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SOLDERING

Prepared by

R. M. Loper and E. A. Olson
Assistant Extension Agricultural Engineers

SOLDERING

There are many repair jobs on a farm which can be done easily and inexpensive if one knows how to solder. It is not a difficult task but skill is developed only through practice and a thorough understanding of the basic principles involved.

Soldering in most cases is the process of joining two pieces of metal together by means of another metal which will melt at a lower temperature. Sometimes a second piece of metal is not needed. Small holes may be closed by allowing enough melted solder to flow into the hole to fill it.

EQUIPMENT NEEDED

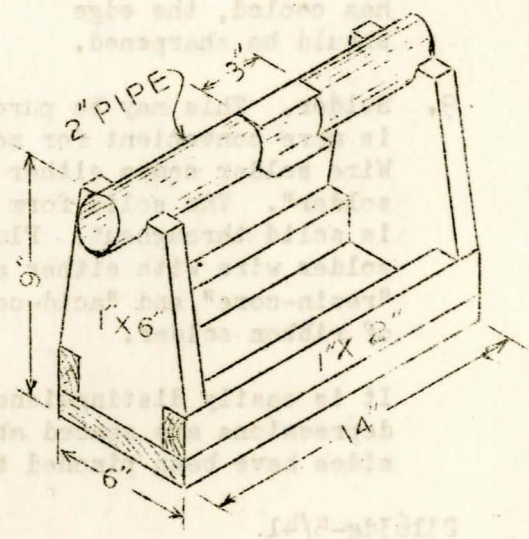
Only a small amount of money is needed to provide enough equipment for soldering work on a farm. This equipment is listed below.

1. Soldering Coppers. (Sometimes called soldering irons). They are sold in pairs and are labeled according to the weight of the pair. For example, a 4-pound copper means two coppers each weighing 2 pounds. A tinsmith always uses a pair of coppers, heating one while he uses the other. However, the average farmer may not need two. Sometimes the hardware merchant will split the pair and sell a customer one of the two. If not, someone else may want one and the pair can be divided after purchase.

   Smaller coppers are handy for many household tasks but even there coppers lighter than 1 pound are not very satisfactory. They cool so rapidly that good work cannot be done with them. Lighter weight electric soldering irons may be used successfully since the heating element is inside the iron itself thereby giving constant heat.

2. Some methods of Heating the Copper. A hot, clean flame is necessary if the copper is to be heated to the correct temperature. A coal or charcoal fire is used sometimes but a blow torch is a more satisfactory source of heat. It is preferred by experienced tinners because the flame is cleaner and the torch may be moved from place to place as needed.

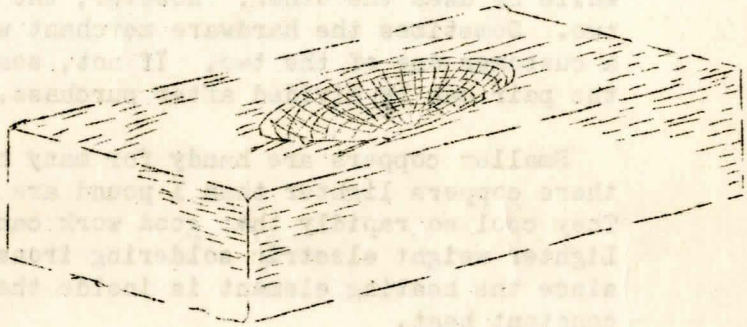
   A home-made furnace such as is shown here provides a means of heating several soldering coppers at once. It is easy to build and can usually be made of old materials which are on hand. Attention is called to the fact that a closed pipe is used and that the center cut is three inches long. This provides adequate space for flame from the blow torch to heat the coppers.



3. Sal Ammoniac. This is needed in tinning the coppers and may be purchased at any drug store. It comes in solid or powdered form. Sometimes a piece about the size of a walnut is dissolved in a pint of water to make sal ammoniac water into which the copper may be dipped from time to time as it is being used. This solution should be kept in a glass or china container - not a metal one. An old shaving mug or something of similar shape is convenient.

4. Soldering Flux. After the surfaces to be soldered have been cleaned flux is applied to prevent oxide from forming and to promote a good union between the solder and the material. Flux may be purchased in paste or liquid form or can be made at home. Fluxes are discussed more in detail on page 6.

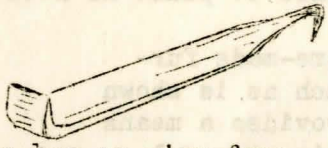
5. A soft brick which has been grooved out as shown. This is for use in tinning the copper.



6. A flat file for cleaning the coppers.

7. Tin shears for cutting material for patches.

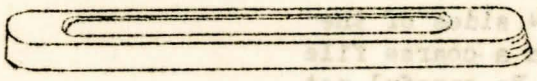
8. A sharp instrument for cleaning the material to be soldered. A good one can be made from an old flat file by heating it and bending it to the shape shown. After it has cooled, the edge should be sharpened.



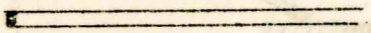
9. Solder. This may be purchased in bar or wire form. The latter is more convenient for most work since it is easier to handle. Wire solder comes either in solid form and so-called "flux-solder". The solid form resembles a piece of wire in that it is solid throughout. Flux-solder is made by filling a hollow solder wire with either a resin or an acid flux. The terms "resin-core" and "acid-core" are sometimes applied to this type of ribbon solder.

It is easily distinguished from the solid type since slight depressions are spaced about ½ inch apart. These are where the sides have been pinched together to keep the acid or resin from

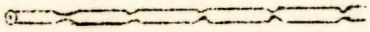
running out of the entire length after one has started using the solder. Flux-core solder ordinarily is not as satisfactory to use as the solid-core type since different materials require different fluxes.



Bar Solder



Wire or solid-core solder



Flux-core solder

Care and Operation of the Blow Torch

Assuming that the source of heat is to be the gasoline blow torch, the first requirement is to fill it with filtered white gasoline. Never use gasoline which contains lead. A blow torch has a threaded plug in the bottom which may be removed when the torch needs filling. When the container is about half full, replace the plug being sure to screw it tightly into place. The air pressure should then be pumped up.

In order to get the torch to burn correctly, it is necessary to heat the needle valve. This can be done, after the air pressure has been pumped up, by filling the cup under the burner with gasoline and lighting it with a match. Gasoline may be poured into this cup from the gasoline can or it may be filled directly from the torch itself. To do this, a thumb should be held over the end of the burner, the gasoline valve opened, and the torch tipped back toward the handle. When the gasoline strikes the thumb, it will drip back into the cup beneath the burner. When the cup is almost full, close the needle valve and light the gasoline in the cup, allowing it to burn until the cup is nearly empty. Open the needle valve then and be sure the burner lights. If it does not light, it is usually a sign that the needle valve has not been heated sufficiently. In such a case, allow the valve to cool and repeat the process being sure that the cup is entirely filled before applying a match to the gasoline.

When the soldering is finished, close the needle valve just enough to put out the fire and then open it a very little to prevent damage to the point of the needle while it is cooling.

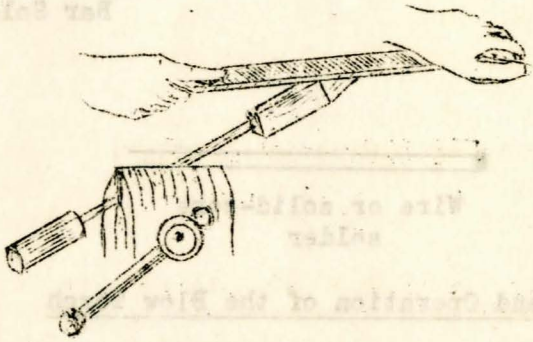
Care of the Soldering Copper

The soldering copper may be heated in any clean, hot flame, but when the point is exposed to the air after heating, it becomes coated with

a reddish grey scale known as oxide. Because of this oxide, it is necessary to "tin" the copper before solder will stick to it. This is a very important part of the work. A good job of soldering cannot be done if the copper is not well tinned. Poorly tinned coppers are probably responsible for more soldering failures than all the other causes.

By tinning is meant the coating of the point of the copper with solder. It is done as follows:

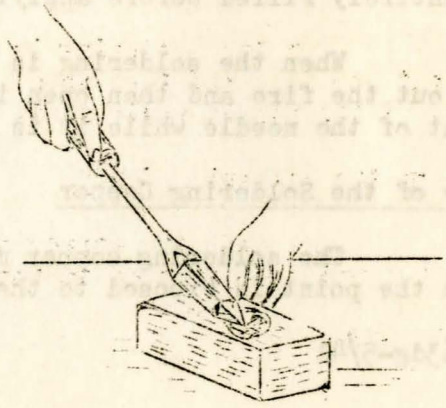
1. Clean all 4 sides of the copper with a coarse file as shown. Be careful not to change the shape of the point when filing it.



2. Heat the copper. Only through experience can one learn to know when the correct temperature is reached. It should be hot enough to melt solder so it will flow freely the moment the two touch. Do Not Get It Red Hot as it is hard on the copper and will burn the solder rather than melting it. Over heating causes the copper to unite with the tin of the solder on the working surface, thereby forming a thin crust of bronze. This bronze is very hard and if left on lessens the effectiveness of the iron. An extremely sharp file or an emery wheel is required to remove this bronze and redress the copper for re-tinning.

3. Apply flux or soldering paste to all four sides of the point just as soon as the copper is taken out of the flame. Some tinsmiths prefer to rub the point on a piece of sal ammoniac or dip it quickly in the sal ammoniac water rather than apply flux. It can be done faster and, therefore, does not allow the iron to cool as much as the other method.

4. Solder should be applied to the point just as soon as step 3 is completed. The grooved brick is useful for this operation. If some solder has been melted and placed in the bottom of the groove, the point of the copper can be placed in it as shown. Rotate the copper while the point is in the groove to get an even coating on all sides. The solder will



melt readily and flow over the four surfaces if the iron is hot enough. If it is too cool, the solder may melt to some extent but will probably stick to the copper in chunks.

5. Remove the copper from the brick and wipe all excess solder off the point with a damp cloth or piece of waste. This should be done rapidly to prevent burning the hand.

Coppers are not tinned when purchased. It must be done before they are used the first time and it is important to keep them tinned. It probably will be necessary to re-tin them from time to time.

Clean Surfaces to be Soldered

Solder must come in contact with the metal itself if it is to obtain a firm grip. Solder will not stick on a dirty surface and for that reason all dirt, grease, oxide or other foreign material must be removed carefully before soldering is attempted.

No one would think of trying to solder rusty iron without first removing all the rust. Rust is simply iron oxide and it is recognized because of its peculiar appearance. Any metal will have an oxide form on it when exposed to the air, but it may be so nearly the same color as the metal itself that one does not realize it is there.

Thorough cleaning of the surfaces to be soldered cannot be overemphasized. It is one of the most important operations in soldering and unless a good job of cleaning is done, one need not expect a satisfactory result. A scraper such as shown on page 2 is a handy cleaning tool. Files are also used in some cases while emery cloth and coarse sandpaper are of use in places which cannot be reached with a scraper or a file. For example, a small hole in the bottom of a pan would be difficult to clean with either a scraper or a file. The emery cloth and sandpaper are flexible and could be used to good advantage. The area around the hole should be cleaned until all oxide and dirt are removed.

It is sometimes difficult to solder holes in the seams of milk pails and wash boilers. Grease from the milk or soap lodges in the seams and prevents a good bond between the solder and the metal. An effective way of removing this grease is to heat the area around the hole with a blow torch and then clean it with sandpaper or emery cloth. In some cases muriatic acid, applied with a swab, may be used for such cleaning jobs with better success than sandpaper or emery cloth. A small piece of cloth wrapped around a small pointed stick and dipped in the acid works very well as a swab. Care should be taken not to get acid on the hands or clothes.

A very thin film of solder is all that is needed when the surfaces are clean. If they are dirty, no amount of solder will do the job.

Preparation and Use of Different Fluxes.

As soon as the surfaces to be soldered have been cleaned, they must be given a coating of some material which will prevent oxide from reforming before the solder can be applied. Such materials are called fluxes. The same flux will not work on all kinds of metals. It is essential to know which kind to use on the various types of metals which may need to be soldered. Some of the most common fluxes are: chloride of zinc, muriatic acid, resin, soldering paste and soldering salts. Chloride of zinc can be prepared at home while the others may be purchased at almost any drug or hardware store.

1. Chloride of zinc (often called cut acid) is the most commonly used of all fluxes. It is usually prepared by putting about 4 ounces of muriatic acid in an open glass dish. Into this drop small pieces of zinc scraps - a few at a time. Such scraps may be obtained by cutting up the outside of an old dry cell or fruit jar cover. When these scraps are dropped into the acid, it will boil violently. They should be added slowly until the boiling action stops. Water is then added but not more than would increase the volume by $\frac{1}{4}$. The mixture should then be strained through a cheese cloth and be kept in a glass bottle having a glass stopper or rubber cork.

   This work should be done out of doors or in a well ventilated room.

   Chloride of zinc may be used successfully on tin, iron, steel, enamel ware, copper or brass.

2. Muriatic acid (hydrochloric) may be used full strength or slightly diluted. It is the flux to use on galvanized iron or old zinc. For high quality soldering work on galvanized iron, it is important to remove all of the galvanizing around the area where soldering will be done.

3. Resin in powdered form may be used on copper, lead and tin. It works better on tin than does anything else.

4. Paste or prepared flux should be used as directed on the can. This type of flux is handy to use on wires because it can be applied with a match stick or toothpick if the job is quite small. It should be used sparingly.

Note: Acid flux or acid core solder should never be used on electric wires since corrosion, similar to that found on storage battery terminals, will result, and may eat the wire in two.

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Soldering

There are four main steps in soldering. These are --

1. Heating the soldering copper.

2. Cleaning the surfaces to be soldered.

3. Applying the correct flux to the cleaned surfaces.

4. Applying the solder with the heated copper.

The most common soldering jobs are listed here and with a little practice will be found to be easy tasks.

1. Soldering a small hole.

2. Soldering on a patch.

3. Sweating on a patch.

4. Soldering wire splices.

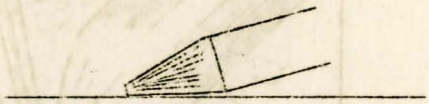
5. Repairing a split copper or brass tube.

The methods to use in each case are listed here.

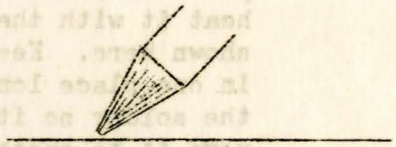
1. Soldering a small hole.

(a) Clean the surface around the hole.
(b) Apply the flux.
(c) Take a small amount of solder on the end of the copper and coat the cleaned surface around the hole.

The correct way to hold a soldering iron is shown here. It is important to have it in a position so that a large area is in contact with the work. It can be seen that such a position will allow more heat to be delivered to the work than when the copper is held at an incorrect angle.



Correct Angle - Large Area in Contact with Work



Incorrect Angle - Small Area in Contact with Work

It is very important that the metal around the hole be thoroughly heated so that the solder flows evenly and fills the hole. If the hole seems a little too large for the solder to flow across, it may be coaxed across easily if a piece of cloth is held tightly underneath the hole.

2. Soldering on a patch.

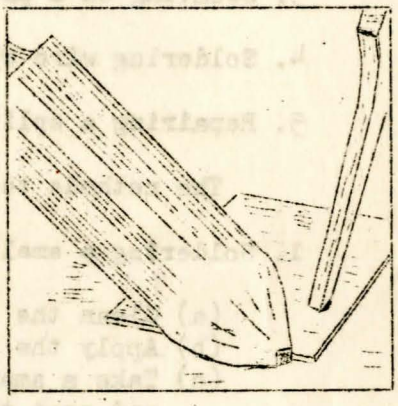
(a) Clean the surface around the hole.

(b) Cut a patch slightly larger than the hole.

(c) Clean the side of the patch which will be placed against the other metal.

(d) Apply a suitable flux to the cleaned surfaces - both around the hole and on the patch.

(e) Place the patch face down over the hole and hold in place with the tang or small end of a file.



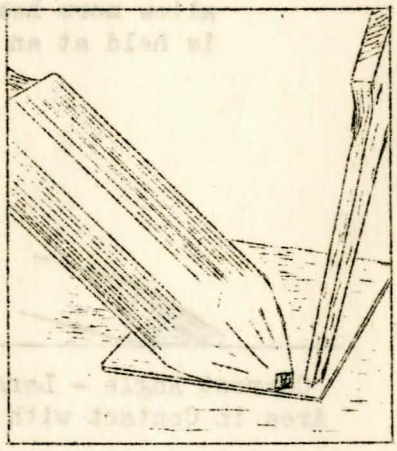
(f) Apply the solder to the copper, using only enough to assure a smooth job.

(g) Place soldering copper on the patch, hold in place until patch is warm enough to melt solder.

Note: In case the article containing the hole is old, it may be necessary to tin the surfaces around the hole before the patch is applied.

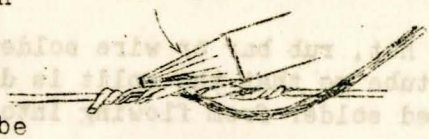
3. Sweating on a patch.

The procedure here is just the same as for soldering on a patch, except that all surfaces will be tinned and then placed face to face. Hold the patch in place with a file and heat it with the copper as shown here. Keep the copper in one place long enough to melt the solder so it will flow, then move it to another place on the patch. Do not move the file until the iron has been over the entire patch and the solder has cooled and hardened after the copper has been removed.

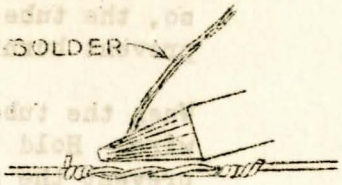


4. Soldering wire splices.

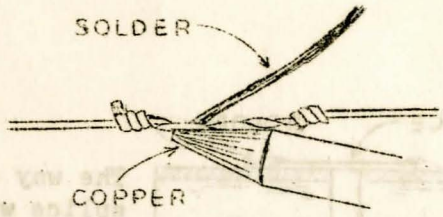
After the wire has been spliced a resin flux should be applied. Correct and incorrect ways of holding the solder and the copper are shown here.



Correct method of holding copper and solder



Wrong method of holding copper and solder.



This is also a correct method of holding the copper and solder because the solder will not melt until the wires are up to the correct temperature.

<u>Never Use Acid Flux or Acid-core Solder When Splicing Electric Wires.</u>

5. Repairing a split copper or brass tube.

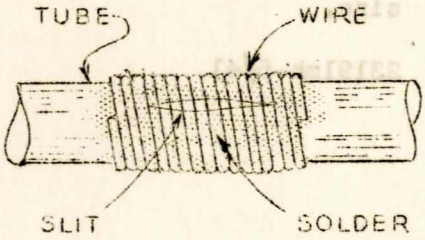
(a) Clean the surface of the pipe around the split. This may be done by filling, sandpapering or scraping.

(b) There are two ways of applying the solder depending upon the size of the split.

(1) If the split is very small, it probably can be repaired by applying flux to the cleaned area and then running solder over it with the heated copper.

(2) Should the split be of any appreciable size, it would be better to wrap some #18 or #20 bare copper wire around the tube and apply the solder on top of the wire. It is essential that both the tube and the wire be cleaned thoroughly before wrapping is started. The wire may be cleaned with sandpaper and the tube as indicated in (a). Since the wire wrapping should extend a slight distance beyond the ends of the split the tube must be cleaned an even greater distance to assure a good bond between the solder, the tube and the end of the wrapped wire.

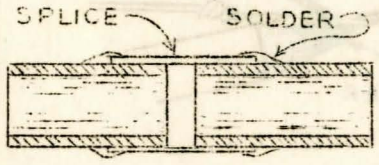
The tube should be tinned after it is cleaned and then the wire wrapped closely and tightly around it. The correct flux then should be applied to the surface of the wire.



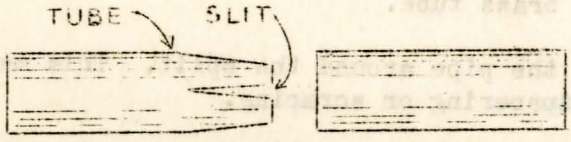
In order to get the wire and tube hot enough, it may have to be held in the flame of a blow torch. If so, the tube should be held with a pair of pliers to prevent burning the hands.

When the tube is hot, rub bar or wire solder over the wire. Hold the tube so that the split is down to prevent the melted solder from flowing into the tube.

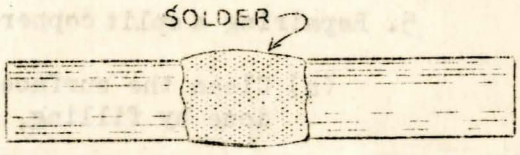
Note: Broken tubes or pipes may be repaired with splices or by so shaping the ends that one piece telescopes over the other. These two methods are shown here.



The way a tube repaired with a splice would look if you cut it in half.



The broken tube with the end of one piece filed and bent down to fit into the other piece.



The two pieces fitted together and solder run around the joint.

6. Enamel Ware: Remove enamel around hole so about $\frac{1}{4}$ inch metal is exposed. Clean metal, apply flux and solder.

7. Aluminum: Very seldom if ever can aluminum be soldered satisfactorily. Do not try it.

Soldering with a Storage Battery

Very satisfactory soldering work can be done by using a storage battery, a carbon pencil from an old dry cell or from a flashlight battery, some electric cord and four battery clips. A direct shorting of the battery heats the carbon pencil to a point where solder will melt very rapidly. This shorting results in a heavy current flow and, therefore, the best results will be obtained by the use of cord of sufficient size.

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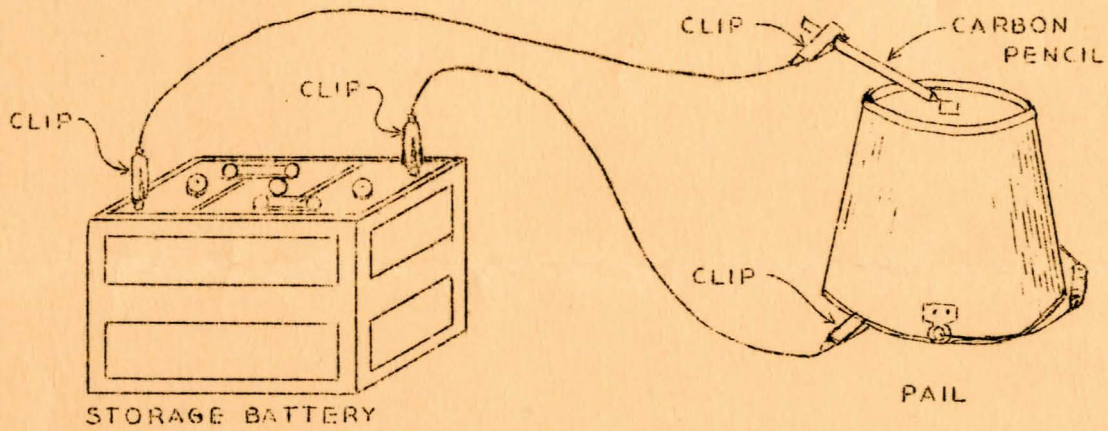
If it can be obtained, brewery cord is recommended for this use. It is flexible and has weather proof covering which makes it more desirable than ordinary lamp cord. Rubber covered cord, would, of course, be satisfactory but its initial cost would be greater than brewery cord. Two three-foot lengths of this brewery cord will be sufficient. They will allow enough reach for almost any type of soldering job attempted with this type of equipment. One battery clip should be attached to each end of each wire. If the wire is soldered to the clip, a much better connection will result than if it is merely twisted around the set-screw.

The carbon from the old dry cell is rather large and for some work it is unhandy to use. The carbon from a flashlight battery is about the size of an ordinary pencil and makes it possible to get into very small spaces.

The material to be soldered should be prepared in the same manner as when an ordinary soldering iron is to be used. Thorough cleaning and the application of the correct flux is always important and should never be overlooked.



After the material has been prepared, one cord should be attached to one terminal of the battery and another to the work as shown. One clip on the other cord is attached to the other terminal of the battery and the second clip is attached to the carbon pencil.

When the carbon pencil is applied to the article to be soldered, the battery is shorted and the flow of current heats the carbon pencil. When the solder is touched to the carbon pencil, it will melt and flow into place. If the solder is to be carried over a considerable area, the pencil should not be kept in contact with the article which is being soldered for too long a time. If prolonged contact is maintained, the pencil gets extremely hot and is rather hard to handle. It also causes an unnecessary drain on the battery and heats the metal of the article which is being soldered to a point where oxidation will occur.

If the article to be soldered is enamel ware, it is necessary to let the clip which is on the article itself come in contact with the base metal. It may be necessary to chip some of the enamel ware off of the iron in some spots so that this contact may be obtained.