Caufman, Frederick Lester

Manual

of

Automotive Radiator Construction

and

Repair

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INTRODUCTION

IN presenting to the radiator repair mechanic this manual of repair, it is fully realized that man sees but a small part of this world. Conditions that confront the reader may never have confronted the authors. However this may be stated, that in the vast amount of correspondence carried on by the F. L. Curfman Manufacturing Company in an endeavor to enlighten a large army of repair men in North America, the questions arising in Nova Scotia are identical with those in California. The automotive vehicles have decreased the size of America very greatly. We therefore feel that by answering in as clear and intelligent a manner as possible the thousands of questions that have passed over the desks of this company, a great aid will be given to the repair of automotive radiators.

It is not the purpose of these pages to attempt to solve all the difficulties incident to radiator repairing, but by a practical talk on radiator construction and by proven methods on typical jobs the beginner is to be given a working basis. The experienced man may also receive valuable bits of information. The purpose further is not an attempt to give all methods, but only some valuable ones. The repair man who can not adapt methods to his local conditions is not a competent man for radiator repairing.

The attempt to explain in detail the construction of tools and other equipment will not be made. The primary motive in the mention of the tools is to explain their use. The mechanic, if he be a mechanic, can easily construct all the non-purchasable equipment.

The stress laid on the study of detail in radiator construction we wish to emphasize. This knowledge of construction has for its purpose the enlightenment of the repair man. It is not the intent and purpose to judge the merits of construction in any certain style of radiator or radiator part. Nor is it designed that we parade the faults of any particular product of any certain manufacturer. Service is the whole aim. If there be a radiator that is leak proof or faultless the life of this volume is short, since all water cooled motors will adopt that particular faultless construction. Then the radiator repair man will pass into the same class with the dethroned livery stable boy.

The authors having originated in rural communities realize the difficulties that arise thru the lack of facilities. The city repair man enjoys a large number of assistants in the way of gas, water supply and artificial light. The largest amount of car owners have been found in thickly populated sections but the farmer has added the automotive vehicle to his necessities. This fact with the advent of the aeroplane makes it incumbent upon the village repair man to meet the demand of the times.

It is our desire to stress the fact that few towns are so small nor so lacking in facilities that the repair, rebuilding, and recoring of radiators is not a practical possibility. The instruction attempted here is framed for the small town mechanic the same as it is for city shops. The speed gained by the use of the facilities in cities is offset by the nearness of the small town shop to the owner. The time necessary for the transportation of the radiator to the city is greater than the decreased speed of repair possible in the small shop.

There has been too much stress placed on tools and too little credit given to knowledge. A poorly informed workman with the most up-to-date tools is a poor match for an educated mechanic with the crudest of equipment. Modern equipment is necessary to meet competition, but knowledge is necessary to continue in business.

TABLE OF CONTENTS

CHAPTER 8

CHAPTER 9

CHAPTER 10

CHAPTER 11

CHAPTER 12

CHAPTER 1

MATERIAL USED IN RADIATOR CONSTRUCTION

IT IS advisable in repairing any article that the workman have a knowledge of the material with which that article is constructed. In the finished radiator the following materials are found: copper, brass, malleable steel or iron, solder, and paint. The flux used while not a permanent material is so closely allied to the other materials that some mention of its nature and function will be necessary, it is therefore included.

1. **Copper**—Copper is a base metal. It is the best conductor of any of the metals included and is a favorite metal for the construction of tubular cores. It will endure much vibration while in a dead soft state. Annealing, or softening, is accomplished by heating and sudden cooling, just the opposite of steel. Vibration, hammering, rolling, or bending hardens the metal. The adhesion of solder is not great. In order to secure a good joint the contacting surfaces should be well tinned prior to soldering. Copper is attacked very slightly by muratic (hydrochloric) acid which is usually employed as a cleaner. A copper radiator will be injured but very slightly by an acid bath. The action of the acid may be accellerated by heating the metal for cleaning.

2. **Brass**—Brass is an alloy of copper and zinc. It is a good conductor, there being little difference in the radiating qualities of a brass and a copper radiator. Its ability to withstand strain or vibration is greatest when in a dead soft state. It is annealed like copper. The adhesion of solder to brass is greater than to copper. It may be worked only when cold. This is very important to the beginner. No attempt should be made to bend brass while hot as it is rotten and will break easily. Brass is more readily attacked by muriatic acid. After the acid is used in any cleaning operation the brass

should be washed. A solution of lime water, lye water or caustic soda solution will neutralize the action of the acid, otherwise the brass will be deteriorated by the continuous eating effect of the acid.

3. **Steel and Iron**—Steel or iron in castings is used in construction; in some cases the entire tank is cast, in others only the hose connections, tie rod brackets, stud bosses or nuts and other tank fittings. These fittings are protected by a coating of solder commonly known as tinning. This is very important as a preservative agent. It is also important in order that the joint between these castings and the tanks may be readily filled with solder.

Sheet steel while occasionally used to construct the tank is usually met with in braces, shells, and other parts with which the water does not come in contact. It is tinned or lead coated. In this case it is known as terne plate.

Muriatic acid acts on steel or iron and is used to pickle or clean the parts preparatory to the tinning. The action of the acid is hastened by heat.

4. **Solder**—Solder is a soft metal applied in a molten state to join two pieces of metal. To the radiator repair man, solder is a mechanical mixture of lead and tin that is used to unite or seal the joints between copper, brass, and iron. In other words solder is a metallic cement or glue and should be applied as thoroughly and given all the advantage of close uninterrupted contact until "set" as is given glue when it is used as a uniting agent. Since solder acts as a cement or glue it should form its joint by its introduction between the two metals and not by piling on outside. This solder piled on the outside is in many cases a real detriment to the joint as it acts as a leverage prying the metal apart. A well sweated joint h[illegible] all the strength it is possible to produce by the u[illegible] of [illegible]r.

[illegible]n of [illegible]h the question of proper flux. After good adhesion is affected by the flux it is imperative that the solder withstand the strain and vibration to which it is subjected.

As hinted above the function of solder is two fold. First, it is used to fill and seal water tight, a joint already made. The riveted joint of a hose connection and a lock seam illustrates this. Secondly, it is used to join two pieces of metal, for instance in a lap joint it is used as binder as well as a water seal.

The proper proportion of lead and tin has long been established as 50-50. The facts are that little solder is half tin and half lead. Almost all solder is named some sort of half and half. The softest solder is about 46 tin and 54 lead. The tenacity strength of this solder is the greatest of any tin and lead mixture.

Recent tests of different proportions of lead and tin in solder have proved that for sticking or adhesive qualities as well as tenacity strength or cohesive qualities this 46-54 mixture is greatest. It is likely that the higher percentage of tin has been found to work faster with the soldering iron, hence, its popularity. In using the torch this quality is unnoticeable. The greater ability to withstand vibration, the enemy of radiator construction, in the softer grade more than offsets this working quality.

The principle of application of solder is, to heat the cleaned and fluxed metal to the melting point of the solder applied. The soldering "iron" or "copper" may be employed. The torch flame applied directly to metal has its advantages. The dipping of the part in molten solder produces the same result in some instances.

Since solder when applied is in a liquid state it is too much to expect it to flow up hill. The joint should be in such a position that the solder will flow into the joint or seam and remain undisturbed until it freezes.

For torch work wire solder is necessary. This can

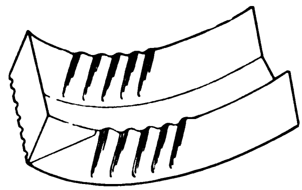


Fig. 1
Pan for Running Wire Solder

be purchased or run successfully by the repair man. A pan like Fig. 1 for melting and running operates well. This pan is constructed by turning edges one and one-half inches wide on three sides forming two bread pan corners. The opposite sides are crimped to form the circular portion of the bottom, a row of holes punched with six penny nail at the break of the end. These holes should be one-half inch apart. The solder is brought just to the molten state when it is removed from the fire. The pan should be set on the cement floor or a sheet of iron, 20-gauge or heavier. The back end of pan is then raised until the lower edge of holes comes in contact with the floor or iron. By moving the pan along this surface the solder is allowed to run from the holes. The rapidity of movement determines the size of wire. To prevent lumps, the edge of holes should be kept against the surface of iron or floor. A little practice will produce the uniform product desired. The wires are then cut in lengths of about 18 inches. This solder is stiffer than the commercial wire solder.

5. **Flux**—To the beginner it may be of concern to know what is meant by flux. A common flux is cut acid, or more properly, the solution produced by allowing muriatic acid to eat all the zinc it will consume. This is no longer an acid but a salt (zinc chloride) in solution, to which should be added an equal quantity of pure rain water. It is applied to the seam after cleaning to assist the solder in flowing into the joint and in close contact th the metal.

The question of proper flux is probably one of the most important to be decided by the radiator repair man. Without proper fusion of the solder and the metal the repair will be of little avail. The action of this flux is chemical. It is necessary to remove the oxide which forms upon any metal when exposed to air. The ideal flux will not only remove the oxide but will remain as a film on the surface to prevent further oxidation; that is, it must not dry or, if it does, it must still prevent oxidation. This ideal flux must not hinder, but assist the fusion of the solder with the metal. Another point to be taken into consideration is the ability of the flux to act properly on the oxides of copper, brass, iron and solder, metals used in radiator construction.

Since cut muriatic acid is so commonly used as a flux, one point to be considered is the purity of this solution when produced by the method of cutting. In order to produce pure zinc chloride it is necessary that the muriatic acid be pure, also that the zinc be free from impurities. Commercial muriatic acid is commonly known as yellow acid. The yellow color is not a property of the pure acid but is produced by the presence of chloride of iron. It is unlikely that the average repair man ever saw a piece of pure zinc. The chemical product produced by cutting therefore is impure. These impurities may or may not be detrimental to the solution when used as a flux. When cut acid is used as a flux, it is necessary to renew the flux on the seam frequently as the water evaporates rapidly, leaving the dry chloride which does not serve as a flux. This property of cut acid is well illustrated by the fact that the tinner habitually applies more flux when changing irons. The heat from the iron has dried the flux and he knows the solder will not take at the point where the iron was removed unless the flux has been renewed. The chances are that in applying the cut acid the seam will not be wetted inside. The result is that at this point the seam will be skinned over and not soaked with solder. It may be stated that the addition of glycerine and alcohol to cut acid will prevent this drying to some extent. A mixture of one part alcohol and four parts glycerine added to five such parts of cut acid is about right.

Cut acid will act properly on all metals used in radiator construction. The drying feature however makes it a poor flux for tinning the malleable castings.

By trial the workman can choose the flux, either home brew variety or commercial, that best meets his needs. It may be stated that of the known flux bases that cut acid (zinc chloride) and sal ammoniac (ammonium chloride) are present in almost all commercial fluxes. The claim that they are not acid is true since cut acid is not acid at all but a salt, as is sal ammoniac. There are numerous coagulants or detergents added that give the commercial flux the more marked ability to cleanse and float away the oxides and other foreign matter together with the non-drying feature. Some fluxes perform these functions after having been dried on the metal. Another point that will appeal to many is the non-fuming property of commercial flux.

Cut acid alone hardly meets the requirements of a flux, when the torch is used as a soldering tool. The addition of other liquids to the cut acid makes the expense of the compound as great as the commercial flux to say nothing of the bother.

That commercial fluxes are to be had that produce strong joints, the results of such experiments may be quoted. By thorough and impartial tests, joints soldered with commercial fluxes were found to break at a r n of from 14,000 to 18,000 pounds per square inch h t l ints broke at a strain of 6,000 pounds

6. **Paint**—Paint is applied primarily as a finishing touch to give a good appearance to the repair job. This is a point too important to be overlooked or neglected. A good job of repair work may be a poor advertisement if the radiator looks messy. When the owner puts his hand in his pocket to pay the bill it hurts less if he has a radiator that looks like new.

Any coating of paint upon the cooling section of a radiator is detrimental to radiation. Therefore a paint that is not insulating should be used. A gloss paint should never be used, lamp black mixed with japan, turpentine or gasoline is best. This dries quickly prolonging the job but little, giving a flat black effect, as on new radiators.

CHAPTER 2

RADIATOR CONSTRUCTION

IN order that any article may be repaired satisfactorily it is necessary that the construction and function of the article be thoroughly understood before the repair is attempted. Internal combustion engines operate to the best advantage when the entire engine is warm. It is necessary that some method is used to prevent the engine from over heating. Water is most commonly used as a cooling agent. The radiator is introduced in the cooling system to keep the water from being heated to the boiling point.

The radiator as now used on aeroplane, automobile, truck and tractor consists of two water tanks with a water cooling core between the two. The upper or hot water tank is connected by a hose connection to the top of the water jacket about the cylinders of the motor. The lower or cold water tank is connected by a similar hose connection to the lower portion of the water jacket of the motor.

This principle of construction has not been changed since water-cooled motors were invented. There has been some improvement in the construction of the parts but the same plan of cooling has been adhered to. The tanks for the most part are now drawn or cast in one piece, reducing the number of joints. Pressed steel shells are bolted over the radiator reducing the amount of labor necessary to produce a well finished job. These shells also relieve the radiator of much strain.

Tank construction easily explains itself, hence little need be said on the subject. The cooling section is more intricately and delicately constructed. For this reason it is advisable that much study be ven to this part in order that satisfactory repairs ı ʳ e made.

Radiator cores are constructed from very light sheet metal. This is necessary that the heat from the water, passing downward thru the small tubes may be readily radiated to the air when drawn thru the core.

As will be explained further in this chapter the cooling section is sometimes made up of water tubes and fins or filler thru which no water passes. The surface of water conveying portion of the core is known as "prime" radiating surface. The fins or filler constitute the "secondary" radiating portion. The heat from the water tubes is conducted to the fins or filler and in turn is radiated to the passing air. This secondary radiation is as important a cooling agent as the primary radiation.

Since the cooling section or core of a radiator is the portion that performs the function for which the radiator is constructed it should be kept in as perfect a state as possible. To repair this, pains should be exercised to preserve the original primary and secondary cooling parts, also the soldered contact between the two.

Radiators divide themselves into two classes, according to the style of cooling section or core, the tubular and honey comb.

7. **Tubular Radiators**—The tubular type, Fig. 2, is made up of a multitude of one-fourth inch tubes acting as a water passage between the upper and lower tanks. The bottom of the upper tank and the top of the lower tank are known as headers. The tubes pass thru and are soldered to these headers. These tubes are made of very thin brass or copper in order to get the closest possible contact between the cool air and the warm water. They are tinned inside and out. The inside tinning reduces the danger of corrosive waters. The fins are soldered fast to the tubes. If these fins become loose on the tubes or are cut out in order to make repairs the cooling capacity of the radiator is lessened accordingly.

There are two classes of tubes used. The round as

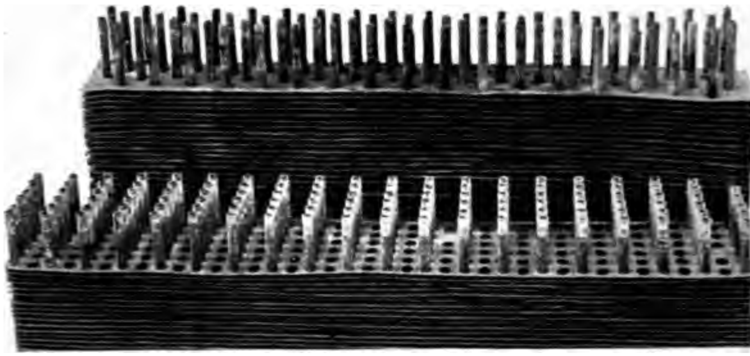


Fig. 2
Round Tube Tubular Core

in the Ford, Dodge, Maxwell, Cadillac and others. The second is the oval tube as used by the Reo and others. See Fig. 3. The round tube is easily broken by freezing while the oval tube is effected but little. The tubes are of two types, the seamed (Ford, Dodge, etc.) and the drawn tube (Cadillac).

The majority of tubular cores are oven soldered. In assembling, the tinned tubes and fins with headers are held in a clamp in a vertical position. A layer of solder punched to fit over the tubes is assembled just above each header. This core assembly is placed in an oven where a temperature is regulated automatically at the melting point of solder. No doubt this explains the multitude of leaks occuring where tubes enter the headers.

There are two general methods of arrangement of tubes in the tubular core, namely; the straight row and the staggard row. The lower core in Fig. 2 is of the straight row type. In this six tubes are spaced on one-half inch centers in a row from face to face of the core. These rows are spaced on one inch centers across the face of the core. The upper core in Fig. 2 is the staggard type. In this two tubes are in line from front to back spaced on one inch centers. These pairs of tubes are

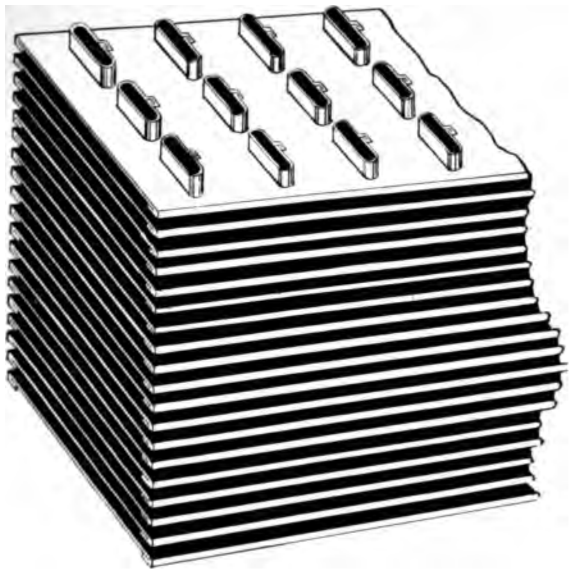


Fig. 3
Oval Tube Tubular Core

spaced on one-half inch centers across the face. The front tube of every other pair being set back on one-half inch centers from the adjoining rows. The result is practictally the same as a four tube row in the first type mentioned. The exposure of the double number of rows to the air entering the face of radiator and equal distribution of fin surface per tube giving an increase in cooling capacity.

This spacing of tubes is not carried out in all radiators. Some cores have tube rows spaced on ¾-inch centers.

Fin arrangement is also varied. As a type, however, the tubular core does not lend itself to the variation that is possible in the honey comb.

8. **Honey Comb**—The honey comb type of core includes all radiator cores presenting a cellular appearance. There are almost countless numbers of different

shaped cells and more being added to this already large number. "Honey comb" as defined when applied to cores, has become a technical term and will be used as such. It will be impossible to discuss all of these cellular cores. After the repair man has mastered the principle of a few representative types it will be found easy to determine the construction of any unmentioned core.

The entire cooling section of a honey comb radiator is made up of a succession of brass or copper ribbons with the exception of a very few makes. This ribbon of which the core is constructed usually averages five one-thousandths of an inch in thickness. The manufacturer experiences no little difficulty in producing a ribbon of metal of this delicate thickness, that contains no holes nor overly thin places. The polished rolls in the factory gather burrings or grit in spite of all precautions. Any hard foreign matter rolled into the metal makes an indentation or puncture. Steel burs are rolled into the metal. This steel rusts out and causes leaks in the core. Thin places break thru under strain or from corrosion.

The definition of "honey comb" has been given. A few definitions of parts in honey comb construction may be useful as reference in the following pages.

"Faces" of honey combs refer to the outside form of the core front and back. The majority of honey comb cores have no front; that is the core may be installed either side out. The front is made so by the placing of the tanks. There are some cores however that have dissimilar faces. In these cores the air is supposed to enter a certain face. This face is installed as the front.

"Cell" will be used to denote the air passage thru the radiator. Cells are various shapes and in most instances they hold the general shape of the openings in the face of the core.

"Water tubes" are the as in t ılar cores, namely, the water passage thru the core. They are flat or oblong channels formed usually by pressing two ribbons of metal in such a manner that the offset or burred edges will meet for a soldered joint when one ribbon is laid flat on the other. The center portion of the ribbons are held away from one another by these offsets or burs, thus forming the water passage. These ribbons are sometimes spoken of as tube "walls." This water channel or tube has an approximate width of from one-sixteenth to an eighth of an inch.

"False tubes" are not tubes at all but a single ribbon of metal usually of the same general shape as the water tube, altho they may be of a decidedly different shape. The false tube is sometimes called an "idle perpendicular." In some cases the edge of this ribbon is folded back upon itself in order to give thickness and to resemble the "face" of the "water tube."

"Laterals" are crosswise fins extending from one water tube to the adjoining water tube. If the core has false tubes they may connect the false tubes to the water tubes. False tubes are sometimes introduced with no connection to laterals. Laterals are not always placed horizontally. Often they extend diagonally from one tube to the next. They may or may not be part of the water tube or of the false tube.

"Headers," as in the tubular core, refer to the top and bottom end of the core where the water tubes, false tubes, or laterals, are so soldered as to permit no passage of water from the tank to the core except thru the water tubes. In the tubular core this is one sheet of metal while in honey combs it is usually made up between each pair of water tubes.

"Lateral Strain" is therefore the strain exerted crosswise on the core. This strain has the tendency to pull the face joints of the core apart or to mash the core side wise.

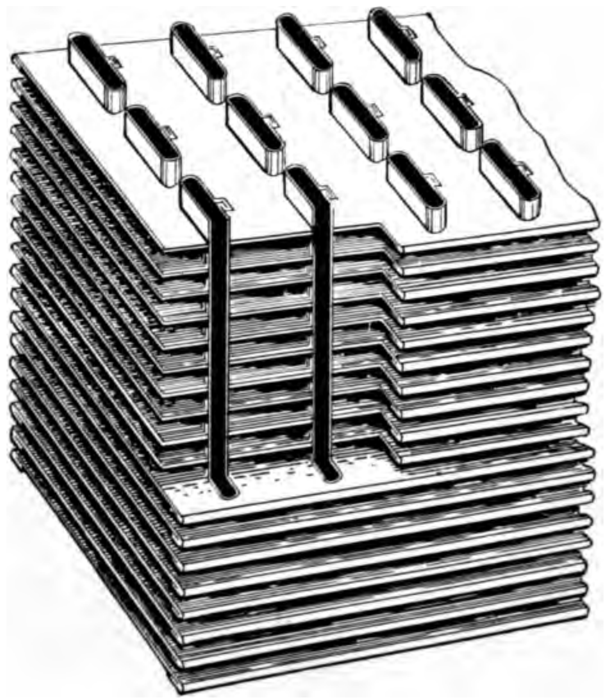


Fig. 4
Oval Tube Cut to Show Water Course

Since the principle of construction is so vital to the repair of the core, the matter will be presented in as careful a manner as possible. The flat tube tubular type as found in the Reo probably forms the best example of the connecting link between the tubular and cellular core. By reference to Fig. 4 notice the three flat tubes in the row with cross fins as any tubular core. The cellular core most resembling this is the one formerly used on the Chevrolet. Fig. 5 illustrates the construction of this core. "A" is a single flat tube extending from face to face of the core. "C" shows lap seam at back of water tube. "B" is a fin or filler strip formed by a series of 90 d ree breaks crosswise the ribbon of r etal. This fin -roject in front of the tu l t acts as a

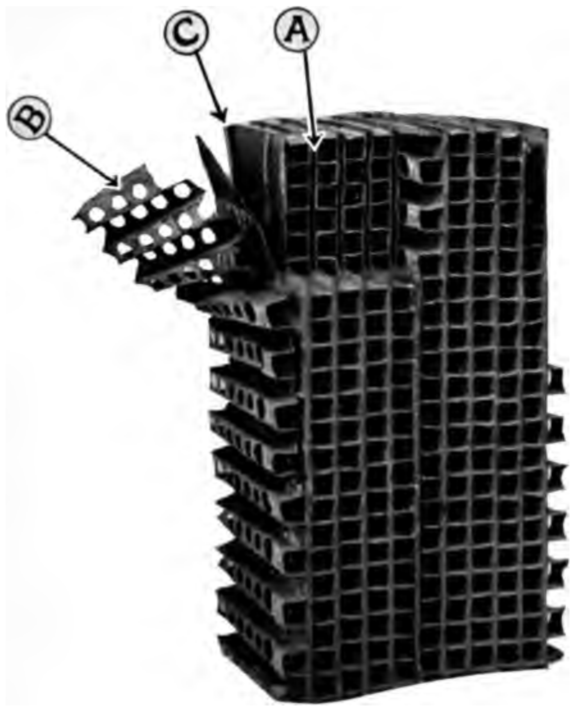
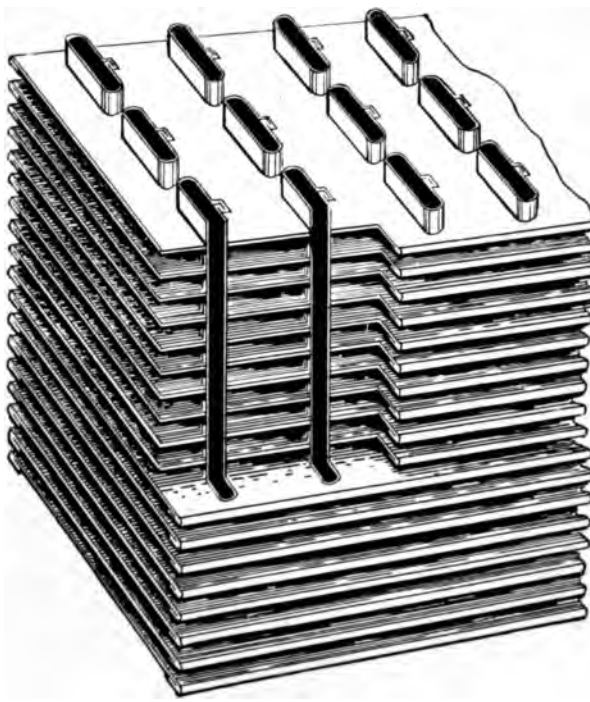


Fig. 5
Flat Tube Honeycomb Core

binder between the flat tubes. As explained, these crosswise fins in this square cell honey comb are known as "laterals." They are attached to the sides of the water tubes by dipping the assembled core in a bath of molten solder, after the application of a flux to the entire face. They are not soldered fast to the side of the water tubes, only at the faces. The solder joint extends back about a quarter of an inch. This dipping also solders the lap seam in the water tube itself.

The square cell construction is carried out in a variety of ways. Some are similar to this core while others are entirely different. Many of these laterals are "wing



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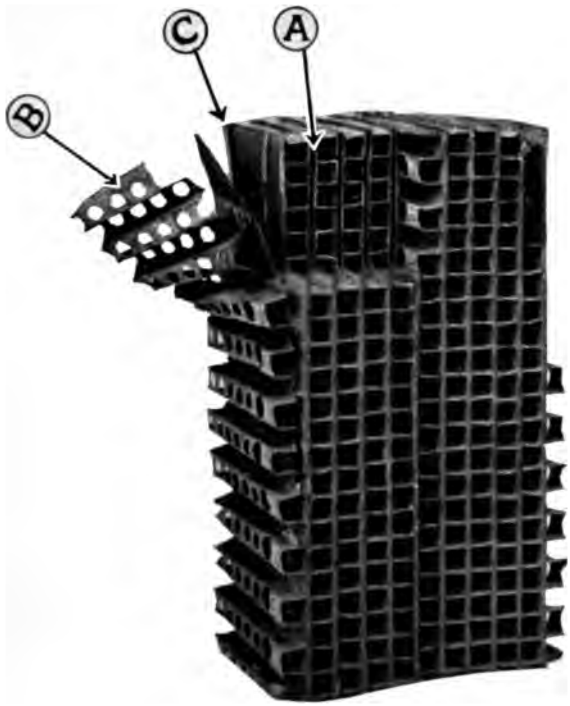

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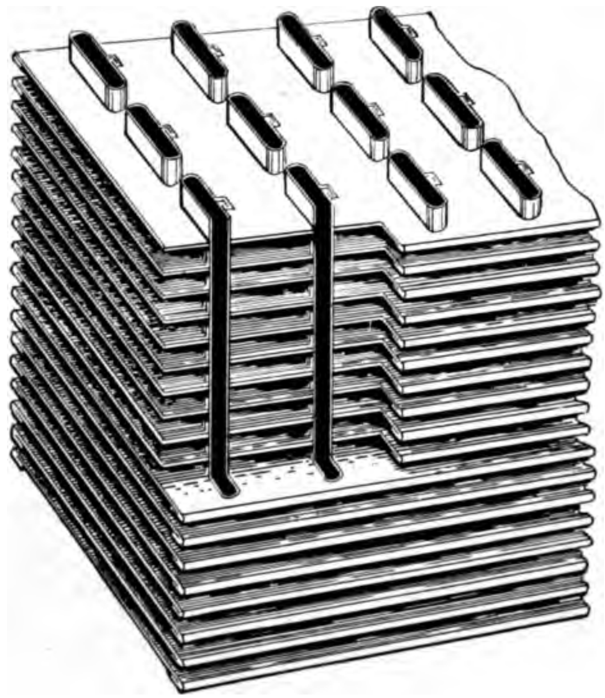

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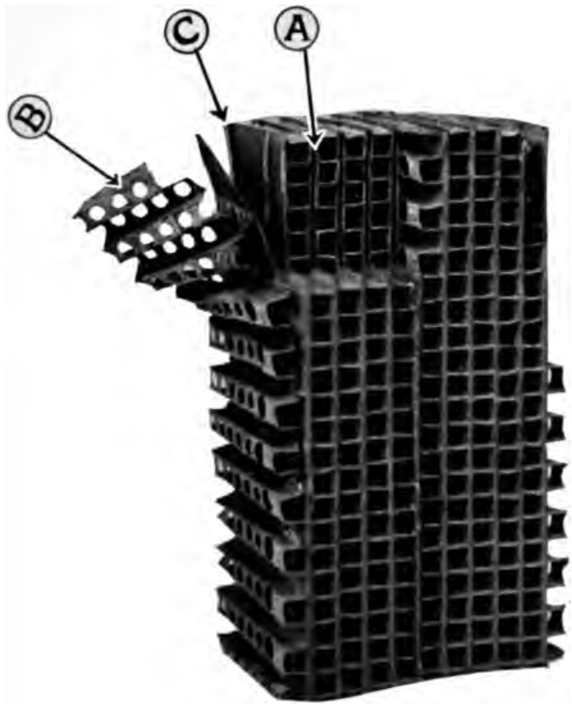

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Fig. 6
Wingformed Laterals on Flat Tubes

formed." They are a part of the wall of water tube. The metal ribbon is folded at a 90 degree angle and then flat back on itself and then again at an angle of 90 degrees righting the first break. "A" in Fig. 6 illustrates the formation of this lateral. The opposite side of water tube is formed by a flat ribbon of brass, "B." Water from the tanks enter the water tubes at "W." The seam on this water tube differs from the one in Fig. 5 and is shown at "O." The ribbon "B" also the lateral forming ribbon "A" are offset in opposite directions, the amount of this offset determining the width of water tube "W." The f es of this core e soldered by the dipping m iod. Th lde s of water

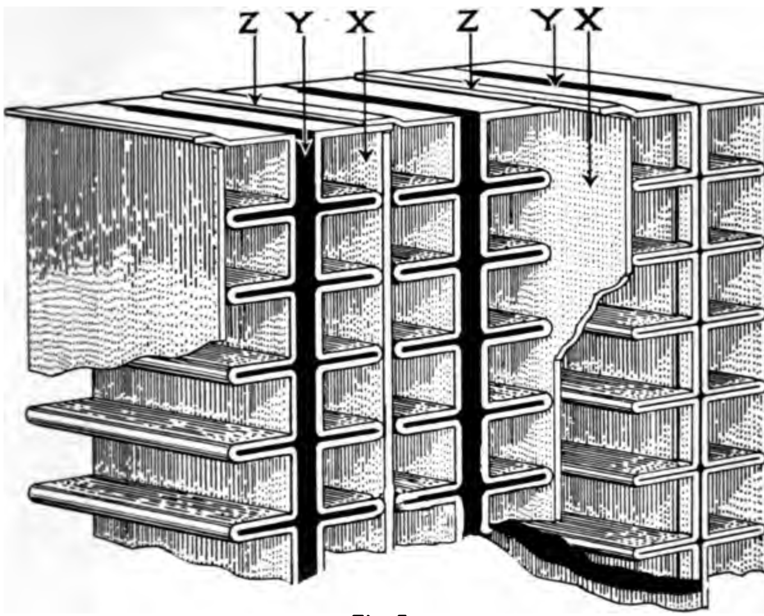

Fig. 7

Wingformed Laterals and Idle Perpendicular

tubes at "O," also tacks the laterals to the flat walls "B." In order to head the water into water tubes, the laterals at each end are soldered to the side of wall "B" from front to back. This forms the header for the core. The point of the formation of a header by bridging from the side of one water tube to the next is common to almost all honey comb cores, and should be carefully noted by the beginner.

The square cell introduces another point in honey comb construction, namely the idle perpendicular as defined. This is often called a false tube, see X in Fig. 7. The water tubes "Y" are formed much the same as the tubes in Fig. 6, except that two walls with lateral fins as "A," Fig. 6, are used. A flat ribbon "X," is inserted

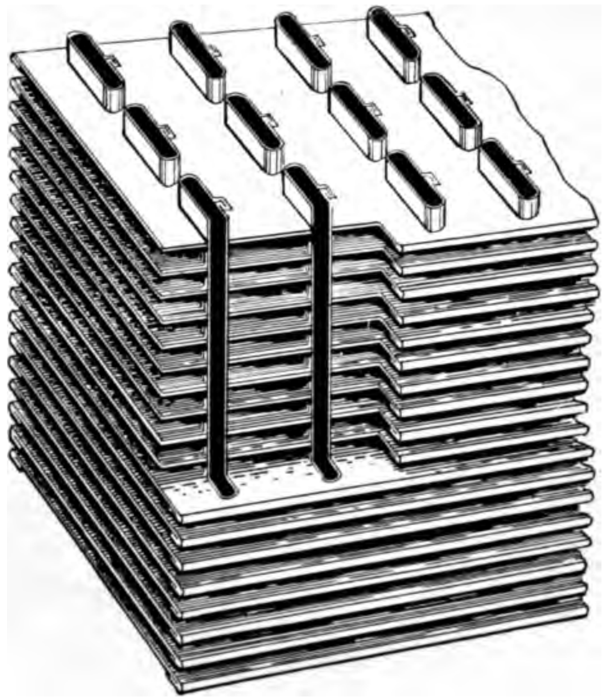

Fig. 4
Oval Tube Cut to Show Water Course

Since the principle of construction is so vital to the repair of the core, the matter will be presented in as careful a manner as possible. The flat tube tubular type as found in the Reo probably forms the best example of the connecting link between the tubular and cellular core. By reference to Fig. 4 notice the three flat tubes in the row with cross fins as any tubular core. The cellular core most resembling this is the one formerly used on the Chevrolet. Fig. 5 illustrates the construction of this core. "A" is a single flat tube extending from face to face of the core. "C" shows lap seam at back of water tube. "B" is a fin or filler strip formed by a series of 90 degree breaks crossw the rib of metal. This fin does not project in t of tl t but acts as a

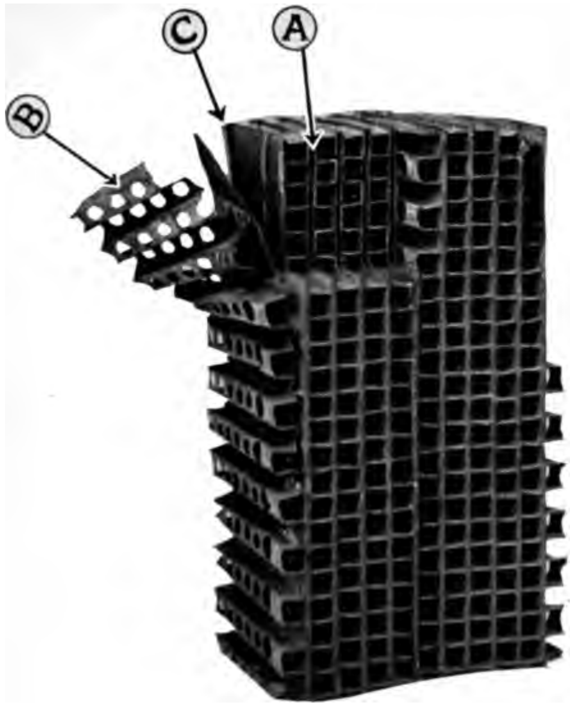

Fig. 5
Flat Tube Honeycomb Core

binder between the flat tubes. As explained, these crosswise fins in this square cell honey comb are known as "laterals." They are attached to the sides of the water tubes by dipping the assembled core in a bath of molten solder, after the application of a flux to the entire face. They are not soldered fast to the side of the water tubes, only at the faces. The solder joint extends back about a quarter of an inch. This dipping also solders the lap seam in the water tube itself.

The square cell construction is carried out in a variety of ways. Some are similar to this core while others are entirely different. Many of these laterals are "wing

Fig 10
Zig Zag Tubes with Lock Seam Header

The manufacturer also conceived the idea of bending the water tube zigzag in such a manner that its conjunction with other similar tubes produces the cellular appearance, leaving out the laterals entirely and producing a diamond shaped cell illustrated in Fig. 10. This core has no false tubes nor lateral (crosswise) fins. Every ribbon of brass is bent the same and offset the same at the edge to give water space to the tubes.

The formation of this core is very similar to the core shown in Fig. 9. The air cell is square but is arranged diagonally in the face instead of vertically, presenting a diamond shaped appearance. The tubes are formed by offsetting the edges of the ribbon as in Fig. 9. The lateral connection is formed by the conjunction of the walls of the water tubes at the points of the diamond cell.

The header is formed slightly different. The metal tube walls of the two adjoining water tubes are formed by bending the strip back upon itself and lock seaming the ends at the opposite end of the core. This makes

Fig. 12
Face Seam Formed by Lapping Square Edge Break

the entrance to the water passages come in pairs and will be noticed in a large number of similarly constructed cores.

Fig. 12 illustrates the diamond shaped cell. The water tubes are indicated by the arrows. The face of this core is cut away to show the water course thru the

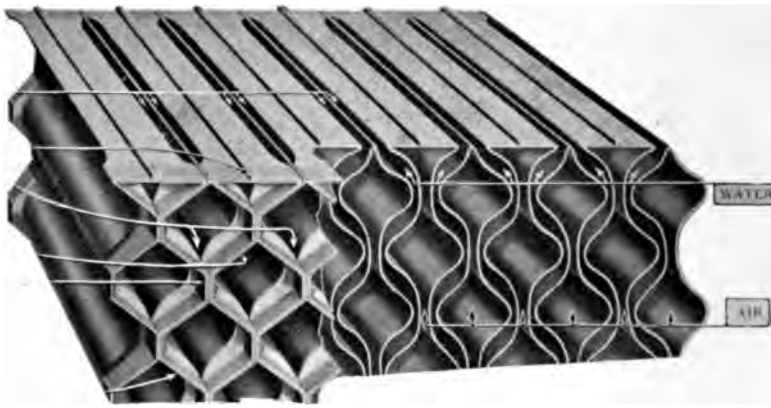

Fig. 13
Water Tubes Do Not Always Follow Face Design

core. The face seams in the water tubes are made by the lapping of a bur on the edge of each ribbon forming the wall of the water tube. This bur, about one-sixteenth of an inch wide, determines the width of the water tube.

Fig. 13 is of similar appearance; however the face form is not held, back in center of the core. The ribbon is corrugated for the water tube portion while the offset at the faces follows the diamond shape. The corners of the diamond are flattened where the adjoining tubes butt for the lateral joints. The hexagon honey comb is derived from this core. By flattening the vertical portion of the water tube at the lateral connections to correspond to length of the other four sides of the cell a hexagon would be produced.

There are a great variety of curves and angles used to produce distinctive patterns in cases of this typical construction. Fig. 14 illustrates a core that is, so far as principle of construction is concerned, identical with the diamond shaped cell. The water tubes are in pairs and each ribbon of metal forms the adjoining sides of two tubes. The ribbon is bent back upon itself and the

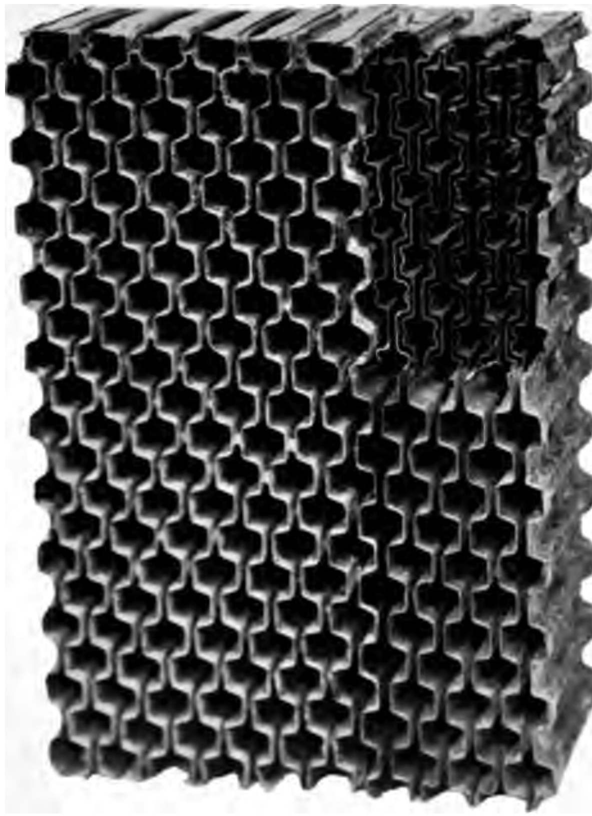

Fig. 14

A Variation in Honeycomb Construction

ends seamed to form the header at the end opposite the bend. Notice in Figs. 10, 12, 13, the bend divides each pair of cells and the seamed end forms the rest of the header for the core.

Some manufacturers claim that a core having both primary and secondary radiation is superior to the all primary type. It can be said at least that they are able to produce many and varied designs by the combination of the different shaped water tubes and suitable laterals or false work to accomplish the design in mind. The

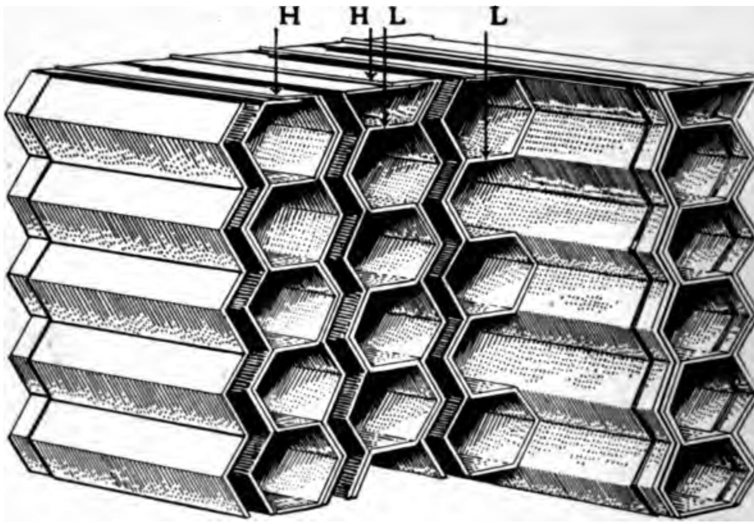

Fig. 15

Zig Zag Tubes and Laterals Forming Hexagon Cell

hexagon cell is produced in smaller cells and more perfect appearance by the addition of a special formed lateral, Fig. 15. In this illustration the lateral "L" not only cross ties the water tubes but follows the side of the adjoining tubes first on one side, then the other. The water tubes are constructed just the same as those in Fig. 10. Notice this similarity in construction. The header "H" in this case is formed by lap seam and solder. The ends of the ribbon sides of adjoining water tubes are thus joined over the end of the lateral ribbon.

The core illustrated in Fig. 16 is very similar to Fig. 15. The water tubes "W" are zigzag and the lateral connection or filler is the same, except; that there is a false tube "F" between each pair of water tubes. This filler is separated at the right in Fig. 16. "A" is a single wall of a water tube, "B" is the lateral fin or filler and is bent the same as "L" in Fig. 15. "F" is the

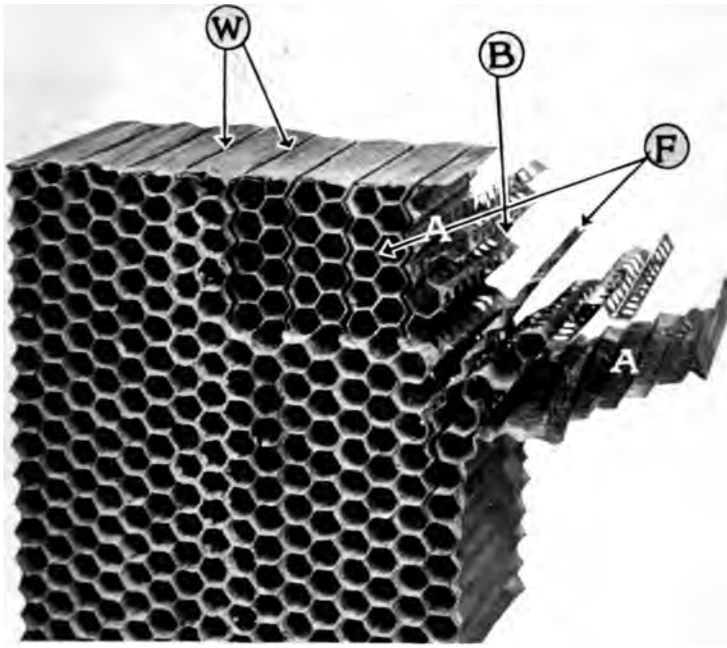

Fig. 16
Perforated Metal Used to Form Laterals and False Tubes

zigzag false tube. This false tube is the main point of difference in the two cores.

The laterals "B" and false tubes "F" are formed from perforated metal. In looking diagonally thru the core these perforations will be confusing to the beginner. A close study of this construction should be made. The claim is made that the perforations allow a vertical as well as a direct front to back movement of the air.

By the addition of the "wing formed" lateral, as illustrated by "A" Fig. 6, to the zigzag tubes in Fig. 10, the core illustrated in Fig. 17 is obtained. These wing formed laterals "L" are formed at the vertex of the angles on the zigzag water tubes. These laterals butt the

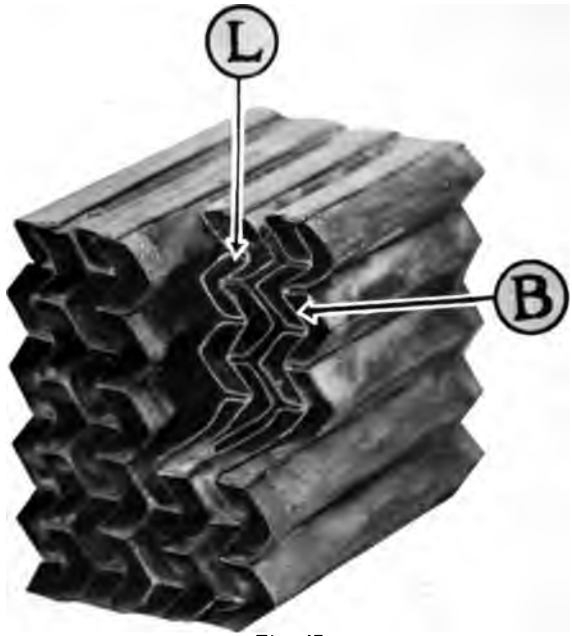

Fig. 17
Zig Zag Tubes with Wing Formed Laterals

adjoining false tube inside at the vertex of the angle. These false tubes are ribbons bent zigzag as the tube walls. The laterals are butt soldered at the face to the wingless false tube to unite the core laterally.

There is a marked resemblance between this core and the cores in Fig. 7 and Fig. 8. The "wing formed" laterals project alternately from the walls of the zigzag water tubes the same as the laterals on the straight water tube in Fig. 8. These laterals are butt soldered to the sides of the zigzag false tube "F" as are the laterals in Fig. 7. The main point of different is the zigzag tube.

The same general appearance is produced by the use of a zigzag water tube in place of the false tubes "F." By this change a core of practically double the water capacity would result.

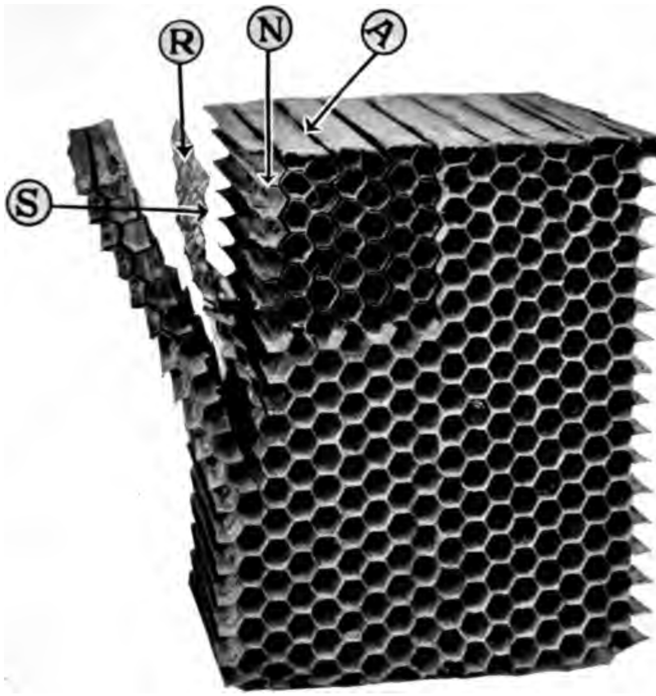

Fig. 18

A Variation in Assembling Zig Zag Tubes with Wing Formed Laterals

Another combination of the zigzag tube with wing formed laterals and the perforated false tube is illustrated in Fig. 18. This core in general appearance is the same as Fig.16. The method of construction follows more closely the style in Fig. 17. The water tube in these two are identical except for length between breaks to form the zigzag. The false tubes are formed in the same zigzag lines. The difference in shape of the cell is produced by making the ends of the laterals butt the zigzag false tube at the point of the angle instead of inside the vertex. In order to hold the laterals in place while assembling and afterwards, the false tube is slit thru the center and so bent that it forms reverse angles at the

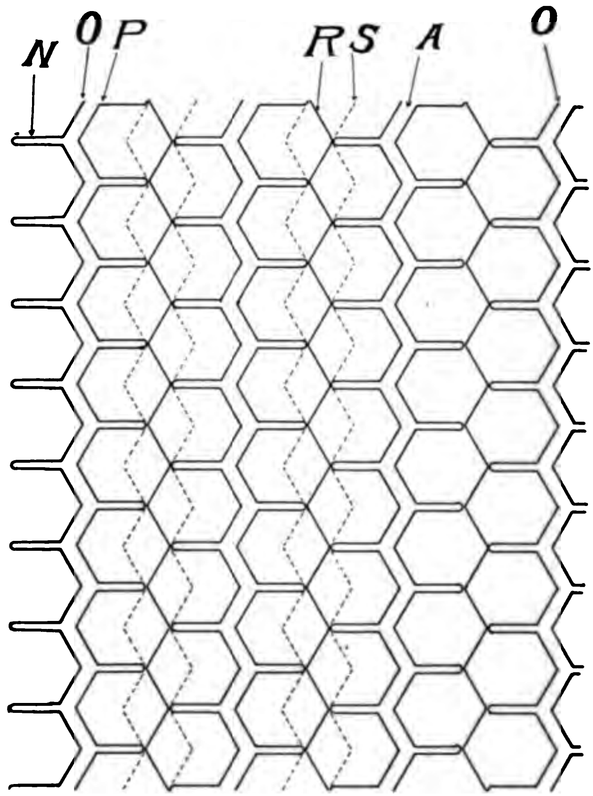

Fig. 19

Cross Section Showing Water Tubes and False Tubes

point where these laterals and false tubes meet. These reverse bends can be seen by looking thru the cells. Fig. 19 is a vertical cross section of this core. The solid lines as "R" represent the main form of false tube. The dotted lines at "S" denote the reverse bends referred to. Notice that the reverse bends "S" hold the butting laterals in place at the point of the angles on false tube "R."

Another hexagon cell core is illustrated in Fig. 20. This core at first glance is very similar in appearance

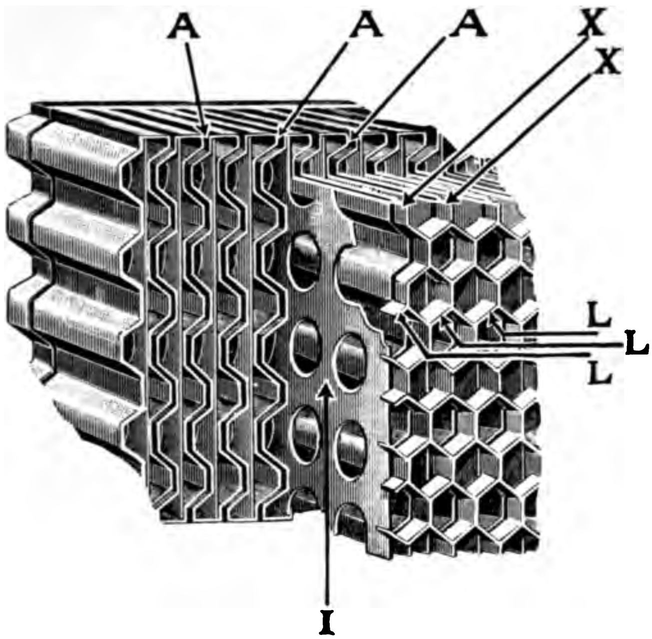

Fig. 20

The Idle Perpendicular as a Brace for Water Tubes

to the cores, Fig. 15, 16 and 18. The hexagon cells however in this core set on the point of the hexagon, while in the figures referred to, hexagon sets on the side. The water tubes "A" are bent to resemble very closely the face form of Fig. 13. Three sides of the hexagon cell are formed by one water tube while the adjoining tube with two diagonal laterals "L" furnish the remaining two sides. These laterals are slightly different from other makes mentioned. They extend back only as far as the offset edge of the tube wall. Notice the offset breaks at "X." Really these laterals are a part of the water tube walls. The brass ribbon is slit, folded flat and bent out to form a series of hexagonal shapes connected by the vertical portion of the tube wall.

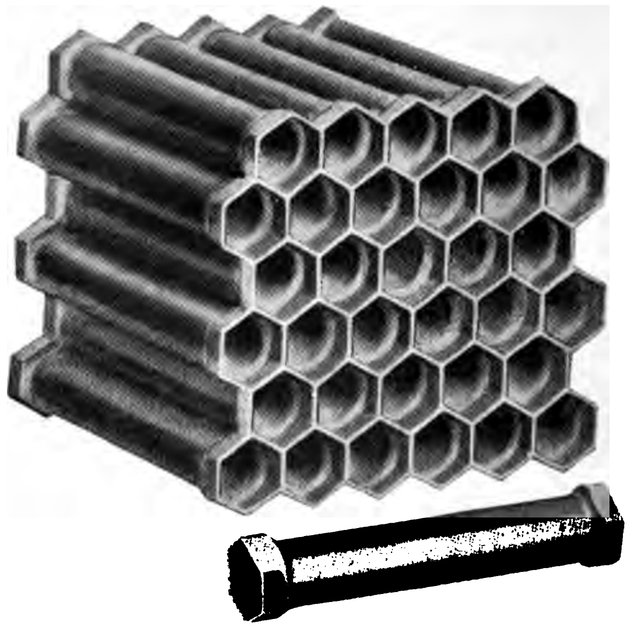

Fig. 22
Parallel Tubes Forming a Honey Comb

The false tube or idle perpendicular "I" is a perforated brass ribbon inserted between the water tubes as a brace for the tube walls. This idle perpendicular is of proper width to lay vertically between the water tubes, extending only to inside edge of diagonal laterals "L" at the faces of the core. The tube walls are headed over the ends of this idle perpendicular.

There are numerous cores that have the same general appearance of a particular type of radiator that are really distinctly different in construction. As has been mentioned in the introduction to honey comb construction, most cellular cores are made of metal ribbons so formed and bent to produce the desired tubes and air cells. However there are honey comb cores that are assembled in a decidedly different manner. Fig. 22

Fig. 23

The Flat Tube with Corrugations Into the Air Cell

illustrates one of this construction. The entire core is made up of round drawn metal tubes laid parallel. These tubes are swelled at the ends into a hexagon. The sides of the hexagon hold the paralleled air cells apart allowing the water to pass entirely around each air cell. The core has as free horizontal passage for water as is the vertical passage. In order to hold the water at the sides of the core a metal ribbon is pressed to fit the external tubes. The solder joint at the faces confine the water to a general downward course.

This example is not the only honey comb of this type as the square cell is also used. Its construction is the same in general principles, the only noticeable difference being in the shape of air cell.

In the square cell construction there is one honey comb type that presents another variation in means to attain an end. The cells are not always square. In some cases they are rectangular. This core is used on Buicks, Overlands and many other cars, and is

Fig. 24
Method of Forming the Sides of Tube Wall

illustrated in Fig. 23. In this core the ribbon is so formed as to make up the sides of the two adjacent water tubes also the false tube or idle perpendicular as well as the lateral (crosswise) fins. This is all formed in one piece from top to bottom of core as shown by Fig. 24. When the core is finished, the air cells are in reality square tubes except that there is a corrugation extending into one side of each cell. This bag or corrugation gives the water tube greater capacity, as well as presenting more surface in air cell than other square cell honey combs.

The manner in which laterals and idle perpendiculars are formed from this ribbon should be studied carefully. By reference to the formed ribbon at "R" in Fig. 25 the course of this metal strip can be easily traced. It will be noticed that a series of air cells in pairs are formed. The outer edges of this formed ribbon are offset at "P." When these formed ribbons are laid together the water tubes "W" are formed. In assembling this core it is necessary that the entire core be dipped in solder, as the laterals open both in air cells and in water tubes. The water tubes are tinned inside and out the same as the tubes in tubular cores.

The core illustrated in Fig. 26 is the ame as in Fig. 25 except that there are two corrugations in the

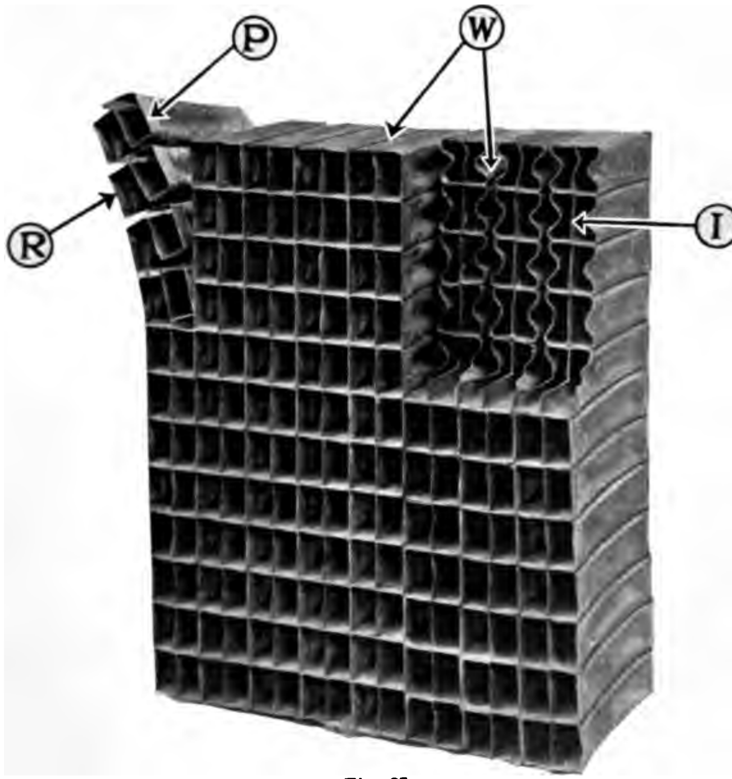

Fig. 25
Showing Formation and Water Passage

tube wall side of each cell. A core of this same construction is also produced which has square air cells instead of the rectangular cells in these illustrations.

There are numerous special features in radiator construction. The claim of some manufacturers is that improved radiation is gained by connecting the upper and lower tanks by large water channels. A number of truck radiators have such water channels, the side walls of the radiator being hollow and opening into the tanks. In trucks the tanks and side walls are cast iron. The header plates are of heavy metal and are bolted to the tanks and side channels with a gasket forming the water

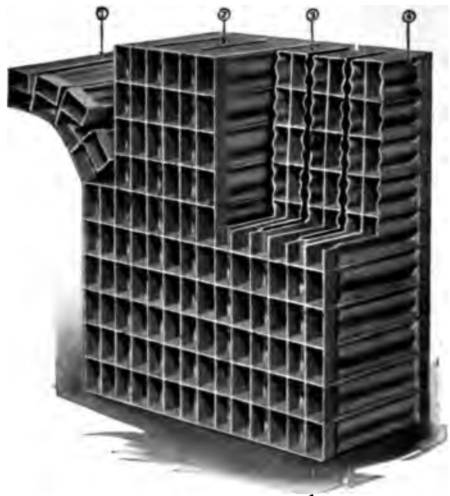

Fig. 26
Double Corrugation into Air Cell

joint. This construction is not confined to the trucks however; the Paige has a similarly constructed radiator. In this case the tanks and side walls are of sheet metal.

There are numerous sectional cores used on trucks and tractors. These present very little difficulty to the repair man, however, as the owner usually removes the leaking sections and brings them to the repair shop to be repaired. They are designed and constructed to make repairing easy, and fall in the class with some of the cores described. The tubular type is more readily adaptable to this sectional division.

9. **Radiator Supports**—The method of fastening the radiator on the car is almost universally a three point suspension. Two of these are at or near the bottom and one at the top, a tie rod passing back over the engine to the body. However the engine hood acts as a brace in many instances and helps to cause a great many leaks. When the body of a car is thrown in a twist the radiator is likewise wrenched. The support for radiators on

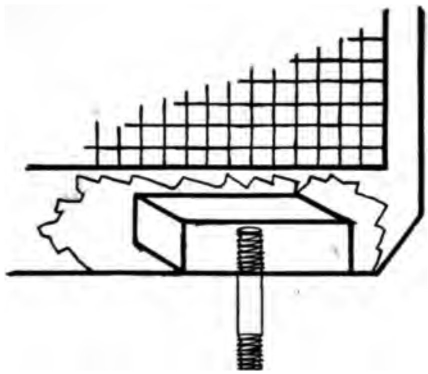

Fig. 27
A Method of Fastening with Stud

aeroplane motors varies from this rule as quite frequently the supporting hangers are attached at the top of radiator with a tie or bracing rod at the bottom.

There are two classes of radiator support. First is the support that connects directly with the bottom tank of the radiator. The stud bolt illustrated in Fig. 27 together with the type that has the stud bolt block or

Fig. 28
Strap Support Soldered to Bottom Tank

nut on the outside of the tank are one division of this class.

The supports on the Ford and Overland radiators represent another division. The Ford support is shown

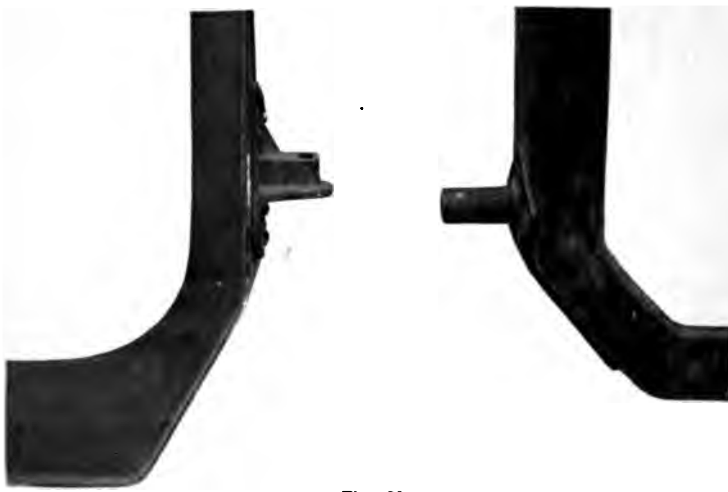

Fig. 29
Shell Support

in Fig. 28. It is a strap of iron riveted and soldered to the bottom of the lower tank and extends in step fashion to the bar thru the radiator core. The Overland support is a channel iron fitting the bottom tank and extending beyond the ends of the tank where it bolts to the side member of the chassis. Since these supports are connected directly to the water containers, it is advisable that they be fastened to the car frame as loosely as possible, to allow the radiator play, protecting it from the twist of the frame.

The second class of support is the shell support. Studs and sometimes the tie rod bracket are attached to the radiator shell. A heavy steel strap is riveted across the bottom of the shell in which the studs are placed. Sometimes brackets are riveted to the side of the shell, as in Fig. 29. Strips of steel (core channels) are soldered to the tanks along the side of the core. Bolts thru the hood ledges of the shell and core channels cradle the radiator, protecting it from dir strain.

A great many manufacturers allowed a margin of safety in attaching the radiator to the chassis. The Ford for instance has a spring on the frame studs which prevents the clamping of the radiator support rigidly to the frame. This spring takes up the weave of the frame when the car is thrown in a twist. The White truck has heavy springs in a housing on the side of the radiator shell to carry the delicately constructed radiator as carefully as possible.

The motor mechanics are coached on tightening nuts until it is difficult for the radiator repair man to convince him that the radiator is one part of the car that should not be fastened rigidly. Many a loosend stud bolt block would be avoided if the motor mechanic could be impressed with the idea of using plenty of rubber or leather washers and castellated nut with cotter pin on a radiator stud.

CHAPTER 3

LEAKS IN RADIATORS

THERE are innumerable causes for leaks in radiators. With the host of repair men, the cars of the United States continue to wear out on an average of three radiators per car. It is hard to tell what causes the most leaks. They are in the main, vibration, freezing, disintegration of parts, strain and shocks.

It might be well to give a list of the location of leaks that the beginner be brought to realize that radiator repairing is not really a difficult job. This classification will also assist in applying the methods given later on in this book to the particular problem at hand.

Tank leaks are but few. Unsoldered joints, a cracked or worn tank and leaks in or around the tank fittings cover the possible ones. Hose connections, filler necks, stud bolts, tank supports, drain cock plates and strut rod and hood rest brackets constitute the tank fittings.

Core leaks in the case of tubular cores fall into five separate heads. Namely: frozen tubes, mutilated or worn tubes, vibration break of tube near the tank, a broken solder joint between the tube and the header, and the creacked header.

Honey comb core leaks are seam leaks either in the face where the edges of the strips are brought together or header leaks where the cells are tied across to head the water from the tanks into the water channels of the core. Cells are punctured or cracked from vibration and metal fatigue. Frequently too, the joint between the core and tank leaks. Very often the water cells are expanded and joints torn apart by freezing.

In all there are twelve or thirteen different classes of leaks. Instances and methods of repair of each of these are given in following chapters.

CHAPTER 4

CLEANING RADIATORS

CLEANING of radiators has for its purpose three things: cleaning to restore perfect radiation, which is important to the motor; cleaning to solder, ιich is of vital importance in repairing; and cleaning remove obstruction of circulation, which is not a repair ɔ but will be spoken of at the close of this chapter.

10. Cleaning to Restore Radiation—Very often oil forced into the water system of a car thru a leaky sket in the engine. This oil collects on the walls of ɜ water tubes insulating the water from the metal using the engine to over heat. The same insulation sults from matter placed in the radiator to stop leaks prevent freezing. The circulation may be impaired ly slightly if at all.

Radiators should be cleaned at least once a year. It not necessary that they be removed from the car. In ct it is advisable that the entire cooling system be aned. This may be done by dissolving one pound of nmon baking soda to each gallon of water. The solun is poured into the radiator and the engine run to at. After heating, the system is drained. The lower se should be removed in order to flush out rapidly. ιe rinse water is flushed out similarly, after which ɜ hose is replaced and the system filled with clear .ter.

11. Cleaning to Solder—Too much can not be said out cleaning the metal preparatory to soldering. It absolutely necessary to have all dirt and corrosion off fore a good job of soldering can be done. In most ses it is necessary to scrape bright with some sharp strument. In radiator work there are so many dif-ent shaped places to solder, that a variety of shaped rapers come handy. A good scraper for plain surface

Fig. 31

Fig. 32

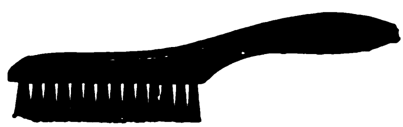

Fig. 33

Steel Wire Cleaning Brushes

scraping is made by grinding a three-cornered file about one-third of its length until all the teeth marks are out and the three edges are sharp. To make odd-shaped scrapers, use old three-cornered files, heat red hot, turn a hoe shape on end and grind to fill need. A V-shape comes very handy. To scrape back of tube, flatten handle end of file and bend end in a circle, then grind inside edge. To scrape inside of tube the same shape is used, except end is ground rounding. After shapes have been formed, heat red hot and dip in water to temper. A little experience in shaping and using these scrapers soon makes it easy.

It will be found convenient to put handles on these scrapers. When the handles are selected no two should be alike in shape. This is advised to make the tools easily found on the bench. All mechanics have the same trouble, namely: the difficulty of seeing the desired tool

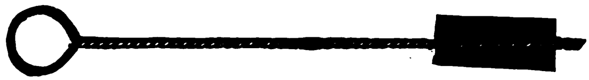

Fig. 34
Bristle Brush for Cell Cleaning

even though it be in plain view. The scrapers themselves being small are very easily mistaken one for the other.

The steel wire brush is particularly good for cleaning flat surfaces and in many cases around joints, such as castings, etc. There are numerous good wire brushes on the market. Fig. 31 is a good all around cleaner, Fig. 32 for small work and Fig. 33 for larger surfaces.

Any leak that has existed for any length of time is covered by a mineral deposit from water. This deposit varies in different localities but for the most part it can be removed by the use of muriatic acid. To speed up this operation scrubbing with some sort of brush will be advantageous. A brush like a pistol cleaner, Fig. 34, with muriatic acid is particularly good to clean joint of tubes and headers, as well as in the cell of a honey comb.

Where the part is found to be copper and the scrubbing does not clean readily the action of the acid will be accelerated if the joint is heated causing the acid to boil. The incrustation will boil out and the copper itself will be attacked by the acid. Continue the application of acid with the eye dropper or swab until perfectly clean.

Sheet steel or malleable castings are cleaned after the same fashion as copper. In cleaning the ends of core channels to resolder to the tanks, or tank fittings to be replaced, first all the rough scale is scraped off. It is quicker to scrape this off roughly than to remove it with acid. In case of pitted castings a pointed V-shaped scraper will get down into the holes. The scale on sheet iron flakes off easily. After this is done heat is applied until the acid will boil readily. This acid cleaning is continued until the depressions will tin. When the part is retinned it will be practically as good as new, since the tinning will prevent further corrosion. Quite frequently the part may be immersed in raw muriatic acid. In this case it is well to remove the scale and heat the fitting to a redness or nearly so before plunging in the acid. After a short stay in the acid the iron has an even gray appearance and is ready for tinning.

At times a small leak around a tank fitting may be cleaned without removing the part. Place the radiator so that the solder will flow from the joint when heated. With the assistance of whisk broom, or some scraper, brush away all the molten solder. Place the radiator in position so that acid will run into the joint. Heat the casting and apply acid. The heat will boil out the dirt and rust. Continue the acid cleaning until the solder will flow into the joint when applied.

There are many instances where it will be advisable to clean the entire radiator. An instance in mind is a tubular core leaking from the effect of freezing. The common method in this instance is to boil the radiator in a solution of concentrated lye, caustic soda, or some commercial cleaner to remove paint, grease or other foreign matter. Lye is probably the most convenient. One pound can to each seven gallons of water in a boiler similar to Fig. 35 will remove foreign matter soluable in this solution. The best plan is to test different strengths of the solution until one is found that will produce results.

A boiler can be constructed very economically in any sheet metal shop. This boiler is designed to use

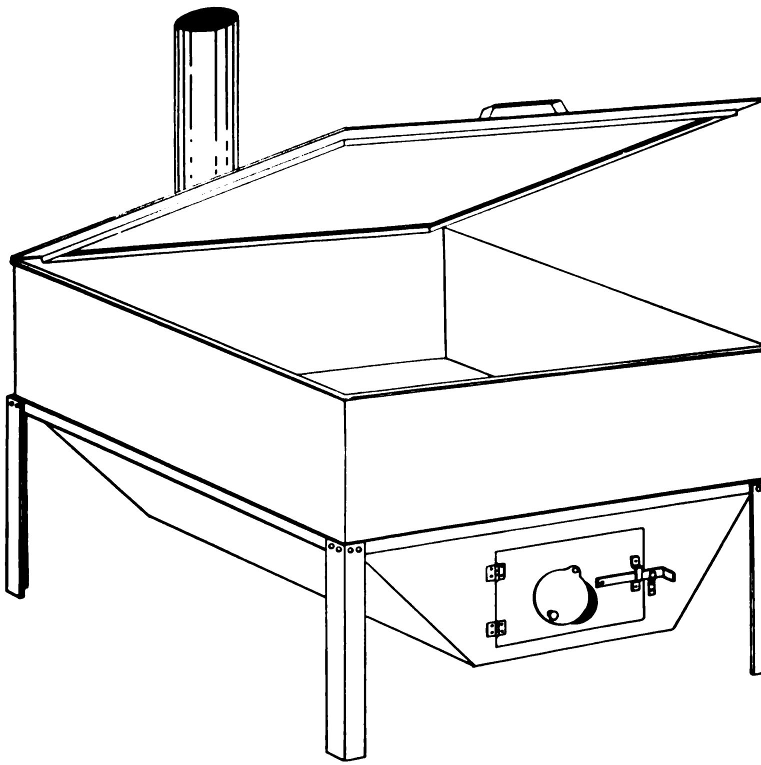

Fig. 35
Boiling Tank

wood as the fuel; gasoline, oil or gas may be used according to local facilities. The tank should be made large enough to accommodate any ordinary radiator. Twenty-eight by forty-two inches will take two Ford radiators and any other single radiator. Twelve to fourteen inches is sufficient for depth. It will be found economical in small shops to have two tanks. One large one as mentioned and another twenty-eight by twenty-one for Fords. The larger tank can be removed and the smaller one used when only a few radiators require boiling. The saving in heat and cleaning compound will be considerable.

The tank should be locked seamed and sweat soldered from inside and out, if lye is used. The lye will eventually eat out the solder and cause the tank to leak.

A drain of some kind will be convenient. This drain should be free from short bends. A molasses gate makes a good drain cock.

The cleaning solution may be used for a number of radiators. If the radiator is washed with the hose before boiling a great deal of sediment may be prevented from collecting in the boiler.

About one-half hour to one hour of boiling is usually sufficient. This can be governed by the condition of the radiator after washing well with a hose. This method will not clean sufficiently to solder with the iron without scraping, but where lime deposit is not too heavy, soldering can be done with a torch. If the radiator is not clean it is better to repeat the boiling until very little foreign matter is left except the lime deposit which is not removable by this solution.

The radiator is then given a bath in muriatic acid. A 50-50 solution is probably fast enough. Twenty minutes in this will usually remove the lime and any remaining deposit. It is important that the radiator be well washed inside and out after the acid bath. After washing, the radiator may be returned to the boiling solution for a few minutes to neutralize the acid. If commercial cleaner is used in boiler, a vat of lime water will neutralize the acid. If the workman does not expect to work on the radiator immediately it should be stored in a vat of clean water. This will reduce the acid remaining in crevices also protect it from the air preventing corrosion. A cleaned radiator will solder after an indefinite stay in clear water.

A wood vat lined with lead is necessary to hold this acid solution. Ten gallons of acid will cover the core of the average size radiator laid face down, in a vat twenty-six inches wide, thirty-two inches long and six inches deep. It will be necessary to draw the acid from this vat when not in use, as the acid weakens by exposure to the air and by the eating action on lead. Two five-gallon jugs or like vessels will serve to store this acid solution.

The lining should be of heavy sheet lead. The seams should not be soldered but melted or burned together as done in battery work.

There are many special cases of cleaning that come up in the course of a day's work, such as removing chewing gum, the many kinds of asbestos roof cement, sealing wax, soap, etc.

Chewing gum is usually in comparatively small quantities. Apply ice or ice water and crack the hardened gum loose. Heat makes a sticky mess. Sealing wax had best be removed cold. Considerable scratching and picking is necessary but it is faster than heat. Gasoline is effective but messy.

Roof cement is met with in larger quantities but can best be removed cold. Ice will help usually. Boiling in lye will be more effective if the radiator is soaked over night in a vat of kerosene after the larger portion of this cement is removed with the scraper.

A very little boiling water poured on soap stuffed in a core will dissolve it readily. Cool water will serve but it is slow. The doping of radiators might be spoken of in connection with soap. While it is poor policy for a repair man to advise the doping of a radiator there are cases where an owner is in dire need of the car when the repair man is unable for lack of time to repair the leak. The owner is sure to ask what he can use in the radiator to stop the leak. If he is advised not to put anything in it he will go elsewhere and get the kind of advice he is looking for. Some druggist, garage owner, or feed store man will sell him something guaranteed to do the job "just as good as solder." In this case it is well to know what is used. Soap shaved into a radiator will stop almost any leak temporarily. The repair man can effect this repair and tell the owner at the same time it will necessitate the radiator being boiled when it is brought for repair. The workman can be sure that the dope is removed and hard feelings will not result. Soap is harmless and easily soluble. It is an advantage to the owner as well as the workman. Another thing it won't stay in long.

12. **Cleaning to Remove Circulation Obstruction**—As stated introductorily, cleaning to remove obstruction to circulation is not a repair job. It does arise as a problem to repair men however. Obstruction to circulation in the cores of radiators results from three causes, namely precipitation from impure water, scale from rusting sheet iron parts, and matter placed in the radiator to stop leaks. The latter is commonly spoken of as dope. The owner who allows dope to be poured in the radiator after reading the caution in all instruction books furnished by car manufacturers deserves the added expense of a new cooling section.

The fact that the repair man can not know the ingredients of the dope, makes it difficult to combat this problem. If only one kind were used the remedy would be possible, but chemical products as well as vegetable matter (cornmeal, flaxseed, pepper, ginger) are mixed with this. The resulting stoppage is of such a nature that a chemist would be required to determine agents for the removal of this mass.

Tubular cores are the least likely to be stopped. They are the most readily cleaned also. By the removal of one of the tanks and the use of a strong wire rounded at the end to prevent puncturing the tube, a sure job may be accomplished. After the tu 'e thus opened the radiator should be boiled in olution is used in the shop. The tubes are then washed out one at a time with water pressure.

Honey comb cores are far more likely to become clogged. The tubes, as explained in Chapter on Radiator Construction, are narrow. In the cores which have straight tubes, the stoppage is less likely to occur. If they do become clogged the method employed in tubular cores may be used, except that a strip of thin sheet metal with rounded end is used instead of the wire. Sometimes the drops of solder will have clung inside the tubes and the strip can not be forced thru. In this case, the cleaning will depend on the boiling.

Badly clogged zigzag tubes are very difficult to clean. They are also more likely to become stopped up. The repair man will find that no method will be rapid. When a tube is once clogged the sediment from the water and the settling dope continue to fill the tube. A two or three inch stoppage in a zigzag tube will resist any method of cleaning for a long time. The liquid used must be given time to soak or eat thru the entire mass.

Vegetable matter may be removed by the use of a compound procurable from the plumbing shops for removal of stoppage in sewer pipes. It is slow. The main objection to any such cleaning is that there is no certain method of knowing when the cleaning is thorough. This compound will not remove lime or magnesia deposits which are usually present.

Some explanation of this deposit might be of interest since it enters into so many of the cleaning operations. Ever since the steam engine was invented there has been an army of chemical engineers trying to solve the problem of boiler incrustation or scale. Very little of the available water is free from mineral deposit which is precipitated upon heating the water. The housewife has the same deposit in her teakettle. These chemists have found some methods of removing the deposit from boilers but they are slow. Since the question has been difficult the solution has been to avoid the deposit rather than to clean it out. In all modern power plants the water source is purified. The repair man is not able to do this but he does have one very sure and efficient method of procedure, namely, the installation of a new cooling section.

Rust scale from terne plate used in tank construction is one of the things that stops the core and is not a fault of the owner. Some manufacturers use this steel plate for splashers or for stiffening plates inside the tank where hose connections are riveted. Tractor radiators are sometimes made entirely of terne plate excepting the core. No doubt this will be discontinued as buyers become educated to the poor construction.

This scale flakes off and is shaken down into the tubes. The deposits from the water collect on this. This stoppage occurs at the upper end of the core. It may be removed by a boiler compound procurable from any steam fitter. About twenty-four hours will be necessary for its removal.

In case the tanks are entirely of terne plate it is advisable that new brass tanks be installed. In this case the core will be removed and can be cleaned more readily. If only a small amount of steel has been used, this steel part should be removed by all means.

This method is advised for the average job. The radiator is boiled in caustic soda or lye after which the hose is inserted in the lower hose connection and the radiator flushed. The flow of the water will test the circulation. The radiator is then placed in the acid vat and allowed to remain from a half hour to an hour. It should be raised from the vat and replaced several times during the bath in order that the acid may be stirred. After a thorough washing inside and out the circulation is again tested as before. It is then returned to the soda or lye solution for a few minutes to neutralize the acid. This solution is washed out thoroughly. After this the radiator is thoroughly dried, not only until the outer appearance is dry but long enough that all matter inside is thoroughly dry. The radiator is then inverted and a large volume of air at low pressure is blown thru the core, by connecting the air hose to the lower hose connection. While the air is being blown thru, the radiator is jarred by tapping along the joint of the core and the upper tank. Any remaining sediment will be blown and shaken out. So long as dope is wet it is in a swelled state, when dry much of it will fall out. The drying must be thorough, however. Sometimes a large amount may be blown out before any chemical cleaning is attempted.

The repair man will find it to his advantage however to persuade the owner to have a new core installed. Every new core installed under these conditions adds one more owner to the educated class. If dope is cleaned out the owners are given the impression that doping is all right since his repair man can remove it. The repair man who has his own and his customer's good at heart will not attempt to establish a reputation as a laundry man when his business is repairing.

CHAPTER 5

TINNING

THE process of coating the surface of a metal with solder is known as tinning. This tin, or more properly speaking solder coating, is applied for two purposes. First it is used as a preservative means. Terne plate is sheet iron or steel, tin or lead coated to prevent rust. The tank braces, core channels, and shells of radiators are of this material. Malleable castings are tinned to prolong the life of these parts.

The second purpose of tinning is more important to the average radiator repair shop. Tinning in this instance is a means to good mechanical construction. A hard and fast rule to be laid down, is that no joint should be soldered until the contacting surfaces are tinned preparatory to soldering. In attempting to solder two untinned surfaces the mechanic can never tell where the solder is hindered from soaking into the seam. When tinned surfaces are being soldered the dependence is not placed on the flux acting properly on the oxides inside the seam. Tinned surfaces will be sweat together if flux is not applied. This does not mean however that the joint should not be well fluxed as a stronger joint will result with the use of a flux. Make it the rule to tin first. The mechanic who tins well is advertising his business aside from the speed added to the soldering operation.

It will be of benefit to explain methods of tinning on different metals for different purposes. Tinning as a preservative is almost universally done by dipping in solder or tin baths. To illustrate, the lower tank support for a Ford radiator, Fig. 36, is first cut and punched from two and one-quarter inch black hoop iron. After forming, this support is pickled in raw muriatic acid. It is allowed to remain in this acid until it has an even gray appearance. It is then washed in water, dipped in flux, then into molten solder.

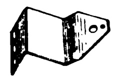

Fig. 36

This method can be used by the radiator mechanic to advantage. A solder vat as illustrated in Fig. 37 can be used in any tin or radiator repair shop. Pan is of twenty gauge black iron with folded "bread pan" corners. The stand is constructed of 1/8 inch by 1 inch strap iron, with heater shield, which is of a lighter gauge

Fig. 37
Tinning Bath

sheet iron. The heater may be gas or as illustrated a painter's common blow torch. This can be arranged as handy as the local facilities permit. Use for this will be explained in various jobs taken up in following chapters.

In tinning malleable castings or other iron or steel parts, clean the part with acid as advised in chapter on Cleaning. Dip part in flux and immerse in molten solder. In doing this insert part slowly as the flux will cause solder to spatter. Allow it to remain until the bubbling ceases. This is necessary in order that all moisture, namely acid, flux and water, be expelled. Upon examination if there are spots untinned dip into the acid again while hot. The boiling acid removes the scale rapidly, repeat the wash, flux and solder bath. After tinning, the surplus solder should be immediately struck off using a clean rag. Old castings can be reclaimed in this manner and stored for future use. The part will be preserved and ready for immediate use when occasion arises.

It is not absolutely necessary that the article be dipped to tin it. The soldering iron or torch will produce the same results but not as rapidly.

In shops where lead coated iron or terne plate is not carried in gauges heavy enough to make tank braces, core channels, or other sheet iron parts, galvanized iron can be used by first removing the zinc coating with muriatic acid, washing the piece and tinning. Galvanized iron makes very poor radiator parts until it is made over into tinned iron. Very often it is only necessary to tin the portion where the solder joint is to be made.

Copper and brass are easier to clean but it is just as necessary that they be tinned. Copper being a good conductor dries the flux rapidly, therefore does not take the tinning as perfectly. This argues for the advisability of tinning preparatory to soldering. The joint will be perfectly made if it is tinned. Brass takes solder better but should be tinned, as it is often the case, that too much heat will produce the same results, mentioned in the case of copper. Aside from this a cleaned portion may look clean and still not be in shape to take tinning.

CHAPTER 6

TESTING

THERE are two methods of testing: one by introducing air in the radiator, immersing in water, locating the leaks by the bubbles. The other by filling the radiator with water and locating the leaks by the moisture or stream of water as it flows from the leak.

13. **The Air Test**—This test is made by plugging up the hose connection, filler neck and other openings

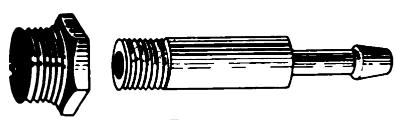

Fig. 38
Bushing and Nipple

in the radiator, placing an air pressure tube on the overflow pipe or connecting with $1/8$ inch nipple or the

Fig. 39
An Expanding Rubber Stopper

nipple and bushing to the drain cock plate, as shown by Fig. 38. Expanding rubber plugs are almost indispen-

Fig. 40
A Radiator Ready for Testing

sable for stopping the hose connections. Fig. 39 illustrates one of these plugs, altho discs of tin may be soldered over the openings. Fig. 40 illustrates a radiator ready for testing. The radiator is immersed in a tank of water. Leaks are located by tracing down the source of the bubbles.

Since testing is a sloppy job it is well to arrange the shop equipment in such a manner as to avoid the

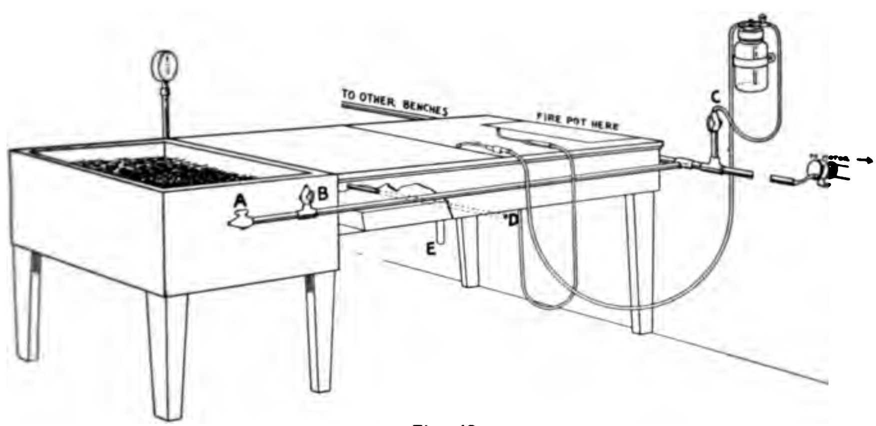

Fig. 42

Convenient Bench Arrangement

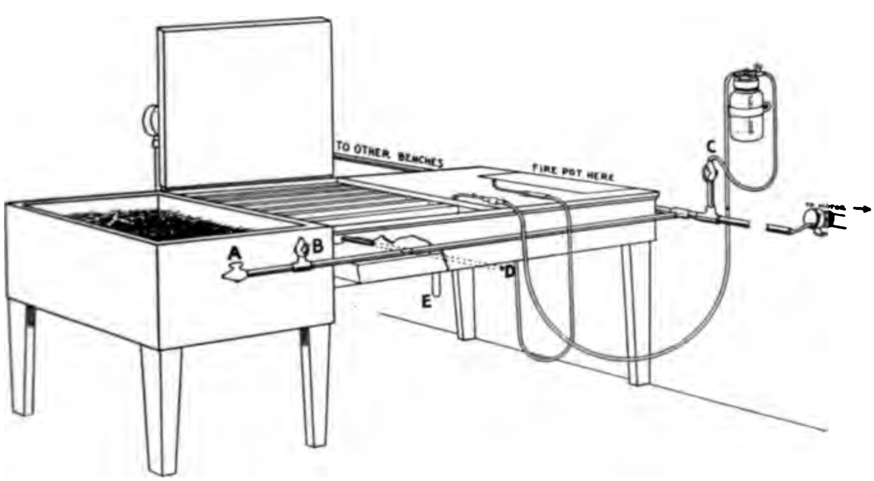

Fig. 43

Showing Lattice and Drain in Work Bench

necessity of wearing rubber boots. Figs. 42 and 43 illustrate a very desirable arrangement. The bench, 32 inches wide, 6 feet long and of height to suit workman is placed end to the wall under or just back of a window. This allows the light to fall upon the radiator at the

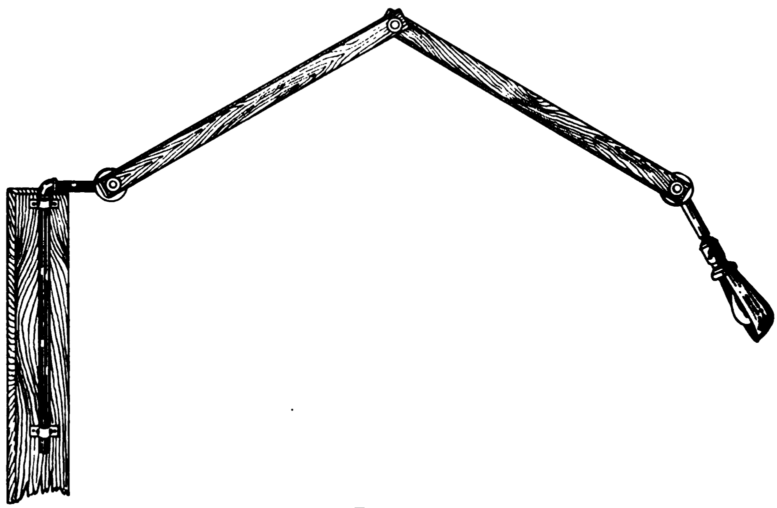

Fig. 44
Adjustable Bench Light

most desirable angle. The top of bench is tight in order that all solder may be saved. This top is cut in half and the section near the tank hinged at the back. For dry work the top of bench is then smooth as in Fig. 42. A hole in this hinged section large enough to take the common run of filler necks is convenient. The radiator will set in any position with the aid of a prop stick. A removable lattice is arranged under this lid, and beneath it a sheet iron pan. The pan should slope gently to one of the back corners where the drain "E" to the sewer is connected. Solder falling in the pan will not be washed away. As the pan gets loaded with solder it can be reclaimed.

The tank for testing should be at least 36 inches by 48 inches by 12 inches to 15 inches deep. There are comparatively few localities where the large radiators are common but the popularity of large trucks and tractors makes it necessary to have a tank that will accommodate the largest radiator.

Fig. 46
Rotary Air Compressor

As there are so many inside leaks and few shops have sufficient light to locate them, some sort of artificial light is necessary. An electric light illustrated in Fig. 44 is worth many times its cost. It stays in any place it is put, don't swing and reaches back under a radiator. It should be fastened at back of bench and arranged to move out over water tank. A handy mechanic can construct one after the lines of this cut. A head light illustrated in Fig. 93 is particulaly convenient for tubular radiators. This is a regular 110 volt lamp on an extension cord and attached to an asbestos padded cap. Notice cord down the workman's back and attached by short strap to button on overalls to relieve the head of the drag on the cord. This light saves a great deal of time as it is always in position to give the best light on the spot before the eyes.

The air pressure may be obtained by a common bicycle pump or more conveniently from a compressor of some sort. If rotary compressor in Fig. 46 is used no pressure tank is needed as the relief cock "A" can be opened with all others closed until the desired pressure is registered on pressure gauge. It may be mentioned that two air lines are frequently used when a rotary compressor is the source of supply. One is for torches and one for testing. The air pressure system used by garages for tire filling consisting of pressure tank, compressor, motor, gauges and reducing valves, fills the requirement when a number of men are employed.

The most practical pressure for testing is from five to ten pounds. The former is sufficient and in most cases better. Frequently a leak will appear on a low pressure when a higher one expands the metal and closes the joint.

The locating of the leaks after the radiator is submerged is the real difficulty to the beginner. It may be stated also that old men at the business have the same trouble however not so frequently. This is the time that knowledge of radiator construction comes in most handily. Often a leak is not to be seen but the knowledge of the possible source of trouble solves the problem. The general rule for locating is to raise the radiator in the tank until the source of the bubbles is at the surface of the water. In a radiator that has a multitude of leaks it is best to locate as many large ones as can be found easily. Repair these and test for more. Quite frequently the large leaks can be located easier if a lower pressure is used. Care must be exercised in this case that water has not entered other leaks which may seal the lower ones in future tests. It is a good rule on the last test to turn the radiator over in the tank. Another difficulty is met when two leaks occur exactly opposite one another, one near the front of the core and the other at the back. These can frequently be found by standing the radiator on edge or nearly so allowing the bubbles to come up the face in the case of honey comb cores. The tubular cores can be raised until only the lower rows of tubes are immersed in the water and the leak marked by guess. A hooked shaped scratcher will locate the opened seams at the back of the tube. Very small leaks are located by

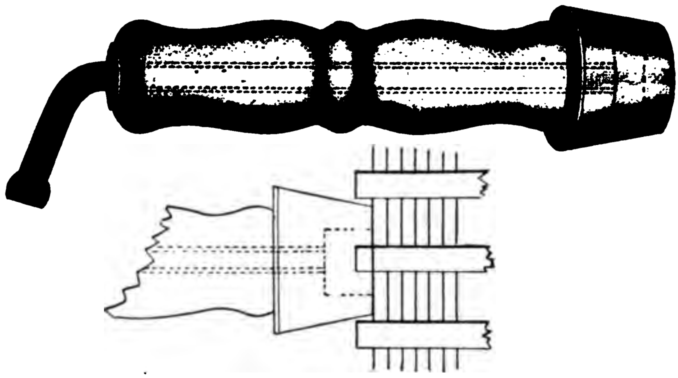

Fig. 47
Tester for Tubular Tractor Radiators

standing the radiator in such a position on the bench that the supposed location can be covered with flux squirted on either with eyedropper, oil can or flux squirter. The flux will foam to some extent. By placing the bench light at the back of the radiator the interior of the cells or inner tubes can be easily seen.

Heavy truck and tractor radiators frequently have cast iron tanks and when shipped for repair come to the workman minus the tanks. In case the core is honey comb, dummy tanks or plates with a tube for air hose must be bolted or soldered to the headers. Then the test proceeds the same as any radiator. In testing tubular cores however a test tool, Fig. 47, with different size rubber cups is very convenient and speedy.

This tool connected to a five pound air supply is used as follows: submerge the core in water tank with the ends of the tubes at right and left. It is convenient to have a rest in the bottom of tank. A one by four inch board wired on two paving brick one at each end to act as legs and weights, serves the purpose. Place this rest crosswise the tubes so that the core is balanced. Rock the right end of tube out of water and place the tester

Fig. 48
Test Cup In Place

rubber cup over the end of tube as shown in Fig. 48, allow the water in the tube to be blown out by the air pressure. The radiator is then moved to a level position entirely covered by water. With finger of left hand close end of tube. If the tube has been frozen the bubbles will indicate the fact out in the core. If the tube is broken near the header opposite the test plug bubbles appear near that header. If bubbles appear near the header where the test plug is held it indicates either a broken tube or a loose joint between the tube and header. In this case place the test plug on the opposite end of tube closing the tube with finger of right hand. If the bubbles continue a broken tube is indicated, if not the soldered joint is leaking. After a little experience these broken joints can be detected with the eye.

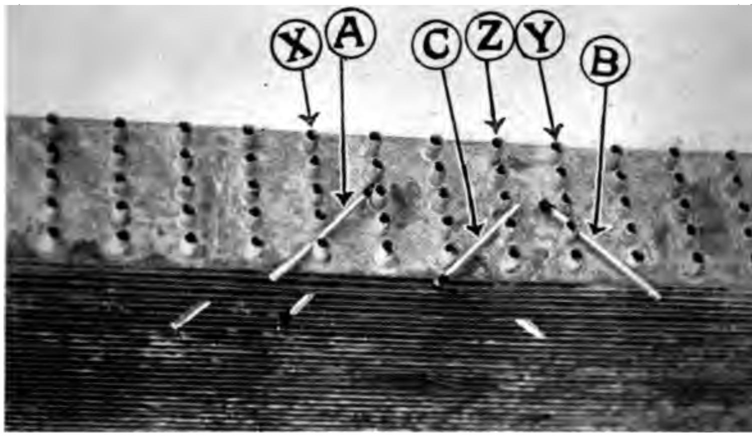

Fig. 49
Suggestion for Marking Leaks in Tubular Core

14. **Marking Leaks**—Some mention of a method of marking leaks may not be amiss. It is good practice to adopt a uniform system of marking, one that meets the conditions. Having only one method prevents forgetting what a certain mark means. For tank leaks the scratcher is most adaptable. For honey comb cores a strip of tin or a small wire bent in clothes pin fashion stays put. In marking inside leaks have one end of the strip or wire project farther than the other in the clothes pin. When this is placed on the edge of a cell the long end will indicate the side of cell leaking.

A method on tubular cores is suggested by Fig. 49. The matches have been inserted at the end of core to illustrate the method of wedging the match between the tubes. The burned match "A" indicates a leak in the first tube in tube row "X." It is held in place by inserting it under the third tube in the next row. "B" indicates a leak in the second tube in row "Y," the burned end of match is inserted first. "C" indicates a leak in third tube in row "Z" having the burned end of match outward. The direction of slope of the match indicates the side of tube which should be up when soldering. Notice "A" and "C" indicate leaks on the one side of tube while "B" indicates the radiator must be reversed to solder. These matches are inserted between fins either one at each end of leak, or one at center of leak is usually sufficient.

15. **Water Inside the Radiator**—The wet or air pressure test is not infallible by any means. Sediment and lime deposits collect about leaky joints. This foreign matter is pressed into joints by air pressure sealing the leak when the radiator is tested. The leak at the joint of tubes and header is one that often refuses to show under air pressure.

For this reason it is important for the repair man to dry the radiator after he has finished repairing the leaks found by air pressure. When the radiator is thoroughly dry remove the plug from filler neck and fill with water, being careful not to run it over or spill on the outside. A good arrangement for holding the radiator in an upright position is illustrated at "D" in Fig. 42. This is a piece of three quarter inch gas pipe three and one-half feet long. This pipe is arranged to slide back out of way, flush with side of bench. The box used as a seat and radiator rest about the bench is set under the pipe parallel with it. By setting the radiator on this box and leaning it against the pipe both sides can be examined carefully for leaks. The bench light swings conveniently both to front and back of radiator. Place the hose from air line over lower end of overflow tube and hold palm of hand over filler neck. Allow a five pound pressure to pass in against the water. It is true that only occasionally a radiator will be found that leaks after a test with air. But those occasional leaks are the ones that spoil all that good advertising the repair man has spent hard cash for. The fact that there is a certain and almost infallible test to which one can work is the most satisfying thing about the business. There are so many repair jobs on a car that have no certain test. This has long made the car mechanic's life a nightmare. Full advantage of this certain test should be honestly taken.

16. **The Eye Test**—In the general run of work, progress can be made on many radiators by soldering all visible leaks before any test is made. Lime or magnesia deposit caused by the evaporation of water indicate these leaks. This deposit will often close a leak to air pressure which will show wet when the radiator is filled with water. The careful mechanic will repair any joint that appears to be the source of this deposit.

Often it will be necessary to estimate the cost of a repair before the radiator has been taken off the car. This can only be done by outward examination or by an eye test. This eye test or ability to calculate the number of leaks and condition of a radiator will come to the repair man by experience. Of one thing he may be certain and that is there are as many leaks as can be seen, and an estimate should be made based on there being more. It is difficult to judge the extent of an inside leak. Aside from the signal of deposit, effect of freezing, condition of shell and support, also the material from which the radiator is constructed will form the basis for this calculation.

In many instances soldering the leaks only partially finishes the repair of a radiator. Before a radiator is allowed to leave the shop, the support whether it be connected direct to the radiator or to the shell should be in condition to carry it properly. If the radiator is of the type which has shell soldered on, and the solder coming loose was primarily the cause of the leak, the shell should be resoldered. If the shell is bolted to the core channels, the channels should be soldered rigidly to the tanks and so strengthened or braced that they will not become loosened and allow the radiator to be worn or shaken to pieces. The connection for the tie rod, either to the top tank, the inlet connection or shell should be reinforced to withstand the thrust or pull at this point. The permanency of a repair reflects to the credit of the workman.

CHAPTER 7

THE SOLDERING IRON

WHILE this chapter is titled "The Soldering Iron" the methods of repair can be applied by the torch user. This is also true of the following chapter. The torch methods are in the main easily applied to the soldering iron method. Where there is a distinct difference in method, the work is explained in both chapters. Otherwise the mechanic may easily deduce the soldering iron methods from those explained under The Torch as well as soldering iron methods may be applied to the torch. Information placed in any certain chapter is not so placed because it is of value only to the method being discussed but may be applied by the reader. The mechanic using the soldering iron is advised to study the suggestions in other chapters.

Radiator repairing as practiced in the largest plants reveals nothing new to the average tinner doing general job work if we except one thing and that is radiator construction. Even this can not be said to be entirely new. However it is something that one taking up the work must learn. The repair work on radiators is a matter of good soldering, no more, no less.

Any radiator repair, can, and is being made with the soldering iron. The torch was not introduced into the radiator repair business to enable the workman to do the work, but to accomplish it in a fraction of the time required by the soldering iron. It is necessary when soldering with the iron to remove many parts in order to reach the joint to be soldered. These joints are accessible with the torch. This accounts for much of its popularity.

It is the purpose of this chapter to give the workman some hints and the beginner the knowledge and extent of equipment, its care and use. The soldering iron is not an iron but a copper bar with handle of steel and wood. For average radiator work the shop should be equipped with a pair of three pound irons, for general work; a pair of one and one-half pound irons for small work; and a pair of honey-comb cell irons for work inside the air cells. A hatchet iron or other special shapes come handy for some jobs.

In preparing these irons for use the three pound pair should be heated to a redness and hammered to a point tapering back about one-fourth the length of the copper. When the iron is being redressed see that all the old tinning is burned or filed off before hammering. If this solder is hammered into the iron it will make it hard and unfit for proper tinning. The iron is annealed after hammering by heating the copper red and plunging into cold water. This not only softens the copper for filing, but enables it to take tinning well and makes it give off heat better.

After hammering to shape all depressions are filed from the pointed end. Finishing down is done with a fine file effecting a flat smooth surface for the tinning. The better the iron is polished the longer the tinning will last.

After the iron is filed it is heated to a point that will just melt solder readily. This is the proper heat for tinning. Too hot an iron does not take tinning well or hold it long. The iron is tinned by rubbing each surface on a block of sal ammoniac applying solder to the iron at the same time.

The one and one-half pound pair should be treated the same, only that the points should be drawn out longer and one hooked at the very point in about a three-eighths inch circle. The cell irons should be pointed only enough) iter the honey comb cells, beir d at the

In using the iron it is necessary to clean the tinned point each time it is removed from the heater. The oxidation of the solder and the residue from the flux, picked up by previous soldering, coats the tinned surface of the point. This cleaning can be accomplished by dipping the point in a solution of sal ammoniac and water or in a solution of liquid flux and water. This dipping will cause the copper to pit just back of the tinning. If a clean white rag, kept soaked with water, is used to wipe the iron on when it is drawn from the fire, these pits will be prevented.

In order to give the workman an idea of the method of repair with the soldering iron, a number of jobs on different portions of the radiator will be discussed. The most important part of any repair made with the soldering iron is that the joint be perfectly cleaned. The contacting surfaces as well as the outer surface for iron contact should be tinned if possible.

Since the common paint burning blow torch is used by most all shops it will be included in this section. It is useful to remove parts and to preheat heavy parts for soldering with the iron. It is not absolutely necessary that a torch be used at all even in removing parts. In order that a part may be removed with the iron it is necessary that the outer surface about the joint to be parted, be tinned. This is done in order that the heat from the iron may be conducted to the metal from the iron. If the surface is not cleaned and tinned the dirt and oxide on the metal acts as an insulator. The heat from the soldering iron is not conducted readily, making it very difficult to melt the solder.

For instance, in removing an overflow tube, the tank at one side of the tube is cleaned and tinned. The hot iron heats the tank and by conduction the solder about the tube is melted. If a hose connection is to be removed the outer surface is cleaned and tinned in order to secure a close contact. The labor in this case is considerable but the operation is possible.

17. **Patching a Crack in Radiator Tank**—Vibration or other cause frequently cracks the metal of which the radiator is constructed. Solder webbed over such a crack will not make a satisfactory repair. It is always necessary to patch these leaks. If the metal has been cracked by the strain, solder alone should not be depended upon to make the repair.

The surface of tank should be scraped clean about the crack with scraper or wire brush. This cleaning should extend an inch if possible beyond the ends of the crack and at least one-half inch along each side. The V-shaped scraper should be used to clean the ragged edges down in the crack. Flux is then applied and the cleaned surface tinned. It is well to wipe the tinned surface with a clean rag while the solder is still molten.

A patch is cut to cover the crack. It should be one and one-half inches longer than the crack and wide enough to extend one-half inch each side. Soft brass should be used for patch work. The gauge should be as heavy, or better, a little heavier than the tank. The patch should be cut so that the grain of the brass will cross the crack when patch is in place. Brass is grained lengthwise of the original sheet. This patch is then tinned and stroke cleaned with a clean rag while hot. It is then fitted to the portion of the tank where the crack occurs. This fit should be as perfect as possible. Square bends should be avoided and the patch should lay tight without the necessity of springing into place while soldering. Rounded corners on a patch are the mark of a careful mechanic.

When a perfect fit is made, flux should be applied to each side of the patch and to the tinned portion of the tank. The patch is laid in place with the radiator in such position that the patch is level. The hot soldering iron with a small bit of solder is laid on the patch with as much of the tinned portion of the iron in contact with it as possible. The idea is to heat the patch and not to poke the solder under it. If the metal is hot the solder when applied will flow, filling the entire space between the patch and tank. The patch is held in place as the iron is moved about over it and only enough solder is applied to fill in between the two pieces of metal.

It is not necessary to touch the tank with the soldering iron. The patch should be held in place steadily with screw driver or other tool while the solder is freezing. If it is not held quietly until the solder sets the joint will be ruined. After the solder is cool any surplus lumps about the edges are smoothed off by a wiping motion of a real hot iron.

18. **Resoldering a Seam**—Radiator tanks are frequently made of pieces, lap seamed at bends. The seam, to be soldered well, should be cleaned inside. This is not so difficult as might appear. With wire brush, see Fig. 31, the dirt is removed from the surface along the seam. Flux is applied to the outer portion of the lap. A well heated iron is laid on this lap with a little solder applied to get a good contact for the heat. A piece of rusty sheet metal is then inserted in the joint and slipped along as the solder is melted by the hot iron. This resembles the process described in connection with Fig. 107. When the joint is loosened well beyond the ends of the leak the two edges of the metal are pried apart to expose the contacting surfaces. With V-shaped or pointed scraper, these inside surfaces are cleaned. After cleaning at least one surface should be tinned. This can be done by holding the iron on outside surface and applying flux and solder to the inside with the seam in

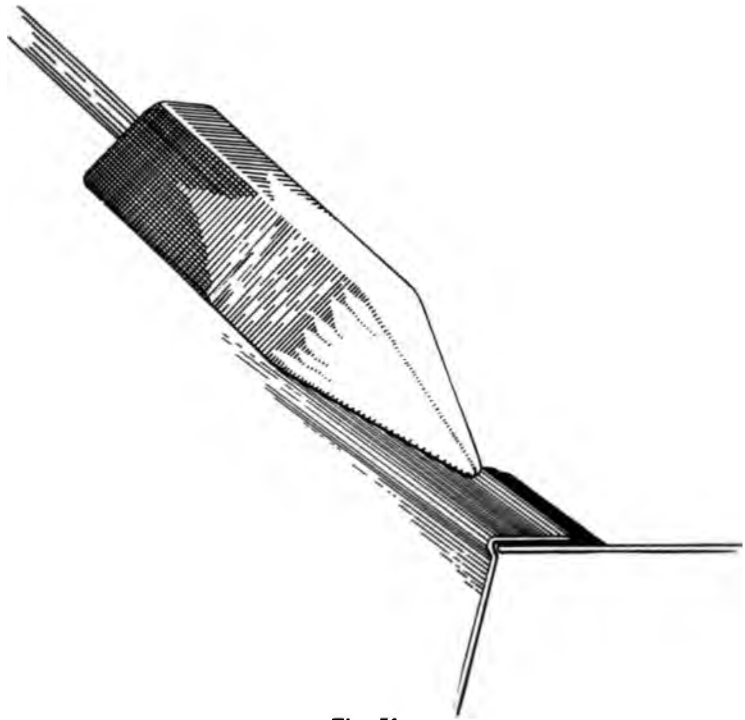

Fig. 51
The Soldering Iron Held Flat on the Seam

a nearly vertical position. Flux is applied to the inside of the seam before it is closed back to original position. The iron is then used to run a water tight seam, see Fig. 51 showing correct position of the iron on a seam.

19. **Resoldering a Fitting**—Quite frequently leaks occur where the solder filling about the hose connection is broken. The painter's blow torch can be used to remove the casting and the soldering iron for resoldering it.

If there is only a small leak the outer surface should be cleaned with scraper or wire brush. This surface should be tinned so far as this cleaning makes it possible. The [illegible]ting and tank [illegible]ould [illegible] cl[illegible]ed in the joint as [illegible] the V [illegible] d [illegible] ra[illegible] r [illegible] ll r [illegible] h, [illegible]d t[illegible] surface in[illegible] . [illegible] ld [illegible] n [illegible] surface is well tinned. Solder is then webbed over the joint. The repair will probably hold if the casting is well soldered at all other places.

20. **Resoldering a Tube Into the Header**—When the leak is located, place the radiator upside down if leak is at the top header or right side up if at bottom. The fins should be pried away from the header so that the small pointed soldering iron can be inserted around the tube. With the V-shaped end of the cell scraper clean the header and joint about the tube. A plain and hooked scraper may be used to clean the tube for a distance of about one-fourth of an inch from the joint. See that the seam in the tube is scraped out clean. A little acid soaked in and washed out before scraping will aid. Apply flux and tin the joint with a hot iron. If the tinning takes well down into the joint the soldering may be completed, if not continue the cleaning until it does.

21. **Repairing Leak Around a Stud**—Radiators which have stud bosses or nuts inside the bottom tank as in Fig. 52 have been a source of much trouble to the repair man. The weave of the frame or the thrust of the tie rod and engine hood loosens the solder between the nut and the inside of the tank. It is an expensive job to remove the bottom tank in order to reset these bosses. There is a very economical way to overcome the leak.

With the old studs as a pattern new ones are procured from a machinist. These are turned from a piece of shafting one inch or one and one-fourth inch in diameter. A washer or flange is left full size of the shafting near the lower end of the threads which screw into the boss inside the tank. This flange is tinned. If the bottom is cracked a heavy patch of tinned brass is placed on the tinned tank with a hole corresponding to the hole for the stud in the tank. Flux is applied

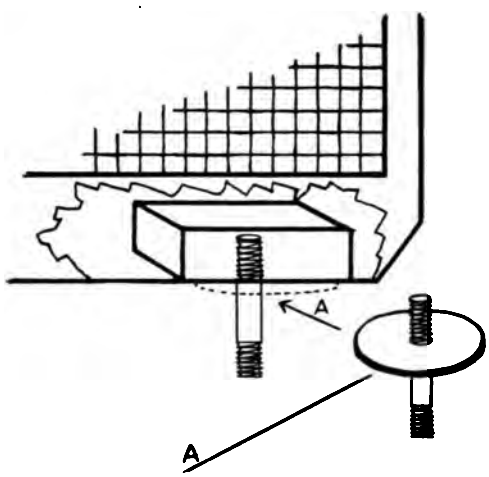

Fig. 52
Method of Repairing Stud

to all the contacting surfaces previously tinned and the stud screwed tight in the boss. The flange should draw the boss tight inside the tank. The blow torch is then applied to the bottom of tank and stud, until the tinned surface is hot enough to melt solder. The solder is then sweated in with a good hot iron.

There are a few cars fitted with this type of radiator that can not be repaired in this fashion. The crank seat from the motor extends thru a hole in the bottom tank and it is necessary to have the studs removed from the radiator in order that it can be slipped back on the frame cross member with the shaft projecting thru the hole. In this case the tank must be removed from the core and the repair made from the inside.

22. **Cutting a Tube Out of the Circulation**—Occasionally it is found necessary to block off a tube so that the water will be excluded from passage. This is not good practice but is more economical when repair bill is concerned. This work should be done neatly so that the appearance of the radiator is not marred.

Cut an oval piece from the side of the tube about one-fourth inch from each tank. Scrape the inside of the tube clean. If the seam is not cut, care must be taken to scrape deep enough in it that a good solder joint is obtained. Raw muriatic acid may be used to assist in the cleaning. If it is used it should be washed out well. Flux is applied to the inside of the tube. With the small pointed iron, block the ends of the tube next to the tanks. If no leak is found by testing, an iron just hot enough to melt the solder is used to fill the hole nicely to correspond to the shape of the tube. When the fins are straightened back and the tube is painted it is very difficult to detect the repair.

23. **Repairing Tubes Broken by Freezing**—The soldering iron is a very effective tool with which to solder

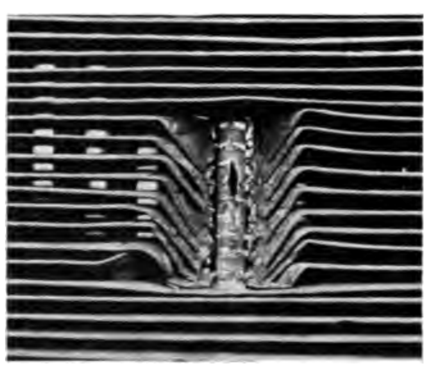

Fig. 53
Typical Freeze in Seamless Tube

leaks in a radiator having seamless tubes. In Fig. 53 the fins have been cut and bent back to show the typical leak in this style tube. It is not usually necessary that the fins be cut at all to effect this repair. It can be done with a long pointed iron after the fins are pried apart with screw driver as in Fig. 54. It is true that in some cases it is necessary to remove the fins. In soldering these leaks in seamless tubes the edges of the crack should be pressed back in place carefully so that the

Fig. 54
Prying Fins Apart to Repair Small Leaks

diameter of the tube is not changed. After cleaning solder is built over the crack. The fins are straightened and painted.

In the seamed tube core, the tubes open at the seams upon freezing. The repair is not difficult if there are only one or two tubes leaking and the seams are easily seen. The fins may be cut along the tube by using a

Fig. 55
Narrow False Fin

pair of sharp pointed snips. The ends of the fins are bent back as in Fig. 53. The seam is cleaned with acid and a scraper. This tube should be closed to as near the original diameter as possible after which the iron is used to solder the seam. After the radiator is tested and joint is found to be water tight the fins are straightened back into place and repaired by clamping over each

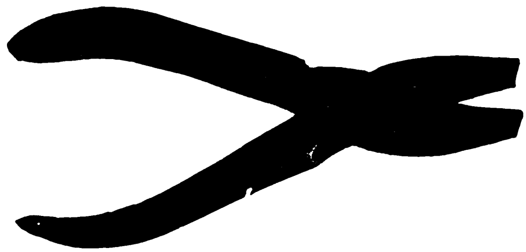

Fig. 56
Pricking Plier

projecting fin edge a fold of light brass or copper, as in Fig. 55. These folds are made from one-fourth inch metal ribbon cut in two and one-half inch lengths and folded lengthwise at the center. It is not necessary that they be soldered on. A pair of pliers with a small tooth in one jaw that enters a hole opposite in the other jaw, Fig. 56, may be used to perforate the fold and enclosed fin at each end of the repair. When the core is painted the work can not be detected easily.

There are however usually a number of frozen tubes. If these are not scattered over the core but bunched as in Fig. 57, the fins may be removed and the repair made. If it is necessary to remove a great many fins the job will be too expensive to do with the iron. Tearing out fins reduces the radiation of a core. It is not advisable to ruin the radiator in order that it may be made to hold water. The radiator must hold water in order that it may cool the engine, but a radiator mutilated so that it will not furnish the proper amount of radiation for the cooling of the engine is no better than one that fails to hold the water.

The fins should be removed carefully and by a strict system in order that the false fins may be placed to hide the amputation as cheaply as possible. The fins are always cut over the center of the tube. After determining the section to be cut out, clean the projecting edges

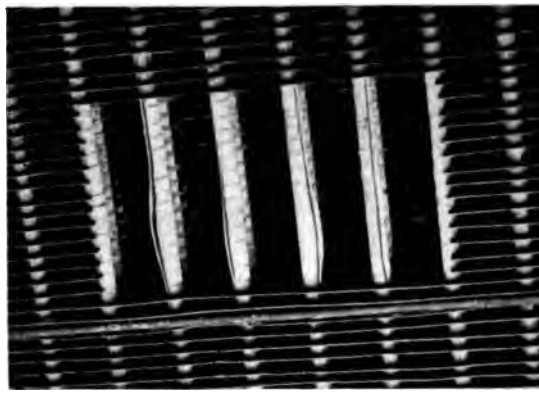

Fig. 57
Lock Seam Tubes Opened by Freezing

of the fins where they are to end after the hole is torn. In removing the fins as shown by this figure, each fin was cut in six places. The first cut was made over the row of tubes to one side of the frozen tubes, each fin was cut over each tube to the other end of the hole ending on the first good tube. This hole is to expose the two front tubes in four rows. The needle nose pliers are used to pull the fins. They are inserted straddling a fin to the depth of the desired hole along a row of tubes. The pliers are pried and twisted slightly to break the fin between the tubes in the row. The pliers are then slipped over against the adjacent row of tubes straddle the same fin. By twisting away from the tubes the fin is torn loose. Continue until the desired hole is torn. If the pliers are inserted too deeply the fin will be torn on the opposite face. The pliers should be twisted away from the tubes in order to avoid flattening them. The fins should be torn out well above and below the leak.

The leaks are repaired as stated before. In case the leak is on the back of the tube it will be necessary to use a small mirror, Fig. 58, to see the condition at this point. A hooked shaped scraper and the one and

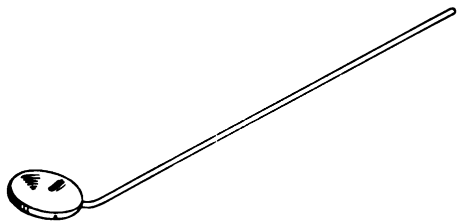

Fig. 58
Magnifying Mirror

one-half pound iron with hooked end is necessary to clean and solder the seam.

The dry or water pressure method is very practical in trying out the radiator when the soldering iron is used as a soldering tool. The flux should be wiped off before testing. For air pressure to be applied, a bicycle pump is sufficient. When the radiator is filled with water the hose from the pump is placed over the overflow tube and the pressure held by placing the palm of the hand over the filler neck. A small flashlight,

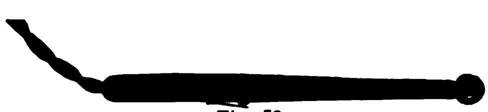

Fig. 59
Electric Flash Light

Fig. 59, inserted back in the torn out section is handy in locating any small leaks.

Before the last test the two center tubes in the cut-out section, Fig. 57, should be tinned along the front so that the false fins may be soldered to them.

Fig. 60

False Fin for Tubular Core

When the leaks are all stopped false fins should be soldered in place. These false fins are made either of roofing tin or brass. The tin fins if painted are good enough. They will rust very little unless the radiator leaks. In this case they will probably have to be re-

Fig. 61

First Cut on False Fin

moved to repair the leak and new ones can be installed as cheaply as the old ones can be put back. Fig. 60 is exact size of fin used on the Ford and many others.

Fig. 62

Second Cut on False Fin

The fins are prepared for filling the hole in Fig. 57, by cutting the fin along lines a-a in Fig. 61. This allows the fin to lap about one-fourth inch over the ends of the original fins. The second cut is made as B. B. in Fig. 62. This is done in order that a smooth joint may be made when the fold on the false fin is straddled over the fins on the radiator. A sharp bladed scraper is inserted in the fold at each end of false fin after the cut B. B. is made. The folded edge of the false fin is placed down and the fold straddled over the ends of the original fin. This fold is pinched flat and while holding the false fin back against the tubes it is tacked to the two center tubes which have been tinned. The ends of the fins are soldered with a sliding motion of the soldering iron. This wipes the surplus solder out along the fin and does not leave a lump where the joint is made. When the false fins are all in place the core should be painted.

When only a short length of fin is used it is not necessary to tack it to the tubes. When longer strips are used it is necessary to tack with solder to about every third tube. These tubes are selected and tinned before the fins are put in place. When the hole extends to the edge of the core, the fin is cut square at the end to correspond with the original fins and tacked to the last tube at the outer end, and to the fin at the other.

24. **Resoldering Face Seam in Honey Comb Core**—The leaks resulting from poorly soldered water tube seams in the face of the honey comb core can be repaired satisfactorily with the iron. Careful cleaning must be done preparatory to the soldering with the iron, that a good job may be accomplished. This leak is discussed in chapter on The Torch in connection with Figs. 103 and 104. It will be of advantage to the repair man using the iron to read this method. Some pointers may be gained.

These leaks usually occur where the laterals (crosswise) fins meet the water tube. The outside of the water tube and these extending laterals where the leak occurs should be cleaned and tinned. With the point of the small iron in the cell against the water tube the sea may be opened by using a sharp pointed scratcher awl. The opening should be extended until a good sold joint is found. With these edges pried apart they shou be scraped bright and tinned. This work must be do carefully as the ribbon of metal is very thin. The open seam is closed after cleaning and tinning as in Fig. 1(Flux is then applied and the seam filled with sold The solder will usually bubble in this seam. If it dc the iron is held on the face of the seam until the mo ture is dried out and the bubbling cases. The sold will be seen to flow down into the seam. It is well web solder over the corners where water tubes and l erals meet. This operation is slow, but effective.

25. **Repairing a Puncture in Tube Wall**—If a le is found back in the air cell whether it be from a cra or puncture it will be necessary that a cell iron, Fig. (

Fig. 63
Cell Soldering Iron

be used. Since it is difficult to tin the metal after clea ing with acid it is more practical to use a small wi scraper, Fig. 64, for cleaning about the leak. The ı diator should be propped upon the bench so that sold will flow over the leak. The small flashlight, Fig. ! held at the back of the core will be useful if electı lights are not available. When the metal is clean flı may be applied with round swab or a small rag twist on a wire.

The cell iron is necessarily very small and shou be used rapidly or it will freeze fast in the cell. In ca this happens it can be removed by ap ying the bl torch to the projecting portion of the i ı about one in rom the core. The flame should be held parallel with he face of the core to avoid melting the solder on the ace. It is convenient to hold the torch in this position o heat the iron. By drawing the iron outward to heat, he work can be rapidly done.

Fig. 64
Wire Cell Scraper

A drop of solder is placed in the cell near the leak ınd the hot cell iron pushed against it to tin the metal. The iron is withdrawn reheated and inserted again. Solder is added as needed to build over the leak. Wire solder may be inserted against the point of the iron from the back of the cell or pellets previously prepared may be used. This work is not at all difficult if ordinary care is exercised.

26. **Resoldering the Header Strip to Honey Comb Core**—When a leak occurs at the joint between the tank ınd the header of the honey comb core the lime deposit ınd paint should be removed with a scraper, or better ı wire brush. The surface of the tank should be clean enough to tin. Flux is then applied and the radiator slanted on the bench so that the solder will run from he seam. A hot iron with a little solder is applied and he surplus solder run from about the leaking joint. The ank and core are then separated in order that the contact may be cleaned and tinned. This may be done by pressing the tank inward to expose the header, and later by pulling the break on the tank outward to tin the surface which bears upon the core. In some cases the break on the tank extends outward and may be bent away from the core to admit the sharp pointed scraper. A stiff swab or brush with muriatic acid will assist

greatly in the cleaning. If the joint cannot be parted for tinning each surface separately, it should be pried apart sufficient for cleaning and soldered open in that position. If the parts can be tinned successfully the tank should be restored to its original position and sweat soldered. The iron being applied to the tank and the soldering accomplished by the conduction of the heat thru the solder to the core.

27. **Removing and Replacing the Bottom Tank Header, Ford Radiator**—The assertion that the repair of radiators can be and is being accomplished by the soldering iron method may be illustrated by comparing the two on one single job. The description of this job will be found in Chapter 8, under same heading.

As stated, the painter's common blow torch is included in the equipment of almost all tin shops or garages. If it is not, no repair man doing any small amount of radiator work can well be without one. Its cost can be earned very shortly by the time saved. Gasoline for fuel is procurable everywhere. A good torch should be purchased and the manufacturers' directions carefully observed. This is mentioned because of the fact that blow torches today are being made to burn the automobile gasoline and are operated slightly different from the old ones. Years ago gasoline was made for stoves. Today it is made for motors. A good torch will operate on this gas if one is purchased and directions are followed.

The repair man using the soldering iron will use a blow torch to remove the bottom tank and header as referred to in Chapter 8. The surplus solder is removed from the tube ends with the same torch. It will be best to turn the flame low to do this.

The tube ends are then cleaned with acid as in the torch method. After thorough washing, the tube ends

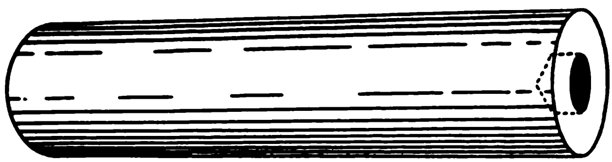

Fig. 65
Tube Bucker

hould be cleaned with a wire brush. Flux is applied nd a drop of solder on the point of the iron is applied o the tube. By moving the iron around the tube it is inned. After careful tinning the radiator is stood bot-om up and the tubes heated with the blow torch to run ny surplus solder down. The tube bucker, Fig. 65, is ised to cup the ends of the tubes so that the header rill slip on easily. This bucker is made by drilling a 7/64 inch hole one-fourth inch deep in the end of a ive-eighths inch rod. The tapered end of this hole will up the end of the tube when the bucker is placed over and struck a light blow with the hammer. The tubes iould be lined up so they will meet the holes in the eader. The header is slipped on the tubes in position ie and seven-eighths inches from the cross bar. The eader is then wet with flux and the tubes soldered. y placing the iron against one side of the protruding ibe and applying wire solder to the other side a good iint can be run. The remainder of the operation is ery simple. The joints on the bottom tank should be nned before it is put in place.

The time consumed by the use of the soldering iron ill be little different from that required by the torch iethod. It is all a matter of good soldering. The most revalent mistake of the mechanic using the iron is the nission of tinning the joint before assembling the part. ; will be stated again "always tin," and to tin a part is necessary that it be "properly cleaned."

Beginners at repairing will attempt to make a repair without removing a part, while less time would have been required in removing, cleaning tinning and resetting. After learning that a radiator can be taken to pieces they have a mania for tearing them up. Many at first do a great deal of unnecessary work when they get to this state of learning. Judgment, it seems, can only be the result of experience. No amount of advice will enable a man to know just when a part should be removed and replaced and when a good repair can be accomplished with all parts in place.

28. **Soldering Gasoline Tanks**--The reputation of an expert solderer is always gained by the successful radiator repair man. A variety of repair jobs will be brought in the shop. The repair of gasoline tanks for cars are much a part of the radiator man's business. The repair of these tanks is a soldering iron job. It is true that the torch may be used but the danger of an explosion, possibly not serious to the workman, but damaging to the tank, makes it inadvisable. The soldering iron is safe and fast enough if skillfully used.

If there are leaks about fittings they should be removed, the joint tinned, the casting bolted in place and resoldered the same as is advised concerning radiator fittings.

Testing is accomplished by the wet or air pressure method used on radiators. Some tanks will stand considerable pressure. Others should be carefully handled. If the ends are flat three to four pounds should not be exceeded. If air pressure is not available by any other means a bicycle pump will supply the need. A little gasoline in the tank run about the seams will show moist on the outside where leaking.

CHAPTER 8

THE TORCH

THE rapidity with which repair work can be accomplished with the torch over the soldering iron gives it first place as a soldering tool. For this reason serious consideration should be given the selection of a torch.

Some of the requirements of a proper torch are: long slim needle like flame capable of reaching out of way places, a flame that will burn in a corner or cavity without scattering or going out, a flame that will not be extinguished by the fumes of the flux and acid, an adjustable flame suitable for working among the fins and in the cell of the honey comb as well as for heavier work of disassembling, a flame giving sufficient heat to accomplish the soldering quickly yet not hot enough to destroy the metal being soldered.

There are several gases available for the production of this flame. In fact there is no locality so lacking in facilities that a satisfactory torch can not be operated. Any of the types of torch adaptable to this work require a supply of air or other gas under pressure to support the combustion of the inflammable gas used. Some torches require more air pressure than others. The required pressure ranges from two to about ten or twelve pounds.

Natural gas varies so much in different gas fields, little effort has been made to manufacture a torch to burn this gas. It is necessary that the torch be modeled for the inflammable properties of the gas in each certain locality. Unless one understands these requirements it is difficult to construct such a torch.

City or artificial gas is more uniform. Concentrated flame torches burn this gas successfully. The flame can be adjusted from a pointed flame as in Fig. 66 to a brush flame in Fig. 67. The degree of heat is about the same as produced by a blue gasoline flame.

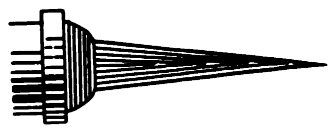

Fig. 66

Needle Flame Produced by City Gas and Air

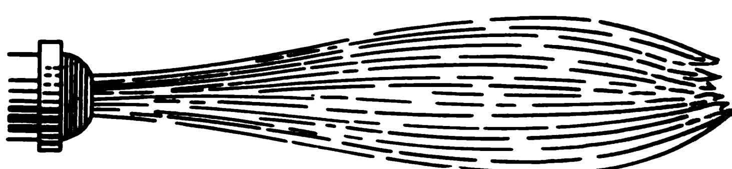

Fig. 67

Brush Flame Produced by City Gas and Air

Fig. 68

Needle Flame Produced by Acetylene and Air

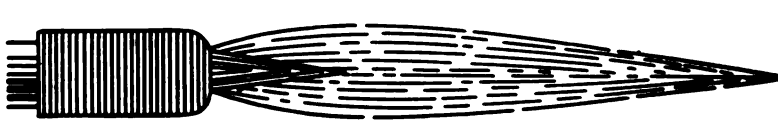

Fig. 69

Brush Flame Produced by Acetylene and Air

Acetylene is used with air or oxygen to support combustion. The acetylene and air torch produces a satisfactory flame. The needle flame is illustrated in Fig. 68.

Its length can be varied to suit conditions. The brush flame is shown by Fig. 69. Work in the cell of a honey

Fig. 70
Needle Flame Produced by Gasoline with Air

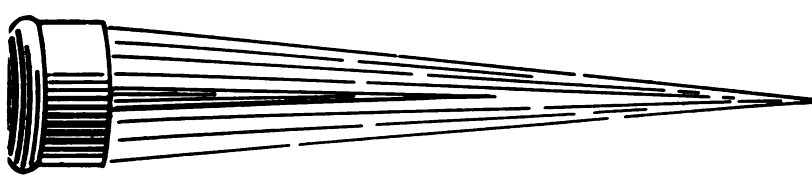

Fig. 71
Brush Flame Produced by Gasoline with Air

comb core is accomplished with difficulty, because of its intense heat at the base of the flame and its tendency to spread when introduced into the cell.

The acetylene and oxygen torch is not well adapted to radiator work. The flame is extremely hot and is not adjustable for the scope of work. In shape the flame is about the same as Fig. 69. This can be varied in size but is too brushy for small places.

Hydrogen with air under pressure to support combustion produces a flame very similar to the city gas torch. The needle flame can be adjusted to a sufficient degree to make the torch adaptable to almost any radiator work. Where hydrogen is procurable it makes a very satisfactory flame.

The gasoline torch, operated with air under pressure passed through gasoline, has a wide range of adjustment. The needle flame illustrated in Fig. 70 can be produced in lengths, varying from one to four inches. It is also capable of wide variance in the brush flame illustrated in Fig. 71.

The gas for this torch is produced by a generator that requires no heat. The air used to support the combustion is forced thru the generator where sufficient gasoline is evaporated to produce the desired flame. This torch has been used by dentists and jewelers for a number of years. Expense of operation is very small.

The wide range of adjustment makes this torch particularly adaptable to honey comb work. Inside leaks can be soldered without damaging the face seams. Two opposite leaks in the same air cell can be repaired successfully when proper adjustment of the flame is made.

The torch in radiator repairing is a left hand tool. The flame is held still on the joint while the right hand is free to perform the rest of the operation. The torch should be held at such an angle that the flame will strike the metal at right angles in order to get the most heat. In running a seam with a torch, solder with or rather in the direction of the flame. In Fig. 77 the tubes are soldered beginning at the left, and the rest of row in order. The reason for this is that the flame preheats the metal to be soldered and allows the soldered part of the joint to cool undisturbed.

In the following paragraphs a number of special repair jobs will be explained. This should give the beginner an idea of methods of repairing the different types of leaks in radiators. It is not the intent to give the reader the idea that these are the only methods nor that these are the only leaks the radiator is heir to, but these examples will merely form a foundation for the experience that is coming to anyone who takes up radiator repairing. If the workman can not apply former experience to present problms, he will never make a repair man. While these suggestions are made with the torch in mind, much of this information is useful when the iron is used.

29. **Removing and Replacing Overflow Tubes**—If the overflow leaks at the joint where soldered in tank, the best method of repair is to remove the tube, that the joint may be well cleaned. To remove, apply the needle pointed flame to the tube near the tank, reaching down thru filler neck push the tube outward. This will avoid breaking as would probably result from pulling on the outer end. After the tube has moved out past the tinned portion it can be extracted without further heat. After cleaning and tinning the tube and tank where the joint is made, insert the tube and resolder. It requires considerable care to resolder properly with the torch. If too much heat is applied the solder will spread and flow away from the joint. Play the flame on joint and apply flux. Touch the tube with solder and heat only until the solder runs well. Remove torch quickly. The flame and solder should be applied to the tube, the solder is then flowed down to the joint. Be sure the tank is heated sufficiently that the solder is flowed into the joint. It is this solder that makes the strength. Resolder the lower end of overflow securely to bottom tank and core channels, using clips over the tube where possible.

30. **Removing and Replacing Filler Neck on Ford Radiator**—The filler necks in the 1917 and later models are peened on a collar to top of tank. To remove a damaged neck, heat at the center between bottom and top. When the brass is real hot, hit the hottest portion with the hammer. The brass made rotten by heating

will cave in. Continue to heat and break until only the bottom ring it left. Remove this by heating and breaking with pliers so that it can be peeled from collar. Brush all solder from collar on tank and retin the contacting portion. When the collar is cooled it can be bent up so that the new neck will slip over it. The collar can then be bent back down to hold the neck. Flux the joint well both inside and out. Hold flame on joint outside and apply wire solder inside flowing the joint well.

In case the collar on tank is broken off or tank cracked about this joint a neck with flat outward flange

Fig. 72
Filler Neck with Outer Flange

as illustrated by Fig. 72 can be used to advantage. The regular Ford shell should be slipped over the loose neck and radiator as a guide for proper placing. When the shell is in proper place the neck is soldered fast by directing torch flame on the joint inside the neck.

This method of placing the neck can be used to advantage on any radiator such as Buick, Overland or others that have similar filler neck trouble.

31. **Removing and Replacing Tank Support on Ford Radiator**—Very often leaks occur underneath the tank support on the Ford radiator. The later models of radiator have spot welded joints where the support is attached to bar. These can be broken with chisel by driving it between the two. Should this joint be soldered, melt the solder with torch and i[illegible]rt a piece of black iron between them, to [illegible] nt without

springing the support. The end of rivet should be sawed off outside the support. Heat the support where it is soldered to tank. Turn it sideways on rivet. Do not pry as the hot tank will be easily broken by the rivet head. Run all the surplus solder off. Keep the support moving after removing the flame so the solder will not set. When parts are cooled, it can be slipped off the rivet. It should not be replaced until all leaks that were underneath it are repaired. The best plan is to continue with repair of the entire radiator and replace the tank support just before the final test.

After the leaks are repaired, heat the rivet remaining in bottom tank and tapping lightly, allow it to fall back in tank. Clean and tin bottom of tank at end also the end of bar where the support solders. The old support can be used if it is not broken. It must be retinned. New supports are so cheap it is more expensive to use old supports than to use new ones. A small piece of tinned brass should be soldered over the rivet hole in tank bottom. See that the tank support fits so that it rests on the bar also flatly on bottom tank back squarely against the end of tank.

This support should fit well at all points. The durability of the whole job depends on keeping the radiator where it belongs. When this fit is attained, flux the contacting surfaces, place the support in position and "sweat solder" the joints.

32. **Support of Overland Four**—On the Overland Four radiator, the support consists of a channel iron fitting the bottom of the tank and extending step shaped at each end to bolt on chassis. Quite frequently the solder holding this support becomes broken. Replacing this is good practice in "sweat soldering." Remove the support from tank, clean and retin it, also bottom of tank.

The best method of retinning the support is accomplished as follows: Remove all the rough solder with torch. Scrape the surface with scraper or wire brush to remove all the scale possible. Heat the support and plunge into acid. Allow it to remain in the acid until it has a gray appearance, when it should be washed and retinned. The entire surface should be coated with solder to prevent rust after this pickling. The torch can be used to heat the part for tinning. A better method is to use the solder bath, Fig. 37, mentioned in Chapter 5. While the support is still hot, place it in position on the bottom tank, having fluxed that part thoroughly. With only slight assistance of the torch the support can be sweat soldered firmly to bottom tank. This makes a repair that will resist all kinds of rough usage.

33. **Tie-Rod Bracket on Ford Radiator**—The threads in tie-rod bracket, Fig. 73, become damaged and necessitate renewing the casting. This bracket is riveted with

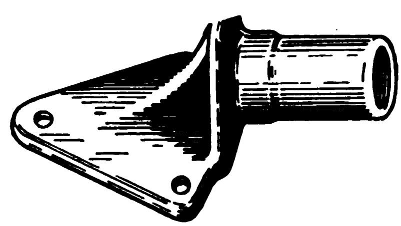

Fig. 73
Tie Rod Bracket

three rivets to top of top tank. Shear off these rivets with chisel and drive them back into top tank. With torch remove washer around the projecting portion of bracket. Heat the top of tank where the bracket was riveted. Allow the old casting to fall back in tank to be removed thru the filler neck. See that the back of tank is well tinned where the washer rests. Also clean and tin inside of top tank where the old casting was riveted. This can be accomplished through the hole in back of tank. The

Fig. 74
Replacing Tie Rod Bracket

new casting should have a fresh coat of tinning. Solder brass nuts on the under side of the new bracket so that brass bolts can be inserted through the holes into the nuts. Solder a short length of wire or wire solder to the bracket as illustrated in Fig. 74. Thread the wire in through the filler neck and out the hole in back tank. Insert the brass bolts through the rivet holes in top tank and screw up firmly. Replace the washer and resolder the part securely. Notice there is a hole in the top tank for soldering the bolted portion of bracket. This method can be used to renew or replace parts on other radiators, gasoline tanks, etc.

34. **Capping Rivet in Tie-Rod Bracket**—A frequent leak in Ford radiators is found about the rivet heads which fasten this tie-rod bracket. To repair, clean and

tin about the leaking rivet. With a one-half inch hollow punch, make a cupped disc of tinned brass. Place this cap over the rivet head and solder. The vibration and strain is then taken by rivet and the cap prevents leaking. This typical repair can be used to advantage on gasoline tanks where splashers are riveted through sides of tank and in many other places.

35. **Removing and Replacing Hose Connection**—It is not advisable to attempt to clean and resolder a hose

Fig. 75
Removing Hose Connection

connection that has been leaking for a considerable length of time without removing it. It can be removed, retinned and replaced in such a small space of time and

Fig. 76
Bolting on a Hose Connection

the strength of the joint is so much improved that it is usually advisable. The rivets are sheared off with the chisel flush with the surface of the casting. They are then driven back into the tank and shaken out thru the hose connection. The radiator is then placed on side so the solder will flow from the joint. The hose connection is heated and jarred with the hammer as in Fig. 75. The vibration prevents the solder from setting as the flame is moved around the joint. After the fitting has been removed the contacting surfaces should be tinned.

In order to replace the casting properly it should be secured by brass bolts to the tank. The brass nuts where unable to reach by other means are solder tacked on narrow strips of galvanized iron. This is illustrated in Fig. 76. The galvanized iron strips are bent so the

pistol cleaner can be used to advantage for this. This acid should be washed off with hose. If this cleaning has not removed all the lime deposit and dirt, apply acid a second time. Time spent cleaning will be repaid when the soldering operation is being done.

To solder, begin with tubes across end at the left. Heat the joints and apply flux with brush or preferably with flux squirter. Apply only a very little solder to tin the joint. While solder is molten, scratch around the joint with V-shaped scraper until the solder flows down into the joint. Build solder around the tube slightly, see Fig. 77. To do this, hold the flame up on the tube about three-eighths of an inch above the joint. Apply solder to the tube and run it down to joint by moving flame downward. When the solder unites with the tank below, remove the torch quickly. Considerable practice will be required to get a good smooth joint. Flux must be applied frequently and the flame moved off at just the proper instant. The flux will serve to cool the joint suddenly when too much heat is applied.

The tubes at the left are soldered first and others across the radiator in order. The flame being directed to the right preheats the tubes, and does not disturb the previously made solder joints. It is only necessary to direct the heat against the front half of the tube and the projection of the header. If the flame is moved to the back of the tube the joint of the second tube will be disturbed. Work in direction of flame.

37. **Replacing and Anchoring Top Tank Braces on Ford**—It is well to know the cause of these frequent leaks at joint of tubes and top header. In the first place, the method of constructing the core, as has been explained, is by assembling the tubes, fins and headers with a washer of solder around every tube above each header. This core assembly is soldered by placing it in an oven

Fig. 78
Resoldering Tubes in Top Header

whose heat is regulated automatically at the melting point of solder. The end tubes and front tubes in each row are at a disadvantage since the break for ends and front allow only a small amount of solder to be assembled at these points. Therefore a weak joint results.

In the second place, the top tank braces are not soldered rigidly to core as was the case in the first '17 models, see Fig. 78. This model with short braces soldered to the fins at the back of core gives little trouble. The long braces of later models reaching down to the bar support are only tacked in the center. This solder breaks loose and the vibration of the side brace throws all the strain on the tubes. The result is that the tubes across the ends work loose, then the tubes across the front. A little more care in soldering these top tank braces will relieve the tubes of the strain and make the repair permanent. In preparing the side for replacing, clean and tin a strip down the inside of the brace where the fins meet it at the back near the top tank. The ends of the fins should also be cleaned. See that side fits

Fig. 79

Top Tank Brace Anchored to the Fins

sely at both ends and along the core. Resolder the ds, then with radiator on block as in Fig. 79 solder e fin ends securely to the brace for a distance of about : inches.

This illustration of method with a little variance, plies to radiators other than Ford. The Oakland and axwell have similar trouble. The principle is to make e tank brace or core channel perform the function for iich it is intended. However it does not apply to honey mb radiators. The core channel in this case should be gid enough to hold with no soldering to core.

38. **Repairing Cracked Header on Ford, Maxwell, kland, Etc.**—The header of the bottom tank frequent- cracks. The Ford will be used as an illustration. This ack is hard to detect. It occurs at the base of collar awn around the holes in the header, Fig. 80, also fre- ently around the overflow tube hole.

Fig. 80
Where Header Usually Cracks

Place radiator on side and remove all the solder possible with torch and scraper. With sharp point of scratcher examine the header for cracks. Some times these cracks extend between tubes particularly across the ends. If crack is found, a patch will be necessary. No amount of piled solder will hold very long.

These patches should be made of brass not lighter than twenty-four gauge, twenty-two is better. Cut a piece ⅝ wide and long enough to reach one-half inch beyond the tubes at each end of leaking portion. Lay

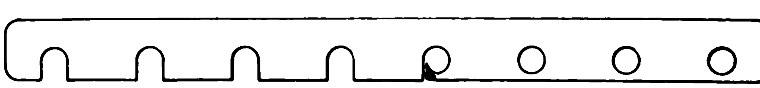

Fig. 81
Repair Strip for Cracked Header

off and punch one-fourth inch holes on one inch centers back about one-sixteenth of an inch from one edge. See Fig. 81. With snips cut to slot these holes back as illustrated. Tin the patch on both sides also the header and tubes about the leaks. Insert patch and hold down with screw driver tacking with solder tween each

Fig. 82
Header Patch in Place

row of tubes, see Fig. 82. With hammer, bend down the extending edge and sweat solder the patch resoldering tube joints as advised in "Resoldering Tubes in Top Tank." It is well to keep a stock of ready tinned patches to use in a hurry as this is primarily a hurry up job.

39. **Removing and Renewing Bottom Tank Header**—It is much better to remove and replace with new header than to try to remedy the leak by patching. If the header is weak enough to crack, the same thing will occur at a different place. Frequently, however, a job must be gotten out in a certain length of time and the method that will produce the desired result in the least time possible should be used.

The removal of the header necessitates the removal of the bottom tank. The tank supports should be removed as advised in paragraph on that subject. Loosen the overflow tube and bend away slightly. Stand radiator on side and apply flame to seams along the tank. Brush away the solder with whisk broom as it runs from seams. After removing this surplus solder, with hose connection projecting toward the right hand, apply

Fig. 83
Removing the Bottom Tank

flame to seam at top end of tank. Move the torch around toward the hose connection. When this portion is hot enough to flow the solder, tap on projecting hose connection with hammer as illustrated in Fig. 83. This vibration should be continued until the solder is loosened down both sides. A little practice will make the workman very proficient in judging when the part is loose. The jar on the hose connection prevents the solder from resetting to tank and header. When a point well down on each side is reached and the bottom begins to leave the header at the top, the hose connection l be seized

Fig. 84
Driving Header From the Tubes

with the pliers and by continuing the shaking movement the remainder of the tank can be removed easily.

To remove the header, lay the radiator face down on bench with header projecting over edge. If a helper is not available, place torch on a box so the flame plays on the header at one end. A painter's common blow torch is handy for this. Any brush flame torch however is satisfactory. Insert a screw driver downward between the first and second row of tubes. When the solder melts, drive the header off the tubes back past the torch. Slide the radiator sideways thus heating another section of the header, see Fig. 84. Continue this operation until header has been removed. The work must necessarily be done rapidly as the end of tubes will be burned by high heat of the flame.

After removing the header, stand radiator on side, melt and brush all the remaining solder from the tube ends. A small lead lined vat just large enough to take the end of core is handy to clean these tubes. Pour in enough acid to reach up to the fins. Allow the radiator to stand in this acid until tubes are clean. A quarter to one-half hour is usually sufficient. This depends on the strength of the acid.

After cleaning stand the radiator on side with tubes projecting toward the workman. Beginning at the top, tin the top side of tubes using the flux swab and wire solder, heating the tubes in succession in direction of the flame. When the top half of the tubes are tinned, turn the radiator over and repeat the process. When this is finished, the radiator is stood neck down on a box or rest arranged on bench. Heat the tubes so that the surplus solder runs down on the fin. With tube bucker, Fig. 65, cup the ends of the tubes so that header will slip on. See that tubes line up and are round. Place new header on tubes. Allow the tubes to be driven well thru the header. The proper position of the header is one and seven-eighths inches from the bar. See that it squares up well both ways, wipe well with flux and anchor by soldering an occasional tube. Begin at tubes to left working to right. It is not necessary to build the solder high about each tube, but just enough to seal the joint. Be careful not to heat the header too hot as the solder will flow thru. A good needle point flame is best for this work.

When the soldering is done, wash the header and examine the work for imperfect joints, which can easily be seen in the bright solder. If none are found the tank may be replaced.

Examine the hose connection and see that it is in good shape. Frequently it will be found best to renew this part, or at least, resolder the old one. Care should be taken to see that the upper side of this connection will solder when replaced. Retin edges of bottom tank and

Fig. 85
Removing the Front Wall

fit it in header. The soldering iron is particularly good to solder this, but the torch is as rapid. Flux joints well. Hold the torch so that the flame meets the metal squarely. Flow solder well into the joint. Be careful that the flame is not held long enough in one place to melt the solder about the tubes in header.

40. **Resetting Top Tank, Ford Radiator**—Occasionally a '17 Ford radiator will be found in which most, if not all, the tubes in top tank header are loose. These radiators are not hard to identify. The top tank supports are loose and the tank can be moved on the tubes by laying the radiator face down on bench and shaking the tank by holding the filler neck. In this case the best

Fig. 86
Removing the Top Tank

repair is to remove the top tank from the core. It can be removed and replaced as quickly as the tubes can be cleaned and resoldered with only the removal of the front wall. In fact the repair man is only doing a half job who attempts to resolder the tubes without removing the header, cleaning and tinning the joint and reassembling the radiator. Resoldering the tubes in the top header with the removal of the front only, is sometimes called "floating the head." Some radiators can be "floated" quickly while others are hard to clean and require much time. The only practical method is to remove the header if resoldering is necessary. The time consumed is the same on each and every job.

Fig. 87
Resoldering the Top Header

The top tank braces are probably off this radiator if not remove them. To remove the front, run the solder as in removing the bottom. Stand radiator on side beginning at the top, heat the seam and using the screw driver, tap lightly against the edge, see Fig. 85. Keep the front wall vibrating as the torch is moved down toward the filler neck. When the top seam is loosened for some distance insert the screw driver blade carefully between the tank and the front wall. With a twisting motion keep up the vibration. Don't pry. The front wall is probably brass and will break easily when hot. Vibration is all that is necessary. When the top seam is loosened, move torch to lower seam. Beginning at the top, run the solder down continuing the vibration by twisting the screw driver between parts near the filler neck. When the front seam is loosened to a point near the lower end, the screw driver should be replaced with the pliers that the front wall may be held and removed carefully to avoid allowing it to fall and break the edges.

Hang the radiator on side of water tank as Fig. 86. Apply torch to the tubes projecting thru the header. At the same time, tap on bar with hammer, utilizing the vibration principle again. A helper comes in handy for this operation as two hammers can be used, altho one man can manipulate it very well. Considerable heat is necessary, but not enough to run the solder from seams about the back of tank. To avoid this wrap water soaked rags on the seams at back of tank. Vibration will have a tendency to cause the radiator to slip out from the tank. This may cause the tubes to bind as they slip from the header. The core should be kept flat back against the tank. A box placed on the floor under the radiator will be of assistance in preventing the loosened side from dropping down far enough to bind the last rows of tubes as they are pulled from the holes. Rapid work is necessary in this case, so time consumed is very small.

Prepare the tubes as in replacing bottom header. Place the top tank in acid vat after surplus solder is removed. Retin the header. Examine the hose connection and replace if necessary, or if cracks occur in top tank patch on the inside.

In replacing the tank, use top tank supports as a gauge for proper position. Anchor in place by soldering an occasional tube. Resolder the tubes as in Fig. 87, beginning at the left work back and to the right, one row at a time. It is convenient to bend the front brake on top header out during this operation. When the tubes are all soldered, see that no solder is piled out in this edge. If so, run it back to tubes.

Fig. 88
Soldering Front in Top Tank

To replace front wall, having tinned the contacting surfaces, insert the part back of break on header. The break on front wall over the top is set back to take the edge of top tank. This groove should be free from lumps of solder. See that top tank is not bent out of shape. By spanning across the top from front to back, the wall can be held in proper position. A piece of one-eighth inch strap iron bent square at each end just long enough to reach from back to front will hold the wall in position. Tack the wall to the tank with solder in several places. The lower seam can be held in position for soldering by using a piece of bar solder, butt-soldered to front wall as in Fig. 88, or a piece of one-quarter inch gas pipe bent and inserted thru filler neck or hose connection, to hold the wall out. When front is tacked well in place, run water tight seams. Replace the top tank braces and anchor securely to the core.

41. **Frozen Tubes**—The most grevious job on any tubular radiator is the repair of frozen tubes. This job is however much more successfully accomplished with

the torch than with the soldering iron, particularly in case of seamed tubes. These frost broken tubes are easily detected, see Fig. 57, with fins torn out to expose these tubes.

42. **Soldering Frost Broken Tubes with Small Flame Torch**—In case there are only a few of the tubes leaking, the radiator may be repaired by cleaning and repairing each frozen tube separately. The workman may see traces of "dope" or the owner may acknowledge he has used one of the thousand and one sure cures of leaking radiators. In this case it is better that the entire radiator be cleaned. Everyone who attempts to repair will have the misfortune to misjudge the extent of leaks. It is wise to expect the worst.

Leaking frozen tubes may be repaired without removing or disturbing the fins. Test the radiator and mark the leaks. Use some method of marking that will tell the location of the leak. The match method suggested is good. Stand radiator on side. With round acid swab and raw acid scrub the opened seam until clean. The tubes are usually copper therefore it is advisable to heat the tube to boil the acid as explained in cleaning copper. If the seam in tube is in position to be seen, continue cleaning until the acid does not boil in seam when tube is cool.

The seam should be closed back to as near original shape as possible. A tube-closer illustrated in Fig. 89 will be necessary. This tool is ten inches long, made of one-eighth by one inch band iron such as is used to bind bundles of sheet iron. The hook on end is bent on three-eighths inch circle. If possible, place tool between fins on seam so that the outer lap of the seam will be drawn against the other. With hammer tap the tool on convenient shoulder or end as case may be at same time pulling or pushing on closing tool so that t seam will

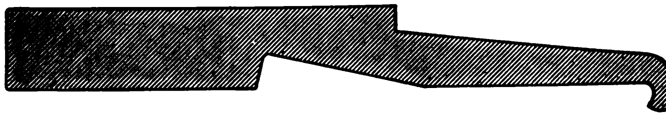

Fig. 89

A Tube Closing Tool

Fig. 90

Closing the Seams on Front of Tubes

be drawn together. In Figs. 90 and 91 the tube-closer is shown closing tubes, the fins having been removed to illustrate clearly.

To solder, heat with a good strong concentrated flame. If the tube is well back, the air should be turned on strong enough to force the flame back between the fins to the tube. Move the flame along the tube to avoid over heating the fins. When tube is hot apply flux and solder to the seam. The flux may be applied with round

Fig. 91
Drawing Lap to Original Position

acid swab, eye dropper, small oil can, or better a fountain fed flux squirter as Figs. 92 and 93.

The flux must not be allowed to dry before the solder is applied. It is best, not only to tin the leaking portion but a little beyond it at each end. If any part does not tin, repeat the cleaning until the tube and seam all take a good coat of tinning. Apply more flux and solder until seam is well soldered. Some times it will be found necessary to scratch along the seam with the small V-shaped wire scraper. This works the solder down into the seam and along the seam under the fins.

This method is slow and should be only where

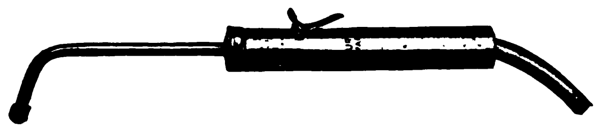

Fig. 92
Fountain Fed Flux Squirter

leaks are few. Two more rapid methods are available. Each however necessitate the cleaning of the entire radiator. One of these methods is described under the following heading, the other is explained in Chapter 10.

43. **Soldering Frost Broken Tubes with Flood Flame Torch**—If upon careful examination the radiator is found to be badly frozen, it should be cleaned by boiling and acid bath, see Chapter 4. A larger brush flame is necessary for this work. The painter's common blow torch is available to all, hence its use will be discussed. The flame produced by a new torch is not as long nor as bushy as is needed. A more efficient flame may be produced by enlarging the port. Only a slight enlargement is necessary. It is best to enlarge the port slightly and try torch until a flame four or five inches long is produced. There should be no yellow, but as large a blue flame as possible. The idea is to heat a large section of the core rapidly but not too hot. Solder melts at about 370 degrees while the gasoline flame is capable of 2,500 degrees of heat. This torch should not be held too close and kept in constant motion while flame is in contact with the core.

Good light is necessary to do this work as rapidly as it must be done. Very few shops have sufficient natural light especially in winter when frozen radiators are abundant. The light illustrated in Fig. 93 is especially good.

Fig. 93
Soldering Tubes with Flood Flame

Since it is necessary to see all the tubes, the fins should be straightened before any attempt is made to solder. It is well to do the straightening before the cleaning process.

Stand radiator on side and examine for freeze line. It is not necessary to test the radiator as all the opened seams must be soldered. The seams visible with radiator in this position are soldered first. Begin at side down next to bench and work up. With torch in left hand, move flame across fins along the tubes applying flux at same time. Don't forget that flux is necessary. Use plenty. Don't forget that the torch is hot and fins are thin. Keep the flame moving. Apply solder to outside tubes whether seams are in sight or not. If the opened seam is in the third tube, tin the first and second tubes before working back to the opened seam. The principle of tinning the soldering iron is involved here. Avoid burning the tinning from the outside rows of tubes while working back to the inner tubes. If the tinning is burned off considerable difficulty will be experienced in getting the tubes tinned again. Leaks will be bound to occur in the burned tubes as the solder is burned from the seam as well as from the surface of the tube. After the opened seam is reached and tinned, close and solder. If the cleaning has been thorough the solder will take as fast as these operations can be performed. After a few trials this work can be done very speedily.

When all visible seams are soldered, turn radiator over end ways standing it on opposite side. Begin at the bottom and work up as before. Turn other side of core outward and repeat the soldering in the two positions across this side.

This process is far more quickly accomplished than might be expected. This is especially true after the mechanic learns to perform each motion automatically. Have a certain place to lay every tool and return it to that place each time.

When the core has been gone over in these four positions, test for leaks. Mark leaks and solder as before. This is the time when there is the greatest danger of burning the fins as the radiator is wet, preventing the heat from radiating from the heated point. Heat a large portion slowly. Move torch continually. Avoid burning tinning from outer tubes, and do not expect to repair leaks by piling solder between the fins. Solder the leak. Give yourself time to learn. A little acid on a particularly difficult leak while tube is hot often does the trick. The majority of leaks found in testing are on back side of tubes. When such are found, examine each with small V-shaped scraper to determine which way the radiator should be stood to flow the solder into seam, also to tell how to hold tube closer to make seam roll together.

When all leaks are repaired, straighten and repair damaged fins. The burned edges of the fins may be repaired by using a one-eighth by one-eighth inch fold, two to three inches long. These false fins must be of very thin material. They are pressed tightly on fin with fin tongs. It is not necessary to solder them. A small pair of pliers with prickling tooth will fasten them firmly. A coat of flat black paint will make the radiator look like new.

The above described process applies to seamed copper tubes. If upon examination the tubes are found to be of brass it will be necessary to close the opened seam before the tube is heated. Otherwise the tube closer will cut the hot tube in two instead of closing the seam.

44. **Removing and Installing Tubes**—In some instances it is advisable to remove a mutilated or broken tube rather than attempt to repair. Frequently the tubes are mashed or cut by collision or by a fan blade. Vibration also breaks the tubes near the tank. If the radiator is in good condition otherwise this method of repair is always best. Copper tubes are not made brittle by heat and can be removed easily.

When only one or two tubes are damaged it is not necessary to remove a tank to replace the tubes. The tube is sawed thru at the center or at the mutilation, also near each tank as shown in Fig. 94. An old hack saw blade wrapped with tape at one end for a handle makes a very satisfactory saw for this work.

Heat is then applied along the half section of the tube to melt the solder connecting it to the fins. As the pliers are twisted the tube flattens and is rolled between the fins. The remaining portion of the tube is removed in like manner. The stumps left in the headers are then removed, care being exercised to prevent melting the

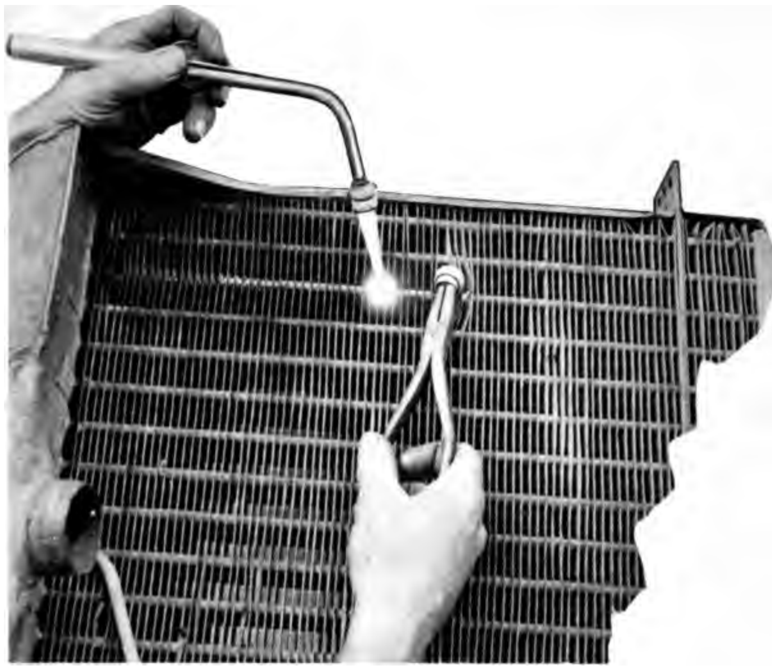

Fig. 94
Removing Tube by Rolling on Pliers

solder from adjoining tubes. The fins are then straightened. A three-eighths inch hole is drilled in the bottom tank in line with the tube way. The hole in the header should be reamed with a 17/64 inch drill. In case of the Ford radiator the hole in the support bar should also be reamed out. Before inserting the new tube the end of tube should be cupped as descriped in "Removing and Replacing the Bottom Tank Header, Ford Radiator," in Chapter 7. When the tube is in place solder it in both headers. Before repairing the hole in the bottom tank see that the solder has not run over the end of the new tube. The tube can be tested for opening in top tank by probing with a wire.

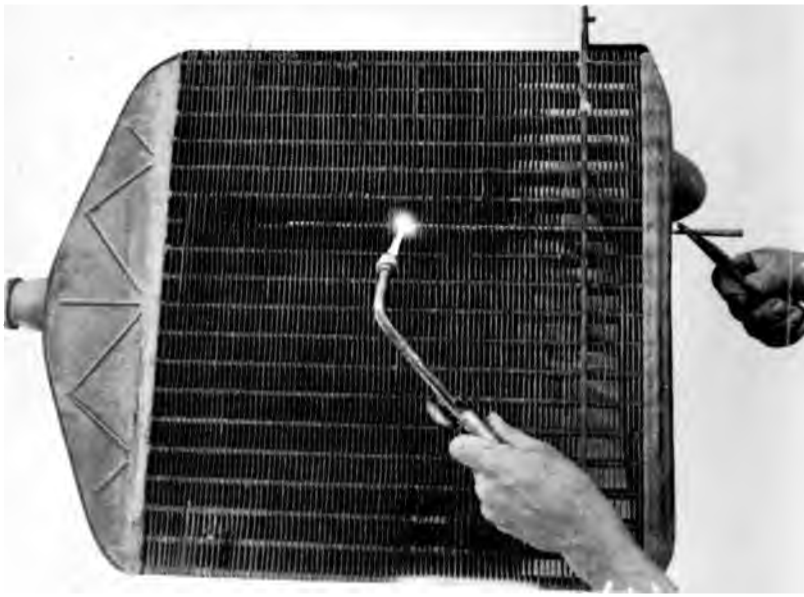

Fig. 95

Removing Tube Through Hole in Bottom Tank

It is very necessary that the tube be soldered to the fins as proper cooling depends on this connection. This is accomplished by placing the radiator in an upright position on the bench and applying flux to the entire tube. The torch flame is held near the top, a drop of solder is placed on the tube and run down from fin to fin. If a number of tubes have been inserted the fins should be soldered to the tube in the center of the repair first. Space the fins properly with the pliers as the solder is run down. Inside tubes should be soldered before the outer ones are inserted. A coat of paint will hide the discolored fins and the radiator will be as good as new.

It is possible to remove the tube in one piece after sawing at the ends and removing the stumps from the

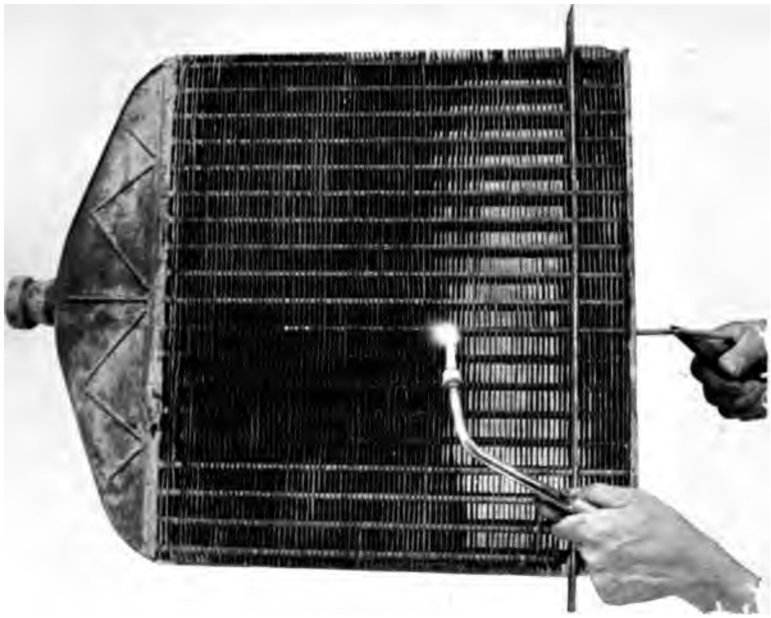

Fig. 96
The Tank Removed for Pulling a Number of Tubes

headers as in Fig. 95. The torch is applied and the tube is driven toward the lower tank by holding the screw driver flat against the upper end tapping it with the hammer. This is continued by moving the screw driver down from fin to fin until the tube projects thru the hole drilled in the bottom tank. By a quick pull with the pliers the tube will slip out easily.

When it is necessary to remove a number of tubes it is best to remove the lower tank. Drilling many holes in the tank is not advisable. The tube is cut thru near the top tank and removed thru the header as in Fig. 96.

45. **Installing Tubes in Radiators Having Cast Tanks**—The Fordson tractor radiator and others of similar construction frequently have tubes broken by vibration. This break will occur near the headers. A core

of this type is illustrated by Fig. 48 in chapter on "Testing." These tubes when located by method suggested in the chapter mentioned should be pulled and new ones installed. It is not difficult to pull these tubes. Prepare the tubes to be removed by sawing in two near each header. Ream holes in headers to 17/64 inch. Notice the direction of cup on holes in fins. Prepare to pull in direction of this cup to avoid binding. The painter's blow torch or other flood flame torch is best for this work. A helper should heat the tubes while the repair man removes them. In pulling the tubes the core should be stood on edge and secured to resist the pull. Start at lower tubes and work up. The heat passing upward between fins and tubes will preheat the upper tubes to be removed. Do not be afraid to use plenty of heat, as long as torch does not overheat the fins. Keep it moving rapidly along the tube. A short length of one-quarter inch rod is inserted thru the header and fins, squarely against the end of tube and tapped lightly with hammer. When the tube is moved out an inch or so thru the opposite header, grasp with pliers and draw out quickly. The torch can be moved from a tube as soon as it starts by plier pull. Helper will then apply heat to the next tube and it will be ready as soon as the repair man can start it with rod and hammer. When new tubes are in place, be sure to solder every tube to fins as the perfection of cooling depends greatly on this connection.

46. **Installing Finned Tubes**—The removal and insertion of tubes in the finned tube radiator illustrated in Fig. 97 is not at all difficult. The damaged tube is cut in two and removed after heating at the joint in the headers. The solder is removed from the hole in the header and the new finned tube is inserted thru one header then slipped back to enter the corresponding hole

Fig. 97
Replacing Finned Tubes

in the opposite header. The inner tubes are inserted and soldered before the outer ones are placed.

47. **Removing Brass Tubes**—If upon examination the tubes are found to be of brass more care must be exercised in their removal. If the following method is used they can be pulled successfully. The tube should be sawed thru at three points as in Fig. 94. The needle nose pliers are used to break the fins loose from the tube for a distance of about two inches on each side of the middle cut. Heat is then applied to the tube beyond this loosened portion. When the solder is molten the tube is slowly rolled on the pliers. The fins that have been broken loose cool the tube as it passes thru them and

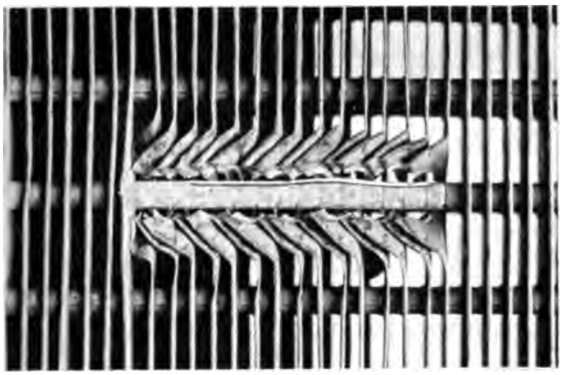

Fig. 99

Fins Cut and Bent to Expose Outer Tube

;alling new tubes, a neat repair can be effected by .cing the tube. Cut tube above and below the damaged tion with the saw. Either remove the fins or bend m out of the way as shown by Fig. 99, to a point a le above and below the sawed out portion. Remove piece.

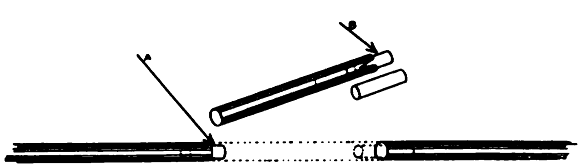

Fig. 100

Making a Splice with Inside Collar

Round up the ends of the projecting tubes, remov- the ragged edge left by saw. With round acid swab, ıb the inside of tube ends with muriatic acid. Cut a :e of new tube that will just fit between ends of pro- ing tube. A V-shape should be filed in one end as wn in Fig. 100. Two collars are formed that fit loosely in tubes. These collars should be of about 36 gauge brass one-half inch long. One of these collars is inserted half way in one projecting end and soldered. Slip collar "B" back flush with end of repair tube. Put the repair tube in place with "V" outward, and opposite end over the fastened collar. With point of knife or sharp pointed scratcher, pry the loose collar down into the end of tube. Apply flux and solder carefully, filling the "V" cut, with solder. Test for leaks, replace fins and paint. This repair defies detection if properly done.

If this radiator is ever frozen, the tube will be swelled between the joints of this splice. The collars inside reduce the size of tube at the two points. There being less water here it freezes solid more quickly. The expansion of the penned up water breaks the section inserted as a splice.

Any splice has this fault for no matter how it is accomplished, a very small amount of solder entering the tube will decrease the size and cause a rupture when tube is frozen.

A splice that has not the good appearance of this first method can be made by placing the collars outside of joints. The same preparation is necessary except that tube ends are cleaned outside and the V is not cut in the repair tube. The repair tube is cut to wedge tightly in place. See "M" in Fig. 101. Collars are cut from 36 gauge brass one-half inch wide and long enough to reach around tube with lap. In order to make a collar fit tight around a tube, a lock seam may be formed as follows: Pass the brass strip around the tube and grasp both ends with the small flat nose pliers breaking an edge on each end of collar. One edge should be one-half the length of the other. Bend the longer edge flat over the shorter one, then flatten the standing seam agai[illegible] tube. Tinners have used this seam, particularly [illegible] roof work.

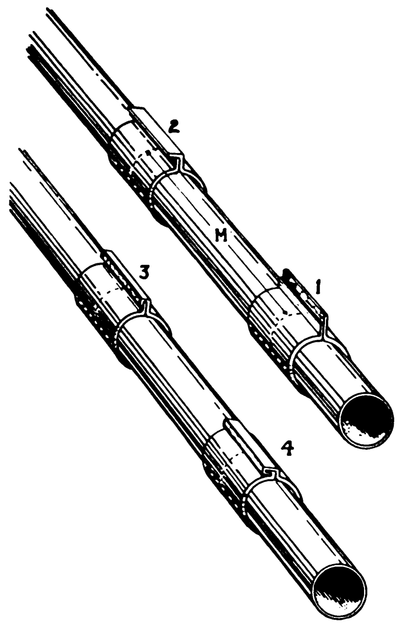

Fig. 101
Splicing a Tube with Outside Collar

This lock seam can be turned to the back side of tube out of sight and the joints soldered. If too much solder is used the splice will have the same bad feature as the previous one. To avoid the accumulation of solder on the inside of tube, clean with scraper instead of acid. The lime deposit inside the tubes will prevent the solder from taking. Any small lump will fall out of tube when radiator is righted.

This splice can be used where tubes are broken by vibration near the headers. However the stiffening of the tube back from header throws a strain on it and another break will occur if the splice itself does not break.

49. **Resoldering Face Seam in Honey Comb Core**— The edge of tube walls are soldered by dipping the honey comb core in solder as explained in Chapter 2. This seam is not always well soldered at the factory. Vibra-

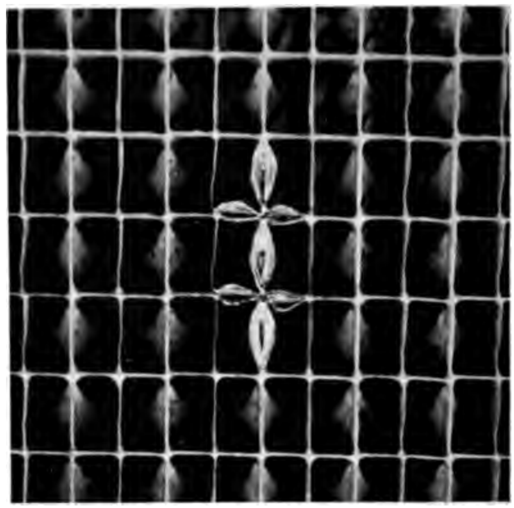

Fig. 103
Face Seam Pried Open for Cleaning and Tinning

tion, deteriorating effect of waters, anti-leak and anti-freeze compounds, and the effect of electrolysis in disintegrating the solder are some of the causes for these leaks. It is not necessary for the repair man to test the radiator or to have it off the car to detect the leaks. The deposit of lime or other sediment will usually signal the leak. To the beginner it is suggested, in passing, that water always runs down. The leak will be found at the top of such deposit. If these white spots are numerous, an attempt to repair the core is not advised. The most practical method is to install a new core if tanks and fittings are in good condition.

When the exact location of the leak is determined, apply torch flame to the seam. A very light flame is necessary. Turn the air down so that the flame is just strong enough to hold itself straight. With scratch awl work the edge of the two tube walls apart each way from the leak. Continue to open along the face m and out

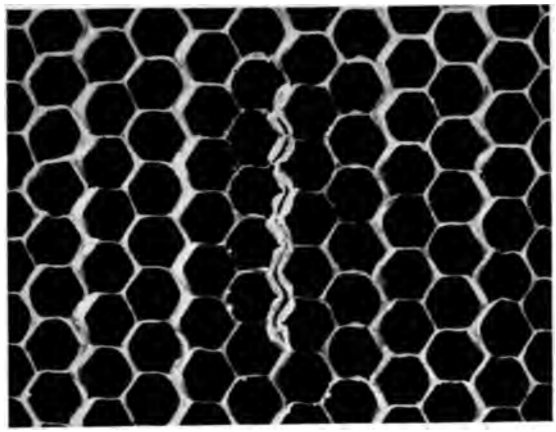

Fig. 104
Face Seam In Zig Zag Opened

at all cross connections or wings until a good solder joint is found. Figs. 103 and 104 illustrate such preparation in two types of honey comb. For this work core construction is of vital importance. If the core is brass, extreme care must be exercised that the edge is not mutilated so that a bad job will result. When the unsoldered portion is opened, clean with acid. If the core is copper heat the seam when acid is applied. When metal is clean, apply torch flame at right angles to face of core to avoid melting the solder in adjoining tubes. Apply only very small amount of solder and swab with flux. The flux swab and wire solder should be held in right hand while tinning the interior of this opening. Swab the molten solder along the walls until the opening is perfectly tinned. Do not leave any surplus solder between the walls. Allow the metal to cool and close the opening by using a piece of tin as a gauge and the needle nose pliers as a closing tool. Fig. 105 illustrates this operation, with two lengths of the seam closed, the gauge inserted in third with pliers pinching the walls

Fig. 105
Closing Face Seam After Tinning

back to position. After closing run joint full of solder. This repair will be neat and unnoticeable.

When these face leaks are found in heavy radiators it is easier to test on the bench than to lift the radiator in and out of the test tank. The following method will locate most of the leaks. Stand the radiator on the side over rack in bench. With hose connections and filler neck stopped and air hose on overflow, turn on a five pound pressure of air. Pour water in air cells near the top of the core. Tilt the radiator slightly forward and allow this water to trickle down over the face of the core, bubbles will show locating the leaks.

50. **Repairing Puncture, Crack or Other Hole in Tube Walls of Honey Comb Core**—The metal from which the radiator core is made is of necessity very thin. A wire or rod used to clean the air passages of dirt, trash, insects, and the like will puncture the metal easily. Vibration and metal fatigue cause cracks. The metal is frequently eaten out. Any of these causes will produce leaks back in the interior of the core. Lack of proper knowledge has caused many to attempt to cure the leak

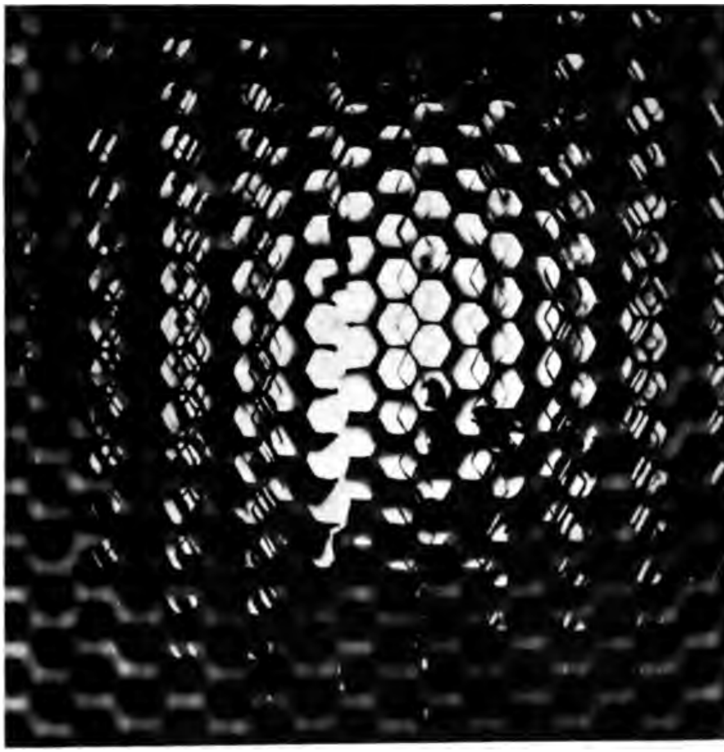

Fig. 106
Portion of False Tube Removed

by plugging the air passages with solder. There are a few cores that can be repaired after this fashion. The proper repair in any case is to repair the leak itself. This is done so easily that there is little excuse for plugging the cell.

Place radiator in such a position that the solder will flow over the leak. With bench light at back of radiator the interior can be seen easily. In case the core is of water tube and filler construction a portion of this filler may be removed if necessary, Fig. 106 showing a section removed from a radiator of this type. Clean the metal about the leak with acid and round acid swab. Apply flux and heat the spot to which a very small amount of solder is applied. It is often best to cut off a little piece of wire solder and push it in place with the wire scraper. As the solder melts distribute it over the metal about the leak with the scraper, tinning the surface. Apply more flux and enough solder to build it over. It is often best to turn on the air and squirt a little flux in cell to see that the job is perfectly done. Almost any flux will foam if a leak is left. The time gained over putting the radiator in the tank will pay for the flux.

If the tube wall is cracked, it will seldom be found to extend from front to back of tube, but up and down the wall. The metal cracks with the grain.

Occasionally, leaks will occur on the opposite sides of one air passage. With some torches, these two leaks are repaired with difficulty. If the needle flame gasoline torch as illustrated is being used, these two leaks can be successfully repaired. Adjust torch so that there is a good long needle flame with no brush. The hot point is at the end of inside light blue cone. If advantage of this hot point is taken the first leak repaired will not be opened while soldering the second.

51. **Resoldering Header in Honey Comb Core**—As explained in "Radiator Construction" the ends of the tube walls are united either by lap or lock seam and solder, to head the water into the water tubes. These seams frequently leak.

In case leaks occur in air passages just above or below the tank the probable location is in this seam. Stand radiator upright in case the leak is above bottom tank. Place bench light at back of radiator. Turn air pressure into radiator and squirt flux into air passage to locate the leak. Clean the header with round acid swab and acid. Solder after the s ion as described in repairing an inside leak. W inning see that the solder takes into the seam. This can be proved by scratching along seam while hot, with V-shaped wire scraper. It is usually best to solder the seam entirely thru. Solder half way and turn radiator to solder other half.

52. **Resoldering Core to Tank**--The tanks on honey comb radiators are attached to the core by soldering a break—either a part of tank or a strip—flat to the top of the core. This break or edge is usually about one-fourth inch wide where it bears on the core. Vibration and disintegration of solder loosens the joint causing a leak. Use brush or thin scratcher to remove all the old solder melted from the joint. More rapid progress can be made by removing the thicker lime deposit with a sharp pointed tool, not necessarily scrape to solder. Use acid to clean the joint with radiator laying flat on bench. The tank and core can be separated by carefully prying them apart when cool. See that every part is well tinned. When this is done satisfactorily, stand radiator in a nearly vertical position to solder. The reason for this is to avoid running solder back into the water tubes. The parts being considerable distance apart solder will run back into tank if much heat is applied. Hold the torch flame on tank and flow solder back, allowing solder so placed to conduct the heat to the core. The full width of the break on tank should be sweat soldered to the head of core.

Some radiators have a strip soldered to the header of the core. This strip is broken at right angles to solder to tank if the tank and core face are in line. Frequently it will be found advantageous to remove the header strip to expose the surfaces to be tinned.

Fig. 107 illustrates the method of removing this strip. Run surplus solder off the joint of tank and strip. With the radiator on side, apply flame to the upper end

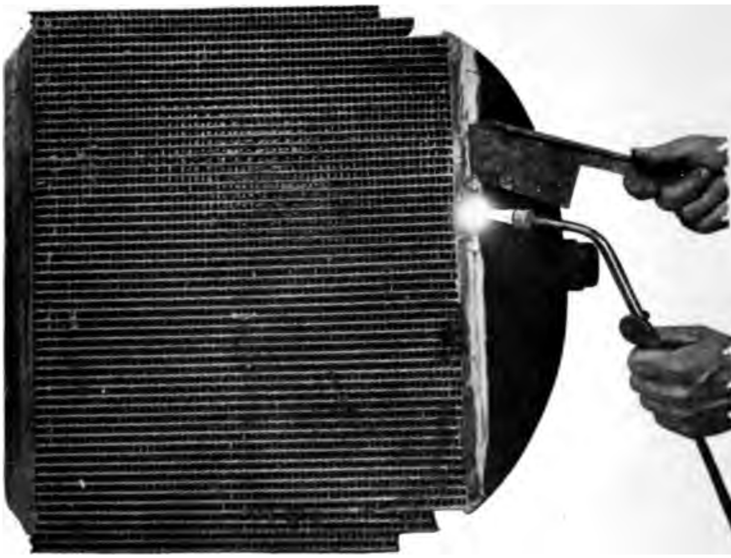

Fig. 107
Removing Header Strip

of joint. As the solder melts insert a piece of rusty metal, following the melting solder down the joint. The solder sets before the strip comes back in contact with the tank. When the tank is loose entirely across and the header strip is cool, bend it away from the tank. Heat the joint between core and header strip. Hold the flame on the strip to avoid melting header seams in core. The strip can be removed by pulling outward and upward with the pliers.

When the part is entirely removed, the tank can be sprung back so that the top of core can be cleaned and tinned. Tin the strip and the contact on top tank before replacing the parts. It is often advisable to remove the tank entirely, renewing the tinning and soldering the strips to core before replacing the tank. The process of soldering these header strips to the core is explained in chapter on "Rebuilding and Recori ".

53. **Installing Section in Honey Comb Core**—Repair plugs or sections can be installed in any honey comb core. The method of procedure is practically the same in all except that the peculiar shape of air passage or face plan makes some more difficult than others.

The core illustrated in Fig. 22 is so constructed that the installation of one single air passage is easily accomplished. The core consisting of drawn tubes with swedged ends. Each tube forming an air passage. The water passage occupying the space so formed around each and every tube.

The method of removing tube is as follows: With torch or soldering iron, heat the joint around the end of damaged tube. With scratch awl cave in the edge of the one tube end so that it has no contact with other tubes on this face. Torch or hot iron is applied to opposite end of tube melting the solder. The tube should be pushed toward the torch using rod or screw driver against the end first loosened. Care should be exercised to prevent damage to adjoining tubes. When the damaged tube is projecting past the swelled end, it may be grasped with pliers and removed. The exposed joint is then well tinned, also ends of new tube. Insert the tube and pinch joint together with needle nose pliers before soldering.

If a section of core is damaged by collision or otherwise, remove the mashed tubes. Any shaped opening may be built in. Assemble same number of new tubes to fit opening. A clamp may be improvised to hold the assembled section. Dip each face in flux and then in molten solder. It is usually best to make this opening as nearly square cornered as possible. Insert new section and solder around the edge on each face.

The core illustrated in Fig. 108 may be repaired after the same fashion but with a little more difficulty. Before attempting the installation of any section, the

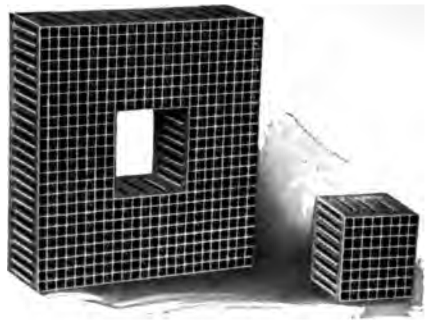

Fig. 108

Preparation for Installing a Section

mechanic should be very certain that he understands every detail of construction. In this core, water tubes are vertical, and easily discernable by the corrugations on the sides of these passages. Between each pair of water tubes is an idle perpendicular, also a succession of double wall lateral fins connecting the water tube with this idle perpendicular. These are in reality lap soldered seams. Figs. 24, 25 and 26 illustrate the construction of this core.

To remove damaged portion, one rule must be followed namely: only a section having corners of 90 degrees can be successfully installed. This does not mean that the plug must be square or rectangular, but any shape so that the 90 degree angle is adhered to.

To cut the section from the core, a chisel made from a piece of old hack saw blade is best. Fig. 109 illustrates this chisel. The only cutting edge is in the "V." It is ground so on the square corner of the emery wheel. When straddled over a member it will guide itself thru the core.

Plan to cut leaving the first go[illegible] er tube each of the damaged [illegible]ction. T[illegible] er tu[illegible]s and idle [illegible] cut [illegible]

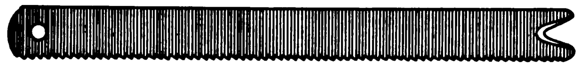

Fig. 109

Core Chisel Made From Hack Saw Blade

fin. Hold the chisel flat against the side of lateral next to the damaged section. Cut the tubes and perpendiculars across top and bottom cutting one more idle prependicular than tube.

With chisel, cut the lateral (crosswise) fins along each one of these outside idle perpendiculars. Hold the chisel flat against the perpendicular on the side away from the damaged section. When these laterals are all cut the section will slip out easily.

Stand radiator on side. With light needle flame heat the face seam along the tube. If the flame is applied to the side of seam next to the hole there will be little danger of melting the solder on laterals projecting from opposite side. Remove the half tube, also half tube from other side of hole in similar manner. At one end of each half tube another cut must be made. This is where the tube wall turns out to form the lateral (crosswise) fin. Cut the metal as close to the remaining half tube as possible in order to leave a good header at these two corners.

Remove all rough jagged edges left by chisel in cutting water passages and perpendiculars along the top and bottom of the hole. A real sharp scraper or a file may be used. See that the laterals here form a water tight header with water passages fully open. With raw acid or scraper clean the outer edge of laterals forming the header about three-eighths inch back from edge. Tin this strip, also the solder joints along the half tube remaining on each side.

If new sections are not at hand, cut a section from a like core. Wrecked radiators furnish parts to an advantage in many cases. Barring the room for their storage they are very inexpensive.

This section should be cut to correspond exactly with the hole already prepared in the core. One half water tube is left at each side of the section. The lateral fins form headers on this section. See that the edges are tinned to correspond to the tinned edges in the hole. The prepared section will probably be found a trifle large. Use hammer or pliers to buck the edges on one side of the section. Insert the crimped end and press in place. Flux applied to section and to sides of hole will act as a lubricant. With needle nose pliers clamp each joint together and solder the four sides on each face of the core. Water passes entirely around and also thru the section. But for the new solder, the repair can not be detected and places the radiator in as good shape as it was before the damage.

Like sections can be installed in any honey comb core. While this is possible it is hardly practical. The same general principle is used. Remove one half water tube on each side and tie up headers across each end of the hole. The sides and ends of the section will have to follow the lines of the water tubes in these cores. The 90 degree cellular construction of the core in Fig. 108 makes this installation easier than the obtuse and acute angles of other cores.

A practical repair for damaged sections in honey comb cores is made by installing a tank and a camouflage in front. The method of procedure is the same as described above. One half water tube being removed on each side, care is exercised in cutting that the chisel is held at r[illegible]t angles so that the back of [illegible] n removed [illegible] in front. The spaces [illegible] are tied over to form headers. After tieing up the headers two pieces of 24 gauge brass are cut one-half inch larger than the hole each way. A one-fourth inch break is turned on each of the four edges. This edge is tinned and the pieces placed in the hole front and back to form a tank of this hole. The edges of these pieces are allowed to extend outward. Make the face of tank so formed lack three-eighths of an inch of coming flush with radiator faces. For false work to hide the tank, saw a one-fourth inch section from the back face of the portion removed. Fit this in the front nicely and tack with soldering iron.

This repair can be made successfully and is not dependent on any part unprocurable. This day of tourists and long hauls by automotive power place the repair man in a position where knowledge of the method most adaptable means a wide reputation. It is not at all unusual for the repair man in California to repair a car carrying a New York license.

It is not to be taken from the foregoing pages that the only remedy for a damaged section of a honey comb is either a new core or the installation of a section or tank. The installation of a section is a practical repair but will be used very seldom in the average run of repairing. Like some special tool it is valuable when the occasion arises for its use. The honey comb core is capable of resisting severe shocks. Probably one collision out of a hundred will damage the core so deeply that the new section is practical. The usual collision brings the end of the fender against the core. In this case the tubes may be damaged only slightly back of the soldered joint in front, or the radiator may be pressed back against the fan bolt puncturing the water tubes. With the aid of the needle nose pliers the damaged part should be pulled and straightened back to as near its original shape as possible. After so doing the leaks are repaired as described under "Repairing Puncture, Crack or Other Hole in Cell Walls of Honey Core." When the core is water tight a few small pieces of light brass should be tinned and tacked in place to re-establish the face design of the core. The successful repair man must use the same amount of careful study of methods to conceal his work as he does to repair the leaks.

54. **Core Damaged by Lateral Strain**—The feature embodied in the construction of radiators that causes the most serious damage is the soldering of the honey comb core to the core channels, side walls or radiator support. Lateral strain thrown on a core by road shock, vibration, etc., centers itself on the solder joints of water tubes and false work at each edge of the core. These joints are only one-fourth inch wide often only one-sixteenth inch. They are designed to hold two ribbons of metal averaging five one-thousandths of an inch in thickness. The result of soldering the core channels to the core is illustrated in Fig. 110. It is too much to expect the core to withstand such cross strain.

The water tubes aside from being pulled apart are torn or cracked. There are two methods of successful repair, either a new core or the exclusion of the water from the torn tubes. This is known as "blocking the tubes out of the circulation." A core that does not justify much expense can be made to serve sometimes. by blocking out a few tubes. To block a tube, first cut thru one of the tube walls about three-eighths of an inch from the tank. A chisel for this cutting is made of a six inch piece of spring wire flattened slightly at one end and ground as the chisel in Fig. 109. Puncture the tube and drive chisel thru until it strikes the opposite face seam. Open this cut to expose the uncut side of the tube.

Heat the face seams at ends of cut and pry tube walls apart. Continue the cut to each edge. Fold the raw edge back so that the inside of the tube can be cleaned with round swab and acid. Run a water tight seam blocking the water from entering the tube, both at bottom and top tank using a long needle flame. Work half way thru, reverse the radiator and finish from the other side.

Fig. 110
Effects of Lateral Strain

CHAPTER 9

REBUILDING AND RECORING

VERY few repair men will be able to enjoy a business that has no dull days, or possibly, weeks. There are rush seasons and just as surely seasons when work is slack. Rebuilding is the practical solution of this difficulty.

In busy seasons some car owners will not wait their turn to have a radiator repaired. They junk the leaking radiator and buy a new one. Some shops have service radiators that are loaned to the customer while his radiator is being repaired. However, there is a limit to the number of service radiators. There is also much dissatisfaction that arises over the service radiator when it is returned in a badly frozen condition. Often the service radiator is better than the one left for repair and the car owner takes advantage of the situation and is negligent in returning the borrowed radiator. There are various methods of labeling service radiators so that they will be returned. The radiators may be painted a distinctive color so that everyone may identify the ownership. The radiator may be built to carry the shop name so conspicuously that the owner will return the borrowed radiator as soon as he receives notice of the completion of repair on his own radiator. This method may be of great service to the car owner and service is a great business motto. There is however, a question of whether the repair man is serving his best interests in this. He has money tied up in service radiators. He also must keep these radiators reasonably free from leaks. All of this is a dead expense. The [illegible] of having radiators for sale proves to be a more satisfactory and better paying proposition.

The plan is this. Arrangement is made with the junk man to pick over his collection of radiators. There will be found a great many that can be repaired easily. These are put in first class condition, not patched up hurriedly but by careful cleaning and rebuilding are put in good shape. These radiators are then sold to the men who won't or can't wait. If the repair man desires, he may allow a little better than junk price on the radiator traded in. A charge should be made covering the repair bill plus the trading price established for a junk radiator. This price may be varied in different localities, but is suggested that the price on these repaired radiators should not exceed half the price of a new radiator. The owner if he is in a real rush will feel that he is receiving service. He does not have to lay up his car even the length of time it takes to repair his radiator. The chances are that his radiator can be repaired and held for sale. Of course a great many radiators come to the shop that are not worth repairing. There are good parts however on almost every radiator. These parts can be removed, cleaned, tinned and stored for future use.

It frequently happens for instance that a radiator comes in with a badly frozen core. Another will have a good core but tanks in bad shape. The good core can be fitted with the tanks from one or more badly frozen radiators. The top being useless can be removed from the good core in very short time. A large torch will heat the tank quickly. All the solder being saved. The bad core is cut from the good tank. The header in the tank and the tubes in good core are tinned and assembled as described in "Removing and Replacing Top Header" in Chapter 8.

Fig. 112
Cutting Tank From Damaged Core

These radiators should be put in the very best condition possible. They should be "rebuilt" and spoken of as such, not as repaired radiators. "Second hand cars" are not being sold now. They are "used" cars. The facts are the same, but the "used" car sells better. Used radiators spoken of as "rebuilt" occupy the same class.

These rebuilt radiators may include also recored radiators. There are numerous honey comb cores being sold for repair cores. When bought in quantity a material reduction is usually made. A number of Ford, Chevrolet, Maxwell, Dodge or other popular car radiators may be recored and sold in rush seasons as well as regularly. Recoring is not difficult work at all and the use of otherwise idle hours will be of advantage. This advantage results not only from the profit on these rebuilt radiators, but the advertising that a shop gains by being busy all the time. The repair man who sits on the bench with the loafers is advertising his leisure. This influences many to question his ability. Practice is also worth considerable. As suggested before the way to learn the best repair is by dissembling radiators and studying their construction. It is frequently found that the solder from an old radiator is worth the price paid for the entire junk radiator. Parts may also be reclaimed for future use.

55. **Recoring Ford Radiator**—The recoring of a Ford radiator will be taken up in detail. The method of recoring any radiator is well illustrated by the steps taken to make a serviceable radiator for the hard usage the Ford must withstand.

The bottom tank is removed as suggested in "Removing and Replacing Bottom Header" in Chapter 8. The hose connection is removed from this tank where necessary, as well as the tank supports. All joints should be retinned. The front wall is removed from the top tank, see method in "Resetting Tubes in Top Tank Header," Chapter 8. The top tank braces and overflow tube are also removed. The radiator is then laid face down on a board parallel with the fins along the top end of the tubes. A chisel in Fig. 112 is used to cut the tubes from the tank. This cut should be made about two

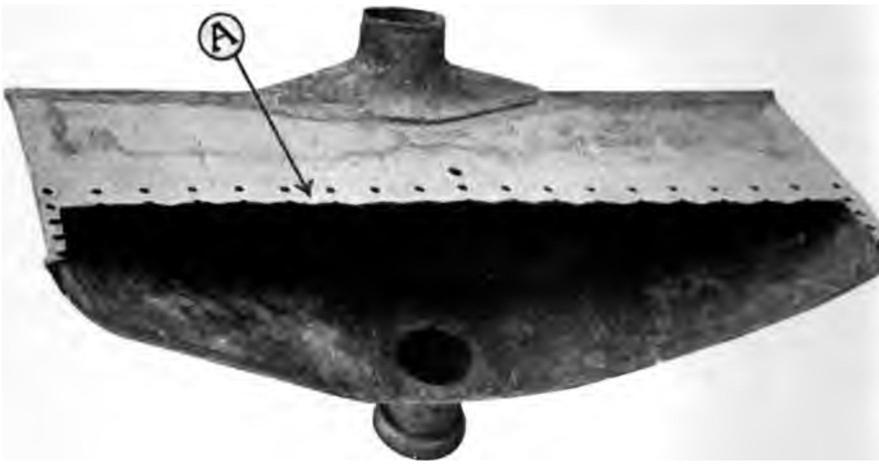

Fig. 113
Top Tank Prepared for Honey Comb Core

fin spaces from the header to avoid accidently cutting the header. When the core is cut away the header is heated and the tube stumps removed. While hot all the surplus solder is removed from the header. The cups or collars for the two back rows of tubes as well as end rows in the header are flattened out. This is done by placing the tank header upon the mandrel and using an oval faced hammer to pound these cups down. The header is then cut out with the snips. This cut is made along the inner edge of the end row of holes and thru the center of the second row of holes from the back as in Fig. 113. This leaves an opening in the header, one and three-fourths of an inch deep and about eighteen inches long. This can be varied according to the depth of the core used.

The hammering to flatten the cups will have stretched the header. This buckle should be taken up by crimping between each pair of holes across the header, A in Fig. 113. This will straighten the header so that it will lay flat on the core strip when the tank is placed in position on the core. The header should be tinned across each end and well back along the remaining row of holes. If the hose connection is not first class it should be replaced with a new one. To make a recore job give long service all hose connections should at least be removed, retinned and replaced on any make of radiator.

The core is then prepared for these tanks. In the type of core illustrated the face edges of each header should be pounded down until the gaps are closed and the header strip will lay evenly on the header. Some cores are headed in a straight line and need no pounding. If the solder on the core is tarnished it is well to brighten by brushing with wire brush, before placing header strips.

The header strips attached to core in Fig. 114 are for the bottom tank. The front strip"A" is cut five-eighths of an inch wide and eighteen and three-fourths inches long of 24 gauge or heavier. Header strip "B" at the back of tank is cut one and one-eighths inches by eighteen and three-fourths inches. End header strips "C" are one inch wide by two and one-half inches long. These brass strips are tinned in solder bath, Fig. 37. The folder is then set to brake strip "A" at 90 degrees in the center. "B" and "C" are edged the same. The two outside water tubes are blocked out of the circulation by soldering up at top and bottom, see "H" on each side of core. Header strip "A" is tacked in place with upturned edge flush with face of core. Strips "C" are slipped under this header strip cornering up with it at right angles. The wide edge of "C" lays over the blocked tubes at "H." Header strip "B" is then tacked in place cornering up with "C." Care should be exercised in fitting the header strips flat on the header of the core in order that little solder will be used.

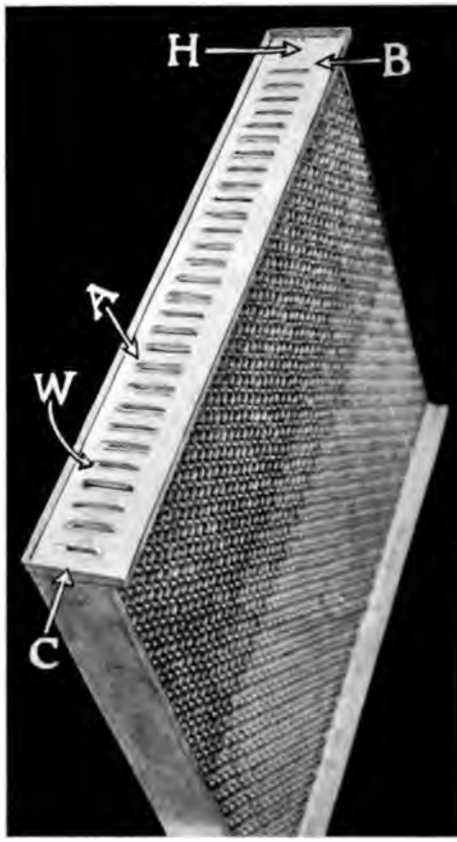

Fig. 114
Core Strips in Place for Bottom Tank

A well tinned soldering iron is the fastest and mo satisfactory tool for sweating the header strips to tl core. The iron should be held on the header strip an wire solder applied to the joint between the core and tl strip. The solder should be webbed in well at end (water tubes as at "W." This solder must necessaril be soaked down in the face of the core. Special car should be taken to get a good joint between strips "C and the core as the greatest strain comes at the corner When these strips are well soldered the bottom tan

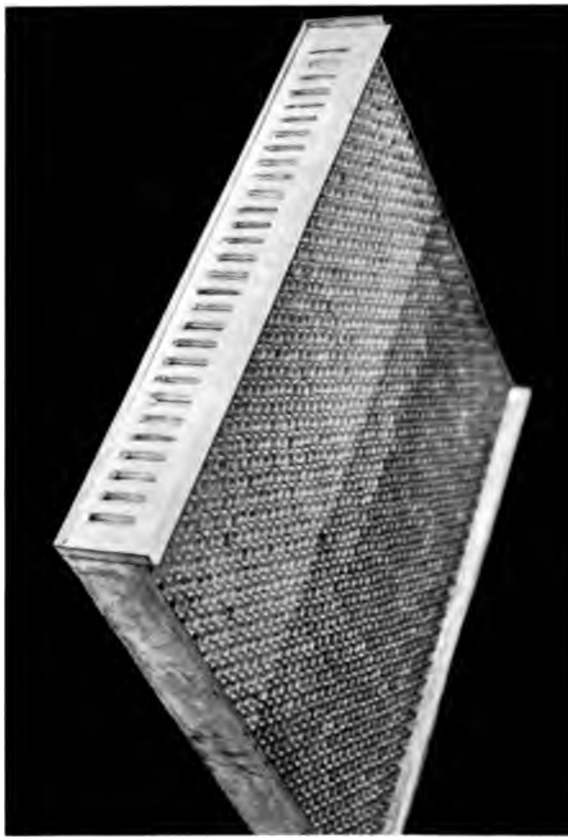

Fig. 115
Core Prepared for Top Tank

nay be inserted. The header strips are tapped down evenly along the sides and ends of the tank after which he seam is soldered.

The header strips at top end of the core are the same is Fig. 114 except that the back strip is one inch wide and has no edge brake, see Fig. 115, being wide enough o cover the tube holes in the top tank. When these strips are soldered in place the top tank is put in posiion and end header strips are hammered down to bind he tank in place. These end headers are tacked to the ends of the top tank. The assembled radiator is placed upright on the bench with the open front of top tank facing the workman. The bottom of the top tank is soldered fast to the back header strip by reaching the iron in at the open front. The needle flame torch is used to solder the tank down to end header strips. This is the point of greatest strain and should be well soldered. The overflow tube and splasher are then put in place. The front of top tank is inserted back of the header strip and soldered. For method of replacing this front see description in "Resetting Top Tank Ford Radiator" in Chapter 8.

The radiator is then ready for the test. Ten pounds pressure may be used on this new work. If the work is carefully done very few leaks will be found. There are sometimes leaks in new cores but they can be soldered easily as the metal is new and requires no cleaning.

The usual fault to be found with replacement radiators is that the radiator supports are not strong enough to stand the rough usage that a Ford radiator receives. The bar thru the tubular core of a Ford radiator takes all the wrench from the springing of the frame cross member under the radiator. The honey comb core can have no such bar, hence the tank supports must be strong enough to stand this strain. Two regular tank supports, Fig. 36, sweated together and properly soldered on the bottom tank serve well.

These supports must be so placed that the radiator will set right on the frame studs. They must be so placed that the shell will fit nicely down on the supports and back against the face of the radiator. An old radiator shell serves as a good gauge for placing the tank supports. Fig. 116 shows the tank supports in p[illegible]ace for soldering. The shell "S" is placed over t[illegible]iator. The radiator is then placed bottom up with t[illegible] fr[illegible]nt of shell

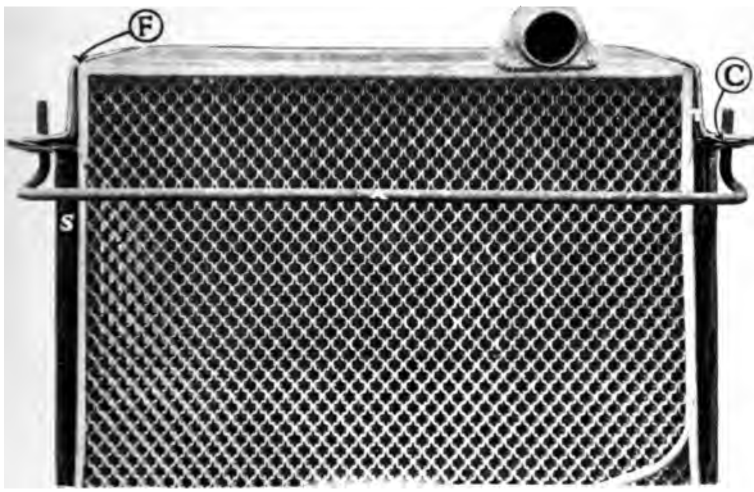

Fig. 116
Proper Placing and Spanning Tank Support

ıd radiator against the front of the bench. The box used r a seat about the bench with a hole for the neck in one ıd makes a good rest. The width gauge is made of ree-eighths inch rod. The stud holes in a bar give a 'oper distance for this gauge.

The regular tank supports are the proper length to ıld the bottom tank off the crank bearing on the cross ember of the car when the radiator is in place. The ep length of these tank supports should never be in-eased in order to make the upper end of the support eet the shell. This should be effected by the length of e core, and carefully seen to before the core is installed. ›re manufacturers are very careful not to make the res overly long, but it is well to measure the core when e header strips have been tacked on to check up the ngth of the finished radiator.

A little space between the shell and the tank support not a fault as the frame studs will hold the shell more rmly on the radiator. Notice gap at "C." The tank support should fit up tight against the end of the tank as at "F." When the tank supports are fitted laying flat against the bottom of the tank and gauging up properly sweat solder them fast. Much care should be exercised to see that the solder flows entirely under the tank support. Do not solder the upper end of support to the side of the core. Lateral strain on the core will soon tear the light metal of water tubes.

The top tank braces should be soldered in place last. They should be soldered well to the top tank and to the core channel for about six inches down from the top tank. The lower end will reach the tank supports. They should be sprung out from the side of the core slightly and soldered to the top of the tank support. The lower end of the overflow tube should be well soldered to the top tank brace and lower tank to prevent any vibration.

All traces of flux should be washed from the finished radiator with a clean rag and clean water. The radiator should be dried out thoroughly and tested dry. Radiators are water containers and should be tested by water pressure. The oxide floated by flux will sometimes seal a joint against air pressure. When the radiator is dry, the water inside will show wet from very small leaks.

The installation of a core in any radiator is practically the same as in the Ford. The core and tanks should be prepared the same. The length of the new core should be watched very carefully. It is well to take measurements on the radiator before the old core is removed so that the length of the recored radiator may be made to fit to the shell. Core channels should never be soldered to the side of a core. The core should be faced up on the tanks so that the shell will fit nicely back against the face of the honey comb. Tubular radiators like the Dodge and Maxwell are a little more difficult

Fig. 117
Heading a Diagonally Cut Core

to face up right as the headers are peened on to the tanks. Allowance should be made for this.

Some radiators have tanks that require the diagonal cutting of the core at the corners. Some cores are so built that they are ready for assembly. Others are made up square and sawed to fit the requirements. Fig. 117 illustrates one of these cores. In this case it is necessary that the repair man "head in" between the water tubes. Metal pieces are cut to fit in diagonally from the wall of one water tube to the wall of the next tube. In this illustration five of these pieces have been inserted and soldered in place. The header formed by these pieces should be straight so the header strip when placed in position will rest flat to give a good solder joint.

It is always advisable to block off the outside pair of water tubes. The lateral strain on the core will be taken by these two outside tubes. This keeps the radiator away from the shop a great deal longer. These two tubes at each edge of the core are not of great value as water carriers.

56. **Straightening a Bent Radiator**—It may be well to state that radiators, mashed out of shape by collision, can frequently be straightened and repaired. It is not always necessary to recore a wrecker radiator. Horses or cattle on the highways when struck by the car do not puncture the core. The main damage is that the radiator is sprung out of shape. Some cores will not stand the strain. The tubes are broken off or the walls torn beyond economical repair. In other radiators the cores will endure a great wrench.

No elaborate equipment is necessary to straighten the radiator. The shell is removed, and in some cases the core channels or tank braces also. The radiator should be laid on a level surface to determine the amount of the twist. If an arbor press is not to be had a block or timber is secured to wall or a post about eighteen inches from the floor. In front of this block is laid a piece of four by four long enough to reach diagonally across the radiator. The radiator is then laid across the block so that the sprung corner is toward the bite block on the wall. A block with a face surface of four to six inches square is laid on the corner of the radiator toward the wall. The pry is arranged over this and under the bite block, see Fig. 118. The opposite corner is held down by a brace, and pressure is applied to the bar. It is necessary to pry this corner slightly past the position

Fig. 118
Straightening a Bent Radiator with Pry Bar

desired as the radiator will spring back some. The radiator is then laid on the level surface to test the correctness of the face.

If the tank is dented it is sometimes necessary to remove and straighten from within. Dents in flat surfaces can be taken out by soldering a bar of solder or metal to the tank and pulling the dent out. This is illustrated in Fig. 119. Very often a short piece of three-quarter inch gas pipe bent to enter the hose connection or filler neck can be used to push the dent outward. Core channels are straightened and replaced after the leaks are all repaired. These channels are gauged by placing shell over radiator and tacking the channels in place.

Another method of straightening the light metal tanks is by the use of water and air pressure. The plug is removed from the filler neck after leaks are repaired and the radiator filled full of water. The plug is replaced in the neck and the air hose placed on the overflow tube. The radiator is then propped upside down on the bench or so that the water will bear on the dented portion. A ten pound pressure of air is turned on and the hammer used to tap on the tank about the dent. The reflex from each blow communicated by the water will force the dent outward. The dent in radiator in Fig. 119 could be lifted easily in this manner. This method should not be used however if the radiator will be damaged by the heavy pressure. Striking on the tank against a ten pound pressure produces a heavy strain all over the radiator.

A radiator struck a side blow by another car in collision will be bent laterally. The radiator should be secured by the bottom tank to a strong bench or timber and the lever applied opposite the blow. In case radiator has no studs, strips may be sweat soldered to the sides of the bottom tank and these in turn nailed to a timber placed between them along the tank. The bite block is nailed to the timber so used and the radiator righted by these tweezers.

The shell is the most difficult to straighten nicely. If badly dented a new one is advised. The shell is not expensive and is placed on the radiator to improve its appearance. Machines are made for this work. The

Fig. 119
One Method of Lifting a Dent in Tank

many different curves and angles limit the scope of work possible with the machines. The damaged part is not of enough value to justify much in the way of equipment. The best method is to place the shell on the mandrel over which a cloth is spread to protect the enamel, doing all the pounding on the inside. A lead hammer, which can be home made, or a ball pein hammer with a smooth oval face scars but little. The best advice along this line is to hammer the dents out as carefully as possible with the regular tools. Scars are bound to occur on the enamel as a blow on the finished surface was the cause of the dent. Shops that are not equipped with an oven for refinishing may use an air drying enamel. It is poor policy to spend a large amount

Fig. 121
Straightening the Fins

of time on a part that is of no more value than the sheet metal portion of a car whether it be radiator shell, fender or other part.

57. **Finishing**—The radiator is so placed on the average automotive vehicle that the appearance is of great importance. The repair man has only partially finished the job when he has sealed the leaks. In foregoing chapters the finish has been suggested often.

The tubular core is not only improved by the trueing up of the fins as in Fig. 121, but in order that it may receive the proper circulation of air to produce sufficient radiation. Breaks in the fins as well as flattened portions should be neatly repaired and a coat of non-insulating paint should by all means be ap[illegible]d. The small amount of time consumed will be ov[illegible]ed by the owner. The radiator is not understood by the majority of car owners. The ability of the repair man will be judged by the outward appearance of the finished radiator. This judgment is well justified. If the finished job is kept in mind during the process of repair, much unnecessary labor may be avoided upon the completion of the repair.

Soldered seams should be run smoothly. No more time is required in doing this than for the solder to be left rough. A rough lumpy seam is usually the result of a half heated joint. A good hot iron aside from being more rapid is also capable of a better looking seam.

After the job is completed the exposed repaired joints should be washed to remove the flux and its oxide products. It is not sufficient that the radiator be rinsed off. A small rag or brush to wipe off the soldered joints will improve the appearance. It will also enable the paint when applied to dry in an even coat. No small point of this kind should be overlooked. An air brush, operated by the air supply used for testing, is ideal for painting radiators.

The radiator should not be finished merely for a good appearance when in place on the car, but so that it looks well when examined off the car. The underneath surface of the fins should be painted as nicely as the upper side.

The water in test tank after testing numerous radiators will become acidulated. Should a radiator come in having a nickel top or unremovable shell, the water in the test tank should be drained off, and tank refilled with fresh clean water before testing this radiator Otherwise the acidulous water will tarnish the shell or nickel plating, damaging the polish beyond restoration.

The radiator should be handled carefully. The owner who sees the repair man spread a cloth over his bench before laying a nickel plated or nicely enameled shell down will be impressed with the care his radiator is receiving. If the shell is wiped off carefully with a little polish or cleaner before leaving the shop it will add materially to the high opinion of the service.

CHAPTER 10

POURING

THE frozen tubular radiator has long been a man-sized problem. The inaccessibility of the inner tubes has marked this core as the most time consuming of any particular repair job. The torch solves the problem in a partially satisfactory manner. A faster method has long been sought and has resulted in much experimenting.

The poured bath has solved the problem to a great extent. There are a number of outfits on the market for this work. The "machines" perform well in the hands of a competent repair man. However it is not safe to say that anyone can operate one satisfactorily. A repair man who has had the experience of the soldering iron and torch method can, by a little practice, repair badly frozen radiators in an average of about two hours. It may be said that the extent of the freeze has little to do with the time consumed. If proper care is exercised there is little danger of stopping up the tubes and in some ways the "pouring" is more satisfactory than the torch method. The fins are not subjected to the burning heat of the torch, and are fresh soldered to the tubes giving good heat conduction to the part "poured." It is not advised in seamless tube cores. The solder coat would be so thin that a good joint could not be made.

58. **Equipment**—The "machine" for doing this work can be constructed at very slight expense in any sheet metal shop. The boiling vat, Fig. 35, and lead lined acid vat have been described. Aside from these there are two "machines" needed. The "pouring machine," Fig. 122, and the flux pan or vat, Fig. 123. The radiator may be dipped in flux instead of pouring it on. In that case a larger supply of flux is needed.

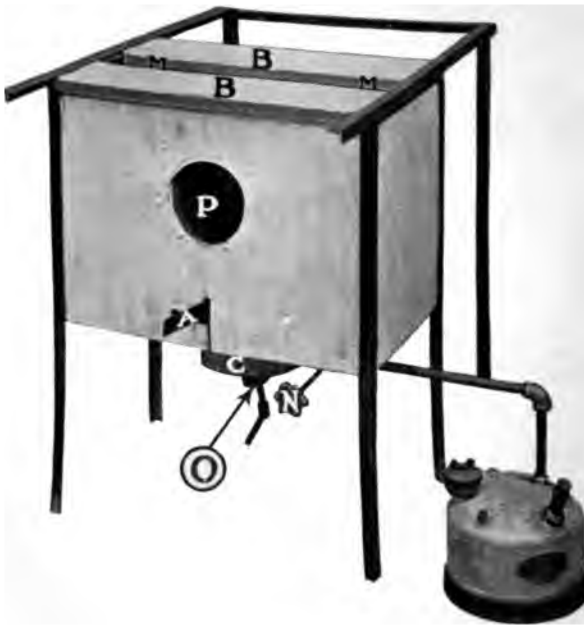

Fig. 122
A Pouring Machine

This flux pouring outfit is well illustrated, only one thing should be stressed, the radiator should not be laid flat over the pan as it is impossible to run the flux on the inner tubes if one is directly above the other. By placing the radiator on a slant it is possible to pour the flux on each tube. The upper tubes can not roof the lower ones. Solder will not take in a seam that has not been wet with flux. The radiator should be dry when the flux is poured on as it is impossible to tell when a wet tube is fluxed. The squirter, Fig. 92, is a great aid in wetting up inside tubes. This part of the process looks simple, but is more difficult than the solder pouring. It is best to turn the radiator [illegible]e up and pour the flux back thru the core. If there is [illegible]eat deal of this work done a dipping vat will pay.

Fig. 123
Applying Flux by Pouring

In this connection it should be said that cut acid is not a proper flux for this work. It dries too rapidly and will not give satisfactory results. It is possible to do the pouring using cut acid but the time consumed will be so great that it is an expensive saving. In the process, as described in the following pages, a commercial flux is used that will not dry badly. If one of these is not procurable the flux mentioned, made by mixing cut acid with alcohol and glycerine will serve.

After the radiator is wet with flux it should drain for a short time. The flux will be given time to soak into seams and cut the oxide.

The height of the pouring machine should be regulated by the height of the workman. When the radiator is laid face down on the machine it should be just about waist high. The portion enclosed by the sheet iron box is twenty-four inches long and about fourteen inches wide. The depth of box should be enough to cover the solder pot. The solder pot is hung by a hoop with handles, "A," extending out beyond the sides of the sheet iron box. These handles are supported by catches on the sides of the box. A circular collar or housing, about the width the pot is high, is attached to this support. The lower edge is seen at "C." Its purpose is to conduct the heat upward around the pot.

The frame with two back legs has the cover attached and is removable. This cover "B" has an opening "M" across the center about two inches wide. Its purpose is to direct the heat thru two rows of radiator tubes. Under this cover is a funnel shaped piece much the same as the pan at "B" in Fig. 123. This funnel is perforated along each side to allow the heat to pass up under the cover "B," then out at "M." These perforations are made back under the cover in order to prevent the solder from running thru on the floor. The funnel "spout" is large enough to fit inside the top of the melting pot. All the molten solder poured thru opening "M" is caught by the funnel and conducted down into the pot. The heat from the burner directed upward around the pot by circular collar "C" keeps this funnel and funnel spout hot. Opening at "P" is the same diameter as the funnel spout. It is connected to the spout by a tube wyed into it. This connection should be made so th[illegible] the ladle can be inserted at "P" and the solder dip[illegible]d handily. T[illegible] direct heat from the flan[illegible] is confi[illegible] inside the [illegible]x [illegible] l[illegible] in[illegible] except as it [illegible]

Fig. 124

Soldering a Tubular Radiator by Pouring Molten Solder Through the Core

of the funnel and is deflected back to the center by the cover "B" where it passes upward thru the radiator.

In Fig. 124, the radiator is laid in place for pouring. Shields "R" and "S" are of twenty gauge iron. The half inch breaks at the ends span the tanks. This holds the shields in place as the radiator is shifted forward on the machine. The edges of the shields under the radiator are edged the same. This edge is inserted between the fins. The purpose of these shields is to protect the tanks and ends of the tubes from the heat coming up thru opening "M" in Fig. 122. The shields also serve to direct the heat thru the frozen portion of the tubes.

Heat is supplied by a large plumber's pot. The burner "O" has been placed on an extension pipe in order that the gasoline tank will be farther removed from the intense heat. Adjusting valve is shown at "N." This arrangement also facilitates the filling of the tank with gasoline and pressure. Where gas is procurable it may be used.

59. **Pouring Frost Broken Tubular Radiators**—The radiator is first examined for leaks. If the tubes have been repaired previously the lumps of surplus solder between the fins are run out. The fins are then straightened. The radiator is cleaned by boiling and acid bath. The cleaning must be far more thorough than is necessary for the torch process. Any little speck of dirt in the seam will prevent the poured solder from entering, and leave a leak. This is where inexperienced men fail on pouring. Experience is necessary to know when a radiator is clean. Paint is probably the most difficult to remove. The boiling solution should be strong enough to cut the paint rapidly. It is true the acid will remove some, but it should be moved by the boiling.

After the acid has been washed off thoroughly with the hose, the core should be looked over very carefully and every tube closed as nearly to its original size and shape as possible. A little experience makes a workman very proficient at this, so much so that it will be very hard to detect the frozen portion when the job is completed.

After the tubes are closed the radiator should be tested with sufficient pressure to make the gauge register at least five pounds. In some cases where it is easily seen that the whole core is frozen a test is not necessary nor is it possible in many instances. If the leaking portion is confined to a narrow strip across the core its bounds should be marked in s systematic manner. Since the radiator will ren n e down in the pouring, marks at the back of the core are all that are necessary. The pour should be made some distance up and down the tubes beyond the visible leaking portion. The fins should be gone over that they may be in correct position and straight. The radiator is then stored in a vat of clean water while other radiators are prepared for pouring. A great deal of time can be saved if a number of radiators can be poured at one heat.

When the radiators are prepared they should be removed from the storage tank, rinsed off and dried. When dry the burner is started under the pot in pouring machine. The radiators are wetted with flux as described. One-half the core is fluxed from the center out to one side. This radiator is allowed to drain a few minutes. It is then set on edge and another radiator fluxed in the same manner. About three or four radiators are so prepared.

By this time the solder is hot. A low grade solder may be used for this pouring. In fact, lead will work. However solder is advisable. The solder should be kept at a high temperature. After skimming off the dirt and dross the oxide film on the surface of the solder in the ladle when dipped from the pot should be "straw colored." A red heat is damaging to the solder and should be avoided.

The first radiator prepared should be laid on the "machine" as in Fig. 124. The shields R. and S. are placed under the tanks and along fins at the limits of the section to be poured. The first two rows of tubes are poured. The radiator is then drawn toward the operator so that the next two rows of tubes will be brought directly over the opening, and so on until the half core next to the operator is poured.

The pouring must be carefully and rapidly done. Beginning at one end of the tube row, in section marked for pouring, pour the ladle full quickly on about a two inch length of the tube. As the tubes are cool at start the first few ladlefuls should be poured on a very short length. When the core begins to heat up the solder will flow thru more freely. The headlight, Fig. 93, should be worn if the natural light is not extremely good. If the solder begins piling between the fins at the lower face it should be melted out by continuous pouring at this point. It may be that the burner is not heating the solder fast enough or the solder was not hot enough at the start. If a pause in the pouring is made, shove the radiator back on cover frame so that the flux will not be dried off the tubes. The flux squirter is necessary to apply flux on tubes that appear to be black where they are not tinning. This squirter should be held in left hand continuously while pouring, that it may be used quickly. Do not expect the flux to shed from one tube to the next. Hold the squirter so that the stream will be directed on each tube in the row.

The radiator will get very hot. Care must be exercised that the solder is not melted from the tubes where they enter the header. The shields "R" and "S" will protect them from the direct heat from the flame. However the heat from the solder will loosen this header joint if care is not exercised all the time. If the radiator is getting too hot do not continue pouring, take time to cool the tanks. The test tank handy may be used to dip the tanks in if the solder starts at the header. The time consumed in the actual pouring is so small that the operator can well afford to exercise every possible care.

When the half of the radiator is poured, it should be removed from the "machine." The remaining portion of the core may be fluxed or if a number of radiators have been prepared, half of another is flux l while the hot radiator is cooling.

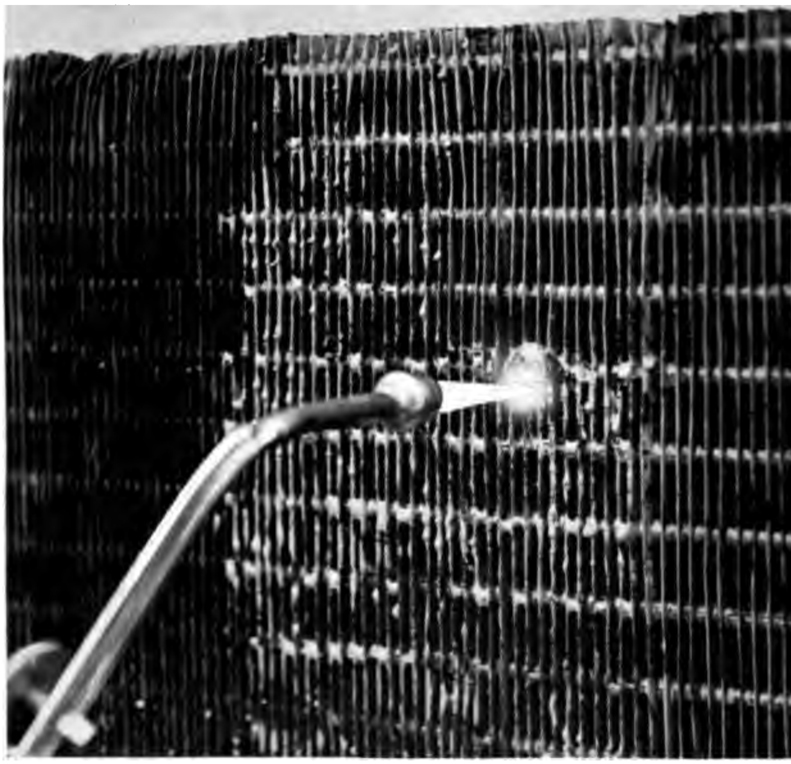

Fig. 125
Running Surplus Solder From a Poured Radiator

The pouring may be finished or half another poured. Continue until the entire lot is poured.

It is impossible to prevent the solder from freezing in lumps on the edge of the fins where it drips off into the machine. After the pouring is done it is necessary to stand the radiator on edge to melt and brush this accumulated solder from the fins. The radiator is propped upon the side inclining forward. A large brush flame is applied at the top and moved down as the solder runs along the fins as in Fig. 125. This solder can be removed more rapidly by applying the torch to a narrow strip down the fins, than to attempt to run it from the whole poured section at once. Flux if applied to the face of the core will cause the solder to run more freely. By weighing the radiator dry before pouring, and dry when finished, the exact amount of solder used can be determined. Pouring should never be attempted closer than about one inch from the tanks. If the tubes are frozen entirely up to the tanks it is best to use the torch to get these leaks or not attempt the job.

When the solder is removed from the fin edges the radiator is tested and the leaks remaining are repaired with the torch. The needle flame is best for this repair as the leaks are small and scattered. If the tubes have been split along the seam or if the seam has held and a hole is popped in the tube wall, the pouring will not have repaired the leak. These large leaks are unavoidable on badly frozen radiators. If upon careful examination before attempting the repair, the core is seen to be in this badly damaged condition, the job should not be attempted. Tubes in which the lock is completely unrolled are very difficult to close satisfactorily. When these large leaks are repaired the small ones can be located and repaired. When all the leaks are sealed the fins should be straightened again preparatory to painting the entire radiator.

60. **Repairing Loosened Bar by Pouring**—There is one job on the Ford radiator that has long given trouble that can be successfully accomplished by pouring. This is the loosened support bar. The radiator is given an acid bath that will clean the bar of rust. The fins are then adjusted to their proper place. Flux is applied to the core along the bar. The radiator is laid on the "machine" with the bar parallel and over the opening "M." Shields "R" and "S" are placed to protect the core a[illegible]ttom tank. The [illegible]lder pour[illegible]apidly on [illegible] iron bar m[illegible] br[illegible]

heat and to do so each ladleful of solder should be poured on a very short length. It is necessary to renew the flux frequently as the heat will dry it rapidly. The lower tank should be well protected from the flame during this operation. The entire bar will be resoldered to the tubes and the strain will distribute itself preventing the breaking of the tubes as they do when only a few are soldered fast to the bar.

Do not expect the pouring machine to perform as a "cure all" for radiator leaks. It is valuable inside the scope of its work, but will only serve this far. A great many frozen radiators will be repaired by the torch even after one learns the pouring method.

CHAPTER 11

ADVERTISING

METHODS of advertising are suggested frequently in the preceding chapters. In order to make advertising successful it is first necessary to have something to advertise. The mechanic must first learn his business sufficiently to have a basis for his advertising. The mere fact that John Jones has a well equipped radiator shop is not sufficient to justify much advertising. The equipment is necessary to do the work, but ability to do the work is the basis for advertising.

There is nothing decidedly new in advertising this repair business. A beginner will very likely over estimate the value of advertising, and if immediate results are not visible the method will be condemned. Advertising to be effective must be continuous. There is such a vast amount of advertising done that the more compelling ads receive the bulk of the attention of the public. The comparatively small amount of business possible to the small shop does not justify a large outlay for advertising. This fact makes it necessary that the beginner attract the attention of the man who has repair work.

A card tied to the steering wheel of the car whose radiator is leaking will be read more generally. The exact location of the shop, its phone number and any distinctively characteristic advantage of this shop should occupy one side of the card. On the reverse side may be some bits of advice or information to the car owner in short sentences. A list of "Don'ts" or "Dos" is good. Do not expect the owner to read a volume on repairing. He will only glance at the card and throw it away unless he is acquainted with the advertiser or greatly interested in having his radiator repaired.

F. L. CURFMAN MANUFACTURING CO.

114 East Second Street

Phone No. 224 MARYVILLE, MO.

CAN TAKE THAT LEAK OUT OF YOUR RADIATOR

The best equipped shop closer than Kansas City

Don't delay having your leaky radiator repaired until it leaks so bad you cannot use it. Have it repaired at once. You will find it cheaper in the end.

Don't put anti-leak in your radiator, thinking you can get by without soldering. You may stop the leak temporarily, at the same time you will be stopping more than the leak. When you finally must have it soldered, which is the only proper way. You have put yourself in for a big repair bill and barred yourself from a guarantee which we could have given had we had the radiator before it was doped.

We must have the Radiator off the car.

An Inexpensive Method of Advertising

The method of getting these cards on the cars is the most difficult. A boy will tie on a few and ditch the rest. A good plan is to seek out some old man who is not able to do hard work but is honest and conscientious. The excitement of the fair, a carnival, or whatever the gathering may be, will not detract him from his work. The small town shop can easily find a man of this description. Larger shops will use more extensive advertising plans.

Motion picture slides are seen by a large majority of car owners. The auto and the motion picture are closely associated. These slides can be obtained from a great many manufacturers of radiator supplies. The expense of showing them is small.

Newspaper advertising to be effective must be continuous. Spasmodic advertising will not produce large results. In small communities however short run ads sometimes pay well.

Road signs are depended upon by tourists to a great extent. They should be neat and well kept. A shabby sign will not convince the motorist of careful workmanship. The location to the shop should be definitely stated in few words in order that the passerby may be directed correctly. The fact that it is one mile to an up-to-date repair shop is good news to the tourist in trouble but it is not sufficient.

Signs in garages, filling stations, tire shops and battery stations are good. These signs are protected and can be kept in good condition.

Good illustrations are attractive. The majority of commercial cuts and sign painters do not produce good illustrations. A poor illustration is worse than none. Bold faced type should be used instead, if a good illustration is not procurable.

The best advertising is the shop itself. A well equipped, neatly kept shop, with a row of properly finished radiators repaired and in evidence, will give an air of careful work accomplished by the workman. The necessity of being or appearing busy is a good advertisement as stated before.

The owner gets a great deal of satisfaction in seeing how his radiator is being repaired. The practice of prohibiting the customer from seeing inside the shop condemns itself. There is a suspicion aroused when a radiator is taken behind closed doors for repair. Shops that have had a monopoly on the business can "get by" with these tactics. As the shops become more numerous the successful repair man will arrange his shop so that at least a part of the work benches are in view of the customer. It is sometimes best that a fence or screen be placed to divide the workman from the office or entrance. The work however should be used as an advertisement. A well impressed customer will be the cheapest of good advertising. Many successful shops are depending entirely on this good-will advertising.

CHAPTER 12

SUGGESTIONS TO THE REPAIR MAN

FREEZING is the cause of such a large number of the leaks in radiators, it is necessary that the repair man understand the causes of these leaks. Honey comb cores are seldom damaged by freezing. The reason for this is that the tubes or water channels in a honey comb core are flat. Expansion by freezing if it doubled this thin column of water would not break or damage the tubes, as when the ice thaws, the spring in the metal brings it back to the original position. The round tube of a tubular core contains the largest volume possible in the amount of metal forming this tube. Expansion will break the walls.

The fact that the tube is very thin has nothing to do with its breaking when freezing. The tubes would break if the metal were one-eighth of an inch thick. Expansive power of freezing water is enormous. If it were possible to construct a solid steel ball six inches in diameter with a cavity filled with only one drop of water, the ball would be broken if this drop were frozen.

The average car operator does not know when his radiator is frozen unless the circulation is stopped and the engine heats. Radiator cores freeze dozens of times to where the owner knows it once, as the heat from the engine is radiated through the metal thawing the ice, with no damage to the tubes.

Freezing does not always break a tubular core. If the circulation of air is not cut off thru any part of the core, and the tubes are regular in diameter the freezing proceeds from the bottom upwards and the tubes are not broken. A new tube soldered up at one end, if filled with water and set out to freeze will not be br by a great number of freezings. The water and particles of ice forming will be found to spew over the open end of the tube each time it is frozen.

Ninety per cent of the frost broken radiators result from cutting off the circulation of air from a portion of the core. For example, a cardboard is placed over the lower part of the radiator. Air passes thru the core above this cardboard, and freezes the tubes quickly. The protected portion at the bottom freezes more slowly. Circulation is immediately stopped. The water back of the cardboard begins freezing in the tubes just above the tank. This freezing proceeds upward to the already frozen part. The tubes being blocked above and below are broken by the expansion.

If a blanket is hung over the front of the core the freeze line will be found to conform to the sag of the cover. License numbers tied to the face of the core protect the section behind them, on freezing every tube behind this plate will be swollen or broken.

If the car owner would place the cardboard over the upper half of the core the freezing would not break the tubes. The idea of the card over the lower half has originated from misinformation. The fact that an open radiator begins freezing at the bottom has lead to the protection of this part. In practice it is not a success, only for the repair men.

A little study of the statement will be enlightening to many. If the top of the radiator is protected and freezing does start, it will begin at the bottom. When the ice line reaches the bottom of the card, the expansion will pass upward and no damage result.

The most practical plan is to cover the entire core or leave it entirely open. Shutters properly operated are a great improvement, but a frost proof cooling liquid is to be advised.

Tubes do not always break when first swelled but repeated freezing opens the seam. The enlarged portion contains more water than the remainder of the tube. The time required for freezing is greater. When the smaller portion is frozen above and below, the pocketed water in the bagged part freezes and opens the seam. An experiment with swelled tubes from a frozen core will prove this.

After a tubular core is frozen and repaired it is impossible to prevent breaking in freezing weather unless an anti-freeze solution is used. The first freeze will break the seams. The seams cannot be closed so evenly that the diameter of the tube will not be greater or less than the unswelled portion. A great deal of dissatisfaction can be avoided by warning the car owner against the use of the radiator without a good anti-freeze solution. A tag or label printed with red ink should be tied or pasted on the radiator with this warning:

CAUTION

OWING TO THE UNEVEN DIAMETERS OF THE TUBES IN THIS RADIATOR, DO NOT ATTEMPT TO USE DURING FREEZING WEATHER WITHOUT A GOOD ANTI-FREEZE SOLUTION.

This advice to use a good anti-freeze solution raises the question of what a good anti-freeze solution is. It should be a solution that will lower the freezing point of the water and not change the boiling point. It should be something that is not injurious to the parts of the cooling system.

Kerosene is sometimes used. It has the low freezing point desired but its boiling point is so high and uncertain that the motor will suffer or the solder be melted from the radiator. It will penetrate the rubber in the hose in a very short time. The gas from t [illegible] l is highly inflammable rendering it very dangerous. It should never be advised.

Some solutions contain calcium chloride. The brine formed by calcium chloride has a very corrosive effect on the iron or steel parts. Its more damaging property however is its disintegrating effect on solder. While it does not effect brass or copper it will remove the solder from these metals. It is used in reclamation plants to remove the tinning from metals. It should not be used in a radiator.

Alcohol has only one fault. It evaporates rapidly. Denatured alcohol should be used if it can be procured, if not wood alcohol will serve. The freezing point can be lowered sufficiently and it does not corrode or have a solvent action on any of the water circulating parts. Manufacturers of automotive radiators advise it universally. The proper proportions to protect the radiator are given below. These freezing points are only approximate. They are safe.

1-4 alcohol solution will freeze at about 0°
1-3 alcohol solution will freeze at about 5° below
1-2 alcohol solution will freeze at about 20° below

If a half and half mixture of alcohol and glycerine is used in the above table about the same results will be obtained. The glycerine prevents the rapid evaporation of the alcohol to some extent. To keep the solution in the radiator correct the addition of alcohol is necessary. If an alcohol solution is being used a mixture of water and alcohol should be kept to fill with. Water alone should never be added to the solution in the radiator.

In the foregoing pages the overflow has been used as a connection for the air hose in each instance. The reason for this is that plugging the overflow is dangerous. The overflow may be soldered up and the air pressure introduced thru the petcock or other connection. If this is done it must be opened before the radiator leaves the shop. Anyone will forget at times. If the mechanic forgets that the overflow tube is stopped a dangerous accident may occur. Steam will find an outlet and if the car owner happens to be near the radiator he may be scalded. The best rule is to leave the overflow open for the attachment of the air hose. In this case no risk is taken.

It is also suggested to the beginner that he test the portion of the overflow inside the top tank. A leak in this portion will deliver the water from the top tank down to the level of the leak. This test is easily made when the dry or water pressure test is made.

A repair man who works in a small community will be able to remember all the jobs. In a larger shop this is impossible. Some check should be kept on each radiator. A dissatisfied customer will return stating that the radiator was repaired "a week ago." Some method of identification will be found convenient. To do this it is suggested that a number plate be soldered on each radiator when it leaves the shop. This number can be soldered on the back of the top tank, corresponding number carried on the shop work ticket with the date and nature of the repair.

This system will also be useful in checking the work of mechanics employed in the shop. Where several men are employed a letter for each man to key the number will give immediate information. These numbers can be prepared by the use of steel letter and number stamps. A supply can be cheaply made and supplied to each workman.

When the boiling and acid cleaning are used these numbers will serve as identification marks in the shop. Shipping tags are liable to become detached the names obliterated. The number plate soldered fast is a sure identification.

A shop tag that will insure the certain charge or credit of the amount of the repair bill will come handy. Fig. 126 illustrates one that will be conductive to good system. The upper portion is left attached to the radiator when it leaves the shop. The portion below the perforation is torn off and filed for the bookkeeper.

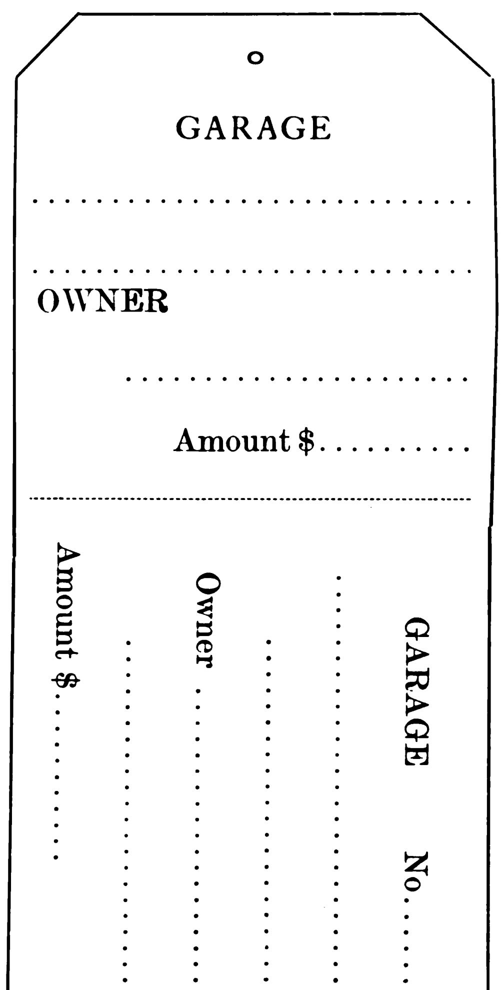

Fig. 126
Suggesting a Shop Repair Tag

REFERENCE NOTES

REFERENCE NOTES

MEMORANDUM