Practical Methods of Repairing FORD CARS

The RADIATOR

Ford Motor Company
Detroit Michigan

Ford

THE UNIVERSAL CAR

Instructions on Radiator Repairing

for

Ford Dealers and Service Stations

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Introduction

It is our object to make these articles as helpful as possible to the experienced repairman as well as to the novice. Therefore it is our purpose to cover the work in detail so that there will be no possibility of the directions being misunderstood by even the most inexperienced mechanic.

The Radiator

Before going into the methods of repairing the radiator, information on the tools, equipment, and the process of soldering, will be in order.

The Solder

1. The first thing one must consider is the solder. There are several types used in building the radiator, but for repairing only one type need be used. What is known commercially as 50-50 solder is adapted for all repair work. We furnish this solder in wire, bar, and a special washer solder, used in soldering the headers to the body.

The Iron

2. The second consideration is the soldering iron. The soldering iron should be heavy enough to convey sufficient heat to the work. The

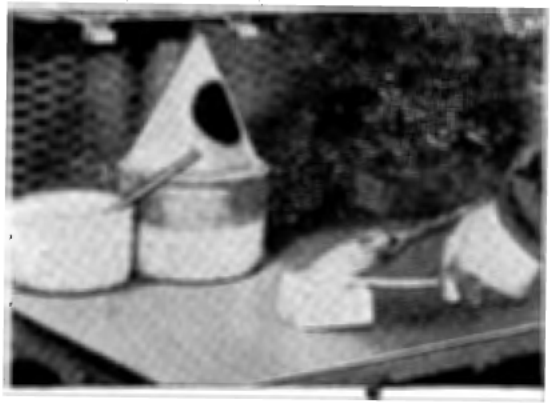

Fig. 1

iron should be tapered to give a flat point for getting into the corners. The care of the iron is most important as a dirty iron will not draw solder evenly. When the iron becomes so dirty that it cannot be cleaned on the sal ammoniac it should be heated and hammered to take out any low spots and the surfaces should be dressed

with a fine file. At the factory, we even polish the copper, having found that the smoother the iron the better the work it will do and the longer it will last.

3. Be careful to file the surfaces squarely. Do not make them the arc of a circle. Remember the more surface you have against the work at one time, the quicker the metal will be brought up to heat. When the surfaces have been properly dressed, chamfer the edges to ½ of an inch.

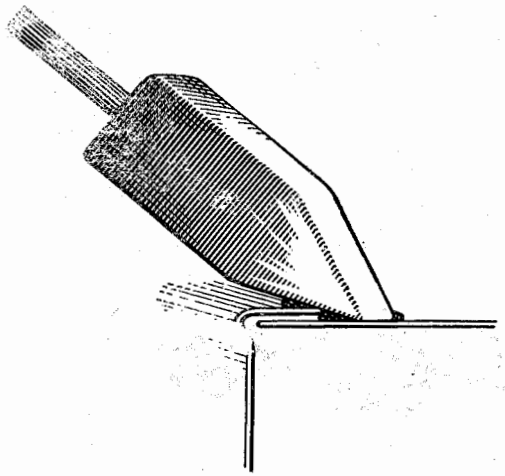

Fig. 2, Wrong Method

4. After the iron has been dressed in this manner, it is necessary to "tin" it. This is done by heating the iron, dipping it into acid and rubbing it on a piece of sal ammoniac, at the same time touching a bar of solder to the iron. (See Fig. 1.) The iron should be turned over from one surface to the other until all sides of the taper are properly coated. Another way is to dip the hot iron into acid for a second and then dip it into a pot of molten solder. This latter method is perhaps the best but in small shops it is seldom that the pot of solder is available.

5. Solder oxidizes readily in heat, therefore, the iron should never be allowed to become red hot as the coating of solder will burn off. Each time that the iron comes from the fire, it should be dipped for an instant into a solution of water and sal ammoniac. Granulated or powdered sal ammoniac should be used in making this solution. The exact proportion of sal ammoniac to water is unimportant. However, a saturated solution or a solution with an excess of sal ammoniac is preferable. If dipping the iron into the solution does not clean it sufficiently rub the iron on a block of sal ammoniac and if necessary re-tin it.

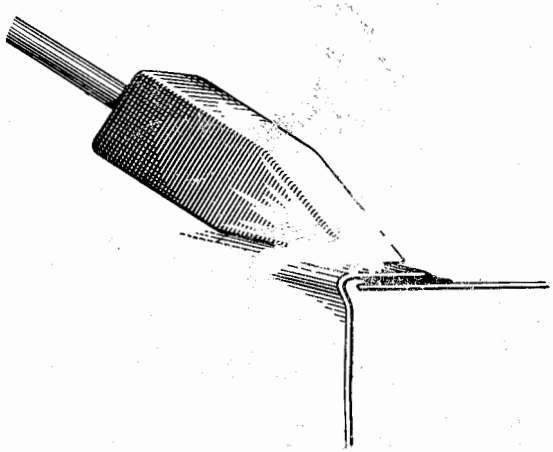

Fig. 3, Correct Method

The Torch

6. The torch should be of a type which can give either a concentrated or a flooding flame. The best kind of a torch is the combined gas and air type. The air must be of low pressure. However, reasonably good work may be done with an atmosphere Bunsen Burner type. Care must be taken in using the torch that the metal, particularly the fins, is not subjected to the heat for too long a period of time, as the metal will burn. To overcome this, the torch should

be kept moving. The torch is a very dangerous tool in the hands of a careless or inexperienced workman. The inexperienced man should experiment on a scrap radiator before attempting an actual repair. He will probably experience some of the following troubles:

(1) The pilot light—if one is provided on the torch—may be turned on so full that carbon (soot) is deposited on the material before the solder joint is made. This flame should not be over ½" long.

(2) The work may be brought to heat so slowly that the acid is dried before the solder runs, which causes a very poor joint, having no holding strength.

(3) The flame is sometimes directed on one part of the metal for too long a time, causing it to burn. Sometimes the metal will be completely burned away. At other times a thin skin will be left which will break through under the strain of ordinary road condition.

The Acid

7. The acid used at the plant is commercial muriatic cut with zinc. By cut, we mean that zinc is placed in the acid, and left in it until the action (boiling) stops. This acid is used both in cleaning the surface and as a flux in soldering. Never try to keep acid in a metal retainer. Keep it in a glass bottle or stone crock. A cone-shaped metal top with a hole in it set over the crock will save the acid or sal ammoniac solution from flying out when the iron is dipped into it, protecting the operator's eyes and clothes.

8. The soldering acid should be clean; do not use the same container for the cleaning acid and the soldering acid. The crocks should be cleaned once a week. The soldering acid may be dumped into the cleaning acid and new acid used for soldering. If too much cleaning acid accumulates, strain the soldering acid through a cloth, and use it again as soldering acid.

9. If a large quantity of acid is made at one time it is advisable to store it in a corked bottle as it has a tendency to become weak when exposed to the air.

10. There are a number of preparations on the market to replace the acid, but from our experience the acid mentioned above gives the best results on the radiator, regardless of cost.

Miscellaneous

11. A small horsehair brush for applying the acid and another for cleaning, are a necessary part of the equipment. The repairman should watch carefully that hairs do not come out of the brush and lodge in the joints as a leak will develop around the hair.

12. A fiber brush, as shown in 21, Fig. 6, is used to scrub the parts with water after they have been cleaned with acid.

13. The oven for heating the irons may be obtained from your local hardware dealer.

14. A pasty mixture of powdered common chalk and water is necessary on the 1916 radiator to keep the solder from running over the exposed surfaces.

15. The repairman should wear a pair of cheap canvas gloves to protect his hands from burns and acids; the gloves should be rubbed with powdered chalk occasionally to take up the moisture and counteract the acid. When working at the test tank rubber gloves should be worn.

Soldering

16. Now, consider that we have two old pieces of metal to be soldered together. The first thing to do is to clean the surface carefully. Any dirt left on the surface has a tendency to expand itself and will be the cause of a leak in the completed work. To clean the surface, heat it with the torch and rub the heated surface with acid on the acid brush. When all dirt is loose, take the parts to the test tank and wash them with a scrubbing brush and water. It is positively essential to have clean surfaces

to run a seam of solder and the operator will save himself time, trouble, and solder by putting in a little more time in cleaning the surfaces.

17. Next, fit the two surfaces together. The closer they are together, the easier the task of soldering and the less solder necessary to run a tight seam. The object of soldering is to hold the surfaces together and not to build up a wall of solder at the edge. The first thing to remember is that solder only flows on well heated surfaces. Second, that it will not flow up-hill. Fig. 2 shows the improper method of applying the iron. Here the iron is cocked against the edge of the surface. In the first place the solder does not flow between the surfaces as shown in the

Fig. 4

figure. In the second place, it requires a greater length of time to run the seam. Fig. 3 shows the method used in good practice. Here the iron is held flat against the upper surface, transmitting the heat from the heel of the iron to the two surfaces, hence drawing the solder

between them, making a strong joint with the least amount of solder in the shortest space of time. Always draw the iron so that the heel heats the metal before the point arrives. The point gives a good clean draw to the seam after the heel has warmed the surfaces and flowed the solder.

18. In using the torch, always solder in the direction of the flow of the flame as shown in Fig. 4. The reason for this is two-fold. First, it preheats the surfaces, saving time in soldering and, second, it gives the solder a chance to cool after it has flowed into place. Do not be afraid to use plenty of acid. Acid applied after the soldering operation is started, while necessary in a number of cases, is never as good as enough put on in the first place. The acid should be used both when soldering with the iron and when soldering with the torch. The iron is used to best advantage in soldering two parallel surfaces, upon one of which the iron may rest. In all other cases the torch is the most advantageous.

19. For removing [illegible] parts, a torch with a flood flame is [illegible] used.

Equipment

20. The equipment necessary for repairing a radiator, while extensive, is not so costly as it would appear. Most of the work of installing may be done by the average repairman and a number of the tools may be made by him in his spare time. The main expense is the bench and test tank. The bench and frame for test tank may be built by the repairman and the tank and covering of the bench could be installed by a tinsmith, although a number of service stations have done all their own work. Fig. 8 shows a good arrangement of bench and test tank, giving the necessary dimensions. The work table should be covered with sheet metal and the test tank should be given a coat of white enamel to keep the acid from attacking the metal. The table top should be as flat as

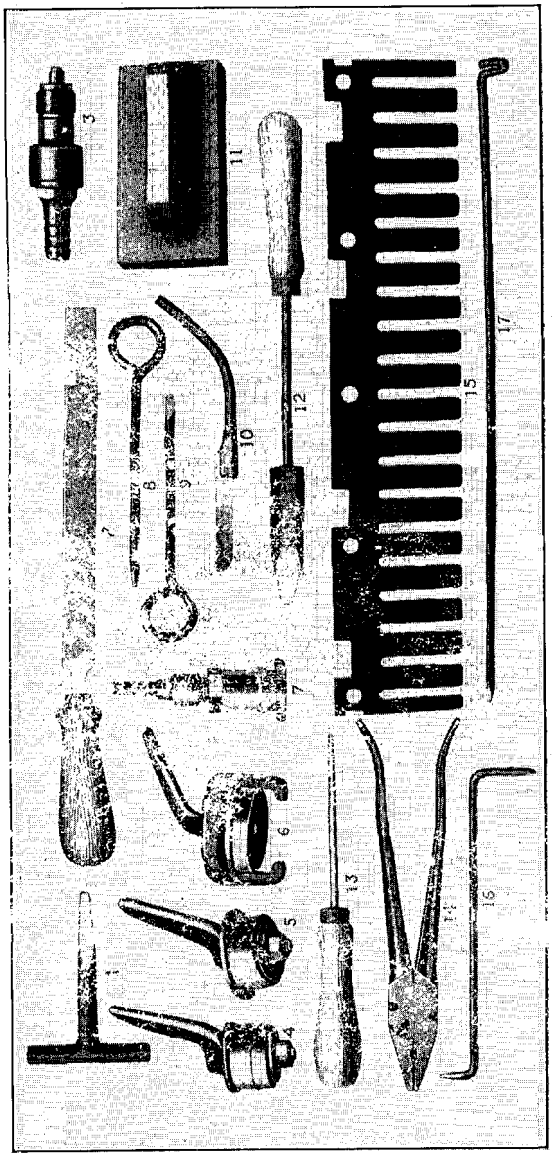
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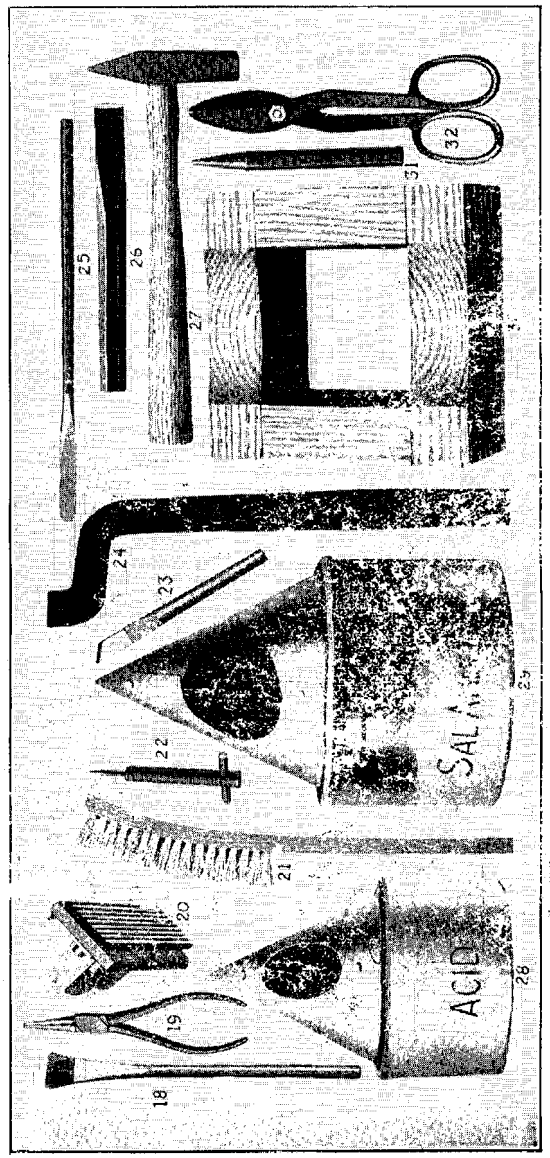
Fig. 5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ACID

Fig. 6

Index to Figs. 5 and 6

1 Dent Puller or Tube Holder. Can be made by a repairman if a forge is available.

2 12″ Mill File

Tools 3 to 7 inclusive used in testing the radiator

3 Outlet Air Connection, to which the hose is attached

4 Outlet Test Plug

5 Inlet Test Plug

6 Filler Flange Plug

7 Inlet Air Connection. Screws into petcock hole in the radiator

8 Scratchall. Made from $\frac{3}{16}$″ to $\frac{1}{4}$″ stock

9 Dent Puller. Made from $\frac{3}{16}$″ to $\frac{1}{4}$″ stock

10 Hacksaw for cutting tubes. Made by soldering a piece of tube to a broken hacksaw blade

11 Weight for holding overflow tube down while soldering

12 Soldering Iron

13 $\frac{1}{4}$″ Rat-tail File

14 10″ Square Nose Pliers

15 Fin Spacer. Drill and saw out a piece of sheet metal $\frac{3}{16}$″ thick to fit by the tubes

16 Tube Spreader, right angle, made of $\frac{3}{16}$″ to $\frac{1}{4}$″ stock

17 Tube Cleaner, $\frac{1}{8}$″ stock. Fin Spreader, $\frac{1}{4}$″ stock for holes in fin

18 Acid Brush. Made by inserting horsehair into a copper tube, flattening the tube and trimming the rough ends of the hair

19 Weavers' Pliers

20 Fin Comb

21 Fiber Brush

22 Tube Regulator

23 Tube Cutter. Made from broken hacksaw blade with a tube handle. Fill handle with solder

24 Rivet Bucker

25 Fin and Header Bar. Made of $\frac{1}{2}$″ stock and flattened on the end

26 Cold Chisel

27 Small Tinners' Hammer

28 Acid Jar

29 Sal Ammoniac Jar

30 Radiator Block. 8″ square, 4″ deep, made of wood with radius to fit 1917 radiator top tank

31 $\frac{1}{16}$″ Punch

32 8″ Shears

possible and no dirt should be allowed to accumulate on it, as the core for the radiator is easily thrown out of square when hot. The steam pipe running into the test tank is for heating the water. The water may be heated in some other way or if the operator wishes he may work in cold water.

21. There should be check valves in the gas and air lines to prevent a combustible mixture forming in either of the lines due to unequal pressure. A serious accident may result from neglect of this precautionary measure.

22. The hose covered strap irons shown at the left may be set to the proper height for the man who is to work on the bench. The radiator may be supported on these brackets as shown or at any convenient angle. The shelf for inverting the radiator is optional. The block shown 30, Fig. 6 may be used in place of it. The pipe line leading to the front of the test tank and designated as air supply is used in testing the repaired radiators, a pressure of 8 to 10 lbs. being carried.

23. Figs. 5 and 6 show the tools used in repairing the radiator. They will be referred to throughout the series of articles as the need for them arises. These tools may be purchased from the Fairbanks Company, 416 Broome street, New York City.

Removing The Radiator

24. As practically all the radiator repairs require the removal of the radiator to the work bench, we will explain here the methods of removing.

25. Drain the water from the radiator by opening the drain cock in the outlet connection. If the water does not flow immediately, stick a piece of wire into the cock to break up the sediment.

26. While the water is draining, remove the carburetor priming rod, run off the two castle nuts which hold the support to the frame of

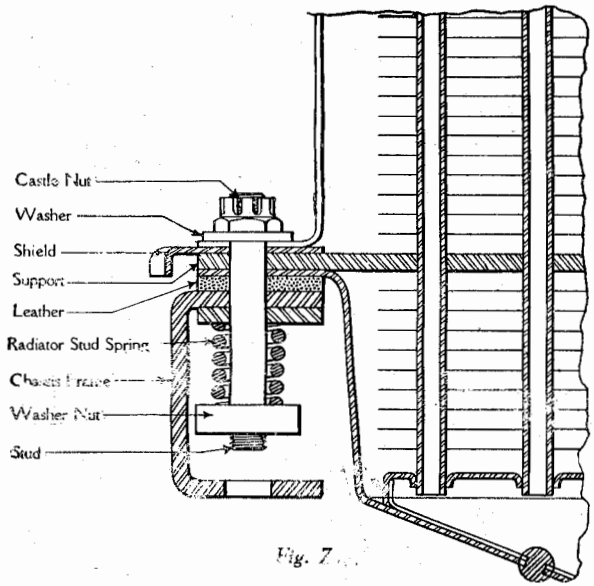

Fig. 7

car. Next loosen the hose clamp on the outlet connection at the engine and the clamp at the engine on the inlet connection pipe. In some cases, it is necessary to run a screw-driver under the hose connections as they become stuck to the metal. Run off the nut which holds the radiator rod to the dash and with pair of pliers or small Stillson wrench, back the rod out of the radiator bracket. As the rod binds, grasp the top tank of the radiator and give it a sharp jerk forward. (On the old style radiator it is necessary to remove the light rods.)

27. When the rod is loose, lift the radiator off of the studs. It may be necessary to pry it up with a screw-driver, in which case, use the screw-driver so the point is against the car frame and the pressure on the tank falls on the support bracket. When the radiator is off the studs, grasp it by the sides and pull it off, taking care not to damage the headlights. If the

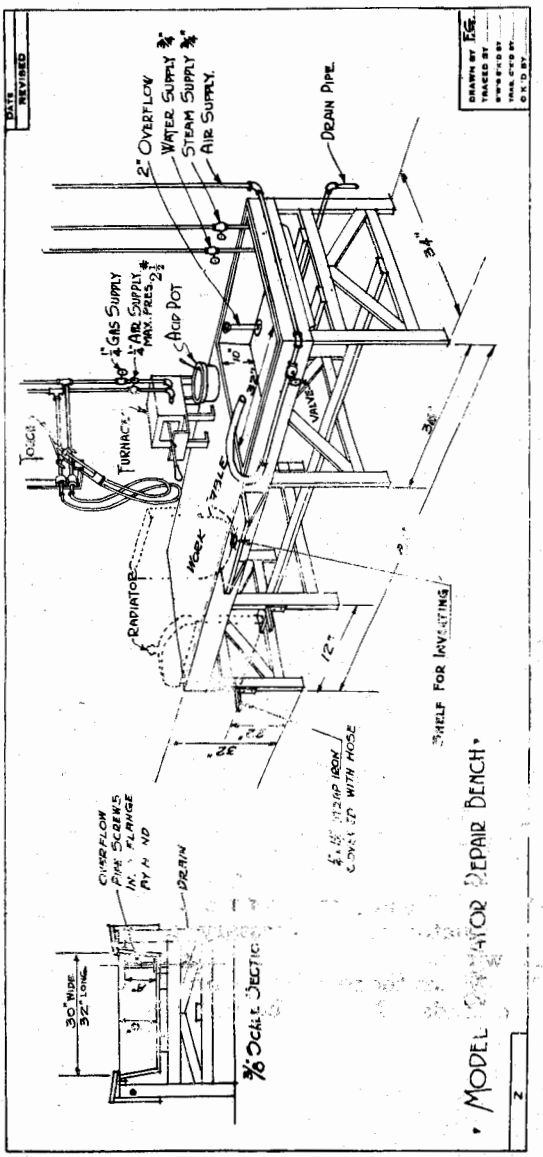

Fig. 8

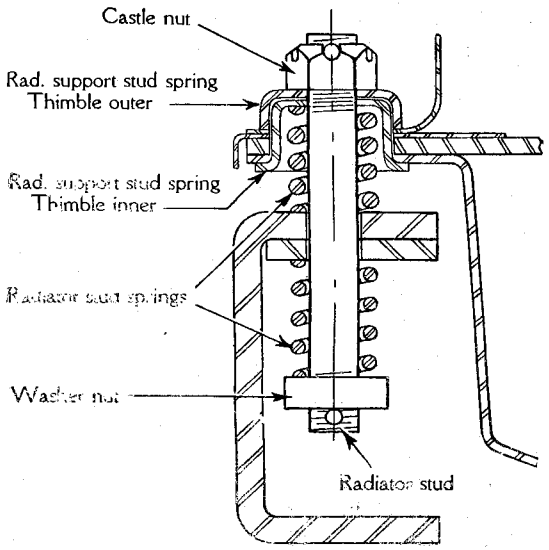

Fig. 9

radiator is of the old style, it is now ready for the repair bench. If it is of the new style, the shell should be drawn off before the repairs are made on it. At the repair bench, heat the solder on the ground wire and withdraw it. This is done to keep the wire from becoming wet and acid soaked during the water test. It should be replaced when the radiator has been repaired and tested.

Replacing The Radiator

28. Before replacing the radiator, examine the hose connections and the connecting pipe to see that they are in good condition and that the leather pieces are placed on the frame. Set the radiator over the stud on the left as you face the car and enter the hose connection on the motor inlet. Force the radiator in and down over the stud at your right hand. Enter the top connection and screw in the radiator rod (if it is a new style radiator, slip on the shell), put on the washers and run down the nuts on

the radiator to frame studs. The setting of these nuts is of the greatest importance. Figs. 7 and 9 show the method of attaching the radiator to the frame. There is a spring between the frame and the nut on the lower end of the stud. This spring is to allow for the weave in the frame as the car goes over rough roads. There should be a fair allowance of play on this spring when the top (castle nut) is down far enough to insert the cotter pin. If there is not enough play, back the stud out of the washer nut far enough to give the required compression. A nail through the cotter pin hole may be used as a wrench. When the adjustment is O. K. insert the cotter pins.

29. The method of suspension shown in Fig. 9 is self-evident. However, the repairman should make a point of fastening the radiator down so that its support is about the same space from the frame that it would be if the leather were under it. If the radiator stands too high the hood will not fit properly.

30. Next, set the radiator rod by screwing it in or out of the rod bracket on the radiator so that the distance is right for the hood center hinge. An extra hinge rod may be used as a gauge for this operation. When the proper distance has been found, lock the rod by running down the lock nut on the rod at the dash. Finally, try the gauge to see that the adjustment has not been disturbed.

31. Tighten the hose connections with a screw-driver and put in the water. If the hose connections leak, strike the clamps at the leaky point with a hammer and take up on the screw. Install the carburetor priming rod and connect the wires to the lamps. Test the fan to see that it does not hit the radiator when revolved by hand. Finally, start the engine and run it with the hood off for a time to see that the vibration does not cause any leaks in the connections.

Replacing The Filler Neck

32. On the 1916 radiator the heads of the three rivets which hold the flange to the top tank are filed off. Next, heat the flange with a torch and while it is thoroughly warm, pull the filler neck off with a pair of pliers. When putting the new filler neck into place, position the three rivets. It is impossible to peen the lower ends of these rivets, but they will fill the holes preventing the solder flowing through them. Do not put the filler neck on until the top tank is thoroughly cleaned to insure easy soldering. It is usually advisable to put a little acid on the under side of the flange before positioning it.

33. There are three ways of soldering the flange of the 1916: the first being the ordinary method of soldering two surfaces with the iron and bar solder. As the solder will be drawn onto the surface of the flange, this method necessitates considerable scraping before the radiator can be polished.

34. The second method is to put a heavy coating of solder on the top tank before positioning the flange. The flange is then soldered to the tank by heating it with a dry iron (one that has not been tinned). Such an iron will not draw the solder from under the flange.

35. The third method is to solder the flange from the inside of the neck with a torch and wire solder. This method is rather difficult on the 1916 radiator.

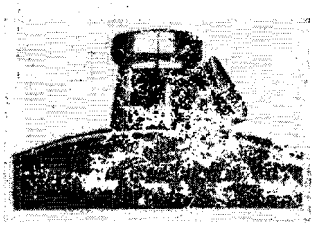

Fig. 10

36. To remove the filler neck of the 1917 radiator, cut it out with a chisel, as shown in Fig. 10. Melt the solder and pull it off. Clean the old solder from the tank and bend the collar up so that the new filler neck will

slip over it. Do not try to bend the metal while it is hot, as it is very brittle at this time. Wipe some acid on the top tank where the filler rests upon it. Set the filler neck in position and solder it with a torch and wire solder from the inside of the neck.

Removing the Bottom Tank Either Style

37. The bottom tank as considered here will include the tank, reinforcements, and outlet connection. The first thing to do in removing the lower tank is to detach the overflow pipe and the conduit for the light wires The conduit

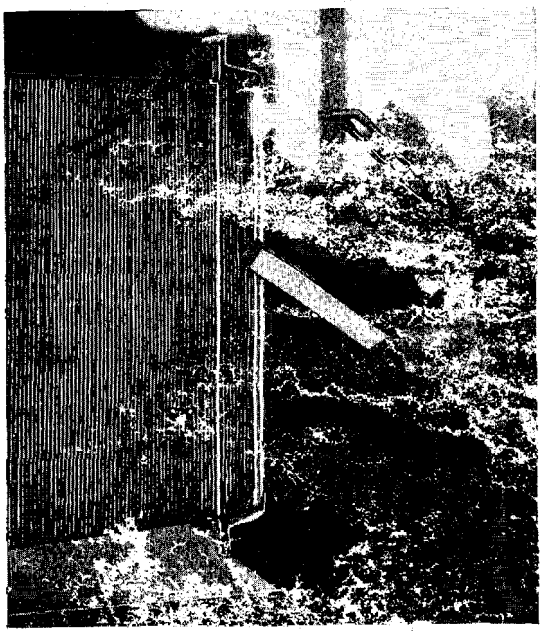

Fig. 11

is removed by melting the solder after which it may be lifted off the tank. The overflow pipe needs only to be loosened from the lower tank and core and bent out of the way. Next, detach

the reinforcements from the radiator support. On the later radiators the support and the reinforcements are spot-welded. The weld may be broken by driving a cold chisel between them. If it is found that they are soldered together, melt the solder with a torch or iron and bend the reinforcement far enough away to keep it from seizing. Next heat the surface of the reinforcement attached to the lower tank, brush off the solder and swing the reinforcement out of the way. (See Fig. 12A.) In the same way detach the other reinforcement.

38. Place the radiator on its side (See Fig. 11) and apply the heat to the side seam. With a brush remove the heated solder as it flows from the joint. Do this on all four seams. When the joints show that most of the solder has been removed, bring all the tank to heat at once by moving the torch rapidly all over it. Grasp the outlet connection with a pair of pliers and remove the tank, applying heat to any point that may be sticking.

Replacing The Bottom Tank Either Style

39. Removing the tank disturbs the solder around the tubes in the header. It is therefore advisable to heat the inside of the header, brush off the old solder and rust and reset the tubes before replacing the tank. (See Fig. 4.)

Fig. 12

40. The torch should be adjusted to give a full flame of light blue color, and should be held

at such an angle that the flame will cover from three to four of the five tube rows; keep the torch moving in a small semi-circle, while the solder which is held in the left hand is touched to the tube to see if it is warm enough to flow. As soon as the solder will flow touch each of the five tubes in the first row, making sure that the solder flows all the way around each tube. Be careful not to get the header too hot as the solder will flow through between the header and the tubes. As soon as the first row has been flowed, move on to the second, watch the flame carefully to see that it does not melt the solder around the first row to the point where it will flow through.

41. In replacing the lower tank, care should be taken that it fits the header as closely as possible. Stand the radiator bottom side up on the shelf (See Fig. 8), flare the edges on the header out a little and spread the tank to fit. It is usually necessary to tap the corners of the tank in a little. Clean the surfaces to be soldered with the heat and acid, and insert the tank into the header, tapping it down with the flat of the hammer.

42. Tack the tank to the header at the ends with a little solder on an iron. With a hammer,

Fig. 13

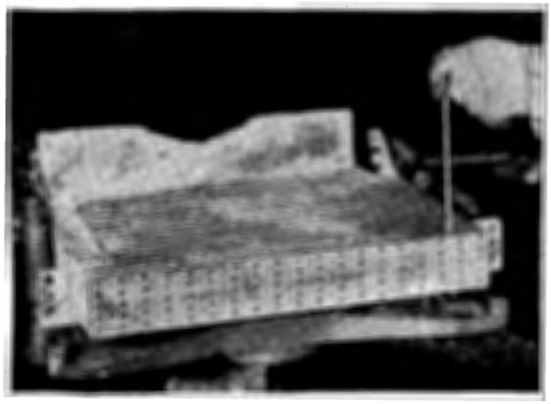

Fig. 14

tap the edges of the header into contact with the tank and it is ready for the soldering operation.

43. First, solder the ends, drawing the solder around the corners about ½ to ¾ inch. The radiator should be stood on its side for this operation. (See Fig. 16A.) Next, solder the face. The radiator should be laid flat on its face with one end, the seam on the back, and laid on its back, supported by the block (30, Fig. 6) over running the front seam. This operation is shown in Fig. 16B. When soldering around the outlet, a little extra time and care is necessary to make a good joint. This is because of the cold heavy metal. It is a good idea to run all around the outlet with the iron to insure a tight seam.

44. Next, stand the radiator bottom side up on the shelf, shown in Fig. 6, swing the reinforcement into place and solder it to the support. (See Fig. 16.) When this joint has set, solder it to the tank. Take the necessary time to insure a strong joint by flowing the solder well under the reinforcement. Excepting resetting the tubes, the soldering iron is used in all the soldering operations when replacing the bottom tank.

Removing The Bottom Header Either Style

45. To remove the bottom header, it is first necessary to remove the bottom tank. (See paragraphs 37 and 38.) The header is removed by heating it and brushing off the solder from around the tubes. Then heat the header by moving the torch over it rapidly and drive it off by inserting the bar (25, Fig. 6) between the header and the first fin. (See Fig. 14.)

Replacing Bottom Header Either Style

46. Set the radiator bottom side up on the shelf (Shown in Fig. 6). Heat all the tubes, brush off all the excess solder and clean any of the tubes, which are dirty, with heat and acid.

47. Next straighten any of the tubes which may be out of line. Using a radiator support as a gauge, draw the tubes into position with a scratchall (Stewart No. 2, Fig. 9). If any of the tubes are out of round same may be straightened by inserting the scratchall and forming the tubes to it. When all the tubes fit properly into the support, proceed to position the header.

48. Place the new header in position, making sure that all the tubes are entering the holes and tap it into position with the hammer. The header should be located about 1 1/16 inches from the radiator support. Wipe the tubes and header with acid and tin the tubes as explained in paragraph 36 and 37.

Removing The Rear Wall of 1917 Radiator

49. In removing the 1917 radiator rear wall, it must be remembered that there are three rivets which hold the outlet pipe connection to the top tank header. If same is removed with this inlet assembled to it, with a chisel, shear the heads from the rivets which hold the inlet connection to the header. Heat the gasher

which holds the rear wall to the radiator rod support and remove it. Clean the solder from the joints by applying heat and brushing it off in the same manner as described in "Removing the Bottom Tank" and drive the top of the rear wall off the tank to allow enough room to insert the rivet-bucker (24, Fig. 6).

50. Next, heat the water inlet connection at the point where it is soldered to the top header and drive out the rivets with the scratchall, inserting the rivet bucker through the opening already made, to buck the top header, near

Fig. 15

the rivet that is being driven out. When the three rivets have been removed, use the flood flame to heat the lower seam and water connection and pull the rear wall off by grasping the water connection with a pair of pliers.

Replacing The Rear Wall of 1917 Radiator

51. In replacing the rear wall of the 1917 radiator, first heat and brush off all excess solder, both from the wall and the relative edges of the top tank assembly. Tap out the edges of

the tank to fit the wall snugly. Insert three new rivets in the header and tack them in place with a touch of solder, on the inside of the tank. Fit

Fig. 16

the inlet connection onto the rivets. If the holes in the connection are too small for the rivets, clean them out with the drift (8, Fig. 5). Insert the rivet bucker (24, Fig. 6) through the opposite side (See Fig. 15) and peen the rivets. Fit the wall to the assembly and tack it at the ends of the header and at two or three points on the top tank top. Then solder the washer in place around the radiator rod support.

52. Run the solder seams between the rear wall and the tank with the iron and bar solder. As the excessive heat applied to the header warps the metal, it is necessary to exercise a little care in soldering the inlet connection and the header, particularly at the point where the header, rear wall and inlet connection come together. It is good practice to clean the joints between the inlet connection and rear wall and re-run this seam also.

53. If there is too great an opening at any point in the joint, solder the dent puller (1 or 9, Fig. 5) to the top near the rear wall as in Fig. 16. With this as a handle, hold the top up to the flange of the rear wall, closing the opening while you tack it with solder at the center of the gap.

Removing Rear Wall 1916 Radiator

54. The top tank assembly on the 1916 radiator fits inside the rear wall. The rear wall is removed in the same manner as is the 1917 excepting the work around the water inlet connection. On this radiator, the connection is fastened to the header only.

Replacing The Rear Wall 1916 Radiator

55. Fit the tank to the wall as described in replacing the 1917 rear wall. Greater care must be taken in fitting because the offsets and the difference in the thickness of the metal make the 1916 hard to draw out. As in the 1917 it is good practice to run the solder seam all the way around the inlet connection.

Removing The Front Wall 1917 Radiator

56. The top tank of the 1917 radiator is so constructed that the front wall slips inside the brake on the top header and over the top. To remove the front wall, it is necessary to heat the seams; brush off the excess solder and tap the top of the wall off with the back of the brush or a hammer.

Replacing The Front Wall 1917 Radiator

57. Before replacing the front wall it is usually necessary to reset the tubes. Clean the tubes in the header with acid and brush or with acid in an oil can as shown in Fig. 17. The radiator is then set on the rack and solder is flowed on the tubes in much the same manner as the bottom header is reset. See paragraphs 39 and 40.

58. Because the top tank assembly already in position, confines the heat, care must be taken not to melt the seams already run. Some repairmen lay cloths soaked in water over the tank to help keep it cool.

Fig. 17

59. When the tubes have been properly set the front wall may be assembled. Slip the front wall into position behind the brake of the top header. Insert a file through the opening between the top of the wall and the tank to hold the wall against the brake while tacking them at several points. Next take a hammer and tap the top header brake into close contact with the wall, and run a water tight solder seam with the iron and bar solder. When the solder has set, tack the wall to the top at several points, and flow the seams. A little extra care is necessary to insure a tight joint at the corners of the front wall where the header turns back to meet the top. If necessary use the dent puller as explained in paragraph 53.

Removing The Front Wall 1916 Radiator

60. The front wall of the 1916 radiator is held in place by the beading of the top and header. It is therefore necessary to remove the rear wall as described in paragraph 54. Heat the splash plate where it is soldered to the top and let it drop down. Disconnect the overflow from lower tank and core. Heat the header at the point where the overflow pipe enters the tank. Keep

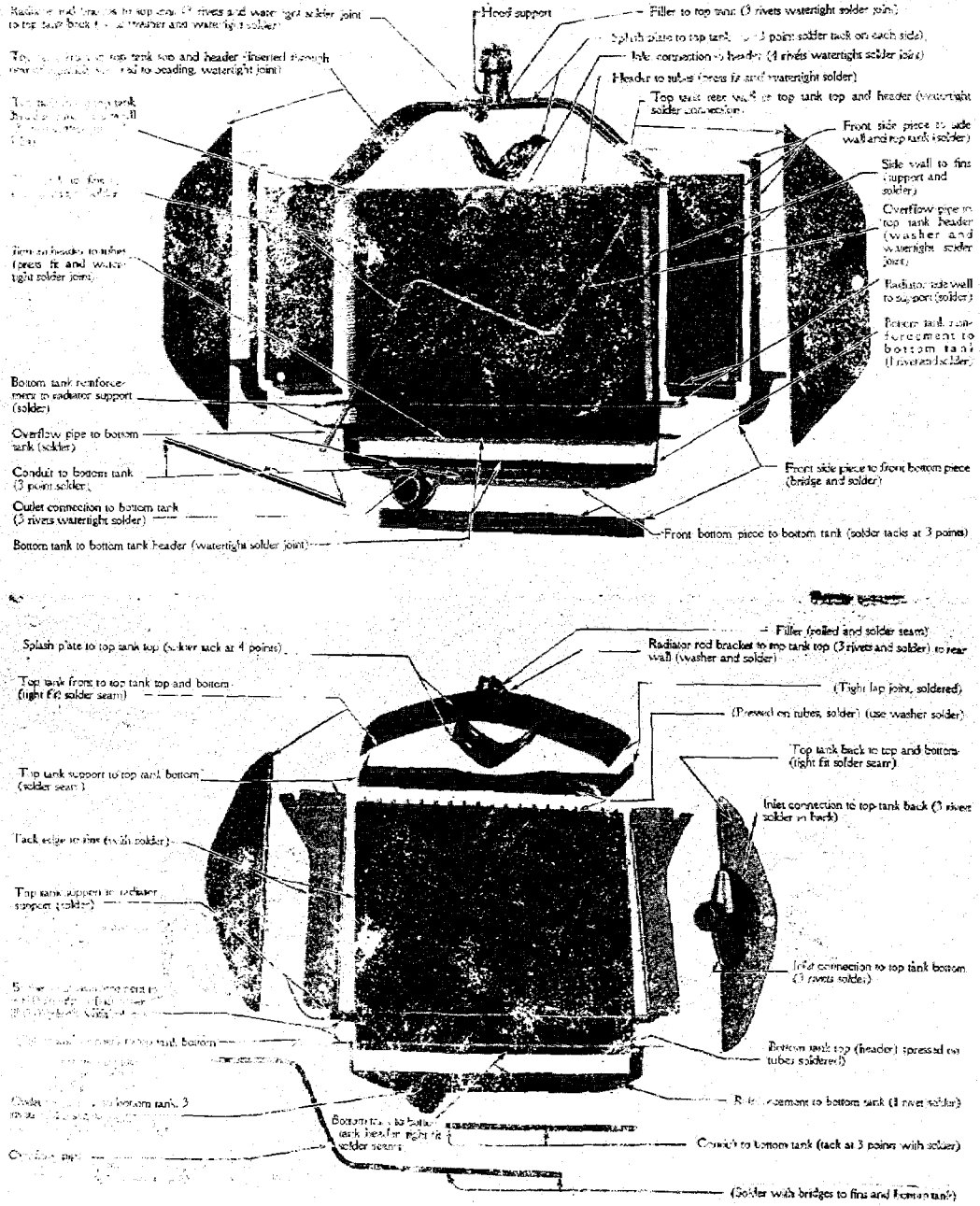
Hood support
Filler to top tank (3 rivets watertight solder joint)
Splash plate to top tank (solder tack on each side)
Inlet connection to header (4 rivets watertight solder joint)
Header to tubes (press fit and watertight solder)
Top tank rear wall to top tank top and header (watertight solder connection)
Front side piece to side wall and top tank (solder)
Side wall to fins (support and solder)
Overflow pipe to top tank header (washer and watertight solder joint)
Radiator side wall to support (solder)
Bottom tank reinforcement to bottom tank (3 rivets and solder)
Front side piece to front bottom piece (bridge and solder)
Front bottom piece to bottom tank (solder tacks at 3 points)
Bottom tank reinforcement to radiator support (solder)
Overflow pipe to bottom tank (solder)
Conduit to bottom tank (3 point solder)
Outlet connection to bottom tank (3 rivets watertight solder)
Bottom tank to bottom tank header (watertight solder joint)
Filler (rolled and solder seam)
Radiator rod bracket to top tank top (3 rivets and solder) to rear wall (washer and solder)
Splash plate to top tank top (solder tack at 4 points)
(Tight lap joint, soldered)
Top tank front to top tank top and bottom (tight fit solder seam)
(Pressed on tubes, solder) (use washer solder)
Top tank back to top and bottom (tight fit solder seam)
Top tank support to top tank bottom (solder seam)
Inlet connection to top tank back (3 rivets solder on back)
Tack edge to fins (solder)
Top tank support to radiator support (solder)
Inlet connection to top tank bottom (3 rivets solder)
Bottom tank top (header) (pressed on tubes soldered)
Conduit to bottom tank (tack at 3 points with solder)
(Solder with bridges to fins and bottom tank)

Fig. 18

the tube turning so that the solder will not set it again and draw it out. Heat the beading around the edge of the front wall and push it out through the opening left by the rear wall.

Replacing The Front Wall 1916 Radiator

61. In replacing the front wall, it should be tacked in place and a paste made of chalk and water should be wiped on the front face at the joint to keep the solder from flowing over it. Lay the radiator on its face, wipe the acid on the inside and solder the joint with an iron,

Fig. 19

holding the wall in position with a file. (See Fig. 19.) It is usually necessary to run the seam heavy at the two ends of the header where the top, the front wall and the header come together. (Note the solder in the corners before removing the front wall.)

62. If necessary reset the tubes as explained in paragraphs 57 and 58. Next replace the overflow pipe and splash plate. For method of attaching see Fig. 18. Care should be exercised in soldering the pipe to the header. Do not forget to put the washer in at this point. The rear wall may now be replaced as explained in paragraph 55.

Removing The Top Tank Top 1917 Radiator

63. The top tank top may be removed in two ways.

First Method

64. To remove the top by the first method, remove the wall as described in paragraphs 49 and 50 or 56.

65. Remove the splash plate and the overflow pipe as described in paragraph 75. Heat the joints between the top header and wall and brush off the solder as it runs out. Lay the

Fig. 20

radiator on the table and grasp the open end of the top with a pair of pliers. After heating the joints with a flood flame tap the pliers with a

hammer as shown in Fig. 20. When the one side has started, start the other side. It is then a simple matter to drive the top off.

Second Method

66. To remove the top by the second method, remove the front or rear wall as described in paragraphs 49 or 56. Cut through the top with a hack-saw about one inch above the top and header joint, stopping at the flange of the remaining wall (Fig. 21). Heat the joint between the top and the wall and brush off the solder as it flows out. Hit the top a sharp blow with a hammer at the corners, formed by the wall and the cuts, to break it loose under the flange.

67. The top may then be brought to heat and removed by pulling it away from the wall and then raising it off the overflow pipe. As will be noted, it is unnecessary to remove the overflow pipe when this method is used. The two pieces of the top remaining attached to the header may now be removed by flowing out the solder and drawing them out with a pair of pliers.

Fig. 21

Replacing the Top Tank Top of the 1917 Radiator

First Method

68. When this method is used the rear wall is generally already attached to the header.

69. Brush the excess solder from all the joints and bend the lips of the header out a little to insure room for those of the top.

Start the header into the lips of the top tank top and force the top tank top in until it positions against the wall.

70. The top should then be drawn up to fit the flange of the wall as closely as possible and tacked to it with a little solder on the iron at two or three points. Hold the rivet-bucker or some other piece of bar metal against the inside of the joint-former by the header and the top and flatten the joint with a hammer as shown in Fig. 22. Flatten the other side in the same way and the top is ready to solder.

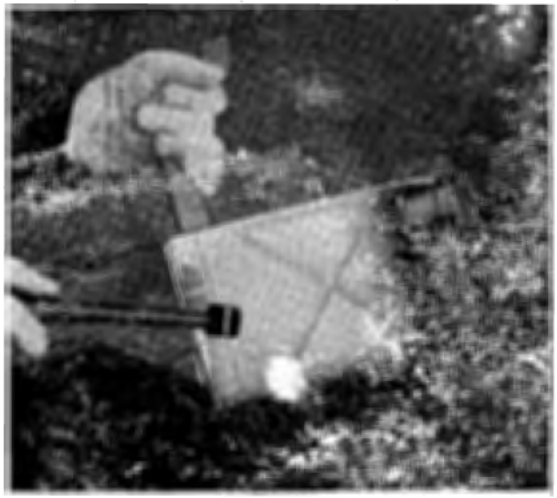

Fig. 22

71. Wipe the three joints with clean acid and flow watertight solder seams with the iron and bar solder. When the top is securely fastened to the wall and header, lay the radiator on the bench with the exposed side of the tank up. Position the splash plate and tack it to the top with solder at three points on each side of the plate and install the overflow pipe as explained in paragraph 76. The tank is now ready for the last wall, which may be assembled as explained in paragraphs 51 or 57.

Second Method

72. Brush the excess solder from all the joints and bend the lips of the header out a little to insure room for those of the top. Set the splash plate over the overflow pipe (if the one on the old header is intact, it may be removed, cleaned and used in making the repair). Next, fit the new top over the overflow pipe and, springing it under the lips of the header, force it into position under the flanges of the wall. Proceed as explained in paragraphs 70 and 71.

Fig. 23

Removing The Top Tank Top 1916 Radiator

73. The top tank top of the 1916 radiator is riveted to the header on each side with three rivets. To remove the top, it is first necessary to remove the front and rear walls as described in paragraphs 64 and 66. Then, cut the top tank about 1 inch above its connection to the top header. This may be done with a hacksaw or by burning the header with a torch and breaking it off with the hammer. The part remaining attached to the header is removed in pieces with the pliers (See Fig. 23), the solder

being first brought to a melting temperature with the torch. When the pieces are removed, brush off the excess solder, cut the heads off the rivets and drive them out.

Replacing The Top Tank Top 1916 Radiator

74. See that the excess solder has been removed from the header at the point where the top is to be fitted. Bend the flaps on the back of the header out of the way, and slide the top into place from the rear of the radiator. When

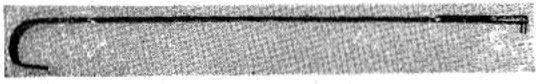

Fig. 24

it is in place, line it up with the front edge of the header and tack it with solder on the outside. With the hammer and bar (27 and 24, Fig. 6) flatten the break as close to the header as possible and insert the rivets with the rivet

Fig. 25

sticker (Fig. 24). Coat the outer surface of the joint with chalk and water and wipe the inside with acid. Place the radiator in an upright position on the rack (Fig. 8) and flow a

heavy solder seam with the bar solder and iron between the top and header. The tank is now ready for the front wall. When the front wall is in place clean the tubes and reset them with the torch and wire solder. The flap at the rear of the header is bent to fit the top after the front wall has been put in place and is soldered at the same time as the rear wall.

Removing The Overflow Pipe Either Style

75. The overflow pipe may be removed by detaching it from the core and lower tank, melting the solder setting in the header, and withdrawing the pipe. Because of the double curve in the pipe, it is necessary to exercise a little care in withdrawing it. First, draw it out until it binds. Turn it over to the other side of the radiator and withdraw it a little farther. Now turn back to the first position and it may be withdrawn completely. As it is practically impossible to get all the solder out of the setting, it is necessary to keep it hot with the torch during the operation of withdrawing. The pipe is very brittle while hot, and unless the repairman is very careful it will be broken. Should it be broken, the top part may be withdrawn through the filler.

Replacing The Overflow Pipe Either Style

76. If the hole is too small for the pipe clean it out with the rat-tail file. Insert the pipe and push it into position, reversing the action described in removing the overflow pipe. By watching through the filler, it is a simple matter to locate the hole in the splash plate through which the overflow pipe extends. When in position, solder it to the header and then to the core and lower tank.

77. In the 1917 radiator the overflow pipe is assembled with a washer on the inside of the header. This washer usually drops out when removing the overflow pipe. As it is impossible to replace the washer unless one of the walls is off, it is necessary to have a well sweat in joint between the pipe and the header. It is also advisable to tack the pipe to the filler flange neck.

Removing The Top Header 1917 Radiator

78. To remove the top header of the 1917 radiator, it is first necessary to remove the rear wall, front wall and top as described in paragraphs 49, 56 and 63. The radiator is then stood on edge while the solder is removed from the tubes. Next lay the radiator on its back with the header sticking over the edge of the bench. The top tank supports are then loosened from the header by brushing the hot solder from them and bending them out of the way. Next, the header bar (25, Fig. 6) is inserted between the tubes behind the header which when thoroughly heated is driven off in the same manner as the lower header (Fig. 14).

Replacing The Top Header 1917 Radiator

79. Before positioning the top header, heat the supports, brush off the excess solder, and bend them back into their approximate position. The tubes should next be inspected to see that they are clean, properly formed and in line for the holes in the header. Fit the header into position and tap it on with the hammer until it rests on the top tank supports; solder the header to the supports and line the header up with those two points. Stand the radiator upright on the rack (Fig. 8), wipe the tubes and the header with acid and flow the solder around the tubes, using the torch and wire solder. When the tubes have been properly set, proceed to assemble the remainder of the top tank as described in paragraphs 68 to 70, 57 to 59 and 51 to 53.

80. Another way of making the assembly is to first assemble and solder the header front wall and top. This is then assembled to the core. The top is first assembled and soldered to the header. Next, position the front wall, tacking it to the header. Now by drawing out the filler, the top will be drawn into contact with the flange of the front wall. While holding it in this position tack it to the flange at 5 or 6 points. The tank may then be soldered as described in paragraph 59; to aid in holding the wall to header, a support may be inserted through the opening in the back of the tank.

Removing Top Header 1916 Radiator

81. In removing the top header of the 1916 radiator, it is first necessary to remove the top tank top, rear and front walls as described in paragraphs 54, 60 and 73. Heat the solder which holds the header to the supports and pull the header off the rivets with a pair of pliers. The rest of the operation is the same as removing the 1917 top header. See paragraph 78.

Replacing Top Header 1916 Radiator

82. The top of the new tank is first assembled to the front wall and tacked to it at several points with solder. Next, spring the top into the new header and insert the rivets with the rivet

Fig. 26

sticker shown in Fig. 24. The rivets should be held in place with a touch of solder on the head. Cut a piece of wire solder to the length of the header and tack it into position along the joint formed by the front wall and the header. Remove the old rivets from the side walls and having brushed off the old solder, straighten the breaks so that the header will set squarely upon them. Set the core with the lower tank on the rack shown in Fig. 8, and position the top tank assembly shown in Fig. 26 on the tubes and side walls. Sweat the joints around the rivets with the iron and bar solder. As very little solder follows the rivets through to the side walls, it is necessary in all cases to stand the radiator on its side and flow the solder into the joint as shown in Fig. 25.

83. The radiator may now be laid on its face and the front wall soldered as explained in paragraph 61. Stand the radiator upright on the rack, wipe the header and tubes with acid and

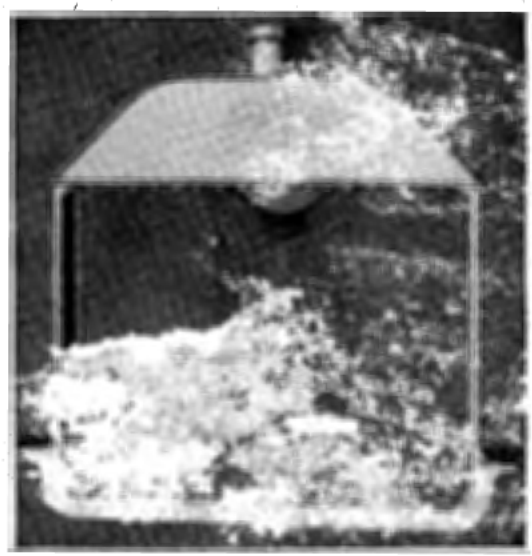

Fig. 27

flow the solder around the tubes, using the torch and wire solder. Washer solder may be used in this operation, but unless a large amount of header work is done, it would hardly pay to carry it in stock. When the tubes have been properly set flow some extra solder around the corners formed by the front wall, top and header. Attach splash plate and overflow pipe and replace the rear wall as described in paragraphs 55 and 76, after which the radiator is ready for the test.

Replacing the Top Header of 1916 Radiator Second Method

84. Another way of replacing the top header of the 1916 radiator is to remove the top tank, side and front wall, as explained in "Changing the Core of the 1916 Radiator," paragraph 85. The tank is then turned upside down and the rivets are sheared from the side wall. After the tank has been brought to heat, these rivets are driven out, thus permitting the assembly to be broken into three distinct parts, as, the top tank top, together with its front wall, the header, and the side and front wall assembly. After cleaning the top tank header and the rivet holes in the wall, the top tank top is fitted into the new header and the rivets are inserted in it. Hold the rivets in position by tacking them on the inside of the tank with a touch of solder. Next, position the wall over the rivets and flow a good solder joint between the walls and the header. The assembly is then completed as explained in paragraph 83.

Changing The Core 1916 Radiator

85. The bottom tank is removed as described in paragraphs 37 and 38, and assembled to the new core as described in paragraphs 39 to 44 inclusive. The rear wall and overflow pipe are next removed and the solder is flowed away from the tubes of the top header. The side walls and front pieces are detached from the

support and core and this assembly is drawn off. (See Fig. 18 for method of attaching.) The core is then fitted into the top tank and side wall assembly, shown in Fig. 27, the tubes positioning in the top header. Force the header down until the side walls rest on the radiator support. The radiator is then inverted on the rack and the walls are soldered to the support as shown in Fig. 13. When the solder on the supports has set, turn the radiator into an upright position, clean the tubes and header as explained in paragraph 57 and solder the tubes to the header. The side walls and front members are then attached to the lower tank, front and rear of the core, as indicated in the assembly shown in Fig. 18. The overflow pipe and rear wall are then soldered into position and the radiator is ready to be tested.

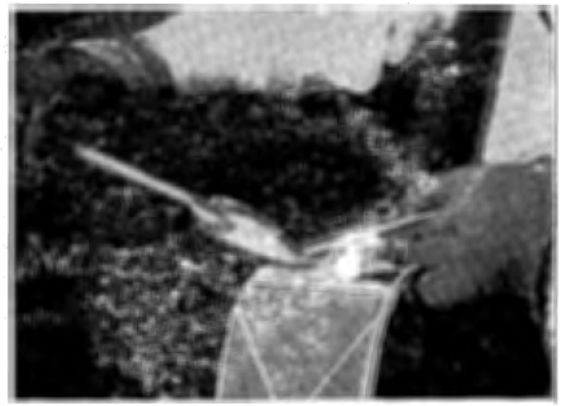

Fig. 28

Changing The Core 1917 Radiator

86. Remove the lower tank as described in paragraphs 37 and 38, the front wall of the top tank (see paragraph 56) and the overflow pipe (paragraph 75). The top tank may now be removed ensemble by brushing the solder from

around the tubes in much the same manner as removing the header. Finally remove the top tank supports.

87. Assemble the bottom tank to the new core as explained in paragraph 39. Set the top tank onto the core, position the top tank supports against the back edge of the fins and the top tank header and solder them to the header (Fig. 28). Draw down the header until the top tank supports rest on the radiator support and solder them together. Clean the tubes and solder as described in paragraph 57. Replace the overflow pipe as described in paragraph 76, attach the front wall (see paragraph 57) and the radiator is ready to test.

Replacing a Side Wall of the 1916 Radiator

88. To replace a side wall it is first necessary to disconnect it from the core, the support and the front side pieces. (For method of detaching see Fig. 18.) The wall is then bent back and forth along the line of the top tank until it breaks off. Next heat the remaining part of the wall with an iron and remove it with a pair of pliers, leaving the rivets in position. The wall should be slotted, as shown in Fig. 29, so that it may be slipped over the rivets. Position the new side wall and attach it as indicated in Fig. 18. As it is impossible to flow the solder between the tank and the break of the side wall, this joint should be soldered as shown in Fig. 25. The side wall is soldered to the support as shown in Fig. 13, and the connections between the core and the front side pieces are made with the iron, using as little solder as possible on the front side pieces, as it is necessary to scrape all the excess solder off.

Fig. 29

89. If the top tank shows a bad leak after the wall has been replaced, the rear wall should be removed and the solder re-run from the inside.

Repairing a Broken Tube

90. When a tube is broken in the core near one of the headers, cut the fins (with the 8-inch shears, 32, Fig. 6) along the tube and bend them back as shown in Fig. 30. Cut the tube a little above the rupture with a saw made of a broken hacksaw blade (10, Fig. 5). Grasp the section with a pair of pliers and having heated the header and fins warm enough to let the solder run, draw it out. Next, warm up the end of the tube and clean it with acid until there is no dirt at the end both inside and out. In the same way, clean around the hole in the header. Examine the tube and the hole to see that there is no excess solder to interfere with the insertion of the new section. If there is, heat and brush it off or file it out with a $\frac{1}{4}$" rat-tail file (Fig. 5). Next, cut a section of tube about $\frac{3}{16}$" longer than the gap

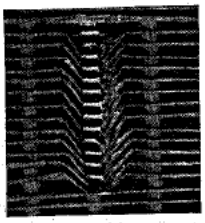

Fig. 30

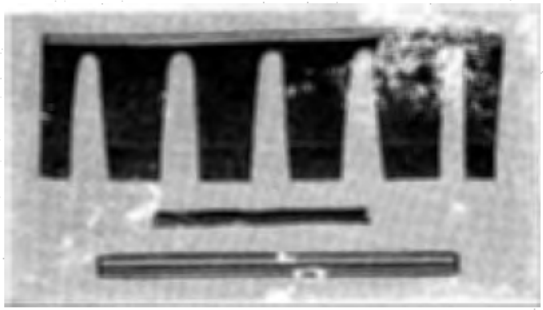

Fig. 31

to be filled. These tubes may be purchased from the nearest branch. File the ends of the tube tapered as shown in Fig. 31 so they will enter the header and the end of the tube in the core. Next, take the drift (16, Fig. 5) and drive it into the end of the tube and into the hole

in the header to give clearance for the new section. Dip the tube holder (Fig. 5) into the acid and solder it to the new section (Fig. 32). Force the tube into the header, hammering it if necessary, striking on the holder. (Never strike on the section of the tube.) Next, insert the free end into the tube, forcing it well in by hammering on the holder. Wipe the joints with acid and while heating with a torch, apply

Fig. 32

wire solder. The radiator should lie flat for all soldering operations to prevent solder from running to end of tube where it will set, stopping circulation.

91. Bend the fins back into place with the flat-nosed pliers and solder them to the tube with the torch and wire solder. If the repair were made on the front of the radiator, the fins should be supported by a strip cut from the edge of an extra fin (Fig. 31) to hold the edges of the cut fins together. If it is necessary to remove a large section of the fins, or to cut to

the second or third layer of tubes, it is best to cut away the fin and insert a patch as shown in Fig. 31. The patch straddles the tubes, and is tacked down by soldering with the iron and bar solder. The patch should be made to overlap the ends of the fin and the edge should be turned down over the edge of the remaining parts of the original fin. No support is necessary when the patch is used.

92. If there is a leak between a number of the tubes and the header, it is best repaired by exposing the inside of the header, cleaning the surface and flowing new solder around all the tubes, as described in replacing the bottom tank.

93. If there are a number of tubes badly damaged, it will pay to remove the lower tank and one wall of the top tank and insert new tubes the entire length. Remove the lower tank and wall as explained in paragraphs 37 and 54 or 56. Heat the header around the tubes to be removed and brush off the solder. Repeat this operation on the other header. Now heat the fins the entire length of the tube and draw the tube out through the bottom header with the square-nosed pliers. Clean the surfaces carefully and insert new tubes. Solder them by flowing solder on the inside of the headers with torch and wire solder and heat the fins along the tube to tack them in place. There is an excess of solder on the tubes, and in most cases this is sufficient for tacking the fins, practically if the fin surfaces have been properly cleaned. If the fins are not tacked properly, add a little more solder while applying the torch.

94. If there are one or two tubes broken near the center of the core, they may be repaired by cutting the injured tubes above and below the rupture, and after cleaning properly, inserting a new section (Fig. 32) by entering it into one part of the tube and then into the other in much the same manner as described in paragraph 90.

95. If there are a number of tubes broken or damaged near the lower header, it is advisable to expose the lower header, cut the tubes above the rupture and draw them out through the header in much the same manner as described in "Inserting and Entering the New Tubes." The tubes may be spread with a long drift (17, Fig. 5) inserted through the hole in the header thereby not damaging the fins. The new section is inserted through the header and driven into place. When the tube is in position cut it off at the header, drive the spreader into the opening so as to completely fill the hole in the header. Solder the tube connections with a torch and wire solder after having cleaned them properly with acid.

Cleaning The Tubes

96. The radiator tubes may be cleaned by removing the lower tank and forcing the tube cleaner (17, Fig. 5) through each tube. If any of the tubes are clogged to such an extent as to not allow a passage, even after tapping the cleaner with a hammer, the tube should be replaced as described in paragraph 93.

97. The radiator should then be flushed out with water, after which the lower tank may be replaced.

98. The radiator should be tested before replacing it on the car.

Replacing The Radiator Support

99. The old radiator support is replaced by removing the lower tank and lower header, after which the fins below the support are heated and driven off, one at a time, with the bar, in much the same way as the lower header is removed. In a like manner, drive off the support and the first fin above it. Invert the radiator on the rack

shown on the left of Fig. 8 and lay the fin spacer on the last fin. Put on a new fin, the bell end of the taper in the holes extending down, drive on the new radiator support and add one more fin. Solder these parts to the tubes with wire solder and the torch. Next, set the fin spacer on top of this assembly and place the next fin in position, all the fins starting on the tube from the bell end of the taper in the holes. Move the spacer into position for the next fin and continue to add fins until the requisite number are in position. They should then be tacked to the tubes with the solder and torch. When they have been properly secured, replace the lower header and tank.

Testing Radiators

100. When the radiator has been repaired it is taken to the test tank. The hose connections, filler and overflow pipe are plugged to prevent leakage, and an air hose is attached to the drain cock hole or one of the hose connection

Fig. 33

plugs. The radiator is then submerged and a pressure of 8 to 10 lbs. of air is let into it. No

air should escape from any part of the radiator. If there is a leak, note the spot from which the

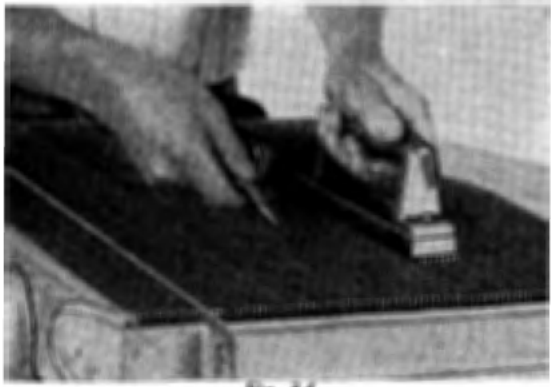

Fig. 34

air is coming. Remove the radiator, let out the air and flow a little wire solder into the hole with the torch.

Touching Up a Repaired Radiator

101. The repaired radiator should always be put in good condition, particularly in so far as the repair work is concerned.

102. If tubes are repaired, no excess solder should be left sticking to the tubes nor fins.

Fig. 35

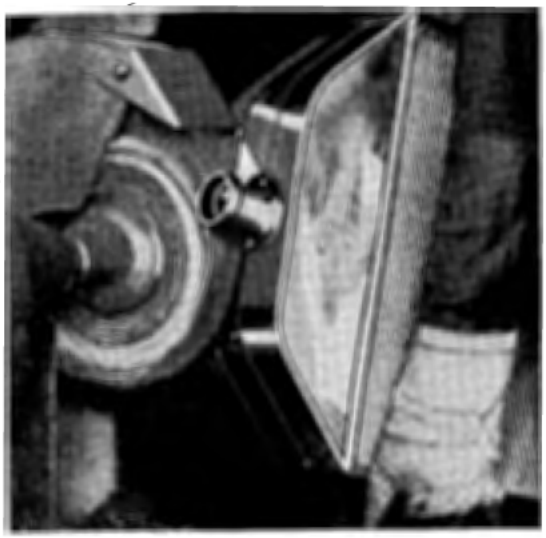

Fig. 36

The fins should be lined up with the weaver's pliers and straightened out with the comb (See Fig. 34). The face of the fins should be given a coat of black paint.

103. When repairing a 1916 radiator all the solder should be scraped from the exposed surfaces (Fig. 35) and these surfaces should be polished on a cloth wheel dressed with Tripoli (Fig. 36). Remember that the wheel heats the metal very rapidly, and do not polish in one spot long enough to melt the solder.

104. If no wheel is available the spot may be cleaned with some metal [illegible]

105. It is possible to [illegible] dents from the radiator top and bottom without disassembling the radiator. If the dent has been driven into the [illegible] to pull it out by soldering the dent puller shown in Fig. 16 to the filler cap, and, having screwed the cap into the filler, pound up on the dent puller. If there is a dent in the tank, solder the dent puller into the center of the dent and draw

it up in much the same manner. Larger dents may be drawn out by removing that part of the assembly and reshaping it on the bench. The repairman may judge the advisability of reforming, and if he considers the dent bad enough, he should replace the damaged part.

APPENDIX

Care of The Radiator

The radiator is one of the most important parts of the car, as concerns the longevity of the engine. As the temperatures of combustion run between 2000 and 3000 deg. F., and a considerable portion of this heat is carried away through the cooling system, it is important that this system be kept in good condition. Before starting on a trip the water level in the radiator should always be examined, and if necessary, more water should be added to bring the level near the top of the tank. The fins should be kept straight and the space between them open. Occasionally the core should be cleaned to remove the dirt which lodges on the fins and the tubes.

A heavy coat of paint hinders the heat transfer, particularly when it curls up near the front edge of the fin. This should be scraped off. A very good paint for the core is made by mixing lamp black and gasoline. It dries quickly and when only a thin coat is applied it does not materially affect the cooling. Avoid the use of paint with a bright surface, such as color varnish.

To guard against stoppage, the system should be drained occasionally by opening the pet cock on the lower hose connection. While the radiator is draining add fresh water until the water from the pet cock runs clear.

It is sometimes advisable to wash the system with a solution composed of ½ lb. of lye dissolved in 5 gallons of water. First, drain the system and fill it with the above solution. Run the engine for about 5 minutes, after which

shut off the engine, drain the system and fill it with clear water. Run the engine again for about 5 minutes. This water is then drained off and the system is refilled with fresh water.

Examine the radiator occasionally to see that none of the tubes are pinched, as a tube which is stopped either by a dent or by sediment will be burst by the water freezing in it in cold weather. Further, when the circulation of one of the 95 tubes is stopped, the efficiency of the radiator is reduced by about 1%.

Never plug the overflow pipe, and before starting the motor in cold weather, it is a good plan to examine it to see that there is no ice obstructing the end, as the radiator will explode if some means is not provided for the steam to escape.

Anti-Freezing Solution

The circulating system should be filled with an anti-freezing solution as soon as cold weather sets in. It is not safe to rely on draining the radiator when returning from a drive and filling again when starting out. In extreme cold weather or when driving against a strong wind, the water may freeze even after circulation starts. Furthermore, if one or more tubes have become clogged with dirt, the water will not drain out. Freezing generally results in a leaky radiator or cracked water jacket, necessitating costly repairs.

The ideal anti-freezing compound is, first, one that will prevent freezing of the radiator liquid without injuring either engine or radiator; second, that will not lose its non-freezing properties after continued use, and, third, that does not materially change the boiling point of water when dissolved in it.

Kerosene has a lower freezing point and a higher boiling point than water, but the inflammability of its vapor makes it dangerous to use, and its high and uncertain boiling point might lead to the serious overheating of the engine, or even to the melting of the solder in

the radiator. It has marked solvent action on rubber parts. These facts clearly indicate that kerosene should not be used as a non-freezing solution.

Most of the anti-freezing solutions sold under trade names have a calcium chloride base. The calcium chloride compounds exert a greater corrosive action than water on the engine jacket and on the solder in the radiator. Tests have shown that calcium chloride solutions will completely remove solder from copper and brass. Another troublesome effect with calcium chloride solutions is experienced if small leaks occur in the radiator, and the solution comes in contact with the spark plugs and ignition wires, as a short circuit is liable to result. Calcium chloride compounds should be used with caution, if at all, on account of their corrosive action.

The alcohol solutions do not exert a greater corrosive action than water alone. Solutions made from either wood or denatured alcohol seem to be the most desirable anti-freezing solutions to use. The table below shows the approximate point at which the different alcohol solutions freeze:

20% solution freezes at 15° above zero.
30% solution freezes at 8° below zero.
50% solution freezes at 15° below zero.

A solution composed of 60% water, 10% glycerine and 30% alcohol is very often used, its freezing point being 8 degrees below zero. Although glycerine tends to retard evaporation the alcohol will evaporate much faster than water. The solution will become weak and ineffective unless more alcohol is added from time to time.

The circulating capacity of the Model T motor with the present type radiator is 2 gallons, 7½ pints; with the former type radiator, or 3 gallons, 1¾ pints. It can readily be determined from these figures the amount of alcohol to use.

When storing a car for the winter, first drain the circulating system. Then put about a quart of alcohol in the radiator, allowing it to run through.

TIME COSTS

As a guide to those starting in on radiator repairing, we are publishing below a list of approximate time costs for the different operations described in the text:

Removing and replacing radiator	Hrs.	Min.
1916		45
1917		45
Replacing filler neck.....1916		30
1917		30
Replacing bottom tank.....1916	1	15
1917	1	15
Replacing bottom header.....1916	1	30
1917	1	30
Replacing rear wall.....1916		45
1917	1	
Replacing front wall.....1916	2	45
1917		45
Replacing top tank top.....1916	3	30
1917	1	30
Replacing overflow pipe.....1916		15
1917		15
Replacing top header.....1916	3	30
1917	2	30
Changing core.....1916	3	30
1917	3	
Repairing broken tube.....1916		15
1917		15
Cleaning tube.....1916	2	
1917	2	
Replacing radiator support....1916	4	
1917	4	