Study Group 1

ELECTRONIC FUNDAMENTALS

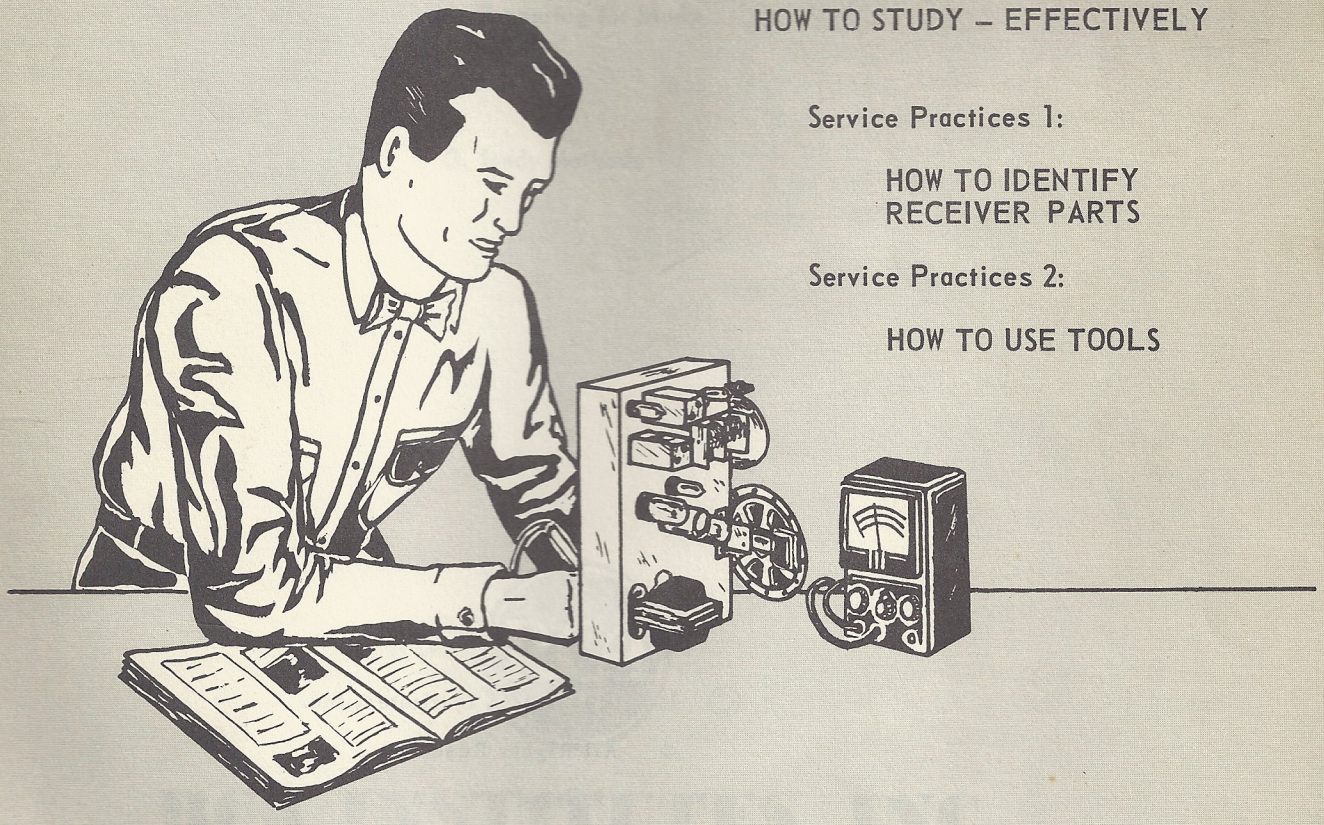
HOW TO STUDY – EFFECTIVELY

Service Practices 1:

HOW TO IDENTIFY RECEIVER PARTS

Service Practices 2:

HOW TO USE TOOLS



RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

New York, N. Y.

ELECTRONIC FUNDAMENTALS

HOW TO STUDY – EFFECTIVELY

1. Preparing for Study

2. Study Methods

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"The most important factor to keep in mind is to continue your education. Science and industry will reward you for your talents and energy. There is everything good yet to be accomplished in our lives and in our work. What man has done, man can do better."

David Sarnoff

Chairman of the Board
Radio Corporation of America

YOUR FUTURE

You are fortunate in having developed an interest in the field of electronics. A knowledge of electrical and electronic circuits, which this course gives you, will prepare you to take advantage of the many opportunities that exist today for trained technicians. In fact, no other field offers so many job possibilities as are found in electronics. This course is designed to give you a thorough background in general electronics, stressing basic radio theory and practical training. This background is essential to any advanced work in the field of electronics. There are many other careers toward which you might aim that require the same basic knowledge that this course provides. There are opportunities in broadcasting, television servicing, public address, industrial electronics, computers, etc. You have shown an interest in this field. We hope that you will maintain your interest and let nothing stand in the way of your electronics career.

Don't, even for a moment, think that your study of electricity and electronics will not cost you many hours of study and hard work. These lessons are not pink, sugar-coated pills of wisdom that you can swallow between supper and a movie or between dances. In fact, if you really mean to go ahead and get a sufficient knowledge of electronics to prepare you for a worthwhile job, you are going to have to work for it and possibly give up many an hour to study that you would rather spend in social activities, listening to the radio or television, or going to a dance or movie. When you do so, realize that the rewards will well repay you for any minor sacrifices that you may have to make. Once you have accepted the fact that learning anything worthwhile takes time, effort, and practice, you will have taken the first step towards success.

The one person who is responsible for for your ultimate success or failure is you. Because this is so, let us speak for a moment of the things you may think or do that may stand in your way. First, you must have the will to learn, even if it means that you *must* work for knowledge. Your will to learn may sometimes weaken because of a temporary lack of interest, resistance to learning something difficult, or just plain laziness. At such times, you must remind yourself of what success in this course will mean to you and get back on the job.

There are students who, for one reason or another, become easily discouraged, when a lesson becomes difficult to understand. With little encouragement, they are willing to give up the whole thing and say that the subject is beyond their capacities. Should you, however, begin to doubt yourself, remember that thousands of people, much like you, have successfully learned electronics and are now successfully working in the field.

Perhaps you may think (if you are an older man) that you are too old to learn electronics. You may even think that "you can't teach an old dog new tricks", but don't you

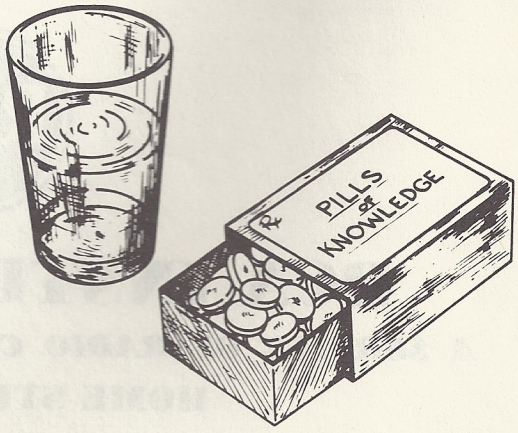


Fig. 1

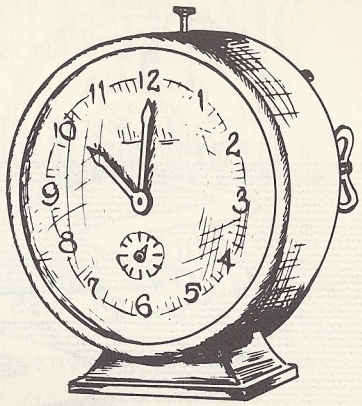
believe it. Between the ages of 22 and 50, your ability to learn a scientific subject declines no more than one percent a year, and this decline is more than compensated for by your ability to exercise judgment, the ability that comes in these later years. In our youth, we learn faster but more haphazardly; in our more mature years, we learn the important things and pass up the useless frills. So never say or even think that you are too old to learn.

Above all, never be guilty of saying "I could learn about electronics, radio, television, or any other subject, if I only had the time. Even those of us who seem to be busy all the time fritter away many an hour in any week. Learn to *make* the time and *take* the time to learn. You will discover that a few minutes spent now and then, in an effort to learn, pay large dividends. In fact, sometimes it is possible to learn more in a series of 5 or 10 minute study periods than could be learned in one session using the same total amount of time. We will speak more about this shortly.

1. PREPARING FOR STUDY

If you are like most people, you may never have learned how to study efficiently. This is not your fault. It is more the fault of your training in school or out of school. Except in certain modern schools and colleges, study methods are never taught, except to problem students. However, in taking this course, you are on your own, and your success in the course may well depend on your ability to study efficiently. So, even if you have never received any training in study methods until now, it will pay you to learn how you may best use your study time.

Budget Your Time. Each and every day you have 24 hours to spend. Let us assume that you spend 8 of them in sleeping and 8 in working. This leaves 8 hours to be spent in eating, recreation, and study. In addition, each weekend many people have more free time because they enjoy a 5-day work week. For most of us, this means that we have an average of 4 to 5 hours a day to spend in one way or another, which adds up to about 30 to 35 hours a week. Even if you spend



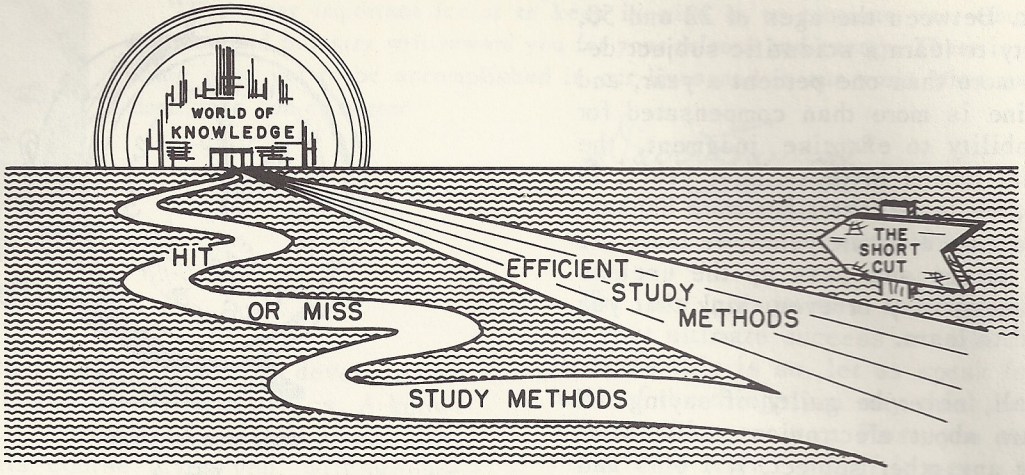
make time for study

Fig. 2

only half this amount of time in study and in doing your experiments, you can finish this course in less time than you may have thought possible until now. Your free time may be broken up into short periods or you may be able to set aside several hours in a row for study purposes. It does not matter much whether your study time is broken up or is in one piece. What is important is that you plan ahead so that you make full use of such time as you have. If you plan to study or work for several hours in a row, it is a good idea to take a five-minute break or rest period in each hour so that you can maintain your interest in what you are doing.

Your Physical Condition. Your success in studying depends in a great measure on your physical condition at study time. When you are physically tired, you may find it so difficult that you may become discouraged and think that the subject is too difficult for you. For that reason, it is a very good idea to rest a while before you study after a hard day's work. You may find that it pays to go to bed early, get up early, and do your studying before going to work. It may be that if you work very hard during the week that your most successful studying will be done during the weekends. If this is the case, be sure to plan your week-end study so that other things do not interfere with it.

Do not try to study just after eating a heavy meal. The blood rushes from your head to your stomach after eating, and makes you a bit drowsy, and in no mood for study. This being the case, do not prepare to study by raiding the ice-box,



take the right road

Fig. 3

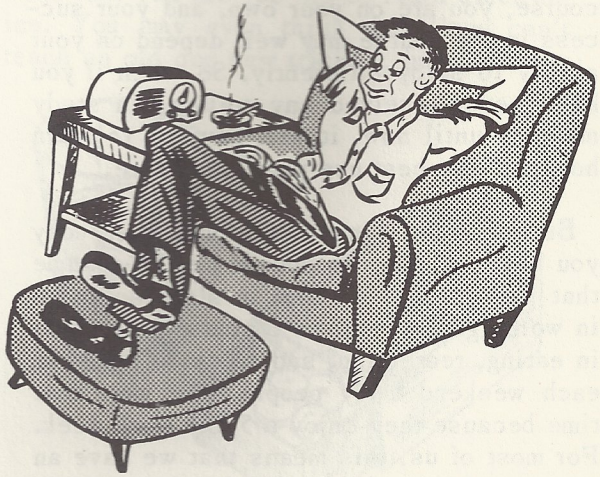
for you probably will be more successful in your learning if you are just a little bit hungry. On the other hand you don't want to try to study when you are very hungry, because you may find it difficult to keep your mind away from the subject of food.

The Place For Study. It is a good idea to set aside a desk, a table, or a bench, just for the purpose of studying these lessons. There is a good reason for this. You will begin to associate the desk, table, or bench with your study and when you sit down to work, you will find that it is easy to get into the mood for study. The chair that you sit in should not be too comfortable. The chairs or benches that you sat in when attending school were designed to keep you awake and mentally alert. So the chair you choose should not be one that will invite you to rest, because in studying electricity and electronics, you will need to be alert and have all your wits about you.

The desk, table, or bench should not be cluttered up with things that will distract you or take your mind off what you are doing. It should be clear of all things, except the lesson booklets, paper, pen or pencil, and the other things with which you may need to work. If your work place is near an open window, it's better that you seat yourself so that your back is to the window so that you won't be tempted to look out the window. For the same reason, you should not try to study and at the same time listen to the radio, phonograph, television set, or the conversations of people around you. To concentrate you should have quiet. This is not always easy to come by, so that it may take a little extra effort on your part and that of your family to see that you get the the quiet that you need for study.

One more note about your surroundings. Make sure that you have good light to study in. With good light you can see better and will not tire as easily.

Getting Started. With time to study, with a place in which to work, and something to study, you can get started in only one way,



don't get too comfortable

Fig. 4

and that is by deciding that *now* is the time to study and by *getting at it!* This sounds very easy, but sometimes requires an extra bit of will power to do. This is the time when you have to remind yourself of what kind of future may be yours when you have finished the course.

2. STUDY METHODS

Each of your lessons consists of three parts: a Theory Lesson, an Experiment Lesson, and a Service Practices booklet. Each of these is treated in a different manner and for that reason is discussed separately in these paragraphs.

We will start off with the Theory Lesson. For example, with this booklet you receive your first Theory Lesson, your first Experiment Lesson, and your Lesson Assignment, which is a test that you take after you have completed the lesson, and which you send to us for grading. We will tell you about this lesson assignment a little later.

Let's assume that you are now planning to sit down and study Theory Lesson 1. How should you go about it? There are, of course, several ways in which you might start to study the lesson. While there is nothing that is going to force you to follow the method that we are about to suggest, we do hope that you will try it out, because it is a method that has proved successful with many students in all parts of the country. So, while you may have some ideas of your own on the subject or some pet method that you have used in the past, we urge you to read the following pages carefully and see if what we suggest makes sense.

If you turn to the title page of Theory Lesson 1, you would find that it is called WAVE MOTION AND COMMUNICATION. You would also find, under the title, that the lesson discusses *Sound, Wave Motion, Sound Waves, Wave Length and Cycle, Frequency, Audio Frequency, Radio Frequency, the Radio Communication System,* and *the Need for Basic Electrical Knowledge.* If you have ever read anything about wave motion before, you may already have an idea of what the lesson is about just by reading the title page. If, as

ELECTRONIC FUNDAMENTALS

THEORY LESSON 1

WAVE MOTION AND COMMUNICATION

1-1. Sound
1-2. Wave Motion
1-3. Sound Waves
1-4. Wave Length and Cycle
1-5. Frequency
1-6. Audio Frequencies
1-7. Radio Frequencies
1-8. The Radio Communication System
1-9. Need for Basic Electrical Knowledge

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Fig. 5

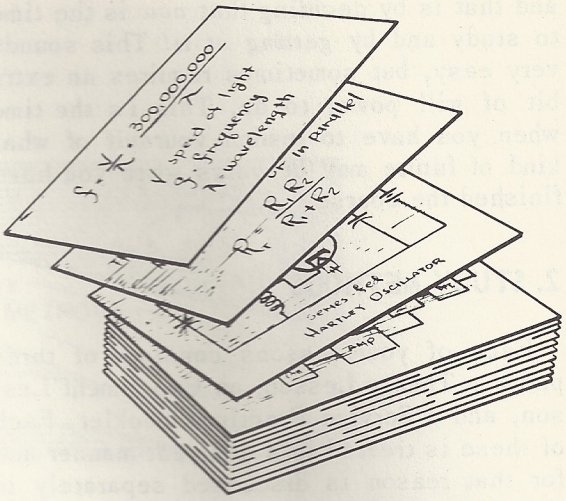
the case may be, *sound waves, wave length,* and *frequency* are brand new terms to you, then this list of topics does not tell you much. Even so, there are some words with which you are familiar. For instance, you must have heard the word *sound* and know that it refers to something that you can hear. You may not know exactly what we mean by the phrase *wave motion* but if you live anywhere near any body of water or have ever seen a moving picture of waves on a sandy beach, you know what a wave is and you probably can guess that *wave motion* must be something about the movement of a wave. So, even before you turn the title page to the first page of the lesson, you have some idea of what the lesson will discuss.

If you read the title page of a lesson in this way, you are taking the first step in

studying the lesson, because the first thing you should do in studying any lesson, any technical article in a magazine, or any page in a text book, is to find out what it is all about. Of course, reading the title page is only the beginning of this finding out process. The next step is to read the lesson, article, or page rapidly, to see if you can get a more complete idea of the subject without actually stopping to study any part of it. In so doing, you may see some words that are strange to you. In a lesson or in a page of a text book, new technical words are sometimes printed in italics (slanted letters). In our lessons, you will find that a word so printed is usually defined or its use is explained. You cannot hope to be able to read these lessons, unless you understand the meaning of each word as you come to it. This is true of even ordinary English words that are not technical words, and yet may be new to you. So, in this first rapid reading of the lesson read the definitions of any strange technical terms. If there is a general vocabulary word that is strange to you, you may find it necessary to look it up in the dictionary. The point that we are making now is that you must understand the meaning of each and every word before you settle down to actually studying the lesson.

Once you have discovered what the lesson is all about and what it is that you must learn, you are ready for the next step in studying. Before we discuss this step, however, it is necessary that we first talk about the way we learn things.

Rote Versus Understanding. We learn things in two ways. The first way is by *rote*, or memorizing. For example, in school when you were given the task of learning a poem or a song, you probably repeated the words over and over again, until you knew them by heart. We call this learning by rote, or memorizing. It's a good and effective method of learning things that cannot be learned in any other way. For example, many of us learn how to spell by rote. You may have learned the multiplication table by rote. But the silliest thing you can possibly do is to sit down and try to memorize Lesson 1 or any lesson in this course. Yet, there are parts of Lesson 1, and of other lessons that you will study in this course, which you should memorize. For example, meanings of certain technical words you should learn pretty much by rote, so that you will understand them when you see them in the text. You will find formulas. For example, it is stated in Theory Lesson 1 that *wave length equals the velocity divided by the frequency*. Unless you are told not to, you should memorize formulas.



small file cards for studying and review

Fig. 6

But formulas and the meanings of words make up only a small part of a Theory Lesson. The rest of the lesson must be studied, but as we have said, should not be learned by rote, which brings us to the other way of learning, which is by understanding. Sometimes it is much easier to learn by rote than it is to learn by understanding. By the same token, it is much easier to forget what you learned by rote than it is to forget what you once understood. What is more, should you forget something that you now understand, it is not difficult to review it at some later time, while if you forget something learned by rote, you find that it is necessary to relearn it completely. In fact, it is almost as if you had never learned it before. So apparently, learning with understanding is a better kind of learning. But just how do you go about it?

First, you start by studying a little bit of the lesson – as much as you think you can take in one bite. Just how much a little bit

is depends on you, on how well you read, the size of your vocabulary, or previous experience, and how quickly you learn. So, a little bit may be a sentence, a paragraph, or one of the numbered sections you find in the lesson. Just how much it is for you is something that you will have to find out for yourself.

So we come to our next step in studying a lesson. Figuratively, we take one bite out of the lesson, chew on it a little while, and see if we can swallow and digest it. Actually, we slowly read a sentence or a paragraph, or whatever your little bit turns out to be. It may take two or three readings in some cases before the sentence or paragraph gives up its full meaning to you. Once you think that you understand its message, that you know what it is all about, close the lesson booklet and in your own words, see if you cannot explain what you have just read. If you can put the meaning of what you have read into your own words, then you understand it. By the same token, if you cannot explain what you have just read in your own words, you don't understand it. It is as simple as all that. If you find that you cannot explain what the sentence or paragraph is all about (if you don't understand it), it will be necessary for you to study the sentence or paragraph some more. However, as soon as you *do* prove to yourself that you *do* understand what you have read, then pass on to the next sentence or paragraph – take another bite out of the lesson. When you come to a formula, work out the arithmetic of it yourself. Prove to yourself that any examples that may be given in the lesson on the use of the formula actually work out the way the lesson says they do. This helps you to understand the formula and also teaches you how to use it.

If you haven't time enough to study the lesson in one sitting, which will be the case in most of the lessons in this course, be sure to review what you have last studied before you go on to the next section. When at last you come to the end of the lesson, review the lesson before you answer the questions of the Lesson Assignment, which appears at the end of each Theory and Experiment Lesson booklet. One way in which you can review is to turn back to the title page of the lesson and see if you can remember what each of the sub-sections is about.

Using Small Amounts of Time for Study. Some of our students have jobs where they have free periods of five, ten, or fifteen minutes in length, periods that are normally wasted, periods that could easily be used for study. Such periods of time may be used in learning the definitions of technical terms, in learning formulas, and how to apply them, or even in learning small sections of the lesson itself. If you have time for reading a newspaper, a magazine, or a comic book, it might better be spent in such study. One advantage of study in this way is that you continue to think about what you have just learned for a short time after you have actually stopped studying and in this way you help to impress it upon your mind. So that three 10-minute periods of study are sometimes worth considerably more than a half-hour of continuous study.

One way to make use of small periods of time is to make notes on ordinary 3x5" file cards. For example, a formula that you want to learn may be put on a file card. Definitions can be treated in the same way, or you can summarize a section of the lesson on a file card. These file cards fit easily into your pocket and may be slipped out at any time you have a few minutes for study. What is more, you can use the same cards to help you review the lesson before you do the assignment.

Answering Questions. When you believe that you know the lesson well enough to answer the questions of the assignment, then turn to the end of the booklet and get to work. However, here are some suggestions that may add points to your grade. *Read each question completely before you answer it.* For example, if you are answering multiple choice questions, do not stop reading the alternative answers when you come to one that you think is the correct answer. Instead, read all four choices before you make your choice. *Do not jump to conclusions.* Read each question carefully. For example, if it is a true-and-false question, make sure that

you understand the statement before you mark it true or false, and remember, with such questions, a statement is true only if it is *always* true. That means, that if a statement is made that is true sometimes and untrue at other times, the answer must be that the statement is false. Reading the question carefully is also important when answering problems. Make sure that you understand what the problem wants you to find. Make sure that the figures that you use are those as given in the problem and then go ahead.

When your assignment is finished and you have answered all the questions to the best of your ability, send it to us for grading. The instructions for mailing an assignment are given on page 1 of each lesson assignment. Before you mail the assignment make sure that you have printed your name and your address and have written the date and your student number in the spaces provided for them at the top of the first page of the lesson assignment.

Doing Experiment Lessons. An Experiment Lesson immediately follows the Theory Lesson in this booklet and in the other Theory Lesson booklets of this course. The first two Experiment Lessons are designed to give you instructions and practice in soldering. Soldering is an easily learned, but important, skill that you will use throughout your electronics career. Later Experiment Lessons are related to the Theory Lessons. When the Theory Lesson and the Experiment Lesson are so related, it is a good idea to study the Theory Lesson, perform the experiments, and then to answer the questions in the Lesson Assignment. Sometimes, the lesson assignment includes questions that cover some of the work done in performing experiments. So you can see why we suggest that you perform the experiments before you do the assignment. Before performing experiments or jobs of any Experiment Lesson, carefully read the entire Experiment Lesson, so that you may know what you are expected to do. Each Experiment Lesson contains some information which you must read and understand before you can perform the experiments or understand what you are doing.

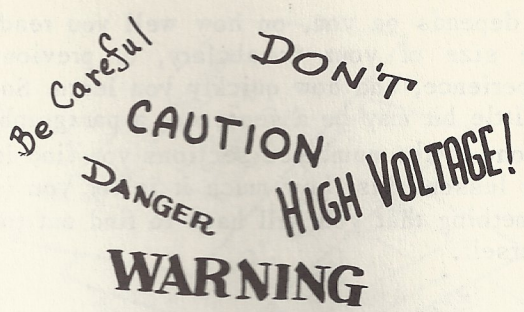


Fig. 7

For example, Experiment Lesson 1 starts off with telling you what the object of the lesson is. This is followed by some information about soldering, flux, soldering irons, etc.

Once you understand what you are expected to do in an Experiment Lesson and have assembled all of the materials needed for the experiment, then go ahead and perform each job or experiment as the lesson tells you to do. Wherever you are told to be cautious and to take special care while performing an experiment, be sure to follow the instructions to the letter. There is no place in this course where you will be cautioned needlessly. Remember that the successful electronics technician is the one who has learned that it does not pay to take chances.

Services Practices Booklet. The purpose of the Service Practices booklet is to give you the kind of information that you need to do radio and television servicing. It's the kind of information that you would receive from the experienced radio and television serviceman. The Service Practices booklets start off by telling you how to identify receiver parts, how to use tools, how to identify radio hardware, how to install a receiver, etc. As you progress in the course, the subject matter of these booklets becomes more complicated, but by the time you receive each of these booklets, you will be prepared to understand the type of information it contains. These booklets however were not designed for you to study in the same way as you would study a Theory Lesson. It is understood that you will read them and then keep them in a safe place where you can refer to them when the need arises. For example, it would be downright

silly for you to sit down and try to memorize the names and shapes of the radio parts shown in Service Practices 1. But when you come across a part that you cannot identify, you may be able to get help by referring to the Service Practices 1 Booklet. Service Practices 5 tells you how to erect an antenna for a radio receiver. It is given to vou in the third lesson group so that whenever you should have the need for information about installing such an antenna you will be able to find it in the Service Practices 5 booklet.

SUMMARY

1. When you first receive the Lesson Material, read it quickly as you would a newspaper to get the gist of it.

2. Then study a paragraph at a time. When you finish a paragraph, cover it up and try to put down in a few words the meat of the paragraph. If you can do this, proceed to the next paragraph. If you cannot, you should re-study it again until you understand it.

3. After you have *studied* all the paragraphs and completed the entire lesson you should try to answer as many questions as you can without referring back to the text. It is suggested that you make your marks initially in pencil.

4. For those questions which you do not know the answer, or are not sure of the answer, you should refer back to the paragraphs and *re-study* them again.

5. After you have answered the questions to the best of your ability, you should ink in your answers, and send them to us for grading.

6. When you receive your graded Lesson Assignment, you should check to see what errors were made, if any. Wherever you have a mistake, you should once again go back to that section in the text and re-study it in order to determine why you did not get the correct answer the first time.

7. If, after performing all the previous steps you still do not understand a specific question, you are at liberty to write us for additional information or explanation.

8. The mathematics you will encounter in this Course can best be learned by doing the problems and similar problems many times in order to understand the technique. It is chiefly a question of practice. There will be a small math booklet sent with Study Group 5.

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 1

HOW TO IDENTIFY RECEIVER PARTS

1-1. How To Identify Parts

1-2. Radio, TV, and Phonograph Parts

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Service Practices 1

INTRODUCTION

This is your first Service Practices booklet. In these booklets, you will find the kind of information that only a radio and television serviceman with years of experience could provide. So, as you learn the theory of electronics, radio, and TV, you will also build up your knowledge of the practical methods of successful servicemen.

Professional people, such as doctors, dentists, and lawyers, usually spend a year or two getting practical experience *after* graduation. In fact, to qualify for most jobs that require knowledge and skill, a person must put in some time getting experience. It's like the apprentice period of a learner in a skilled trade. With this course, you can get experience as you study.

Many of the jobs done by radio and television servicemen require very little training to do well. For example, installing a radio, putting up an antenna, polishing a cabinet, testing tubes — these and many other operations are quickly learned. In fact, you will know how to do certain kinds of radio work after very few lessons. Then, if you wish, you may do some part-time radio work for yourself or for some local dealer and actually earn while you learn.

After you are through with each Theory Lesson and have performed the experiments in the Experiment Lessons, turn to the Service Practices booklet that you will receive with each lesson and add to your practical training. Read each Service Practices booklet carefully; then place it in a loose-leaf binder or some place where you can readily find it. By the time you have completed this course, you will find that all of these Service Practices booklets will form a handbook of the kind of information that experienced radio and TV servicemen use every day in their work. When you have all of the Service Practices booklets, you will find in them the answers to many of the problems that will come up in your radio and TV work.

1-1. IDENTIFICATION OF PARTS

All radio receivers, phono players, and TV sets are made with *resistors*, *capacitors*, (sometimes called condensers by old-time radio servicemen), *inductors*, and *electron tubes*. An example of each of these parts is shown in Fig. 1-1.

It is important to know what radio, phonograph, and TV parts look like because:

1. Knowing parts makes circuits easier to trace when you are trouble-shooting.

2. All parts are not tested in the same manner. Therefore, you must know one part from another in order to give it the proper test.

3. In order to replace a defective part, you must know what part to order.

Even without much training or experience, many people can make a repair or remove a part and replace it with a new one, once the trouble is found. The greater part of servicing time is often spent in locating the bad part. But knowing parts is necessary in order to locate trouble.

Of course, there is no substitute for knowing *why* certain parts are used as they are, or for knowing *how* they work. That's where the theory you will learn in this course comes in. No matter how familiar you

may get with parts and no matter how expert you may become in replacing them, a real success in servicing can come only when you know the theory behind each part and know what can go wrong with it. The man who locates troubles in the least amount of time is the man who knows his theory. Because he locates troubles faster, he can easily handle more jobs and make more money. The slowpoke is the man who isn't sure of himself because he just doesn't *know*. So, never neglect to learn the theory; it is as important as anything else in this course.

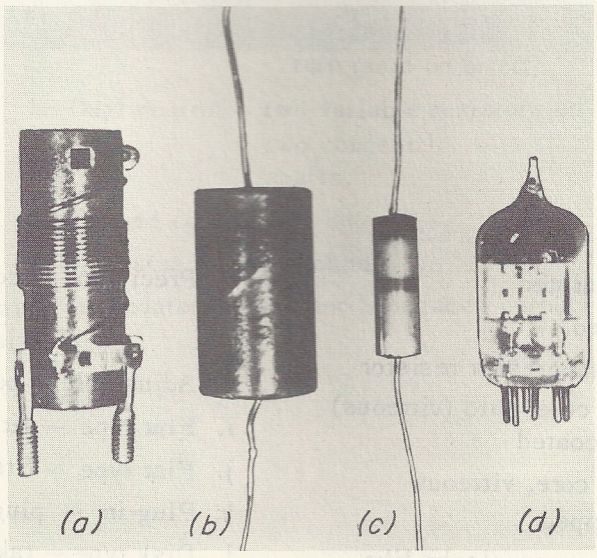
1-2. RADIO, TV, AND PHONOGRAPH PARTS

In the pages that follow, the most commonly used parts are grouped together in figures. The parts shown in each figure have some quality or characteristic in common that makes it convenient to group them all together. For example, one figure shows fixed and adjustable resistors. It includes many kinds of resistors; some are made from carbon, others are made from wire. They have different shapes, sizes, and outer coverings, but no matter what they are made from or what they look like, they are all resistors.

This figure is followed by one showing variable resistors. Variable resistors are used in radio and TV receivers as volume controls, tone controls, brightness controls, and in the adjustment of many other circuits. Another figure illustrates fixed capacitors, followed by still another one showing variable capacitors.

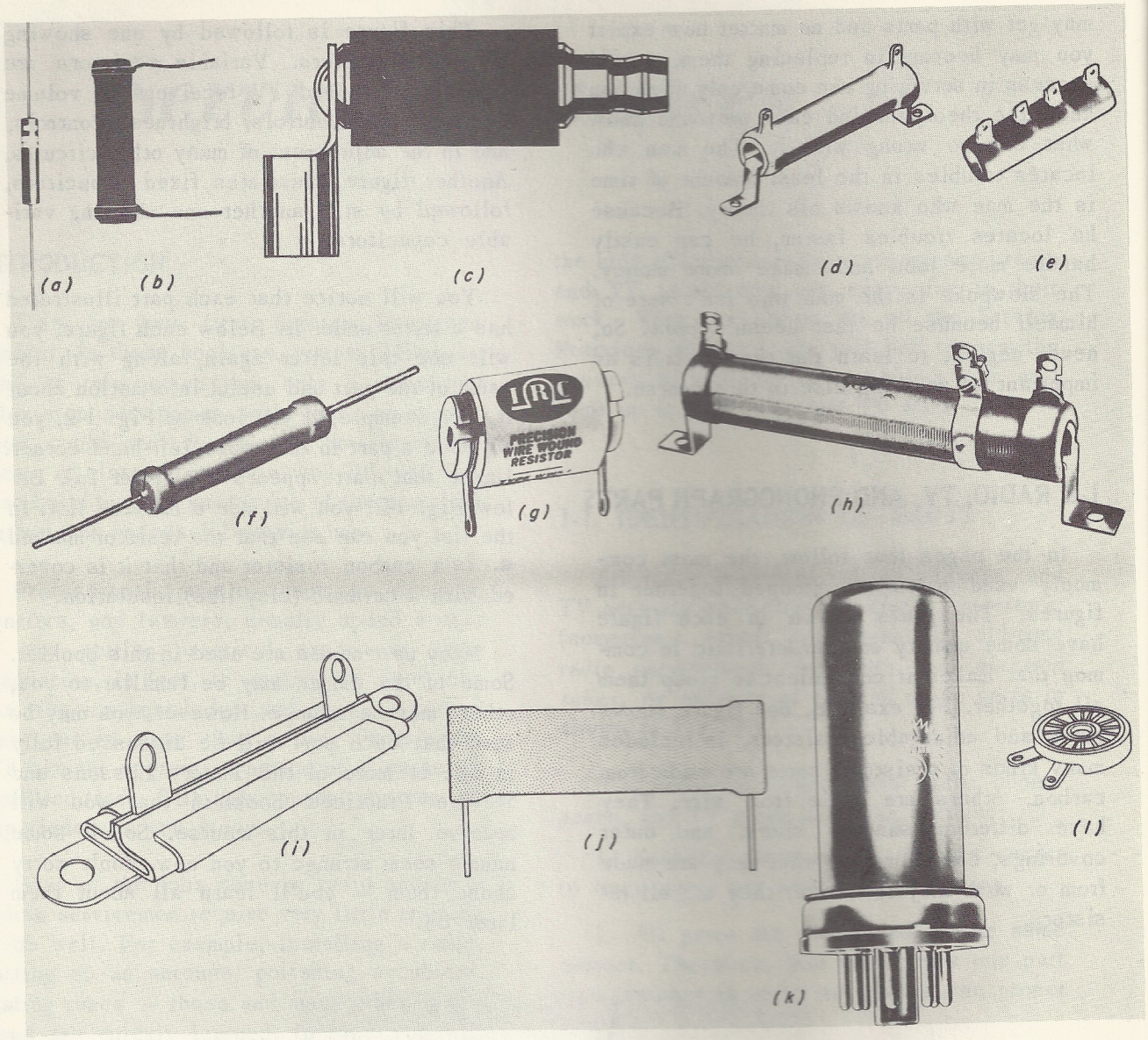
You will notice that each part illustrated has a letter under it. Below each figure, you will see this letter again, along with the name of the part and useful information about it. For example, if you look at Fig. 1-2, you will see a part in the upper left-hand corner. Under that part appears the letter *(a)*. Below Fig. 1-2, you will see a lettered list. In the list you can see that the resistor marked a. is a carbon resistor and that it is covered with a ceramic (clay-like) insulation.

Many part names are used in this booklet. Some of the names may be familiar to you, others may be strange. However, you may be sure that each part will be discussed fully in one or more of the Theory Lessons and Service Practices booklets that you will receive later in this course. So, if some names seem strange to you now, don't worry about them – you'll learn all about them later on.



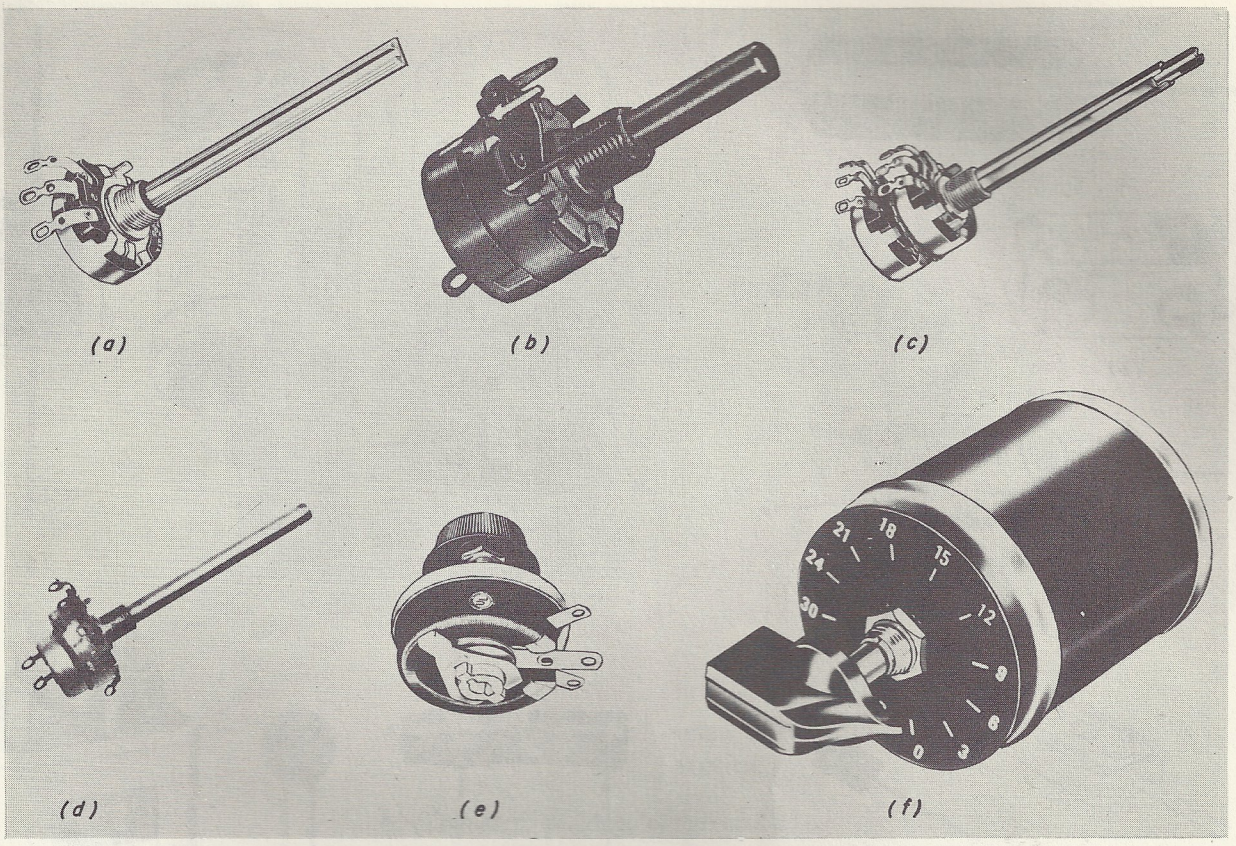
a. Inductor
b. Capacitor
c. Resistor
d. Electron tube

Fig. 1-1. Fundamental Components



a. Carbon – ceramic insulated
b. Carbon – non-insulated
c. Carbon – auto-radio suppressor resistor
d. Wirewound – ceramic core, hard (vitreous) enamel coated
e. Wirewound – ceramic core, vitreous core, tapped
f. Wirewound – ceramic cover (looks like carbon resistor)
g. Precision – accurate within 1% (most resistors are accurate only to within 10%)
h. Adjustable – permits close accuracy
i. Flat type – fits in tight places
j. Flat type – fits in tight places
k. Plug-in – plugs into socket like a tube
l. Disk type – takes little space

Fig. 1-2. Fixed and Adjustable Resistors



a. Carbon control – standard type

b. Carbon control – same as above with switch (used to turn radio on or off)

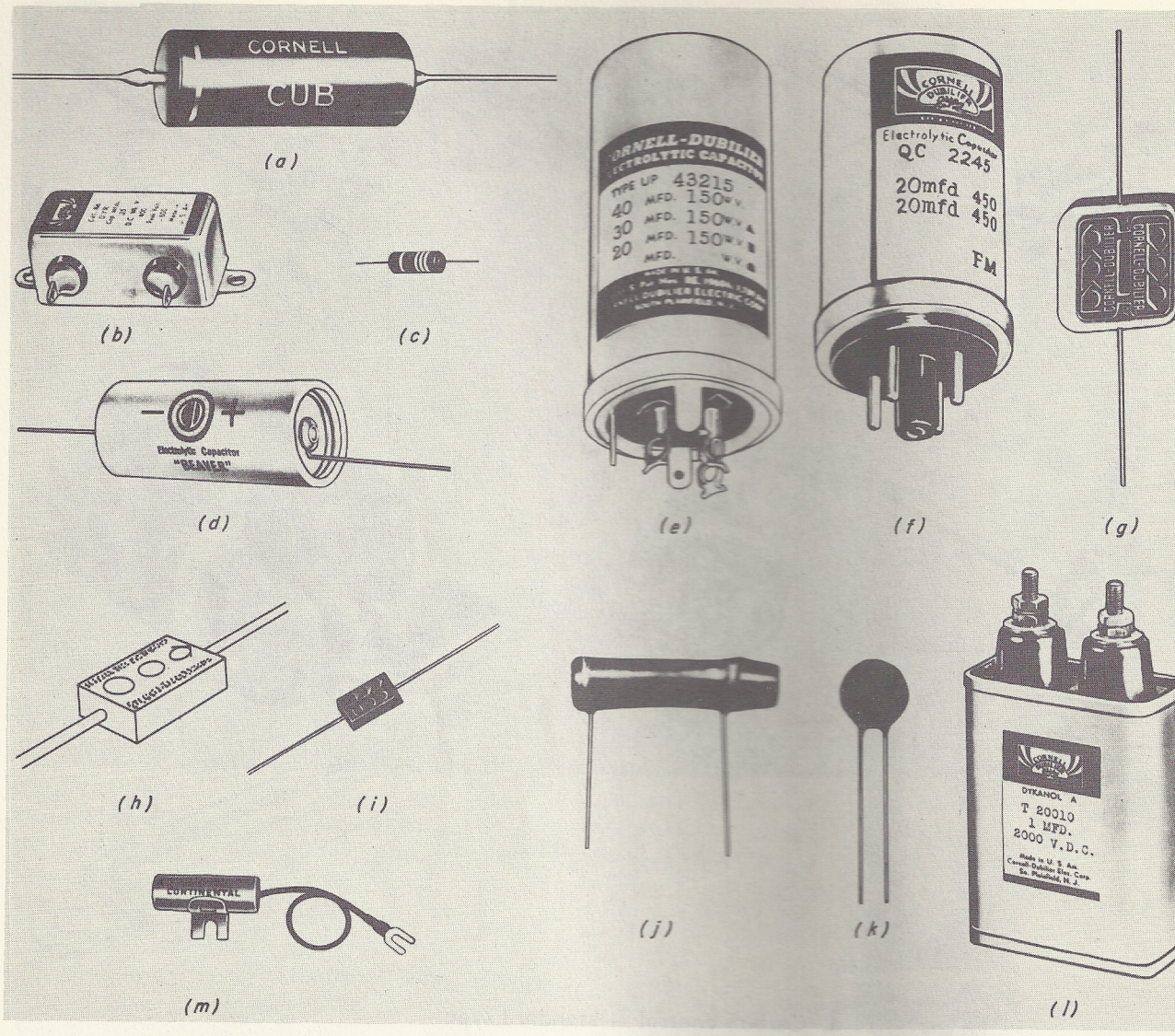
c. Dual control – two variable resistors on two concentric shafts

d. Tapped control

e. Rheostat – wirewound

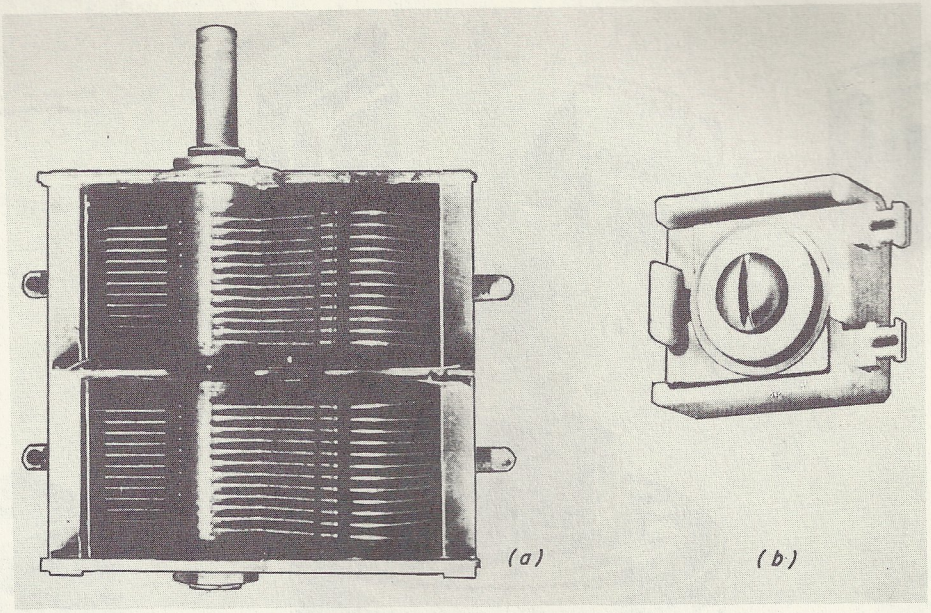
f. Attenuator – constant-impedance output

Fig. 1-3. Variable Resistors



a. Tubular paper
b. Paper in metal can, called bathtub
c. Molded metallized paper, looks like carbon composition resistor
d. Electrolytic – paper covered
e. Electrolytic – metal covered
f. Electrolytic – metal covered, plugs into socket
g. Mica
h. Mica
i. Silver-mica
j. Ceramic
k. Disk type – uses ceramic between plates
l. High-voltage, oil-filled
m. Auto-generator

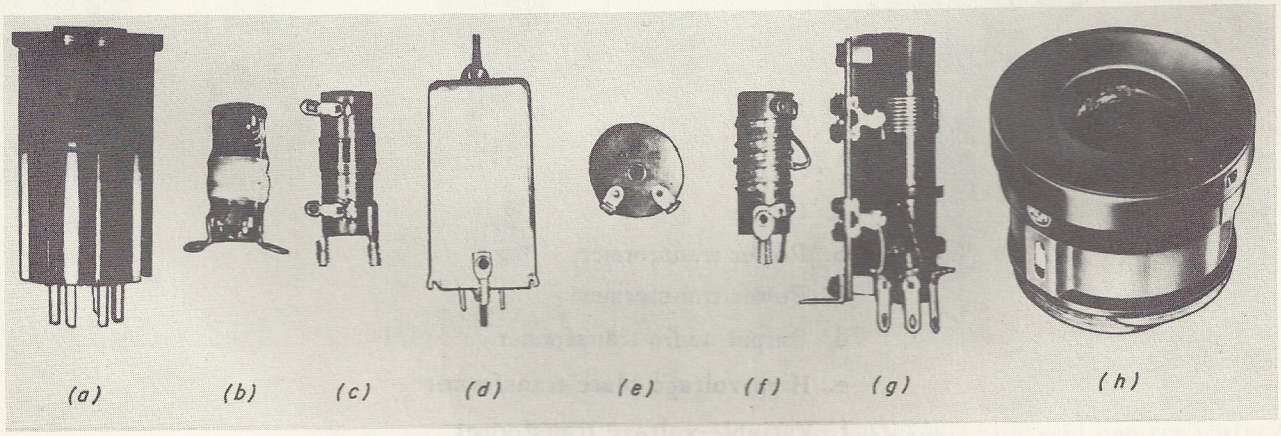
Fig. 1-4. Fixed Capacitors



a. Tuning capacitor – used to tune in stations

b. Trimmer, padder, or neutralizing capacitor

Fig. 1-5. Variable Capacitors



a. Plug-in coil

b. R-F transformer – for standard broadcast frequencies

c. Oscillator coil

d. I-F (intermediate-frequency) transformer

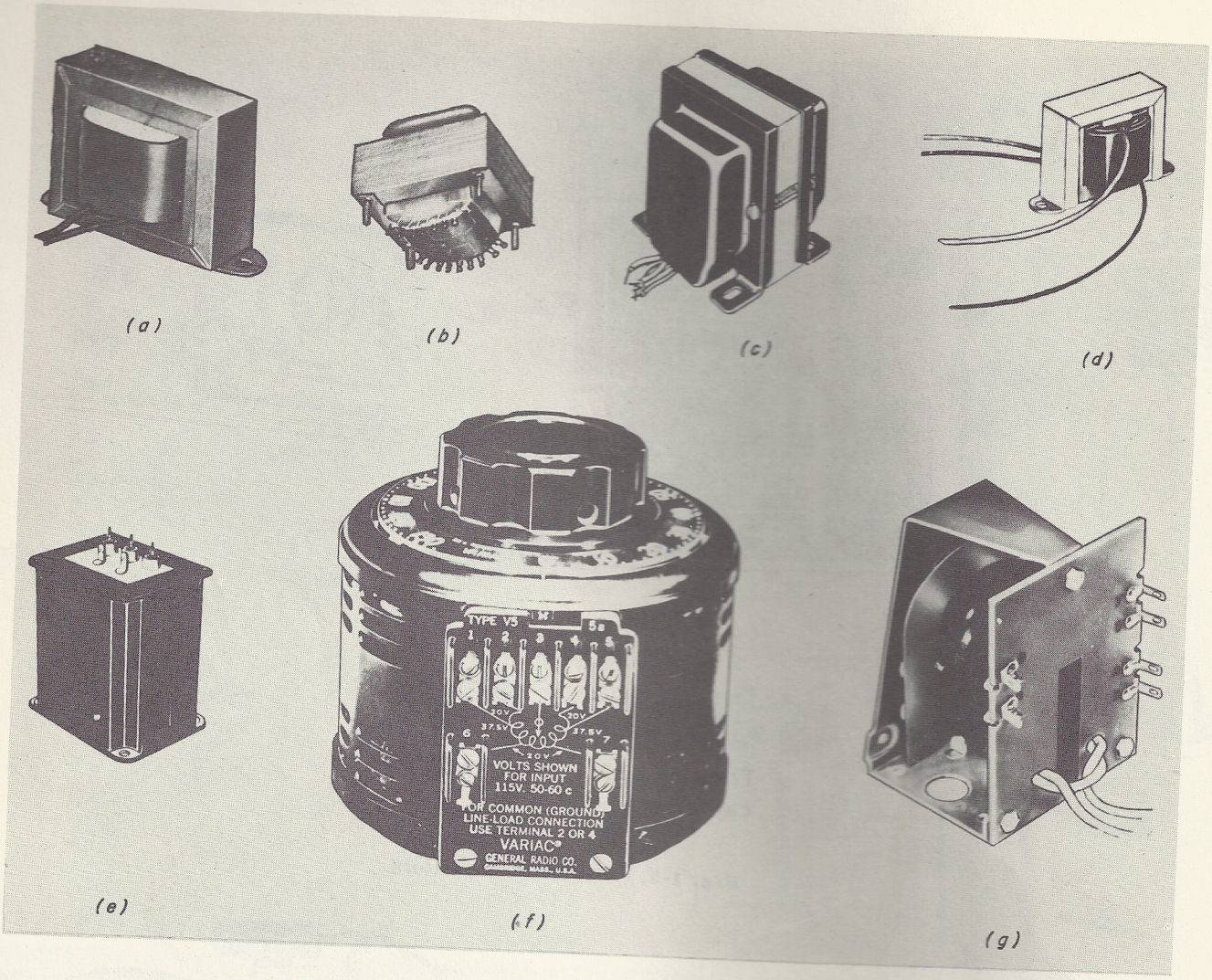
e. R-F choke

f. R-F transformer – for FM

g. R-F transformer – for standard and short-wave land receiver

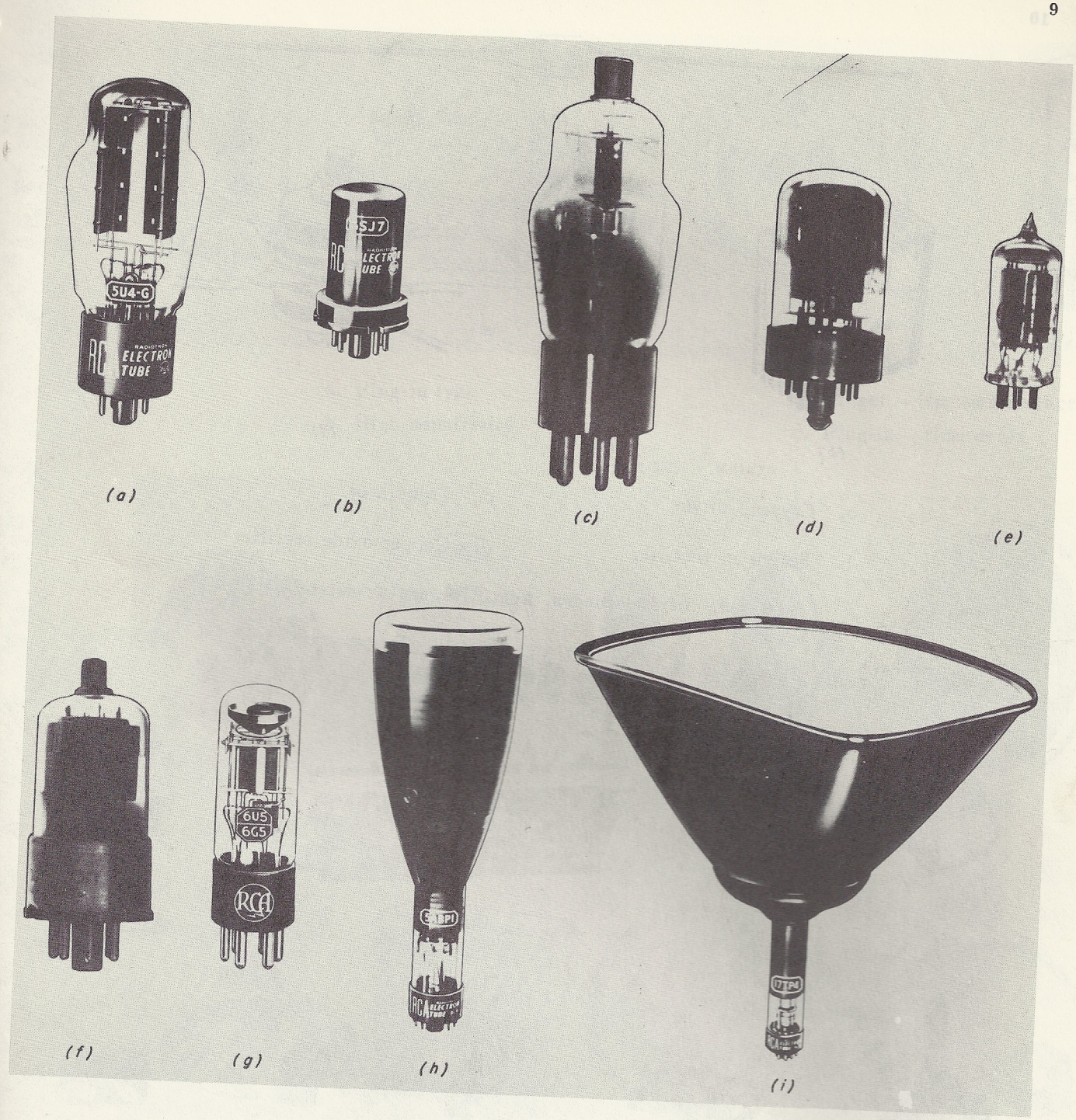
h. Yoke for television picture tube

Fig. 1-6. Air-Core Coils



a. Choke
b. Power transformer
c. Power transformer
d. Output audio transformer
e. High-voltage plate transformer
f. Variable-voltage transformer
g. Television flyback transformer

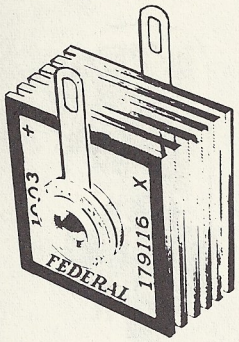
Fig. 1-7. Iron-Core Coils



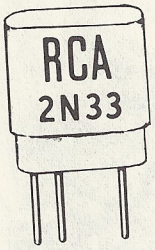
a. Glass envelope rectifier with octal base
b. Metal shell with octal base
c. Glass envelope pentode tube with grid cap
d. Lock-in type
e. 7-pin miniature
f. Octal-base tube with grid cap for battery-operated set
g. Magic eye
h. Cathode-ray oscilloscope tube
i. Television picture tube (kinescope)

Fig. 1-8. Electron Tubes

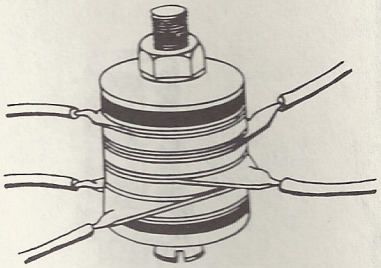
(a)



(b)



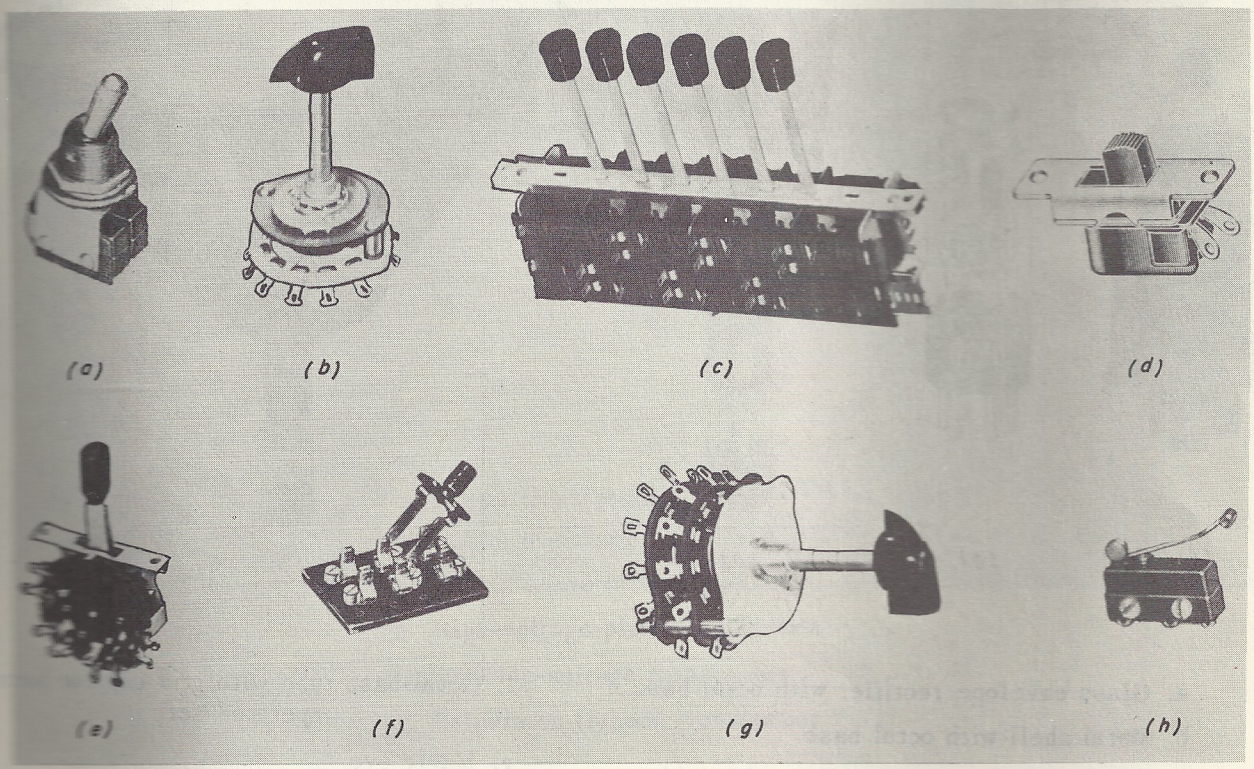
(c)



(d)

a. Crystal diode
b. Selenium rectifier
c. Transistor
d. Copper oxide rectifier

Fig. 1-9. Crystal Diodes, Rectifiers, and Transistors

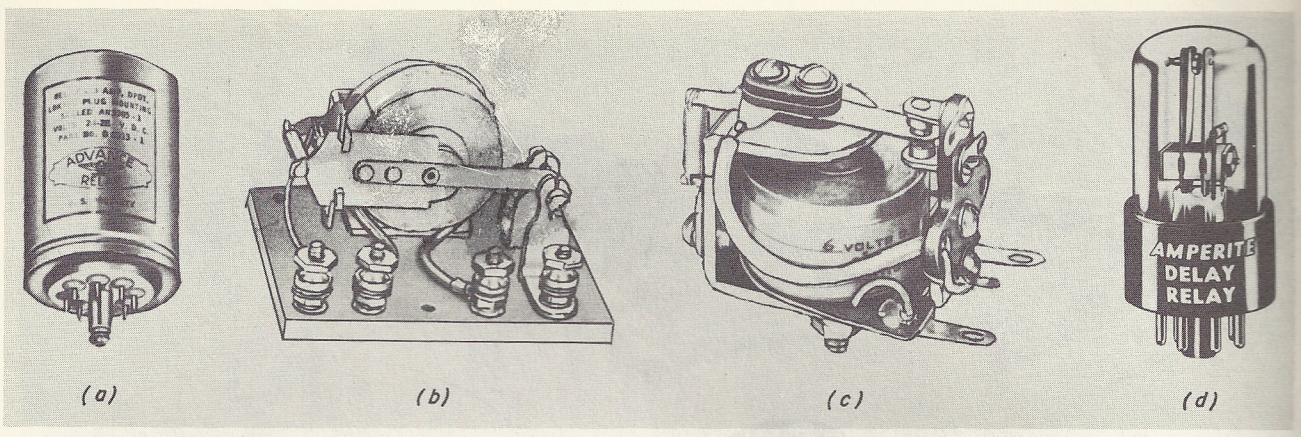


(a) (b) (c) (d)

(e) (f) (g) (h)

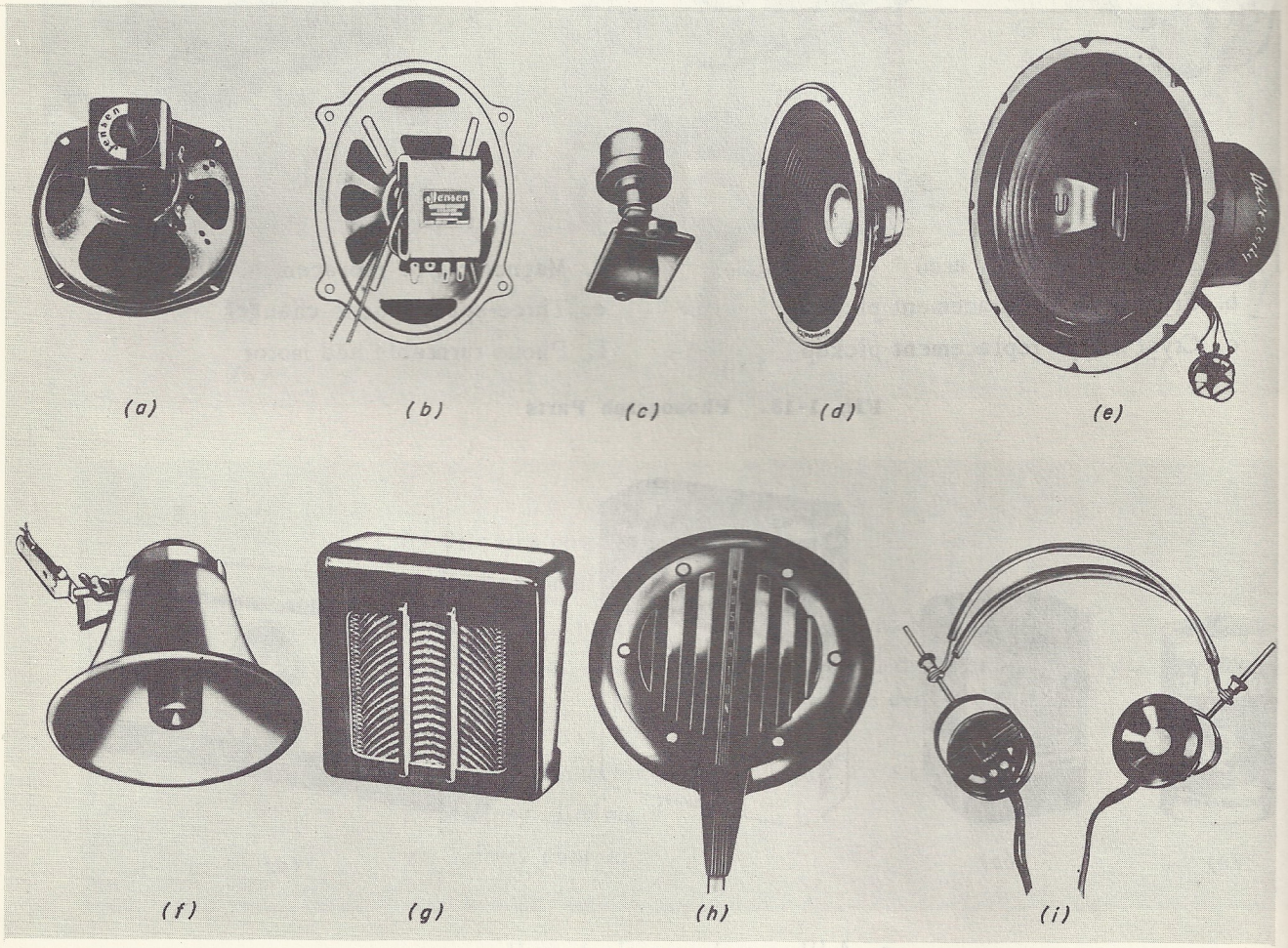
a. Toggle
b. Rotary
c, Pushbutton
d. Slide type
e. Lever action
f. Knife throw
g. Multisection band
h. Snap action

Fig. 1-10. Switches



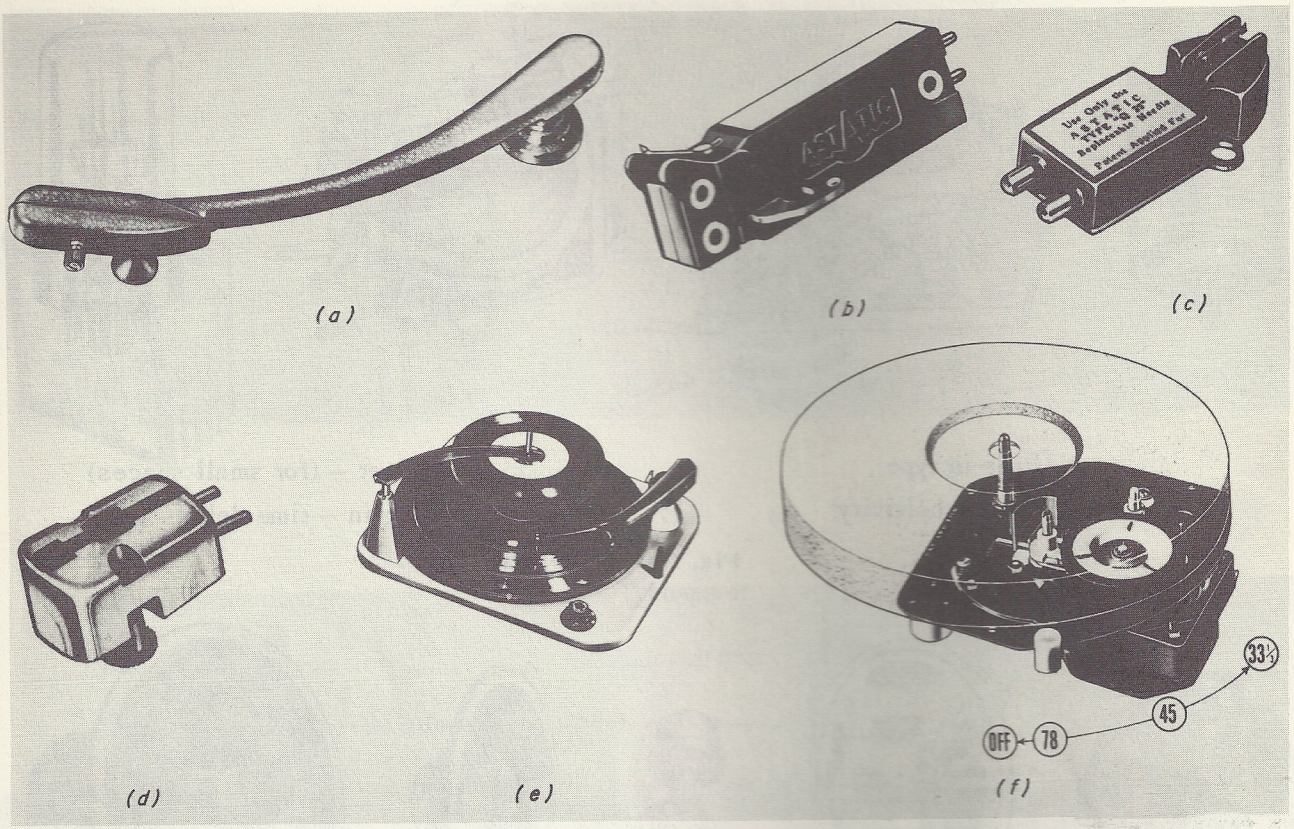
a. Plug-in type
b. High sensitivity
c. Midget – (for small spaces)
d. Plug-in – time delay

Fig. 1-11. Relays



a. Permanent-magnet speaker
b. Electrodynamic speaker
c. Tweeter (reproduces high notes)
d. Woofer (reproduces low notes)
e. Hi-Fi coaxial speaker
f. Reflex-type speaker
g. Speaker baffle and cabinet
h. Pillow speaker
i. Pair of earphones

Fig. 1-12. Loudspeaker Equipment

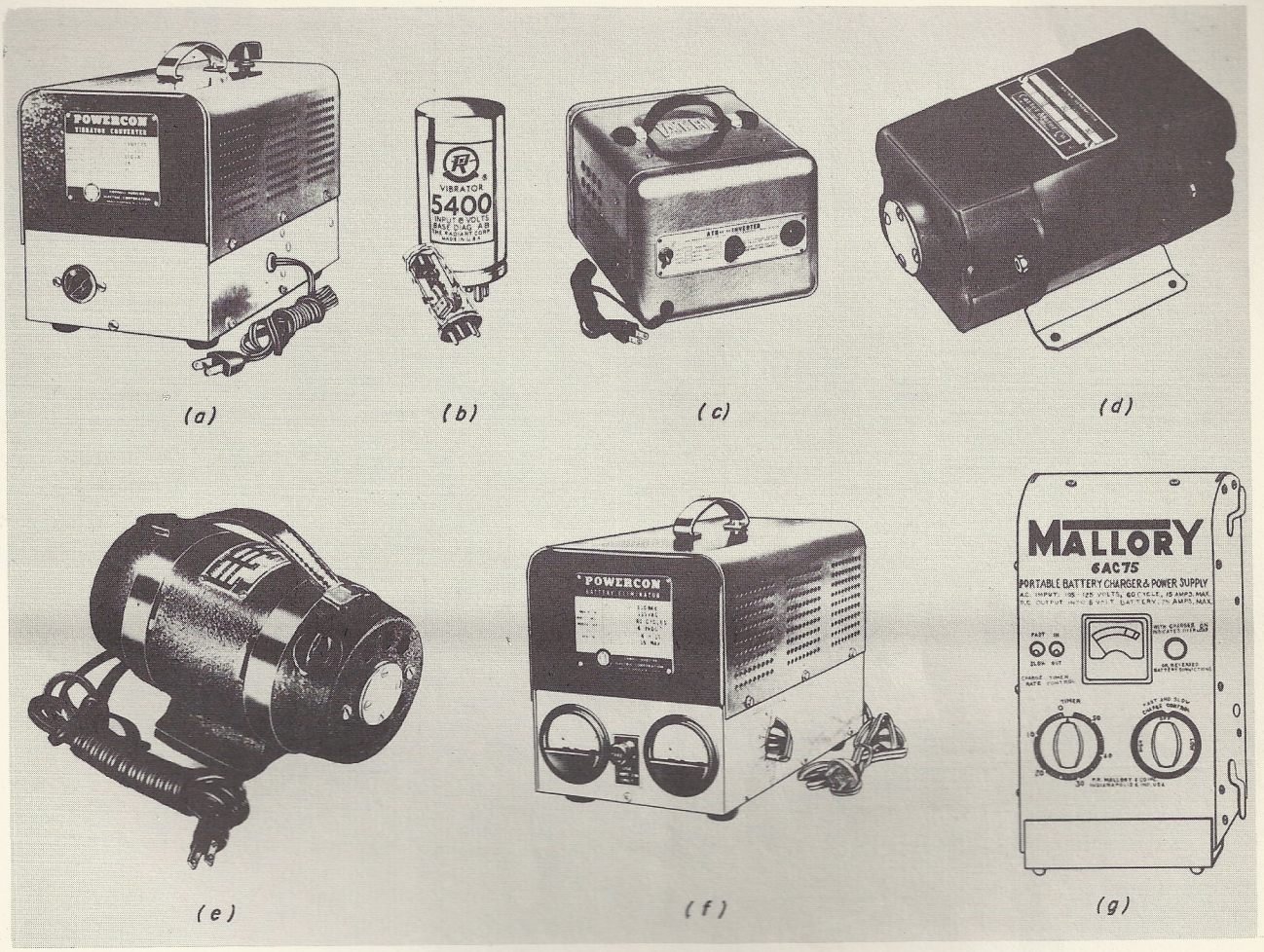


a. Tone arm (pickup arm)
b. Crystal-type replacement pickup
c. Crystal-type replacement pickup
d. Magnetic-type replacement pickup
e. Three-speed phono changer
f. Phono turntable and motor

Fig. 1-13. Phonograph Parts

a. A "battery' – a single cell
b. Battery of several cells
c. B battery
d. A-B battery pack

Fig. 1-14. Batteries and Battery Packs



a. Vibrator power supply
b. Replacement Vibrators
c. A.C.-D.C. inverter – changes d.c. to a.c.
d. Dynamotor – changes low voltage d-c power power to high voltage d-c power
e. Rotary converter – changes d.c. to a.c.
f. Battery eliminator
g. Battery charger

Fig. 1-15 Power-Supply Equipment

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 2

HOW TO USE TOOLS

RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

HOME STUDY SCHOOL

350 West 4th Street, New York 14, N. Y.

Service Practices 2

INTRODUCTION

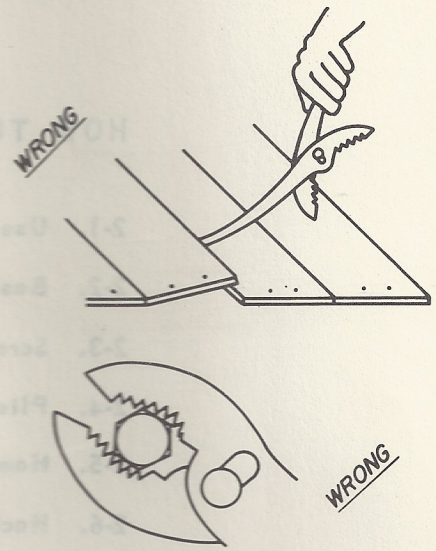
A radio and TV serviceman is judged by the tools he has, how he uses them, and how he cares for them. To start out in radio, it is not important that you have many tools. It *is* important that you have good tools, use them properly, and take care of them.

In the beginning, it may be necessary to use cheaper tools or whatever is available, without thinking about quality. However, replace them with good-quality tools as soon as you can afford to. With good tools, you actually can do better work with less effort. Furthermore, good tools often give a lifetime of service, when properly cared for, while inexpensive tools easily chip, twist, bend, or break.

2-1. USE AND CARE OF TOOLS

The way you use tools often tells others what kind of a mechanic or technician you are. Anyone who tries to pry open a wooden crate with a screwdriver or who hammers a nail with a pair of pliers shows that he doesn't know how to use tools properly. When he has finished, the screwdriver is bent or the pliers are sprung. A good serviceman uses each tool for the job it was made to do. As a result, he gets full value out of his tools and is known as a careful workman.

The care you take of your tools shows your customers the kind of treatment their radios, phono players, or television sets are likely to receive from you. When tools are allowed to get rusty, chipped, or dirty, they show all who see them that you are careless. When tools are all over the place, dropped where last used, or just dumped into a tool case or bag, people think you are disorderly. Keep tools clean. Keep them free of rust by dipping them in light machine oil and wiping them carefully with a clean cloth. A small amount of the oil will remain to protect the tool.



do not use pliers as a pry bar or on a nut

Fig. 2-1

Each tool should have its place and should be kept there when not in use. At your workbench, tools may be placed in a rack similar to the one shown in Fig. 2-2. Tools used in a customer's home may be carried in a tool box, a tool bag, or in a flexible canvas, leatherette, or plastic roll that has a pocket or loop for each tool. Servicemen tend to lose tools by leaving them on the floor, behind the radio, in the radio cabinet, or some such place in the customer's home. This can be avoided by placing each tool where it belongs and by counting tools before leaving the customer's house. If each tool has its place, such a count may be made almost at a glance.

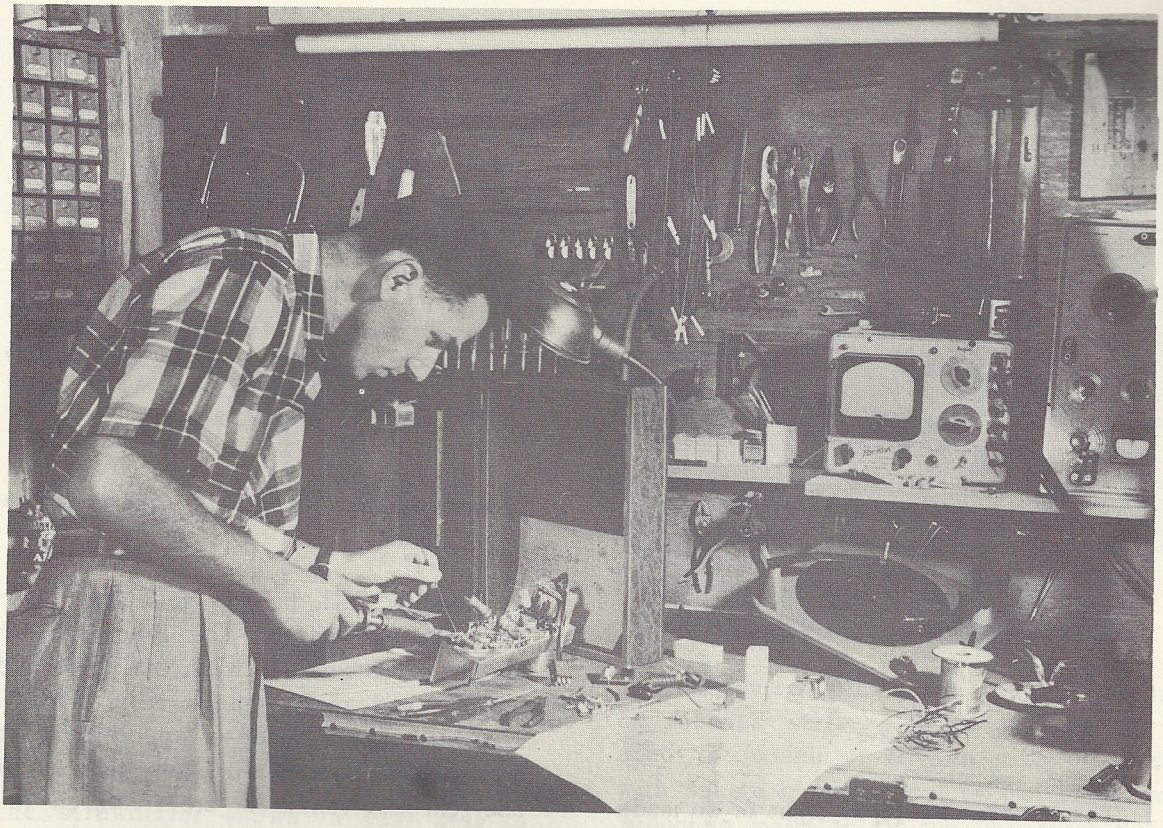


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Fig. 2-2

2-2. BASIC RADIO TOOLS

While very few tools are needed to get you started, some tools are needed right away. You will need the tools shown in Fig. 2-3 as soon as you start. Some of them, such as the hammer, flashlight, and hacksaw, you probably have already. The soldering iron is given to you in Kit 1 and is the subject of Experiment Lessons 1 and 2.

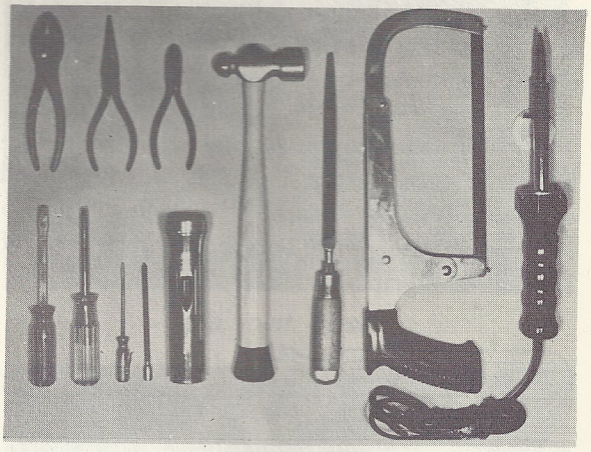
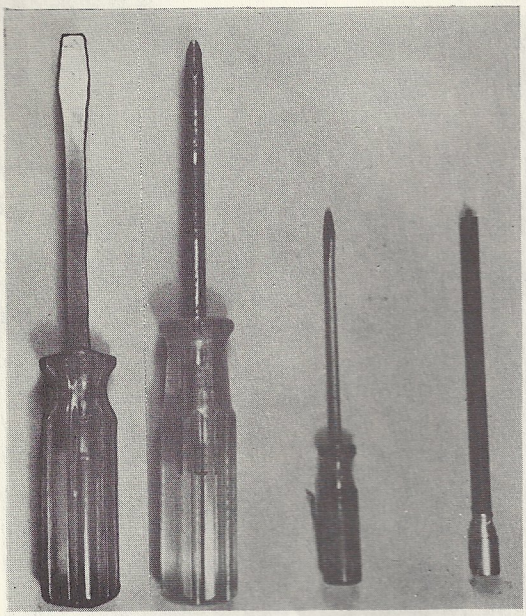


Fig. 2-3

2-3. SCREWDRIVERS

The four types of screwdrivers shown in Fig. 2-4 are basic radio and TV tools. Before long, you'll probably add several more screwdrivers to your kit. So many different kinds and sizes of screws are used on jobs that servicemen need screwdrivers with short, medium, and long blades; narrow, medium, and wide blades; thin and thick blades; and others with tips of special design.

The familiar standard screwdriver is shown in Fig. 2-4. Most servicemen prefer a blade from 3 to 6 inches long, 1/4 to 3/16 inches wide. When buying such a screwdriver, remember the following things:



(a) (b) (c) (d)

Fig. 2-4

1. The handle should be tight or so made that the shaft cannot turn inside it. Most servicemen prefer an insulated screwdriver handle that is made of plastic and molded around the blade. To prevent the shaft from turning in the handle, the end of the shaft may be formed with wings, as in Fig. 2-5, or it may be square or flattened at the end.

2. Grip the handle of the screwdriver before you buy it, to see if it fits the hand comfortably. The handle shown in Fig. 2-5 is very popular with servicemen because of its non-slip grip.

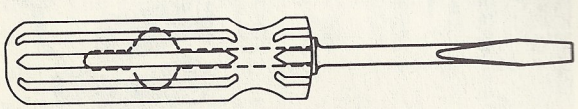


Fig. 2-5

3. The blade should not taper too much, as shown in Fig. 2-6*a*, but should have a slight taper, as shown in Fig. 2-6*b*. Too great a taper tends to make the blade slip and chew up the screw head.

4. The tip of the blade should not be rounded as in Fig. 2-6*c*, but should be

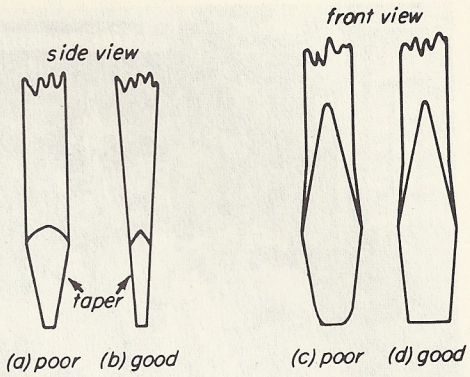


Fig. 2-6

ground so that the tip is squared off as in Fig. 2-6*d*.

5. Above all, buy as good a screwdriver as you can afford. The blades of cheap screwdrivers tend to twist, their tips become burred, and their shanks slip. Fine-grade screwdrivers are made of special tool steel, hardened and tempered. Many manufacturers use chrome vanadium steel, which is excellent for screwdrivers and wrenches.

When using a screwdriver:

1. Use a screwdriver that is long enough to reach the screw conveniently. Longer screwdrivers have handles with larger diameters, which make it easier to drive screws.

2. Choose a screwdriver with a blade that fits the screw head. (See Fig. 2-7.)

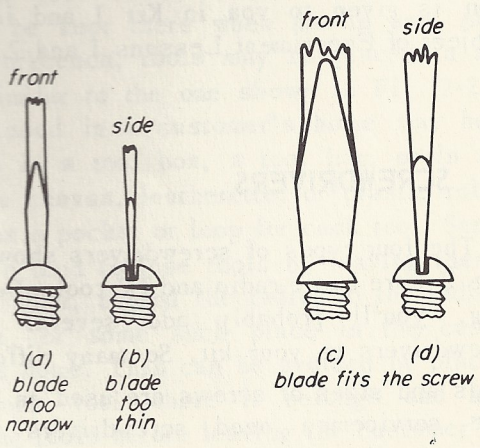


Fig. 2-7

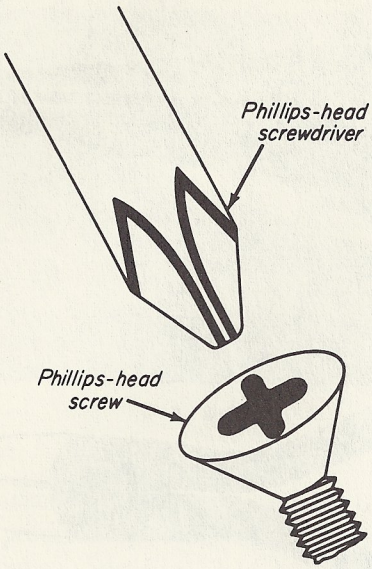


Fig. 2-8

3. Don't use a screwdriver as a chisel or a pry bar.

4. Never hammer the handle. It can break.

The screwdriver shown in Fig. 2-4*b* is made for Phillips head screws, one of which is shown in Fig. 2-8. The heads of these screws have a specially shaped cut that does not fit the standard screwdriver. Because many radio manufacturers use these screws, a Phillips screwdriver is part of the basic tool kit.

The screwdriver shown in Fig. 2-4*c* is a standard screwdriver with a very narrow blade. It is used for very small screws, such as are found in the tuning knobs of radios.

The screwdriver shown in Fig. 2-4*d* is called an *alignment* tool. It is used to *align* or adjust radio and TV circuits so that the station may be tuned in at the proper point on the dial.

2-4. PLIERS

Three basic types of pliers are shown in Fig. 2-9. The first type, *combination pliers* (shown in Fig. 2-9*a*), has a slip joint that opens the jaws of the pliers wider. This feature is illustrated in Fig. 2-10.

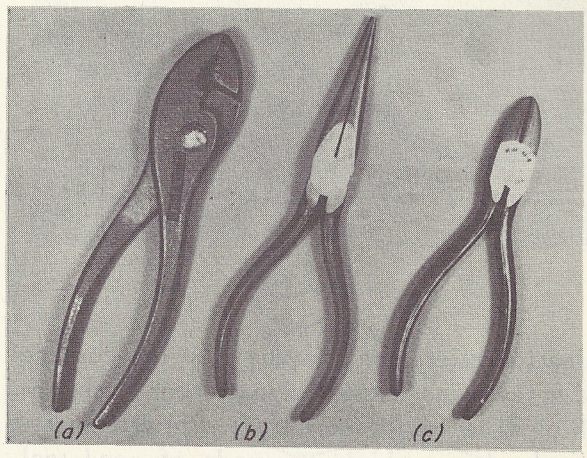
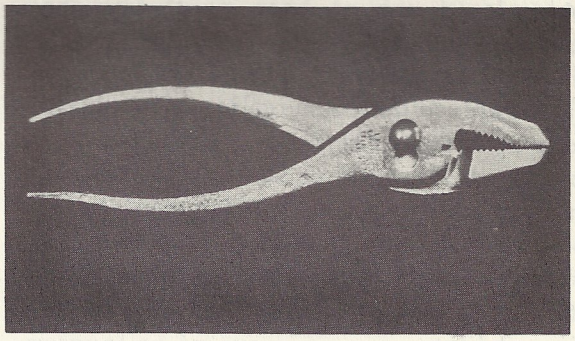
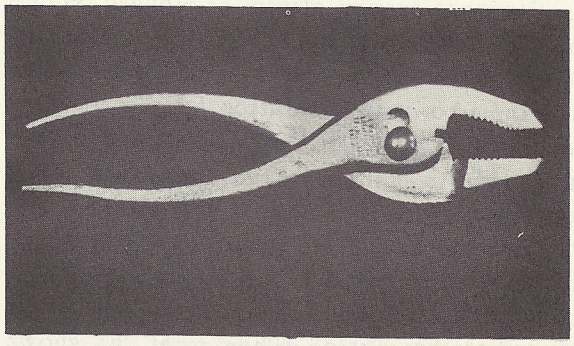


Fig. 2-9

Combination pliers are designed for use on rounded surfaces. They should not be used to loosen or tighten nuts or screws with square or hexagonal (six-sided) heads. Wrenches made to fit the particular nut or screw should be used for this purpose. Com-



slip joint closed
(a)



slip joint open
(b)

Fig. 2-10

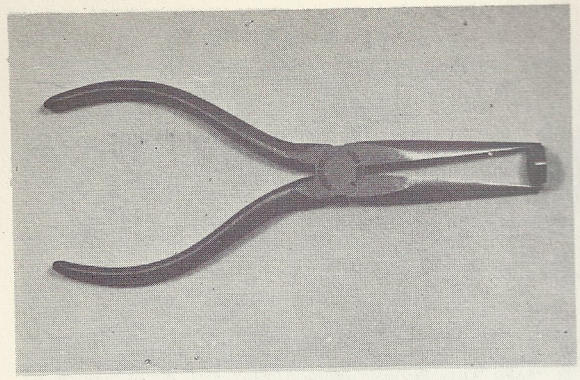


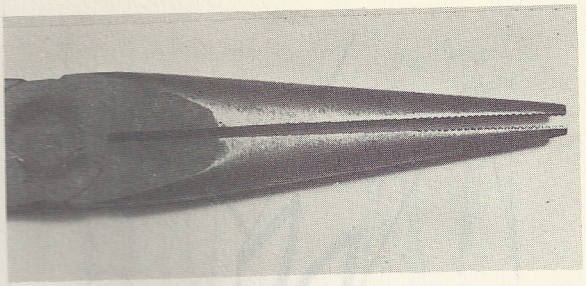
Fig. 2-11

bination pliers tend to chew up the corners of screws and nuts—a sign of poor workmanship. When buying combination pliers, insist on the best, which are made of good tool steel. The jaws should move easily but should not slip from the narrow-jaw position to the wide-jaw position when an object is gripped.

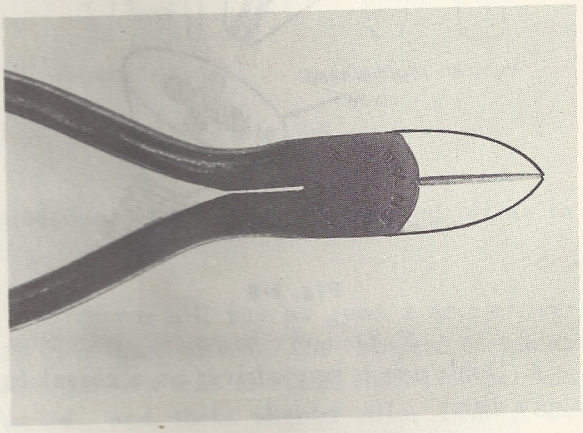
The long-nose pliers (shown in Fig. 2-9*b*) is one of the most frequently used radio tools. Servicemen use them to hold leads or wires in position while soldering, to bend wires into angles, and to hold small nuts when starting to thread screws into them, as shown in Fig. 2-11.

Never use long-nose pliers to tighten or loosen nuts or screws. If you do, you'll spring the jaws and the pliers will lose much of their value. When buying long-nose pliers, select the best you can afford. They should be made of first-quality tool steel and the jaws should meet (mesh) as shown in Fig. 2-12*a*.

Diagonal-cutting pliers, or nippers (shown in Fig. 2-9*c*) are used to cut small wires found in radio equipment. Some servicemen use them to strip insulation from wire. This is not good practice, because stranded wire may lose a couple of strands, and solid wire may be nicked. In either case, the wire is weakened and its safe current-carrying capacity is changed. When buying diagonal-cutting pliers, hold them up to the light to be sure that the cutting edges meet, as shown in Fig. 2-12*b*. Here again, it pays to buy the best.



(a)



(b)

Fig. 2-12

2-5. HAMMERS

At present, a ball-peen (machinist's) hammer is the only one shown in Fig. 2-13. A nail or claw hammer may be added to your kit sooner or later. In fact, you probably already have one, for it is in almost every family's tool box. As you know, the claw hammer is used in woodworking to drive nails, pegs, wedges, and dowels, and to drive punches, cold chisels, star drills, and so on. Servicemen also use it to tack antenna and ground wires to floor molding when running these leads to the receiver.

The size of any hammer is determined by the weight of the head (without the handle). Hammer sizes range from 5 ounces to 28 ounces. A light claw hammer is good for driving small nails; heavier hammers are used for driving larger nails, particularly into hard wood. A rule of thumb is that a hammer of the right size should drive a nail in five blows. Servicemen generally prefer an 8-ounce ball-peen hammer for general work and a 24-ounce ball-peen hammer for use with a star drill for drilling holes in brick walls.

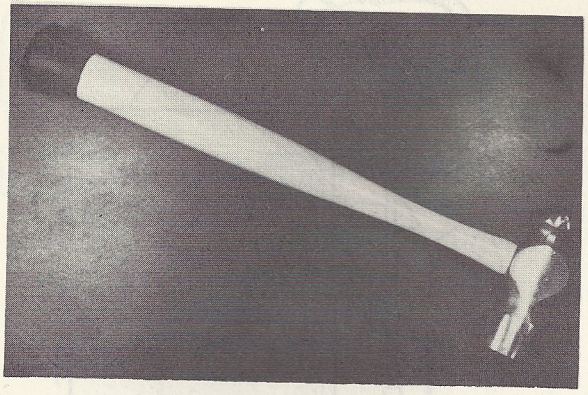


Fig. 2-13

A hammer should be grasped so that the end is practically flush with the lower edge of the palm. (See Fig. 2-14.)

In this way, the hammer does most of the work. When driving a nail into wood, hold the nail perpendicular (straight up and down) to the surface of the wood – unless, of course, you want to drive it at an angle. Place the center of the hammer face on the head of the nail, raise the hammer about an inch, and tap the nail a couple of times to start it. Then take your hand away from the nail and drive the nail into the wood. If you are using a hammer of the proper weight, it should take about five blows. Each blow should be delivered so that the hammer handle is parallel with the surface of the work. Using a ball-peen hammer is much the same as using a claw hammer. The hammer-head is in line with the punch, chisel, or star drill when it strikes.

It pays to buy a good hammer. The heads of cheaper hammers often are made by pouring molten steel into a sand mold. Such a hammer head is brittle, and may easily break. On the other hand, a drop-forged hammer head is made by hammering red hot steel alloy into a steel mold. Later it is shaped, by grinding, to an exact design and given a smooth face and beveled edges to prevent chipping. When fitted with a first-grade hickory handle, shaped to fit the hand, the hammer is well balanced and slightly springy. It's the kind of tool you like to work with.

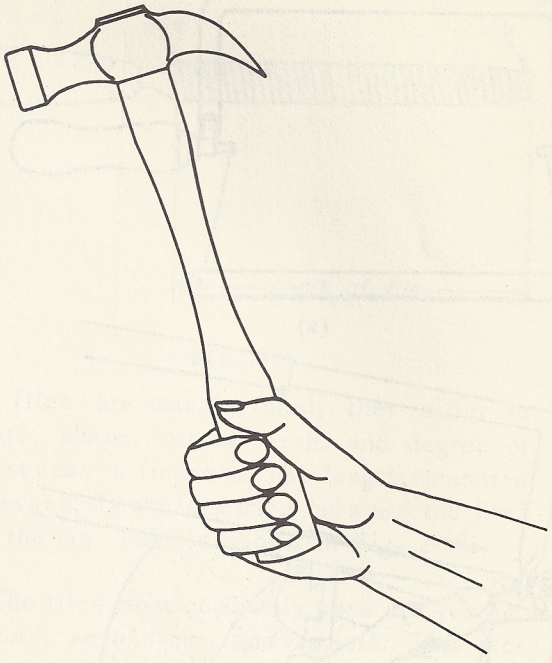


Fig. 2-14

2-6. HACKSAWS

A serviceman must know how to use a hacksaw. It is used to cut metals, hard rubber, masonite, bakelite, and other materials that would clog the teeth and dull the cutting edge of a wood saw. Blades for hacksaws may have 14, 18, 24, or 32 teeth per inch. In general, the coarse-toothed blades are used for cutting soft stock and the fine-toothed blades are used for tool steel, thin stock, or thin tubing. It is important that the proper blade be chosen for the material to be cut.

To insert a blade, adjust the hacksaw frame to the length of the blade. The holes in the hacksaw blade are placed over the pins on the frame, as shown in Fig. 2-15*a*. Note that the teeth of the blade point away from the handle. Tighten the blade in the frame so that it cannot bend or buckle when sawing. The material to be sawed should be clamped tightly in a vise. (Trying to saw loosely held material leads to trouble.) If the stock is very thin, place it between two blocks of wood before clamping it in the

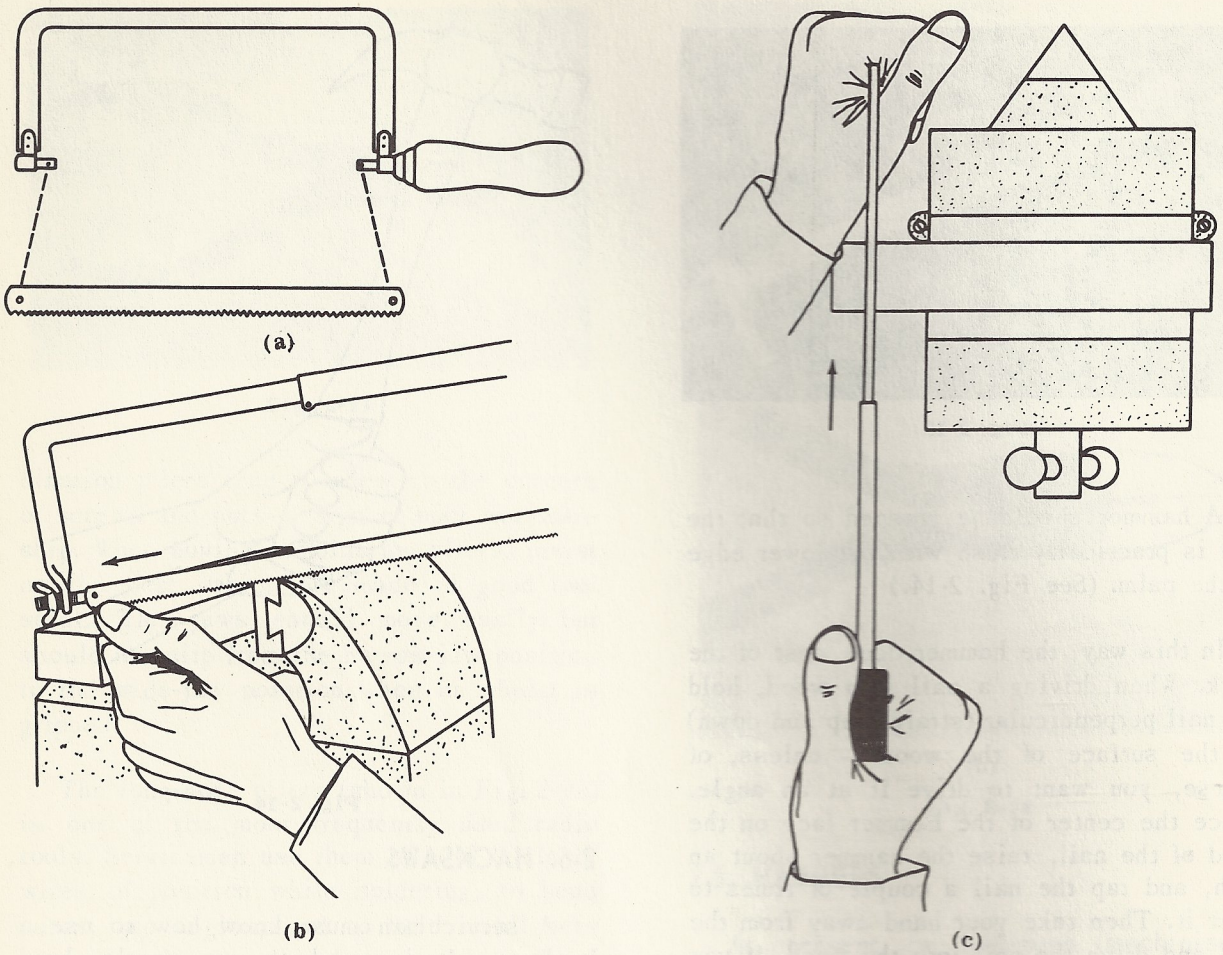


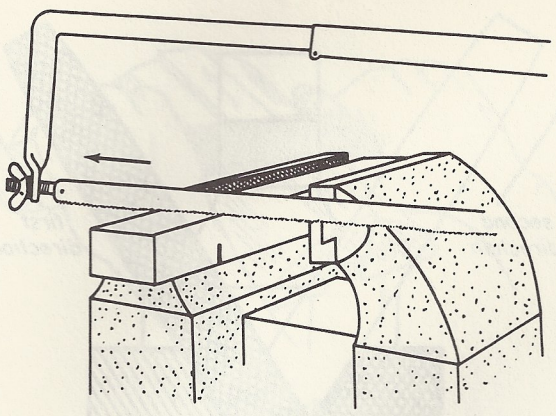
Fig. 2-15

vise. To start the cut, it is a good idea to guide the saw with the left thumb for the first few strokes. (See Fig. 2-15*b*.) Once the cut is started, hold the frame with both hands, as shown in Fig. 2-15*c*. The blade is slanted slightly forward and downward. The cut is on the forward stroke. Therefore, pressure is applied only on this stroke; there should be no pressure on the return stroke. In fact, once the cut is started, the saw may be lifted slightly away from the cut, so that the teeth barely touch the work on the return stroke. For best results each stroke should be long and steady, with no wobbling. Limit speed to about 40 or 50 strokes per minute. Most beginners tend to saw too fast and tire too easily. The experienced man works steadily, at a slower speed, and accomplishes more with less effort. If the blade heats while sawing, apply light oil in the cut or to the blade.

If a blade breaks or is too worn to complete a cut, do not try to continue the cut with a new blade. If you do, the new blade may stick in the cut and break. Instead, turn the work around, as shown in Fig. 2-16, and start a new cut in line with the first one.

Take care of your hacksaw. Wipe the blade with an oily rag to prevent rust. Hacksaw blades break easily if something falls on them, so hang them up when they are not in use. If you carry a hacksaw loosely in a tool bag, it is a good idea to remove the blade from the frame. This protects the blade, and also protects you from getting cut while rummaging in your bag for a tool.

When buying a hacksaw, get one with a pistol grip like the one shown in Fig. 2-17 or with a grip like a carpenter's saw handle. Here, again, it pays to buy the best you can afford.



Start new cut after changing blade.

Fig. 2-16

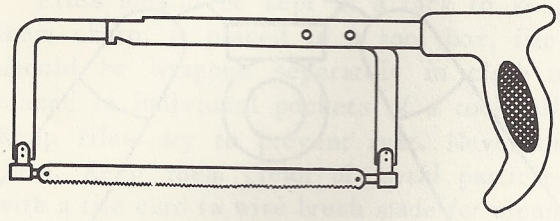


Fig. 2-17

TABLE A – HACKSAW BLADE FOR CUTTING VARIOUS MATERIALS

Material	*Teeth per Inch*
Aluminum; copper	14
Brass (cast); cast iron; cold-rolled, high-speed, tool, or structural steel	18
Iron pipe; brass or steel tubing	24
Thin stock and thin wall tubing	32

2-7. FILES

Servicemen find many uses for files. They are used to enlarge the holes in a chassis, to clean work before it is soldered, to smooth work after it is hacksawed, and for many other jobs. More than three thousand different files are manufactured; they differ in length, shape, cut of teeth, and degree of coarseness or fineness. The length, measured in inches, is the distance between the heel and the tip. This is shown in Fig. 2-18.

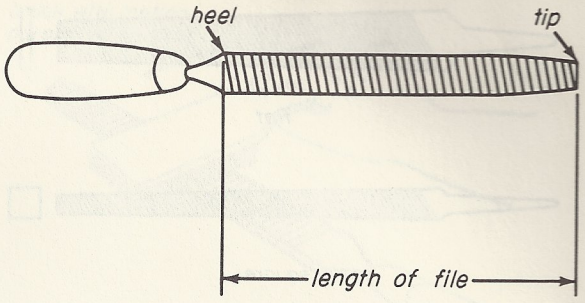


Fig. 2-18

The files most commonly used are *coarse, bastard, second-cut,* and *smooth.* The second-cut might be considered standard in coarseness. The smooth is used for finishing, the bastard when faster cutting is desired. The coarse usually is used only for such jobs as removing large chunks or jags of metal. Files may be further classed according to cut: *single-cut, double-cut,* and *rasp.* Single-cut files are used for smooth work. Double-cut files are used when faster cutting is required. However, work done with a double-cut file is rough, and requires smoothing with a single-cut file. Rasp files are used for rapid coarse filing on wood or plastic. The number of teeth in files varies from 20 to 120 an inch. Files come in many shapes. The most common are: *flat, square, triangle, round, half round.* They are shown in Fig. 2-19*a, b, c, d, e,* and *f* respectively.

Flat files, tapered in width and thickness, are the most commonly used. Square files, tapered on all sides, are used to enlarge square or rectangular holes. Triangle files, tapered on all three sides, are used in sharpening handsaws and trimming square corners. Round files, sometimes called *rat-tail* files, are used to enlarge round holes. The half-round file is another general-purpose file: the curved side is used on curved work, and the flat side on flat work. The flat wood rasp is used chiefly in carpentry and other woodworking.

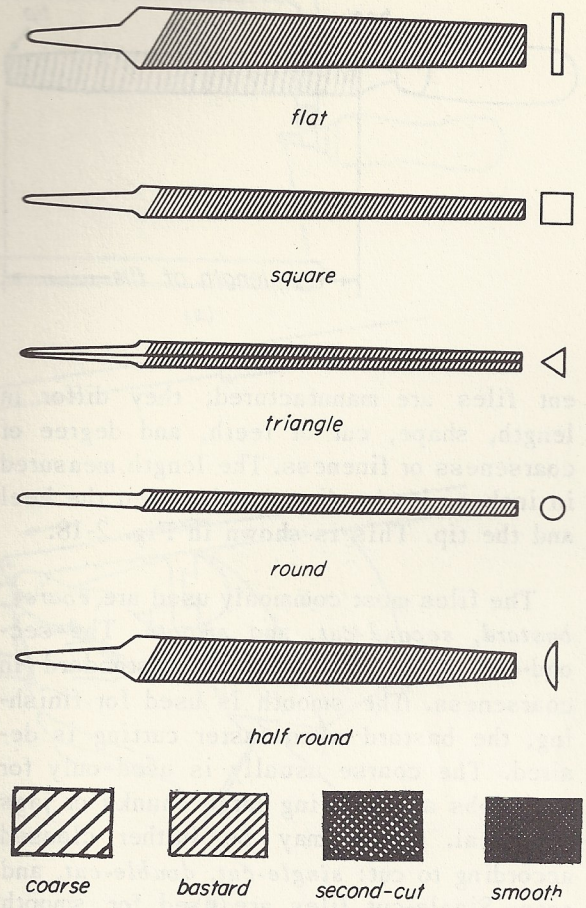


Fig. 2-19

There are two general methods of filing: *cross filing* and *draw filing*. Cross filing, which removes the most metal in the least time, is most often used. In this method, as shown in Fig. 2-20, the tip of the file is held between the thumb and first finger of the left hand, while the right hand holds the handle. Do not try to use a file without first inserting the tang into a file handle. The best type of handle is the screw-on type, shown in Fig. 2-18. The file is moved away from the body across the metal in a direction parallel with the length of the file.

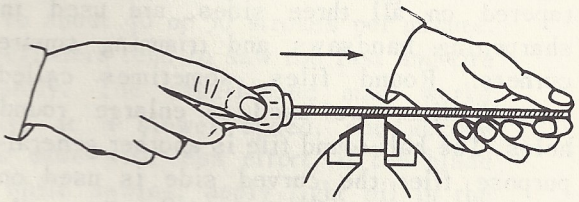


Fig. 2-20

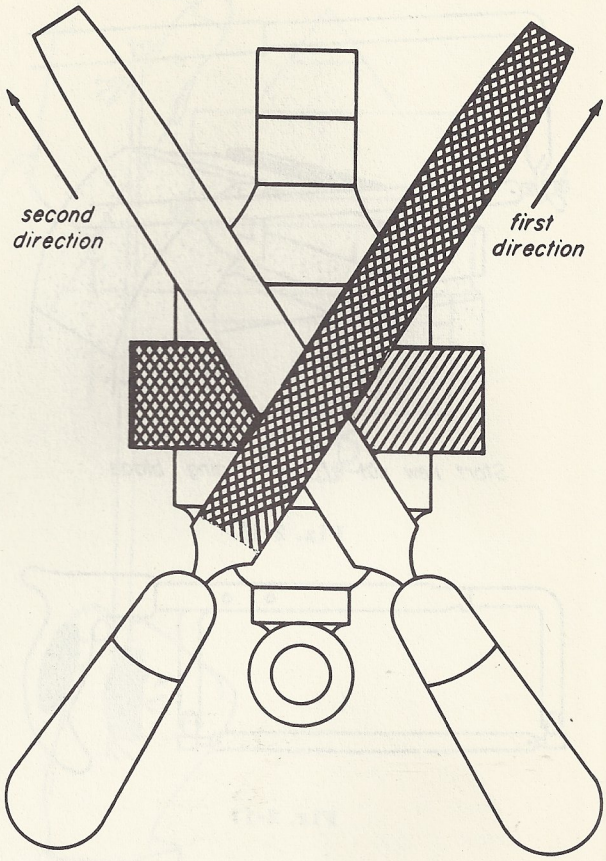


Fig. 2-21

Sometimes, on rough work with a coarse file, metal is removed more rapidly by cross stroking, as shown in Fig. 2-21. The pressure on the file depends on the coarseness and size of the file and the metal being cut. Since the file cuts only on the forward stroke, it should be lifted from the work on the return stroke. This helps protect the cutting edge of the file teeth, which would be damaged if the file were drawn across the work on the return stroke. On soft metals, it is not necessary to lift the file on the return stroke.

Draw filing is sometimes used to put the finishing touches on work that has been cross-filed to size and shape. It produces a smooth, true surface. The work is firmly clamped in the vise, and the file is drawn sidewise back and forth along the length of the work, as shown in Fig. 2-22. The cutting is done on the stroke away from the body; no

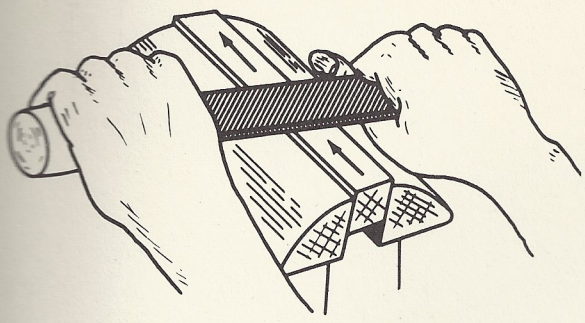
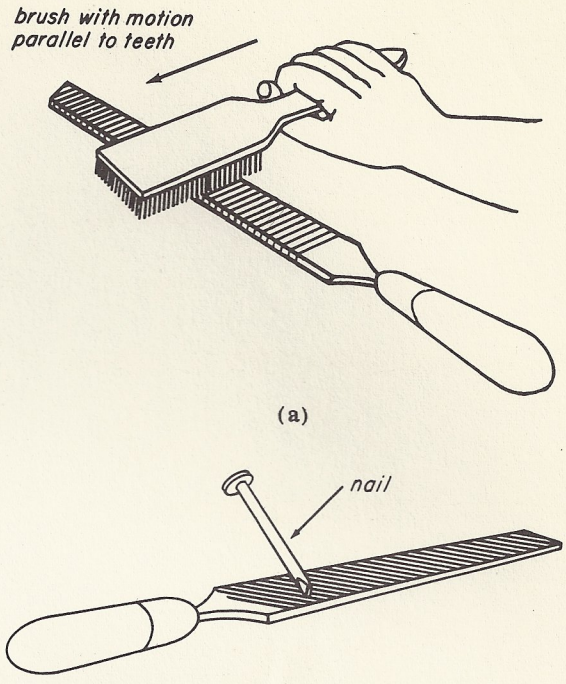


Fig. 2-22

pressure is applied to the file on the return stroke.

Files should be kept in a rack to keep them sharp. If placed in a tool box, files should be wrapped separately in cloth or placed in individual pockets of a tool roll. Keep files dry to prevent rust. Never oil them. Keep them clean of metal particles with a file card (a wire brush made for cleaning files, shown in Fig. 2-23*a*) or a soft iron nail whose tip has been flattened out (Fig. 2-23*b*). Files do not clog as much if rubbed with chalk before filing.

When buying files, get the type best suited to the job to be done. For the basic tool kit, get a double-cut, half-round, medium-length bastard file. You can do many filing jobs with this file.



(a)

(b)

Fig. 2-23

2-8. BUY WHAT YOU NEED

All the tools described, and others, are used by servicemen. As your work increases and you can afford more tools, by all means add to your tool kit. However, do not buy tools until you need them and can afford good ones. A few good tools are much better than many poor ones. Other tools are discussed in later booklets.