RESTORATION OF ARMS AND ARMOR BEING DONE AT THE POLDI PEZZOLI MUSEUM

by Merrill Lindsay

Bill Williamson tells the story of visiting one of the little Connecticut shore towns, either Clinton or Madison, with fellow collector Meade Patterson. For no conscious reason, Bill took off across the village green to the other side, away from the Boston Post Road, where in the window of a tiny book store he found a Georgia Armory percussion musket, now in the Hermann Warner Williams collection in Washington. Bill explains his luck to extra sensory perception and says that this is the only explanation for other finds that he has made in the most unpredictable places.

A year or so ago I went to Milan to supervise the printing of Peter Copeland and Harold Peterson's book, *America's Fighting Men*. I spent two weeks in Milan with the printer o.k.'ing color forms which were then run off. I stayed at the Cavour Hotel on the Piazza Cavour in downtown Milan. In the evenings, having nothing better to do I wandered around the nearby streets. Extra sensory perception or what, I don't know, but I found myself in front of the Poldi Pezzoli Museum, located no more than a couple of blocks from the hotel in an anonymous looking building on the Avenue leading to Milan's great cathedral, the Doumo.

I marched into the Museum and presented myself to Professor Guido Gregorietti, the Director, and asked to be permitted to go backstage to examine the museum's arms and armor which were almost entirely in stores. Professor Gregorietti could not have been more gracious or helpful. Even though the museum was in the midst of making an installation of industrial and graphic arts in their main galleries, Gregorietti took me behind temporary display walls where there were hundreds of fifteenth, sixteenth and seventeenth century helmets on a permanent shelf molding running around an entire gallery.

He took me into other rooms where wheel locks, smaphaunces and flintlock long guns were in cases pressed into corners and then into a storage area where swords, daggers and elements of armor were stored in bins. Finally the Director introduced me to his restorer, Collura who took me to his workshop where he was surrounded by all sorts of mysterious tubes, pipes, wires and glass fish tanks. The laboratory was quiet except for a high pitched whine (note the soundproof ear phones in the picture) which I later discovered was caused by ultra sonic vibration.

I spent all of my spare time after that in the museum, mostly in Collura's laboratory, and when I returned to the States, Collura had promised me an illustrated account of his restoration procedures. The following is his report.

Report on Methods of Restoration by Domenico Collura, Conservator of Antique Arms at the Poldi Pezzoli Museum in Milan, Italy

Preliminary notes

The detailed description of an antique piece, the first observations of the repair to be made, the study of the technical characteristics of the degradation, and therefore all the possible inquiries into the potential restoration of the object, are indispensable to the successful outcome of the restoration because they are, aside from the cleaning methods used, the only means of assuring the preserved state of the object.

Firearms, edged weapons, and antique armor are generally composed of materials other than iron. The methods which follow refer only to ferrous materials in the most degraded condition, and in need of urgent protective treatment.

Excluded, therefore, are objects from excavations or the deep sea, on which a particular method of restoration must be practiced because of the notedly different type of surface contamination found, and the different nature of the corrosion.

However, there are also various techniques and methods for the restoration of ferrous materials. As a rule, one method does not preclude using another. To the contrary, often because of the varying states in which different parts of an object may be found, it is necessary to use a couple of methods.

It will be better not to discuss here the reasons leading to the choice of one method over another, because to do so we would have to also describe all the characteristics of the particular metal, along with the reasons for choosing one method over another. In every case it is useful to report the

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effects of those phenomena that have impaired the surface of the metal, classifying the different natures of corrosion – abrasion, oxidation, and other compounds adhering to the surface. It will also be useful to determine their solidity, hardness, flakiness, etc.

After these initial observations, one should take photographs of the whole, and closeups taken from a technical point of view. A wide range of gray and chromatic tones will give the right tone to the photographs. Enough photos should be taken to illustrate the piece from every angle. The closeups should depict the type of corrosion or encrustation, and also engraving marks.

For certain types of restoration (i.e. electrolytic), it is necessary to separate ferrous from non-ferrous materials by means of a patient and careful dismantling of the pieces. This operation allows one to clean every receding formation of the piece thoroughly, and to avoid the troublesome occurrence of electrodeposits.

If the number of pieces to be cleaned is large (for example, all the parts of a suit of armor), one must tag every little piece with an iron tag, with corresponding numbers shown on a schematic diagram of the object. When the treatment is finished, each piece can then be returned to its proper position.

Although there are many various cleaning methods, all worthy of consideration, it is useful to evaluate for the moment only the most complex:

Electrochemical reduction
Electrolytic reduction
Ultrasonics

It is understood that before applying electrochemical or electrolytic reduction one must ascertain scrupulously, with local tests, that the surfaces of the piece are not covered with any antique surface treatments such as gilding, silver-plating, burnishing, polishing or any coloration. These would be destroyed upon the first application of the electrochemical. When pieces with such characteristics are found, the restoration must be done with special methods.

Before and during the restoration it is always good to question the authenticity of the piece. The recognition of authenticity comes with the systematic observation of all the elements of a technical nature – processes of workmanship, metallographic composition, types of corrosion, stylistic elements, etc. After gathering this information, all the observations must be compared to the known working methods of the historical period in question. This method is infallible.

Going on to describe the electrochemical method which, like the other methods, I have taken directly from the restoration laboratories of the Poldi Pezzoli Museum, it is the first method ever adopted following almost entirely the detailed advice of Harold J. Plenderleith in his volume *The Conservation of Antiquities and Works of Art.*

The preliminary operations described above are valid. What to do next is summarized below:

Electrochemical reduction

– In an enameled iron container with an average depth of 40-50 cm., place the pieces of armor so every part of the surface can be covered by granulated zinc.

– When the pieces are placed in the container, pour in a well-mixed solution of 15 percent sodium hydroxide (Na OH) in water, covering the zinc, but at least 20 cm. from the top of the container.

– You can then begin to heat the solution using a gas stove, careful not to heat above 80°C, for about

Figure 1. Domenico Collura, Conservator at the Poldi Pezzoli Museum in Milan looks out from a tangle of pipes, wire and tubing – part of his various ultrasonic cleaning rigs.

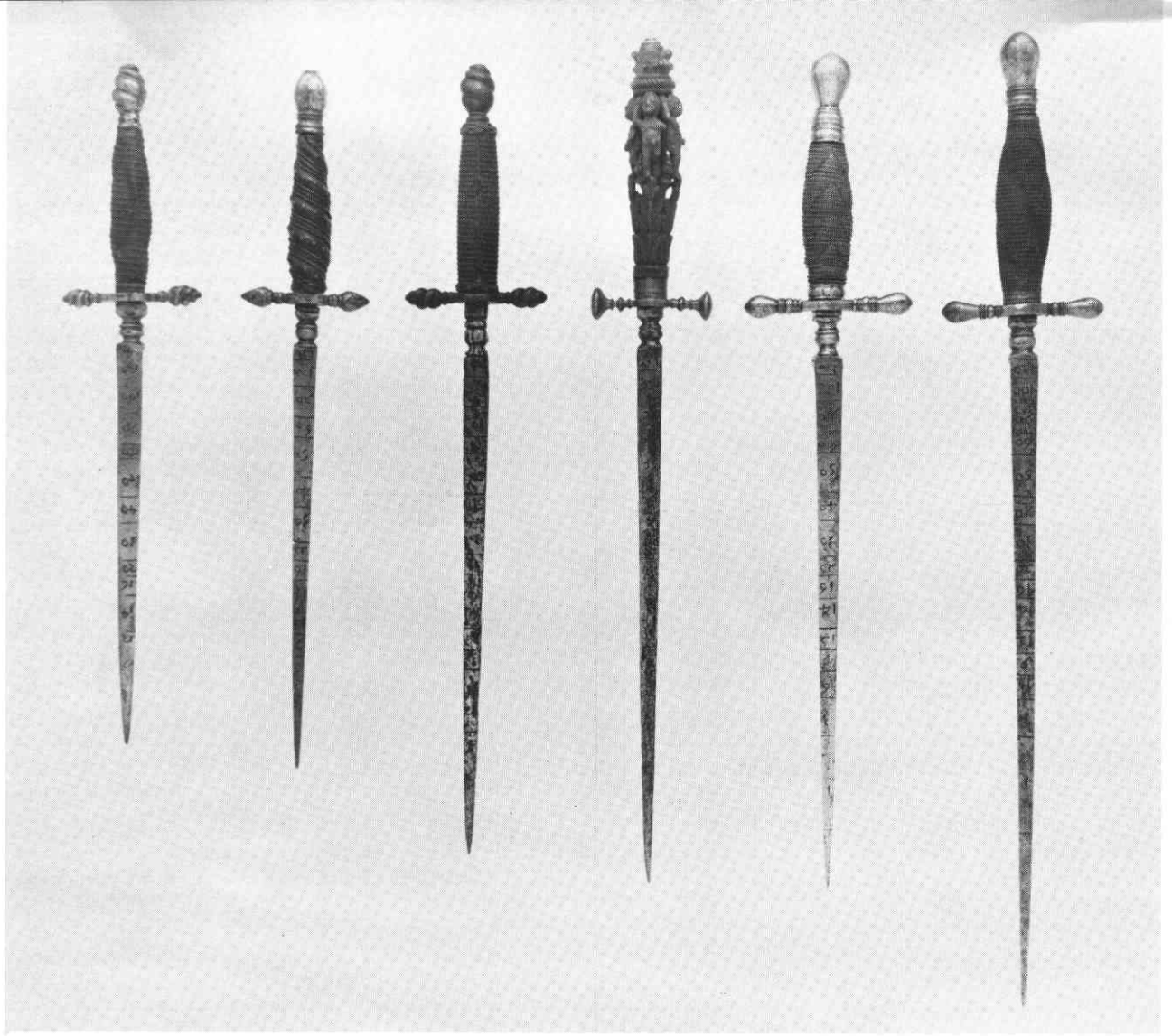


Figure 2. Six artillerymen's bombardier daggers with the measuring calibrations on the blades. These cleaned pieces which now show the markings on the blades – from 1 to 120 – illustrate the wealth of material in the Poldi Pezzoli Museum which Collura has to clean.

30 minutes. After a necessary cooling period, the pieces may be taken from the container.
– With a brush of hard synthetic fibers, remove under running water the rust and encrustation now softened and reduced to slime. Water temperature: Alternate between 20°C and 60°C. (68°F & 140°F)
– Then give a prolonged bath in distilled water – first cold at 15°C and then hot at 60°C – with a change of water about every five hours. At every change it is good to scrub the pieces under running water.
– The final polishing can be done with a solution of 30 percent anhydrous aluminum oxide of 0.7 micron diameter, the rest water, using a rotary brush of goat hair.
– Rinse with running water at 15°C, to eliminate the excess polishing paste. (59°F)
– To dry, first rub the pieces with cotton cloth. Then put them in a bath of acetone. Then put them in a dryer where, in the presence of chemicals of high indicator power and high ability to absorb humidity, the use of a suction pump will create a vacuum.
– The final protection of all the surfaces of the pieces can be effected by using a varnish of transparent film – hard, thin and adherent.
– The acrylic Paraloid type at 20 percent, prepared in a solvent, responds well to these needs. The passage from the dryer to the varnishing must be rapid – possibly by immersing the pieces directly in the varnish.
During the electrochemical reduction it is not possible to control what happens to the metal. This negative note is very serious. The temperature of the solution is not uniform: on the bottom it is higher and can be dangerous. The zinc sometimes attached itself to the metal in a most adherent way.

After this treatment, it is necessary to give a good mechanical polishing with an abrasive that will not harm the original surface of the metal.

To cover pieces of irregular shape with the zinc is not very practical: one needs too much zinc. Besides, to reuse the zinc it is necessary to give it a lengthy and troublesome washing. One good thing however, is that oxidation, encrustation, rust and all other foreign elements are eliminated even in the deepest recesses.

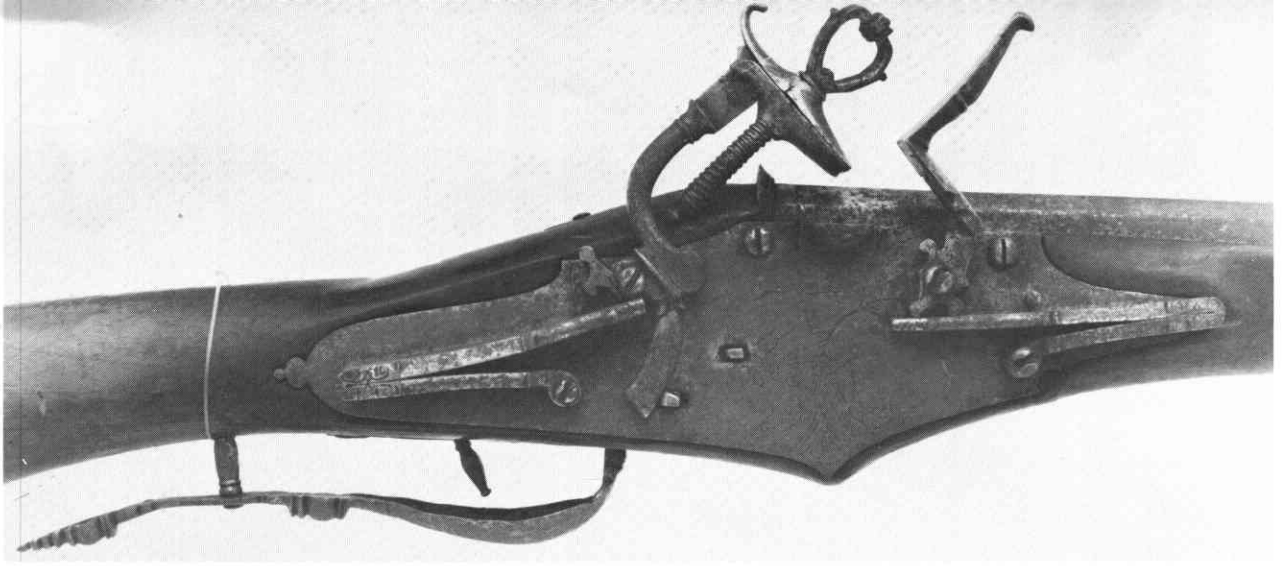


Figure 3. Here is the rusty, dirty lock of a fine early Italian snaphaunce. The lock, showing by its shape that it dates from the immediate post wheel lock period has probably not been cleaned since before World War I.

Often the baths in distilled water, especially if prolonged, produce, besides great quantities of rust, certain substances which will cause undesired spots on the metal's surface. It is always useful, therefore, to keep checking the piece to interrupt this phenomenon. Frequent agitation of the bath diminishes these defects.

I believe that electrochemical reduction is of limited application.

Electrolytic reduction

The preliminary phases of the restoration are unchanged, and are the same as for the above method.

A sample test of electrolytic reduction was done in the research laboratory of the Falk steel-works in Milan. The armor treated by this electrolytic method carries the inventory number 1983 (Museo Poldi Pezzoli—Milan).

—A preliminary bath in caustic soda at 10 percent, the rest water, will take away a good part of the dirt. Temperature: about 60-70°C Time: 30 minutes should be sufficient

—Rinsing in running water, alternating between 20 and 60°C, improves the cleaning.

—At this point, the observation of the pieces under a binocular microscope is absolutely necessary before effecting a good electrolysis.

—Electrolytic reduction

—An iron basin adapted to the function of cathode-anode apparatus

—Caustic soda solution at 5 to 8 percent, the rest water, or ungreased salts, free of cyanide, at 10 percent, the rest water

—Electrolyte temperature: 50°C, thermoregulated

—Voltage: Variable, but in relation to the geometry and nature of the piece

—Amperage: Approximately 2 amps per dm^2 of surface area (10 square cm.)

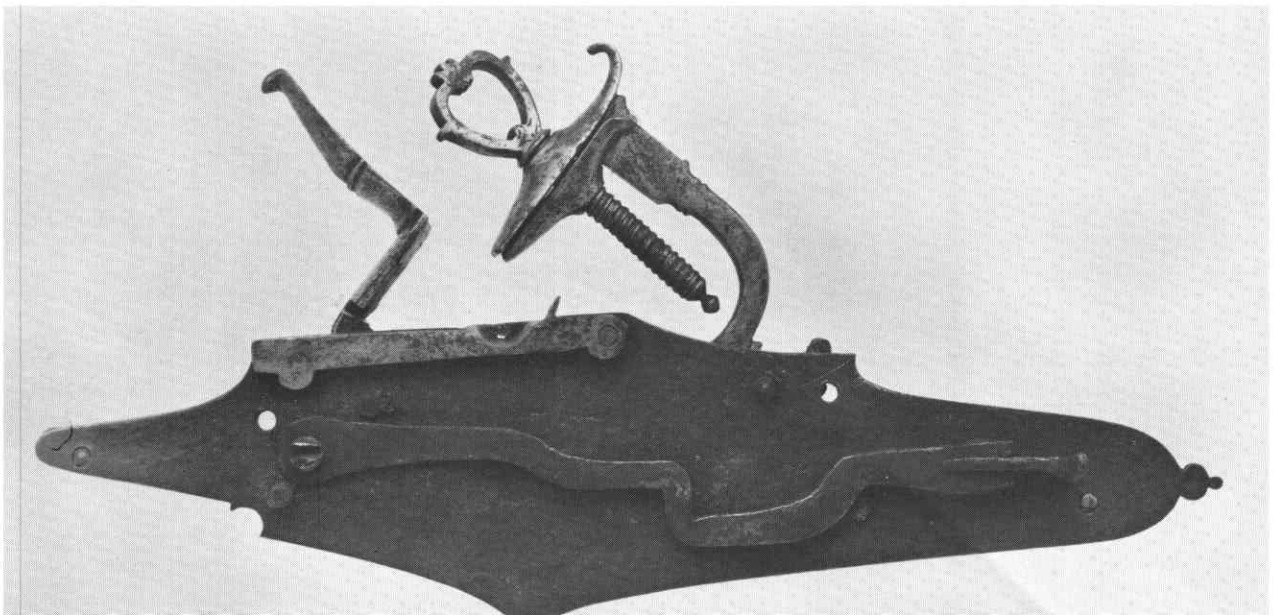
—Timing: Every five minutes, anode-cathode inversion

—Number of inversions: From 4 to 6

—Total treatment time: About 40 minutes

After this point, the rest of the operations are the same as those for electrochemical reduction.

Figure 4. The inside of the lock was a black horror. However, the quality of the soft Brescian iron from which it was made plus ancient coatings of hog's lard have prevented any large scale.



The electrolytic treatment presents certain difficulties because phenomena arise that are not always perfectly controllable and against which maximum care must be taken. Untreatable pieces are those gilded, silver-plated, burnished or colored, because these surface treatments would be destroyed.

Even though the preliminary bath will have notably reduced the dirt, the electrolyte will tend to become filled with substances which can interfere and electrodeposit themselves on the surfaces of the piece. In this condition the piece will have to be repeatedly immersed in a slightly acid solution.

Another danger is the so-called "fragility of hydrogen" (*Corrosion of Metals* by Guzzoni—G. Storace), which consists of the excessive absorption by the metal of free hydrogen in the electrolyte.

The color of some metals tends to be too gray, with obvious alteration of the original color.

With this treatment, rust is eliminated in deep places.

Ultrasonics

An electronic and ultrasonic device constructed by the ACEL Society in Milan, under the direction of Tecnica Pers. Tec. Marelli and Tecnico Sig. Bonsignori, solves satisfactorily the many difficult problems of restoration. The devices are made in the U.S. by Branson, GE, and others. It means that changes are occurring even in this area.

Qualified technicians have simplified and reduced the time necessary to obtain the desired results of this treatment. And it is only with this premise that one can understand the rapidity with which a machine becomes the tool of the restorer.

The technical borrowings confirmed by the experiments on old metals have not fallen short of any of our hopes.

Here, then, is the process (verified by Tecnica Per. Tec. Marelli):

—The preliminary operations are identical to the ones for preceding treatments.

—The use of the preliminary degreasing bath, even though it may be useful, is not always required.

—The solution in the ultrasonic basin is composed of Tensioactive alkaline substances. Actually, good results were given, for example, by "Ferlon," a product of the Wyandotte Chemical Corporation, Michigan, USA. There are also a series of products made by Oakite.

—Working temperature of the bath: From 40 to 50°C

—Concentration: "Ferlon" at five-percent, the rest water

—Power of the ultrasonic system: 1000 W with a (piesoelectric) transducer system of the double type

—Frequency: 22kHz

—The objects should be slowly immersed in the bath when cavitation is at a maximum and, therefore, the liquid is completely degasified. The piece to be cleaned must be turned toward the transducer zone.

—The optimum cavitation, besides being determined by the specific power (W/1) in the tub, depends on the tensioactivity of the detergent used, on the temperature of the bath, and on a perfect degasification of the bath.

—The detergent must adhere readily to the contaminations to be removed.

—The number of immersions varies, and depends on the speed with which the foreign and degraded substances begin to detach themselves from the objects' surface. The time, therefore, is always in relation to the following variables:

—Nature of the object to be treated

—Nature of the contamination to be removed

—Specific ultrasonic power in the tub (W/1)

—Temperature of the detergent solution

—Tensioactivity (surface tension?) of the detergent solution

—Chemical nature of the detergent

—Geometry of the piece to be treated

—Weight of the piece to be treated

—Aging of the detergent solution

—Ultrasonic frequency

—Uniformity of the cavitation in the tub

—In general from one to five, up to ten minutes, is enough to take off the adherent contaminating substances limited to the surfaces of the piece.

—Normally it is good to check the part being cleaned at least every two minutes in order to stabilize the stop and start of the treatment.

—At the end of this process the object must be rinsed generously with running water, first at 40 to 60°C for about ten minutes, and finally at 15°C, accompanied by energetic scrubbing with a hard brush of synthetic fibers.

—At this point it is easy to confirm the existence of hard encrustation in corroded pockets. If necessary, one could now have recourse to cleaning in depth, by electrolytic reduction.

—If you decide instead not to use electrolysis, the pieces can now be lightly scrubbed with anhydrous di-aluminum oxide at approximately five percent, the rest water.

—Rinse with running water at 20°C, and then immerse for one minute, completely rotating the piece in the ultrasonic bath. Rinse again with running water at 40 to 60°C for ten minutes and scrub occasionally.

—Next, dry the pieces with cotton cloth and immerse them in a dehydrating solution—an oxidation inhibitor (i.e. "Nordall," 1 part in 100 parts water, a product of Wyandotte)—at a temperature close to bubbling.

—Perfect drying can be obtained using a suitable ultrasonic system with "Freon" solvents. With the type of apparatus used in this location, the treatment proved to be somewhat laborious; for precision and brevity, the solvent used must be distilled continually (47°C). A solvent such as Freon TF by Dupont acts on all the geometry of the pieces, degreasing them to the utmost, (the liquid phase distilled with ultrasonics), and drying them perfectly (steam phase) thanks to the thermal exchanges permitted by the apparatus.

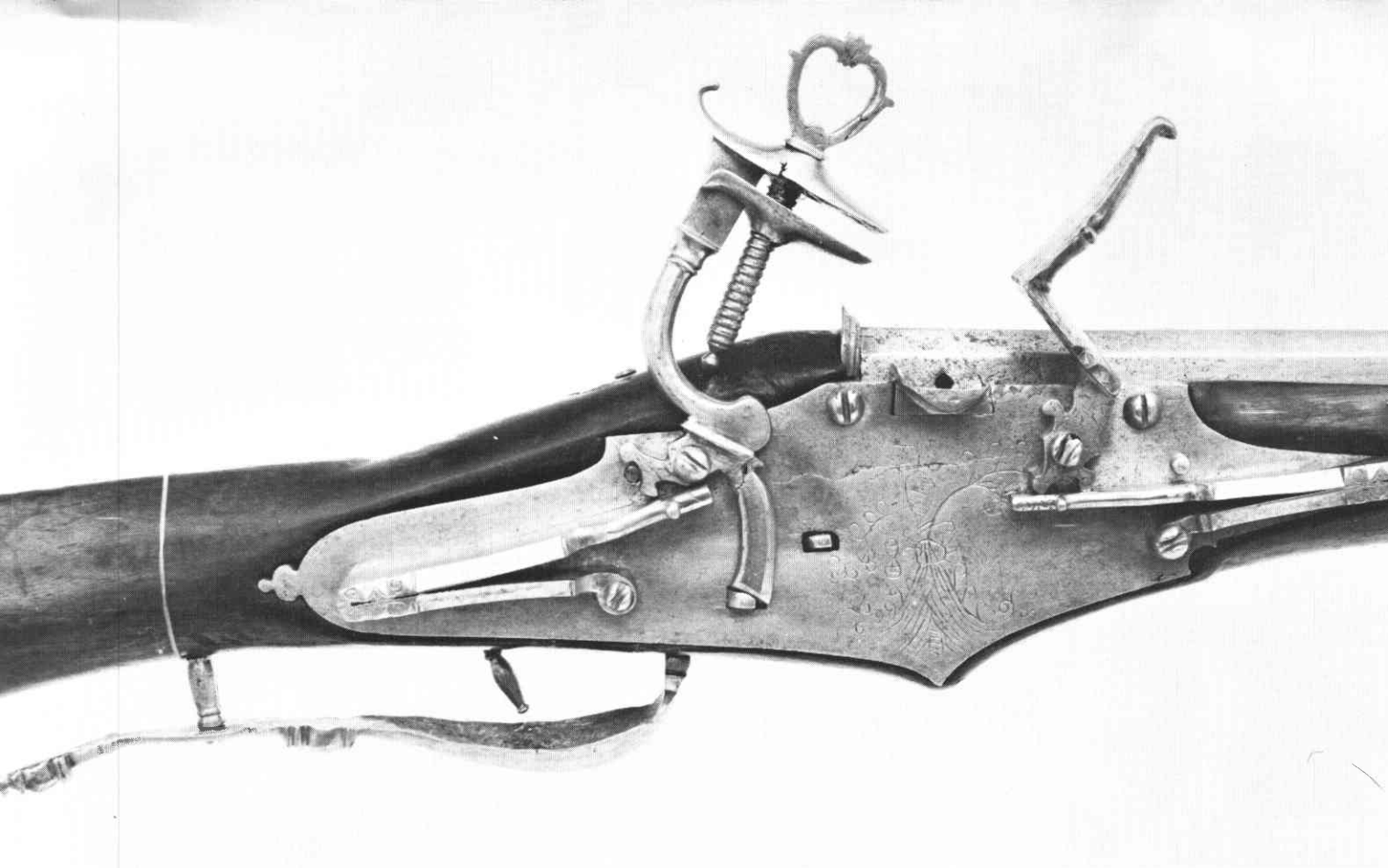
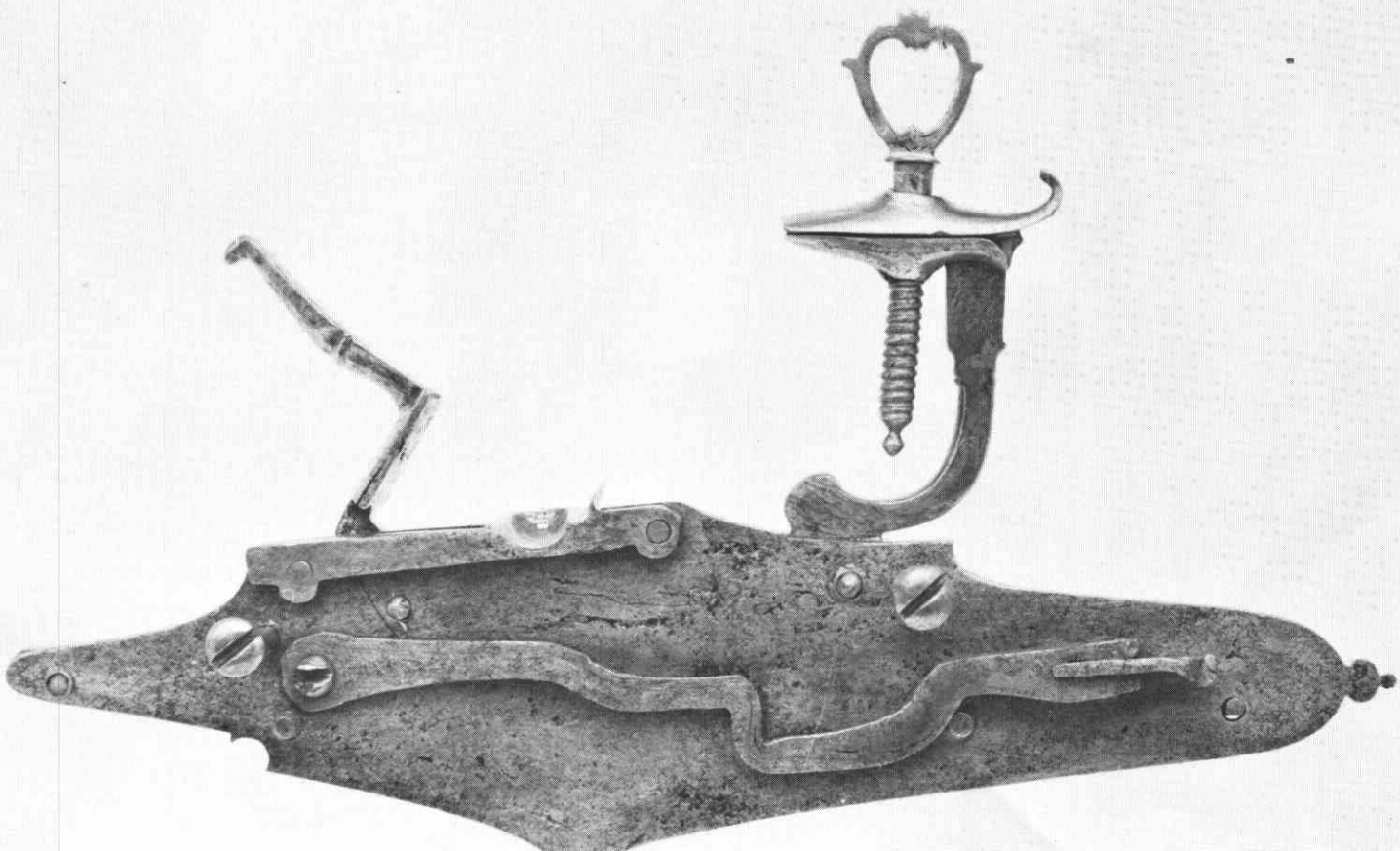


Figure 5. Here is the restored lock which has been removed from the gun after being photographed and described in its dirty condition, cleaned with ultrasonics and judicious hand polishing and replaced in the treated and cleaned stock.

Figure 6. Ultrasonic vibration has removed the crud consisting of rust, powder, dried grease and dirt of centuries, leaving a fairly respectable, lightly pitted surface which can be maintained without further work for a long time.



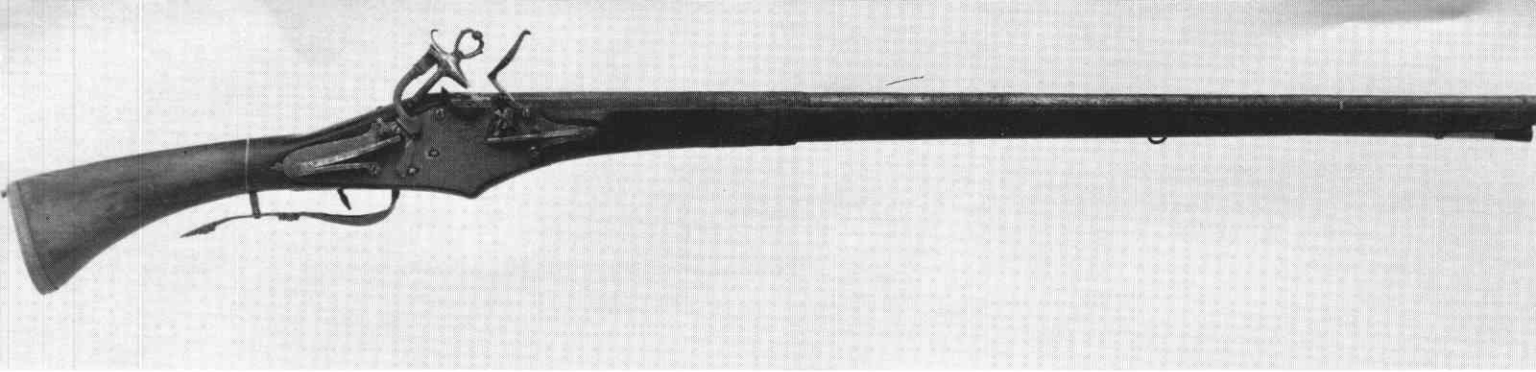
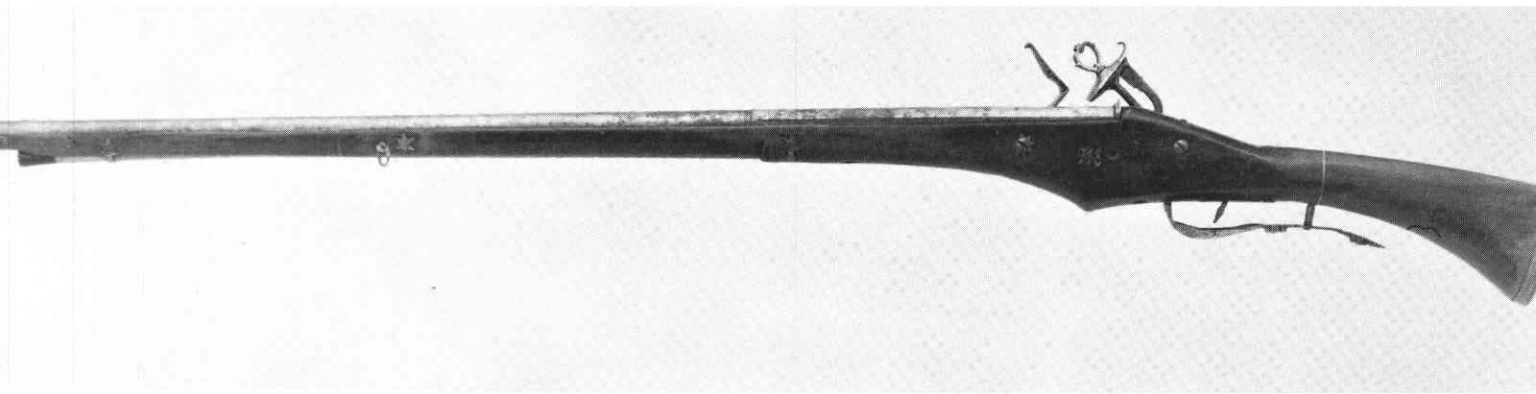


Figure 7. The whole dirty long snaphaunce gun. Note the trigger guard and the shape of the stock. Although the snaphaunce is a Spanish invention, this snaphuance was made in Brescia or north central Italy some time around 1580 to 1590.

Figure 8. The back of the snaphaunce gun was dirty as the front with perhaps a bit more erosion of the barrel.



– After several hours, bathe the pieces with ethylene tetrachloride and then with acetone. The treatment finishes, then, with the final points cited in electrochemical reduction, the only variable being the final protection of polish, which can be applied using the ultrasonic systems that permit the capillary penetration by the varnish of every irregularity of the treated piece.

I consider the ultrasonic treatment indispensable in the restoration of antique metals. It is true that the encrustation of a certain hardness cannot be removed without using highly concentrated chemical solutions, but it is also true that this method obtains only a partial, superficial cleaning. In fact, delicate parts, such as gilted, silver-plated, or burnished parts, will not be damaged except in those areas where they have already become detached from the surface. In this case one must turn to other treatment which will help to reinforce these parts. For encrustation on these delicate surfaces, I advise a very gradual operation.

After a brief ultrasonic cleaning, the piece can be protected with inhibitory preparations and rust emollients. By repeating the ultrasonic treatment in a period of 60 to 90 days, or better yet, every time a piece of the encrustation is softened, good results will be obtained. The use of ultrasonics does away almost completely with the use of abrasive preparations which, together with the mechanical action of rotary brushes, destroys parts of the surface.

The use of ultrasonic systems, other than being economically valid, permits one to intervene rapidly on processes erroneously begun during different stages of restoration.

It is to be hoped that certain other methods will now be definitely abandoned because they are damaging the artistic and cultural patrimony.

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As Collura's references to Milanese suppliers of equipment are not very useful to American collectors or museums, I have made inquiry both of Arthur Beal who heads the department of conservation at the Fogg Art Museum in Boston and of Jim Hartley, former head of research and development at Winchester's. These querys led me in turn to the Branson Company in Stamford, Connecticut who make a wide range of tanks and vibrating equipment ranging from small tray cleaners which would be o.k. for lock parts, to custom designed fish tanks shaped to take gun barrels, breast plates, sword blades or helmets. In working with valuable

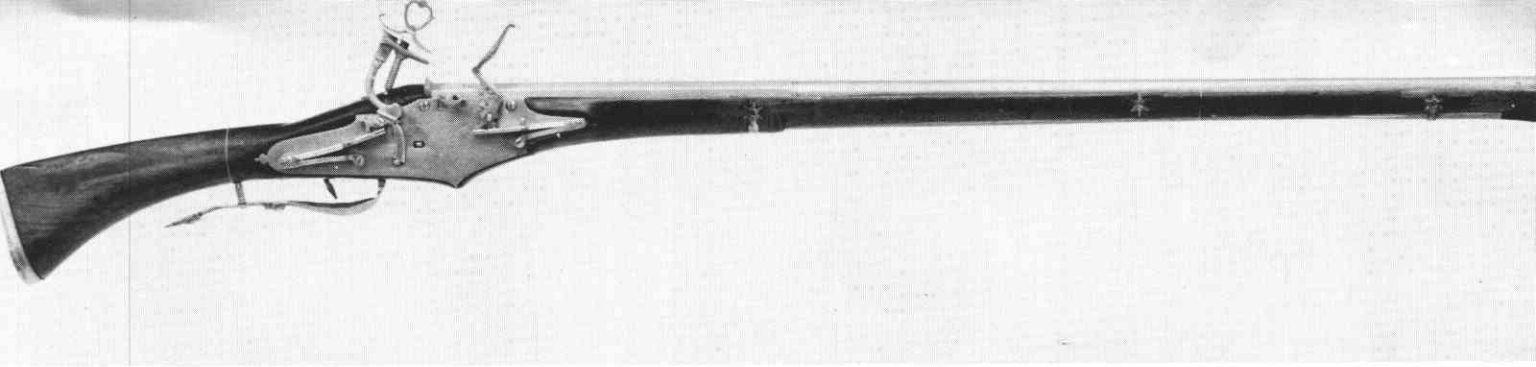

Figure 9. The snaphaunce emerges from Collura's careful cleaning with a bright barrel and capuchines, a clean lock plate and trigger guard with now visible engraving and a well grained walnut stock.

Figure 10. The cleaned left side of the gun shows the characteristic early Italian star shaped metal inlays under the screw heads. These took the place of side plates. Barrel pins secure the barrel, the capuchines hold the ram rod. Note the Italian molding of the butt plate and the button or bead to protect the plate which one associates with early wheel-locks.

antiques it is important to be able to see the work as it is being cleaned so that the process can be instantly arrested if the cleaning is too positive and also so that the work can be rotated to stimulate cleaning of a special area which may have more scale and rust than another. Glass tanks are, therefore valuable and so are bright lights on top, in back and underneath as well as in front of the cleaning tanks.

Above all, as Collura points out, the skill, patience and judgement of the operator is of vital importance in preserving an antique arm at its most attractive stage of restoration. Total cleansing may leave you with a total unrecognizable wreck of a piece if the metal is poor and the rust has penetrated too far. Ultra sonics can do things that other rust removal processes can't and the finest restoration employs ultrasonics along with a lot of rubbing and loving care.