a speed range of 13 to 35 wpm and is easy to use. However, one must have a rhythm that matches the speed setting of the key.

To set the speed, one first moves the dot weight to the speed of dots desired. All that is needed then is to move the dash weight until the dash lengths are the correct ratio with respect to the dots. The completed Duover, fully automatic key is shown in **Fig. 15, 16 & 17.**

As was true for the Monovert key, a unique design feature has allowed this key to have the paddle and dash knob above the arbor and at standard speed key height. This is accomplished by arresting the dot lever with a stop screw through a hole in the dash lever. This has allowed both the Monovert and the Duover keys to be about 3" shorter than would otherwise have been possible.

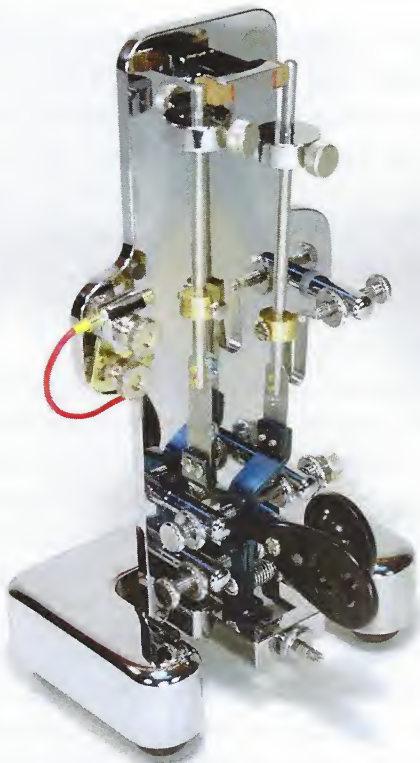


Fig. 15. The Duover



Fig. 16. Duover--Another View



Fig. 17. Back View

THE MAGNEVERT, VERTICAL, MAGNETIC, SPEED KEY

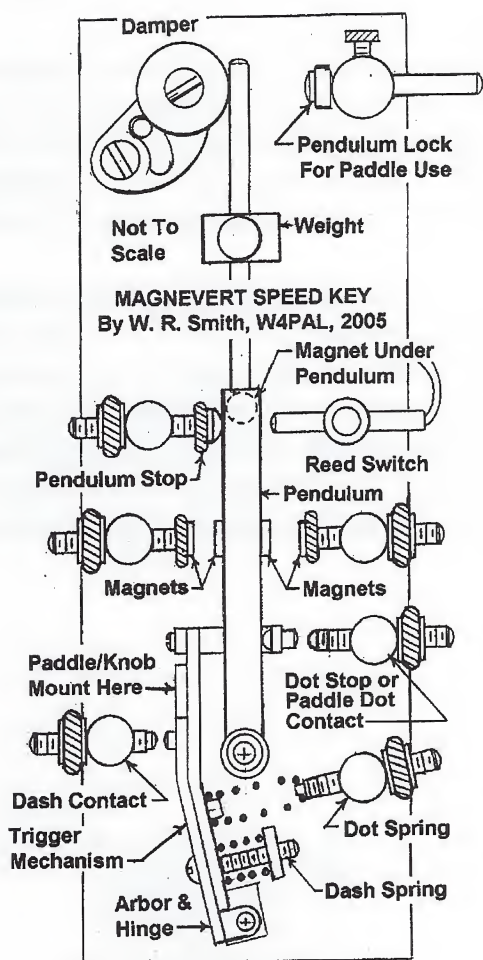


Fig. 18. The Magnevert Key

presses on the side of the pendulum, causing it to rotate counterclockwise until arrested by the pendulum stop. However, this is in opposition to the force of the magnet on that side of the pendulum. Thus, if released, the pendulum will move rapidly away from that opposing magnet. However, as it does so, it moves into the field of the opposing magnet in the thumbscrew on the other side. This force stops it and causes it to rotate back toward the field of the first magnet. In this manner, if nothing stops it, the pendulum will oscillate until windage and friction consumes its stored energy.

As can be seen, if the dot bar is pressed clockwise, the U moves out of the way, the pendulum goes into oscillations and continues to oscillate until the dot bar is released. At that time, the dot bar spring rotates the dot bar counterclockwise, the right wall of the U, on the end of the dot bar, strikes the right

The Design— After having designed and built the Monovert and Duovert speed keys, I began thinking of what other sort of key might be built that had never been offered before. By then, I was familiar with the use by Richard Meiss (WB9LPU) of rare earth magnets in speed key designs. Since no vertical, magnetic key had ever been made, I decided to try to design one of that type.

Although I seldom work from drawings, as I wrestled with the many problems of such a key, I found it necessary to sketch many attempted design solutions. This puzzlement prevailed for weeks before I was satisfied that a workable solution had been found. **Figure 18** is a sketch of that final design.

The key functions in this manner. The pendulum is pivoted on ball bearings and has a magnet bonded on each side of it about midpoint of the square portion **Fig. 19**. Opposite these two magnets and opposing them are two magnets embedded in the rope knurled heads of two thumbscrews.

A dot spring presses on the side of the dot bar, which is pivoted to rotate. On the end of this dot bar, near the two magnets, is mounted a "U" shaped member that goes down below the pendulum, rises up on the right side and



Fig. 19. The Ball Bearing Pendulum

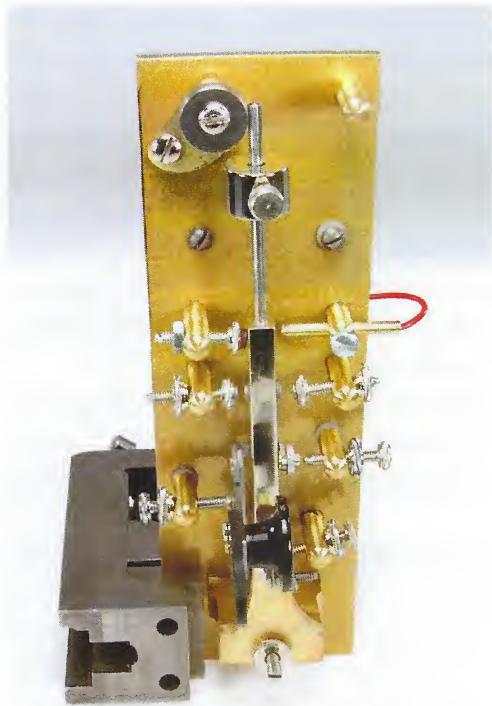


Fig. 21. Testing The Key

to the right of this, and held in a post, is a brass tube containing a reed switch. As the pendulum is released and oscillates, it passes over the reed switch and closes it. Although only five dots are needed for CW, the pendulum is capable of making approximately 50 dots before it finally stops.

With these components completed, a main frame, a base and the small items were made and mounted. The key was clamped in a machinists's vise, **Fig. 21**, adjustments made and a few tests run. These indicated that it performed well and was ready for a foot and plating.

The Foot— Following the example of the Monovert and Duovert keys, the feet of which had made stable keys, I again made a foot from 1" thick brass plate stock, **Fig. 22**.

Threaded holes for the usual four feet were added and it and the parts that I had not already nickel plated were taken to a local plating shop. When returned, they were assembled as shown in **Fig. 23**.

Labels for the three keys were made in a local trophy shop and added to them.

On the air tests of this key have been made over a period of several months and it has performed exceedingly well. The speed range is from approximately 15 to 35 wpm, it is easy to adjust, holds its setting well and has a good feel.

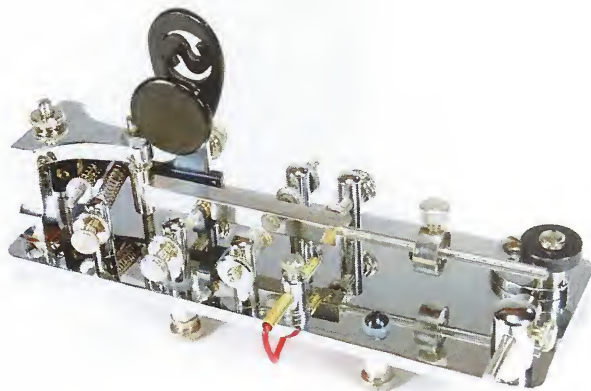


Fig. 23. Key Ready For Its Foot

side of the pendulum and moves it against its stop. **Figure 20** shows the dot and dash bar assembly. Note the "U" attached to the end of the dot bar with 0 - 80 screws. Also, note that on the end of the "U" is mounted a silver contact. This is for use when the key is to be used as a paddle, as will be described later.

And how are dots made? Beneath the pendulum, at the end of the square section, is mounted a rare earth permanent magnet. Be-



Fig. 20. Dot/Dash Bar, "U," Assembly



Fig. 22. The Key's Foot

The Paddle— The Magnevert is not only a semiautomatic speed key, it is also a paddle because the thumbscrew that stops the clockwise rotation of the “U” on the dot bar is also an insulated silver contact. To use the key as a paddle, the stop opposite the end of the weight rod is released, moved against the weight rod and locked. This prevents pendulum movement. The dash bar closes the dash contacts and the dot bar closes the dot contacts. The key is provided with a special cable having two, 3-way phone plugs at the transceiver

end. Depending on the mode the user wishes, semiautomatic key or paddle, one of these plugs is plugged into the electronic keying jack or the other into the semiautomatic speed key jack.

These three speed keys, the Monovert, Duovert and the Magnevert have been used for CW with good success by Shelby Rye (AD4WQ) for several months each.

The completed Magnevert key is shown in **Figs. 24, 25, & 26.**

Note that the key has a swinging damper. This was not needed to dampen the pendulum but was required to swing the damper out of the way when weights were added or removed from the weight rod.

The red wire is the lead from the reed switch to a terminal post on the back side of the key. The pendulum stop, at the left end of the square portion of the pendulum is a thumbscrew with an embedded portion of a leather pool cue tip.

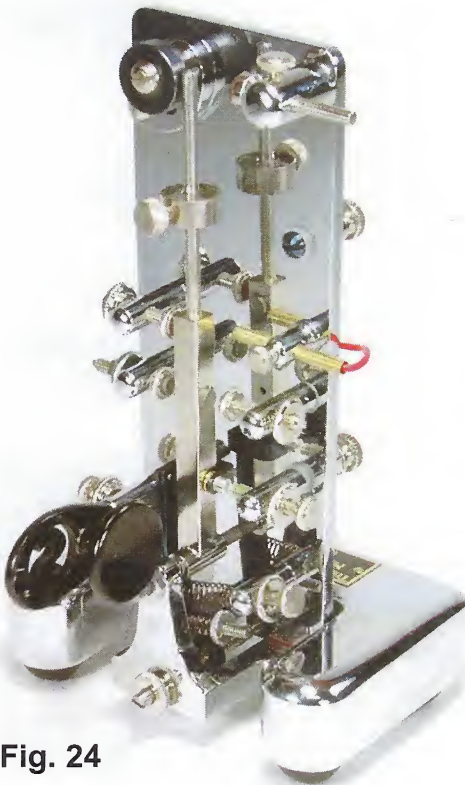


Fig. 24

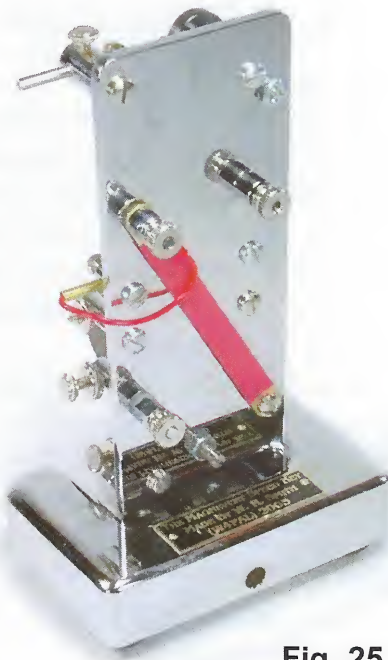


Fig. 25

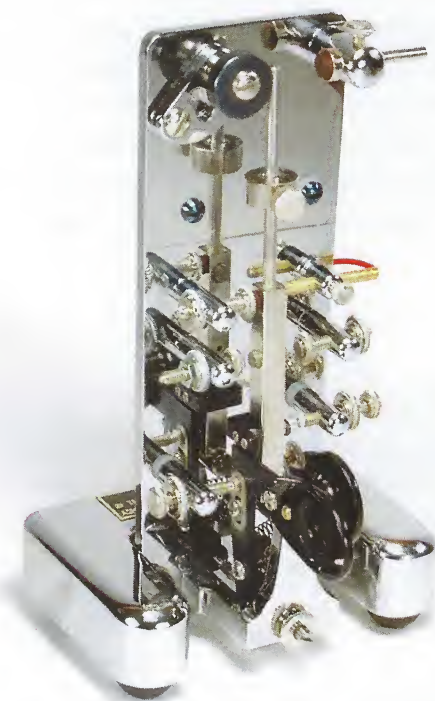


Fig. 26

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