

**REPAIR  
AND  
MAINTENANCE  
OF  
LARGE  
APPLIANCES**

+++++

**John E. Traister**

# **REPAIR AND MAINTENANCE OF LARGE APPLIANCES**

**John E. Traister**

**PRENTICE-HALL, Inc., Englewood Cliffs, New Jersey 07632**

*Library of Congress Cataloging-in-Publication Data*

Traister, John E.

Repair and maintenance of large appliances.

Includes index.

1. Household appliances, Electric—Maintenance and repair. I. Title.

TK7018.T68 1986 683'.83 85-23248

ISBN 0-13-773458-1

Editorial/production supervision: *Raeia Maes*

Cover design: *Ben Santora*

Manufacturing buyer: *Rhett Conklin*

© 1986 by Prentice-Hall, Inc.

A Division of Simon & Schuster

Englewood Cliffs, New Jersey 07632

All rights reserved. No part of this book may be reproduced, in any form or by any means, without permission in writing from the publisher.

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 0-13-773458-1 025

Prentice-Hall International (UK), Inc., *London*

Prentice-Hall of Australia Pty. Limited, *Sydney*

Prentice-Hall Canada Inc., *Toronto*

Prentice-Hall Hispanoamericana, S.A., *Mexico*

Prentice-Hall of India Private Limited, *New Delhi*

Prentice-Hall of Japan, Inc., *Tokyo*

Prentice-Hall of Southeast Asia Pte. Ltd., *Singapore*

Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*

Whitehall Books Limited, *Wellington, New Zealand*

## PREFACE

The repair of household appliances has been a profitable sideline or a full-time occupation for many people over the past several decades. In many cases, appliance servicing is a profitable adjunct to related businesses such as electrical contracting, radio-TV servicing businesses, and the like. In most cases, however, the appliance servicing department will be a part of an appliance sales business, and their advertisement may run something like "WE SELL THE BEST AND SERVICE THE REST!"

There are also numerous homeowners who are becoming aggravated with the waiting period required in getting their own appliances serviced, and are now learning to do the work themselves. This poor service is really not the professional's fault; there are just too many sick appliances out there and not enough service technicians to repair them—at least not in the allotted time that most appliance owners will give. Still the problem exists, and more and more homeowners are learning how to repair their own appliances.

At first glance, some appliances may seem complicated. Although some of them are, most can be repaired easily and quickly by following a few simple troubleshooting techniques—many of which are described in this book. Disassembling certain appliances may be a bit tricky, but it can be done with a little knowledge and patience.

We have limited this book to large appliances mainly because with the current high labor rates, it is often more practical to purchase new small appliances than to have them repaired. For example, many appliance service shops are charging a minimum of \$15 per hour plus the cost of parts with a reasonable markup. By the time, say, that a toaster has had a heating

element replaced, the cost is probably about \$20, and a new toaster can be purchased for around \$15 at discount houses. In most cases, the only way the repair of small appliances can be practical is when the appliance owner has the time and knowledge to do the repair himself or herself. Then the only expense is the cost of the parts.

Another reason for limiting this publication to large appliances is because of the many, many other fine books available that deal strictly with small appliances. Few, however, are available that cover large-appliance servicing as thoroughly as we do in this book.

*Repair and Maintenance of Large Appliances* starts off at the beginning and takes first things first. You will obtain a basic understanding of electricity, tools of the trade, testing and the like. The chapters that follow cover practically every conceivable large appliance, including the newer microwave ovens and ground satellite receiving stations. Common causes of each appliance's malfunctioning are given as well as the best methods to correct them. You will also find valuable hints on making your appliances last longer by giving them proper maintenance.

My thanks go to all the manufacturers who supplied valuable reference material for use in this book. It would have been a difficult task indeed without their help.

*John E. Traister*

# CONTENTS

PREFACE, v

- 1 INTRODUCTION TO HOME APPLIANCE  
SERVICING, 1
- 2 PRINCIPLES OF ELECTRICITY, 10
- 3 TOOLS FOR APPLIANCE REPAIR, 28
- 4 TESTING AND MEASURING, 39
- 5 ELECTRIC RANGES, 47
- 6 ELECTRIC SPACE HEATERS, 49
- 7 ELECTRIC WATER HEATERS, 63
- 8 ELECTRIC MOTORS, 69
- 9 ELECTRIC WASHING MACHINES, 93

- 10** AUTOMATIC CLOTHES DRYERS, 96
- 11** SATELLITE TELEVISION, 104
- 12** ELECTRIC DISHWASHERS, 117
- 13** GARBAGE DISPOSALS AND COMPACTORS, 127
- 14** MICROWAVE OVENS, 131
- 15** HOUSEHOLD REFRIGERATORS AND FREEZERS,  
150
- 16** ROOM AIR CONDITIONERS, 159
- 17** ELECTRONIC AIR FILTERS, 169
- 18** HUMIDIFIERS AND DEHUMIDIFIERS, 173
- 19** WATER PUMPS, 178
- 20** MOTOR CONTROLS, 186
- INDEX, 213

CHAPTER

1

INTRODUCTION TO  
HOME APPLIANCE  
SERVICING

Most modern appliances manufactured in the United States are designed to last several years—if not decades—but all of them are subject to certain common malfunctions that will occur from time to time. Worn or broken parts will need to be replaced, electrical wiring and controls will burn out or change their electrical value, and a host of other problems may arise. In every case, before an appliance can be repaired, the problem must be determined; then a definite plan must be followed to do the actual repair. Finding out exactly what is wrong with a malfunctioning appliance is known as *troubleshooting*, and that is the main focus of this book—to determine what the problem is and how to correct it.

Experienced appliance service personnel have found and corrected so many appliance problems that most repairs are second nature to them, but all still use troubleshooting techniques. For the novice, there are simple, efficient procedures that can be followed until one starts acting and thinking like a seasoned technician, which does not take long. In any case, it must be remembered that the problem has to be identified before it can be corrected.

**SAFETY**

To service and repair appliances of any type, the service technician should have a good understanding of electricity and mechanics and know how to apply modern test techniques. Testing instruments are covered thoroughly in Chapter 4, but since these instruments will be used quite frequently in





**Figure 1-1** Large appliances such as electric ranges, refrigerators, dishwashers and the like are found in practically every kitchen in the United States and abroad. (Photo courtesy of author.)

testing all types of large appliances, certain safety precautions should be mentioned at this time.

When any testing instrument is being used, always consider your personal safety first. Know the voltage levels and shock hazards related to all appliances being tested and make certain that the instrument used has been tested and calibrated; this should be done at least once a year. To prevent damage to the instrument, or the possibility of receiving an uncomfortable or hazardous electric shock, select a range (on meters with different ranges) that ensures less than full-scale deflection of the needle. A midscale (or higher) deflection of the needle usually provides a more accurate reading.

During any testing, the service technician must always take certain precautions. For example, there is the possibility of the frame or housing of an appliance being shorted; that is, a broken or frayed “hot” conductor touches the supposedly grounded frame, making the frame itself “live.” If the technician happens to be standing on a concrete floor without insulated shoes, merely touching the frame of the appliance could give a severe shock, and if any moisture is present, this shock could be fatal. Therefore, it is always good to use only the test probes of the instrument to touch an

appliance's frame once the power cord is plugged in, until it proves to be safe. Even then, it is recommended that a dry wooden board be placed on the floor in front of the bench or test area for the technician to stand on during testing of appliances.

Many large appliances, such as electric ranges, clothes dryers, and electric ironers, utilize heating devices for their operation. These heating elements can cause severe burns and caution must be exercised in this respect. Never touch open conductors with the bare hands while an appliance is energized; use the testing instruments. Furthermore, once a heating appliance has been disconnected, the elements normally stay hot for several minutes afterward, so certain precautions are in order here also.

Some appliances, such as automatic washers, utilize gears to enable them to perform certain operational functions. With the gear housing off, this gear train can be exceptionally hazardous, and most can chew up fingers, grab pieces of clothing such as a necktie, and produce similar happenings. Be extremely cautious when operating such appliances without guards or gearbox housings in place.

Although volumes could be written describing the essential safety precautions of each large appliance, here are a few that should always be observed while using or servicing such appliances:

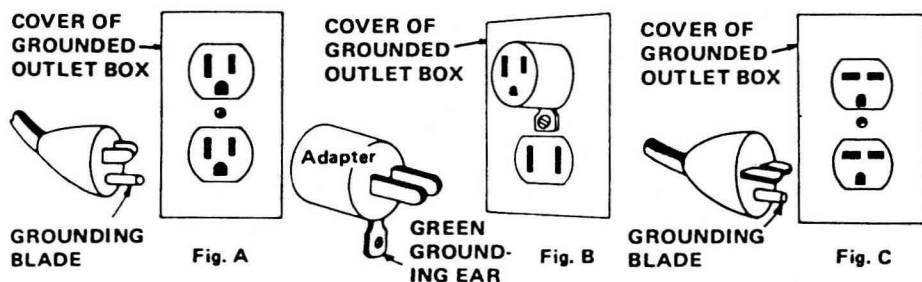
1. Know the appliance before using or repairing. Read the owner's manual carefully. Learn its applications and limitations as well as the specific potential hazards peculiar to it.
2. Ground all appliances—unless double-insulated. If the appliance is equipped with a three-prong plug, it should be plugged into a three-hole electrical receptacle that is functioning properly. If an adapter is used to accommodate a two-pronged receptacle, the adapter wire must be attached to a known ground. Never remove the third prong. For some large appliances that are directly connected, make absolutely certain that the frame is thoroughly grounded before putting the appliance back into use.
3. Guards will sometimes have to be removed when servicing, but make certain that they are back in place before the appliance is put into permanent use.
4. Keep the work area and test benches clean. Cluttered areas and benches invite accidents.
5. Avoid dangerous environments. Avoid performing tests in wet, damp, or gaseous or explosive locations. The average basement has all these hazards. Keep the work area well lit.
6. Keep children away from the work area. Children and other visitors will always want to touch something if allowed in the work or testing area. Keep them at a safe distance.

7. Wear proper apparel. When testing or repairing large appliances, make sure that you are not wearing loose clothing or jewelry that could get caught in moving parts.
8. During certain repair operations, grinding, drilling, or cutting may be necessary. When performing any of these operations, it is a good idea to wear safety glasses. Also, when performing electrical tests, an arc or spark could damage the eyes, so wearing safety glasses at all times is a good practice.
9. Do not abuse the power cord to any appliance. Never pull or carry the appliance by the cord or yank it to disconnect it from any receptacle. Keep the cord away from heat, oil, and sharp edges.
10. Keep hands away from cutting edges, heating elements, and all moving parts.

## GROUNDING

All appliances should be grounded while in use to protect the operator from electric shock. Most 120-volt (V) appliances that are not designed for direct connection are equipped with an approved three-conductor cord and three-prong grounding-type plug to fit the proper grounding-type receptacle. The green conductor in the cord is the grounding wire. Never connect this green wire to a live terminal. Some 240-V appliances, such as room air conditioners, also utilize a three-wire cord, but the plug is different from those used on 120-V equipment. Figure 1-2 shows three types of appliance plugs in common use.

If an extension cord must be used for testing or operating an appliance, make sure that it is of the three-wire type and has a three-prong, grounding-type plug. In fact, the appliance cord is usually the first thing to look at when servicing an appliance, and all defective or otherwise damaged cords should be replaced before any other testing is performed.



**Figure 1-2** All appliance cords with plugs should be of the grounding type, three versions of which are shown here.

## MECHANICS

Since many large appliances operate through gears, belts, and pulleys, those involved in the repair and servicing of appliances should have a basic knowledge of the principles involved.

Work is the overcoming of resistance through a distance, and the unit of measurement is the foot-pound; that is, a foot-pound equals a weight of 1 pound raised vertically a distance of 1 foot. The amount of work done is equal to the resistance in pounds multiplied by the distance in feet through which it is overcome. In other words, if a body is lifted, the resistance is the weight or the overcoming of the attraction of gravity, and the work being done is the weight in pounds multiplied by the height of the lift in feet. However, if a body moves in a horizontal direction, the work done is the friction overcome, or the force needed to move a resistant body or combination of bodies, multiplied by the distance the object has moved.

Motion, in itself, is not work. Also, the mere application of a force is not work. To be classified as work, a force must act through a distance overcoming some type of resistance.

Power is the rate of doing work, or the quantity of work done in unit time. The ordinary unit of mechanical power is horsepower, which is equivalent to 33,000 foot-pounds per minute, or 550 foot-pounds per second. The term "horsepower" is commonly abbreviated as hp.

**Centrifugal force.** If a ball is fastened to a string and is whirled so as to give it a circular motion, there will be a pull of greater or less amount on the string, accordingly as the speed of the ball increases or decreases. If the string is cut while the ball is in motion, the ball will fly off, away from the center of the circle in which it is whirling. The force that acts to draw a body away from the center around which it revolves is termed the *centrifugal force* of the body. It may be found by the equation

$$F = 0.00034WRN^2$$

where  $F$  = centrifugal force, in pounds

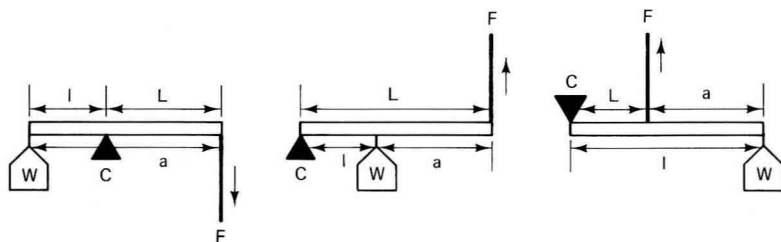
$W$  = weight of revolving body, in pounds

$R$  = radius, in feet, of circle in which the center of gravity of the revolving body moves

$N$  = revolutions per minute of revolving body

## MACHINE ELEMENTS

**Levers.** A lever is a bar that may be turned about a pivot, or point, as shown in Fig. 1-3. In each case, the object  $W$  to be lifted is called the load, or weight; the force that accomplishes the lifting is represented by  $F$ ;



**Figure 1-3** Three forms of levers in common use for all types of applications.

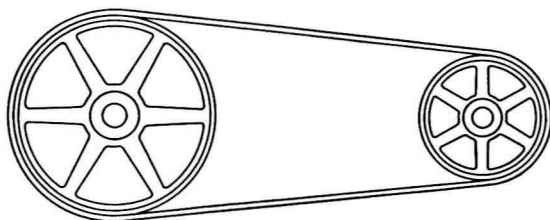
and the fulcrum, or pivot, is indicated by  $C$ . The distance  $l$  from the weight to the fulcrum is termed the *weight arm* and the distance  $L$  from the force to the fulcrum is termed the *force arm*. The distance between the force and the weight is denoted by  $a$ . Whenever the force  $F$  is just great enough to balance the load lifted, it will be found that the force times the length of the force arm is equal to the weight times the length of the weight arm. Therefore, in each of the forms of levers shown in Fig. 1-3,  $F:W = l:L$ , or  $FL = Wl$ . From this it follows that  $F = Wl/L$  and  $W = FL/l$ .

**Belting.** A belt, for our purpose, is a flexible band by which motion is transmitted from one pulley to another (see Fig. 1-4). The materials most commonly used for belts are rubber, metal, or other synthetic material. Belts may be termed two-ply, three-ply, and so on, and are further made in various shapes, such as V, flat, and so on. Rubber belting is probably the most popular at this time, as it can withstand changes of temperature without injury, is durable, and is claimed to be less liable to slippage than other types.

The distance between pulley centers depends on the size of the pulleys and of the belt; it should be great enough so that the belt will run with a slight sag and a gently undulating motion, but not great enough to cause excessive sag and an unsteady flapping motion of the belt.

The higher the speed of a belt, the less its width must be to transmit a given horsepower; consequently, in most conditions, a belt should be run at as high a speed as conditions will permit. To illustrate, the extremely wide leather belts of yesteryear have been replaced with narrow V belts a fraction of the size of the leather ones. The speed of a belt, in feet per minute, may be found by multiplying the number of revolutions per minute of the pulley by 3.1416 times the diameter of the pulley, in inches, and dividing the product by 12.

The pull on a belt is greatest on the tight, or driving, side, and least on the slack side. The difference between the tensions, or pulls, in these two sides is called the *effective pull*. However, in choosing a belt for a given



**Figure 1-4** Pair of pulleys set up for flat-belt drive.

appliance, it is always best to refer to the appliance manufacturers' specifications and acquire a belt that corresponds to their recommendations.

## ELECTRICITY/ELECTRONICS

Electrical problems with large appliances will, by far, outweigh all others combined, and it therefore stands to reason that anyone involved in appliance repair must have a good basic knowledge of electricity and how it operates under various conditions. In fact, electricity is so important that an entire chapter has been devoted to it in this book (see Chapter 2). However, some basic troubleshooting facts are in order at this time.

In general, there are only three basic electrical faults: a short circuit, an open circuit, or a change in electrical value.

**Short circuit.** A short circuit, basically, is an undesired current path that allows the electrical current to bypass the load on the circuit. Sometimes the short is between two wires, due to faulty insulation, or it can occur between a live wire and a grounded object such as the metal frame on an appliance.

When a short circuit is suspected, disconnect all loads from the circuit and reset the circuit breaker or replace the fuse. If this corrects the problem, it indicates that some load on the circuit is at fault. With the loads still disconnected, connect the test leads of an ohmmeter to the appliance leads—one test lead to each appliance lead—and take a reading. If there is a full-scale reading on the meter, the short circuit is probably in that particular appliance. A partial reading, however, may be had on the scale, which is an indication of resistance in either the motor or heating element. Try another load on the circuit until the fault is found.

Should the fault be in the circuit wiring itself (indicated by a tripped circuit breaker or blown fuse when all loads are disconnected from the circuit), the next step is to go along the circuit and open up the various outlet and junction boxes, and so on, until the trouble is located. In most

cases, the short circuit will be found at one of the heater junction boxes where a terminal has vibrated loose. Or perhaps one of the splices has become loose and is rubbing against the grounded heater housing.

At times, however, if repair or remodeling work has recently been done, the trouble may be caused by someone having driven a nail into a piece of nonmetallic cable, surface molding, or even through a piece of thinwall (EMT) tubing; or the conductors may have been cut in two by accident with a saw or drill.

**Open circuit.** An open circuit is an incomplete current path, like the broken wires in a circuit. Therefore, if the circuit is supplying an electric wall heater, and the circuit is open, the heater will not operate. A light switch or thermostat, for example, purposely opens a circuit supplying a load. If the switch is then turned to the ON position and the light does not burn or the heater does not heat, the first assumption is that the lamp is bad or the heating element has burned out. Both can be checked with the ohmmeter to determine if the element is good or bad. If either is good, the ohmmeter should show some resistance reading on the meter. If bad, there will be no reading on the meter. Should the element prove to be good, check for other problems in the circuit, in the following order.

1. A blown fuse or a tripped circuit breaker
2. A wire loose at the switch or thermostat, or in the fuse box
3. A faulty switch or thermostat

If the circuit in question is protected by a plug fuse, the nature of the problem can often be determined by the appearance of the fuse window. For example, if the window is clear and the metal strip appears to be intact, the fuse is probably not blown. But it is always best to check the fuse with a voltmeter or test lamp just to make sure. To test a plug fuse, place one lead of the voltmeter on the neutral block in the panelboard or fuse cabinet, and the other on the load side of the fuse. If a reading obtained is between 110 and 120 V, the fuse is all right. If the voltmeter does not show any reading or one that is below 100 V, examine the fuse window more closely. If the window is clear but you notice that the metal strip is in two pieces, it was probably blown due to a light overload. Perhaps a portable appliance was plugged in on the same circuit. In any event, check to see what overloaded the fuse before replacing it.

**Change in electrical value.** A change in either current, voltage, or resistance from the normal can lead to electrical problems. One of the most common causes of electrical problems is low equipment input voltage. This problem usually occurs for one or more of the following reasons:

1. Undersized conductors
2. Loose connections
3. Overloaded circuit
4. Taps set too low on power company's transformer

To check for low voltage, set the multimeter to the voltage setting of 250 V and take a reading at the main switch or service entrance. In most cases, residential electric services are single-phase, 120/240 V, three-wire. Therefore, the voltage reading taken between any two “hot” wires (usually colored black on one conductor and red on the other) should be about 240 V, and the reading between any of the hot wires and the neutral (white) wire should be about 120 V. If the reading is below these figures, the fault lies with the utility company supplying the power, and the company should be notified to correct the problem. However, if the reading checks out normal, the next procedure is to check the voltage reading at various outlets throughout the heating system.

When a low-voltage problem is found on a circuit—say, 100 V instead of the normal 120 V—leave the voltmeter terminals connected across the line and begin disconnecting all loads, one at a time. If the problem is corrected after several of the loads have been disconnected, the circuit is probably overloaded, and steps should be taken to reduce the load on the circuits or the wire size should be increased in size to accommodate the load.

Loose connections can also cause low voltage. The entire circuit should be deenergized, and each terminal of panelboard circuits, heater connections, and so on, should be checked for loose connections. A charred or blackened terminal screw is one sign that indicates this problem.

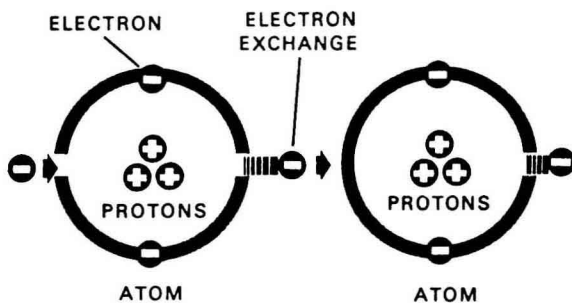


# CHAPTER 2 PRINCIPLES OF ELECTRICITY

Anyone involved in the repair and maintenance of large appliances should have at least a basic understanding of electricity and how it works, because the majority of repairs will deal in some way with electrical circuits.

Actually, it is easier to understand what electricity can do rather than to try to understand exactly what it is. The accepted theory is that electricity is the moving of electrons from one atom to another as shown in Fig. 2-1, and the number of electrons in motion determines the amount of electric energy produced.

When a wire or conductor is moved so as to cut magnetic lines of force as shown in Fig. 2-2, an electric voltage is generated. An electric circuit is a completed path for the exchange of electrons, and this action in a circuit



**Figure 2-1** Electricity is the moving of electrons from one atom to another.  
(Courtesy of American Association for Vocational Instructional Materials)