

## THE CONSTRUCTION OF JOB SHEETS IN FARM FORGE SHOP

by

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## INTRODUCTION

This material is prepared to aid the teacher of Vocational Agriculture to do more efficient instruction in farm forge work and to be of help to members in the all day, part-time and evening classes in Vocational Agriculture throughout the state in performing the common repair jobs needed on the farm.

The jobs are arranged in a logical teaching order. No one job should be overlooked.

The farmer is not only a producer of agricultural products but he is, because of necessity, a farm mechanic. Every farmer has the problem of keeping the farm machinery in working condition. Many situations arise where the farmer will have to do various repair jobs or buy new equipment.

If there is money to spend, any farmer can go to the hardware store and buy new equipment, but fortunate and economical is the farmer who can also make new ones out of scrap iron. It is the latter type of farmer who invests his spare money, which he has saved through his own economy, to bridge the lean years that every farmer knows will be his visitor sooner or later. Teachers of Vocational Agriculture must have foresight and knowledge of this fact in order to prepare boys to make a success of their chosen vocation, that of farming.

Within recent years, the country blacksmiths have disappeared rapidly. The smiths are becoming old and unable to carry out the duties required of a blacksmith. It is quite evident that very few

young men today are following this trade. In many sections of the country a farmer is compelled to travel several miles to a blacksmith. Sometimes he travels ten to fifteen miles.

The average farmer can save many dollars by having his own repair shop and doing his own repair jobs. This would not be taking the work away from the blacksmith, because the blacksmiths are leaving the work to the farmers. By a thorough study of this book the farmer, agricultural instructor, or student can set up his shop and perform the needed jobs. This work, as well as any other work that requires practice to become skilled in, must be done carefully and performed several times before becoming efficient. The farmer can teach his hired help some of the fundamental skills and on rainy days or rough winter days the laborer could be employed. The amount of repair work that can be done on the farm by the use of a forge is unlimited.

Most people can take several pieces of lumber, a saw, hammer, and nails and make a box. But when one works with metal he must be familiar with the properties of the metals to be worked with, their reactions to heat and the use to be made of them. This cannot be done by merely guess work, but by a thorough study of the skills in forge work.

This matter of inventorying and surveying farm machinery, tools and equipment, and shop jobs cannot be over-emphasized, since farming is becoming more of a business each day. A successful farmer today needs to be as good a business man as a man who heads a factory. No good business man attempts to carry out his work without careful planning.

Agricultural Instructors should encourage students to bring to school scrap iron such as bolts, rings, rake teeth, old axles, Model-T magnets, and with these perform many useful jobs in the shop.

The amount of forge work to be done in a community will depend upon the type of farming being followed. For example, there would, in all probability, be more forge work done in a general farming area than in a cotton and tobacco section.

It is hoped that this material will aid in the establishment of more forge shops throughout the state, even if the shop at the beginning has only a few tools, and that every farmer and agricultural instructor will reap some benefit.

## PROCEDURE AND SOURCE OF INFORMATION

The author made a study of farm forge jobs that are most commonly taught, done, and needed in the school and on the average farm in Virginia. A list of these jobs was made and 48 of the most important jobs were selected. The jobs were arranged in what seemed to be a logical teaching order.

Job sheets which had previously been worked up in the Department of Vocational Education, which consisted mainly of wood working jobs, were studied in an effort to determine the best possible procedure to follow in working up a job in the farm forge work.

The technical information of this study was gotten from specialists in the Industrial and Agricultural Engineering Departments, skilled mechanics in private and public employment, literature available on forge work, and experience of the author.

This material was studied and assembled and illustrations made to accompany the procedures.

Practically all these jobs have been tried out by the author. To prove that the procedures and illustrations were correct, this information was checked by a specialist in farm forge, Industrial Engineering Department, V. P. I.

## INVENTORY AND SURVEY OF FARM MACHINERY

Job 1

Dollars upon dollars are lost annually on the farm. This is due chiefly to the putting off the repair jobs until time the machinery is to be used. For example; when the harvesting is through with the binder should be surveyed and all repair jobs listed. This should be done very soon after finishing with that piece of machinery in order that many of the repair jobs will not be forgotten. The repairing should come during the fall or winter at some spare time. For machinery and equipment that is being used continuously throughout the year, it would be practical to survey every month or so. As the saying goes, "A stitch in time saves nine", that is true on a farm if anywhere. For example; if a farmer takes his binder into the field and starts cutting wheat, after several hours work, a roller or canvas wears out, which was in need of repair at the end of last season. Suppose this farmer had four men shocking wheat and was paying them at the rate of 20 cents an hour, during the course of a day or two he would lose several dollars. Another example, suppose after the binder had cut several rounds, a wheel would wear out and it would be necessary that the piece be purchased from the factory. This may delay the cutting several days and in the meantime a storm would come and ruin the wheat. These are a couple of many instances that occur on many farms annually. The form given here is merely a suggestion, but has proven very useful. It is not as much the form as it is the making of the survey. Surveys



should be made several times during the year for the different kinds of machinery.

This form may be used by the student of Vocational Agriculture as well as the farmer. Several of the more important parts have been listed as an example. It is a very good idea to have the persons name who made the inventory and the date it was made. In the event the inventory was improperly made a definite check could be made on the individual at fault. There should be a surplus on hand of the parts that are broken quite frequently; such as shown in the last column, knives and guards for a mower. This would save much time in a busy season. Space should be left at the bottom for additional parts. In the event you need to know the name or serial number just refer to your files and look in the leaflet sent by the company.



### Inventory and Survey of Farm Machinery

This is a master key of important farm machinery and parts to be used when taking the inventory and survey of farm machinery.

<u>Machinery</u>	<u>Parts</u>
1. Mower	Knife; guard; ledger plates; clips; inner and outer shoe; grass board; Pitman; bearings; gears; pawls and springs; levers; hitch, etc.
2. Grain drill	Furrow opener - hoe boots, bearings. Feed mechanism - gears, chain wear, cups, wheels. Fertilizer attachment - drive, gears, drop, feed control. Hoppers; levers, wheel, and ratchet machinery, hitch, etc.
3. Hay rake	Teeth; wheels; levers; drive ratchet; hitch; rotating cylinder and bearings; gears and ratchet.
4. Plows	Mold board; share; landside; beam; handles; hitch; coulter; gage wheel; other accessories.
5. Feed mill	Grinding mechanism - plates, adjusting parts, spring tension, nut wear, hearings, feed gates, cob crusher, elevator or bagger. Power transmission - belt, worm, pulleys, etc.
6. Grain binder	Canvas - buckles, straps, slats, etc. Canvas roller alignment. Roller adjustment on platform canvas. Tying mechanism - needles, knotter, twine holder disc, binder attachment clutch. Timing of mechanism if repairs made; packers. Driving mechanism. Reel arm and slats. Sickle guards; ledger plates and knives.
7. Corn planter	Furrow openers - runner type for wear, runner type for bearings. Dropping mechanisms - worm gears, plate, clutch, check wire. Fertilizer attachment distributors. Wheel lubrication. Hitch.
8. Manure spreader	Runner gear - clean and lubricate, wheel pawls and ratchets, apron, apron drive, gears and ratchets. Spreading mechanism. Body Hitch
9. Wagon	Paint and grease on running gear. Bed or body. Bolsters. Coupling pole. Brake. Hitch.

Questions

1. When is the proper time to survey and inventory farm machinery?
2. Why should the survey be made.
3. Why is it advisable to have extra parts on hand?

## SURVEY OF FARM FORGE JOBS

Job 2

This survey pertains to metal work only. A similar form could be made for other jobs on the farm as well. A survey of these jobs should be done at various intervals throughout the year; however, there are certain seasonal jobs in which a definite time should be set in which to make the survey; for example, sharpening ensilage cutter blades, these should be sharpened well in advance of the time they are to be used, as well as other jobs. There may be numerous other jobs to be added to this list.

<u>Suggested Jobs</u>	<u>Need to be bought</u>	<u>Jobs need to be repaired</u>	<u>Time to be done</u>	<u>When done</u>
<u>1. Fuel for the forge</u>	X		May 1	
<u>2. Cold chisels</u>				
<u>3. Iron braces</u>				
<u>4. Fitting horse shoes</u>				
<u>5. Gate hooks and hinges</u>				
<u>6. Stove hooks</u>				
<u>7. Cutting threads, pipe, etc.</u>				
<u>8. Screw drivers</u>				
<u>9. Punches</u>				
<u>10. Sharpen plow shovels</u>		X	Mar. 1	
<u>11. Sharpen maddocks</u>		X	" "	
<u>12. Sharpen picks</u>		X	" "	

Suggested Jobs	Need to be bought	Jobs need to be repaired	Time to be done	When done
13. Sharpen digging irons		X	Mar.1	
14. Sharpen plow points				
15. Welding				
16. Open links				
17. Tongs				
18. Clevises				
19. Grinders				
20. Grindstone	X			
21. Single trees				
22. Tinning and glazing the forge				
23. Bailed hay hook				
24. Staple puller				
25. Repairing broken chains				
26. Riveting				
27. Sharpen knives				
28. Sharpen axes				
29. Sharpen ensilage cutter blades		X	Aug.1	
30. Sharpen mower knives		X	Aug.1	
31. Sharpen saws				
32. Sharpen butcher knives				

Questions

1. What are some of the seasonal shop jobs?
2. What are additional shop jobs that are not listed here?
3. Why should the time the job is to be completed be listed?

## INVENTORY AND SURVEY OF FORGE SHOP TOOLS AND EQUIPMENT

Job 3

It is just as essential that a survey and inventory be taken of the forge tools and equipment as any other equipment on the farm or in the school shop. Space should be left in the form for additional tools and equipment that one may possess. This inventory should be taken annually.

Tools & equip- ment in shop	No. on hand	Make	Value	Repairs needed	Add. tools needed	Cost	Date pur- chased or repaired
<u>I. Fire tools</u>							
1. Poker							
2. Rake							
3. Shovel							
4. Dipper or Sprinkler							
<u>II. Tongs</u>							
1. Straight lipped							
2. Link							
3. Hollow bit							
4. Pick up							
5. Parrallel Jawed							
<u>III. Hammers</u>							
1. Cross peen							
2. Ball peen							
3. Sledge							
<u>IV. Chisels</u>							
1. Hot chisel with handle							
2. Cold chisel							
3. Cold cutter							
<u>V. Punches</u>							
1. Center							
2. Drift							



Tools & equip- ment in shop	No. on hand	Make	Value	Repairs needed	Add. tools Needed	Cost	Date pur- chased or repaired
<u>VI. Others, Not Mentioned</u>							
1. Hardie							
2. Heading tool							
3. Fuller top and bottom							
4. Swage top and bottom							
5. Flatter							
6. Swage block							
<u>VII. Major Equipment</u>							
1. Anvil, factory made							
2. Anvil, home made							
3. Vise							
4. Drill, hand							
5. Drill, power							
6. Grinder, hand							
7. Grinder, power							
8. Grindstone							
9. Stock							
10. Dies sizes							
11. Mandrel ring							
12. Water tub							
<u>VIII. Minor Equipment</u>							
1. Steel square							
2. Caliper rule							
3. Metal files							
4. Sandpaper							
5. Emery paper							
6. Welding flux or borax							
7. Goggles							
8. Hack saw							
9. Grinding wheel dresser							
10. Pipe wrenches							
11. Monkey wrench							
12. Metals							
13. Steel							
14. Iron							

Questions

1. Why is it essential that an inventory be made of the forge tools and equipment?
2. When should this inventory be taken?
3. What are some additional tools that could be added to this list?

## FILING SYSTEM

Job 4

Every farm should have some form of a filing system along with its bookkeeping. When a piece of machinery is purchased the name of equipment, date purchased, whether second-hand or new, cost and the condition, and from whom it was purchased, should be filed.

If the machinery is new the company generally sends a leaflet with it. This shows the different parts and their serial numbers. In case a purchase of a second-hand piece of machinery is made, one can write to the company and they will gladly send you the leaflet containing the serial numbers, parts, etc. This will aid a person in purchasing the desired part of the machinery. Any filing system that is suitable to the individual is good. It is not so much the filing system as the matter of keeping records. The form given is very useful.

For example:

Name of Equipment	<u>Hay rake (2 horse)</u>
Date purchased	<u>April 2, 1940</u>
Second-hand	<u>X</u>
New	<u></u>
Cost	<u>\$27.00</u>
Condition	<u>Good</u>
Purchased from	<u>John Doe</u>

## FORGES

### Job 5

There are various types of forges found throughout the country. Some are made of brick and concrete and others are the various types of factory made. Since the home-made forge is quite practical, a separate job will be given to the building of one. The forge is the most essential part of the blacksmith's equipment. The kind of forge used will depend upon the amount of work done, kind of work done, amount of money available to purchase one with, and the desire of the individual.

The principal parts of the forge are blower and the tuyere; that is, when the tuyere and fire pot are considered as one. Blowers are operated by hand or electric power. Some forges have the down draft system, which is found chiefly in schools or shops where a large number of forges are being used. For the average school and farm shop it is not advisable to use such. A 12" to 14" fan is sufficient for the average blower. The tuyere is that part of the forge through which the blast is conducted from the blower to the fire pot. Since it is attached at the bottom of the fire pan, it serves as a grate as well as an air duct. Most of the tuyeres are combined with the fire pan. It is very essential that a good size fire pan be used, especially if any heavy work is being done. For the school and farm shop a 14" long, 12" wide and about 5" deep fire pan is sufficient. Regardless of the type of forge used it is always advisable to line and glaze the fire pot.



Although several different types of forges will be shown, it seems only practical that a school shop be equipped with a hand blower, since the farm shop would, in all probability, be equipped with the hand blower.

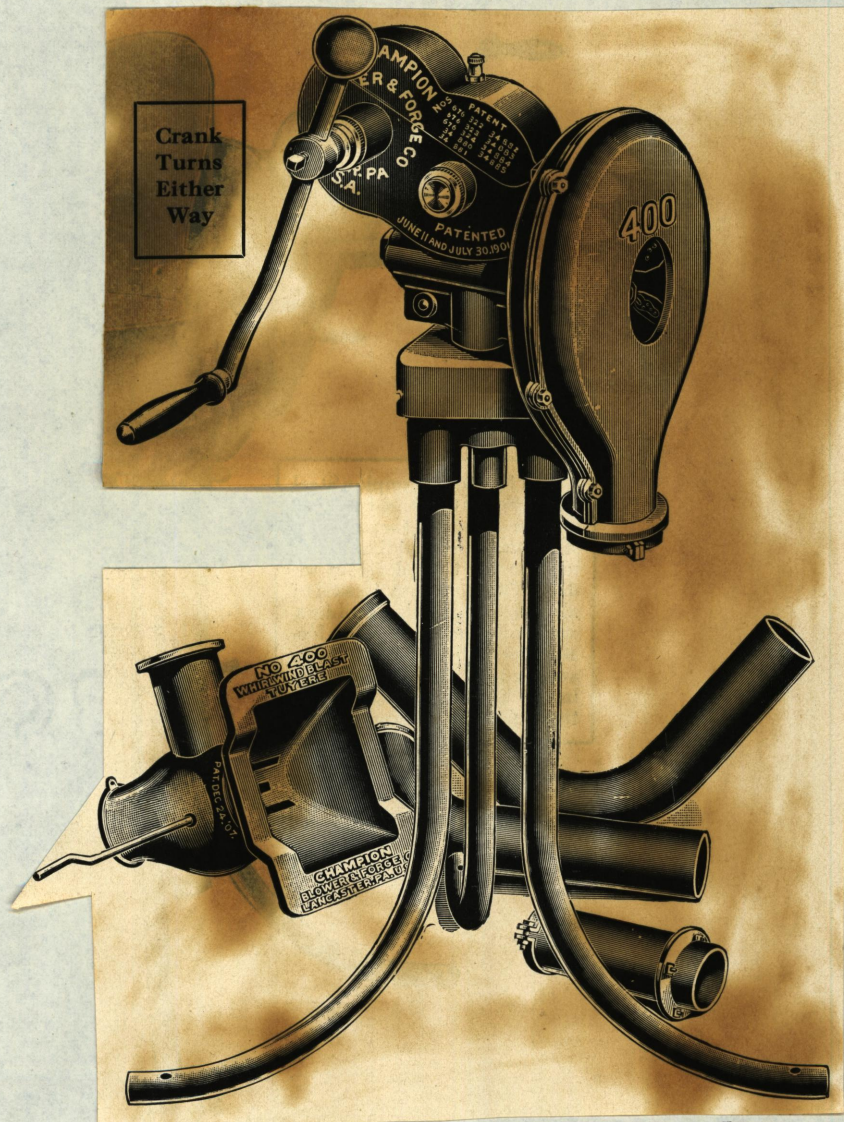


Figure No. 1



Figure 1 gives a clear picture of the blower and tuyere. These two essential parts are sufficient in the building of a home-made forge. The blower is generally located close to the forge in order that the blacksmith may turn the blower while handling the irons in the fire. The blower may be on a stand as shown, or may be fastened to a bench. In the majority of shops the blower is on a stand similar to this one. This tuyere iron is excellent, since it is supplied with a revolving pick to remove the clinkers out of the side slots; therefore, the slots can always be kept open without disturbing the fire from the top.

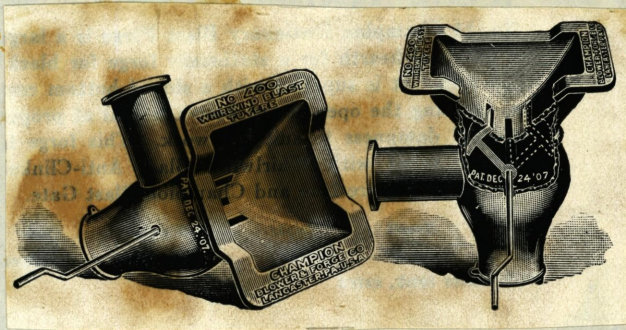


Figure No. 2

Figure 2 gives a good view of the tuyere. This tuyere is called the anti-clinker, because it is supplied with a revolving pick that removes the clinkers out of the side slots. This type of tuyere produces a circular blast rather than a straight up blast.



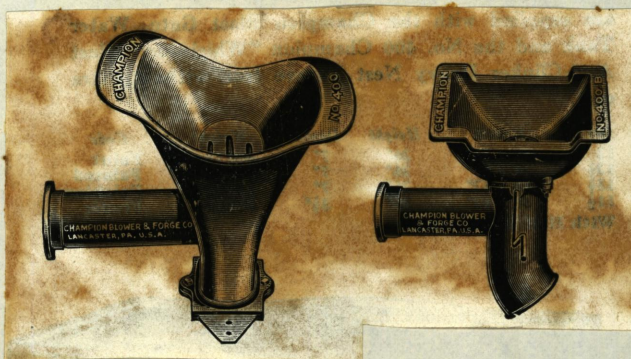


Figure No. 3

Figure 3 shows two different shaped tuyere irons. Both are very desirable.

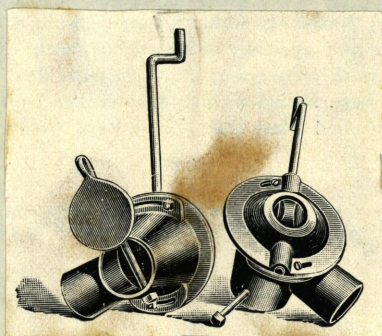


Figure No. 4

This tuyere iron does not have the anti-clinker but is very useful.



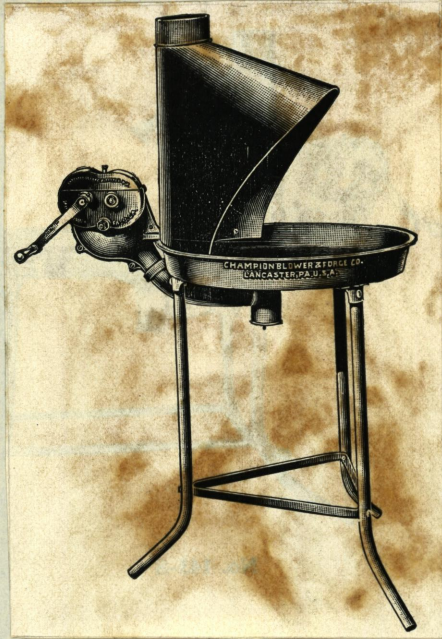


Figure No. 5

Figure No. 5 is a forge used in light to medium work. Where the portability is desirable, such a forge would be useful. The hood equipped for the attachment of a pipe for a flue is very desirable. A forge this light is not desirable for the school shop. In the farm shop where heavy work is being done, such a forge would be too light.



Figure No. 6

Figure No. 6 is not equipped with a hood, and would need to be used chiefly where the smoke would not interfere with other equipment. A hood could be placed over No. 6. No. 5, and No. 6 are not roomy enough to handle big pieces of stock.



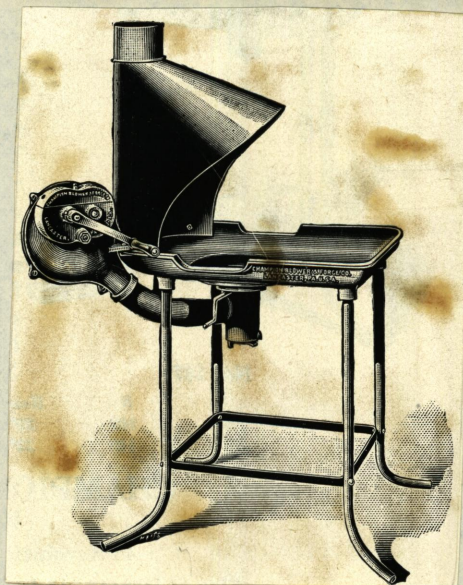


Figure No. 7

Figure No. 7 is a desirable forge for general use. It has a desirable size fire pot and also has room enough for green coal to be kept for ready use. Larger work can be done in this type than in No. 5 or No. 6.



Figure No. 3

Figure No. 3 lacks the deep fire pot that is essential in a forge where much work is being done. The deep fire pan enables one to build a deep fire.





Figure No. 9

This forge is very desirable where the down draft and the power blast is used. By having the coal box on one side of the fire pot and the water tank on the other, this makes the work very handy. Heavy work can be done in this forge.



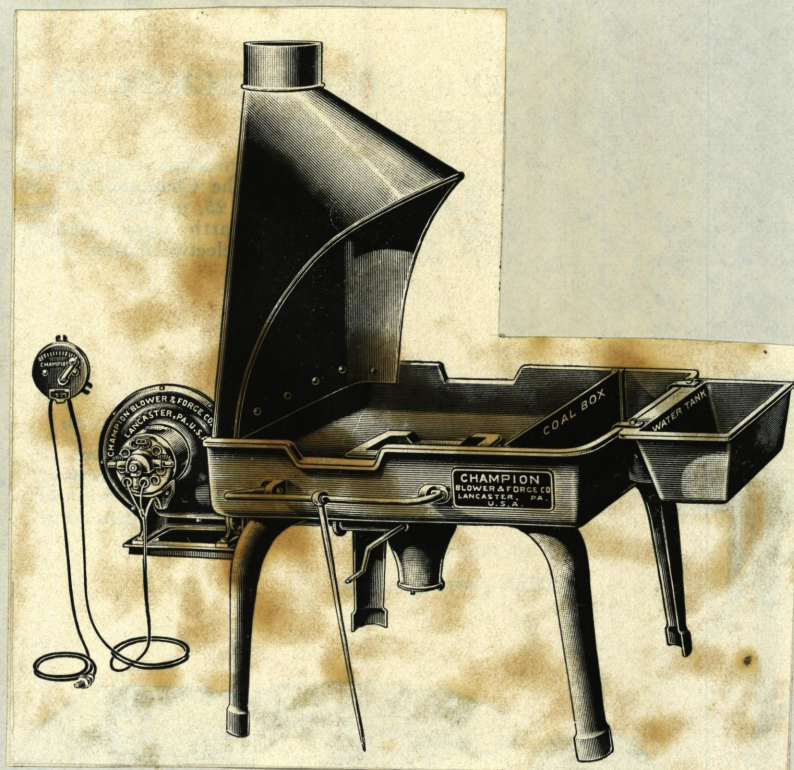


Figure No. 10

This gives the electric blower, which has its advantages over the hand blower, but in the school and farm shop this is seldom found. It is built for heavy work and has the coal box and water tank very handy.





Figure No. 11

Where the force blast and down draft system is used, this is an ideal forge for two workers. The water tank is placed between the two workers. The water tank is placed between the two and the coal box on each individual one.

It must be remembered that these forges are rather expensive. For the person who has much forge work to do and has very little money to invest, it is advisable for him to buy the blower and tuyere and build a home-made forge.

### Questions

1. What is the chief disadvantage of No. 5 for a school shop?
2. Which is recommended, the hand or power blower?
3. Why should the fire pot be large?

### References

Champion Blower Company



## BUILDING A HOME-MADE FORGE

Job 6

Since factory made forges are rather expensive, it seems highly important that some space be given to the making of a home-made forge. In spite of the forge being called home-made, there are two important parts which must be purchased; the blower and the tuyere, when the tuyere and fire pan are considered as one. The blower and tuyere are described in the job on "Selecting A Forge."

The forge may be made from concrete or brick material, depending upon the desire of the individual. If made of brick the top should be gone over with cement. The height should be 2'6". This again would depend upon the individual, or individuals doing forge work. A tall man would generally need a higher forge than a short man.

As for the arrangement of the top, some persons prefer having a coal box built in on the right side of the fire pan, and a water tank built in on the left side. The drawings given in this plan provide for a coal box. If you follow this plan and decide to build in a water tank, simply extend the width on the left side of the fire pan. In the event one is pinched for space, the fire box and water tank both could be left off. There should be space enough, however, to lay the tools on while performing a job.

A piece of flat iron can be attached in front near the top edge, on which to hang tools. This is a distinct asset to the forge worker.

It enables him to have the tools out of the way while not in use, instead of having them lying around in his way.

This plan is one of concrete. Whether it be of concrete or brick, care must be exercised in seeing that the blower and tuyere are built in properly. The success of the forge work will depend largely upon the blower and tuyere.

This plan also shows the hood and pipe outlet instead of the brick chimney. This hood and pipe system is becoming very popular in many high schools throughout this state. This has an advantage over the chimney in that the forge can be built out from the wall, which provides more room to work.

If the chimney type of outlet is used make sure that ample room is left on both sides of the fire pan to work with long pieces of stock. Where a chimney is used, it is advisable to have a small hood extending out over the fire pan.

#### Points to Keep in Mind While Building a Forge

1. Understand thoroughly the blueprint.
2. Decide definitely about the advisability of building in the coal box and water tank.
3. Decide whether or not you want a 3" curb on the three sides.  
Many forges are being built without this curb.
4. Get proper height.
5. Bolt legs of blower to the floor.
6. Provide ample space to remove ashes.

7. Build in the blower and tuyere properly.
8. Make sure the pipe for the outlet is large enough to draw well.

### Procedures

1. Construct a 4" concrete wall. Leave an opening 9" wide through which to remove the ashes. Leave an opening 6" x 8" or larger in the left side through which to attach pipe from blower. A piece of flat iron can be attached in front on which to hang tools. Exercise care in removing inside forms.
2. After forms have been stripped, construct a brick support for the iron hearth and set it in place. Place corrugated pasteboard around hearth to allow for expansion. About 50 bricks will be required.
3. Fill space around hearth support with broken stone, old bricks or sand up to within 7" of the top, tamp well. Pour a bottom for the fuel box, and set forms for it in place.
4. Finish filling space with concrete, forming top of structure. Build curb around three sides of top 4" wide and 3" high. The legs of the blower should set on concrete blocks in which bolts have been embedded. This should be done where they cannot be bolted to the concrete floor. The roof jack, pipe and hood for the smoke outlet should be made of heavy galvanized iron #22 gauge. Five bags of cement should be sufficient using 1:2½:5 mix. Brick may be used instead of concrete except for the top.



### Questions

1. Why is it advisable to keep the forge out of the corner?
2. Which material would you prefer in making your forge from, concrete or brick? Why?
3. Would it be necessary to use a hood to extend over the fire pan, when a chimney is used? Why?

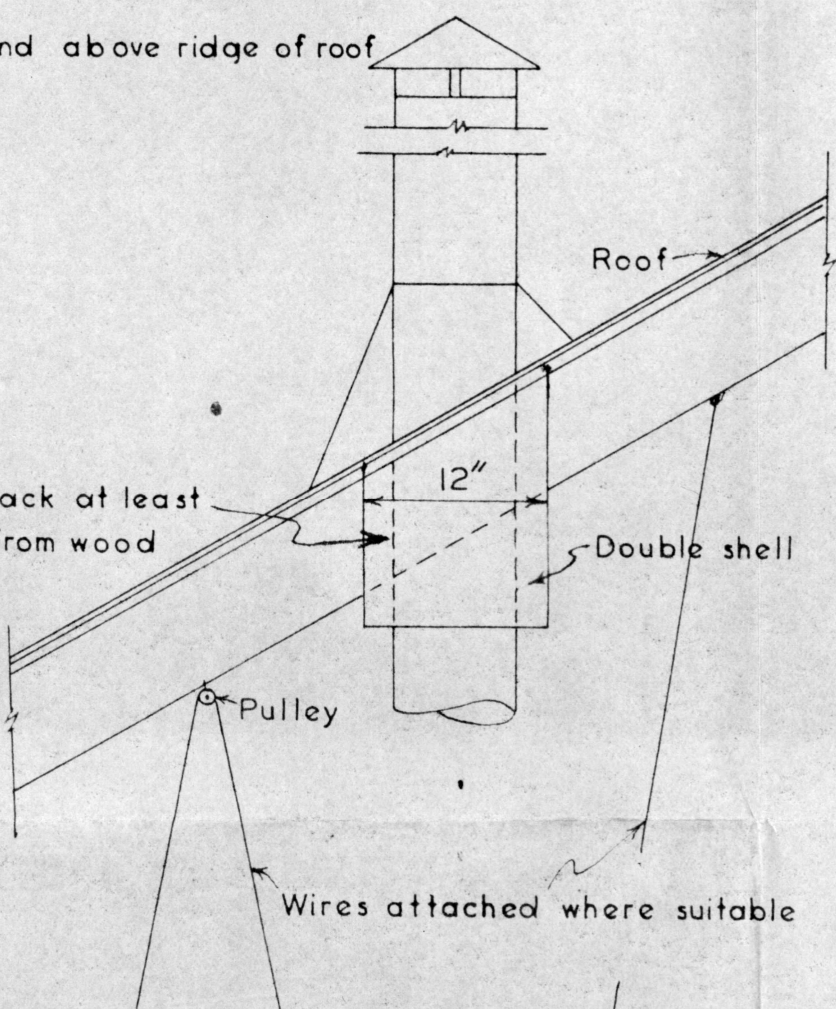
### Reference

Drawings furnished by State Department of Education.

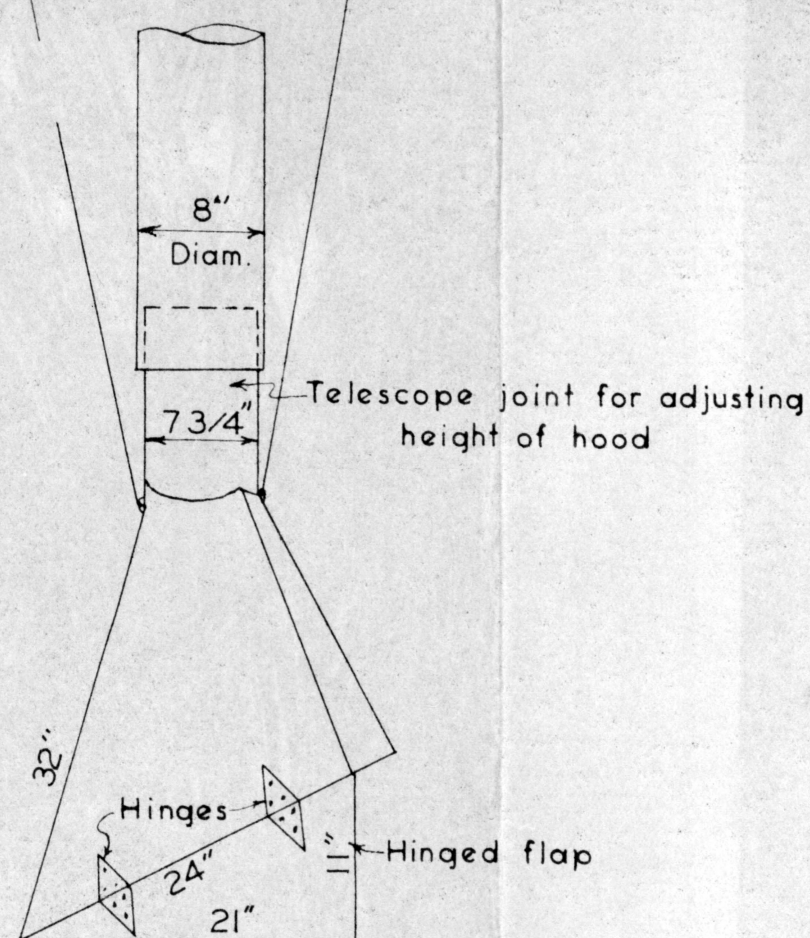


Top to extend above ridge of roof

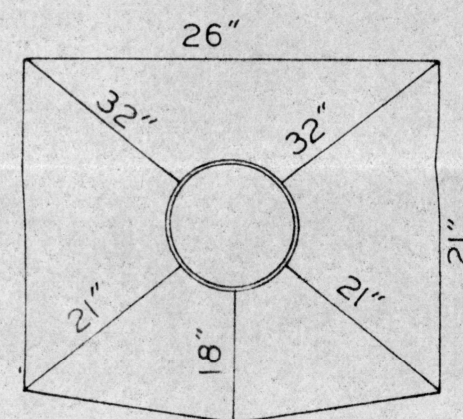
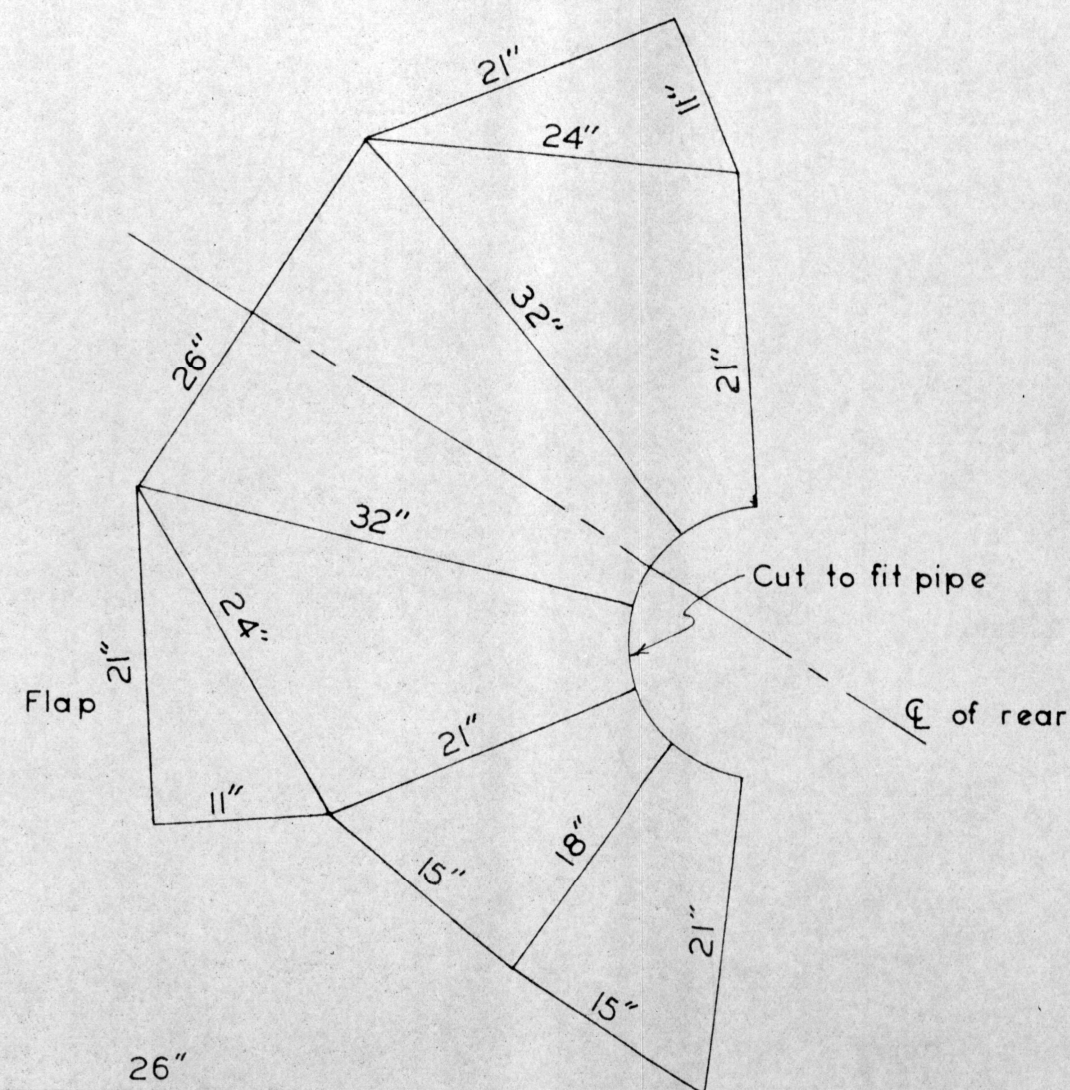
Keep stack at least  
3" away from wood



Wires attached where suitable

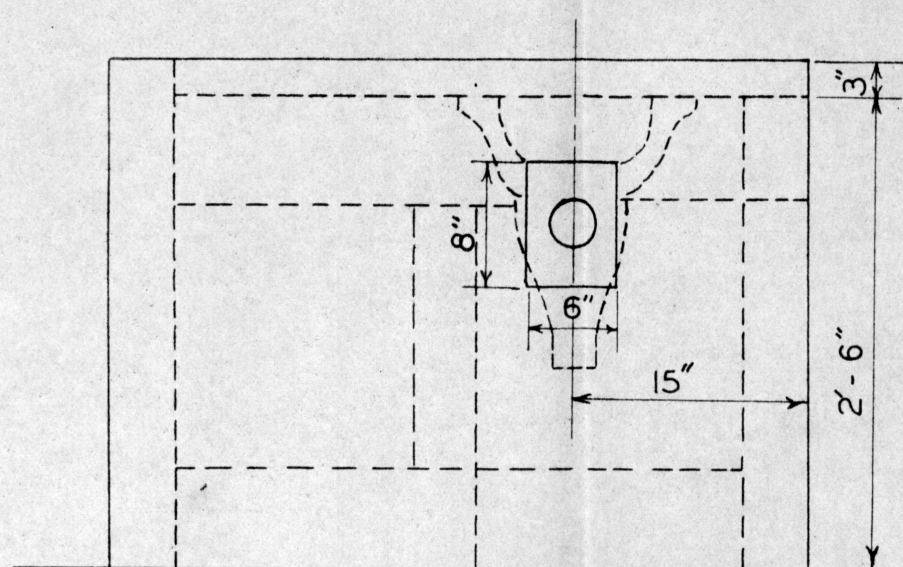


LEFT SIDE VIEW OF HOOD AND PIPE

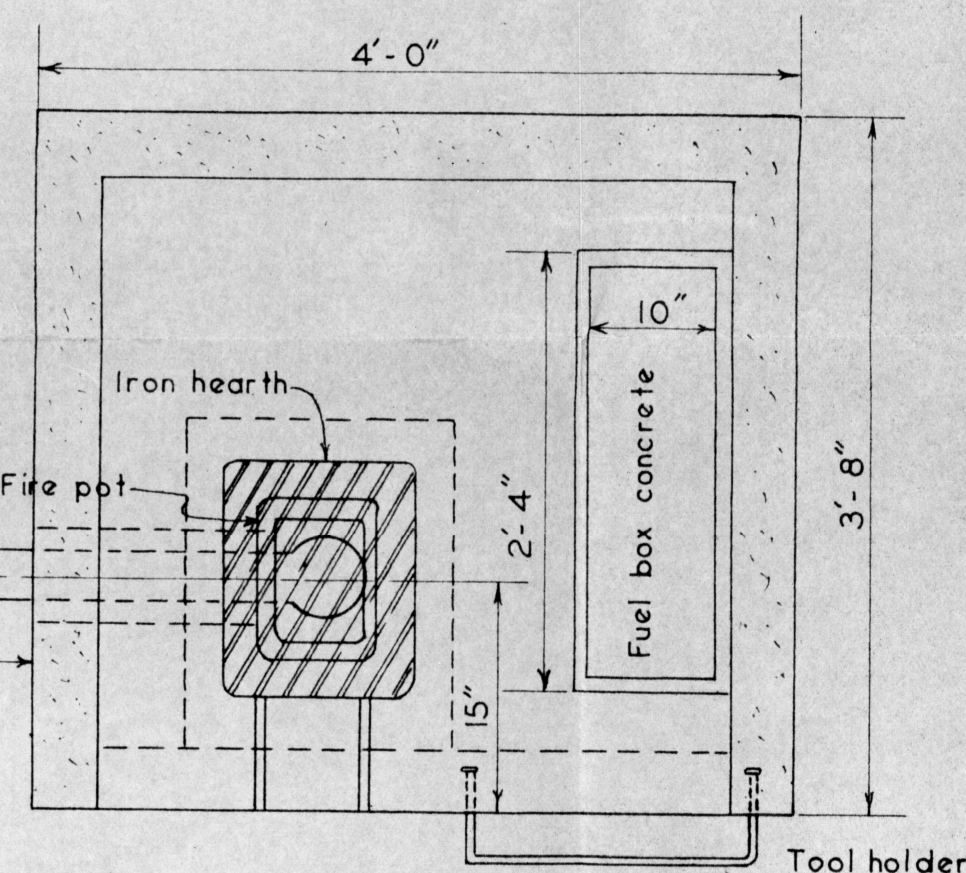
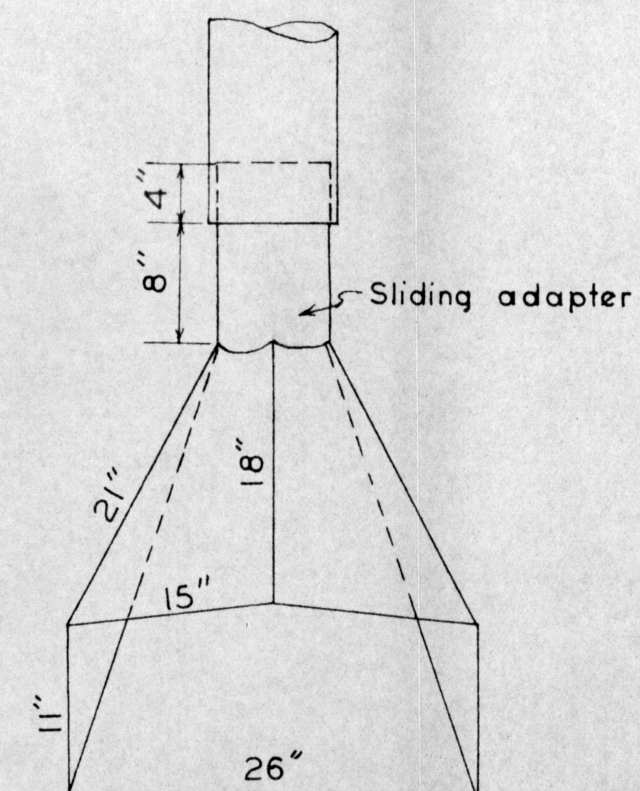


PLAN OF HOOD

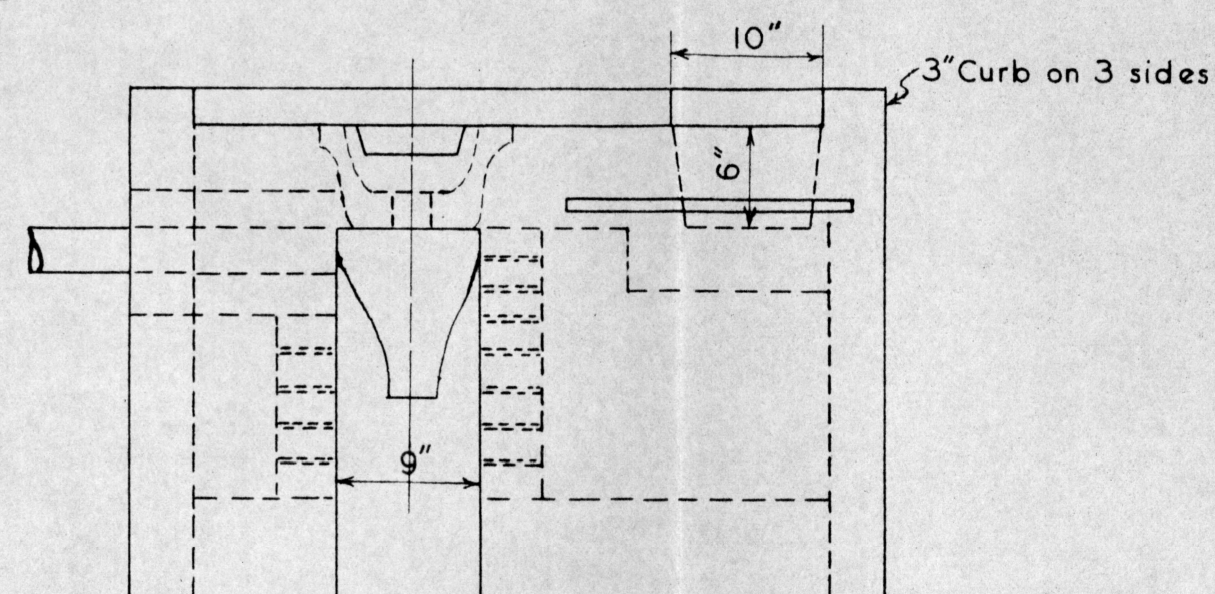
CHAMPION BLOWER  
NO. 400



LEFT SIDE VIEW



TOP VIEW



FRONT VIEW

Scale: 1" = 1'-0"



## LINING AND GLAZING THE FORGE

### Job 7

The metal in fire bowls will burn out in time, but when properly lined and glazed will last indefinitely. This job can be done with very little labor and cost. The forge is expensive enough that we cannot afford to permit the fire bowls to burn out due to the neglect of lining and glazing. Forges should be lined and glazed each year, depending upon the use of the forge and the condition of the lining.

Tools - Small platform or box to mix the materials in, fire shovel, poker.

Materials - Fire clay, cast iron turnings, common salt, sal ammoniac, wood shavings, fire cinders, burnt sand.

### Operation 1. Mixing Lining Materials

#### 1. Mixtures

- A. 20 parts clay (fire clay is preferred but is rather expensive.

20 parts cast iron turnings.

1/2 part sal ammoniac

This makes a good lining material:

- B. 20 parts clay (fire clay is preferred but is rather expensive.

20 parts burnt sand or fire cinders.

1/2 part sal ammoniac.

Notice that two substitutions may be made for iron turnings, depending upon the available material.

C. Clay is very good, but it has a tendency to crack if used by itself.

2. Enough water should be added to the above mixtures to make a plastic mass. The water should be worked in well. The mixture should be pliable enough to work easily without crumbling.

### Operation 2. Applying the Lining

1. Mix clay and water into a liquid solution. If the bowl has been lined before, remove all loose material and wash bowl with the liquid solution, then apply lining.

2. Apply the lining to the fire bowl with the hands. Use the hands to shape the mass over the fire pan. The thickness will depend upon the type of fire bowl.

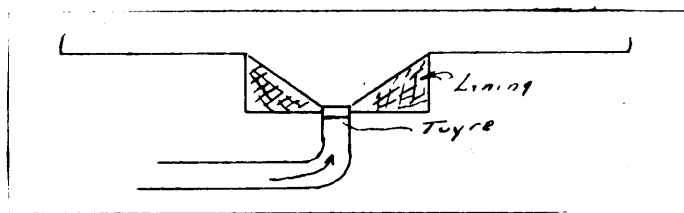


Figure No. 1

In Figure 1, the bowl should be rounded. Therefore, more lining would be required for Figure 1.

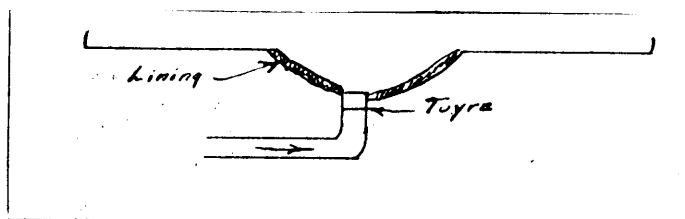


Figure No. 2

In Figure 2 the pan is rounded and requires less. But in either type of pan attempt to make the lining about 2 inches thick.

### Operation 3. Glazing the Fire Bowl

Materials - common salt, or graphite.

1. Lining should be permitted to dry three to four hours, and, if possible, one day before being glazed.
2. Sprinkle salt on lining or whitewash with graphite solution.
3. Use shavings and start a small, slow fire.

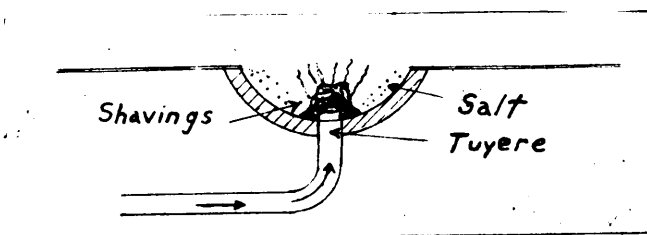


Figure No. 3

4. There is a danger of cracking the lining if heated too rapidly.
5. Bake the lining thoroughly.
6. After being thoroughly glazed, you may build the forge fire.
7. Graphite may be made into a whitewash and applied to the lining then heated as the above operation. However, many use salt in preference to graphite since it is very economical and is generally at hand.

### Questions

1. Why line the fire bowl of a forge?
2. What will result if you heat the lining too fast while glazing?
3. Why shouldn't clay be used by itself as a lining for the forge?
4. When do you apply salt in this job?

### References

1. "Repairing Farm Machinery and Equipment" - G. H. Radebaugh.
2. Individuals in Industrial Engineering Department.

## BUILDING A HOME-MADE ANVIL

Job 8

There is a necessity for an anvil in every farm shop. The cost of purchasing a factory made anvil is sometimes prohibitive on a farm. This home-made anvil can be made at a very low cost. On many occasions in the school shop there is a demand for several anvils. This could be taken care of by building a home-made one. Also this anvil can be moved to various places in the shop. The one shown in the drawing is made from a piece of railroad rail, so arranged on the frame work that either side of the rail may be placed up. (Figure 2) This is more advantageous than placing the rail on a large block. By being placed on the form, this provides more room to work around, and also allows the narrow edge to be placed up to do bending if necessary. Many times one can obtain these rails at a railroad station. The matter of cutting the rail and building the anvil is very simple.

Tools and Equipment - Claw hammer, nails, screws, wood saw, steel square, fine chicken wire, steel brace and bit, wood brace and bit, cold cutter, sledge hammer.

Materials - Rail, lumber, bolts, scrap iron, water.

Operation 1. Determining the Length  
of Anvil.

---

1. The length will depend upon the individual's own desire.
2. The one in the drawing is 30".

3. It is advisable to choose one of medium length, in order that it will not be bundlesome in the event you desire to move it.

#### Operation 2. Cutting the Rail

1. Take a cold cutter and sledge hammer and mark or chip all the way around, where you want to cut.

2. Pour water on markings.

3. Turn face of rail up.

4. Place cold cutter on face of rail at the mark and hammer with sledge hammer.

5. If this fails to break the rail, place a prize toward end of rail that piece is to be cut from and be sure to put a solid block directly under the mark of the rail.

6. Hammer the cold cutter while pressure is exerted on the prize. This should break the rail very easily.

7. You may just mark with cold cutter and sledge hammer, pour water on the markings, and pick up one or both ends and let it fall on ground, it should break with the fall.

#### Operation 3. Bill of Material

1. 2 - 2" x 8" x 32"

2. 4 - 1" x 8" x 24"

3. 1 - Railroad rail 30"

4. 1 - Round headed machine bolt 6"

5. 2- Strap iron  $1\frac{1}{2}$ " x 6"

6. 4 - Bolts, tap and washers, 3"



7. 1 - Piece of fine mesh chicken wire 24" x 32" or wood to cover same place.

8. 12 - 10 d nails.

9. 16- Screws 2" long.

10. Small piece of material to hold chisels, punches, rule, file and header, and steel square.

This bill of material is one of the many you may use. For instance, you may use 2" x 10" x 30" for upright pieces if you so desire and change other material accordingly. Any kind of lumber will be sufficient for this anvil, depending entirely upon the kind you have at hand. Strap iron is suggested, but if you do not have it at hand, build your anvil accordingly.

#### Operation 4. Preparing the Rail

This deals entirely with the matter of drilling holes in the rail, for the use in punching holes or in riveting. There may be other uses made of them, these being the main ones. The number of holes will depend entirely upon the desire of the individual making the anvil. For general purposes, two punching holes of different sizes are sufficient, with two or three counter sunk depressions for the use in riveting.

#### Operation 5. Building the Anvil

In general, the drawing should clarify most of the situation, however, there are several points that should be called to your attention.

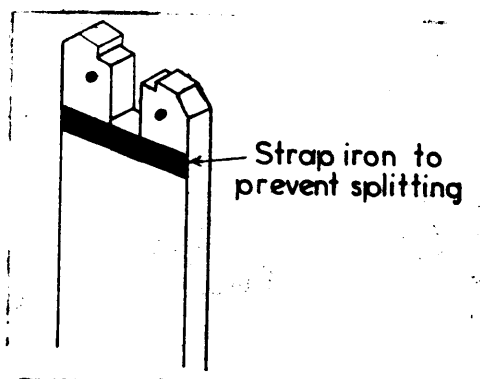
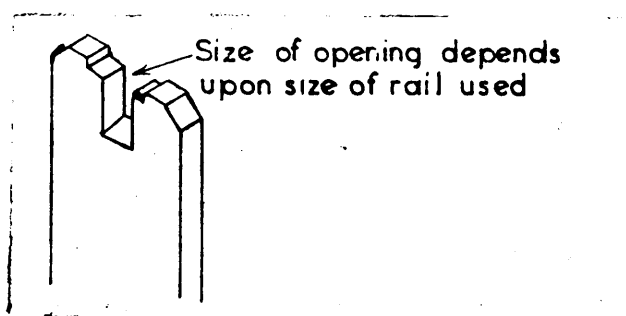
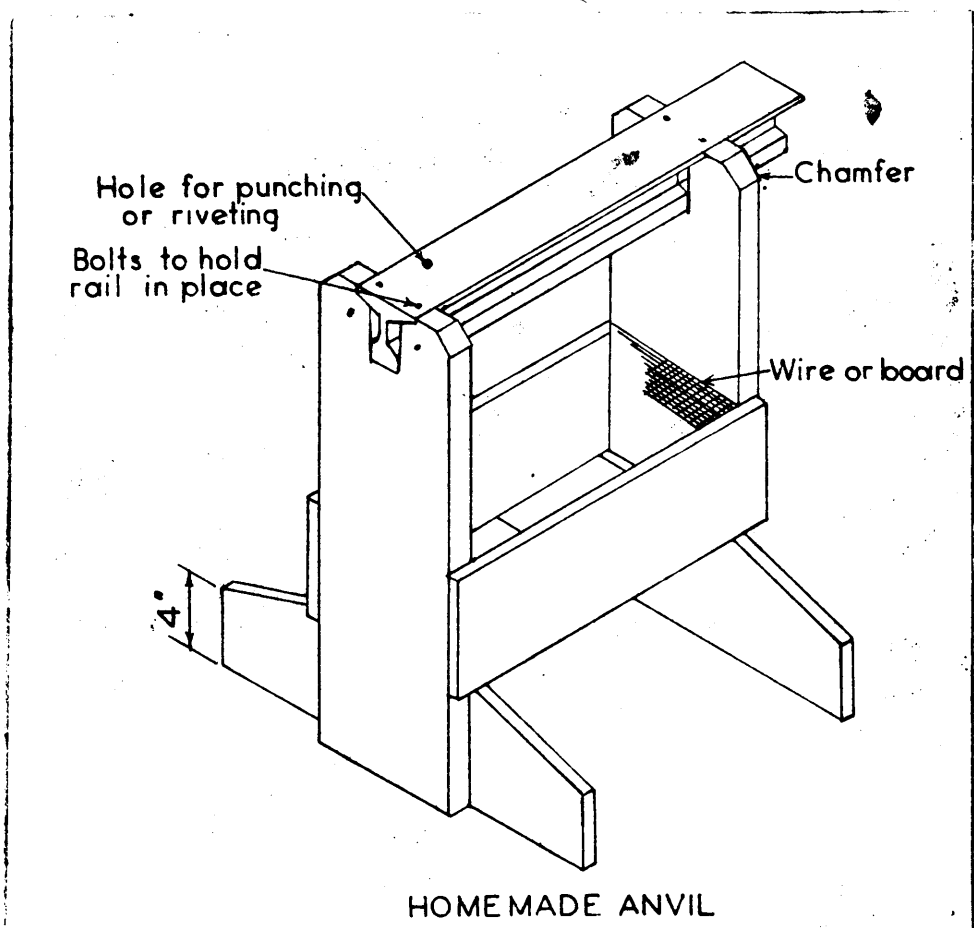
1. When deciding upon the length of cross pieces, always have in mind the length of the rail, since it is advisable to have the rail extending beyond the end of the frame. This makes the anvil much handier for doing much of the ordinary work.

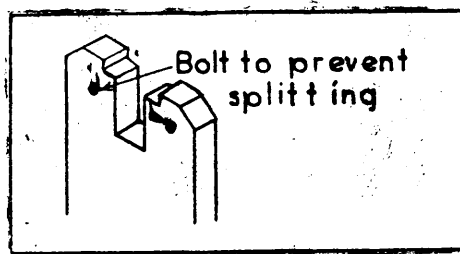
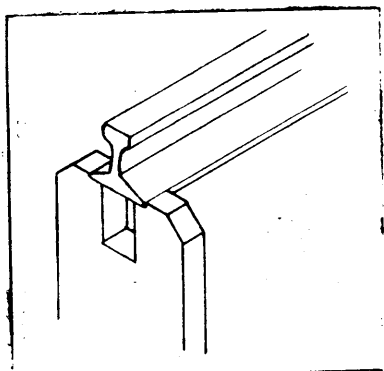
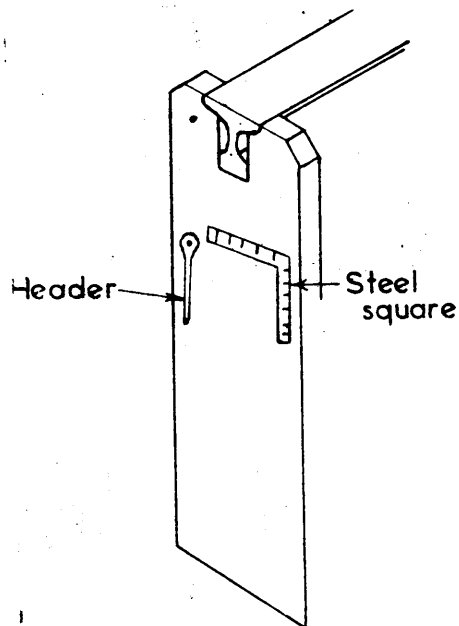
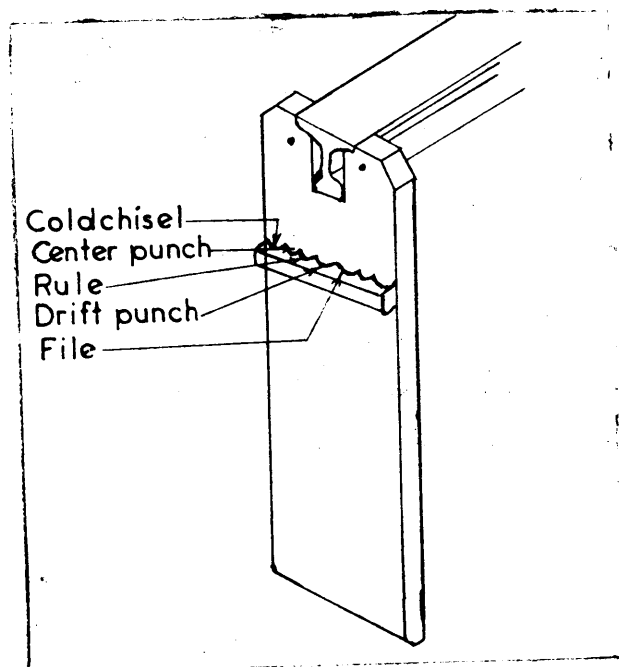
2. Where screws are available it is desirable to use them instead of nails, as the screws would make it more stationary; however, nails are sufficient.

3. Tools can be easily placed on each end of the frame, which will not interfere with the work and will make them very handy. (Figures 3 and 7).

4. Always chamfer the top end of the upright pieces, as it will make the working much easier. (Figure 1).

5. It is suggested that wire or boards be used as shown in Figure 1. There may be times when you would need to lay some of your work or tools in it temporarily.





### Questions

1. What is an advisable length for the face of the anvil?
2. What metal is the anvil made from?
3. Can the anvil be moved about in the shop?
4. What advantages are there in having an anvil like this?
5. What use can be made of the holes that are in the face of the anvil?

### References

1. "Farm Mechanics" - Mississippi Agricultural Experiment Station.
2. "Farmers Shop Book" - Roehl.

## TOOLS AND THEIR USES

### Job 9

Every person who works in forge has need at various times for certain tools. The number and kind of tools depends entirely upon the nature of the work. The majority of the blacksmiths work is done with the same tools. I have listed a major portion of the tools used in a forge shop. However, those listed will take care of the majority of forge jobs done on the average farm and in the school.

It is highly important that one familiarizes himself with the various tools and their uses before attempting a job. It is not so much the number of tools that counts in the production of work of a high quality as it is the ability and skill of the workman. The number of tools used by a blacksmith are small compared with those used by a mechanic.

In case of doubt about the use of certain tools the student or individual should study carefully the uses mentioned. It is far better, therefore, to learn a few things thoroughly than to learn many in a slipshod manner and to be unable to use them later when they are needed.

### Forge Tools

#### A. Fire Tools.

Figure 1. Poker.

Figure 2. Rake.

Figure 3. Shovel.

Figure 4. Dipper or sprinkler.

B. Tongs.

Figure 5. Proper and improper use of tongs.

Figure 6. Straight lipped.

Figure 7. Pick up.

Figure 8. Hollow bit or bolt.

Figure 9. Pick up tongs.

Figure 10. Parallel jawed.

C. Hammers.

Figure 11. Cross-peen hammer

Figure 12. Straight peen

Figure 13. Ball-peen hammer

Figure 14. Sledge hammer.

D. Chisels.

Figure 15. Hot chisel with handle.

Figure 16. Cold chisel.

Figure 17. Cold cutter.

E. Punches.

Figure 18. Center punch.

Figure 19. Drift punch.

F. Other tools not classified above.

Figure 20. Hardie.

Figure 21. Heading tool.

Figure 22. Fuller top and bottom.

Figure 23. Swage top and bottom.

Figure 24. Flatter.

Figure 25. Swage block.

A. Fire Tools. Fire tools are used in connection with the forge. An individual can easily make his own fire tools after studying some of the more fundamental jobs of forge. He can also substitute a tin can with holes punched in the bottom for a dipper. The use is listed with each tool.

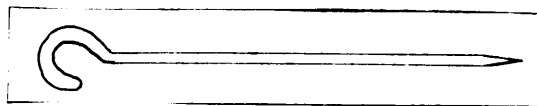


Figure 1. Poker used to clean the coal and adjust the fire.

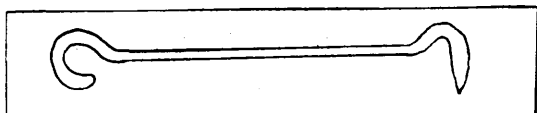


Figure 2. Rake - remove the clinkers and slag and build up fire.

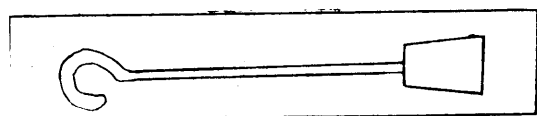


Figure 3. Shovel.

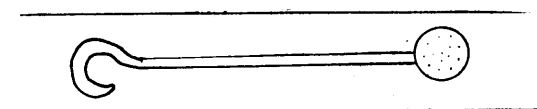


Figure 4. Sprinkle edges of the fire.



B. Tongs. - Tongs are used to hold the stock upon the anvil while being forged. They are also used in placing the stock in the fire and in removing it from the fire. The kind of tongs used will vary with the size and shape of the stock. Blacksmiths may have as many as 25 or 30, but for the average jobs done on the farm only a few would be necessary. The flat lipped and bolt tongs are the basic ones. Flat lipped are used chiefly in holding flat or square stock, while the bolt tongs are used in holding cylindrical stock. The size of the throat will determine the size of stock to be used with those particular tongs, as the jaws must fit parallel to the stock. Since a wide variety of tongs cannot be purchased, it is advisable for the forge worker to heat the throat of the tongs to a cherry red and fit them according to the stock being worked with.

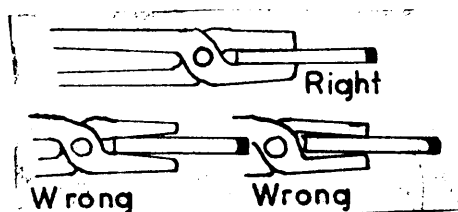


Figure 5. Proper and improper use of tongs.

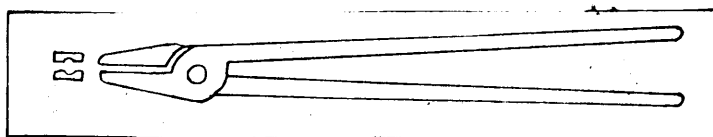


Figure 6. Straight lipped.

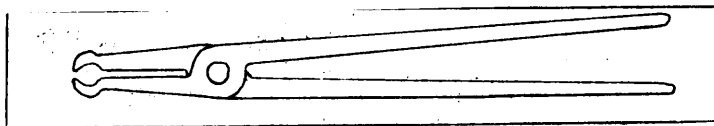


Figure 7. Pick up.

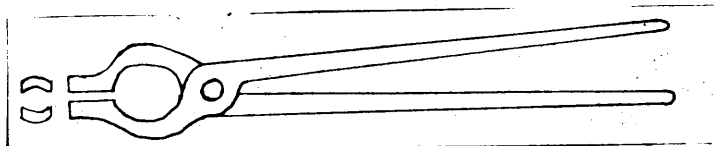


Figure 8. Hollow bit or bolt.

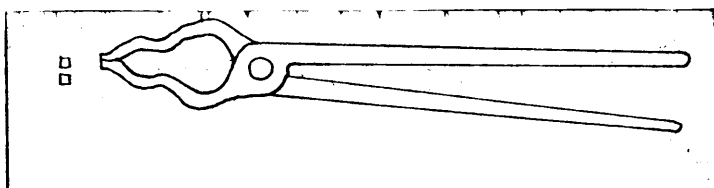


Figure 9. Link.

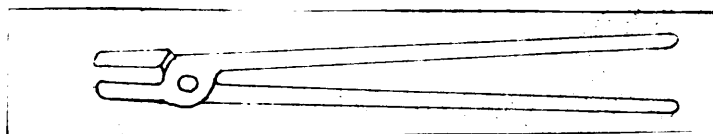


Figure 10. Parallel jawed.

C. Hammers.-- Most of the forge work is done with the hammer. The hammer is the most important tool in the forge shop. Hammers are made from cast steel or tool steel. Hammers vary in weight from  $1\frac{1}{4}$  to 4 pounds, depending upon the use being made of them. Sledge hammers from 5 to 18 pounds. There are many different types of hammers used

but the cross peen, straight peen, ball peen, and sledge hammers are the more common ones used in the shop. One and one-fourth pound hammer should be used by beginners in forge work.

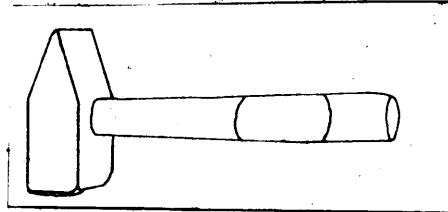


Figure 11. Cross-peen. This hammer is used more frequently in forge work than any of the others recommended. It is used almost extensively in European countries. The peen and face are slightly rounded. The rounded face hammer is recommended over the ball-peen hammer, because of the flat surface the ball-peen has.

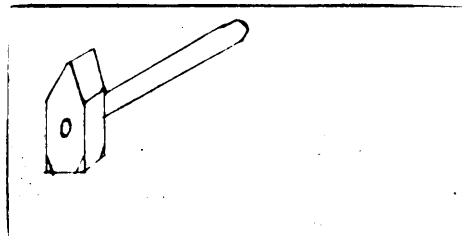


Figure 12. Straight-peen hammer is used quite frequently. It has rounded face and therefore would be recommended over the ball peen.

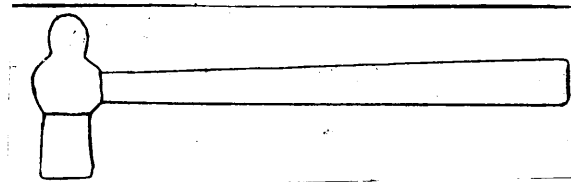


Figure 13. Ball-peen. This hammer is recognized more as a machinist's hammer rather than a blacksmith's hammer. It is objectionable in most of the forge work due to its flat face, which leaves groves on the flat surface when hammered upon.

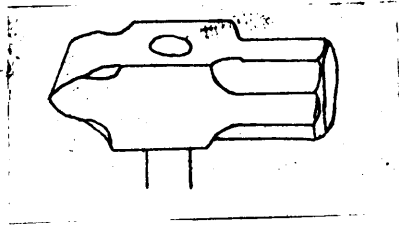


Figure 14. Sledge Hammer. This hammer weights from 5 to 18 pounds, and generally has a long handle for the purpose of using two hands when needed. The sledge hammer is used chiefly in heavy forge work.

D. Chisels.-- The term "chisel" refers to both hot and cold chisels. Chisels are made of tool steel. These chisels are used in cutting both hot and cold metals.

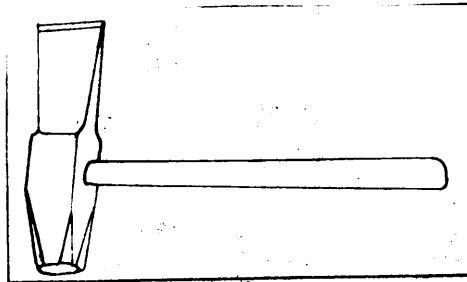


Figure 15. Hot Chisel. This chisel is used in cutting hot metal.

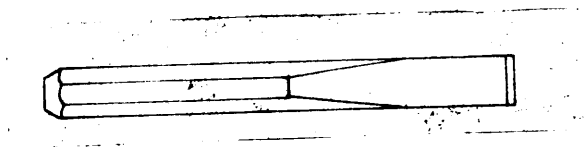


Figure 16. Cold Chisel. The cold chisel is used chiefly in cutting cold metal, however, it can be used to cut hot metal.

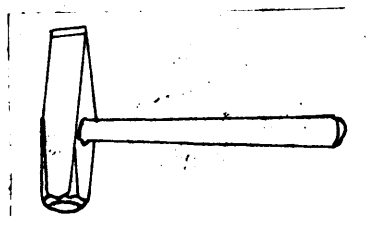


Figure 17. Cold Cutter. This is somewhat similar to the cold chisel. Both are used in cutting cold metal. The cold cutter as a general rule is heavier and thicker than the regular cold chisel. Therefore, the cold cutter is used mainly in cutting heavy pieces of stock.

E. Punches.— Punches are used chiefly in punching holes through stock. Although they are used in marking stock and in punching one piece of metal out of another. Punches are made from tool steel. The size of the punch depends upon the use being made of it. It is advisable to have several punches of different sizes and kinds at hand.

There are two main kinds; center punch, which is used in marking stock and in punching one piece of stock out of another; and drift punch, which is used in punching holes through stock.

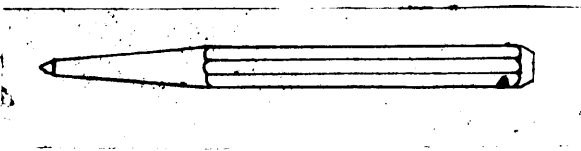


Figure 18. Center Punch

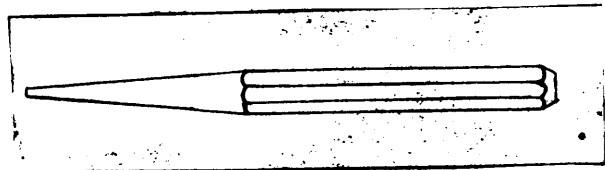


Figure 19. Drift Punch

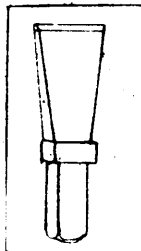


Figure 20. Hardie. The hardie is used in cutting hot, small stock. The hardie fits into the hardie hole of the anvil.

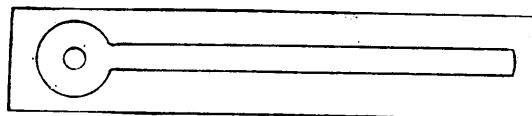


Figure 21. Heading Tool. Heading tools are used in forming and shaping heads of bolts and rivets. Only one heading tool will be given, although there are others.

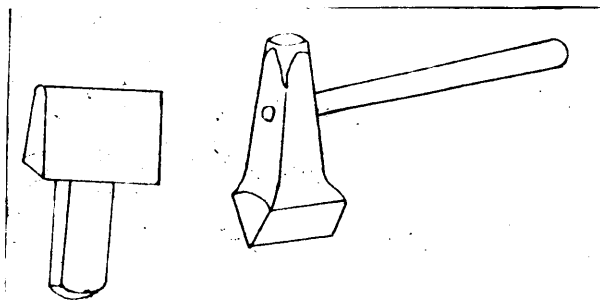


Figure 22. Fuller Top and Bottom. The fuller is used in forming grooves, scarfing and drawing out of iron. It has two parts, the top and bottom fuller. The bottom fuller fits in the handle hole of the anvil. Many times the top fuller is used without the bottom.

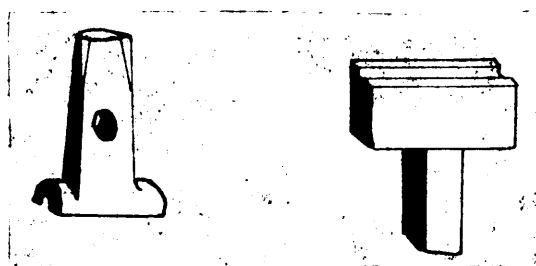


Figure 23. Swage Top and Bottom. The swage is a tool whose shape is exactly opposite that of the fuller, and is used to shape and finish cylindrical surfaces, or to form hot metal to a shape similar to the swage. It is of two parts bottom and top. The bottom fits into the handle hole of the anvil.

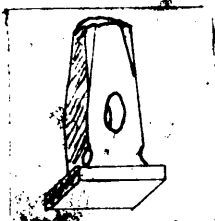


Figure 24. Flatter. The flatter is a finishing tool. Flatters are used to make a flat surface on the metal. They should be used on stock when it is very hot, so that the scaling off will not take place and leave a rough surface. When using the flatter always see that the anvil is free of scale.



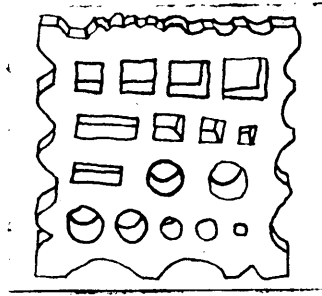


Figure 25. Swage Block. The swage block is a very useful tool. There are a number of different sizes of round, square, and oblong holes in the block. It is used for punching round, square and oblong holes in heavier stock. In forming shoulders on round, square and oblong pieces of stock, and in many cases takes the place of the heading tool.

### Questions

1. Why is it essential that one familiarize himself with the various tools and their uses?
2. Why is it important that a job be done well?
3. How many of the tools listed could you identify at first sight?

### References

1. "Blacksmithing on the Farm" - Industrial Book & Equipment Co.
2. "Farm Shop Practice" - Jones.
3. "Blacksmithing" - Selvidge and Allton.
4. "Farm Blacksmithing" - Friese.

## EQUIPMENT AND ITS USES

Job 10

## A. Major Equipment.

1. Anvil
  - (a) Factory
  - (b) Home-made
2. Vise
3. Drill
  - (a) Breast
4. Grinders
  - (a) Grinding wheel
  - (b) Grindstone
5. Stock and Dies
6. Mandrel Ring
7. Water tub.

## B. Miscellaneous Equipment.

1. Steel square
2. Caliper rule
3. Metal files
4. Sandpaper and emery paper
5. Welding flux or borax
6. Goggles
7. Hack saw
8. Grinding wheel dresser
9. Pipe wrench

10. Monkey wrench
11. Hand saw
12. Metals, steel, iron

A. Major Equipment

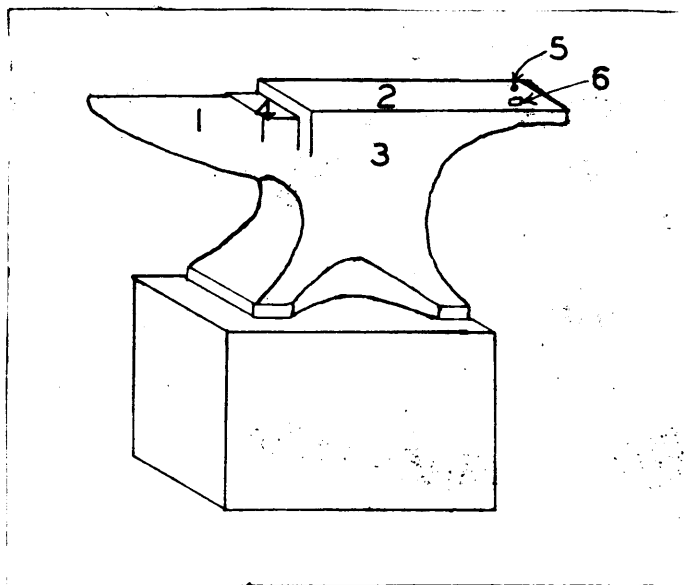


Figure 1. Anvil and Block.

The anvil is the piece of equipment upon which the heated metal is forged to shape. Anvils are generally made from wrought iron, and have a steel face welded to the iron. A thin coating of lead is usually on the base of the horn. Sizes of anvils for a school and farm shop range around 150 pounds to 250 pounds. Wood base is generally used, however, in some school shops a cast iron base is used. The height of an anvil is around 3 feet, as shown in the figure. A person doing forge work should familiarize himself with the various parts of the anvil. Parts of the anvil shown in Figure 1 are: 1 - horn; 2 - face; 3 - body;

4 - base of horn; 5 - pritchel hole; 6 - hardie hole.

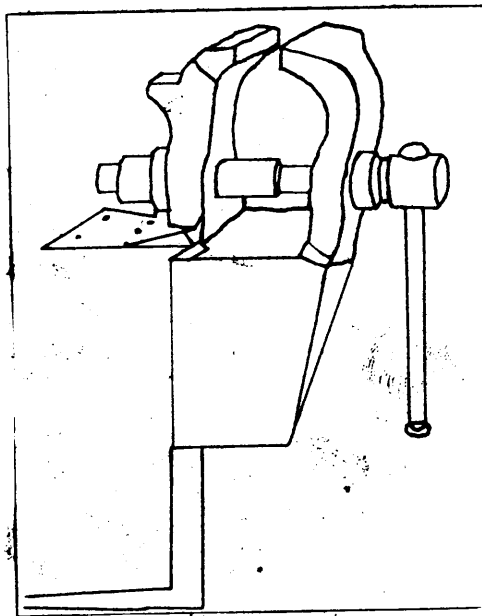


Figure 2. Vise.

There are several types of vises. Home-made vises are sometimes made for light work. The vise is used for holding both hot and cold metal. The size of a vise is based upon the width of the jaws. For school and farm work it is advisable to have jaws from 4" to 5" wide. The height of the vise will depend upon the individuals using it. About elbow high is a very good workable height. The vise, shown in Figure 2, is used for general blacksmith's work. This vise has a leg extended to the floor or nearly so which takes up much of the strains. The bench vise is fastened to the top of the bench, thereby placing all the strains on the top of the bench.

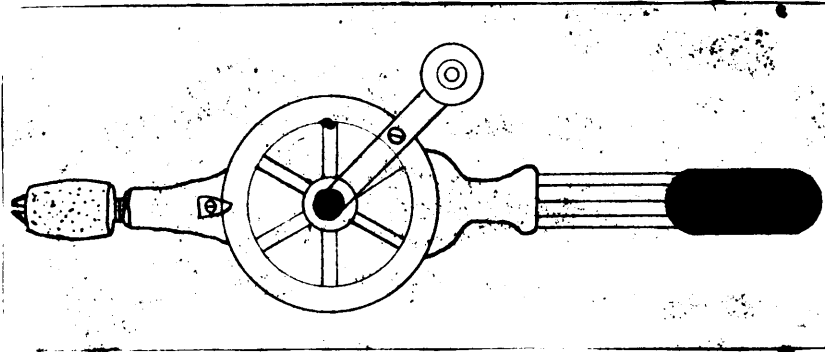


Figure 3. Drill.

The drill is used to drill holes in iron or steel. In Figure 3 the breast drill is shown. This drill is very handy in that it can be moved from place to place. The post drill is usually mounted upon a post extending from the ceiling or on the wall. Most drills have both hand and automatic feeds. More detailed information on drilling is given in the job "Drilling Through Metal."

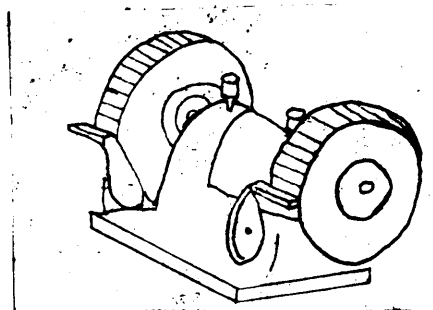


Figure 4. Grinding Wheel.

Stocks and Dies - These are taken up in the job on "Cutting Threads".



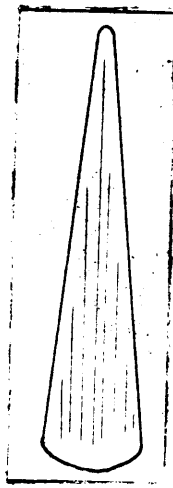


Figure 5. Mandrel.

This is used in shaping rings and circular objects when a circle or part of a circle is desired. The top diameters are one inch, two inches, and five inches. They range in height from 32 to 50 inches.

Water Tub. This will depend upon the desire of the individual. It should be at least twelve inches deep and twelve inches in diameter.

B. Miscellaneous Equipment.

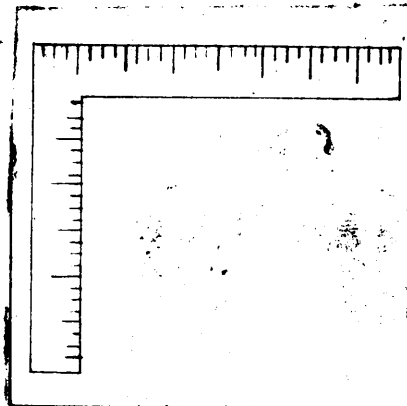


Figure 6. Steel Square.

The steel square may have many uses. To a certain degree of accuracy, one may check board feet with a square.

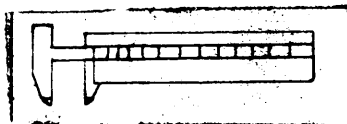


Figure 7. Caliper Rule.

This rule is used in measuring the diameter of stock.

Metal Files. These are taken up in the job on Files.

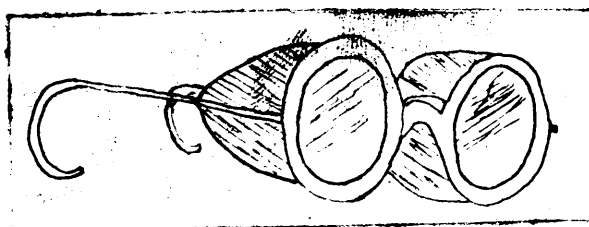


Figure 8. Goggles.

These are very essential when any grinding is being done on the grinding wheel. They should be worn whenever the grinder is being used.

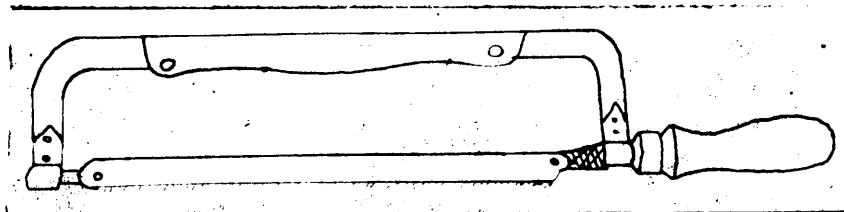


Figure 9. Hack Saw.

This is taken up in more detail on the job, "Cutting Cold Metal".

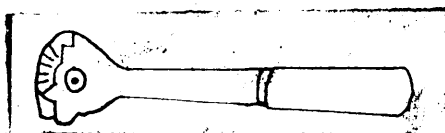


Figure 10. Grinding Wheel Dresser.

This is taken up in the job on "Grinding Wheels".

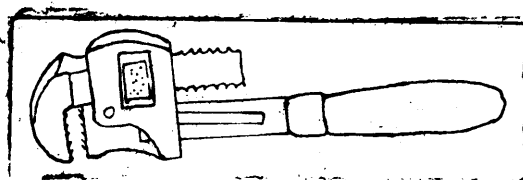


Figure 11. Pipe Wrench.

These wrenches are invaluable in the school and farm shop. Care must be taken to prevent straining the wrench. The wrench should be according to the size of job being done. In the event you cannot get a good hold with your hands, a piece of pipe may be slipped over the handle which would give a good leverage.

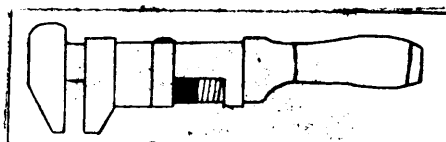


Figure 12. Monkey Wrench.

This wrench is also very useful on the farm and in the school shop. The same leaverage may be used with a piece of pipe on this wrench as with the pipe wrench.

Welding Flux or Borax. There should always be a sufficient amount on hand. This is inexpensive and a large quantity is not necessary.

Sand Paper and Emery Cloth. This material is used not only while tempering steel, but also in smoothing surfaces of wood and metal.

Hand Saw. This is used sometimes in the forge work, especially in the ironing of wagon frames, single trees, etc.

Scrap Iron and Steel. There should always be some scrap iron handy. Much scrap iron is lying around on practically every farm that could be useful in the forge work.

### Questions

1. What are some of the highest price pieces of equipment?
2. What is the mandrel ring used for?
3. What do you consider the most important pieces of equipment?

### References

1. "Blacksmithing on the Farm". Industrial Book & Equipment Co.
2. "Farm Shop Practice" - Jones.
3. "Blacksmithing" - Selvidge and Allton.
4. "Farm Blacksmithing" - Friese.



## BASIC EQUIPMENT AND TOOLS FOR THE FORGE SHOP

### Job 11

The equipment and tools, as a whole, for a farm forge shop will vary with the locality in which one lives, but the basic equipment and tools will vary only slightly. One should consider several things before equipping a forge shop. The initial cost is an important item. The amount and character of work likely to be done is also very important. Although every farmer cannot profitably own blacksmithing equipment, many farmers can. He may not be financially able to provide for all the basic equipment and tools at the beginning. This can be a gradual process of building up as you would increase the fertility of your land. One may need to start with a hammer, and a home-made anvil, and from this build his forge shop. One who is able to equip, I would suggest the following list as basic. The same list would apply to a high school shop. Increase as the need arises. All simple jobs can be done with the following:

### Equipment

#### A. Major

- |          |               |
|----------|---------------|
| 1. Forge | 3. Vise       |
| 2. Anvil | 4. Grindstone |

#### B. Miscellaneous Equipment

- |                 |                                   |
|-----------------|-----------------------------------|
| 1. Steel square | 3. Borax or welding flux          |
| 2. Metal file   | 4. Pipe wrench and monkey wrench. |

Tools

## A. Fire Tools

1. Poker
2. Rake
3. Shovel

## B. Tongs

1. Straight lipped
2. Hollow bit

## C. Hammers

1. Cross peen

## D. Chisels

1. Cold chisel
2. Hot chisel

## E. Punches

1. Center punch
2. Drift punch

## F. Hardie

### Questions

1. Which one of the tools do you consider the most important?
2. Should a farmer buy all the basic equipment at the beginning? Give reasons for and against.

### References

1. "Farm Blacksmithing" - Frieese
2. "Blacksmithing" - Selvidge and Allton
3. "Farm Shop Practice" - Jones
4. "Farm Mechanics" - Crenshaw and Lehman

## LOCATION AND PLACEMENT OF TOOLS AND EQUIPMENT IN THE FORGE SHOP

### Job 12

The size of the farm shop, and the kind of tools it should contain, depend upon the size of farm, amount of repairing to be done, and upon the ability and inclination of the farmer.

For the small farm, a handy shop may be fitted up in any suitable space which is available in one of the farm buildings. There must be proper space in which to work. The room must have plenty of light.

Some shops are large enough to house complete equipment for the ordinary jobs on the farm. Such as the binder, mower, tractor and farm car. Such a shop may be in a building by itself; it may be part of another building, or it may require addition to the present structures.

Some farmers partition off one end of the implement shed. Others prefer to establish the shop in connection with the farm garage, so that the shop heater will take the chill off the garage when desired. Some shops are found under a tree, while others may be found under a high porch of a dwelling house.

We all agree that a basement farm shop is the least desirable because of the difficulty in getting heavy work in and out, the lack of good light, and danger that dampness will rust the tools and supplies. Shop located under the porch is not so desirable where the forge is being used, since there is considerable danger of fire. Under the tree seems sufficient only in the case of emergency.

Wherever the shop is located, it should have plenty of natural light, that from north and east windows being easier on the eyes. Where electric current is available, plenty of artificial light should be provided. Extension cords should be used when close up light is needed. Sockets should be available for connections to operate any shop machines. Artificial light is important, since emergency repairs must often be made at night. A shop that receives only a small amount of direct sunlight can be much improved by whitewashing or painting the ceiling and walls a dead white, so as to reflect and diffuse the light.

The shop floor may be of wood, concrete, or packed earth. Wood is very satisfactory to work on but will not support tractors and heavy machines. Packed earth is very good, but usually gets dusty and dirty and loses small objects easily. Concrete is recommended as being the most satisfactory farm shop floor, in the long run.

The arrangement of the shop equipment will depend on the work to be done, on the lighting, on whether the workman is right or left handed, and so on. The forge, anvil, grinder, and post drill should never be placed in a corner, as this would interfere with work on binder and mower knives, and on long rods or timbers. For a right handed man there should be plenty of room at the right, while for the left handed man the open space should be at the left. The farm shop should be laid out with the intentions of adding more equipment later.

The arrangement of tools will vary according to the type of shop. For the average shop, the following is very satisfactory.

- A. Fire tools - located around the forge.
- B. Tongs - located around the forge.



- C. Hammers - If you have several, place the one used most frequently at the forge, others placed either on wall or in cabinet.
- D. Chisels and punches around anvil.
- E. Hardie - At anvil.
- F. Steel square - At anvil.

Every shop should contain a tool cabinet. One that has a special lock on it, which contains the more valuable tools, and those not frequently used. This could easily be placed on the side of wall. Tools not mentioned above should be placed either in the tool cabinet or hung along the wall.

The placement of equipment will depend upon a number of conditions as has already been mentioned. Regardless of the shop, the more valuable tools and equipment should be placed under special lock, since they are rather expensive.

Forge, located near the wall but not in a corner. Leave ample room to work long pieces.

Vise, on work bench along wall. Advantage if near anvil.

Anvil, front of forge so you can make half turn from forge, horn facing to left.

Drill, on side of wall with ample room to work.

Grinder, probably at one end of work bench or entirely off to itself.

Mandrel ring, near anvil.

Miscellaneous equipment should be placed along the wall and in the cabinet.

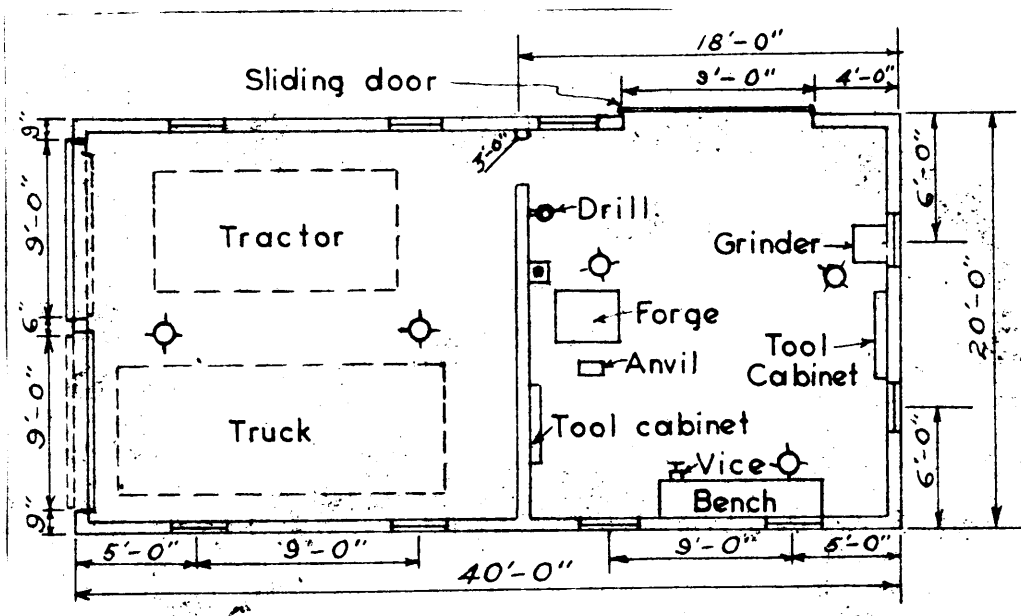


Figure 1.

Figure 1 shows plan of shop in the end of a large garage, with farm car in shop, and truck and tractor in other room.

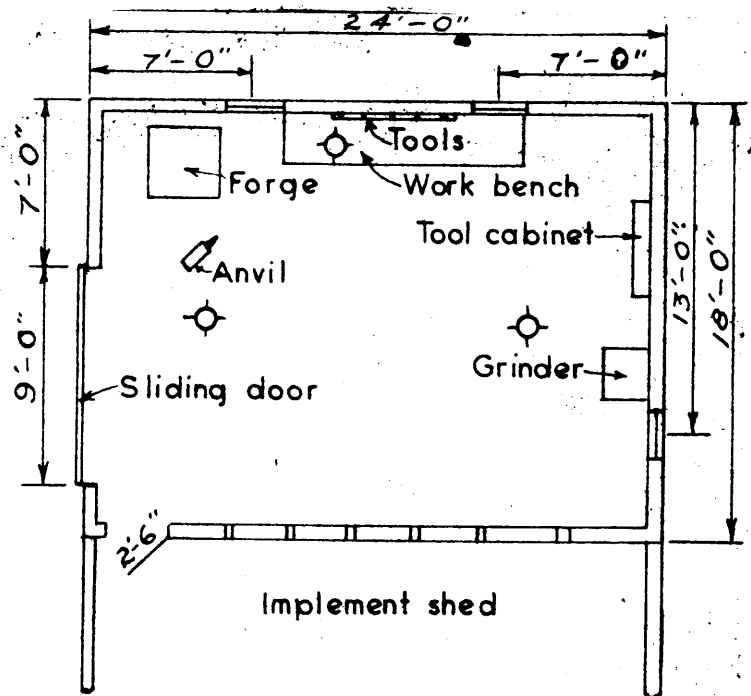


Figure 2.

Figure 2 shows floor plan of a shop fitted up in one end of an implement shed. The portion shown for implement shed may be the other part of the shop for a school in which the wood work is done. In such a case the partition, with the tools on, would not be there and the tools would be where the arrow points.

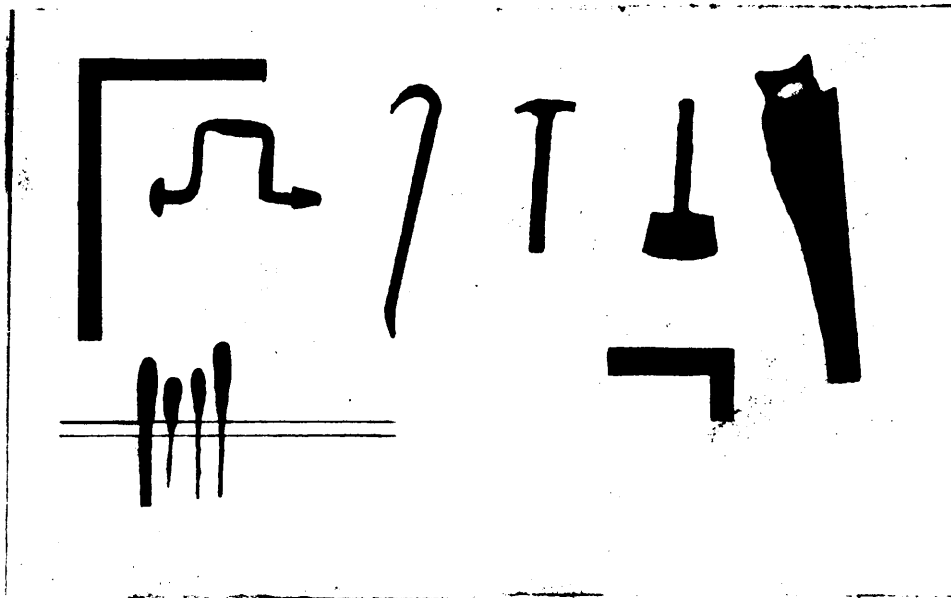


Figure 3.

Figure 3 shows the tool rack with the tools removed. This should be done in every shop in order that the tools may be placed in their proper place after being used. A quick check up on the tools can easily be made. It is a very good plan to paint the background white and paint the shape of the tools black.

### Questions

1. Why should the forge be kept out of the corner of the shop?
2. Is it advisable to have a tool cabinet in a shop? Why?
3. Should the more expensive tools be kept under a lock?

### References

1. "Cornell Extension Bulletin".
2. "The Farm Workshop and Woodlands" - E. C. Atkins Company.



## SELECTING THE FUEL FOR THE FORGE

Job 13

The selection of fuel for the forge fire is quite an important problem, since the success of blacksmithing depends largely upon the fire. Trying to build a good fire without good fuel is like attempting to build a house without a foundation. Many farmers, as well as students in high school find it difficult to weld at times. The majority of the difficulties that arise in welding are due to the poor quality of fuel. Many individuals assume that there is very little difference in the kinds of coal used. A careful selection of fuel for our forge work would eliminate much expense and time.

Coal - Coal is burned for its heat energy. Soft coal (bituminous) is used in preference to hard coal, because hard coal does not burn so freely and burns to ash without forming coke, which is necessary in the forge. Soft coal is used in forge work, but it is quite difficult problem to obtain the very best grade of coal. The best grade of soft coal is called blacksmith's coal.

The requirements of a good Blacksmith's coal are:

1. Best grade of bituminous coal.
2. Free of sulphur, slate and earthly matter.
3. Should produce but little ashes and cinders.
4. Should coke easily and the coke should not be consumed quickly.

Coal that meets the above requirements should, when dampened and packed down around the fire, readily change to coke, which is light weight material that burns with a clean, intense flame.

Ordinary stove or furnace coal will not always work satisfactorily in a forge. Many schools are compelled to use the same coal for their forge work as is used in the heating plant of the school. Also on the farms, many farmers find it necessary to use the same coal that is used in their furnaces or stoves. Since this situation is somewhat general throughout the state and many other states, it is necessary that we substitute something for this coal when we are welding. This substitution is only necessary when we find it difficult to work with the present supply of coal.

Sulphur, is the element in this impure coal that prevents the welding of metal. When the impure coal is heated, the sulphur oxidizes and forms a skin over the particles in the iron that prevents those particles from going together. Therefore, in selecting our fuel it is necessary that this element be eliminated.

Coke - At first thought, one would assume that coke, which has the impurities removed, would be a good fuel for forging. Commercial coke produces an intense heat that would in a short while burn our forges out. For this reason pure commercial coke is prohibitive in farm forge work. The coke that is found in the forge fire by heating the green coal, is very good, but this is only made by heating the green coal, and if it were impure coal the sulphur would be present, in this process of coke forming.

Charcoal - Charcoal is the very best of fuel to use in welding. This coal is pure and produces an excellent heat. The best charcoal is made from hard wood. This coal is made in various localities. However, one can purchase a small quantity at a very low cost.

#### Summary

Soft, (Bituminous) coal is the practical coal to use in forge work. Only the very best grade of this coal should be purchased. In the event that one is so situated that the obtaining of the very best grade of soft coal commonly called "blacksmith's coal" is impossible, he should substitute charcoal, when there is any welding to be done. Impure coal contains sulphur which prevents the welding of metal. In purchasing the very best grade of soft coal it is advisable to ask for blacksmith's coal. To many dealers, it is known as such. Oil is not in practical use as yet for forge fuel. A careful selection of forge fuel will determine to a great extent the success of farm forge work.

A one-hundred bag of blacksmith's coal can be bought for approximately 75 cents. Charcoal would be very reasonable also.

### Questions

1. Why is the average grade of coal used in furnaces, not suitable for forge work?
2. What fuel is recommended as a substitute for welding purposes?
3. What effect does sulphur have upon the metal while welding?
4. What is the chief cause of the difficulties that arise in welding?

### References

1. "Farm Shop Practice" - Jones
2. "Blacksmithing on the Farm" - Jarvis and Abbott
3. "Farmer's Shop Book" - Roehl
4. "Farm Blacksmithing" - Friese

## BUILDING, MAINTAINING, AND OUTING THE FIRE

### Job 14

A good fire is the first requirement for good blacksmithing. Approximately fifty percent of the poor work that is done by blacksmiths can be traced to a poor fire. The kind and size of the forge fire depends upon the kind of job being done. If a person were sharpening a digging iron, he would need a much larger fire than if he were sharpening a cold chisel. A good fire depends to a great extent upon the quality of coal used.

Tools - fire tools.

Materials - coal, shavings or fine kindling, matches, paper or kerosene, and water.

### Operation 1. Building the Fire

1. If there has been a fire in the forge previously, push the coal and ashes to the side of the fire pot.
2. Turn blast to remove any particles that may be in the tuyere. Make sure a good blast comes through. Close the blast.
3. See that the tuyere is closed.
4. Place a handful of paper in the fire pot, then add fine kindling or shavings on top of paper. If you have no paper, add a few drops of kerosene to the kindling or shavings, depending upon the one you use.

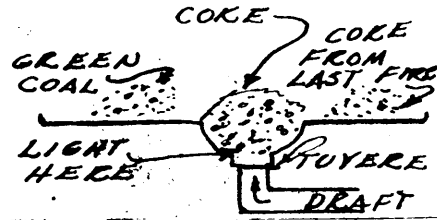


Figure 1.

5. Lift shavings slightly from side of fire pan and place lighted match there as shown in Figure 1.

6. Cover the fire gradually with coke left from previous fire. If you didn't have fire recently, use coal and add gradually. While adding fuel, turn blower gently to provide draft.

7. When a live bed of coal is formed, rake coal onto it on three sides, leaving the side to you slightly open, for the insertion of the iron to be heated, and used to hold the iron while being heated.

### Operation 2. Maintaining the Fire

1. Heat should be concentrated towards the center.
2. As the coal changes to coke push it to the center and add more green coal. Maintain a mound about 5" high.
3. Allow enough air to maintain a gradual heat. An over-supply of air may ruin the metal.
4. Keep outside surface of the mound damp, to prevent the spreading of flames.
5. It is important to keep a deep fire because the iron being heated should have burning coke below, around, and above it. The only way to keep a deep fire is to keep a high mound.



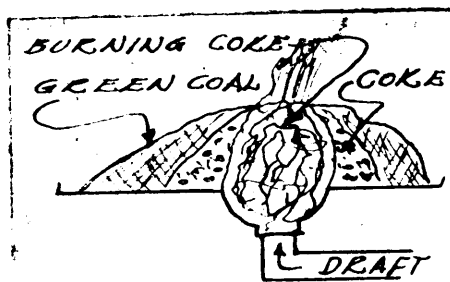


Figure 2. Cross Section of a Good Fire.

6. The size of the pieces to be heated will determine the size of the fire used. Use a fire that will heat only that portion of the stock that is to be worked.

7. If a small fire is wanted and it tends to get too big, add wet coal on the sides. If there is already enough fuel add water to the sides and pack down with a shovel.

8. If clinkers are formed over tuyere or elsewhere in the fire, rake or push them out and bank fire again.

### Operation 3. Outing the Fire

1. Cut off blast or outside draft.
2. Rake fire from center of pan to the sides.
3. Move tuyere, to remove ashes in bottom of pan.

### Questions

1. What is the first requirement for good blacksmithing?
2. Why should you close the tuyere before starting the fire?
3. Why do you not want to bank the fire high on all sides?
4. Where should the heat be concentrated to?

### References

1. "Farm Shop Practice" - Jones.
2. "Farm Mechanics" - Crenshaw and Lehman.
3. "Farm Mechanics" - Cook, Scranton, and McColly.
4. "Farm Mechanics" - Mississippi Agricultural Experiment Station.
5. "Farm Blacksmith" - Friese.

## METALS AND THEIR USES

### Job 15

Whether it be the farmer, student, or teacher, it is highly important that he be familiar with the different metals, their properties and uses. For example, if a person wanted to make a cold chisel, he would certainly want to know what metal to ask for; if he were buying it from a hardware company, or elsewhere. One should not only know what metal to ask for, but must know the qualities of the metal in order that the job will be successful.

#### I. The Commercial Forms of Iron

1. Cast iron.
2. Chilled iron.
3. Wrought iron.
4. Steel
  - a. Mild steel.
  - b. Medium steel.
  - c. High steel.

#### II. Origin and Uses

Iron and steel products are derived from pig iron. Pig iron is derived from the iron ore, through the smelting process. This iron contains from 3.00% - 4.00% carbon.

1. Cast Iron. Cast iron is made by re-heating pig iron and pouring it into castings. Due to very little processing involved in

making cast iron, it is rather cheap and is used extensively. Much use is made of this iron on the farm. It is very hard and brittle and cannot be bent. Cast iron will break or crack easily when strick a hard blow with the hammer. This iron can be drilled and sawed easily; however, cast iron cannot be forged or welded in a forge fire, but can be oxyacetylene welded. The carbon content is 2.50% - 3.75%.

Uses - machine frames and stands.

2. Chilled Iron. Chilled iron is cast iron that has been made into special molds, and in the process of cooling, the outer portions were cooled more rapidly than the inner portions. Therefore, making the surface very hard and wear resistant.

Uses - plow shares and mold boards, as well as bearings on many farm implements. Carbon content 2.00% - 2.50%.

3. Wrought Iron. This iron contains from .02% - .04% carbon. It is derived by the processing of pig iron, which takes out practically all the impurities and in turn is called pure iron. Wrought iron can be bent cold, also welded in forge fire or electric. This iron corrodes very little. When wrought iron is subject to very much hammering, while cold or while not heated at the proper temperature, will cause internal cracks and weaken the metal considerably. When heated to a full red and quenched in water, it will not harden. Wrought iron is used more frequently by a blacksmith than any other metal, due to its variety of uses.

Uses - Chains, links, hooks, rivets, etc.

4. Steel. Steel is derived by heating wrought iron and adding the desired amount of carbon needed.

(a) Mild Steel. Mild steel, commonly known as low-carbon steel or machine steel. It is stronger than wrought iron and forged readily without breaks or fractures. The carbon content being less than .30% and generally around .10% - .15%.

Uses - Chains, rivets, screws, pipes, bars.

(b) Medium Steel. Medium steels have a carbon content of .30% to .60%. Used where much strength is required.

Uses - Automobile parts, farm implements.

(c) High Steel. Commonly known as tool steel and has a carbon content of .60% - .90%. This steel is used for the making of pick axes, smithing hammers, punches, cold chisels, etc.

### III. Chemical Elements and Their Influences

Carbon, manganese, silicon, sulphur and phosphorus, with the addition of iron, are present in all carbon steel. Carbon has a greater influence on the mechanical properties of steel and iron than any other element. As the carbon content increases, the strength and hardness become greater, while the percentage of elongation and reduction of area are lowered. Steels containing over 1.00% of carbon are used only for appli-

cations requiring great hardness. The range in carbons in commercial steels is from .05 to 1.50%. In referring to the carbon content, it will give one a very good idea of the kind of metal needed. However, he should thoroughly understand the need. In buying metals for farm forge work, one should know the use, carbon content, and the commercial form of the metal to be used.

Examples:

<u>Use</u>	<u>Carbon Content %</u>	<u>Commercial Form</u>
1. Cold Chisel	80 - 90	Tool steel
2. Chain link	.02 - .04	Wrought iron



Carbon Content Per Cent	Name of Metal	Uses
3.00 - 3.75	Cast Iron	Machine frames, stands
3.00 - 3.75	Chilled Iron	Plow shares, mole boards, bearings.
.02 - .04	Wrought Iron	Chains, rivets
.30 and less	Mild Steel	Pipes, screws, plates, bars.
.30 - .60	Medium Steel	Machine parts requiring high strength.
.60 - .90	High or tool steel.	Anvil faces, punches, cold chisels, rock drills, rivet sets, springs, axes, knives, shear blades.
.90 - 1.50	Very high	Wood chisels, lathe tools, files, reamers, razors, saws for cutting steel.

### Questions

1. What effect does the increased amount of carbon have on steel?
2. What is wrought iron?
3. What are the main uses of chilled iron in farm forge work?
4. What would be the proper metal to use in making a chain link?

### References

1. "Farm Shop Practices" - Jones.
2. "Steel" - Campbell.
3. "Farm Mechanics" - Crenshaw & Lehman.
4. "Blacksmithing on the Farm" - Jarvis and Abbott.
5. "Wrought Iron" - Aston and Story.

## HEATING METAL

### Job 16

It is of importance that this job be given careful consideration. Many times money is spent on metal and in a few minutes the metal is ruined because of the improper heating. One can spend time on a job and at the very last moment spoil the whole thing by over-heating. For example, if while making a cold chisel you were to heat it to white color the steel would be practically useless. This is one of the many instances that occur daily, especially with those individuals who are inexperienced. Only generalized information on the heating of metal is given here , as more detailed information will be given when the individual jobs are taken up, such as welding, tempering, and others. Generally the amount of heating depends upon the kind of metal and the job to be performed. Since the majority of the forge work is done with heated metal, it seems highly important that we have a thorough knowledge of such.

Tools - Fire tools, other tools depending entirely upon the job being done.

Materials - Depending upon the job.

### Procedures

1. Always cut off blast before inserting irons or fixing the fire.
2. Irons should be placed in the fire in a horizontal position. Dont point metal down. Make sure that blast does not come in direct

contact with the iron.

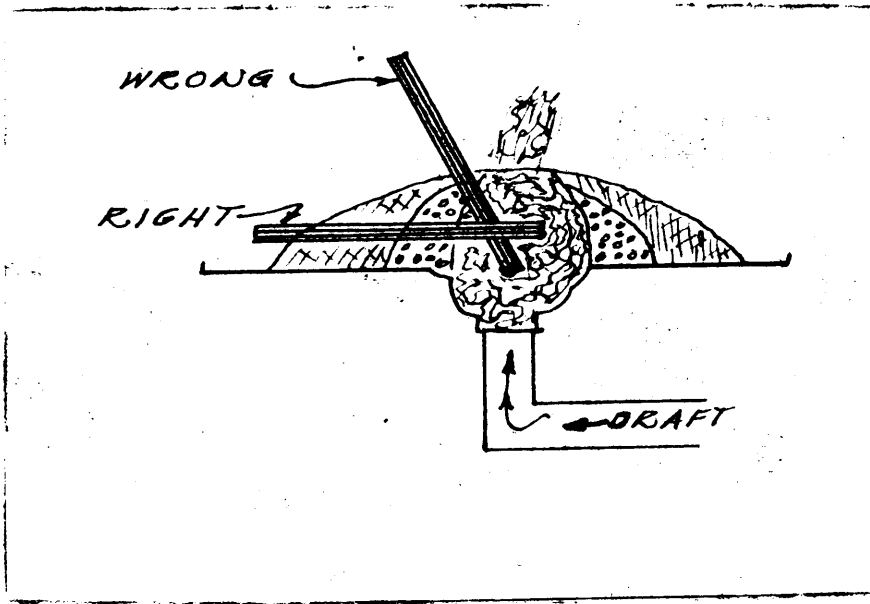


Figure 1.  
Shows proper insertion of metal into fire.

3. There should be burning coke below the irons, on both sides of them, at the end, and on top.

4. Oxidation of iron takes place when the metal comes in direct contact with the blast. Some oxidation will always take place, but by keeping plenty of coke on all sides as in Figure 1, this will be limited. The result of oxidation is the forming of a scale on the iron that comes off in the process of hammering. A good blacksmith always keeps this scale wiped off his anvil.

5. Irons heated in a deep, compact fire, heat much more rapidly and oxidize or scale off less than when heated in a shallow, burned out fire.

6. Use just enough blast to keep the fire burning well.
7. Always heat metal slowly, in order that the temperature will be evenly distributed at the proper place.
8. If heated too rapidly, the inner portion of the iron will be cooler than the outer portion, which will result in cracking or splitting of the outer portion when hammered upon. This is due to the fact that when iron or steel is heated the particles increase in size with the degree of heat.
9. After the iron has been in the fire a while, remove it to see how the heat is progressing.
10. Small thin parts heat much more rapidly than heavier and thicker parts. To prevent burning the thinner parts, they may be pushed on through the fire to a cooler place, or the position of the irons otherwise changed to make all parts heat uniformly.
11. If two pieces are being heated at the same time and one is heating more rapidly than the other, remove from the fire and let cool slightly, then insert again.
12. Always dip tongs in water at various intervals to prevent them from over-heating.
13. Dip punches or other tools in water when they become hot from working with hot metal.
14. In selecting tongs to work with in heating metal, always select the tongs that most nearly fit the materials being worked with. The size of the throat of the tongs vary considerably.

15. Best heats to work with:

- (a) Wrought iron - bright yellow.
- (b) Mild steel - good bright red.
- (c) Tool steel - cherry red or low, dark orange.
- (d) Above .90 carbon - cherry red (light)

16. Always hold iron in a shaded or slightly dark place to determine color. As a general rule, it is dark enough under the hood of the forge. Generally, most forges are in a shaded position.

17. Heating metal above these heats in most cases will cause the metal to crystallize, or burn.

18. The higher the carbon content, the less heat should be applied, since carbon alloys with iron and forms compounds that resist much heating.

19. Metals have a critical temperature, which we determine by colors. Colors are given above in Number 15. If heated above critical temperature, the grains will become large and will require special attention to bring back to normal or may be ruined. See jobs on annealing and hardening.

### Questions

1. Why keep the iron in nearly a horizontal position in the fire while heating?
2. What is the effect of using too much blast?
3. How can one prevent the blast from coming in direct contact with the iron?
4. Why should you dip the tongs into water quite frequently while heating metal?
5. Why should metal be heated slowly?

### References

1. "Plain and Ornamental Forging" - Schmarzkopf.
2. "Farm Shop Practice" - Jones.
3. "Blacksmithing" - Selvidge and Allton.
4. "Farm Mechanics" - Crenshaw and Lehman.



## MEANS OF IDENTIFYING SCRAP IRON ON THE FARM

Job 17

Within recent years, many farmers have sold considerable amounts of scrap iron from their farms. Much of this metal was sold at a very low price. Many farmers have sold iron that could have been put to a very good use on the farm had they been able to identify the metal and known the use that could be made of it. For example, a magnot from an old T-Model Ford makes the very best of cold chisels and punches. Also broken rake teeth can be made into excellent hay hooks or meat hooks, and old files into wood chisels. There are many others that could be listed. There are two important ways of identifying scrap iron on the farm. One is by grinding on the grindstone or grinding wheel, and the other is by heating. In most cases, heating would be more accurate in identifying.

I. Grinding Wheel

To a certain degree of accuracy, one can determine the grades of iron and steel by the use of the grinding wheel. The higher the carbon content of the metal, the brighter and more explosive are the sparks.

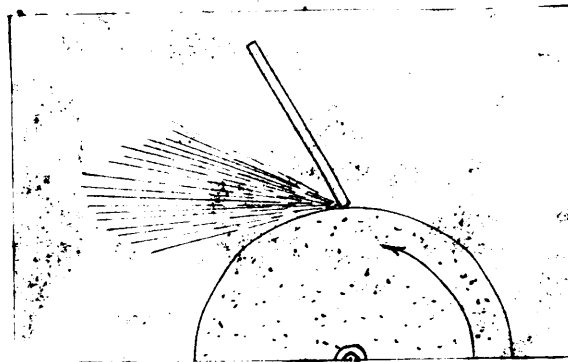


Figure 1. Wrought Iron - Golden Yellow Streaks.

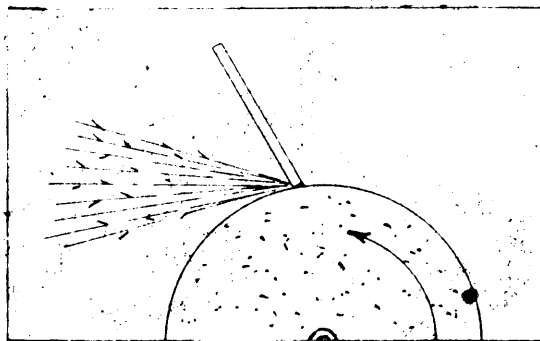


Figure 2. Mild Steel. Bright streaks are divided or forked by slight explosions.

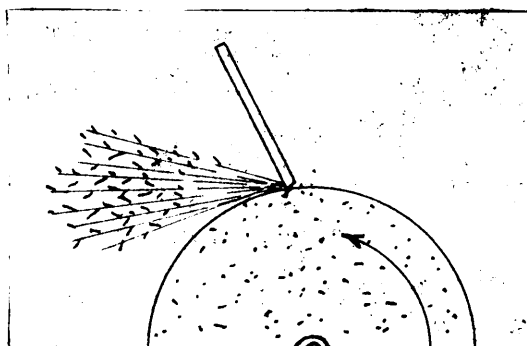


Figure 3. Medium Steel. More numerous and more brilliant.

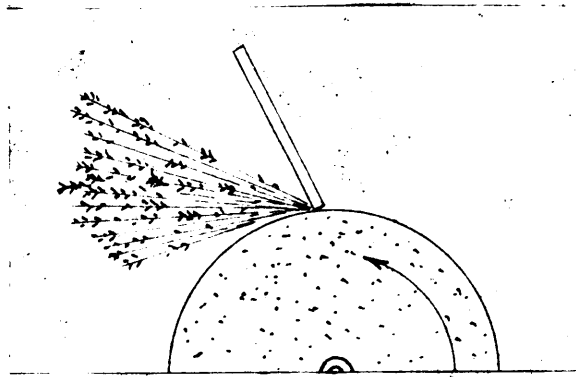


Figure 4. High Steel (Tool Steel) - Explosions produce short bushy clusters of sparks beginning close to the end.

## II. Heating

For most blacksmiths on the farm it is advisable to use this method, especially if the grinding wheel is not in a very good condition. After going through these procedures the metal will not be injured by heating and placing in water as the metal can be re-heated and allowed to cool gradually which will bring it back to normal.

Tools - metal file, metal, tongs.

### Procedures

1. Heat one end of the metal to a cherry red.

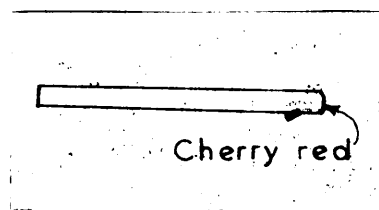


Figure 5.

2. Insert cherry red end in water immediately and cool in water.

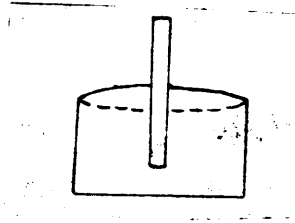


Figure 6.

3. File the end which was heated and cooled.

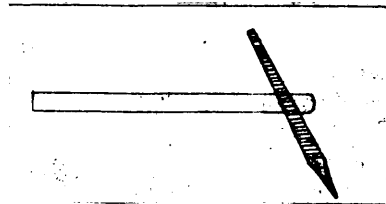


Figure 7.

If filed easily, the metal has a low carbon content, as the carbon content increases, the hardness will increase. A good grade steel will not scratch when filed.

### Questions

1. Of what value is the knowledge of being able to identify scrap iron on the farm?
2. How can you distinguish between wrought iron and tool steel when grinding on a wheel?
3. If carried out according to directions, would the metal be injured in the heating process?

### References

1. "Farm Shop Practice" - Jones.
2. "Steel" - Campbell.
3. "Farm Mechanics" - Crenshaw and Lehman.

## MEASURING STOCK

### Job 18

There are many occasions on the farm as well as in the school shop that require the measuring of stock. A thorough knowledge of this job before attempting many jobs will be very beneficial. For example, if you wanted to make a clevis or hay hook, you would first of all want to know the length of the stock to be used. There are several things to be considered in measuring stock.

1. The length or size of the completed material.
2. Amount to be drawn out.
3. Amount to be upset.
4. Proper position to measure from.

Tools - caliper rule, steel square.

Materials - stock, string or a flexible piece of wire.

### Marking Stock

In the process of measuring one must mark the stock. Two means of marking, one with chalk and the other with a center punch.

1. Chalk or good soapstone. Use chalk when you are working with cold iron. Will burn when heated.

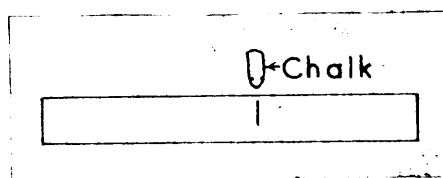


Figure 1.



2. Center punch. This marking is used more frequently than any other in the forge work. You can see the marks after heating as well as before.

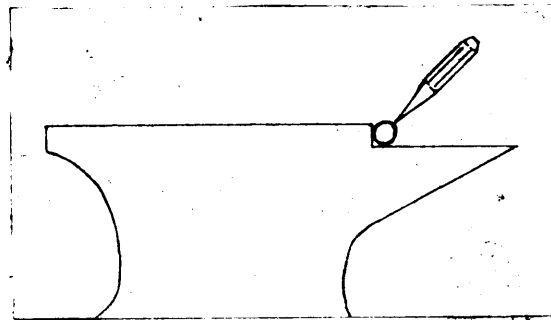


Figure 2.

### Operation 1. Measuring Straight Stock

1. Without upsetting or drawing out. When there is no drawing out or upsetting or any other form made, then use exact measurement as it is.

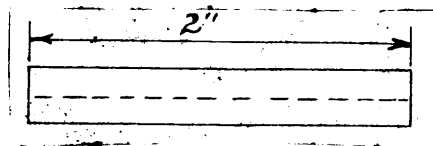


Figure 3.

2. Measuring stock that is to be upset. The allowance in this figure is  $\frac{1}{4}$ " for upsetting, however, this does not hold true in all cases. The length allowed for upsetting will depend upon the amount to be done and for what purpose.

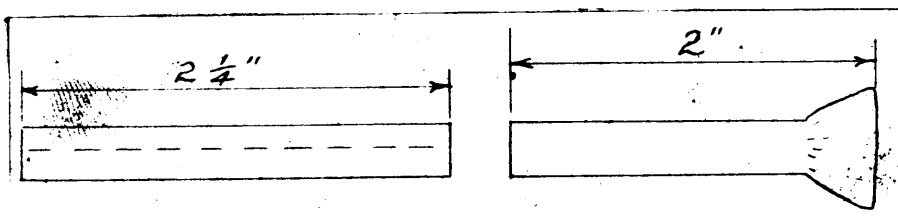


Figure 4.

3. Measuring stock that is to be drawn out. The same rule holds true in drawing out as in upsetting. That is, the allowance for upsetting is determined by the amount and purpose. Always allow extra as you can cut off rather than add on.

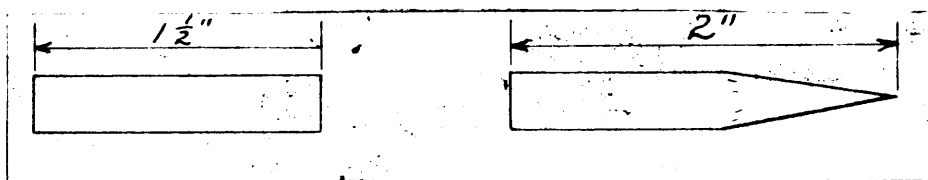


Figure 5.

### Operation 2. Measuring Irregular Shapes

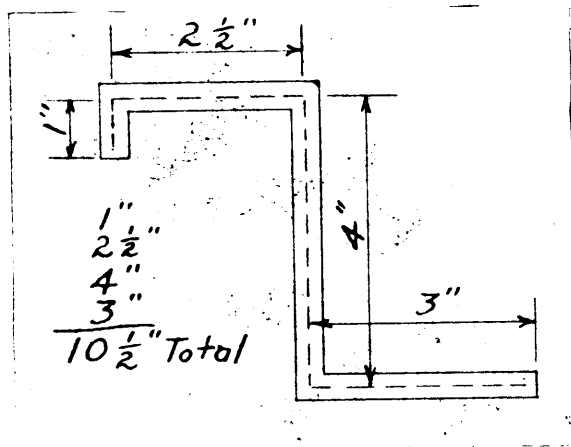


Figure 6.

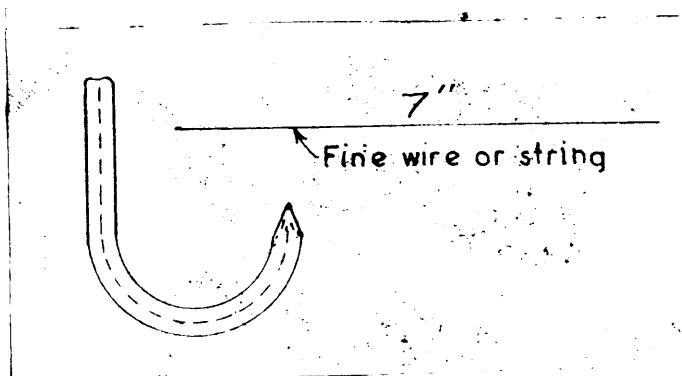


Figure 7.

1. Always measure in the center of the stock.
2. As shown in Figure 6, where angles are formed it generally takes more metal, however, in the center of angle the length always remains the same.
3. In measuring irregular shaped stock, small wire can be bent into the desired shape and then straightened out and measured. Also a piece of string may be used, if the shapes are suited. (Figure 7).
4. The simplest method of determining the length needed for pieces, successive parts of which are straight, or portion of circles as shown in Figure 6, is to calculate separately the length required for each part and then take the sum of these with necessary allowances. In this calculation the basis should be from the center line.

### Operation 3. Measuring Rings or Bands

1. Use fine wire or string and place on center of stock. Then straighten out and measure. (Figure 8). Fine wire will hold in place better than string.

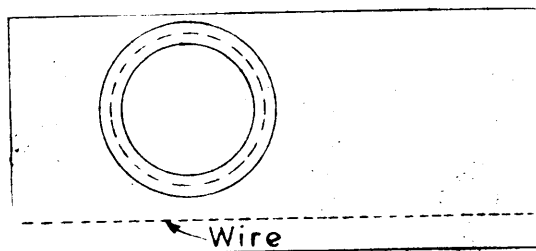


Figure 8.

2. Length required for rings or bands may be calculated by taking three times the inside diameter plus four times the thickness of the stock. If the ring is to be welded, an allowance must be made for the weld equal to the thickness of the stock. The method of obtaining the length of stock is very close to the exact fraction of an inch. For general shop work, it is quite practical. If you intend to weld a 10" by  $\frac{1}{2}$ " ring, you would need  $10\frac{1}{2}$ " of stock. This is not as exact as Number 3.

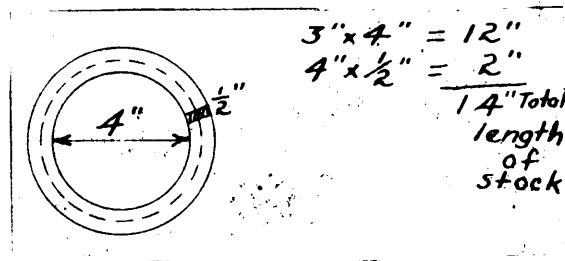


Figure 9.

3. Another method of calculating the length of rings or bands is shown in Figure 10.  $3\frac{1}{4}$  times inside diameter of the ring plus thickness or diameter of the stock. As was mentioned in No. 2, if the ring is to be welded, an allowance must be made for the weld equal to the thickness of stock. For a welded ring  $8\frac{3}{4}$ " by  $\frac{1}{4}$ " would need 9" of stock. This method will determine the length to the hundredth of an inch.

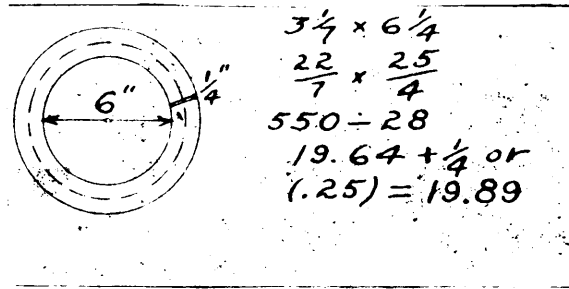


Figure 10.

#### Operation 4. Measuring the Width of Stock

1. Caliper rule is one of the best ways of measuring the thickness of stock. (Figure 11) This shows the round stock. Figure 12 shows square stock. Any shape of stock may be measured with this rule.

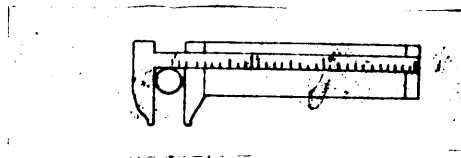


Figure 11.

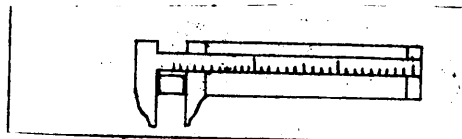


Figure 12.

2. You may use steel square if the caliper rule is not at hand. This is not as accurate as the rule. For general purposes, the square serves very well.

### Questions

1. Why would you use the center punch in preference to chalk for marking material that is to be heated?
2. What is one method of measuring rings or bands?
3. Would you allow for extra material if you were planning to upset the material? Why?
4. What is the best tool used in measuring the width of stock?

### References

1. "Plain and Ornamental Forging" - Schwarzkopf.
2. "Blacksmithing" - Selvidge and Allton.
3. "Farm Shop Practice" - Jones.
4. "Farm Blacksmithing" - Friese.

## HOW TO USE THE HAMMER

### Job 19

Success in blacksmithing depends largely upon the ability to strike effectively with the hammer. The beginner in forge work should familiarize himself with the various hammers and their uses.

#### Operation 1. Proper Grip

1. For the average work grasp the handle about two-thirds of the distance from the hammer.
2. When light blows are to be delivered, grasp nearer the hammer.
3. When exceptionally hard blows are to be delivered it is sometimes necessary to grasp nearer the end of the handle.

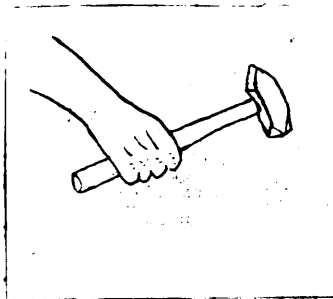


Figure 1.

#### Operation 2

The kind of blow will depend upon the nature of the work and the size of hammer used. The type of work done will, to some extent, determine the size of hammer used. For beginners it is advisable to



use  $1\frac{1}{4}$  pound hammer. More experienced persons use  $1\frac{1}{2}$  to 4 pounds. A heavy hammer on light work is awkward as well as a light hammer on heavy work. To direct the blows accurately, always strike one or two light taps first, to get the proper direction and feel of the hammer, and then follow with quick, sharp blows.

1. Wrist blow is struck largely with the wrist action. (Figure 2)  
This is used chiefly in light work or finishing work.

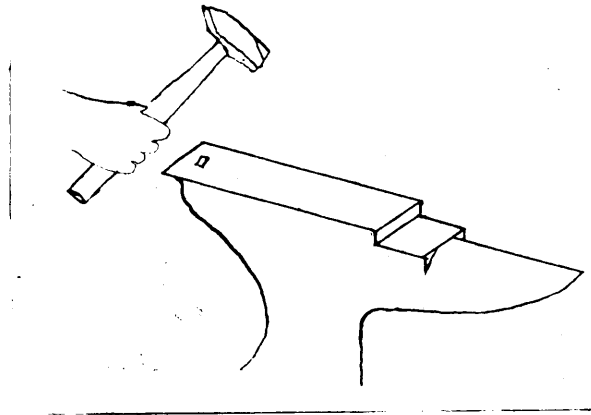


Figure 2.

2. Elbow and wrist blow is used where moderate blows are required.  
Much of the forge work is done with this blow. (Figure 3).

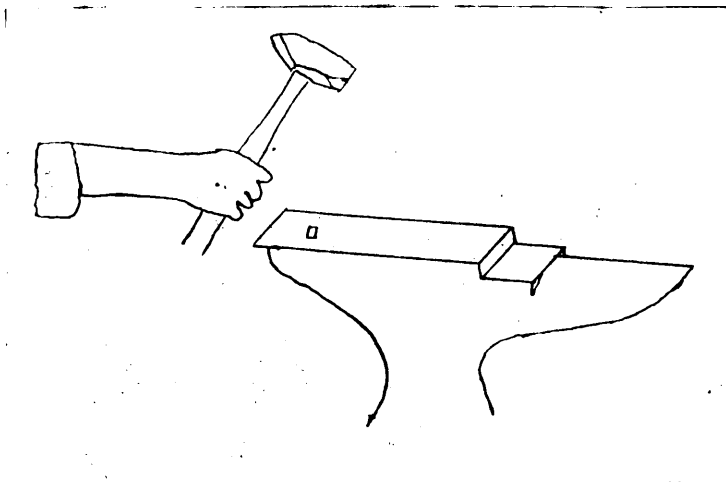


Figure 3.

3. Shoulder, elbow and wrist are used in delivering heavy blows.  
(Figure 4) Heavier hammers are frequently used when heavy blows are required.

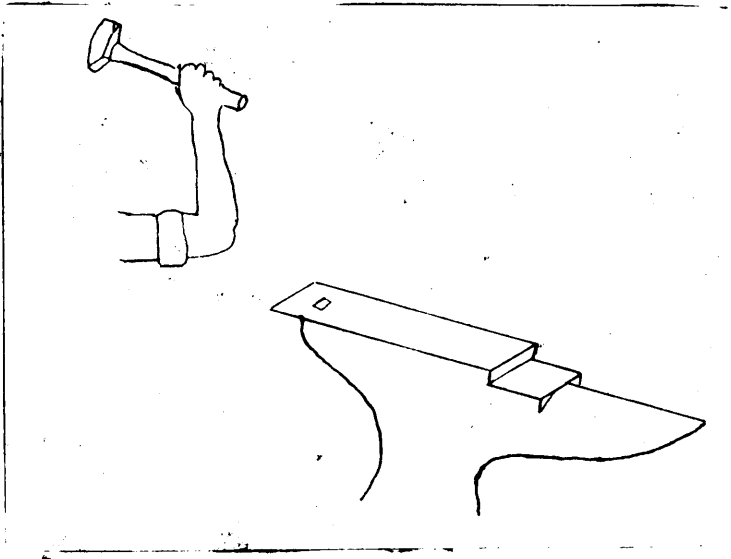


Figure 4.

### Questions

1. What is the disadvantage in using a light hammer on heavy stock?
2. What is the recommended size of hammer for the beginner in forge work?
3. Why should you strike one or two light taps before striking heavier blows?

### References

1. "Plain and Ornamental Forging" - Schwarzkopf.
2. "Farm Shop Practice" - Jones.

## CUTTING METALS

Job 20

A great many jobs done in the farm forge require cutting of some kind, whether it be hot or cold. The method used in cutting metals will depend upon the tools available, and the kind and size of stock. The hardie is used more often in cutting hot metal than any other tool. However, outside of the shop the cold chisel is used the most frequently, with the hack saw ranking second.

Tools - hardie, hack saw, cold chisel, hot cutter and hammer.

Materials - tool steel, wrought iron.

Operation 1. Cold Cutting

## A. Hardie and Chisel.

1. Before cutting, always mark the exact point where the cut is to be made.

2. Small pieces of wrought iron and mild steel  $3/8"$  and less may easily be cut without heating.

3. Place stock over hardie, and deliver the blows at that point. (Figure 1) Cut about two-thirds through and then place cut edge of stock on edge of anvil and break off. (Figure 2).

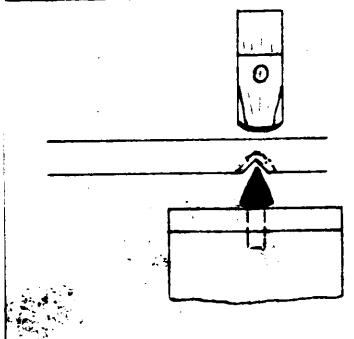


Figure 1.

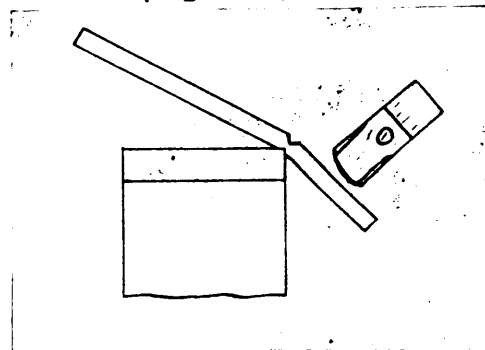


Figure 2.

4. To make a smooth break, do as shown in Figure 1, except cut about one-fourth of the thickness. Then reverse sides, Figure 3, and cut about one-fourth of the thickness. Break off as shown in Figure 2. In cutting, you may substitute the cold chisel, or cold cutter for the hardie.

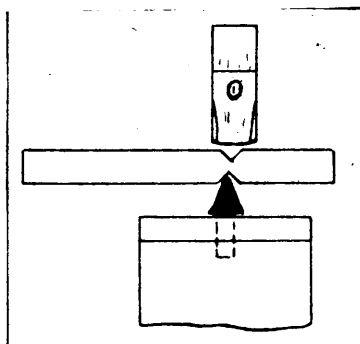


Figure 3.

5. Cold chisels are used very often in cutting rivets and bolts. Whenever cutting out old rusty bolts from farm implements, it is much easier to cut at a slight angle. It can be done much quicker.

#### B. Hack Saw.

1. Make sure the blade is fastened securely in the hack saw frame in order that it will not twist and break.

2. Hack saws are used to cut wrought iron, cast iron, low and high carbon steel and nails and rivets.

3. When sawing heavy material, use blades that have 16 to 18 teeth per inch. In sawing small stock use a finer tooth.

4. Place stock into vice with the mark near the jaws, in order that the stock will not bend while sawed. Springing back and forth may cause blade to twist and break.

5. Notch the mark with a chisel, punch, or file. The notching will aid in getting the saw started at the proper place.

6. Run the saw evenly, using long strokes. Apply slight pressure on the forward stroke and release on the backward stroke, which in turn will lengthen the life of the blade.

7. In cutting tool steel stock, you may saw about one-fourth of the way through and place upward in the vice. With a few blows with the hammer it should easily break off. Special blades should be used in cutting tool steel.

8. The same general principles of cutting metal by the use of the hack saw applies to the cutting of metal outside of the vice as well as in.

### Operation 2. Cutting Iron and Steel While Hot

1. Medium steel, tool steel and large pieces of wrought iron should be cut while hot.

2. Mark before cutting as described in cold cutting.

3. Heat metal to cherry red heat.

4. You may use the same methods as are shown in Figures 1, 2 and 3 of cold cutting. Also the cold chisel, and hot cutter are used in addition to the hardie in the cutting of hot metal.

5. There is another method used in cutting hot metal that requires some skill in doing. That method is shearing off.

(a) As shown in Figure 1, cold cutting, you place the stock on the hardie at the mark where the cut is to be made. Strike several blows with the hammer until the metal at the cutting point becomes thin. See Figure 4. Use the shearing off blow. This blow requires skill and must be well directed.

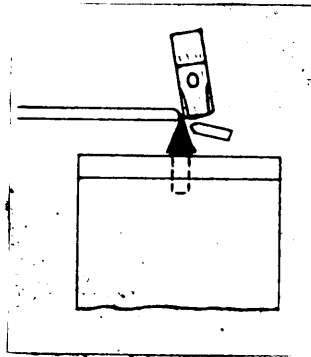


Figure 4.

(b) Do as shown in Figure 1, except that you turn the metal while delivering the blows, in order that the metal will be cut on all sides. Place stock on edge of anvil and strike with the hammer. (Figure 5).

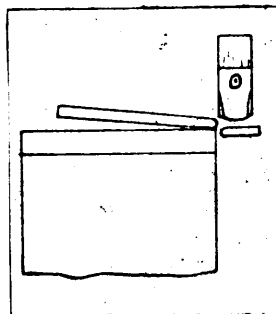


Figure 5.



6. Cutting of steel with a carbon content above .90 should be done by the hot method. Cutting of this high carbon steel requires no special treatment other than that described in the operation of hot cutting. Cast iron and chilled iron having a carbon content of 2.50 to 5.00, when heated to a cherry red will crumble. Therefore, this metal must be cut cold. The use of the hack saw is the best method of cutting such metal. The cutting of a railroad rail, which has a high carbon content, can be done as explained under the job on "Making a Home-Made Anvil".

### Questions

1. Why wouldn't you cold cut tool steel, except with the hack saw?
2. What tool would you use in cutting nails, rivets, and bolts?
3. What color should the metal be when cut hot?
4. When shearing off on the hardie, why should you be careful and hit on opposite side of the hardie?

### References

1. "Farm Mechanics" - Cook, Scranton and McColly.
2. "Farm Shop Practice" - Jones.
3. "Blacksmithing" - Selvidge and Allton.
4. "Plain and Ornamental Forging" - Shwarzkopf.

## DRAWING OUT

Job 21

Drawing out is the process of making a piece of metal longer and thinner. This job is very important, since many forge jobs require some drawing out. Drawing out is usually done while the metal is hot, but some can be done while the metal is cool. However, when the metal has been heated, do not hammer after it has become fairly cool, as cracks may be formed internally. As was mentioned in the job on heating metals, the following should be the proper heat for working these metals.

Wrought iron - White

Mild steel - Yellow

Tool steel - Cherry Red or Dark Orange

Higher steel - Cherry Red

The size of the hammer depends upon the size of stock being drawn out. Also the weight of blows varies with the size of material and the amount to be drawn. The weight in every instance should be sufficient that the force of the blow be transferred throughout the entire thickness of the metal.

Important points to keep in mind in drawing out stock.

1. Work at the proper heat.
2. Deliver proper blows.

Tools - tongs, hammer.

Materials - Piece of stock.

Operation 1. Drawing Out Stock on Face of the Anvil

1. Heat metal to the proper heat, depending upon the kind of metal. The heat should be uniform.
2. Stock should be turned frequently to insure proper distribution of heat.
3. Place heated stock on the face of the anvil. Deliver blows, with the face of the manner parallel to face of the anvil. Many beginners have a habit of striking down and forward with the blow. Pushing forward with the blow has no advantage whatever.
4. Between blows turn the stock so that the blows fall alternately on the sides and top, keeping the work in the desired form.
5. Keep slag off the anvil at all times.
6. In drawing out metal always draw to a square or four sided form first, which should be the approximate size of the drawn out stock.  
(Figure 1).

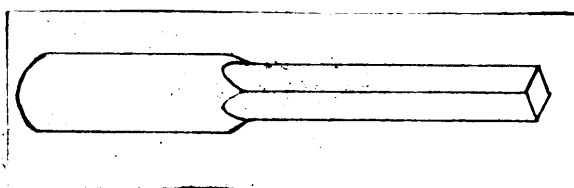


Figure 1.

7. After it is drawn sufficiently on four sides then make it distinctly eight sided, by hammering on the corners of the four sides.  
(Figure 2).

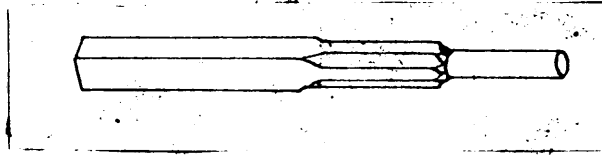


Figure 2.

8. Make it round by rolling the stock slowly on the anvil and hammering rapidly with light blows. (Figure 2).

9. When stock becomes blue, re-heat, hammering on stock when not properly heated will cause cracks in metal.

10. Too light a blow tends to set up uneven forging strains, which may later, in hardening, form breaks or fractures in the grain.

Operation 2. Drawing Out Stock on the Horn of Anvil

1. Heat as described in Operation 1.

2. Place heated stock on horn of anvil. (Figure 3) Strike blows directly above the horn. Bottom fuller may be used in place of the anvil horn.

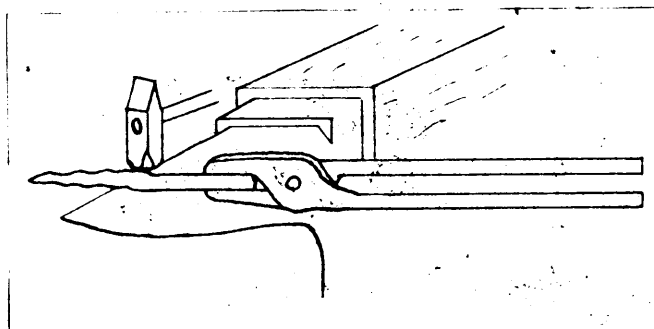


Figure 3.

3. Then place the stock on the anvil, and proceed as in Operation 1, by drawing to a square, then eight sided, then round. (Figure 4)

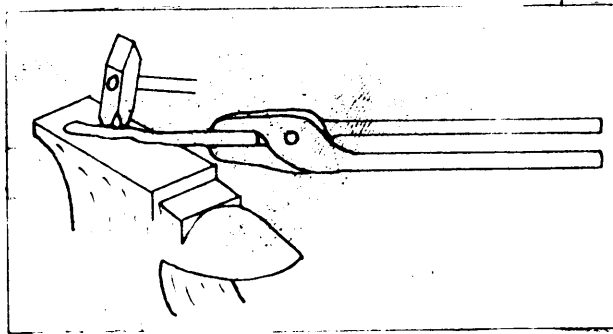


Figure 4.

### Operation 3. Drawing to A Point

1. Round points should be made square first, as in the drawing out, then octagonal, then round.

2. Stock should not be held flat on the anvil. (Figure 5) The back end of the stock should be raised. (Figure 6).

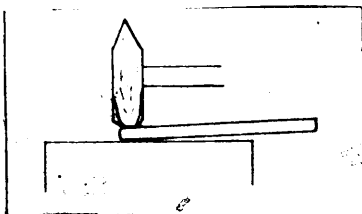


Figure 5.

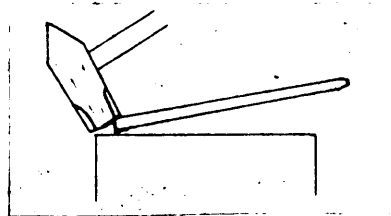


Figure 6.

3. Hammering should be done with toe of the hammer lower than the heel. (Figure 6).

4. The hammering should be done on the far edge of the anvil, so that the toe of the hammer will not leave marks in the anvil face.

5. By rolling the pointed end of the stock on the face of the anvil, or some other flat surface, and watching the point, you can tell whether it is straight and the point is centered. If the point wabbles, it is off center.



### Questions

1. Why turn the stock between blows?
2. Why should the pointing be made with blows from the toe of the hammer?
3. Why should the pointing be done at the edge of the anvil?

### References

1. "Farm Mechanics" - Cook, Scranton, McCally.
2. "Blacksmithing on the Farm" - Jarvis and Abbott.
3. "Farm Shop Practice" - Jones.
4. "Blacksmithing" - Selvidge and Allton.

## UPSETTING STOCK

### Job 22

Upsetting is a common operation in forge work. Upsetting is the shortening or enlarging of a piece of metal by decreasing its length and increasing its width and thickness. It is quite fundamental in forge work as it is a preliminary step in many jobs, such as welding, making a bolt, making a clevis and numerous other jobs. Again the kind of metal being forged determines to a great extent the ease of the operation. Tool steel is more difficult to upset than wrought iron, indicating that the higher the carbon content the more difficult the operation. In any forge job we cannot over-emphasize the proper heating of metal. It is impossible to upset metal to any great extent without heating.

Tools - tongs, hammer.

Materials - stock, water.

### Procedures

1. Mark 1" where stock is to be upset to. (Figure 1)

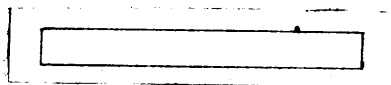


Figure 1.

2. Heat stock to cherry red as described in job on "Heating Metal". Do not heat any farther than the mark in Figure 1. Sometimes it is impossible to heat only a limited amount.

3. If heated below mark in Figure 1, then cool back to the desired point by dipping in water. (Figure 2). This should be done quickly, but is not always necessary.

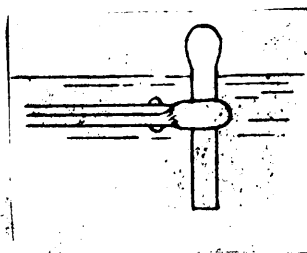


Figure 2.

4. Place the stock on the anvil in a perpendicular position, forming right angles to the face of the anvil to prevent the stock from bending. (Figure 3). Heated end up. A better job can be done when in this position.

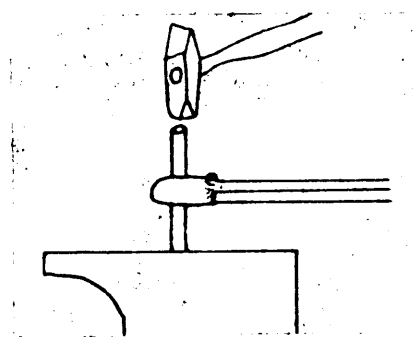


Figure 3.

5. Strike the heated end with heavy blows. (Figure 4). Heavy blows give even upsetting. Light blows simply flatten and burr, instead of upsetting throughout. (Figure 5). Strike with a couple light blows at first to get the direction. Then strike heavy blows.

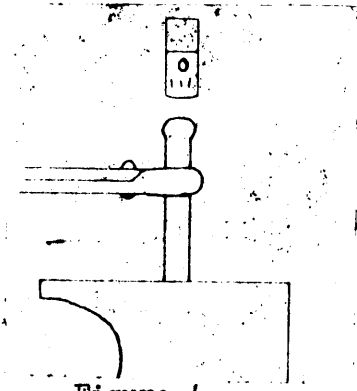


Figure 4.



Figure 5.



Figure 6.

6. If stock bends, place over the anvil and straighten. You must not wait until the bend is too great.

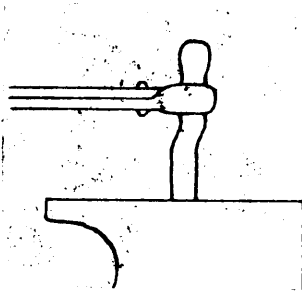


Figure 7.

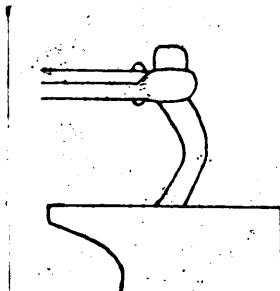


Figure 8.

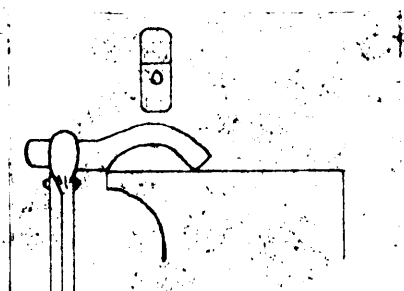


Figure 9.

Figure 7. Time to straighten.

Figure 8. Too great a bend, takes too much time to straighten.

Figure 9. Proper placing of stock on anvil to straighten.

7. When upsetting a 5" piece of stock. Figure 10, upset from each end as in Figure 11.

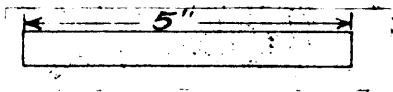


Figure 10.

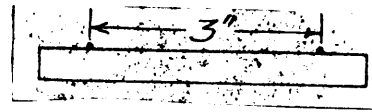


Figure 11.

8. In upsetting stock, the heat should be uniform in the portion that is to be upset. Figure 12 shows ends hotter than center. Figure 13 shows proper heat.

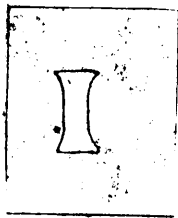


Figure 12.



Figure 13.

9. In heating long and heavy pieces of stock where it requires the use of hands to hold the stock, it is necessary to place the heated end on the face of the anvil. (Figure 14) Otherwise heated fragments may burn hands.

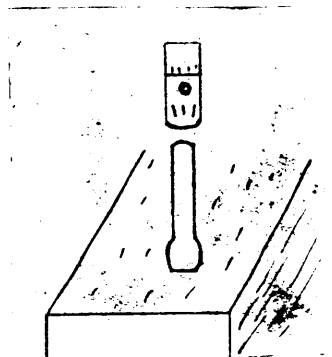


Figure 14.

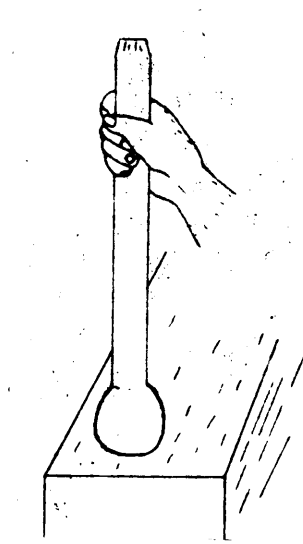


Figure 15.

10. Sometimes the stock is placed in the vise and upset. Considerable heat is lost in this procedure.

Sometimes long stock is taken in two hands and used as a ram, swinging the heated end against the side of the anvil.

### Questions

1. Why place heated end of stock up?
2. Why should the end of stock be perpendicular to the face of the anvil?
3. What effect does light blows have in upsetting?
4. Why should you place the heated end of the stock on the face of the anvil on certain jobs?

### References

1. "Blacksmithing" - Selvidge and Allton.
2. "Farm Mechanics" - Cook, Scranton, McCally.
3. "Farm Shop Practice" - Jones.
4. "Blacksmithing on the Farm" - Jarvis and Abbott.

## PUNCHING HOLES THROUGH METAL

### Job 23

Many farm shops do not contain a drill. Therefore, it is quite essential that we familiarize ourselves with the proper method of punching holes through metal. Even if you had a drill, there are times in which punched holes would be necessary. It is sometimes easier to punch a hole in a piece of iron than to drill it, and for some purposes a punched hole is better. In certain jobs, drilling is the more satisfactory, but on certain other jobs punching is the more satisfactory. For instance, in forming an eye on the end of a bar in making a hook or clevis, punching makes a stronger eye.

Tools - center punch, drift punch and hammer.

Materials - piece of stock.

### Procedures

1. Mark stock, with a center punch preferably, where the hole is to be made.
2. Heat the stock to a cherry red heat.
3. Place the heated stock on the face of the anvil, but not over the pritchel hole. Punching over the pritchel hole would stretch and bulge the iron.



4. Place punch on the mark made for the hole. Strike several heavy blows until you have punched about  $2/3$  of the way through. The size and kind of punch will depend upon the supply you have. For punching holes the flat bottom drift punch is preferred. The punch with a handle would be preferred as it would relieve you of excess heat of the punch.

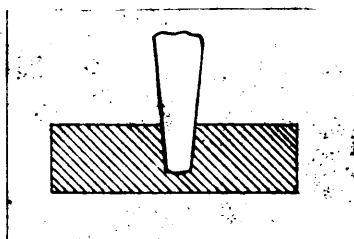


Figure 1.

5. Turn the stock over, and place punch opposite the first punch, if metal is red hot, there will be a dark spot. Drive the punch back through to the other side. (Figure 2).

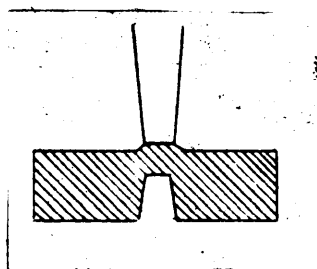


Figure 2.

6. Cool the punch and re-heat the stock.

7. Place the stock over the pritchel hole and drive the burr or slug out. (Figure 3).

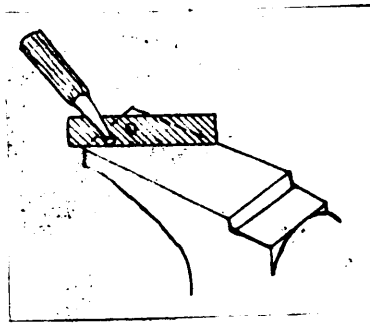


Figure 3.

8. Place the stock over the hardie or pritchel hole and drive the punch through from each side alternately until the hole is the desired size. (Figure 3). Always keep the metal at a good working temperature, re-heating as may be necessary.

9. During the process of punching, occasionally dip the punch in water to prevent over-heating.

10. If the punch sticks, drop a little dry powdered coal into the hole.

11. If the punch upsets during the process of punching, it is due to the over-heating of the punch. Remove it, draw it down, and temper before using again.

### Questions

1. Why shouldn't you punch all the way through without reversing sides?
2. Why is it wrong to place the stock over the pritchel hole for the first punch?
3. What causes the punch to upset while punching?
4. What is proper temperature to have the stock while punching holes through it?

### References

1. "Farm Mechanics" - Cook, Scranton, McColly.
2. "Blacksmithing" - Selvidge and Allton.
3. "Farm Shop Practice" - Jones.
4. "Farmer's Shop Book" - Roehl.
5. "Farm Blacksmithing" - Friese.

## DRILLING THROUGH METAL

### Job 24

The drill is one of the most useful pieces of equipment in the farm or school shop. Many repair jobs can be done by simply splicing a piece of metal rather than heating and punching the holes. Also the drilling of a hole is generally a neater job than punching, for certain purposes. Many times pieces of machinery are discarded which could otherwise be repaired and in turn, considerable money could be saved. For the average farm and school shop the hand post drill is the most useful. The self-feeder has its advantages and the hand feeder has its advantages, but in general, we find more hand feeder drills. For the farm and school the hand feeder is satisfactory.

### Drill Bits, Reamers and Chucks

Twist drill bits are sold as carbon-steel drills and high-speed drills. The carbon-steel drills are softer and need to be sharpened more often, but are very satisfactory for the farm shop. The high speed drills are more expensive but do not need to be sharpened nearly as often. Blacksmith drill bits, Figure 1, have a straight round shank with a flat side.

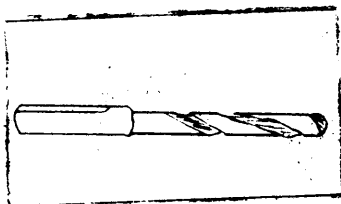


Figure 1.

A Reamer is used in enlarging a hole for some particular purpose. See Figure 2. These shanks are adapted to the carpenter's brace.

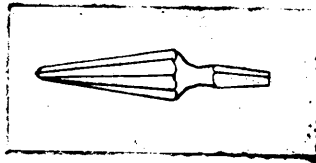


Figure 2.

Chuck is the part of the drill that holds the bit. There are different chucks, but for the blacksmith's drill bits there is one kind which holds the straight round shank with a flat side shown in Figure 1. The flat side prevents the bit from slipping.

#### Sizes of Drill Bits

The sizes will vary with the type of work being done. It is advisable to have bits from  $1/16"$  to  $3/4"$  for the farm and school shop. The smaller bits would be used chiefly in the drilling through thin metal as for riveting and drilling out old rivets, while the larger would be used for drilling holes for bolts and rods.

#### Lubricants Used in Drilling

Hard steel - Turpentine or kerosene.

Mild steel - Lard oil, screw cutting oil, or machine oil.

Cast iron - Nothing.

Brass - Nothing.

Wrought iron - Lard oil, machine oil, or screw cutting oil.

The reasons for the use of these liquids are twofold: First, they aid in keeping the drill bits cool, and secondly, they make the bits cut easier and smoother.

### Drilling

#### Procedures

1. Mark place to be drilled. A cross section of two lines makes accurate work. (Figure 3). Make a deep center punch mark at place marked in Figure 3. Figure 4 shows center punch at the marked location.

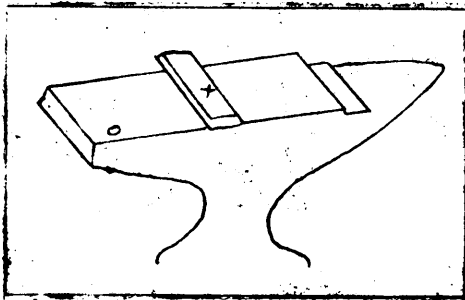


Figure 3.

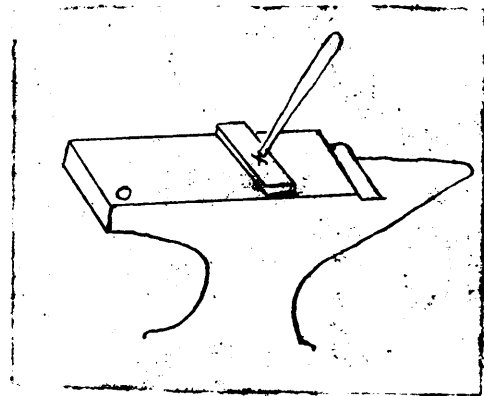


Figure 4.

2. If stock is round, place in a wooden "V" block. This holds the stock steady and lessens the chance of breaking the drill by turning of the stock. (Figure 5).

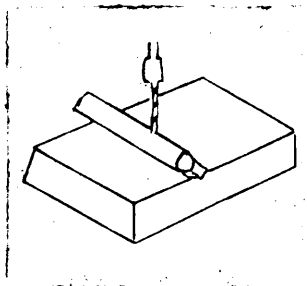


Figure 5.

3. Always place stock on a wooden block, Figure 6. Unless table has a hole in it. Wood is used to prevent drilling hole in table.

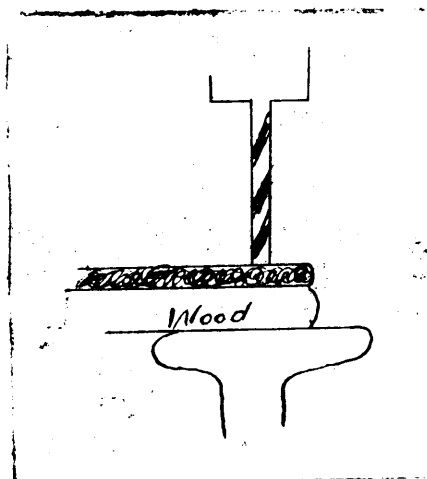


Figure 6.

4. After a turn, lift the drill and see if the drill is in the exact location.
5. Turn, feed, and start drilling.
6. Lubricate as often as needed. Experience will determine the amount.

### Questions

1. What are the suggested sizes of bits to keep on hand?
2. Why should round stock be placed in a "V" shaped block?
3. Is it necessary to have a piece of wood under the stock while drilling?

### References

1. "Farm Shop Practice" - Jones.
2. "Repairing Farm Machinery" - Radebaugh.
3. "Blacksmithing" - Selvidge and Allton.



## RIVETING

### Job 25

There are many occasions in the farm shop when riveting is necessary. Much repair work can be done that would prevent the purchasing of some new pieces of machinery.

Tools - hammer, clippers.

Materials - rivet.

### Procedures

1. Holes may be drilled or punched through stock. It would depend upon the circumstances as to whether the holes would be punched or drilled.

2. Place pieces close together and determine the length of rivet to be used. Leave about thickness of rivet in length beyond the hole for heading. If rivet is too long, any method of cutting soft steel may be used.

3. Place rivet through holes, turn stock over and rest head of rivet against solid piece of metal. Press pieces close together and strike hard blows with hammer directly on top of the rivet. After the pieces are held together solidly, then hammer at an angle in order that a good solid head is formed. Figure 1 shows rounded head formed by delivering final blows at angle.

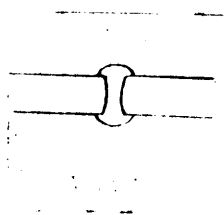


Figure 1.

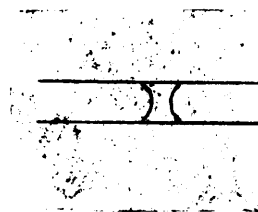


Figure 2.

Figure 2 shows the rivet after being counter-sunk. In counter-sinking one may take a bit slightly larger than the hole for the rivet and drill slightly for the counter sink. Rivets are generally counter sunk when the surface where the riveting is done must be smooth.

4. In case riveting is done where play is needed between pieces, such as a pair of tongs, place a piece of heavy paper between pieces when riveting.

5. Heated rivets make a good job but are not frequently used.

### Questions

1. Is riveting usually done with heated rivets?
2. When would it be necessary to do countersinking?
3. What material is a rivet made from?

### References

1. "Farm Shop Practice" - Jones.
2. "Blacksmithing" - Selvidge and Allton.

## TEMPERING

### Job 26

Tempering is the process of reducing the hardness or brittleness of tools. It is the giving of the required degree of hardness, toughness or softness to a piece of steel, or the giving to a tool the degree of hardness required for the purpose for which the tool was made. The process of hardening and tempering are closely related; one is opposite the other. A tool is hardened before it is tempered. If a piece of tool steel is heated to a cherry red and then cooled quickly by dipping in water or other solution, it will be made very hard, the degree of hardness depending upon the carbon content of the steel and the rapidity of cooling. The higher the carbon content, the harder it will be, and the more rapid the cooling, the harder it will be. Remember that you cannot temper wrought iron, and low carbon steel will temper but very little. In addition to the steel becoming very hard, the steel is also brittle, and has but little strength, as compared to its strength under other conditions. Tempering involves the removing of a certain amount of the hardness and brittleness to allow the tool to do the work required of it.

The common baths used in cooling the metal are, water, brine, and oil. Water is the one most commonly used. The water should never be over 70°F. and the best temperature is around 60°F. It is not satisfactory to have a bath too cool, as well as, too warm. Brine baths are used under certain conditions. Salt or saltpeter are used in making the brine. This solution produces great hardness. Oil is used where a high degree of hardness is not required, and where it is more

desirable to have toughness rather than hardness. Oil has less tendency to warp or crack steel than either water or brine.

Steel must be heated in order to remove the brittleness. For general purposes, the proper degree of heat to temper a tool is determined by temper colors. Every tool is first given a high degree of hardness and brittleness by heating to proper heat, and plunging a portion of the tool into water, or other liquids. A tool with this extreme hardness and brittleness is not fit for use, but if it is heated up slowly the hardness will be drawn. The hardness may be reduced until it will conform to any requirement of the tool. In order that this may be made clear, the description of tempering a cold chisel will be given. Other tempering would be done fundamentally the same.

Since there are so many different alloys of steel today, it is advisable to use water in tempering in preference to other solutions. This is the most useful and practical.

Tools - tongs.

Materials - emery cloth, or file, and cold chisel.

#### Procedures

1. Heat the sharpened or forged and slowly and carefully up to about 1", to a cherry red. (Fig. 1) While heating frequently turn the chisel in order that it will be thoroughly heated. The color should be seen in the shade of the forge or in a slightly dark place, as the cherry red will not show up well in a bright light.

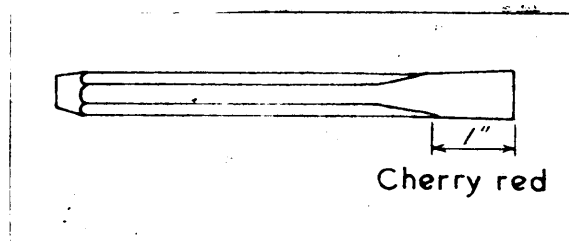


Figure 1.

2. Dip the heated end in the water immediately, to about the depth of  $\frac{1}{2}$ " (Figure 2). Move it slowly back and forth, and slightly up and down. Moving back and forth brings the chisel in contact with cool water. The up and down motion prevents the fracturing of steel at any definite water line. This fracturing is due to the contraction of one portion away from the other at the water line.

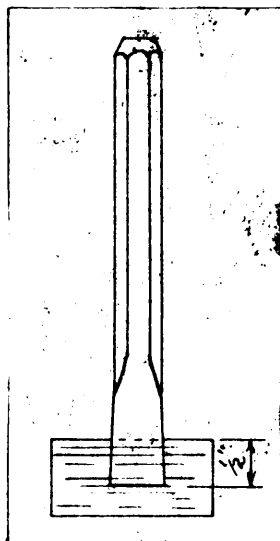


Figure 2.

3. The portion of the chisel dipped in the water should be cool enough to place your hand on. This should not be practical, but after a little tempering your judgement will be satisfactory.

4. After the chisel is cool, remove from the water immediately, and quickly polish with a piece of emery cloth, a file or a piece of old grind stone, to remove the scale.

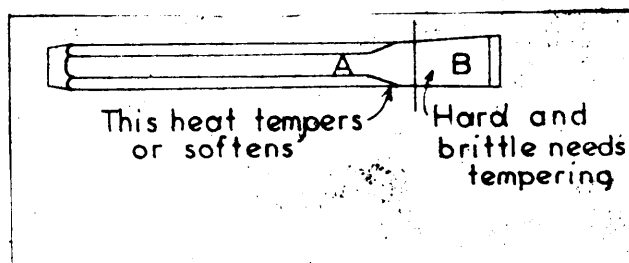


Figure 3.

5. The tempering is accomplished by the heat which is left in the uncooled portion of the tool, that moves down to the cutting end and softens it. When the heat is moving down the shank of the tool, colors are detected. First color to pass down will be light or pale straw, followed in turn by dark straw, brown, red, purple, dark blue, and light or pale blue. (Figure 4.)

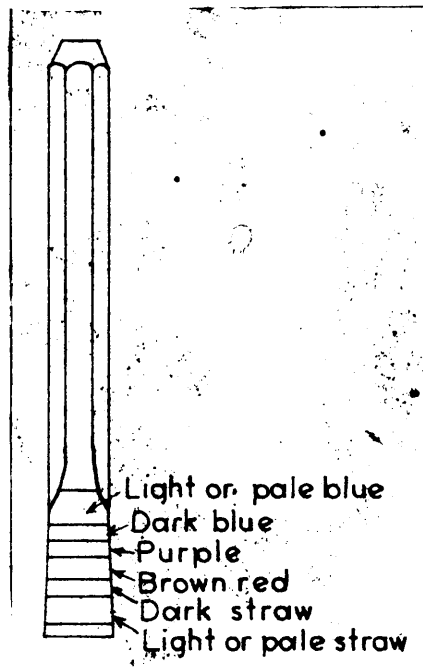


Figure 4.

6. When the color representing the required degree of hardness for the tool reaches the end, plunge into water immediately. (Figure 5) Keep the whole chisel under water until cooled. For ordinary cold chisels, purple or dark blue are the proper colors. For other tools, see chart.

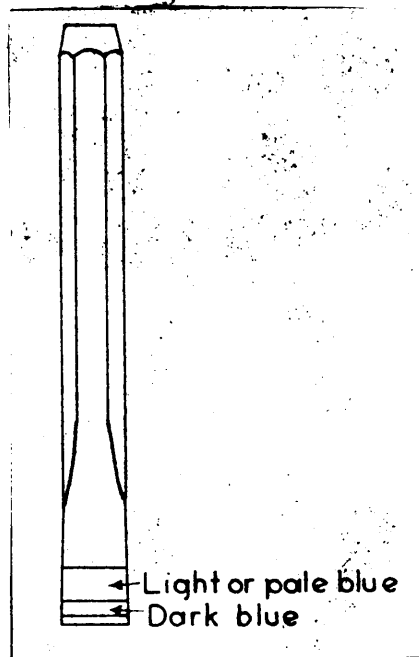


Figure 5.

7. After being cooled, test to make sure it is properly tempered; if not repeat the process. If the tool chips or breaks when used for the purpose intended, it indicates that it was not tempered enough and the tool is too hard. If the tool dents or bends it indicates that it was tempered too much and is too soft. In either case repeat the tempering process, and watch carefully the colors, remember that the yellow or straw color tempering, produces the greatest hardness and pale or light blue the softest temper or degree of hardness.

8. Method of testing. Cut a piece of wrought iron, or an old bolt or some iron similar.



## GUIDE FOR TEMPERING TOOLS

Applications	Temper color	Action of File
Lathe tools, surgical instruments Razors	Pale yellow	File will hardly work
Thread cutting tools and dies	Straw yellow	File will work
Drills for iron	Full yellow	
Carving Knives and Springs	Dark Straw	
Punches and dies, wood working tools, Sledges, blacksmith's hand hammers, stone drills	Deep Straw or Brown yellow	
Stone Drills (hard stone)	Dark Blue	
Table Knives, shears, cold chisels, (for light work) and twist drills.	Purple	
Cold chisels, punches, digging iron, pick and maddocks, General tempering, Hammers.	Blue	

Important Points To Keep In Mind In Tempering

1. Heat to cherry red. Notice heat in shaded place.
2. Move tool up and down slightly and back and forth in water.
3. Never have water over 70°F. or below 60°F.
4. Polish tool immediately, and watch carefully the colors.
5. Temper at the desired color.
6. Test immediately after tempering.
7. If not tempered properly, follow same procedure again and watch desired color.
8. When tempering, a small amount of carbon is lost and if repeated too many times, the tool will be ruined.
9. Different grades of tool steel will have different degrees of hardness when quenched at the same color. Therefore, it may be necessary to experiment with the first piece of a new lot of steel, in order to secure the desired degree of hardness.

### Questions

1. What is the proper color to heat tool steel?
2. Why should you keep the tool immersed in the water until the end cools slightly, before using the emery paper on it?
3. Why polish the surface after the tool is hardened?

### References

1. "Plain and Ornamental Forging" - Schwarzkopf.
2. "Farm Shop Practice" - Jones.
3. "Blacksmithing" - Selvidge and Allton.
4. "Farm Mechanics" - Cook, Scranton, & McColly.
5. "Blacksmithing on the Farm" - Jarvis and Abbott.

## WELDING

Job 27

Welding is one of the most important jobs in forging. The blacksmith is judged to a great extent upon his ability to weld. Welding is the joining or uniting of two or more pieces of metal, usually iron and steel, into an intimate and permanent union. There should be no foreign substances between the welded surfaces, is so the weld would be weak and upon wear would separate. A good weld should be as strong as the other part of the stock; if not stronger.

Essentials which govern the welding of iron and steel are:

1. Fire. Deep, thick and free of foreign materials, such as, slate, clinkers, sulphur and ashes. Thick enough to not allow direct blast on iron. Direct blast will cause iron to absorb oxygen and form an oxide of iron scale on the surface, that prevents welding. A deep, thick fire is very essential.
2. Air forced in should not be great. Irons should be heated slowly and evenly.
3. Irons should be well scarfed.
4. Heating to the proper heat is very essential in welding. It is impossible to weld unless the proper degree of heat is reached.
5. Good flux.
6. Accurate and rapid manipulation.

### Welding Fluxes

Welding fluxes are used for four main reasons:

1. Prevent oxidation or scale formation on the scarfed ends.

Flux melts and forms scale on heated surface.

2. Aids in dissolving any oxide that may have formed.

3. Serves as a protective covering to the scarfed ends, preventing dirt, cinders or other materials adhering to the weld.

4. Lowers the melting point of iron oxide.

The most common fluxes are, borax, clean sharp sand, and welding compounds. Clean sand is hard to obtain, therefore, it is advisable to use compounds or borax.

In welding wrought iron the welding heat is high enough to melt the iron oxide and does not necessarily need the welding flux. However, it is advisable to use the flux in the welding of all iron and steel.

Borax is sometimes mixed with clean fine sand. Some smiths use the borax plain, others use them mixed with equal parts. Commercial welding flux, however, such as may be bought from hardware stores, is usually more satisfactory; and since but a little is needed, it is probably best to buy a small package for the shop.

### Scarfig The Irons

Scarfig is a preliminary step in welding. The scarfig of irons before welding makes a much stronger job of welding. Scarfig is the shaping of irons for the weld.

## Procedures

1. Heat the iron to a working heat.
2. Upset the iron back to about 1", depending upon the kind of job.

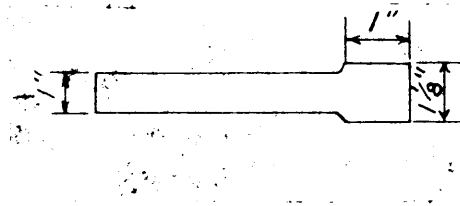


Figure 1.

The upset portion should be about  $1/8$  of an inch thicker than the stock. Upsetting is used chiefly in heavier stock. There is not much need for it in small stock.

3. Place the end of stock on edge of anvil and form scarf. (Figure 2.). Length of scarf should be one and one-half times the diameter of the stock. (Figure 3.)

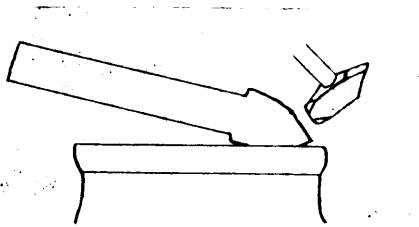


Figure 2.

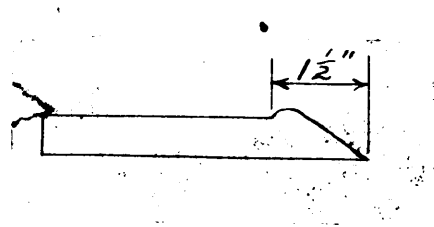


Figure 3.

4. Scarfing should be done in all types of welding. (Figure 4) shows scarfing on a flat piece of stock.

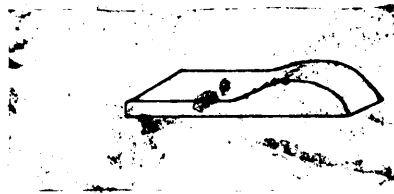


Figure 4.

### Kinds of Welds

There are a number of different kinds of welds, but only a few of the more common ones are given here.

1. Scarf weld, is the weld most frequently used. It is suitable for welding round, flat or square stock. It is used for rods, bolts, rings, links and single tree clips. (Figure 5).

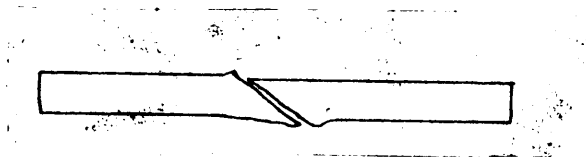


Figure 5.

2. Butt weld, not so strong.

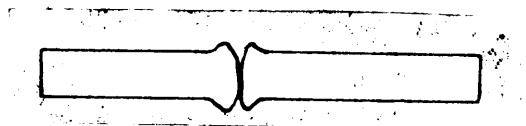


Figure 6.

3. Lap Weld.

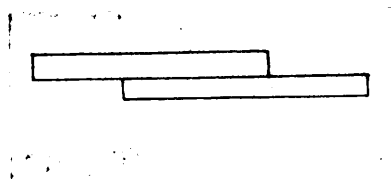


Figure 7.

#### 4. Cleft Weld.

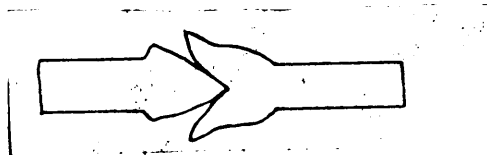


Figure 8.

There are numerous other welds. The majority of the welds in the farm shop are the scarf welds.

#### Procedures of Welding

1. Heat ends of stock, upset and scarf according to the procedures of scarfing.
2. Place both scarfed ends in the fire at the same time and heat slowly. Scarfed ends down.
3. The stock should be turned frequently to insure a well balanced heat. If one end heats faster than the other pull one to the edge of the fire and cool slightly.
4. When the scarfed ends reach a red color, place some welding flux on scarfed portions. In the event you do not have a flux spoon, pull the irons to the edge of fire and drop flux on with the fingers.
5. Heat according to the kind of stock you are working with. If tool steel, do not heat above a lemon color, since high carbon steel heated above a lemon color will crumble. If you are heating wrought iron, it should be heated until whiskers are growing, sweating, spitting sparks, and in a pasty condition. You do not want to keep it



in the fire but a few seconds after sparks begin to fly from the iron; if so the metal will burn.

6. Do not cut off forced air until ready to remove stock from fire.

7. Remove the irons from the fire, rap them sharply on the anvil to remove the scale from on the scarfs. In removing from the fire, raise up and out to prevent dragging through the ashes.

8. Place in position on anvil. (Figure 9). Scarfs should be lapped so that the point of one scarf will meet the heel of the other.

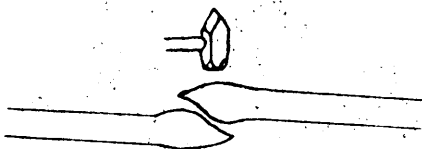


Figure 9.

9. The work must be done fast before the irons loose their welding heat.

10. Strike with medium blows. The first blow should be in the center to force any scale to the outside. (Figure 9). If the irons do not stick together in the first blow or two, it is useless to continue hammering. If it doesn't stick, re-shape the scarfs, reheat and add flux as before.

11. If the pieces stick together, hammer several blows on one side, turn over and strike several on other side. Do not work weld after proper heat has gone. It is frequently necessary to take two extra heats. In taking an extra heat to weld down a lap, the lap

should be on the underside just before removing. This insures thorough heating. Add flux to weld at extra heatings.

12. After weld is completed in a round rod, the welding section should be smoothed and brought down to desired size by first making the section square, as in drawing out, then eight sided then round. This depends upon whether the welded stock is straight or in the form of a link or weld. In any case the weld should be brought to the size of stock, to make a neat job.

#### Common Causes of Failure in Welding

1. Stock not heated to proper temperature.

2. Fire may be too slow, too shallow, or may have clinkers, slate or poor grade of coal that contains sulphur. It is out of the question to attempt to weld with coal that has much sulphur in it. Good coal will crumble.

3. After two or three attempts irons may be burnt, if so cut off ends and re-scarf and repeat the heating process.

Only one weld is described, but after one familiarizes himself with this weld he can do the others as well.

### Questions

1. Why upset the stock before making a weld?
2. Why should all welding heats be taken slowly?
3. Why should the first blow be struck in the center?
4. What are some of the common causes of failure in welding?

### References

1. "Plain and Ornamental Forging" - Schwarzkopf.
2. "Blacksmithing" - Selvidge and Allton.
3. "Farm Shop Practice" - Jones.
4. "Blacksmithing on the Farm" - Jarvis and Abbott.
5. "Repairing Farm Machinery and Equipment" - Radebaugh.
6. "Farm Mechanics" - Cook, Scranton and McCally.
7. "The Farm Work Shop and Woodlands" - E. C. Atkins Co.
8. "Farm Mechanics" - Crenshaw and Lehman.

## HARDENING METAL

Job 28

Many jobs in the forge work require hardening. It is very essential that one becomes familiar with the hardening of metal since many jobs are based on this. If a piece of steel is heated to a cherry red and immediately quenched in water the metal becomes hard. The degree of hardness depends upon the amount of carbon present in the metal, and the rapidity of cooling. The higher the carbon content and the more rapid the cooling, the harder the steel will be. Other baths are used in hardening steel besides water.

1. Oil or lime or soda lessen the intensity of the effect, thus steel articles that do not need to be very hard may be cooled in the above solutions.

2. Salt or salt peter intensify the effect and produce greater hardness. These solutions are used where a great degree of hardness is needed. The best temperature of liquids for hardening metal is from 50° to 70°F.

3. The greatest hardness of all is made by heating steel to a cherry red and plunging into mercury. This process makes the metal very hard and a file will have no effect on it. Also this degree of hardness will not stand bending.

4. Hardened in the air - this method should not be used for the average metal that is used in the farm and school shop.

5. Water method - this is the most practical for the school and farm shop.

In the hardening of certain metal it is necessary that we temper. Tempering is the softening of metal. We must first harden the metal and use the color scheme in obtaining the proper degree of hardness as in tempering.

#### Hardening A Short Axle

1. Stock is heated to a cherry red and immediately quenched in water. All of the stock is quenched. It is moved backwards and forwards and up and down to insure proper cooling.

2. Taken from the water and placed end first in a piece of pipe larger than the axle. This is to permit the blue color to return to the surface evenly. The end should be pulled out of pipe far enough to detect the color. When the colors are nearing blue, watch carefully and when dark blue appears, remove from the pipe and quench in water until cooled. This is recommended over keeping the axle in the open air and waiting for colors as with small tools, such as the cold chisel, punches, etc. Left in the air may set up uneven strains by the inner part not being evenly heated.

### Questions

1. What are the baths used in hardening metal?
2. Which is the most practical one for school and farm shop work?
3. Why wouldn't you harden an axle like you would a cold chisel?

### References

1. "Plain and Ornamental Forging" - Schwarzkopf.
2. "Blacksmithing" - Selvidge and Allton.
3. "Farm Shop Practice" - Jones.

## ANNEALING OR SOFTENING METAL

### Job 29

Annealing is a process of softening steel. Often tool steel is annealed by the manufacturer before being sold, but in forge work on the farm or in the school shop there is a need for annealing. Often in forging steel, strains are set up which should be taken out before hardening or tempering. These strains may be set up by alternate heating and cooling and by hammering. Various degrees of heat when applied to iron and steel have different reactions on metal.

The reactions of different heats are as follows:

1. A coarse grain structure results from heating to a yellow or white color, and cooled quickly.
2. A finer grain results when steel is reheated to a cherry red and allowed to cool slowly.

Through this process of annealing, the steel is changed into a uniform structure, uniform strength, and a tough nature. Annealing of steel is important in the process of making cold chisels, punches, etc. of any kind of steel that is forged.

Steel may be annealed and then easily sawed with a hack saw, which otherwise would be almost impossible.

### Procedures

1. Heat slowly that portion of stock that is to be annealed to a cherry red. All portions of the stock do not need to be softened.

It is only the portions that have been hammered on that need to be softened to relieve certain strains that may be present.

2. Bury stock in a box that contains lime, wood ashes, or fine coal, at least away from all drafts. Let the stock remain there until cold. In this procedure it should cool slowly.

3. Most blacksmiths after working out the metal, before tempering, lay the stock out in the open to cool. This is the more common practice.

4. If time does not permit, the water method may be performed. This is much quicker than the above. If properly performed, good results may be obtained. Heat to a cherry red and permit to cool without packing until no heat colors are visible in a dark light, then plunge it into the water to cool immediately. One must not be in too much of a hurry, and cool too rapidly, if so then you may make the metal hard rather than soft.

5. Copper and brass may be annealed by heating to a red heat and plunging into water immediately.



### Questions

1. What are two methods of annealing?
2. What does the word anneal mean?
3. Why should we anneal before hardening?

### References

1. "Plain and Ornamental Gorging" - Schwarzkopf.
2. "Blacksmithing" - Selvidge and Allton.
3. "Farm Shop Practice" - Jones.
4. "Farm Mechanics" - Cook, Scranton, McCally.

## BENDING AND SHAPING STOCK FOR EYES AND RINGS

Job 30

There is a constant need for the bending and shaping of stock in the farm shop. It requires considerable skill in doing the job well. Many times the beginners have difficulty in keeping the stock in line. Bending and shaping of stock is employed in making iron rings, eyes and hooks, lap links, opening rings, etc. Many other jobs could be done after obtaining the principles by which rings and eyes are formed.

Tools - tongs, hammer, steel square.

Materials - stock (2 pieces).

Bending And Shaping Stock For Eyes

## Procedures

1. Measure off and mark with center punch the amount of stock required for the eye.
2. Heat to a cherry red and square the ends as shown in (Figure 1).

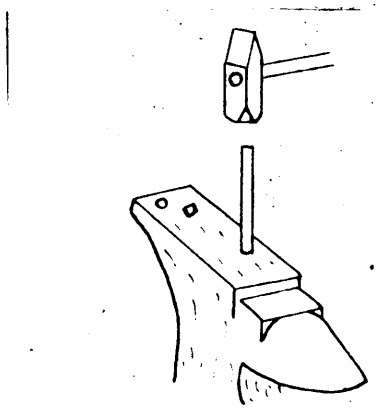


Figure 1.

3. Place stock on face of anvil and extend the stock over the side to the point marked. (Figure 2).

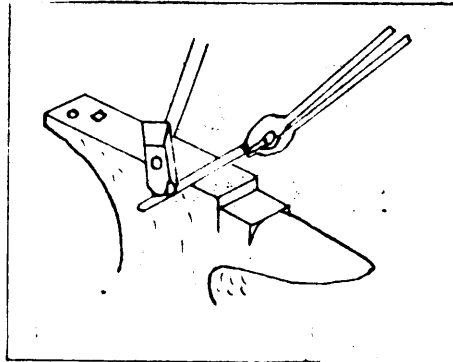


Figure 2.

4. Bend stock to a sharp right angle. (Figure 3). There should be a gradual bend at first by striking blows beyond the mark. Blows must be struck on top of stock frequently as shown by the arrow in (Figure 3.) The blows on the side and top should be balanced enough to keep the stock in the proper direction. Care must be taken to prevent too much spread at the point of offset, where the right angle is made.

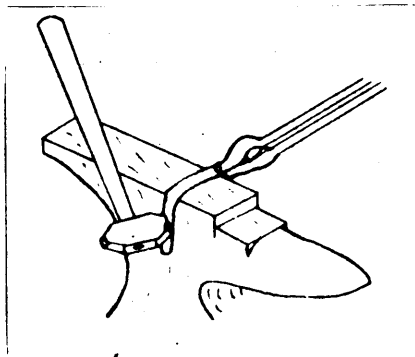


Figure 3.

5. Extend the end of the stock that is to form the eye over the tip of the anvil horn and bend tip end until it is about the same bend of the finished eye. (Figure 4). Reheat whenever necessary.

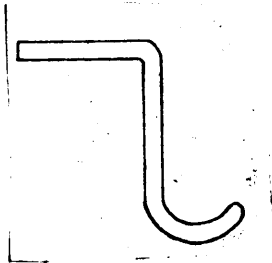


Figure 4.

6. As the curve is formed, keep moving the stock over the horn, striking glancing blows on top of the stock until all the stock back to the right angle is formed into a circle. (Figure 5).

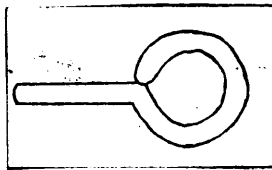


Figure 5.

### Bending And Shaping For Rings

#### Procedures

1. For measuring stock see job on measuring stock.
2. Cut stock the desired length.
3. Heat stock to cherry red and square both ends.
4. Heat stock again and bend one-third of the stock over the anvil horn. Then bend the other end. (Figure 6).

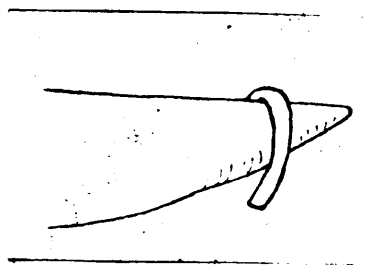


Figure 6.

5. Heat the center of stock and bend it making the two ends come together. Just before bringing the two ends together, place the stock in the vise and file the ends in order to make a snug fit. Sometimes rings are welded. In such cases see job on welding.

6. In turning the ring this may be done either on the horn of the anvil or the mandrel if one is available. (Figure 7.) The finished ring. (Figure 8).

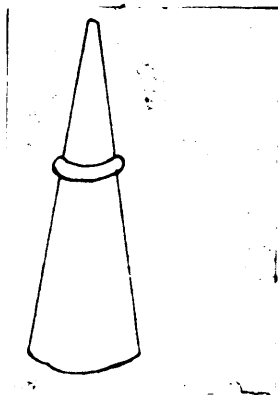


Figure 7.

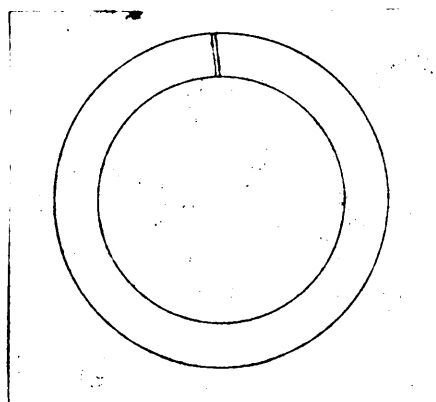


Figure 8.

### Questions

1. What are the advantages in knowing different methods of bending metal?
2. Which gives better results in truing a ring, the mandrel or the anvil?
3. Why should you first square the ends?

### References

1. "Blacksmithing" - Selvidge and Allton.
2. "Farm Blacksmithing" - Friese.
3. "Farm Mechanics" - Cook, Scranton, McCally.

## FILES

Job 31

A file is one of the most valuable cutting tools in the forge shop. A file is handier on certain jobs than the grinding wheel. For example, sharpening a garden hoe, one can do this much quicker with a good file. Files are made from very high carbon steel. An old worn out file can easily be made into a wood chisel, but it is too hard and brittle to make into a cold chisel. There are many kinds of files, but the single cut, double cut and the rasp cuts are the most commonly used. These are based on the kinds of cuts that form the teeth.

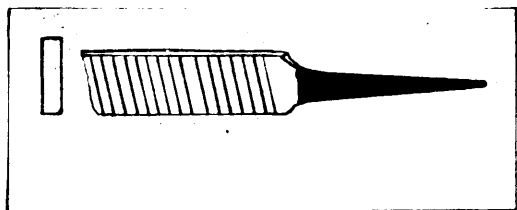


Figure 1.  
Single cut

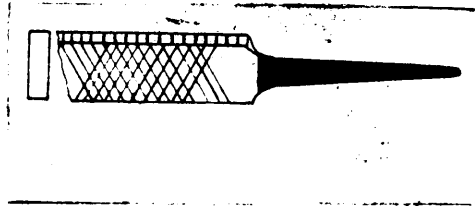


Figure 2.  
Double cut

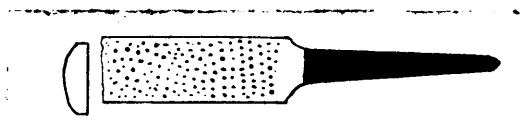


Figure 3.  
Rasp

Files according to their shape are:

1. Flat, as shown in Figure 1, 2 and 3.
2. Triangular, Figure 4, and 5.
3. Rat Tail.

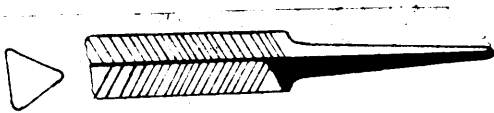


Figure 4.  
Saw File (Triangular)

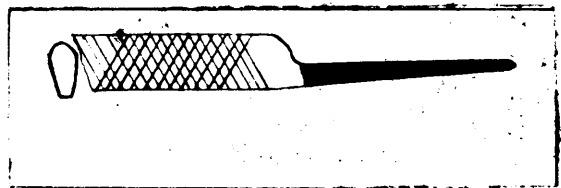


Figure 5.  
Cross cut (Triangular)

The rat tail is used in filing out holes.

The round, square and half round are used, but the flat and triangular are used more often in the school and farm shop.

#### Care of Files

Since files have sharp tempered cutting edges it is very important that the proper care be given them. Handles should be placed on the files before using. Some use an adjustable metal handle, as in (Figure 6). This handle can be removed, and placed on any file.

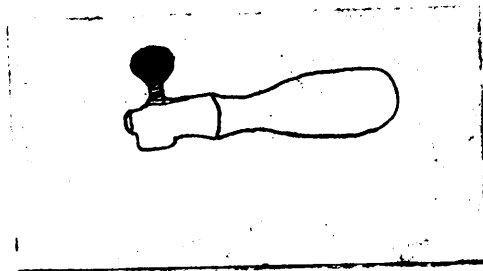


Figure 6.



The wooden handle is used quite frequently. (Figure 7). Many people on the farm make their own handles, out of wood or a corn cob. Files should not be thrown around and be permitted to be in weather and rust.

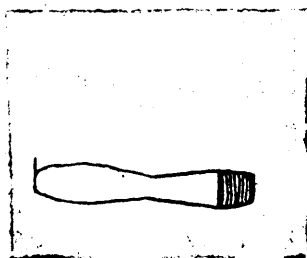


Figure 7.

Also one should be careful not to throw a file on other metal, in order that the cutting edges are not dulled. Have a definite place to keep file, as shown in(Figure 8). The point of the tang may be put in the hole bored in a piece of wood. This can be done if the handles are taken off. If the handles are not taken off place them in the grooves as shown in(Figure 8). All files while being used should have handles on them.

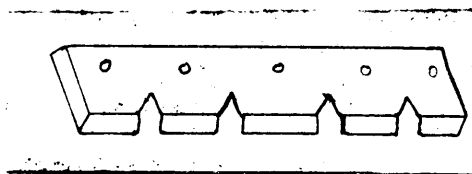


Figure 8.

### Groups Of Files According To Their Uses

1. The saw file group, comprising the kinds of files whose particular use is in sharpening or filing saws of various descriptions. This includes mill files, triangular or three cornered saw files and saw files of special sections.

2. The machinist's files, comprising those kinds generally used in machine shop practice, including the various styles of flat, hand, half round, round, square, etc.

3. Rasps of various types. This group comprising wood rasps, cabinet rasps, shoe and horse rasps.

Classification of files according to their coarseness and fineness:

1. Coarse
2. Bastard
3. Second Cut
4. Smooth

Mill files are flat single cut files, tapered slightly in thickness and in width for about one-third of their length. Used principally for filing mill or circular saws, and various kinds of tools and knives.

### Points In Selecting A File

1. Know the type and kind of material to file.
2. Know the rate of removal. The file should carry away most of the material. The proper file used on the proper material will relieve much gumming or filling up of the file.

3. Quality of finished product. Coarse file will give rough finish, and a fine file a smooth finish.

#### Three Distinguishing Features of Files And Rasps

1. Their length, which is always measured exclusive of the tang.
2. Their kind or name, which has reference to the shape or style.
3. Their cut, which has reference not only to the character, but also the relative degree of coarseness of the teeth.

#### Procedures In Filing

1. Clamp the work to be filed firmly in the vise in a horizontal position.
2. The size of the file to be used will depend upon the kind and size of the work.
3. The work is easier to file when about elbow high, but this will depend upon where the vise is mounted.
4. Grasp the handle with whole hand and the other end with thumb and forefinger for light work. (Figure 9).

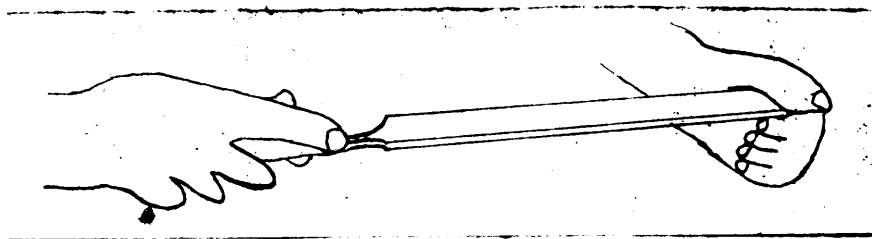


Figure 9.

5. For heavy filing grasp handle with whole hand and grip firmly the other end. (Figure 10).

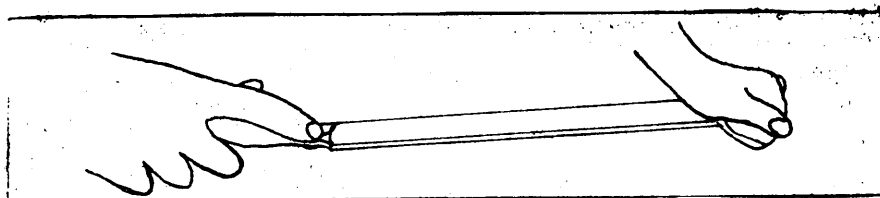


Figure 10.

6. Use moderately slow, long full length strokes.

7. Always put pressure on outward stroke and release pressure on backward stroke. Never drag file over metal.

8. Before attempting to file, first determine the angle that is to be filed.

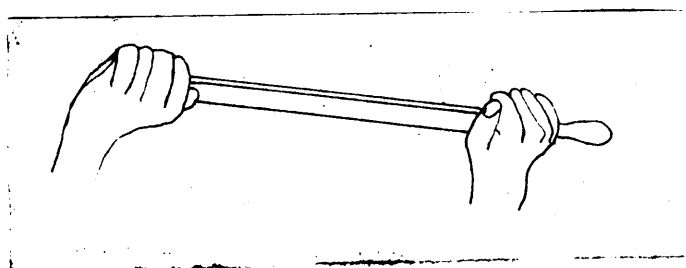


Figure 11.

9. Draw filing is used chiefly in smoothing long rough surface. Grasp each end of file as shown in(Figure 11).

10. Always keep the file clean. If the file does not clean itself, use a small wire brush known as a file card, or use an end of a small piece of wood. Either rubbed across the file will clean well.

### Questions

1. What is a mill file used for chiefly?
2. Is it necessary that files have handles while being used?
3. What is the rat tail file used for chiefly?

### References

1. "Farm Shop Practice." - Jones.
2. "Repairing Farm Machinery and Equipment" - Radebough.
3. "Farm Mechanics" - Crenshaw and Lehman.
4. "Blacksmithing" - Selvidge and Allton.
5. "Farm Mechanics" - Cook, Scranton, & McCally.

## CUTTING THREADS

Job 32

Many repair jobs can be done on the farm by the use of some threading tools. The common threading tools are given below. Stock is used in holding the die.

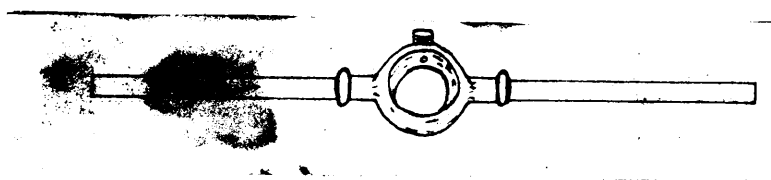


Figure 1.  
Stock

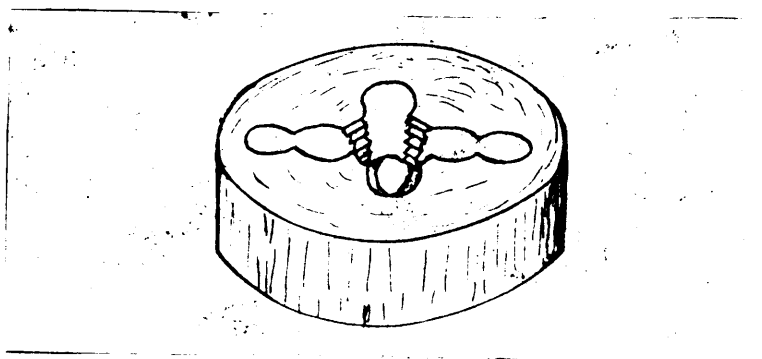


Figure 2.  
Die

The dies are adjustable in the stock given above.

There are two most commonly used threads. The U.S.S. (United States Standard) and the S.A.E. (Society of Automotive Engineers). The U.S.S. threads are used chiefly in the farm repair work while S.A.E. threads are used in automobiles, engines, and machine work. The chief difference in the two is that the U.S.S. has many less threads per inch than the S.A.E. and S.A.E. are much finer. For general farm work use U.S.S. dies.

Most common sizes of dies used in farm repair work are;  $1/4$ ,  $5/16$ ,  $3/8$ ,  $7/16$ ,  $1/2$ ,  $5/8$  and  $3/4$ .

The U.S.S. threads are "V" shaped as shown in (Figure 3.) With a  $60^\circ$  angle between threads.

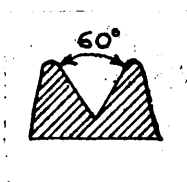


Figure 3.

The lubricants used in threading of stock vary somewhat. Lubricants must be used in threading stock except in the case of cast iron where very little is used. If oil is used in drilling or threading cast iron it causes the chips to stick to the bits, and dies respectively. The commonly used lubricants are:

1. Animal lard oil.
2. Sperm Oil.

Machine oil is not used when the above can be obtained.

Tools - stock, die.

Materials - lard oil or threading oil, stock to cut threads on, rod or a bolt.

#### Procedures

1. Round end of stock slightly, (Figure 4). This may be done on the grinding wheel, grindstone or with a file or a hammer. The purpose of rounding the stock slightly on the end is to aid the die in starting easily.

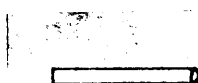


Figure 4.

2. Place in the vise in an upright position.

3. Make sure that the die is level and that the threads are started even, that is, do not have the threads crooked. Exert equal pressure on each handle. Make a downward turn first to get thread started. (Figure 5).

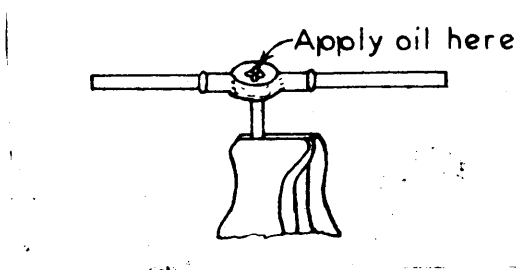


Figure 5.

4. Make about two turns forward, then turn left one-half turn and apply lubricant in the die, this will permit the oil to soak down through the threads. (Figure 5).

5. Continue this procedure by working two to three turns to the right and one-half turn back to the left and apply oil.

6. In case the die is left handed turn to left in the beginning.



### Questions

1. Would you use machine oil in threading stock?
2. Why turn left one-half turn before applying oil on die?
3. Why should the end to be threaded be rounded slightly before starting the threads?

### References

1. "Blacksmithing" - Selvidge and Allton.

## GRINDING WHEELS

Job 33

Since there are many difficulties in keeping a grinding wheel in the proper condition, it is essential that some space be given here on the grinding wheel. To obtain the best results from the grinding wheels, the individual should know before buying, the types and grades to be used. For a long time many persons had the idea that knives, axes and other small tools could not be sharpened on a grinding wheel because the chances of burning the metal was too great. Knives, axes, scythes, cutter blades, chisels and many other small tools may be sharpened on the grinding wheel provided it is carefully done and the proper wheel is used. Details will be given on grinding in various jobs, but one important factor to keep in mind is not to burn the tool. To prevent this keep the tool light on the stone and move backwards and forwards across the wheel.

Operation 1. Selecting The Wheel

In order that proper grinding be done, two types of grinding wheels should be on hand. One for soft metal and another for hard metal or tempered metals.

Carborundum wheel - Carborundum is a chemical combination of carbon and silicon. It is made up of small sharp crystals, that break slightly in use. Used in grinding brass, bronze, cast iron, chilled iron, marble and granite.

Aloxite wheel - purest form of aluminum oxide. It is extremely successful in all steel grinding because of its hardness, sharpness, toughness and proper temper. Used in grinding steel.

Emery wheels were at one time used extensively for grinding purposes. Emery wheels are not used in the better wheels today, as they glaze or load easily and rapidly over-heat.

In the majority of farm shops the two kinds of wheels are sufficient, the Carborundum wheel and the Aloxite wheel.

In school shops additional wheels are needed for special jobs, such as polishing and buffing wheels.

#### Operation 2. Testing the Wheel for Safety

When you receive a new wheel it is advisable to test it for defects such as cracks or broken places. This would prevent certain accidents later. All reliable manufacturers test their wheels before shipping, but they may be cracked while being shipped. Simply tap the side of the wheel slightly with a hammer and if it rings the wheel is sound.

#### Operation 3. Adjusting the Wheel

The wheel should go on the spindle easily and not pressed on. Flanges should be used that are at least one-half the diameter of the wheel. Compressible washers of old leather, rubber packing, or blotting paper, slightly larger than flanges, should be placed between the wheels and flanges. This protects the wheels, as the pressure is distributed evenly, when the flanges are tightened. The flanges should

be tightened only enough to hold the wheel firmly. Many times the nuts are turned too tight on the spindle.

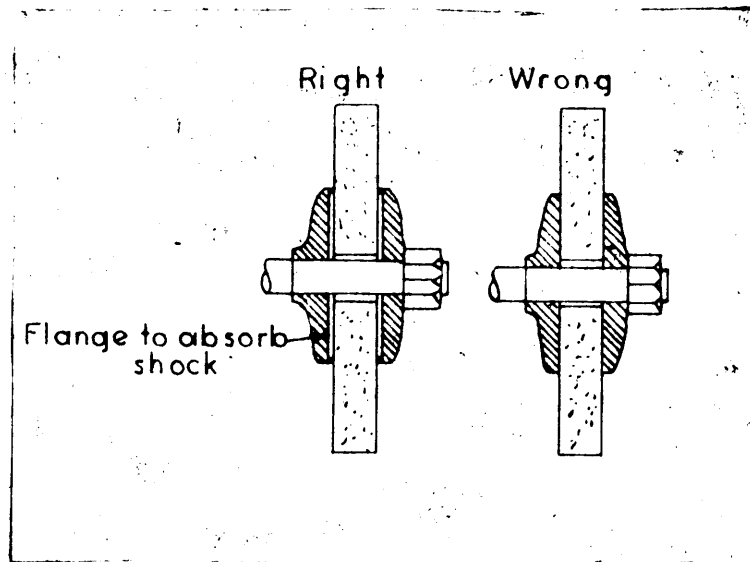


Figure 1.  
Right

Figure 2.  
Wrong

#### Operation 4. The Safety of the Grinding Wheel

The grinding wheel should always be properly enclosed. The grinding rest should always be placed close to the wheel. When grinding, the wheel should always be turning towards the operator with the work being moved over the entire face of the wheel. The wheel should never be operated unless the operator wears goggles to protect his eyes. If the wheel has a glass shield on it, it is not necessary to wear goggles. The rest should be placed close to the wheel.

### Operation V. Truing the Wheel

#### 1. Reasons for truing:

##### (a) When wheels become loaded.

(1) They become loaded by grinding soft metal such as aluminum, lead or brass on a wheel which is not made for the grinding of such.

(2) By grinding when the wheel is too hard.

(3) By grinding when the wheel is running at too slow a speed.

(4) By grinding when the wheel has improper grain.

(b) When the wheels become unevenly worn by continuous grinding.

(c) When the tool becomes hot and is not cutting, generally a result of being loaded.

2. Method of truing. Move the wheel dresser back and forth across the wheel while the wheel is in full speed.

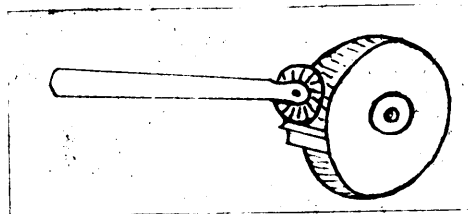


Figure 3.

In the event the wheel becomes loaded with grass, lead or aluminum, it should be picked out with some fine pointed tool.

Points to Keep in Mind About the Grinding Wheel

1. Select a good grinding wheel.
2. Select wheels that are adapted to the kind of work you are doing.
3. Never grind aluminum, lead and brass on a wheel unless that wheel is especially made for such.
4. Test the wheels for cracks when purchased.
5. Mount the wheel properly by placing packing between flanges and wheel, and do not tighten the wheel too tight.
6. Keep the rest close to the wheel.
7. If you do not have the glass shield, use goggles.
8. In grinding move the tool from side to side to insure proper grinding and prevent over-heating and untrueness.
9. Always turn the wheel towards the work.
10. True the wheel immediately when it needs it.

### Questions

1. How would you test a wheel for safety?
2. Why wear goggles or have a safety glass shield on the grinder?
3. What wheel would you use if you wanted to grind aluminum, lead or brass?

### References

1. "Repairing Farm Machinery" - Radebaugh.
2. "Farm Shop Practice" - Jones.

## TRUING A GRINDSTONE

Job 34

This job is very essential to the success of any grinding. The stand on which the grindstone sits must be solid, that is, it should not wobble in anyway. When the stands are not solid, the wheels become out of line and makes grinding very difficult. As soon as you find the stone out of true you should take time to true it, since the longer it goes the more untrue it becomes. The grindstone may be trued with a piece of gas pipe or a file, or with both. Many cases it is not necessary to use the file. The file should be used only when the stone is extremely untrue. Water should be kept on the grindstone continuously while using it, but when not in use do not permit the stone to stand in water since this would soften the stone.

Tools -

Materials - piece of iron pipe about  $3/4$ " to  $1\frac{1}{2}$ " size. An old file.

The grindstone is used less today on the farm than a few years ago, due to the great improvements in the faster cutting grinders. Grindstones do not cut as fast as a grinding wheel. There is much less danger of burning the tool while sharpening and for this reason the grindstone is preferred by many people for the sharpening of edge tools, such as, mower knives, scythes, ensilage cutter blades, etc.

Procedures

1. Place pointed edge of an old file on a rest. (Figure 1). Turn grinding wheel. The file is used only when the stone is in a bad



condition. This will remove the rough spots quickly. After this is done the stone will be rough.

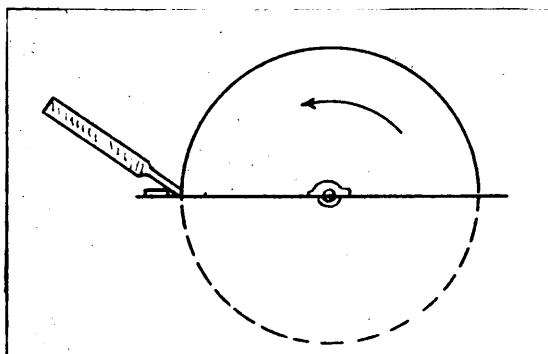


Figure 1.

2. Place a piece of iron pipe in the same position as you did the file. (Figure 2). Turn the stone. This will smooth the stone. The pipe should be moved back and forth across the stone to obtain an even and smooth surface. Ordinarily the pipe is sufficient without the file.

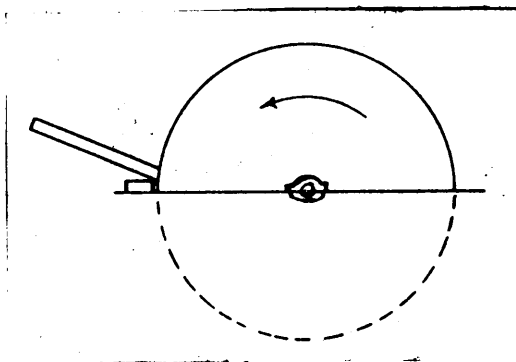


Figure 2.

### Questions

1. What is the chief cause of a grindstone becoming untrue?
2. Is it good for a grindstone to set in water when not in use? Why?
3. Which would you prefer to true you grindstone with, the pipe or file? Why?

### References

1. "Repairing Farm Machinery and Equipment". - Radebaugh.

## FITTING A SCREW DRIVER

Job 35

Many heads of screws are ruined because of the improper fitting of the screw driver. Generally, we attempt to sharpen the end of a screw driver to fit a small screw and as a result the tool has been damaged. There are various styles of screw drivers, but for general shop work the styles do not vary much. Generally, a complete metal screw driver is used in metal work and a wooden handled one is used in wood work. This, however, does not hold true in the school and farm shop, as both kinds are used in the metal and wood working shops. The main thing to keep in mind in using the screw driver is to obtain one for the job that fits the head of the screw. For this reason, it is advisable to have a several different size screw drivers in the shop. There are only a couple of screw drivers in the average farm shop. Due to a limited number of screw drivers in the shop it is necessary that they be fitted for certain screws. You can easily fit one on a grinding wheel. (Figure 1). is the result of attempting to remove a screw with an improperly fitted screw driver.

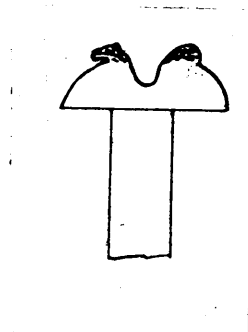


Figure 1.

Tools - hammer, tongs, grinder.

Materials - screw driver, emery cloth.

### Fitting on a Grinding Wheel

#### Procedures

1. Determine the size of groove in the head of the screw. Figures 2, 3, 4 and 5, give the proper and improper fitting. The end should be blunt and the sides of the screw driver parallel to the slot in the head.

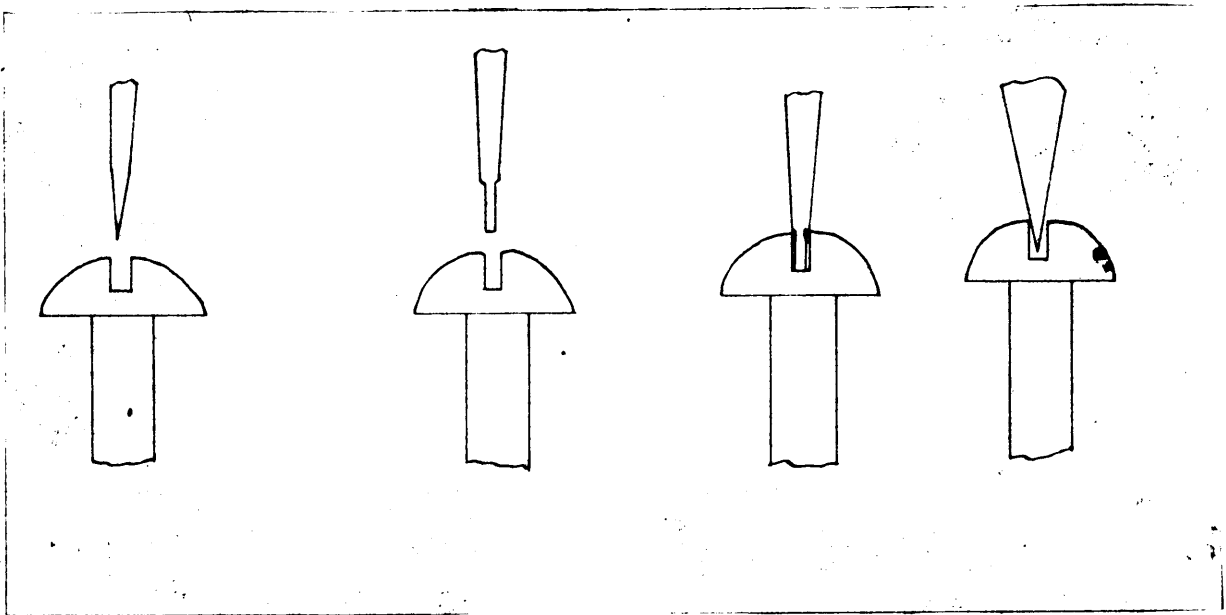


Figure 2.  
Improper.

Figure 3.  
Proper.

Figure 4.  
Proper.

Figure 5.  
Improper.

2. Place on grinding wheel and shape to fit the head of the screw.

### Fitting By Forging

#### Procedures

1. Determine the size and shape of the slot in the head.

2. Heating and shaping is not necessary, except when the screw driver becomes thick, or when it has been ground back past where it was tempered. This would be detected by the end becoming soft and twisting.

3. Screw drivers are made from tool steel.

4. Heat to a cherry red or low orange, shape and let cool. Smooth down on grinding wheel.

5. Temper as you would a cold chisel except the temper color should be a light blue. This is slightly past a dark blue.

### Questions

1. What kind of metal is a screw driver made from?
2. What should be the temper color of the screw driver?
3. Why shouldn't you forge all screw drivers in fitting them?

### References

1. "Repairing Farm Machinery " - Radebaugh.
2. "Farm Mechanics" - Crenshaw and Lehman.

## HEADING A HAMMER AND HATCHET

Job 36

Many times hammers, hatchets, axes and many other useful tools are thrown away because their heads are battered and have spread out which makes them unuseful for successful work. It is impossible to drive nails successfully with a hammer that has a rounded head. Wedges and many other tools can be headed the same way. The job of heading the hammer is different than that of a hatchet and larger tools, therefore, careful attention must be given to the two jobs.

Tools - tongs, hammer.

Materials - hammer, hatchet, emery cloth.

Hammer

## Procedures

1. Remove handle from hammer.

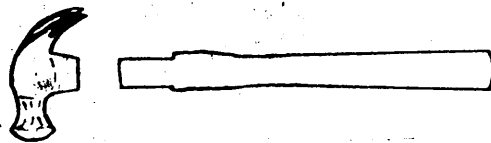


Figure 1.

2. Remember that the hammer is made of high carbon steel, therefore, heat according to the metal you are working with. Heat to cherry red or dark lemon color and shape as shown in(Figure 2).

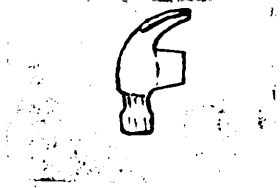


Figure 2.

3. Permit to cool and smooth head on grinding wheel.

4. Hammer must be tempered. Place a temporary metal handle in the hammer, an old piece of pipe will do. Place hammer in fire and heat to cherry red, remove and immerse in water as you would in tempering a cold chisel, moving up and down and backward and forward for a few seconds, then remove from water and watch colors. When the hammer becomes blue, immerse in water until cooled. In case the claws or some other portion shows blue first, place that portion in water temporarily until other portion turns blue. You may, on first thought, think that you could temper the head and claws separately, but this would not be satisfactory since the heat from either when tempering would soften or cause the other to loose its temper. For example, if you tempered the head and then expected to temper the claws, when heating the claws the chances are the heat would drive the temper from the head.

5. Place the handle back in the hammer. Hammer should be as good as new. (Figure 3).

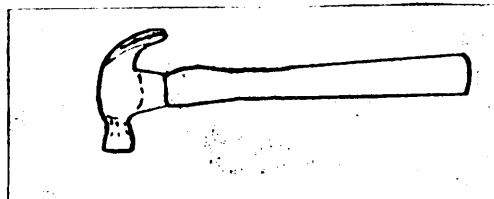


Figure 3.



6. In tempering the hammer, another method may be used. Heat head to cherry red and temper to a blue color. Then wrap some thick wet paper around head and grasp head with tongs, then place claws of hammer in fire and heat to a cherry red, and temper to a blue color. Do the head first since it takes but little heat to make claws cherry red.

### Hatchet

#### Procedures

1. Remove handle from hatchet.

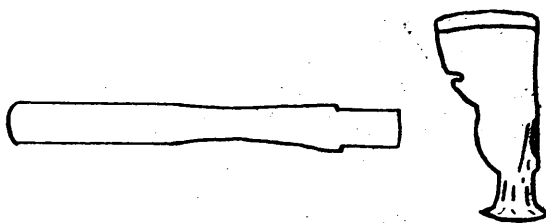


Figure 4.

2. Heat hatchet and shape as the original hatchet was. (Figure 5). Remember that hatchets are made from high grade tool steel and must be heated accordingly - cherry red or dark lemon color.



Figure 5.

3. Let hatchet cool, then sharpen the cutting edge and grind the head smooth.

4. Hatchet must be tempered. Temper the head first as there will be less heat required in tempering the cutting edge. Heat about 1" of head to a cherry red and place about 3/4" of head in water as you would a cold chisel. Remove and watch colors, when blue appears on end of head place in water until cooled. Then heat cutting edge to cherry red, being careful not to heat any more of the cutting edge than is necessary for fear of softening the head. After heating about 1" of cutting edge to cherry red, then immerse in water, as you would with cold chisel, to chill the edge, remove and watch for blue color. When it appears place in water until cooled. Your hatchet should be as good as new. If the head chips off while in use, it indicates that you have tempered too hard, and on the other hand if it spreads too much, you have the head too soft.

5. Place the handle back in the hatchet.

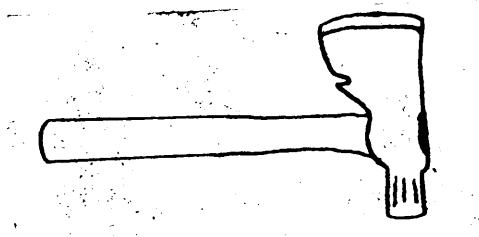


Figure 6,

The axe may be re-headed the same way the hatchet has been done. Other tools can be done in the same manner as the hammer and hatchet.

Questions

1. What is the temper color for the hammer and hatchet?
2. Why use a temporary handle in these tools?
3. What other tools can be reshaped like the hammer and hatchet?

## MAKING A BAILED HAY HOOK

Job 37

The hand hay hook is a very useful tool on the farm. It may have numerous uses, such as handling bailed hay, hogs at butchering time, cotton bales, fruit boxes and barrels. The job of making this hook is not difficult. On many farms rake teeth are often broken and can be used for a hook when forged. There are many styles of hay hooks, each with different shaped handles and hooks. The one I am describing is simple in construction and has a wide handle which fits the hand. The hook is so shaped that it will pierce the bale and will not pull out until the workman wishes. The handle may or may not be welded, depending upon the desire of the individual. An unwelded handle will stand heavy work without pulling apart. The welded handle makes a slightly neater handle. The length of the hook depends somewhat on the use, but for general purposes a piece of stock 22" long is sufficient. The hook is made from tool steel.

Tools - hammer, steel square, tongs.

Materials - broken rake tooth or similar material, high carbon steel.

Procedures

1. If made from a rake tooth, heat stock to a cherry red, beat and straighten.
2. Heat 1" of one end and draw out to a sharp point.(Figure 1).

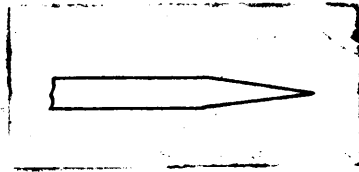


Figure 1.

3. Mark off 10" from pointed end. Heat at this point and bend to a right angle. The bend may be made over the edge of the anvil or by placing the stock in the pritchel hole and bending.

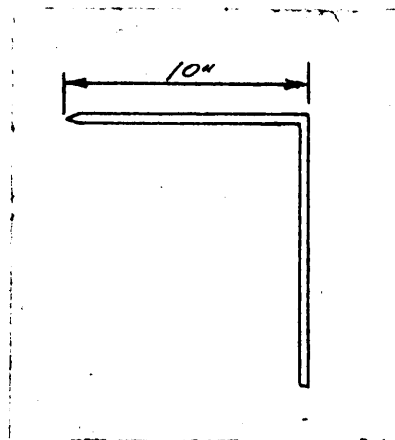


Figure 2.

4. Measure off  $2\frac{1}{2}$ " from A towards B, and bend as shown in (Figure 3). This bendingshould be done over the horn of the anvil.

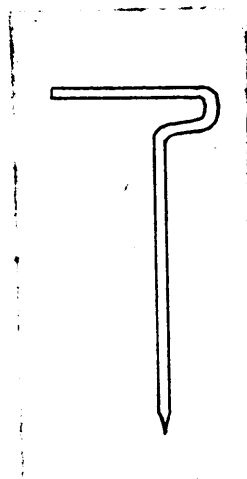


Figure 3.

5. Complete the bend of the handle as in Figure 4. In doing this the end will not always meet the stem on the right plane. If too short or too long you can enlarge or make smaller the handle. (Figure 5).  
Complete handle.

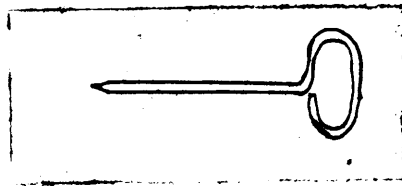


Figure 4.

6. This part should have a dip in order that it will enable you to obtain a better hold on the object. Mark 3" from the handle, heat and bend at this point. Then complete the bend of the hook. Always let the point bend slightly outward in order that it will grasp easier. (Figure 5).

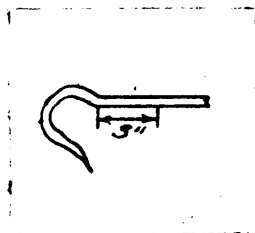


Figure 5.

7. Temper the point to a blue color.
8. The completed hook. (Figure 6).

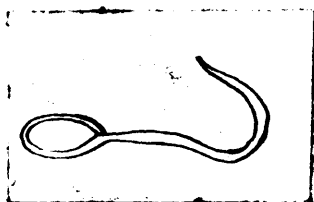


Figure 6.

If the handle of the hook is to be welded you simply scarf the opposite end of the point and weld where the handle has been formed. (Figure 7). Completed hook. (Figure 8)

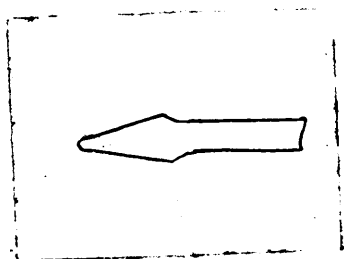


Figure 7.

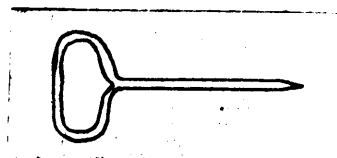


Figure 8.

### Questions

1. What should be done if the metal is badly burned?
2. If the end will not meet the stem in making the handle, what would you suggest doing?
3. What uses are made of the hand hay hook?

### References

1. "Farm Blacksmithing" - Friese.
2. "Blacksmithing on the Farm" - Jarvis and Abbott.
3. "Repairing Farm Machinery and Equipment" - Radebaugh.



## MAKING A STAPLE PULLER

Job 38

Staple pullers are in need on every farm. Many times when a staple puller is not at hand, a grubbing hoe, hatchet or some other tool is used to cut the staples from the post. Such methods would not be a satisfactory way of performing the job. A staple puller can be made very economically and quickly. The puller is not used as a prize bar, but its point is driven in the staple and by several blows with the hammer the staple is removed from the post. I will give two kinds of pullers which have proven very useful. One is made from an old harrow tooth, while another is made from a piece of tool steel.

Tools - hammer, tongs.

Materials - piece of octagon tool steel  $\frac{1}{2}$ " by 8".

Old harrow tooth.

Staple Puller From A Piece of Tool Steel

## Procedures

1. Obtain tool steel 8" by  $\frac{1}{2}$ ". (Figure 1).

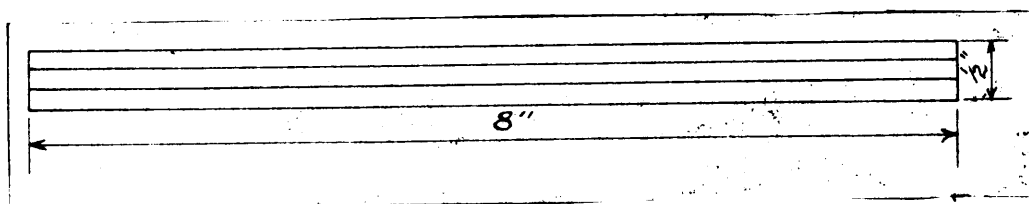


Figure 1.

2. Heat to a lemon color and draw out as shown in Figure 2.

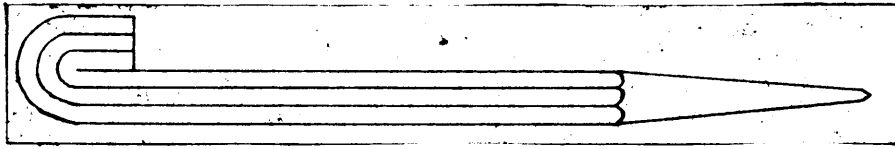


Figure 2.

The point should be rather small but the portion drawn out need not be very narrow, because it needs to be thick enough to push the staple out.

3. Heat opposite end 1" and bend to shape shown in Figure 2. This is used in drawing the puller back in case it gets stuck in the post.

4. Heat pointed end to cherry red and put about  $\frac{1}{4}$ " bend in the drawn out portion. (Figure 3).

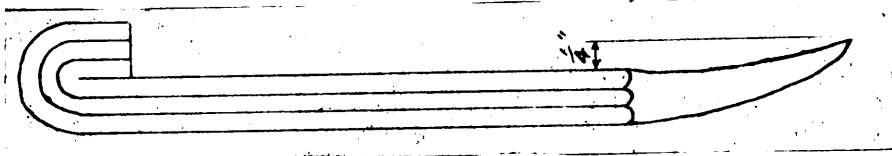


Figure 3.

5. Grind drawn out portion to a fine point.
6. Temper the point to a blue color as you would a cold chisel.

Staple Puller From A Harrow Tooth

## Procedures

1. Draw out to a point. (Figure 4).

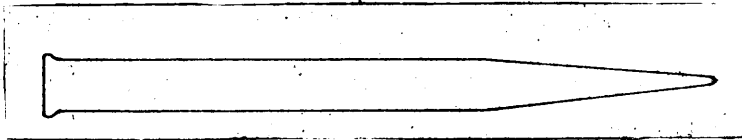


Figure 4.

2. Place about  $\frac{1}{4}$ " bend in point. (Figure 5).

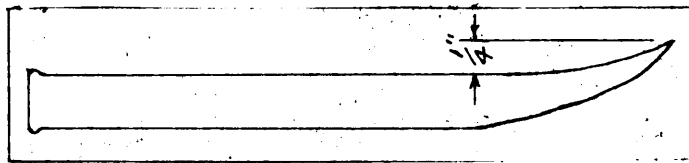


Figure 5.

3. Some harrow teeth have a fair amount of carbon while others have very little. It is advisable to temper the point.

### Questions

1. Why is the end opposite the point bent back an inch?
2. Is the staple puller used to prize the staples from the post?
3. Of what value is a staple puller?

### References

1. "Fitting Farm Tools" - Roehl.

## MAKING A CLEVIS

### Job 39

The making of a clevis is quite a simple job. There are several ways of making a clevis and the one that suits the individual is the best. The clevis is a piece of equipment that is used quite frequently in many kinds of farm work. There are many pieces of scrap iron on a farm that can easily be made into clevises. Old bolts, rods and flat iron make good material for this work. A pin can very easily be made to fit the clevis. I will give three methods of making the clevis; one without the weld and one with the weld and another made from flat iron.

Tools - tongs, hammer, punch.

Materials - soft steel, such as long bolts, rods or flat pieces of iron, welding flux, if you intend to weld.

### Clevis Without The Weld

This type of clevis is used chiefly in light work. Obtain stock the desired length. In case you have a model to pattern by, take measurements from that. If you do not have a pattern to go by it will be necessary that you determine the amount of stock to be bent for the pin hole. A rule to follow in obtaining amount of stock to be bent for the eye.

(Thickness of pin - thickness of stock -  $1/16"$ )  $\times 22/7$  = amount of stock to be bent.

The 1/16" is for the amount of play needed for the pin. You may need more depending upon the shape of the hole.

#### Procedures

1. Measure and mark the amount of stock to be bent for the eyes.

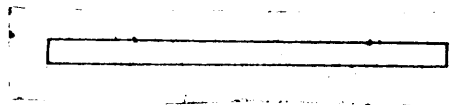


Figure 1.

2. Scarf or shape the ends in order that the fit will be close.

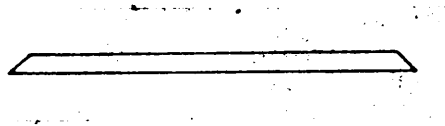


Figure 2.

3. Bend first to right angle then bend the eye.

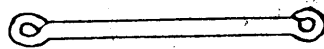


Figure 3.

4. Mark the center of stock, heat and bend to the proper shape.

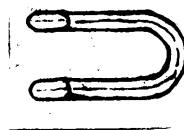


Figure 4.

5. Pin to be used may be an old bolt. You can take a piece of rod and bend one end and then cut the desired length. (Figure 5). Or you may head a bolt which would take considerable time.

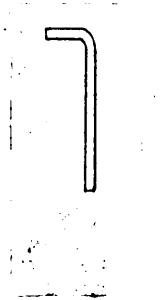


Figure 5.

#### With A Weld

#### Procedures

1. Measure and mark the amount of stock to be bent for the eyes, as number 1. Allow for weld.
2. Scarf the ends for the weld.

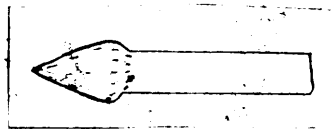


Figure 6.

3. Bend the ends in the form of an eye and weld. (Figure 7).

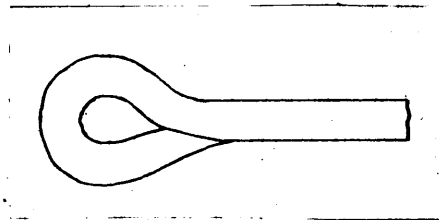


Figure 7.

4. If the hole is not round enough for the bolt, heat and drive the punch through hole and round it.
5. Shape clevis on horn of anvil.
6. Pin for Number 1 will be the same for this.
7. Complete clevis. (Figure 8).

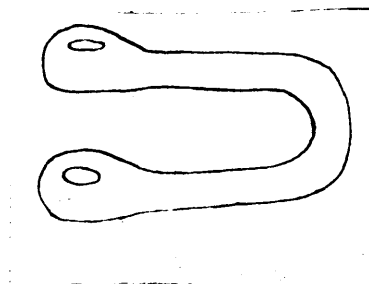


Figure 8.

Made From Flat Iron

Procedures

1. Cut piece of flat iron the desired length. 14" by 20" by 3/8" by 1-1/4" make very good clevises, but the size will depend upon the need and kind of material.



2. Head two inches of one end and punch a hole through the metal slightly larger than width of pin. Repeat the same on opposite end. The holes could be drilled but the punched hole would make the clevis stronger.

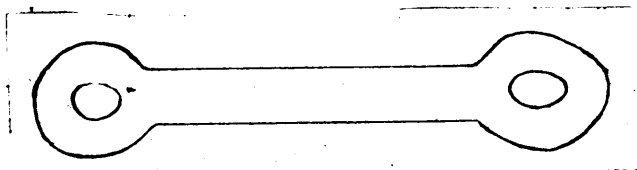


Figure 9.

3. Mark off about 4" in middle of stock and round slightly in order that clevis will wear well. (Figure 10).

4. Complete Clevis. (Figure 11).

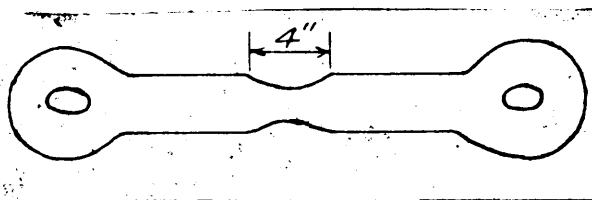


Figure 10.

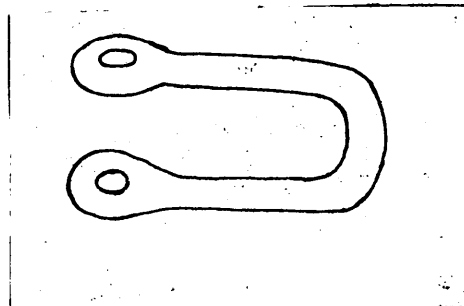


Figure 11.

5. Pins for this clevis may be same as for any other clevis.

#### Preparing The Pin For A Cotter Key

##### Operation I. Drilling The Hole Through The Pin

1. Mark with a center punch one inch from the end opposite the head. (Figure 12).

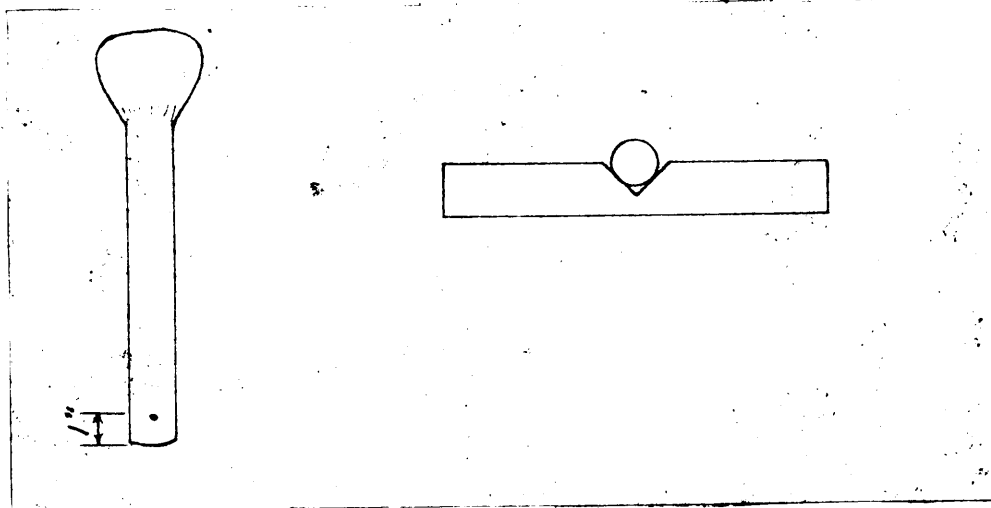


Figure 12.

Figure 13.

2. Place in a groove made from a piece of wood, in order that it may be made steady. (Figure 13). Drill  $1/4$ " hole for the key. When the drill is almost through the pin do not apply any pressure; let it drill easily to prevent the breaking of the bit. Some cut threads on end of pin and use a tap, but in most cases the threads become battered which makes it difficult to remove the tap.

#### Operation II. Punching A Hole Through The Pin

1. Mark with a center punch as in Operation 1.
2. Heat the stock to an orange color and place on anvil.
3. Use a punch if possible  $1/8$  by  $3/8$ . In case you do not have one with these dimensions use one that will make a hole suitable for a key.
4. Drive punch through partly from one side, then reverse sides. You may need to reverse this several times until the hole is finished. In the event the pin is thicker where the hole is punched, the punch should be cooled and the pin heated to a cherry red. Place

punch in the key hole and hammer on both sides of the hole until the pin is the same width from one end to the other. If not, it would not go through the clevis.

As for a key, you may use a key or a nail, just something that will hold the pin and keep it from working back through.

### Questions

1. Which of the three clevises is the strongest?
2. What is the length of stock used in the average clevis?
3. What uses are made of a clevis?

### References

1. "Farm Blacksmithing" - Friese.
2. "Repairing Farm Machinery and Equipment". - Radebaugh.

## MAKING A CHAIN LINK

### Job 40

There is a constant need for chain links on many farms. Skill in doing the job can easily be learned. The size of stock used in making the link will depend upon the use to be made of the link. For a general purpose link,  $3/8$ " stock is sufficient.

Tools - tongs, hammer.

Materials - stock, welding flux.

### Procedures

1. The method of determining the length of stock needed for the link is given in the job on measuring stock.
2. Cut stock the desired length.
3. Heat and square the ends for scarfing. This is done in heavier stock. Some recommend upsetting, but experience shows that it is not necessary in this job.
4. Heat the center section of stock and bend over the horn to the "U" shape. (Figure 1.)

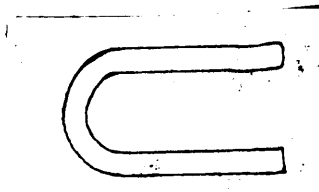


Figure 1.

5. Scarf the ends as shown in (Figure 2). One side must be scarfed to the right and the other side must be scarfed to the left. (Figure 2).

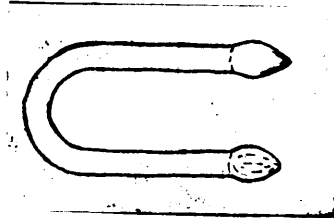


Figure 2.

6. The two ends of the "U" are brought together. (Figure 3). This is done on the horn of the anvil. Scarfed ends should overlap slightly, as shown in job on "Welding".

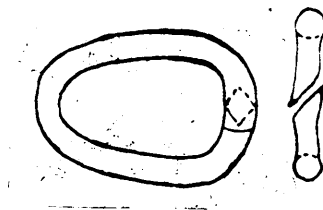


Figure 3.

7. The same procedure is followed in the welding as described in the job on "welding". After the weld is made place the link on the horn and round up the newly welded joint. To round off the weld, raise the link from an upright position to about a  $45^{\circ}$  angle. Working in this position, the horn will round the inside edges of the link while the hammer will round the outside.

8. After rounding out the weld, then heat the entire link uniformly and shape the link. True up the curves on the horn, and see that center sections are straight and parallel to each other. (Figure 4).

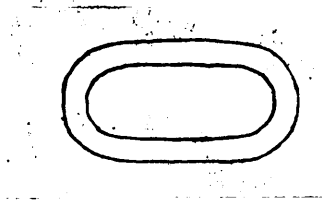


Figure 4.

9. If the link is to be twisted, heat to a red heat, either place one end in a vise or hold with tongs and the other end held by tongs, and a quarter turn given. Two tongs are very satisfactory.

10. If you desire to blacken the link, heat slightly and rub with an oily rag.

11. Permit the ring to cool gradually.

### Questions

1. Why do you scarf ends on opposite sides?
2. What part of the anvil do you form the "U" shape on?
3. Is it necessary to upset stock in making a chain link?

### References

1. "Farm Mechanics" - Crenshaw and Lehman.
2. "Blacksmithing on the Farm" - Jarvis & Abbott.
3. "Plain and Ornamental Forging" - Schwarzkopf.
4. "Repairing Farm Machinery and Equipment" - Roehl.
5. "Farm Blacksmithing" - Friese.



## REPAIRING A BROKEN CHAIN

Job 41

Just one glance around on many farms will justify one in saying that dollars are lost annually, due to the lack of repairing broken chains. On many farms this is a job of parctical importance. Skill in doing this job can easily be learned. With an hour or so of time one can repair many broken links. A temporary repair can be made with a bolt, which will make a strong link but is never as satisfactory as a new link. Chains are used in heavy hauling, wagons, harness and other farm work. Chains are made from either wrought iron or milk steel, the latter being the stronger, but in making repairs it is better to use the best quality of wrought iron on account of the greater ease in making a stronger weld. Chains are classified according to the size of stock in the link. A chain whose links are made from  $3/8$ " round stock is tested from 3,500 to 4,500 pounds, according to the quality of material in the link. A safe working load for a chain is one-half the proof test. The breeking strain is supposed to be about twice the proof test. A lap link or an opening ring make a very satisfactory temporary repair job. However, the welded link is the most satisfactory when time is available to do the job.

Tools - hammer, tongs.

Materials - welding flux or borax,  $3/8$ " stock, bolt, tap and two large washers.

### Operation I. Repairing With The Welded Link

At first thought one may think that welding a link while on a chain is difficult, but this job can be performed very easily. This is by far the most satisfactory way of repairing the chain. The repairs should be made while there is spare time around the farm.

1. Heat link, bend in "U" shape, scarf ends and bend so that scarfs will overlap.

2. Open ends enough to get other rings in. (Figure 1). This should be done on the hardie, by placing the two scarfed ends, on each side of the sharp edge of the hardie and striking a blow with the hammer. (Figure 1).

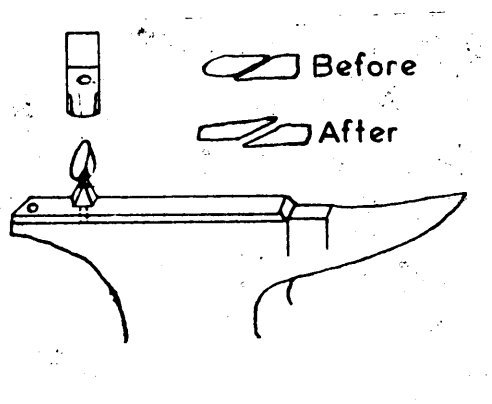


Figure 1.

3. Place two links in the link that is to be welded. (Fig. 2). Grasp the link on the side or as near the end of the link, opposite where the weld is to be made. You can handle the link very well this way. Hammer the scarfed ends close together for the weld.

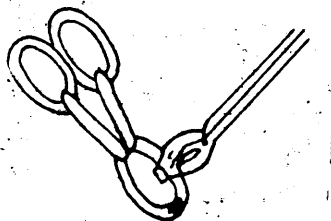


Figure 2.

4. Weld the link, as you did in the "Job on Making A Link".

In this operation on repairing; it is necessary that you heat several links when you are heating the one to be welded. This will not affect the other part of the chain.

5. To make a chain or a portion of a chain, the following steps should be followed:

- (a) When a large number of links are to be made do all the shaping first and then the welding.
- (b) Weld two links separately.
- (c) Weld these two together with a third.
- (d) Weld three more in the same manner.
- (e) Weld the two groups of three together with a seventh.

#### Operation II. Repairing With An Opening Link

If a log chain is in use and a link is broken, a very quick way of repairing it is with the opening link. There should be some extra links available in order that such a repair can be made when needed.

### Procedures

1. If the opening is not wide enough to allow the link to go through, open by the use of the hardie as shown in (Figure 1).
2. Place two links in the one as shown in (Figure 2).
3. In this operation do not heat the link but hammer the scarfs together on the anvil.

### Operation III. Repairing With A Bolt.

This method of repairing can be done without much loss of time. For many occasions this is very practical, however, the first method is the most satisfactory especially when time is available.

1. Obtain bolt twice the thickness of the stock from which the chain is made.
2. Use a washer under the head and nut of the bolt. (Figure 3).

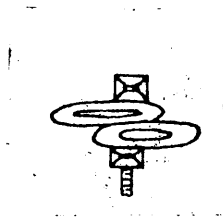


Figure 3.

3. Lap one link over the other and place the bolt through as shown in (Figure 3). Tighten top enough to make the repair stable.

### Questions

1. Which method of repair is the most satisfactory?
2. Why is the bolt or lap link recommended over the welded link for temporary repair?
3. What size should the bolt be?

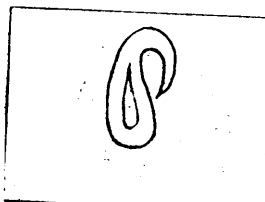
### References

1. "Repairing Farm Machinery and Equipment" - Radebaugh.
2. "Plain and Ornamental Forging" - Schwarzkopf.
3. "Farm Blacksmithing" - Friese.

## IRONING A SINGLE TREE

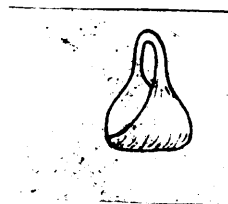
Job 42

Many times on farms much time is lost in repairing single trees. The chief job in repairing is the ironing of the single tree. The irons are generally placed on the single tree while cold and a couple nails are driven in the end and bent back over the clip to prevent the clip from working off. When the clip is placed on the single tree cold the clip cannot be hammered to the wood good enough to make a snug fit. As a result, the clip soon works loose. By heating the clip, placing it on the single tree while hot, and hammer the clip on the wood, this will prevent the clip from working loose much longer than with the cold method. There should always be a hole in the clip for a nail or a screw, preferably a screw, to hold the clip on. In case you buy a clip and a hole is not in it, either drill a hole or heat to a cherry red and punch one. It doesn't seem advisable to make clips and hooks for the single trees when one can buy a center clip and the two end clips, with hooks, enough to completely iron a single tree for approximately 30 cents. The time and material involved in making such would be considerably more. However, if a hook was broken it would be very easy for one to make another hook and weld it into the clip. Clips are usually sold to fit 2" - 3" single trees.



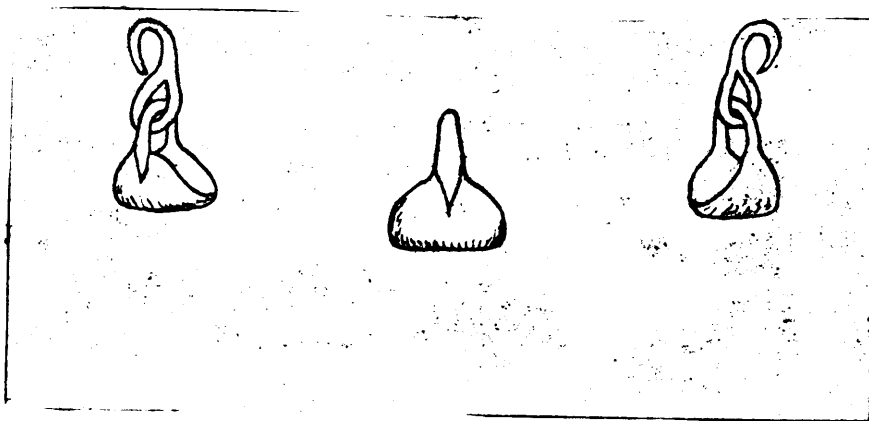
Hook

Figure 1.



Clip

Figure 2.



Left End

Figure 3.



Center

Figure 4.



Right End

Figure 5.

Tools - hammer, tongs.

Materials - clips, single trees.

### Procedures

1. See that the single tree is properly shaped.
2. Measure off from end to end the center of the single tree and mark. (Figure 6).



Figure 6.

3. Heat center clip to a cherry red, and immediately slip clip on single tree and make sure that clip is directly in the center. Hammer clip tight on the wood. While the clip is still hot, hammer the portions of the clip where the round portion meets the flat portion. (Figure 7). This will prevent the clip from slipping and working loose. All of this fitting should be done rapidly, if not, the wood would become charred. Place in water immediately after the fitting has been done.

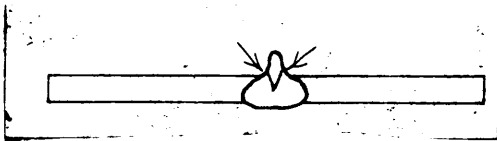


Figure 7.

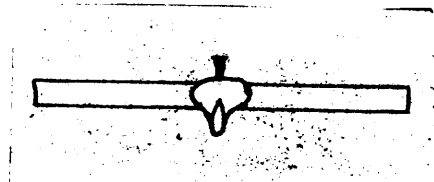


Figure 8.

4. Put a nail or screw in the clip to prevent any slipping. (Figure 8).

5. The same procedure is followed in placing the clips on the end. Be sure that the clips are put on the proper way. (Figures 9 and 10), show the wrong and right way. Always place the center clip facing the opposite direction of the end clips.



6. Always keep the hooks facing up to prevent the traces from working out.

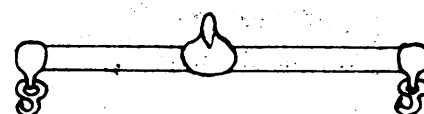
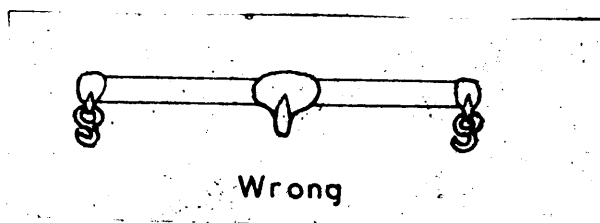


Figure 9. Wrong.

Figure 10. Right.

### Questions

1. Why should the hot clip be fitted on the single tree very rapidly?
2. Why should a screw or nail be placed through the clip into the single tree?
3. Is it cheaper to make the clips than to buy them?

### References

1. "Blacksmithing on the Farm" - Jarvis and Abbott.

## MAKING A CENTER PUNCH

### Job 43

The punch is probably used as much in forge work as any other too. There are two main punches, center punch and drift punch. Center punches are used chiefly in marking metal and in punching out old rivets. Drift punches are used chiefly in punching holes through hot metal.  $3/8$ " stock makes a very handy punch for ordinary work, but if heavy work is to be done it may be advisable to use heavier stock in making the punch. All punches and chisels are made of tool steel. Drift punches should be much longer than center punches because of the intense heat from the metal that is to be punched. 12" - 14" makes a very good length for a drift punch, while  $3\frac{1}{2}$ " to 8" is good length for the center punch. After one learns to make a punch he can easily re-shape old punches which are in need on every farm.

Tools - tongs, hammer, center punch, steel square, emery paper.

Materials -  $3/8$ " oct. tool steel  $3\frac{1}{2}$ " long. Length and size will vary with the use.

### Operation I. Shaping The Punch

1. Heat one end to a bright red, forge the bevel on the face of the anvil and square up the end to form the head. (Figure 1). The purpose of the bevel is to prevent the end from flatening out and chipping off when struck by the hammer. As shown in (Figure 1)

(a) and 1 (c). The bevel of the head should be in proportion to the size of the stock used. (b) and (c) are only a generalized rule to follow. Smooth the head by grinding at the same time the point is ground.

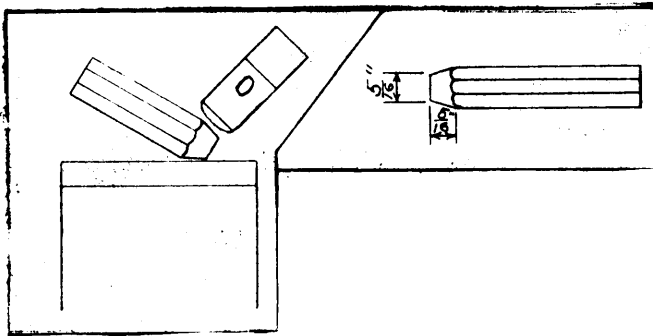


Fig. 1. (a)

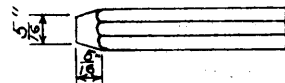


Fig. 1 (b)

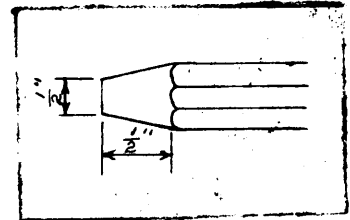


Fig. 1 (c)

2. Heat opposite end back about  $1\frac{1}{2}$ " to a cherry red, and draw out to the desired length. As a guide, see (Figure 2.) which is drawn out to  $\frac{1}{4}$ " thickness and  $\frac{1}{4}$  bevel. The dimensions will depend entirely upon the use to be made of the stock and the size of the stock used. In drawing out, draw to a square first, then octagonally, then round as shown in job on "Drawing Out Metal." The thickness of the stock at the bevel may be  $\frac{1}{4}$ ",  $\frac{1}{2}$ ",  $\frac{1}{8}$ " depending upon the use. Make sure the punch is perfectly straight and symmetrical. Let the punch cool gradually.

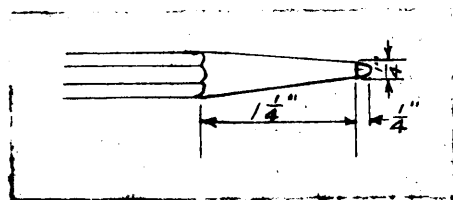


Figure 2.

3. Grind or file the point to a  $90^{\circ}$  angle. (Figure 3.) The grinding should be done before tempering. If a drift punch is to be made, grind the end straight.

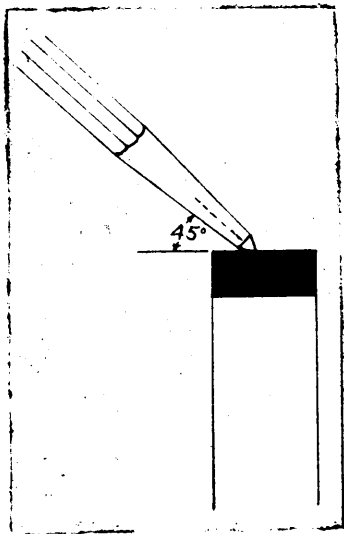


Figure 3.

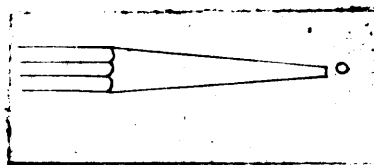


Figure 4.

### Operation II. Tempering

1. In tempering follow the same procedures as shown in job on "Tempering". Use same heating and follow same procedures as for a cold chisel. Temper at blue color.

2. Test to see if tempered properly. (Figure 5).

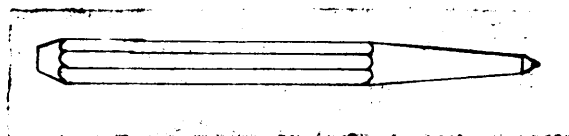


Figure 5.  
Complete Punch

### Questions

1. What size stock should be used in making a center punch?
2. What is the difference between a center punch and a drift punch?
3. What color should the punch be tempered?

### References

1. "Farm Blacksmithing" - Friese.
2. "Plain and Ornamental Forging" - Schwarzdopf.
3. "Farm Mechanics" - Cook, Scranton, McCally.

## MAKING A COLD CHISEL

### Job 44

The cold chisel is used for cutting soft metals and is made from tool steel. Chisels and punches are made from steel high in carbon ranging from .30 to .90 carbon. The size and shape of the chisel is determined by the nature of the work it has to do. Chisels are usually made from octagon steel, but are sometimes made from round steel. A cold chisel used for ordinary farm forge work, is usually made from 3/4" octagon steel and is 6" to 8" long. Due to the particular hard service given a cold chisel, considerable care should be given in forging and tempering. Several cold chisels should always be kept in a school and a farm shop. After one has learned to make a chisel he can easily re-shape and sharpen old chisels that are lying around on the farm.

Tools - hammer, tongs, center punch, steel square, emery cloth.

Materials - 3/4" stock 6" long.

### Operation 1. Shaping The Chisel

1. Heat one end about 1" and head stock. (Figure 1). Head as shown in job "Making A Punch". The same rule applies as to the heading of the chisel as did to the punch, that is, head according to the size of stock being used. Smooth head on grindstone when the cutting edge is ground.

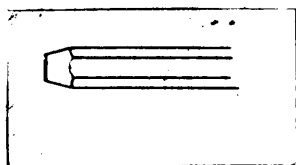


Figure 1.

2. Mark with center punch two inches from the end opposite the head. Heat to a cherry red heat, and draw out the end to  $\frac{1}{2}$ " thickness. (Figure 2).

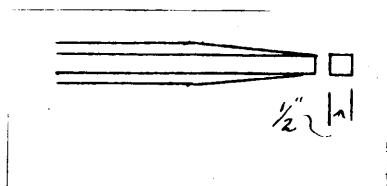


Figure 2.

Then flatten the square end to  $1/16$ " thickness. The chisel should be wider at the flattened end than the thickness of the stock, depending upon the size of stock. The taper should start about 1" from the end. (Figure 3).

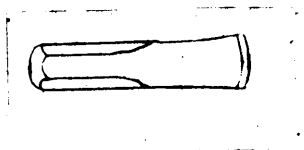


Figure 3.

3. After the end has been tapered down to a thin edge, square off the end. (Figure 4). Let the chisel cool gradually.



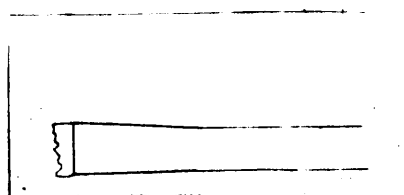


Figure 4.

4. Grind cutting edge to a  $60^\circ$  angle. (Figure 5). Curve the end slightly as shown in Figure 6. In grinding do not let the chisel burn, because the burning would reduce the percent of carbon. Remove the chisel from the stone frequently.

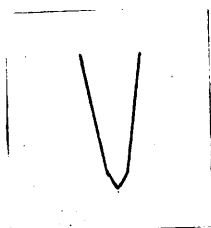


Figure 5.

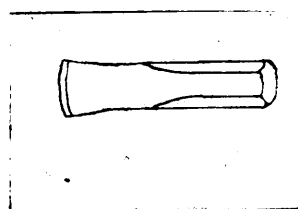


Figure 6.

Many beginners quite frequently make the mistake in grinding a chisel, in that they grind the cutting edge to more than a  $60^\circ$  angle, sometimes as much as  $100^\circ$  angle.

### Operation 2. Tempering the Chisel

1. See the job on "Tempering", a full description of tempering a chisel is given.

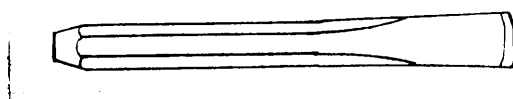


Figure 7.

### Questions

1. What is the recommended size and length of stock used in making a chisel for ordinary shop work?
2. Is the ordinary cold chisel tempered the same as the center punch?
3. At what angle is the cutting edge ground to?

### References

1. "Blacksmithing on the Farm" - Jarvis and Abbott.
2. "Plain and Ornamental Forging" - Schwarzkopf.
3. "Farm Blacksmithing" - Friese.

## SHARPENING A GRUBBING HOE

Job 45

There are many very dull grubbing hoes used on a farm. This can be overcome by taking a little time in sharpening. The same principles involved in sharpening picks, digging irons, and other similar tools are involved in sharpening the grubbing hoe. Therefore, only the sharpening and tempering of the hoe will be mentioned.

Tools - hammer, tongs.

Materials - grubbing hoe, emery cloth.

Procedure

1. Remove the handle from the hoe.
2. Heat to a cherry red or low orange that portion of the hoe which is to be shaped and sharpened. Care must be taken in preventing the tool from burning.
3. Place the heated end over the edge of anvil (Figure 1) and hammer edge back until it is straight across. In case the cutting edge is badly worn or is very irregular, it is better to strike several blows on the edge (Figure 1) then move tool back on anvil and hammer to shape the end, (Figure 2). In case the cutting edge is very much rounded the edge should be marked off square and the uneven edge cut off.

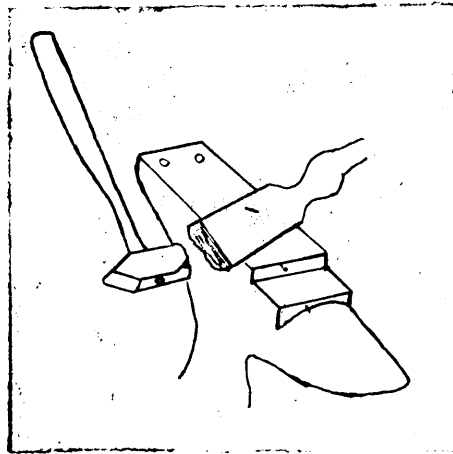


Figure 1.

4. As shown in Figure 2, place hoe on edge of the anvil with the bevel up, and smooth out the bevel. Blows should be somewhat alternated on the bevel and edge. You should attempt to shape the bevel very well in order that very little grinding will be needed. In shaping the bevel always keep end on edge of the anvil.

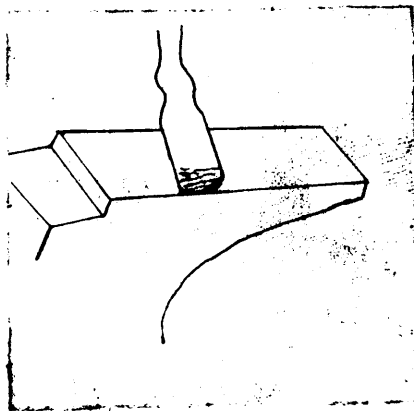


Figure 2.

5. Allow the tool to cool, then shape the opposite end. The opposite end is shaped differently from the flat end in that both sides are tapered the same, as shown in Figure 3. Hammer several blows on one side then reverse sides and do the same.

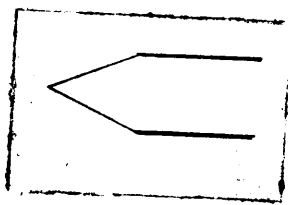


Figure 3.

6. When both ends are cool, sharpen with a file or grinding wheel.
7. Temper to a blue color. In sharpening any tool, first understand the shape of the tool when completed, before attempting to work with it.

### Questions

1. Are both ends of the grubbing hoe shaped the same?
2. What temper color should one use?
3. What is the proper heat to use in shaping the hoe?

### References

1. "Fitting Farm Tools" - Roehl.

## MAKING AND REPAIRING A WRECKING BAR

### Job 46

Many times wrecking bars are broken and are then thrown down as useless. Generally the ends are broken. These can easily be repaired and made as good as new. It is true that many times we can buy a wrecking bar cheaper than we can buy the tool steel from which to make it. The important phase in this job is the repairing.

Tools - hammer, tongs, hot cutter, emery paper.

Materials - Piece of tool steel,  $3/4"$  x  $36"$  oct. tool steel makes good wrecking bar. Smaller ones may be used in light work.

### Operation 1. Making the Bar

1. Cut your stock  $36"$  long.
2. Shape one end to a chisel edge  $2"$  long and bend as shown in

Figure 1.

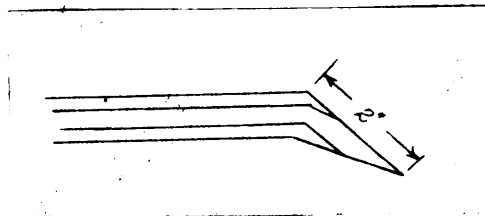


Figure 1.

3. Shape the other end to a chisel edge  $2\frac{1}{2}"$  long. Figure 2.

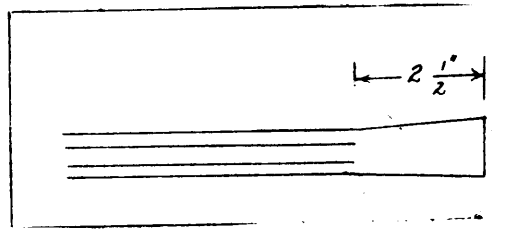


Figure 2.

4. Split open the end shown in Figure 3. This can be done several different ways, but one of the best is to use a hot cutter. By the use of the steel square and the center punch measure off and mark the center line off in order that you will know where to split. Heat to a cherry

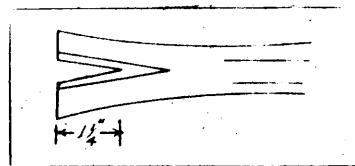


Figure 3.

red or light lemon color and place the shaped end flat on the base of the horn of the anvil, take the hot chisel and place on the marked line near the end and strike light blows with a hammer. Gradually move the cutter back towards the thicker portion of the stock. Split back to approximately  $1\frac{1}{4}$ " for general use. All the splitting is done on one side in order that the catch will be strong and will have a good groove. File the edges down smooth.

5. Bend the split end to the shape shown in Figure 4. Leave  $3\frac{1}{2}$ " between the end and the other part of the bar. (Figure 4). This  $3\frac{1}{2}$ " is sufficient for this particular bar but the width may vary with individual bars.



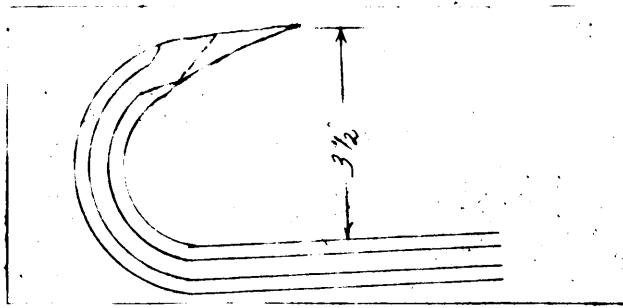


Figure 4.

6. Temper both ends the same as you would a cold chisel-blue.  
This may be done before or after bending.
7. Complete bar. (Figure 5).

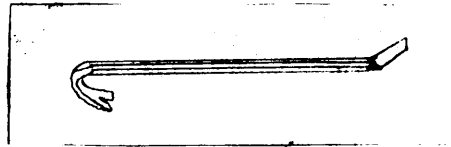


Figure 5.

### Operation 2. Repairing The Bar

1. In case one or both jaws are broken off, heat the bar and cut off as shown in Figure 6.

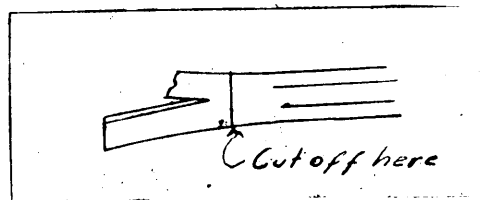


Figure 6.

2. Perform the same operations as in the making of a wrecking bar.

### Questions

1. Why is it important that one should learn how to repair a wrecking bar?
2. Why should you split the end all from one side?
3. How long should the split be?

### References

1. "Farm Blacksmithing" - Friese.

## HEADING A BOLT

Job 47

There are many occasions on a farm in which the heading of bolts is necessary. Sometimes a good bolt head may become battered or worn and by re-heading could be made as good as new. You may want to head a pin for a clevis. It is almost necessary that you have a header present in order that a good job be insured. In heading a bolt it is a good practice to calculate the amount of stock required in the upsetting. Some smiths guess at the amount, but for the inexperienced worker the guessing is rather uncertain.

Tools - hammer, header, center punch, steel square, tongs.

Materials - piece of  $3/4"$  x  $6"$  round stock (wrought iron).

Calculation of the amount of stock needed in making a hexagonal or square head bolt from a solid stock. Diameter of stock x 3 which is the allowance for upsetting.  $1/4"$  is allowed for beginners as wastage.

Example:

Stock =  $3/4"$  x  $6"$ .

$3/4 \times 3 = 2-1/4$  allowance for upset for advance practice.

$2-1/4 + 1/4 = 2-1/2$  for beginners.

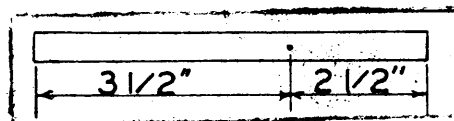


Figure 1.

Calculation of the distance across the head of a finished bolt.

Diameter of stock  $\times 1\text{-}1/2$  and add  $1/8"$ .

Example:

$$(3/4 \times 1\text{-}1/2) + 1/8 = 1\text{-}1/4 = \text{distance across flats.}$$

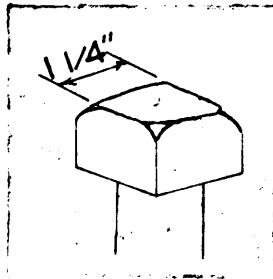


Figure 2.

Calculation of the thickness of the head.  $1/2$  the distance across the flats.

Example;

$$1/2 \times 1\text{-}1/4 = 5/8 \text{ thickness of head.}$$

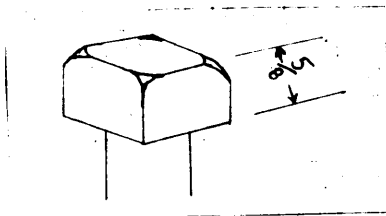


Figure 3.

### Procedures

1. Cut off a piece of stock 6" long and mark  $2\text{-}1/2"$  from the end with the center punch for the upsetting. (Figure 4).

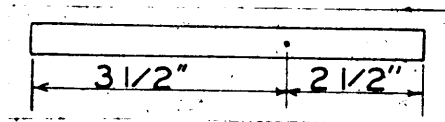


Figure 4.

2. Heat opposite end of head and make a small bevel about  $1/8"$  to insure that this end will easily go through the header and also prevent spreading while the headed end is being upset. Bevel similar to that of a punch or cold chisel but make it smaller. See that the beveled end is square to prevent improper upsetting.

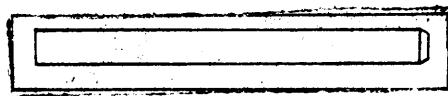


Figure 5.

3. Heat the end of stock that is to be headed back to the point layed off for upsetting to a nearly white heat and place on anvil and upset. Cool portion below the mark in water before delivering blows if that part below mark has a tendency to upset. Upsetting the head requires careful attention since the head must be kept in the center and straight.

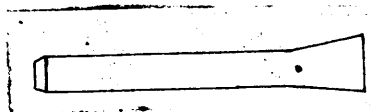


Figure 6.

4. When the head is upset to  $1"$  (Figure 7) it should then be re-heated and placed in the heading tool and worked. (Figure 5). Place

the header over the pritchel or hardie hole depending upon the size of the bolt. Deliver blows on the head. Always strike them as even as possible to keep the head in the center. Continue this until the head is about  $5/8$ " thick. (Figure 3).

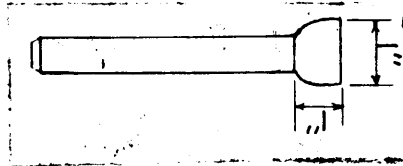


Figure 7.

5. Remove bolt from header and place on face of anvil with shank parallel to face of anvil. Hammer on sides of the head until they are about parallel to the edges of the shank.

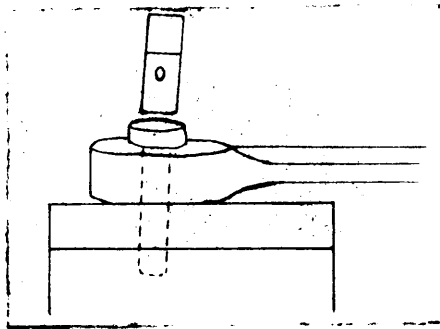


Figure 8.

6. Place the bolt head down on the face of the anvil to see whether the head is in the center. If the shank is found to be nearer one side of the head than the other, re-heat, place in the header with the narrow edge of the head to the right, and deliver a heavy blow on the left or

wide edge of the head, with the face of the hammer forming a forty-five degree angle with the face of the angle. Continue this until the head is on the center.

7. To form the square head, continue to hammer alternately on the sides and top until the head is uniformly square, uniformly thick, and the corners come out perfectly sharp and of the required width and thickness.

8. To form the arch on each side, hammer the edges lightly along with the squaring.

9. If a hexagon head is to be formed, the operations are exactly the same, except that in treating the stock after it is perfectly round, it is turned.

10. The completed bolt. (Figure 9).

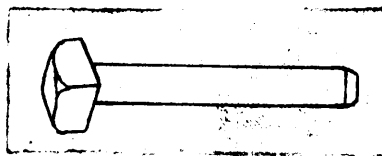


Figure 9.

### Questions

1. Why is 1/4" allowed extra for upsetting the bolt head?
2. Is it necessary to properly calculate the amount of stock needed for the bolt head?
3. How would you center the head in the event it was off line?

### References

1. "Blacksmithing on the Farm" - Jarvis and Abbott.
2. "Blacksmithing" - Selvidge and Alton.
3. "Plain and Ornamental Forging" - Schwarzkopf.



## SHOEING A HORSE

Job 48

Within recent years, many blacksmiths have left their shops and no one is taking their place. This presents a serious problem to the farmer who is in need of having his horses shod. It is quite evident that farmers today, in many sections, find it necessary to take their horses as far as ten to fifteen miles to a blacksmith. Due to this condition arising, it seems quite necessary that the individual farmer have a knowledge of the shoeing of a horse along with other blacksmith jobs.

For an inexperienced person to attempt to shoe a horse from the knowledge gained from this description or any other writing, it would be an unsound policy. One should read this description over carefully then visit a blacksmith and observe the shoeing of a horse. There will be some details picked up by actual observation that are not given here. If at all possible it would be very beneficial to actually take part in the shoeing of a horse under the supervision of an experienced blacksmith.

A Vocational Agriculture Teacher could take a class to a blacksmith's shop and have a demonstration made by the smith.

Operation 1. Examination of the Foot.

1. Always look the foot over thoroughly first. As shown in Figure 1 (a), the toe pointing in, where as (c) is the opposite, pointing out. (b) is the correct form.

Observe from the front view first.

## Shoeing a Horse

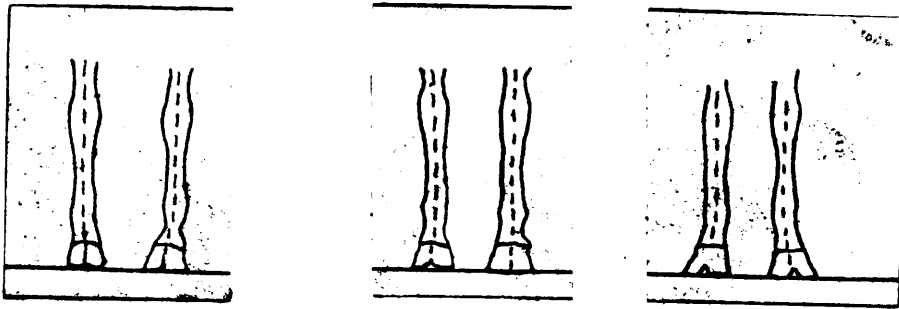


Figure 1.

(a)

(b)

(c)

2. Observe from the side of the horse to see if the foot is sloping (Figure 2). (a), regular, (b) , or stumpy (c)

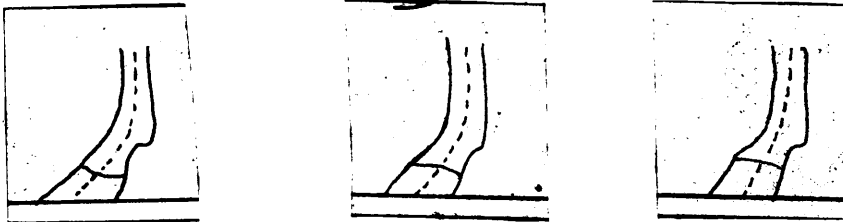


Figure 2.

(a)

(b)

(c)

3. The action of the horses feet while in motion should be examined. You observe the action while the horse is going past you, toward you, and away from you. In the event there is a fault in the action, some correction may be made by good shoeing.

4. The bottom of the foot should be examined, to see how the shoe has been worn and the condition of the frog, etc. There are more details that are looked into by the intelligent blacksmith. These are a few that enable one to do a very good job of shoeing. A thorough examination of the foot is the first essential of good horse shoeing.

### Operation 2. Removing The Old Shoe.

1. Either cut off or straighten out the clinches. Place the sharp edge of the clinch cutter under the edge of clinch and strike with the hammer. This will either straighten out the clinch or cut it off. Make sure that all the clinches are either broken off or straightened out to prevent the breaking off of a portion of the wall of the hoof.

2. Take the pincers and work under the shoe, beginning at the heel and work toward the toe. After one side is worked loose, start at the heel of the other side and do the same. When you have loosened both sides then grasp the shoe firmly at the toe and pull toward the center of the foot. You should always pull toward the center of the foot to prevent breaking off of a portion of the outside edge of the hoof.

### Operation 3. Preparing The Foot for The Shoe.

1. Keep in mind a thorough knowledge of the previous examination of the foot.

2. Place the palm of the left hand under the foot and use the shoeing knife in cleaning out the chalky substance from the bottom of the foot. Be careful about cutting around the frog, since it is very tender.

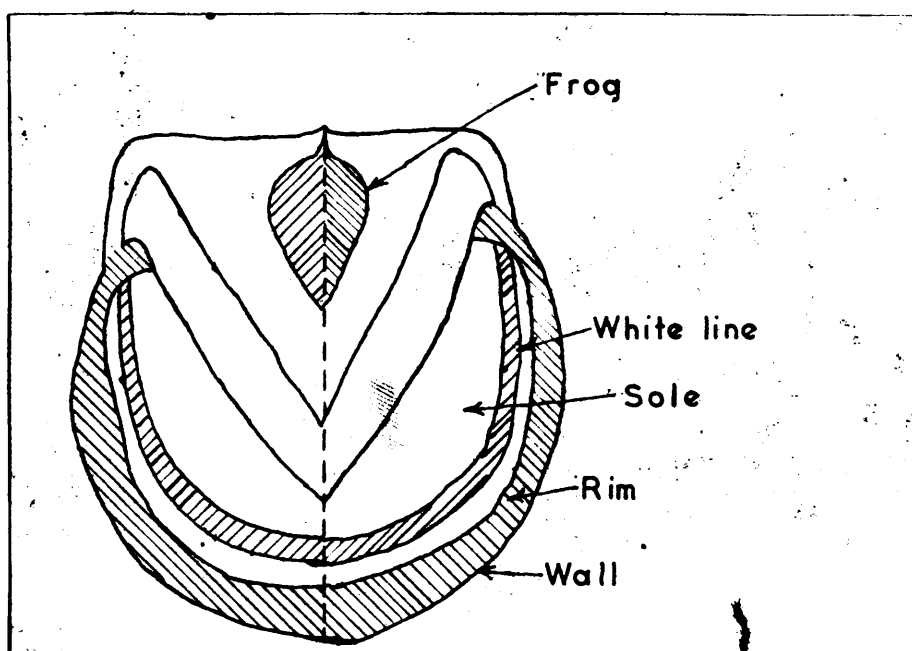


Figure 3. Bottom of the Foot.

3. Use the nippers in removing the wall or rim from the foot. In using the nippers keep the cutting edge on the inside and the blunt part on the outside to insure a good job. The rim should always be left slightly higher than the sole of the foot. Always start removing the rim from the toe first, and from the toe work to the heel. This will insure better shaping. In cutting with the nippers, take a thin cut at first to get the proper shape, then increase the cut later. Continue this cut until the foot is practically level, then smooth the bottom by the use of the rough side of the rasp. On the right side, draw the rasp towards the toe and the left side draw towards the heel.

4. In shaping the foot remember that one must notice the following:

- a. Whether the toes turn in or out.
- b. Whether the toes are straight.
- c. Whether the hoof is backward or forward.
- d. Whether the hoof is correct.

- (e) Whether the foot is sloping or stumpy.
- (f) Whether the foot is regular.

The toe of the shoe should come in direct line with the center of the frog, as shown in Figure 4. Figure 5 shows unbalanced foot.

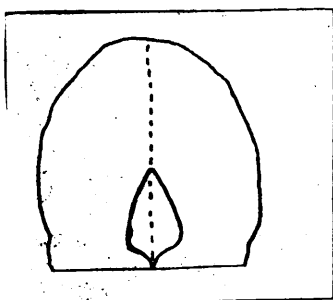


Figure 4.

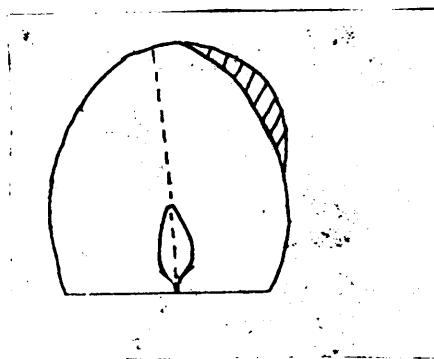


Figure 5.

If the foot is stumpy, cut as much as possible off the heel without damaging the foot. If the foot is sloping, cut as much off the front of the foot as possible. Sloping, stumpy, and regular hoofs are shown in Figure 2. If the toes point in, cut as much from the inside as possible. If the toes point out cut as much from the outside as possible. Figure 1 shows the straight, pointed in, and pointed out toe. This operation is very important in the shoeing of a horse, since many faults can be corrected in the shaping of the foot.

#### Operation 4. Fitting The Shoes.

Shoes are being sold today that are prepared to have calks screwed into them, rather than the old method of welding a calk on. These new calks screw in and when the calks are worn down they can be unscrewed and

new ones screwed in their place. This seems very practical for the school and farm shoeing, since the matter of welding on calks is a skilled job. Calks are only used on shoes in winter or when conditions require it. It is rather dangerous to turn horses out on pasture together that have calked shoes, especially if they are inclined to kick.

1. How to measure a shoe.

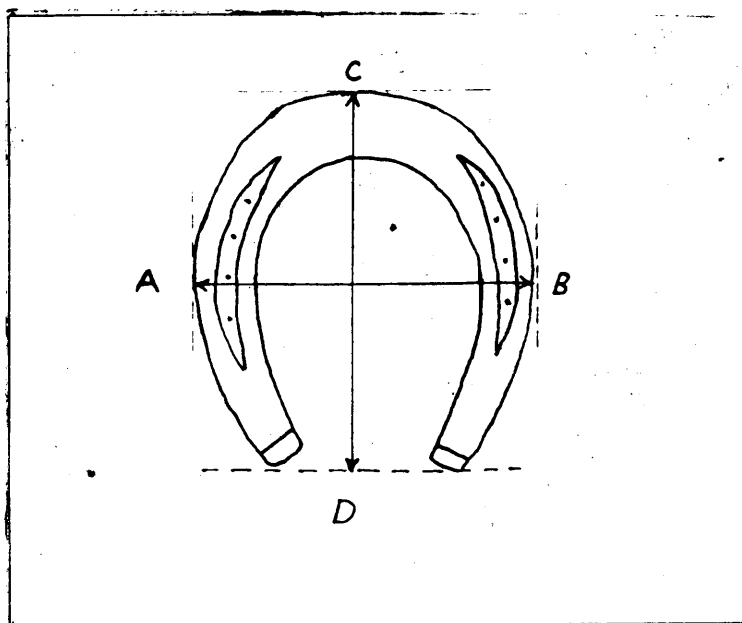


Figure 6.

In measuring a shoe make sure that an allowance is made for the heels if the shoes are sold plain, that is, without heels. Measure actual width of horse's hoof (A to B), add  $1/2$  inch to length of hoof, (C to D), so shoe will extend beyond wall at heel of hoof.

2. Heat to a yellow heat and punch nail holes. In punching nail holes, punch from the under side first, then the upper side, so that nails can be driven into the groove. Be careful in not punching the

holes too large, if so, the shoe will be ruined.

3. Heat the heels of the shoe and shape.

4. Re-heat and place on face of anvil with the groove facing down, so that about  $1\frac{1}{2}$ " of the ends stick over the edge. Bend ends to a right angle forming the heels.

5. Place shoe on face of anvil, groove side up, and the heels toward you, place the pritchel in the nail hole on the right side and carry the shoe to the horse's foot. Fit the shoe to the foot, instead of fitting the foot to the shoe. Make sure the shoe is not too long or too short, and that the heel is wide enough but not too wide. The shoe may need to be re-heated several times in order that the shoe is properly fitted to the foot.

#### Operation 5. Nailing on the Shoe.

1. Make sure that the toe of the shoe is in line with frog of the foot. Place shoe on foot so that the tip of the toe is in line with the front of the hoof.

2. In starting the nail make sure that the straight side of the nail is towards the outside and the beveled side is towards the inside.

3. Set nail in second hole from heel on right-hand side of shoe. Set nail so that it points towards a point on top the hoof about  $1\frac{1}{2}$ " from the shoe. Nail should come out not over  $\frac{7}{8}$ " of an inch on side of hoof. Just enough to make it hold well.

4. Inexperienced persons should be very careful in driving nails. Drive the nail cautiously and when point comes through the hoof continue

driving until the nail will go no further. If the nail goes easy it may be in the soft part of the foot or in an old nail hole. One should become familiar with the sound of the drive.

5. Bend the nail down and twist it off, grasping it between the claws of the hammer and twisting it quickly. Leave enough nail for a clinch.

6. Straighten shoe on the foot and drive nail in opposite side of foot. Follow the same procedure for the rest of the shoes. In the event the nails do not go straight, pull them out and drive a new nail.

7. After all nails have been driven, place the clinch block under the broken off end of each nail and hammer several heavy blows on the head of the nail. Nail heads must be driven flush with the bottom of the shoe. If not, the horse may be thrown off balance.

8. Make a slight groove in the wall under each clinch. Then the clinching block should be held under the head of the nail and the clinch bent down by hammering lightly to make a good clinch.

9. Dress down the hoof with a rasp, then let the foot rest on the ground and carefully examine from all sides to make sure that it is done correctly.

10. If the horse becomes lame in a few days, the foot should be examined. If nothing externally is found then remove the nails and examine each nail carefully. If the nail is wet or blue, it has penetrated the quick of the foot. If the case is bad the wall should be cut so as to permit the foot to drain. Then put the foot in a poultice boot.



This table will give the approximate dimensions of a shoe in relation to its size number, and the size of nail that is generally used with the shoe.

---

Size	Approximate width	Approximate length	Nail number
0	4-3/8	6-1/4	5
1	4-1/2	6-5/8	5
2	4-3/4	7	6
3	5	7-5/8	6
4	5-1/2	8	7
5	5-3/4	8-1/16	7
6	6-1/4	9	8
7	6-5/8	9-1/4	9

---

### Questions

1. Why is the examination of the foot so essential in good horse shoeing?
2. What should a person do if a horse becomes lame from improper shoeing?
3. Can proper shoeing correct pigeon-toedness to a certain extent?

### References

1. "Blacksmithing on the Farm" - Jarvis and Abbott.
2. "Blacksmithing" - Selvidge and Allton.
3. Local blacksmiths.

## RECOMMENDATIONS

1. That each teacher use the forms given in this study or similar forms in making surveys of farms in his community in determining the need of farm forge jobs.
2. That each teacher familiarize himself with the procedures of each job, and actually do the job, in order that he will increase the efficiency of his instruction.
3. That the students have access to these procedures and drawings while planning and doing the job.
4. That this material be made available to each teacher of Vocational Agriculture in Virginia, in such a form that it can be systematically filed and that it can be made accessible to the students.
5. That each teacher make surveys of the need of forge shops in his community and set, as a departmental objective, to establish shops on farms that have been found to be in need of shops.
6. That each student use this material as a guide in planning other forge jobs which are not found in this study.



## APPENDIX

Speeds of Grindstone and Grinding Wheel

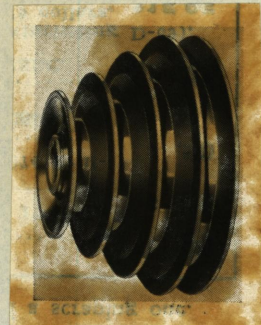
A 30" grindstone should run at approximately 100 revolutions per minute for grinding machinist tools. When used to grind carpenter's tools a 30" wheel should run at approximately 60 revolutions per minute.

The grinding wheel should run at approximately 3,000 to 6,000 revolutions per minute, depending somewhat on the material being ground.

Speed Table

This table will enable you to select the proper pulleys for the approximate speeds listed. These speeds are based on a motor speed of 1,725 revolutions per minute.

This table will enable you to select the proper pulleys for the approximate speeds listed. Machine pulley speeds are based on a motor speed of 1725 R.P.M.													
Mot. Pulley Size, In.	2	2 1/4	2 1/2	2 3/4	3	3 1/4	4	5	6	7	8	10	12
2	1725	1498	1325	1187	1075	905	781	614	505	425	371	295	245
2 1/4	1828	1725	1525	1360	1235	1040	897	684	577	490	426	327	282
2 1/2	2120	1875	1725	1542	1402	1180	1019	794	655	536	463	372	319
2 3/4	2330	2120	1880	1725	1562	1317	1148	887	732	624	542	416	356
3	2550	2260	2040	1860	1725	1452	1252	980	807	685	596	458	392
3 1/4	2690	2450	2380	2185	1985	1725	1489	1162	958	815	708	543	466
3 1/2	3800	3300	2920	2605	2360	2000	1725	1345	1100	940	820	650	540
4	4875	4230	3750	3350	3040	2560	2205	1725	1425	1210	1050	835	695
5	5900	5140	4550	4060	3700	3105	2680	2095	1725	1480	1250	1010	840
6	6950	6050	5340	4775	4350	3650	3160	2160	2025	1725	1500	1190	990
7	8000	6950	6150	5490	5000	4200	3600	2825	2320	1985	1725	1350	1135
8	10000	8750	7750	6920	6300	5300	4575	3560	2940	2500	2160	1725	1430
10	12000	10500	9350	8350	7560	6400	5500	4300	3540	3020	2620	2080	1725



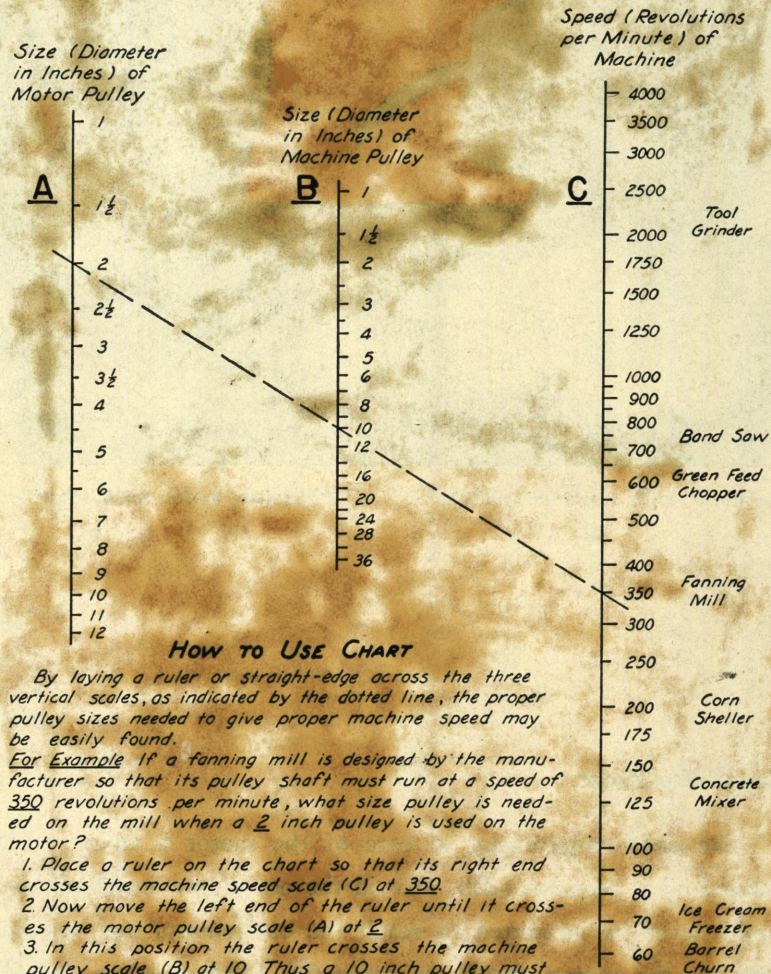
"Delta Manufacturing Company"

In mounting a pulley on the motor it is advisable to use the cone or step pulley in order that the same pulley may be used to obtain different speeds without changing the wheels. Use a single wheel on the machine that is driven.



# PULLEY SELECTION CHART

FOR USE WITH ALL ELECTRIC MOTORS WHICH RUN  
AT 1750 REVOLUTIONS PER MINUTE



Furnished by the Georgia Agricultural Experiment Station



## DECIMAL EQUIVALENTS

Fractions	Decimal	mm.	Fractions	Decimal	mm.
$\frac{1}{64}$	.015625	.397	$\frac{33}{64}$	.515625	13.097
$\frac{1}{32}$	.03125	.794	$\frac{17}{32}$	.53125	13.494
$\frac{3}{64}$	.046875	1.191	$\frac{35}{64}$	.546875	13.890
$\frac{1}{16}$	.0625	1.587	$\frac{9}{16}$	.5625	14.287
$\frac{5}{64}$	.078125	1.984	$\frac{37}{64}$	.578125	14.684
$\frac{3}{32}$	.09375	2.381	$\frac{19}{32}$	.59375	15.081
$\frac{7}{64}$	.109375	2.778	$\frac{39}{64}$	.609375	15.478
$\frac{1}{8}$	.125	3.175	$\frac{5}{8}$	.625	15.875
$\frac{9}{64}$	.140625	3.572	$\frac{41}{64}$	.640625	16.272
$\frac{5}{32}$	.15625	3.969	$\frac{21}{32}$	.65625	16.669
$\frac{11}{64}$	.171875	4.366	$\frac{43}{64}$	.671875	17.065
$\frac{3}{16}$	.1875	4.762	$\frac{11}{16}$	.6875	17.462
$\frac{13}{64}$	.203125	5.159	$\frac{45}{64}$	.703125	17.859
$\frac{7}{32}$	.21875	5.556	$\frac{23}{32}$	.71875	18.256
$\frac{15}{64}$	.234375	5.953	$\frac{47}{64}$	.734375	18.653
$\frac{1}{4}$	.25	6.350	$\frac{3}{4}$	.75	19.050
$\frac{17}{64}$	.265625	6.747	$\frac{49}{64}$	.765625	19.447
$\frac{9}{32}$	.28125	7.144	$\frac{25}{32}$	.78125	19.844
$\frac{19}{64}$	.296875	7.541	$\frac{51}{64}$	.796875	20.240
$\frac{5}{16}$	.3125	7.937	$\frac{13}{16}$	.8125	20.637
$\frac{21}{64}$	.328125	8.334	$\frac{53}{64}$	.828125	21.034
$\frac{11}{32}$	.34375	8.731	$\frac{27}{32}$	.84375	21.431
$\frac{23}{64}$	.359375	9.128	$\frac{55}{64}$	.859375	21.828
$\frac{3}{8}$	.375	9.525	$\frac{7}{8}$	.875	22.225
$\frac{25}{64}$	.390625	9.922	$\frac{57}{64}$	.890625	22.622
$\frac{13}{32}$	.40625	10.319	$\frac{29}{32}$	.90625	23.019
$\frac{27}{64}$	.421875	10.716	$\frac{59}{64}$	.921875	23.415
$\frac{7}{16}$	.4375	11.113	$\frac{15}{16}$	.9375	23.812
$\frac{29}{64}$	.453125	11.509	$\frac{61}{64}$	.953125	24.209
$\frac{15}{32}$	.46875	11.906	$\frac{31}{32}$	.96875	24.606
$\frac{31}{64}$	.484375	12.303	$\frac{63}{64}$	.984375	25.003
$\frac{1}{2}$	.5	12.700	1	1.	25.400

Furnished by Milton Manufacturing Company.

STANDARD WROUGHT WASHERS  
U. S. STANDARD SIZES

Outside Diameter Inches	Hole Inches	Bolt Inches
9/16	1/4	3/16
3/4	5/16	1/4
7/8	3/8	5/16
1	7/16	3/8
1-1/4	1/2	7/16
1-3/8	9/16	1/2
1-1/2	5/8	9/16
1-3/4	11/16	5/8
2	13/16	3/4
2-1/4	15/16	7/8
2-1/2	1-1/16	1
2-3/4	1-1/4	1-1/8
3	1-3/8	1-1/4
3-1/4	1-1/2	1-3/8
3-1/2	1-5/8	1-1/2
3-3/4	1-3/4	1-5/8
4	1-7/8	1-3/4
4-1/4	2	1-7/8
4-1/2	2-1/8	2
4-3/4	2-3/8	2-1/2

Furnished by Milton Manufacturing Company.



# **WEIGHT OF ROUND, SQUARE AND HEXAGON STEEL**

**IN LENGTHS OF 1 INCH**

Weight of 1 Cubic Inch—.2836 lbs.

Diameter	Round	Square	Hexagon	Diameter	Round	Square	Hexagon
$\frac{1}{4}$	.0139	.0177	.0154	$2\frac{1}{4}$	1.1276	1.4357	1.2434
$\frac{5}{16}$	.0218	.0277	.0240	$2\frac{3}{8}$	1.1911	1.5165	1.3135
$\frac{3}{8}$	.0313	.0405	.0345	$2\frac{1}{2}$	1.2564	1.6569	1.3854
$\frac{7}{16}$	.0426	.0543	.0470	$2\frac{7}{8}$	1.3234	1.6849	1.4593
$\frac{1}{2}$	.0557	.0709	.0614	$2\frac{1}{2}$	1.3921	1.7724	1.5351
$\frac{9}{16}$	.0705	.0897	.0777	$2\frac{5}{8}$	1.5348	1.9541	1.6924
$\frac{5}{8}$	.0870	.1108	.0959	$2\frac{3}{4}$	1.6845	2.1446	1.8574
$\frac{11}{16}$	.1053	.1340	.1161	$2\frac{7}{8}$	1.8411	2.3441	2.0304
$\frac{3}{4}$	.1253	.1622	.1381	3	2.0046	2.5548	2.2105
$\frac{13}{16}$	.1470	.1872	.1620	$3\frac{1}{8}$	2.1752	2.7719	2.3986
$\frac{7}{8}$	.1705	.2171	.1880	$3\frac{1}{4}$	2.3527	2.9954	2.5918
$\frac{15}{16}$	.1958	.2492	.2159	$3\frac{3}{8}$	2.5371	3.2303	2.7977
1	.2227	.2836	.2456	$3\frac{1}{2}$	2.7286	3.4740	3.0083
$1\frac{1}{16}$	.2551	.3201	.2773	$3\frac{5}{8}$	2.9269	3.7265	3.2275
$1\frac{1}{8}$	.2819	.3589	.3109	$3\frac{3}{4}$	3.1323	3.9880	3.4539
$1\frac{3}{8}$	.3141	.4142	.3464	$3\frac{7}{8}$	3.3446	4.2582	3.6880
$1\frac{1}{4}$	.3480	.4431	.3838	4	3.5638	4.5374	3.9298
$1\frac{5}{8}$	.3837	.4885	.4231	$4\frac{1}{8}$	3.7900	4.8254	4.1792
$1\frac{3}{4}$	.4211	.5362	.4643	$4\frac{1}{4}$	4.0232	5.1223	4.4364
$1\frac{7}{8}$	.4603	.5860	.5076	$4\frac{3}{8}$	4.2634	5.4280	4.7011
$1\frac{1}{2}$	.5012	.6487	.5526	$4\frac{1}{2}$	4.5105	5.7426	4.9736
$1\frac{9}{16}$	.5438	.6930	.5996	$4\frac{5}{8}$	4.7645	6.0662	5.2538
$1\frac{5}{8}$	.5882	.7489	.6480	$4\frac{3}{4}$	5.0255	6.6276	5.5416
$1\frac{11}{16}$	.6343	.8076	.6994	$4\frac{7}{8}$	5.2935	6.7397	5.8371
$1\frac{3}{4}$	.6821	.8685	.7521	5	5.5685	7.0897	6.1403
$1\frac{13}{16}$	.7317	.9316	.8069	$5\frac{1}{8}$	5.8504	7.4496	6.4511
$1\frac{7}{8}$	.7831	.9970	.8635	$5\frac{1}{4}$	6.1392	7.8164	6.7697
$1\frac{15}{16}$	.8361	1.0646	.9220	$5\frac{3}{8}$	6.4351	8.1930	7.0959
2	.8910	1.1342	.9825	$5\frac{1}{2}$	6.7379	8.5786	7.4298
$2\frac{1}{16}$	.9475	1.2064	1.0448	$5\frac{5}{8}$	7.0476	8.9729	7.7713
$2\frac{1}{8}$	1.0058	1.2806	1.1091	$5\frac{3}{4}$	7.3643	9.3762	8.1214
$2\frac{1}{4}$	1.0658	1.3570	1.1753	$5\frac{7}{8}$	7.6880	9.7883	8.4774

For wrought iron multiply above weights by .993  
 For cast iron multiply above weights by .918  
 For cast brass multiply above weights by 1.0331  
 For copper multiply above weights by 1.1209  
 For phosphor bronze multiply above weights by 1.1748

The area of a hexagon is equal to the short diameter multiplied by 8660.

The distance across the corners of a hexagon is equal to the distance across the flats multiplied by 1.155.

The distance across the corners of a square is equal to the distance across the flats multiplied by 1.414.

The illustrations which follow were furnished by Milton  
 Manufacturing Company.





Square Head Machine Bolt



Carriage Bolt



Hexagon Head Machine Bolt



Gimlet Point Lag Bolt



Blank Bolt

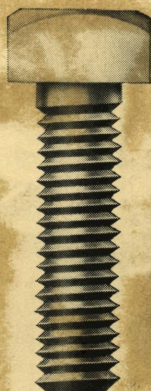


Fitting Up Bolt

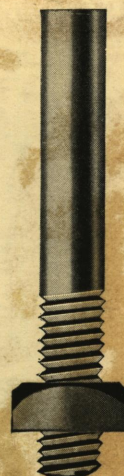




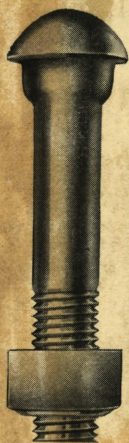
Stud Bolt



Tap Bolt



Bolt End



Track Bolt



Hanger Bolt



Step Bolt



Washer



Button Head Rivet



Cone Head Rivet



