



# **REPAIRING WIRING HARNESSES**

# **REPAIRING OF WIRING HARNESSES**

**PACKARD ELECTRIC DIVISION  
GENERAL MOTORS CORPORATION**

Warren, Ohio

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# I INTRODUCTION

It is important in any business to give the customer products which are of the highest quality, products which will please him and insure his patronage in the future. Our goal at Packard Electric is precisely that — to give our customers the maximum in value and reliability.

The purpose of this manual is to serve as a guide to persons working in repair to enable them to detect defects and make effective repairs. Listed are common types of defects with explanation of how to make acceptable repairs.

Individuals working in a repair capacity should familiarize themselves with the contents of this manual. Repair methods which are not in accordance with those prescribed in this manual should be approved by the production and quality control supervisors before being applied. Alternate methods or methods which are superior to those covered in this text may be submitted through supervision for incorporation in future publications.



# PREFACE

Repair is considered by Management as a necessary and important function at Packard Electric in the manufacturing of wiring harnesses.

This project, requested by Plant Supervision, was assigned for the purpose of re-evaluating the reop standard data, designing a better layout, providing proper tools and equipment and establishing periodic communication meetings among Repair Operators, Plant Supervision, and Engineering for the purpose of exchanging repair methods, new tool concepts, discussing additional needs in the repair station and to review and/or comment on number and frequency of types of rejects.

The repair manual, which is another phase of this repair project has been developed to aid both Supervision and the Repair Operators in recognizing and correcting various types of defects. This manual is also to be used as a tool for instructing and training new Repair Operators.

We are indebted to Mr. W. C. Wehmer, Mr. A. Gosnell, and Mr. E. Zuga, Plant Managers for their assistance and cooperation during this project study. Extreme gratitude also goes to the personnel of the Public Relations Department at Packard, especially Mr. W. Gromofsky, for the photographs in this manual.

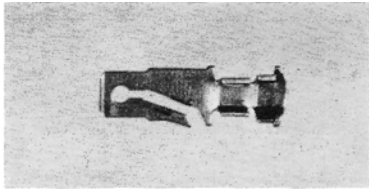
S. Stocz, Jr., Superintendent, Plant 11

W. M. Shuttic, Industrial Engineering

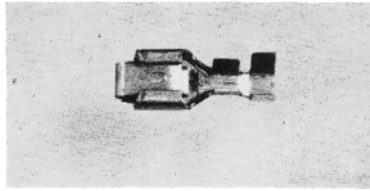
# II TERMINALS

## A. Introduction

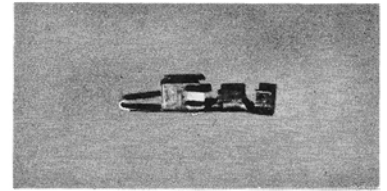
### SOME COMMON TYPES OF TERMINALS BY FAMILY NAME



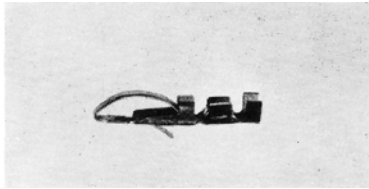
MALE BLADE



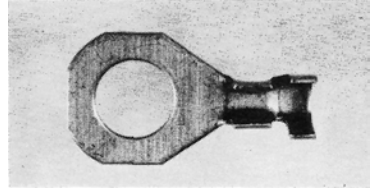
FEMALE



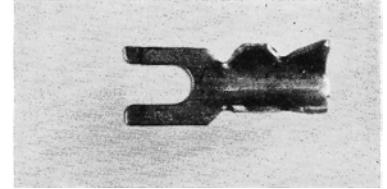
TWINLOCK



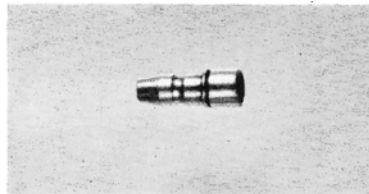
PRINTED CIRCUIT



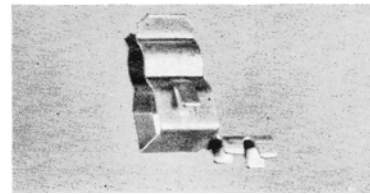
RING



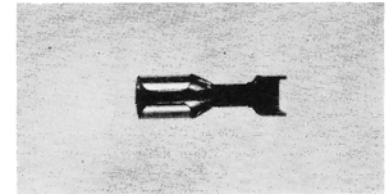
SPADE



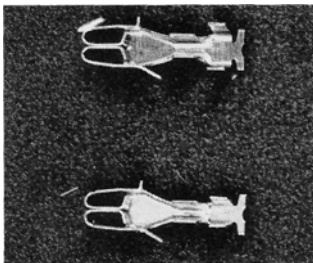
TIP



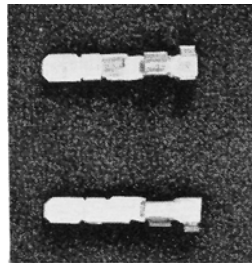
FUSE CLIP



BARRELL



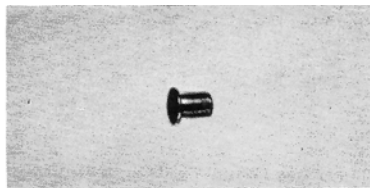
PACK-CON FEMALE



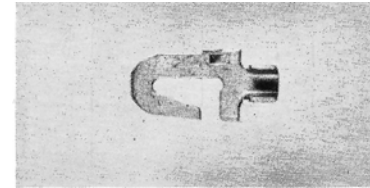
PACK-CON MALE



MINI FUSE CLIP

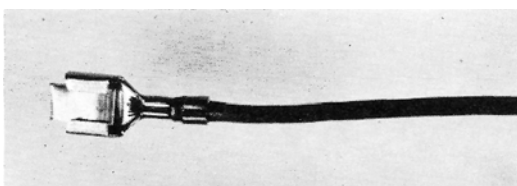


RIVET

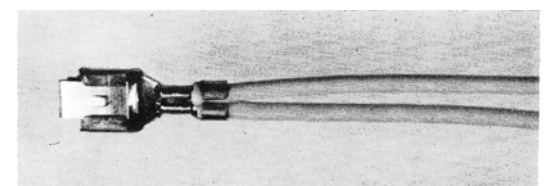


FISH HOOK

Terminals may be crimped to one or two wires.

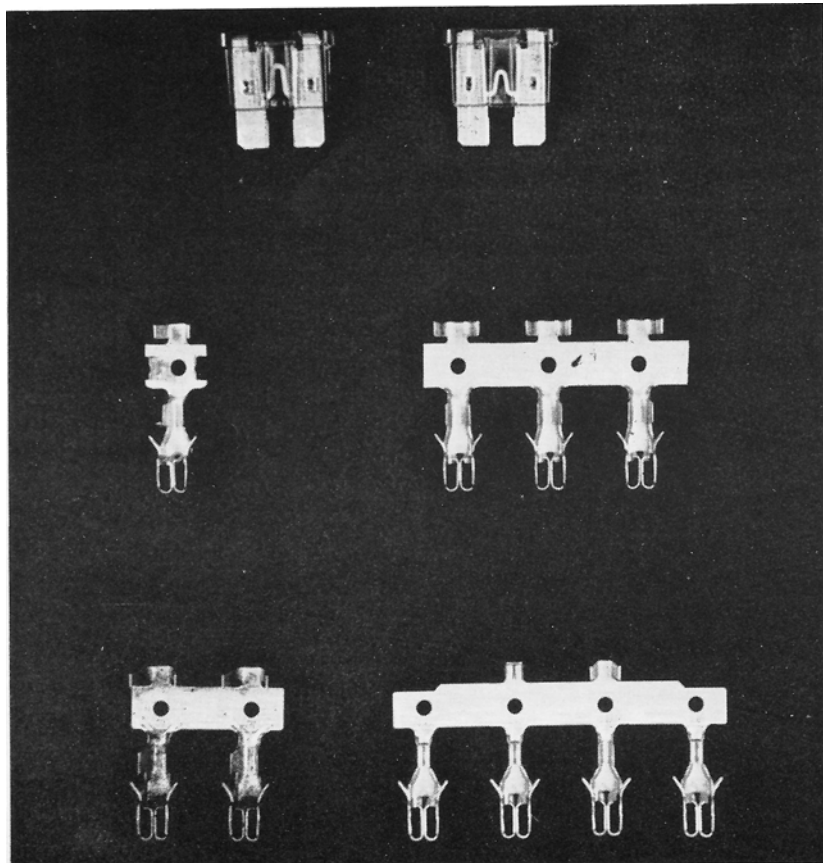
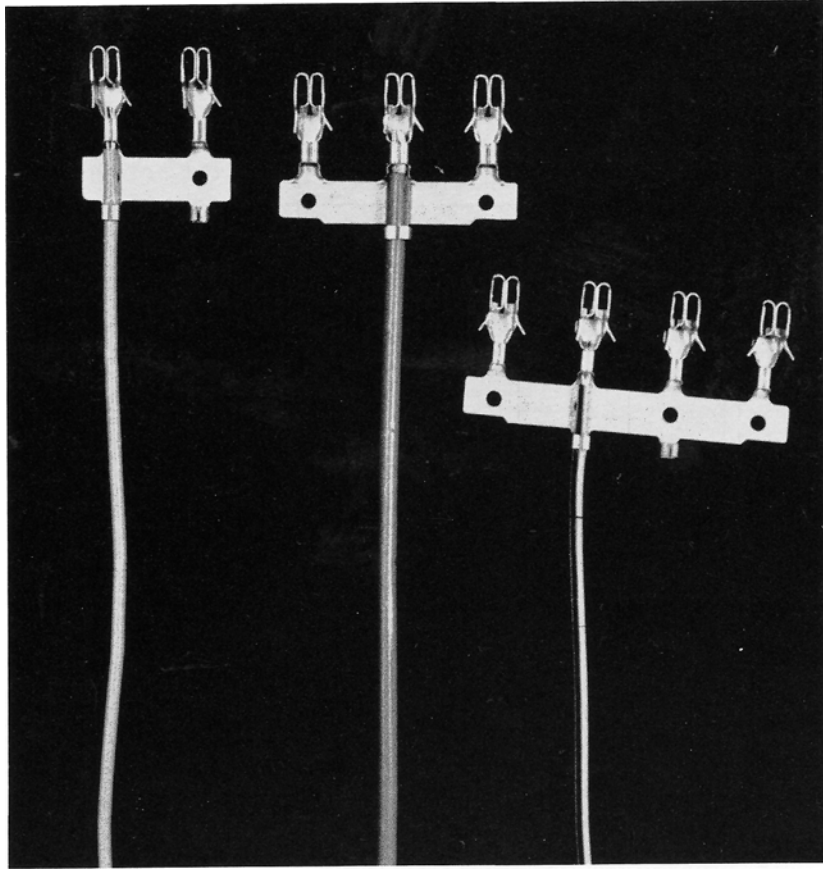


SINGLE



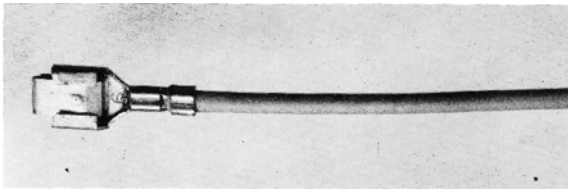
DOUBLE

AUTO FUSE TERMINALS

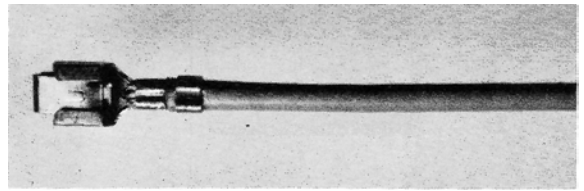


AUTO FUSE TERMINALS AND AUTO FUSES

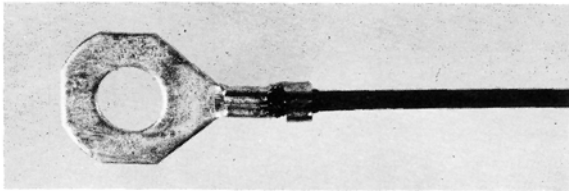
Normally one of the following applications is required in connecting the core of the wire to the terminal.



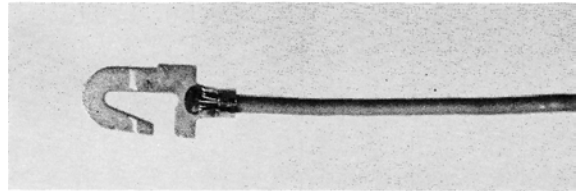
CRIMP ONLY



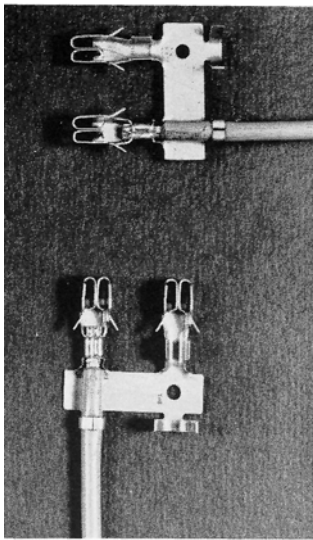
CRIMP & SWEAT SOLDER



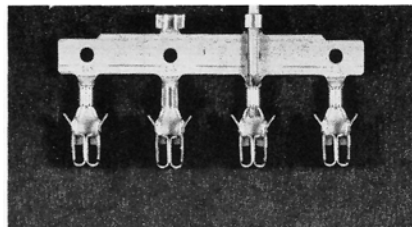
CRIMP & DIP SOLDER



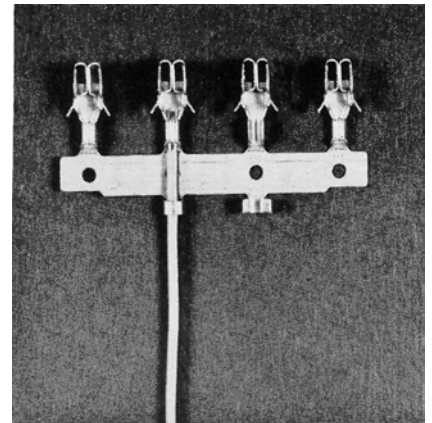
WELD



BAD CRIMP ON TERMINAL STOCK

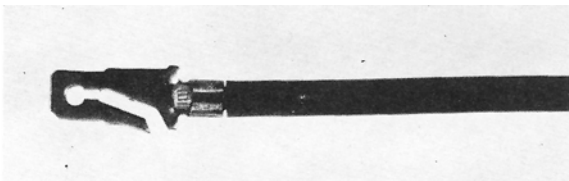


BAD CORE CRIMP

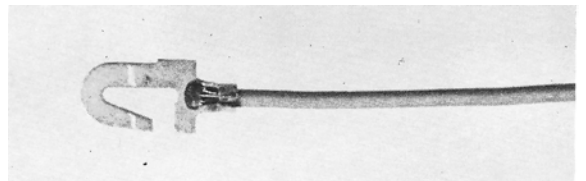


BAD CRIMP ON INSULATION

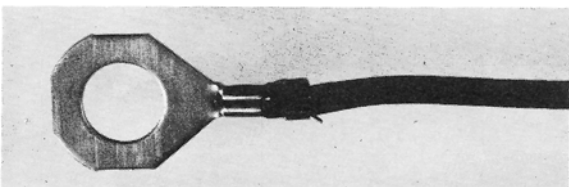
A terminal may or may not have insulation and core wings.



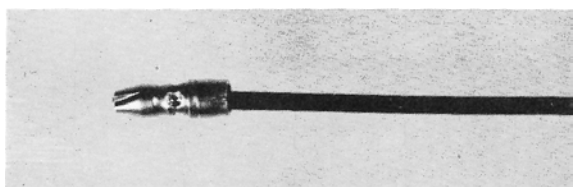
TERM. — CORE WING ONLY



FISH HOOK — INSUL. WING ONLY



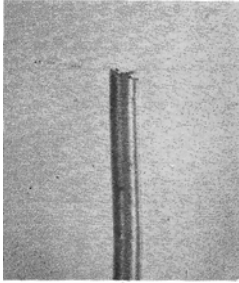
TERM. — BOTH CORE & INSUL. WINGS



TIP OR RIVET — NEITHER CORE  
OR INSUL. WINGS

B\* Types of Defects

Following are some common type defects that may occur with terminals.



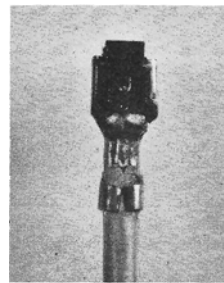
END OF STRIPPED  
WIRE MISSING



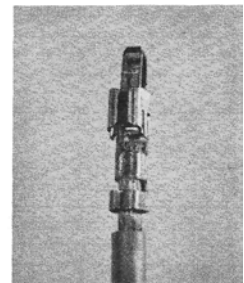
BAD LOCKING  
TANG



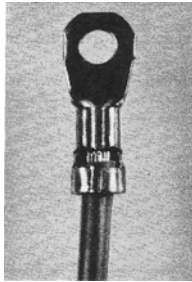
GOOD LOCKING  
TANG



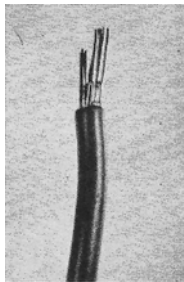
INSULATION UNDER  
CORE CRIMP



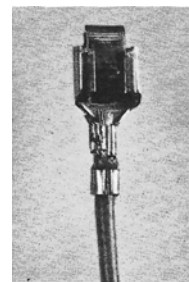
INSULATION NOT UNDER  
INSULATION CRIMP



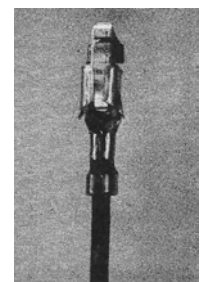
CORE NOT VISIBLE  
AT END OF CORE CRIMP  
(LOW CORE)



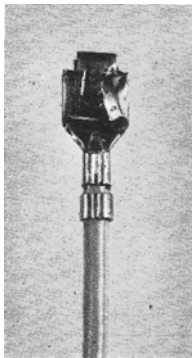
CUT STRANDS



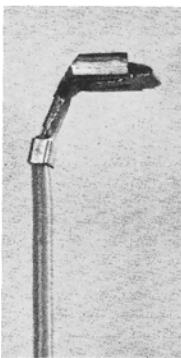
STRANDS OUT OF CRIMP



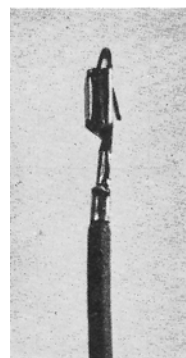
BURR ON TERMINAL



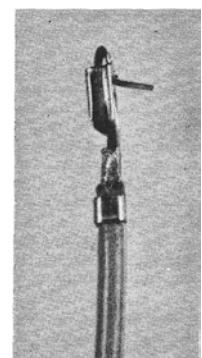
SMASHED



BENT



LOW TANG



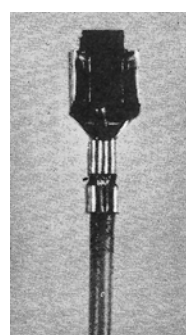
HIGH TANG



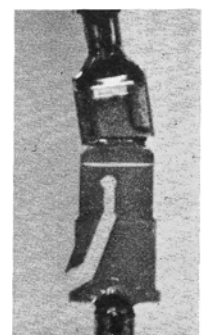
EXCESSIVE OR  
INSUFFICIENT SOLDER



CRIMP TOO HIGH



HIGH CORE



WRONG TERMINAL

### C. Identification of Defect

If one or more of the preceding defects caused the harness to be rejected, the defect(s) will be marked with a piece of red or yellow tape. The tape will be placed on or near the defective terminal.

### D. Repair of Defective Terminal

It may be possible to correct the following defects without removing the terminal.

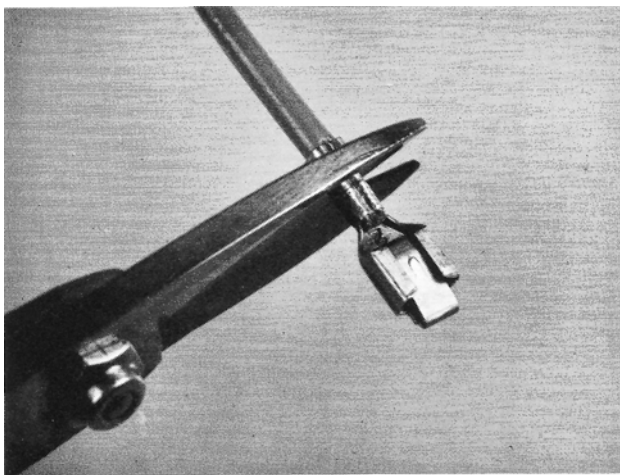
1. Burr on terminal — Remove burr with shears or file.
2. Smashed or bent terminals — Straighten terminal.
3. Low or High Tangs — Raise or lower tang.
4. Low tongue — Raise tongue.
5. Excessive or insufficient solder — Re-dip terminal.
6. Crimp too high — Squeeze down crimp with pliers.

The effectiveness of this repair will depend on the extensiveness of the damage, the strength of the terminal, and the resulting performance of the repaired terminal.

If the defect is damaged beyond repair or if the repair results in a weak or non-functionable terminal, the terminal will have to be removed. In addition to this, the following defects can only be repaired by removing and replacing the defective termination.

1. Insulation under core crimp.
2. Insulation not under insulation crimp.
3. Core not visible at end of core crimp
4. Strands cut and/or out of crimp.
5. Wrong terminal.

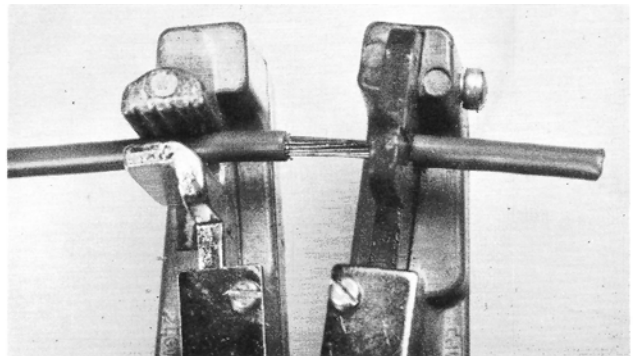
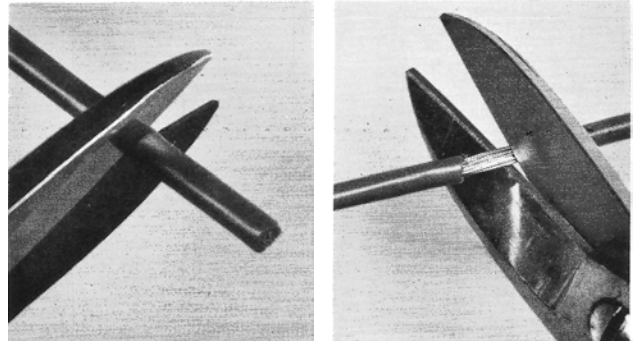
Removing a terminal is accomplished by cutting it off as close to the end of the wire as possible. The following picture shows a terminal being cut off between the core and insulation wings.



The wire must then be restripped so that a strip will be produced long enough to extend from the end of the insulation crimp to approximately 1/32 of an inch beyond the core crimp.

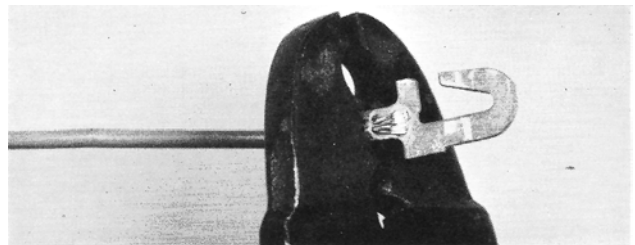


Stripping the wire is performed by cutting thru the insulation in a ring like fashion with a pair of shears or with a stripping tool. Caution must be used not to cut the core of the wire.

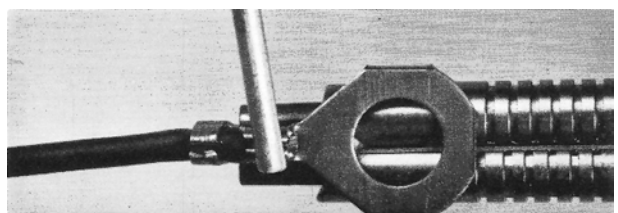


STRIP TOOL

The new terminal is then crimped to the stripped end using pliers or a crimping tool.



On repairs, it is always necessary to solder the core crimp even though the original application may have called for crimp only. This is done with core solder and a variac iron.



The following points should be considered when repairing terminal defects.

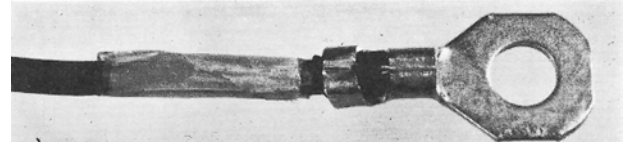
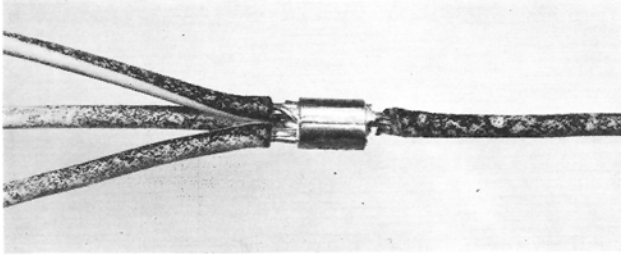
1. When repairing and not replacing a defective terminal.
  - a. Will the repaired terminal mate properly?
  - b. Has the repaired terminal been physically weakened?
  - c. Will the repaired terminal carry electricity as intended?
2. When removing a defective terminal and restripping.
  - a. Will the shortened length of the wire be acceptable?
  - b. Is the core of the newly stripped wire cut?
  - c. Has the correct terminal been used in repair?
  - d. Is the new terminal secure?
  - e. Was the new terminal damaged in hand crimping?
3. Certain customers specify solder flux requirements (such as no acid). Check these requirements with your supervisor before using solder.



# III WIRES AND SPLICES

## A. introduction

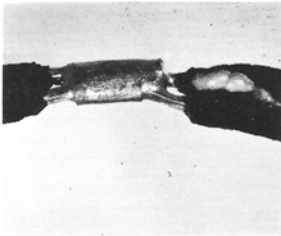
A splice is a group of wires which are joined together by placing a metal clip around the stripped ends and securing the connection with solder.



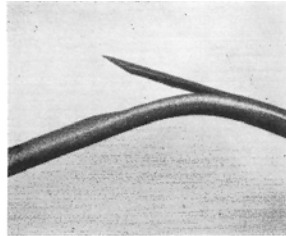
- b. If defect is in area which will be covered with vinyl tape, wrap a piece of splice tape over the entire defective area.

## B. Types of Defects

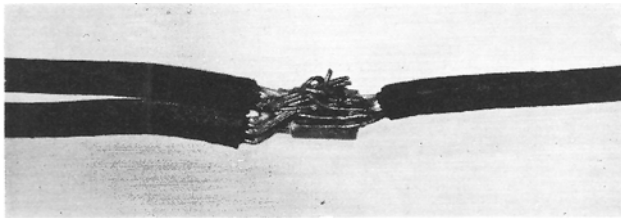
Following are some common type defects that may occur in splices and/or wires.



BURNED INSULATION



CUT INSULATION



DEFECTIVE CLIP

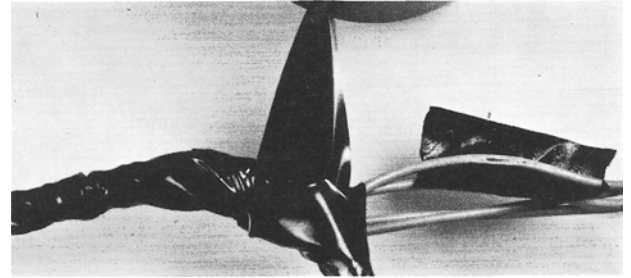
Wire lengths that are too long or short, the wrong color or gauge of wire, and missing wires may also occur as defects, in addition to those shown above.

## C. Identification of Defect

If one or more of the preceding defects caused the harness to be rejected, the defect(s) will be marked with a piece of red or yellow tape. The tape will be placed on or as close to the defect as possible. If the defect is a missing wire, it will be indicated by a white tag which will tell which lead is missing.

## D, Repair Procedure

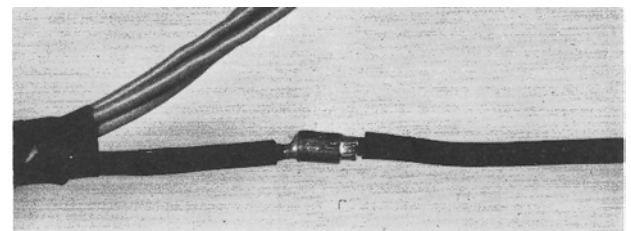
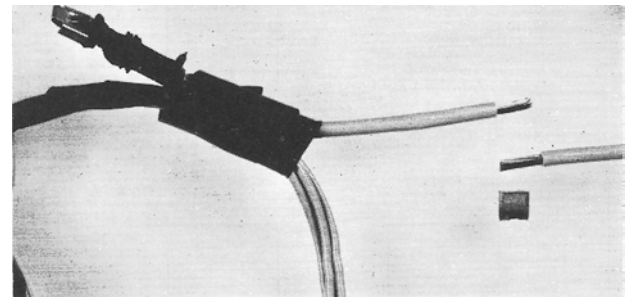
1. Defective insulation — core not damaged.
  - a. If defect is out of tape (vinyl harness covering), double wrap the defective area with a clear sticky back tape.



Defective insulation — core damaged.

Wire length too short.

- a. Cut off lead at a place that is under tape. Splice desired lead length to the cut off lead with a splice clip. Solder the splice joint, tape with splice tape and cover with vinyl tape to correct position. The exception to this is resistance wire. In this case, the entire lead must be replaced.



## 3. Length too long

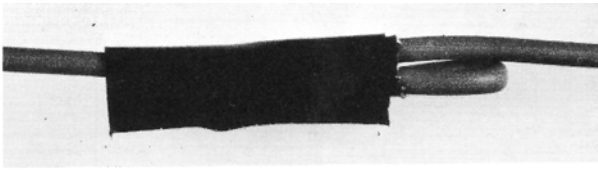
- a. Heavy gauges (8-10-12-14)

Cut off excess length and re-terminate (see section on terminals.)

- b. Light gauges (16-18-20)

Double excessive length back and tape securely to obtain desired length.





c. Resistance lead — Replace entire lead.

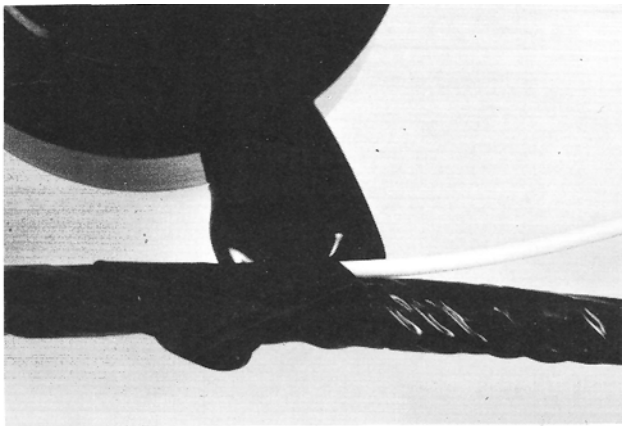
4. Wrong gauge.

a. Heavier than required.

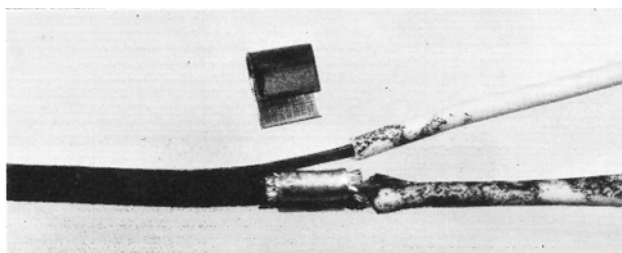
First check with your supervisor. Heavier gauges are often permissible unless the resistance of the wire must be controlled. If heavier gauge is not acceptable, follow procedure for Wrong Gauge, Lighter Than Required (4b).

b. Lighter than required.

1. Single lead. Cut off both ends of defective lead so that cut off ends are inside tape. Tape new lead along outside of harness.



2. Splice lead. Remove vinyl tape back to point where splice joint is exposed. Cut off defective lead. Splice in new lead by clipping over the existing clip. Solder, add splice tape, and re-tape harness.



5. Wrong color.

- a. Treat as a wire length too short. (Section 2.)

6. Missing wire.

- a. Single lead. Tape to outside of harness with vinyl tape. (See picture in 4b.)
- b. Splice. (See section 4b-2.)

7. Defective clip.

This may include strands out of clip, sharp edges, not enough solder, cold solder, etc. Repairing can usually be accomplished by hand manicuring the defect. Sharp edges and strands out of clip can be squeezed down with pliers and re-soldered. Lack of solder or cold solder can be repaired by added heat and solder. If a new clip is required, it is permissible to clip over the existing clip.

**E. Conclusion**

The following points should be considered when repairing defects related to wires.

1. Excessive wire lengths can be caught in pinch points and/or cause congestion in tight areas of the automobile.
2. Short lengths will prevent the harness from assembling properly.
3. Defective insulation can cause shorts in the electrical system which might result in fires.
4. Proper colors are required so that the assemblers of the harness will connect the leads as intended. Wire hook up is by color. Also, future service work that may be required is greatly complicated unless color coding is followed.
5. A core which is of the wrong gauge can be overloaded electrically and burn up. It is particularly important that the wire be no smaller than required.
6. Certain customers specify solder flux requirements (such as no acid). Check these requirements with your supervisor before using solder.

# IV TAPING

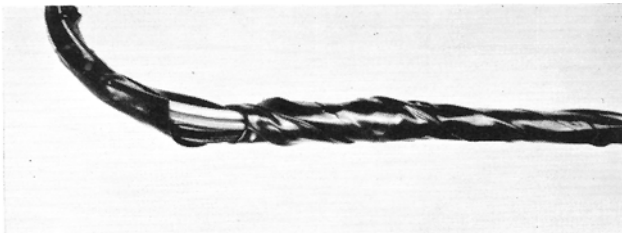
## A. Introduction

Tape is the outer jacket of the harness. It is used to contain and properly locate the wires and also to protect them from abrasion, heat, moisture, dirt, and various other elements. Proper taping is essential to prolong the life of the wiring and to prevent assembly and wear defects.

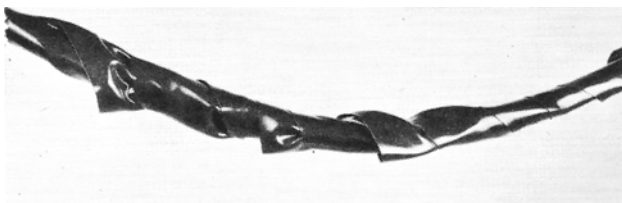
## B. Types of Defects

Tape defects normally occur as one or more of the following:

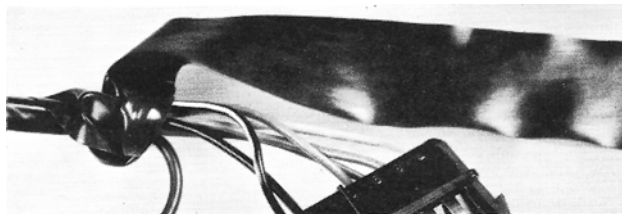
1. Holes or gaps exposing leads.
2. Tape applied too loose.
3. Dimensional errors resulting in incorrect branch lengths or position.
4. Missing covering, spot, or marker tape.
5. Improper identification or color of marker tape.
6. Excessive length of tape tails.



GAPS IN TAPE



LOOSE TAPE



TAIL LENGTH EXCESSIVE



GOOD TAPING

## C. Identification of Defect

If one or more of the preceding defects caused the harness to be rejected, a piece of red or yellow tape will be placed on the defective area.

## Repair Procedure

1. Missing, loose, holes, or gaps in vinyl covering.
  - a. Defective area only a few inches in length.  
Tape over defective area with sticky electrical tape.
  - b. Defective area extensive in length.  
Retape with vinyl tape following normal taping procedures.
2. Dimensional errors.  
Remove existing tape causing dimensional error and retape to correct dimensions.
3. Missing spot or marker tape.  
Incorrect spot or marker tape.  
Add as required and remove the incorrect application.
4. Excessive length of tape tails.  
Cut off to correct dimension. Tape tails should not exceed 2" in length and should not reach the end of the nearest terminal or connector.

## E. Conclusion

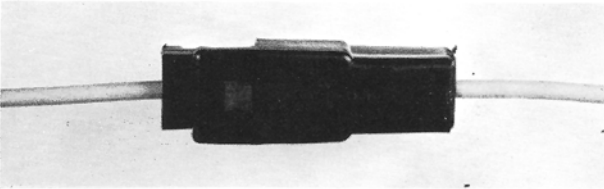
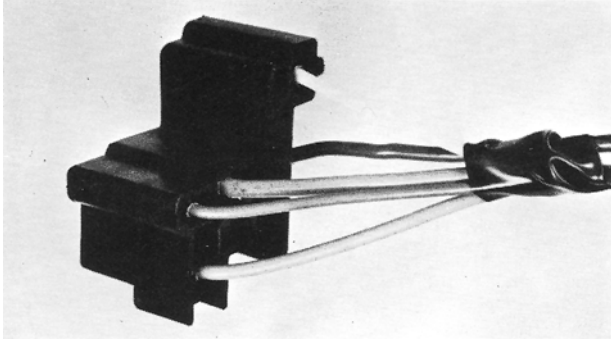
The following points should be considered when repairing defects related to taping.

1. Tape intended to form a jacket for the harness should overlap itself by at least 1/8 of an inch.
2. Jacket tape should be snug and neat in appearance.
3. Dimensional errors are extremely difficult to correct in the vehicle. These problems must be fixed correctly at Packard.
4. Tails which are too long can become caught in moving parts of the vehicle or cause connecting problems of the harness.
5. The customer's only means of identifying the harness is the marker tape. It must be there and correct.

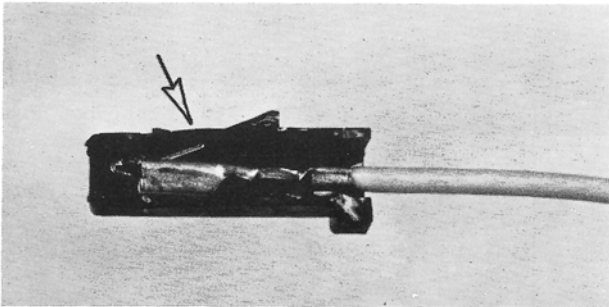
# V CONNECTORS

## A. Introduction

Connectors are usually a plastic shell designed so that two or more terminated wires can be joined together. The connector provides a mechanical joint for the wires and also insulates the connection.



In most cases, the terminal(s) are held in the connector through the means of a locking tang(s).



The Tiger-Paw connectors have a locking latch which aids in keeping the terminals inside the connector instead of becoming unseated and pushed or falling from the connector cavities. If the terminals are bent or burred, the latch on the Tiger Paw connectors will not close. These terminals would have to be replaced. Any Tiger Paw connector with three (3) cavities or more, that is replaced, will also require the harness to be electrically rung-out.

## B. Types of Defects

Common type defects related to connectors are as follows:

1. Wires placed in the wrong position (crossed wires).
2. Wrong connector.
3. Broken or unfilled connector.
4. Terminals not seated.

## C. Identification of Defect

Defects that are known will be identified by a piece of red or yellow tape placed on the defective connector. In the case of crossed wires, the harness may be rejected as an electrical and will be identified with a piece of red and white striped tape on the body of the harness.

## D. Repair Procedure

1. Crossed wires.

Remove the crossed wires and place them in the correct position. This is accomplished by depressing the terminal locking tang with a pick or specially built tool and withdrawing the terminal. Make certain to lift the locking tang before reseating the terminal. If the tang becomes damaged in the process, the terminal will have to be replaced. (See section II-D.)

2. Wrong connector.

Remove all the wires following the procedure above (V-D1) and replace with the correct connector.

3. Broken or unfilled connector.

(See V-D2.)

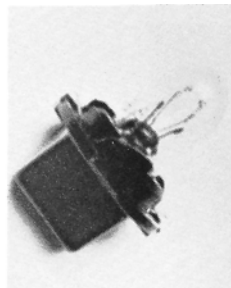
4. Terminal not seated.

First try to seat as is. If this is not successful, remove the terminal from the connector, reposition the locking tang and then attempt to seat the terminal. If this fails, replace the connector. (See V-D2.)

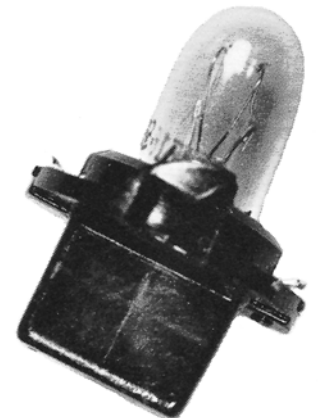
## E. Conclusion

In all types of connector problems, it is important to make sure that the terminal is seated, locked, and in the correct position after the repair. A terminal not seated may hold its position through all assembly steps and become disengaged while in service.

## F. Wedge Base Lamp Sockets

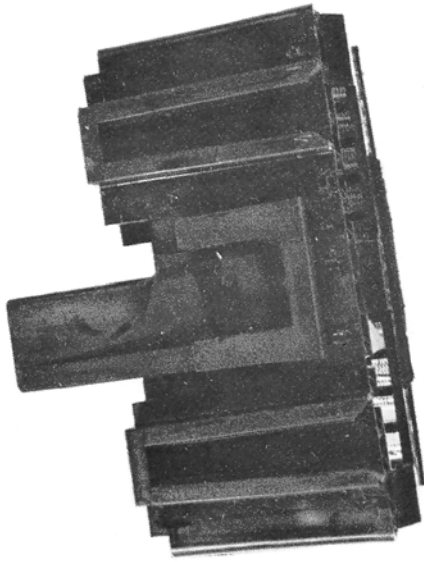


1/2" WEDGE BASE  
LAMP SOCKET

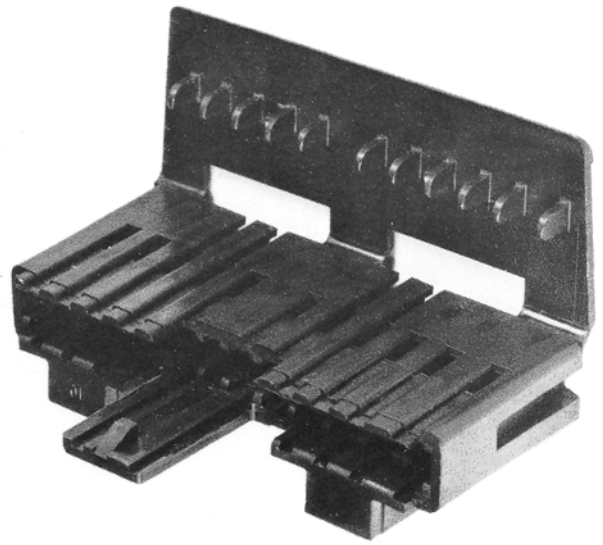


5/8" WEDGE BASE LAMP SOCKET

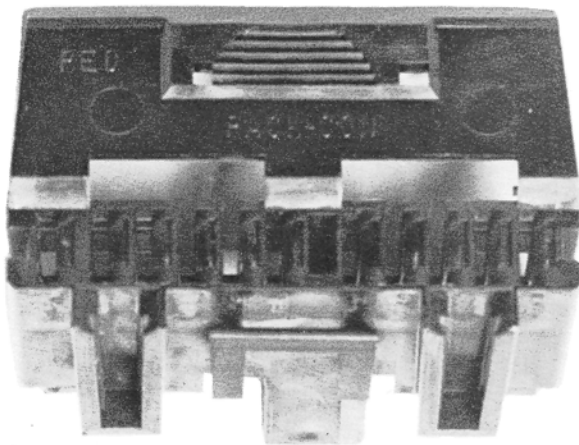
SOME COMMON TYPES OF TIGER PAW CONNECTORS



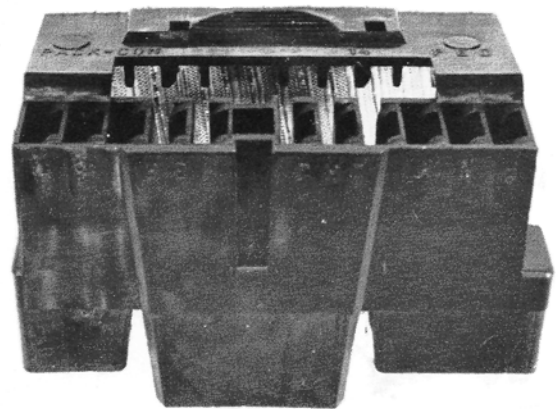
TURN SIGNAL



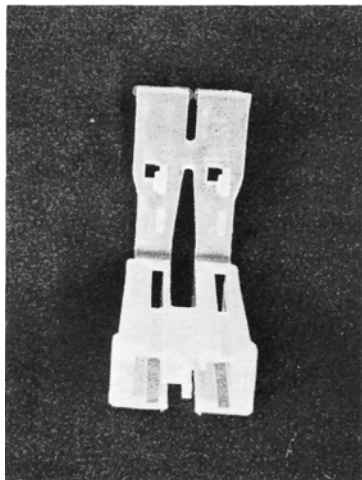
TURN SIGNAL



BODY CONNECTOR



BODY CONNECTOR



CLOCK FEED CONNECTOR

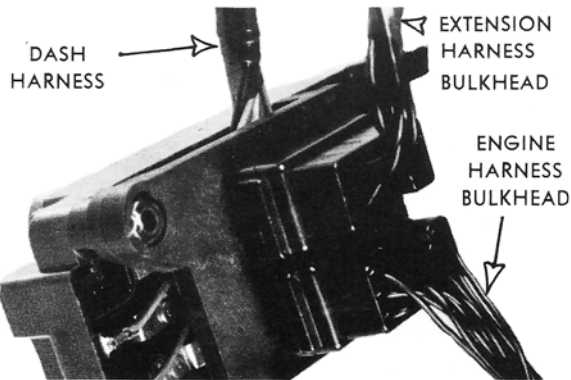


CORNERING LAMP CONNECTOR

# VI BULKHEAD AND FUSE BLOCKS

## A. introduction

Fuse blocks and bulkhead connectors are related in that they fit together in the automobile joining the dash, extension, and engine harnesses. The fuse block is part of the dash harness and is located on the passenger side of the firewall of the automobile. The extension and engine harnesses each have a bulkhead connector that mate with the fuse block from the engine side of the firewall.



It is important that the correct parts are used and that they are not defective. The repair of a bulkhead or fuse block in an automobile becomes very difficult. Also, since three electrical "nerve centers" join together at this point, their functions are quite critical. The bulkhead connectors, being located on the engine side of the firewall, are exposed to water, salt, dirt, etc. and must be sealed to protect the terminals.

## B. Types of Defects

### 1. Fuse blocks

The fuse block is molded from a hard phenolic material which can break or crack if subjected to shock. Thus, broken, cracked, or unfilled blocks are potential defects. Blocks with missing, defective, or wrong-bus bars, printing, and fuses will also be rejected.

The fuse block using the auto-fuses, is made of nylon material. This material reduces the number of fuse blocks rejected due to cracking, chipping or breaking. Crossed wires and terminals not seated properly will be marked as a reject in the fuse block.

### 2. Bulkhead connector - Engine Compartment

A corrosion preventative compound substance (CPC), is applied to the rear of the bulkhead connectors to make them water tight. This compound is applied by a machine process around the wires and terminals to seal the terminals. Any "holes" showing daylight are rejects. As

in other types of connectors, crossed wires and unseated terminals are also potential rejects in the bulkhead connector.

If the bulkhead connector has to be changed, the repair operator should have a "grease machine" in the repair station to seal the repaired connector.

The method used to replace the metal insert in the bulkhead connector is to heat the metal insert on the variac solder gun for a time of approximately 30 seconds, using long-nose pliers, then place metal insert into bulkhead connector, using water to cool.

## C. identification of Defect

A piece of red or yellow tape will be placed on the bulkhead or fuse block indicating that it or something to do with it is defective. In the case of bulkhead connectors, crossed wires and terminals not properly seated are normally observed prior to sealing. Therefore, when these defects occur, the inspector will not seal the connector so that the repair can be more readily accomplished.

## D. Repair Procedure

### 1. Fuse blocks.

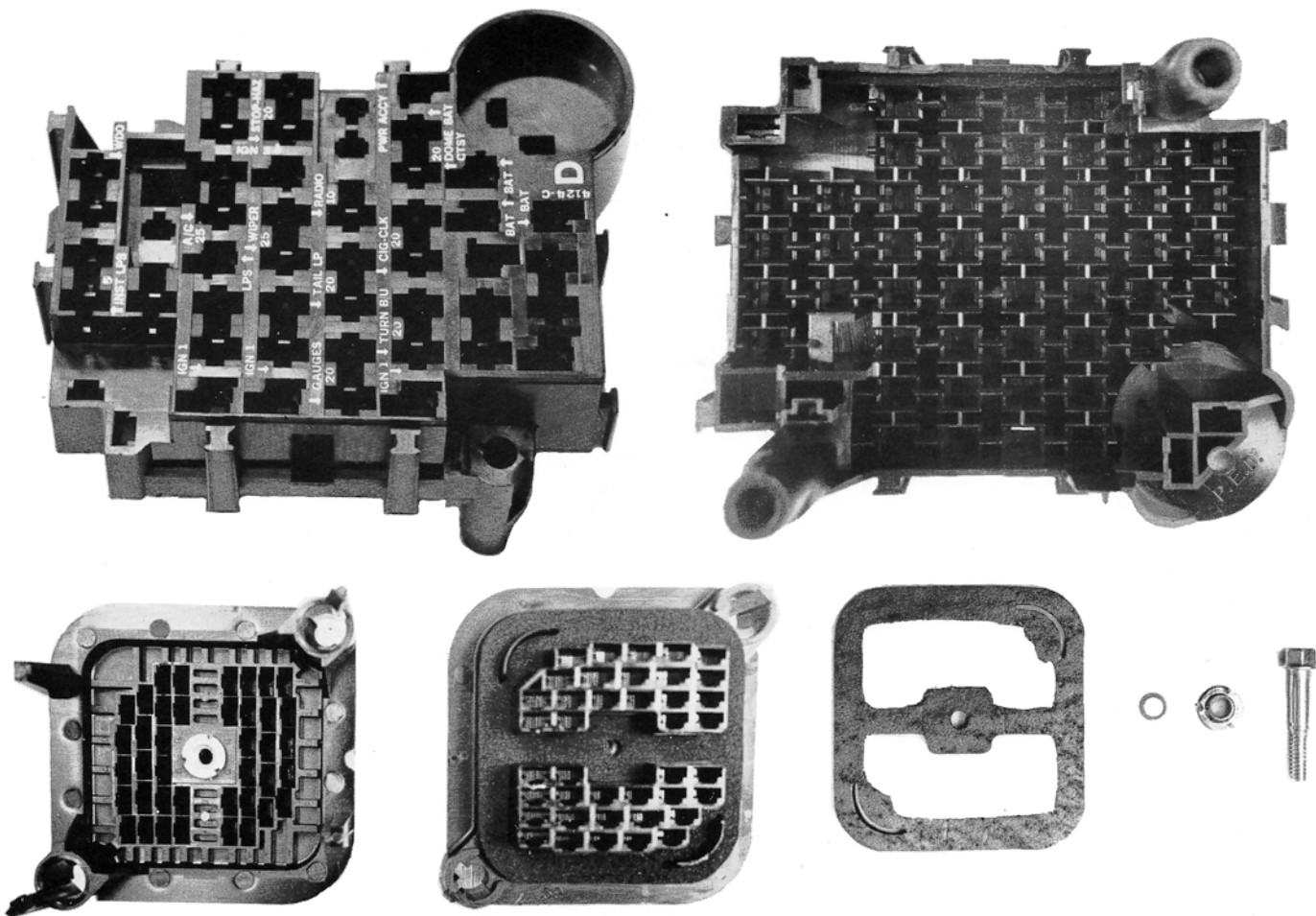
- a. Cracked, broken, wrong block, not filled out, and in some cases, missing, wrong, or defective printing and bus bars. Repair by disconnecting the terminals and replace the fuse block.
- b. In some cases, it may be necessary to replace the missing, wrong, or defective bus bar.
- c. Printing errors should be checked through the supervisor as to the method of repair.
- d. Crossed wires and unseated terminals should be corrected by uncrossing or seating as the case may be. See the section on terminals if the terminal must be replaced.
- e. After repair of fuse block defects, the harness must be checked out electrically.

### 2. Bulkhead Connector — Engine Compartment.

## E. Conclusion

Fuse block and bulkhead defects occur as defective connectors, crossed wires, unseated terminals, and missing or defective components. These connectors play an extremely important roll in the automobile in tying together the dash, extension, and engine harnesses.

INSTRUMENT PANEL



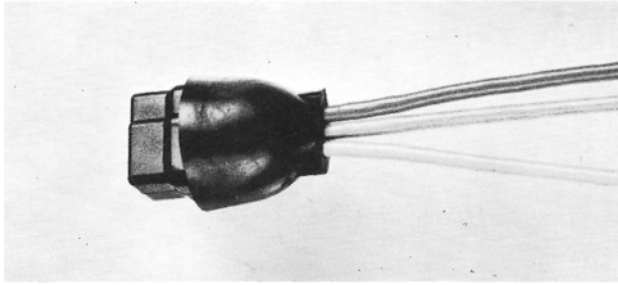
ENGINE AND FORWARD LAMP



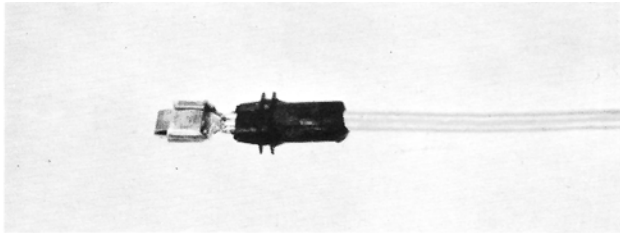
# VII MOLDS

## A. Introduction

Generally, molds will occur as plugs or cavity seals.



PLUG

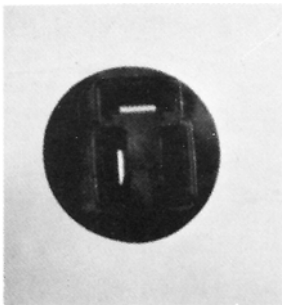


CAVITY SEAL

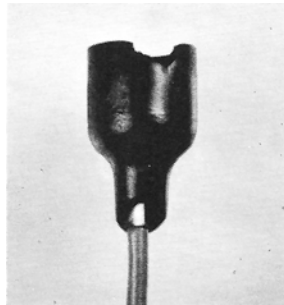
In either case, one of the primary functions of a mold is that of water sealing. The molded part is usually found in the engine compartment, head lamp area, or tail lamp area of the automobile. In these areas, the electrical connection is exposed to water, road salt, and other elements leading to corrosion.

## B. Types of Defects

The molding process is accomplished by heating material until it becomes liquid and then forcing the liquid into a die and around the terminal. Consequently, if things are not just right a possibility exists of getting compound on the terminal where it is not wanted, of not getting enough compound where it is needed, or of getting excess compound around the part in the form of flash. It is also possible for the pressure of molding to move the terminal in the die and cause it to be mislocated in the mold.



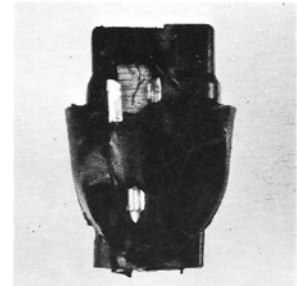
COMPOUND ON TERMINAL



NOT FILLED



EXCESSIVE FLASH



TERMINAL NOT SEATED PROPERLY

## C. Identification of Defect

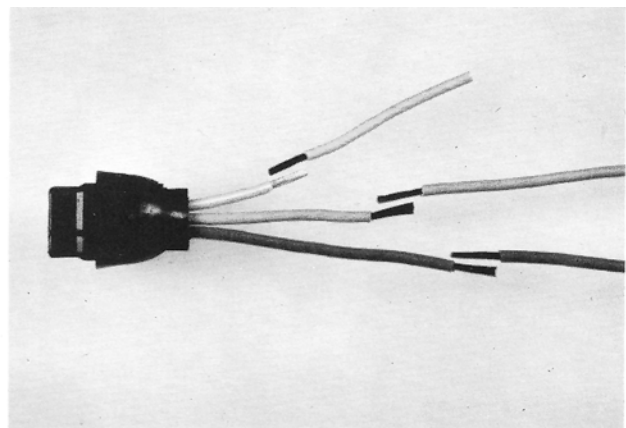
If one or more of the preceding defects caused the harness to be rejected, the defect(s) will be marked with a piece of red or yellow tape. If the defect is due to compound on the terminal or a terminal not seated properly, it may result as an electrical reject. In this case, the harness will be marked with striped tape. The inspector may not have known the cause for the electrical failure and it will be the responsibility of the repair operator to locate it. (See section on Electricals.)

## D. Repair Procedure

In cases of excessive flash and sometimes for compound on the terminal, it will be possible to trim off the excess molding with shears.

If the part is unfilled or the terminal is not properly seated or the excess cannot be trimmed off — use the following method.

Remove the defect by cutting off the wire(s) at a point which is under tape. Splice in a new molded section following the procedure under the section titled 'Splices and Wires'. If this type of defect occurs frequently, it is advisable to have some ready made molded pieces which can be spliced in.



PRE-MOLDED ASSEMBLY FOR REPAIR

### **E. Conclusion**

Defective molds will usually occur as:

1. Material over contact surface of terminal.
2. Excess flash.
3. Unfilled molds.
4. Terminals mis-seated.

It may be possible to trim off excessive material. Usually repairs are made by cutting off the defective molded section and splicing in a new one.

Molds must "fit" with their mating parts and must function to seal off the elements as intended.



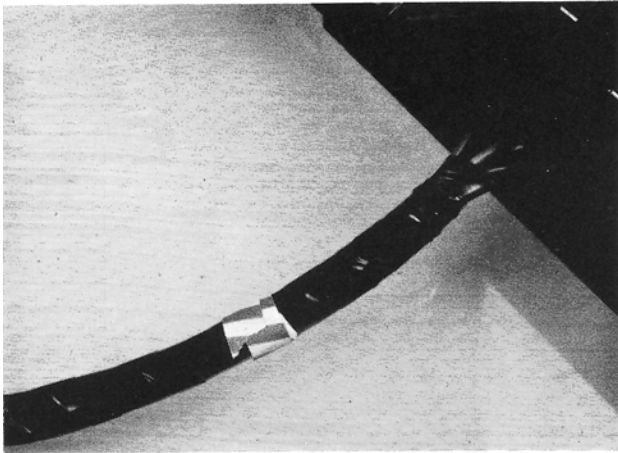
# VIII ELECTRICALS AND BULB TESTING

## A. Introduction

Electrical rejects are so named because the ringout system of the tool on which they were built did not clear itself. This is an indication that something may be wrong with the harness which does not permit the electricity to flow in each and every circuit in the manner it was supposed to. Defective terminations, crossed wires, terminals not seated properly in connectors, broken or cut wires, and missing wires can cause failure. Because of the complexity of the electrical ringout system, sometimes a harness fails to ring out because the system itself is defective.

## B. Identification of Defect

Electrical rejects are so indicated by a piece of red and white striped tape around the body of the harness.



## C. Repair Procedure

The first step in repairing an electrical is to hook it up on the repair ringout board and use the electrical read-out system to locate the defect.

Once the harness has been repaired, the fuse(s) must be replaced. The fuse block, with the replaced fuse(s) must then be placed on fuse continuity checker to insure all fuses are in the block and in the proper place.

Once the defect is found, if one exists, it can be repaired by following a method described in a preceding section. If the harness is found to contain no defects, the inspector and foreman should be notified so that the building board's ringout system can be checked.

There may be other defects in the harness.

NOTE: any three (3) cavity or more connector that is replaced will require the harness to be electrically rung-out. Also, any splice that is replaced will also require the harness to be electrically rung-out.

The Electrical Read-Out System is as follows:

A chart is provided which shows which number should appear in the read out windows for each circuit tested in the harness. If the electrical read-out stops on a particular number before the read-out returns to zero (0), look on the chart and find which circuit caused the failure. Then, by investigation of this circuit, its end terminations, checking for crossed wires, seating of terminals, missing splice wires, etc. - normally, the cause for rejection can be found.

## D. Conclusion

Electrical testing of a wiring harness is a very important step in preventing defective harnesses from reaching the customer. All electrical rejects should be treated very seriously and checked out thoroughly. Never allow an electrical reject to be shipped until it passes the electrical test on the ringout board.



## BULB TESTING

Bulb rejects are to be marked with a piece of yellow tape around the body of the harness. The electrical ring-out board has been re-designed to allow a separate switch setting for checking bulbs.

Where the switch selector for bulb checking is available, the repair operator only has to hook up the lamp sockets, radio connector and in most cases the turn signal connector. All other connectors and terminals are not hooked up on the ring-out board.

Occasionally, a bulb may be missing from

the lamp socket. Upon replacing the bulb, the operator must hook up the harness on the ring-out board (hooking up those items mentioned above) and check out the bulbs.

#### **AUTO-FUSE**

On all harnesses using the auto-fuse fuse block that are rejected for electrical reasons, the fuses will NOT be inserted on the conveyor line by the production or the inspection operator. This allows the repair operator to hook up the harness without removing the fuses from the fuse block. However, after "ringing-out" the harness, the operator must insert the fuses into the fuse block in the auto-fuse inserter (located in reop area), place the fuse block into the fuse presence checker (located next to the fuse inserter in the reop-area). The harness can then be placed on the dispose rack.

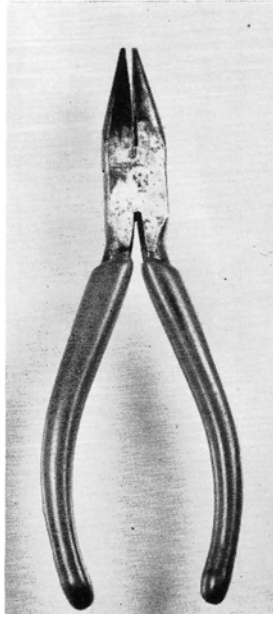
#### **Repair Procedure**

After repairing a harness, the operator will place a small piece of colored tape (identification tape) on the fuse block. If the harness has been checked on the ring-out board because of being rejected electrically, a piece of colored I.D. tape and a piece of red tape are placed on the fuse block to show that the harness was repaired and checked electrically.

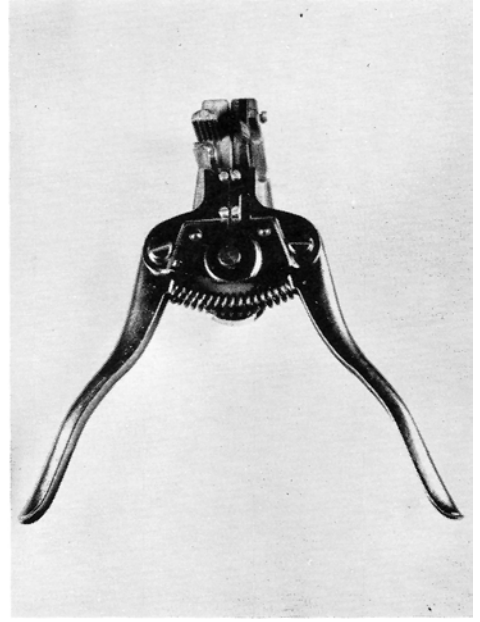
# IX STATION AND TOOLS



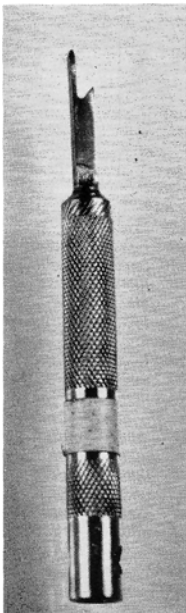
SHEARS



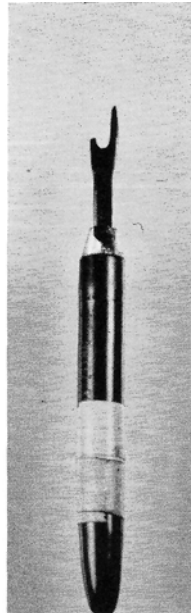
PLIERS PINCHERS



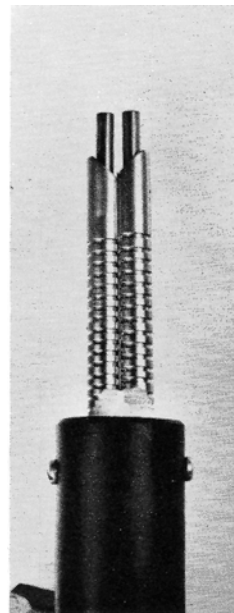
STRIPPERS



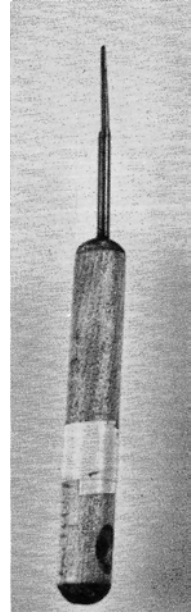
iii  
TWIN LOCK  
STRAIGHTENING  
TOOL



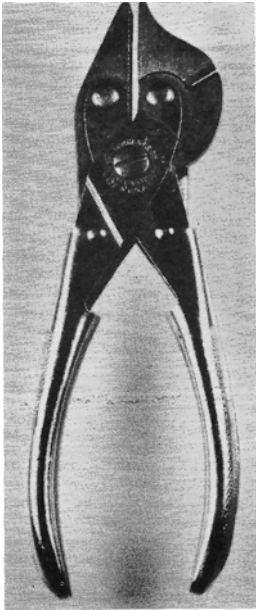
SEAM RIPPER



VARIAC IRON



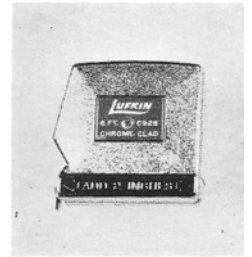
PICK



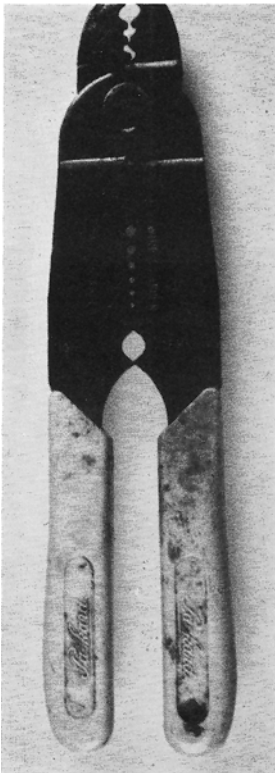
BENARD PLIERS



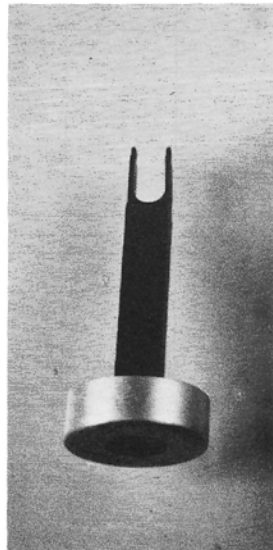
6 in. RULE



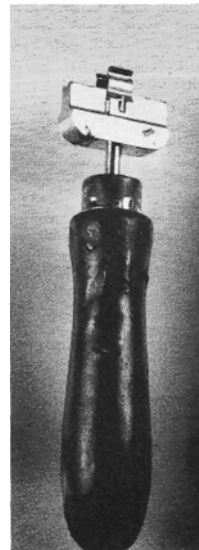
6 ft. TAPE



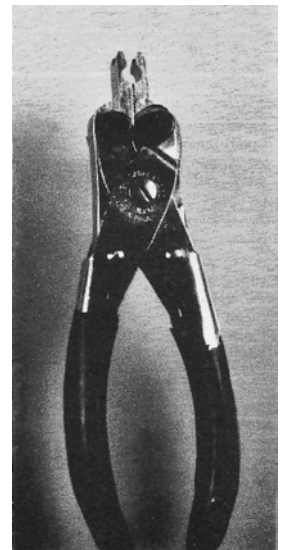
CRIMP TOOL



FUSE CLIP  
REMOVING TOOL



FUSE INSERTION TOOL



FUSE REMOVER

# REPAIR STATION

INSTRUMENT PANEL WITH BUS BAR FUSE BLOCK



# REPAIR STATION

INSTRUMENT PANEL WITH AUTO FUSE BLOCK

