TELEVISION
Trouble Shooting
by
PHILCO

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Laboratories
Jerseyville
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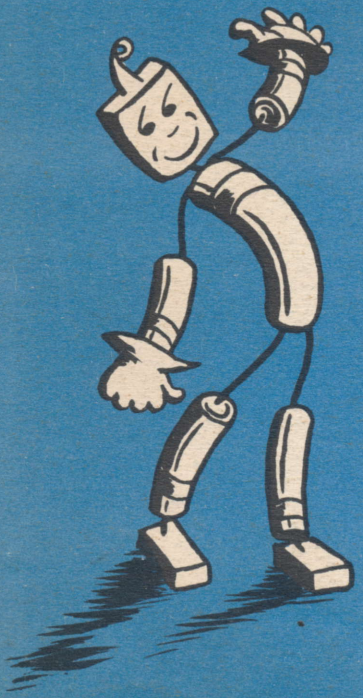
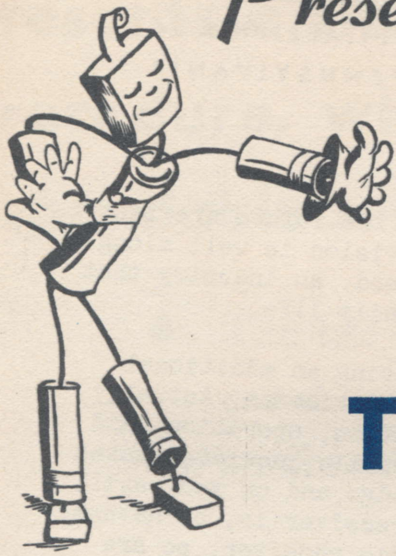
'47



PRESENTATION OF THE COURSE
LESSON 1
LESSON 2

Presenting . . . .



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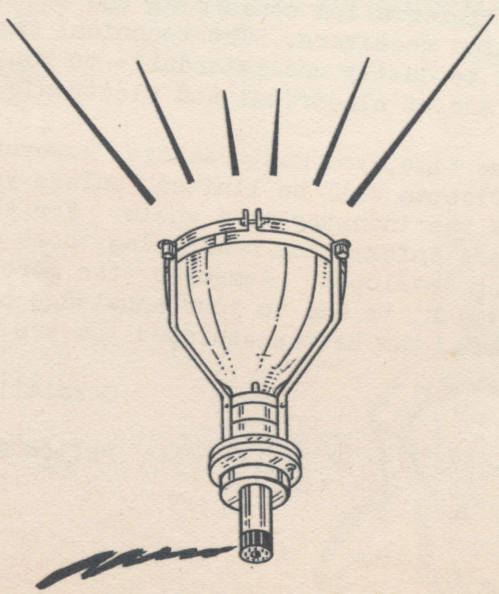
P H I L C O



PHILCO CORPORATION

PHILADELPHIA 34
PENNSYLVANIA

To the Serviceman:

Past predictions concerning television of the future are fast becoming present realities. It is evident that television is well along the road toward the status of a major industry--indeed, an industry that will soon have a far-reaching practical effect on daily life.

The advance of television is already creating an additional field of opportunity for the fully qualified radio serviceman. Actually, the public knows exactly nothing about the installation, operation, and daily care of television receivers. This lack of public knowledge makes an intense demand on your specific technical knowledge and on your skill as a television serviceman. Just as a television receiver is, by nature, a more complicated electronic instrument than a radio receiver, so are the demands on a television serviceman more exacting.

This course has been written for you--the television trouble shooter. Philco is using the material in this book as a means of passing on to you the results of its own many years of experience in television field service. The procedures described here have been found to be the most efficient and the fastest means of servicing a television receiver. To make things clear for you, this course presents not only the basic principles of television receivers--it also solves, and explains, every-day television problems in the home. All the written material has been simplified by the use of many accurate, carefully placed illustrations.

Except in a general way, you will not be interested in the techniques of television broadcasting--so, Philco has built this course chiefly on practical information concerning the actual operation and the servicing of television receivers. The technical material, simplified in this course, will be easily understandable to you, because of your background of radio and of electrical and electronic theory and practice.

At the same time, you must realize, however, that your value as a television serviceman will be limited, unless you have sufficient general knowledge of the industry as a whole. For this reason, Philco has also included here information concerning those phases of television which are still being developed. Remember--the more you know about the background of television, to add to your knowledge of the operation and servicing of receivers, the better equipped you are as a trouble shooter.

Cordially yours,

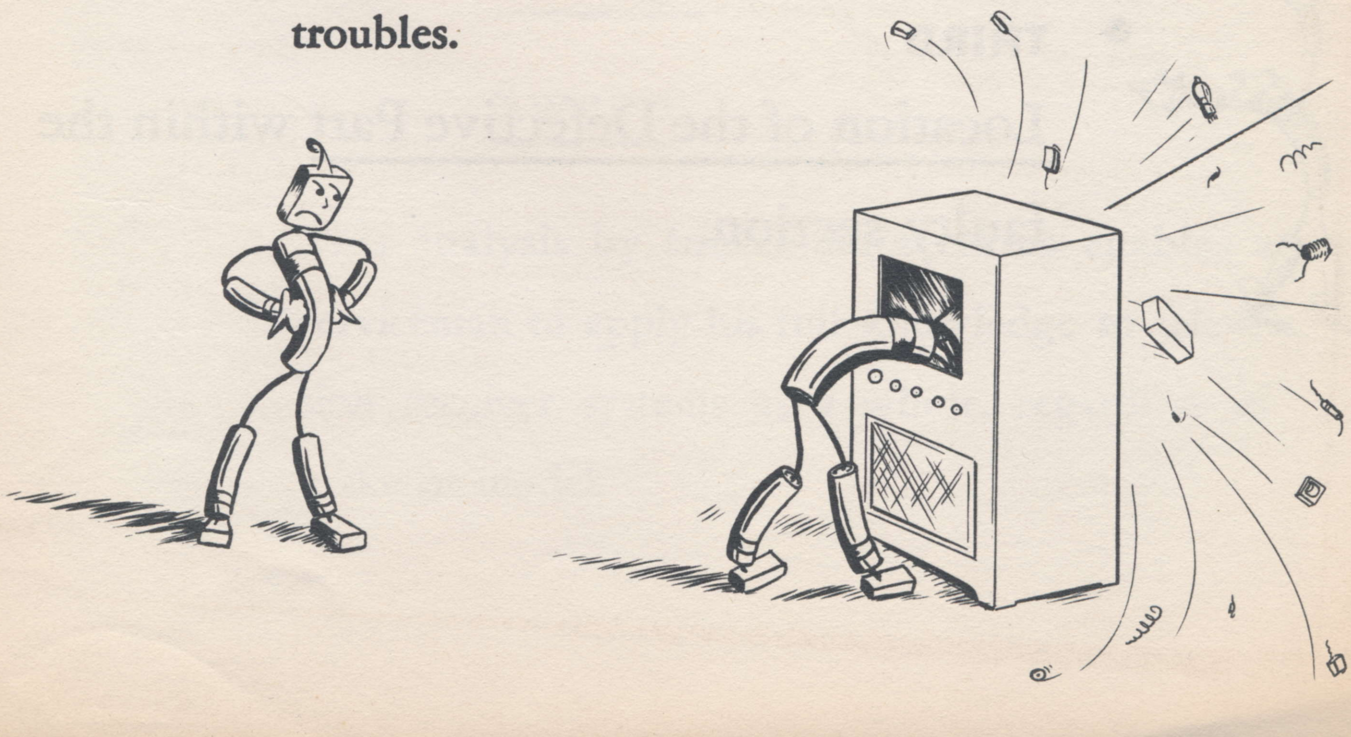
Philco Service Division

TELEVISION TROUBLE SHOOTING BY PHILCO presents a simplified, practical, convenient procedure, which results in fast, efficient, dependable service.

- The use of this method means that a serviceman can shoot the trouble in a television receiver with an absolute minimum of time and work.

- This procedure may also be used to real advantage in teaching logical, standardized, television trouble-shooting techniques.

- The PHILCO method constitutes a thorough and carefully planned trouble-shooting system. HAPHAZARD testing wastes time and often causes the serviceman to overlook obscure circuit troubles.



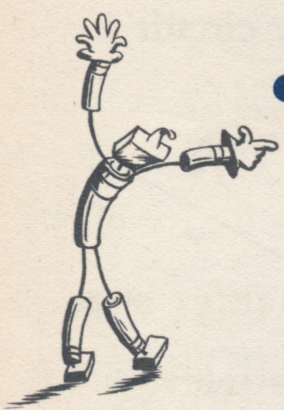
The BASIS of all effective television trouble shooting methods is

- **FIRST**

  General Localization of the Trouble to a single section of the television receiver.

- **SECOND**

  Isolation of the Faulty Section within the television receiver.



- **THIRD**

  Location of the Defective Part within the faulty section.

The PHILCO method of television trouble shooting bases its analysis of the equipment upon functional units.

- A television receiver is reduced to the following functional sections:

Power Supply

Sound

RF

Picture

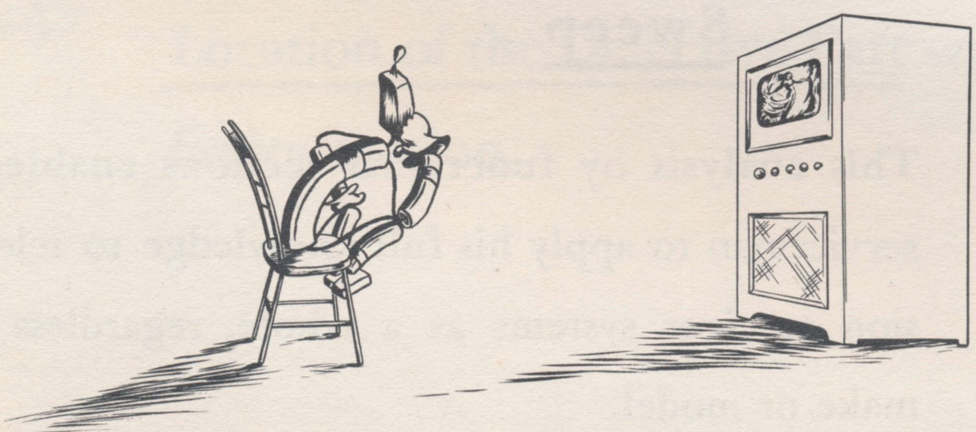
Sweep

This analysis by functional sections enables a serviceman to apply his full knowledge to television receiver systems as a whole, regardless of make or model.

The PHILCO method accomplishes <u>GENERAL LOCALIZATION OF THE TROUBLE</u> to a single section of the television receiver by

- An examination of specific operational indications, particularly picture presentation—or by

- A few checks at specific Major Test Points throughout the receiver.



The PHILCO method accomplishes ISOLATION OF THE FAULTY SECTION in a television receiver by

- A series of tests at specific Key Test Points within the entire receiver.

The PHILCO method accomplishes LOCATION OF THE DEFECTIVE PART in one section of a television receiver by

- Simple voltage and resistance measurements.

TELEVISION TROUBLE SHOOTING BY PHILCO

presents a logical method of servicing television.

- An operational check gives normal indications. When an indication is abnormal, such a check can usually point out the functional section at fault.

- A test chart systematically localizes the trouble, if the operational check alone is not sufficient, and it also isolates the trouble to a specific circuit. This chart is a part of the PHILCO Test-Point Method, which is basic to PHILCO television procedure. In this method, test points are indicated on an over-all schematic and on corresponding sectional base layouts.

  Major Test Points, indicated by a numeral within a star (☆1, ☆2, ☆3, etc.), are used to localize trouble to each functional section. A normal indication at such a point may clear a large block of circuits from further suspicion of trouble.

  Key Test Points, indicated by a letter within a black disc (●A, ●B, ●C, etc.), are used to isolate trouble to a faulty circuit. Then, voltage and resistance measurements of the components within the isolated stage can locate the defective part.

- The PHILCO Visual-Analysis Method supplements the Test-Point Method. Practically all the troubles which occur in a television receiver cause abnormal indications, either on the picture tube or from the loudspeaker, or in both sources. Careful visual examination of the receiver performance may often localize the trouble to a specific section, without following through the complete Test-Point Method.

- Supplementary aids are available, when they seem necessary. These aids include:
  Special alignment notes and chart, and
  A functional block diagram.

- The function of this course is to teach a basic method of servicing television receivers through the use of systematic trouble-shooting procedures.

LESSON 1

TELEVISION BROADCASTING TODAY

This introductory lesson gives you general information that you must know early in the study of television. It includes material about the channels used, the types of transmission, the advantages and disadvantages in the use of high frequency, and FCC station assignments.

FREQUENCY BANDS

Two frequency bands have been assigned to television broadcasting. Both of these bands are considerably higher in frequency than the normal broadcast band. The lower band of the two is from 44 to 88 mc., and the other from 174 to 216 mc., as presented in figure 1. Channels 1 to 6 inclusive are in the 44-to-88 mc. band, as follows:

Channel No.	Frequency
1	44 to 50 mc.
2	54 to 60 mc.
3	60 to 66 mc.
4	66 to 72 mc.
5	76 to 82 mc.
6	82 to 88 mc.

You will notice that there are two gaps in this band. The space from 50 to 54 mc. has been assigned for amateur radio operation, and the space from 72 to 76 mc. has been assigned either for fixed or mobile operation. The channels in the band between 174 and 216 mc. are numbered from 7 to 13. These channels are as follows:

Channel No.	Frequency
7	174 to 180 mc.
8	180 to 186 mc.
9	186 to 192 mc.
10	192 to 198 mc.
11	198 to 204 mc.
12	204 to 210 mc.
13	210 to 216 mc.

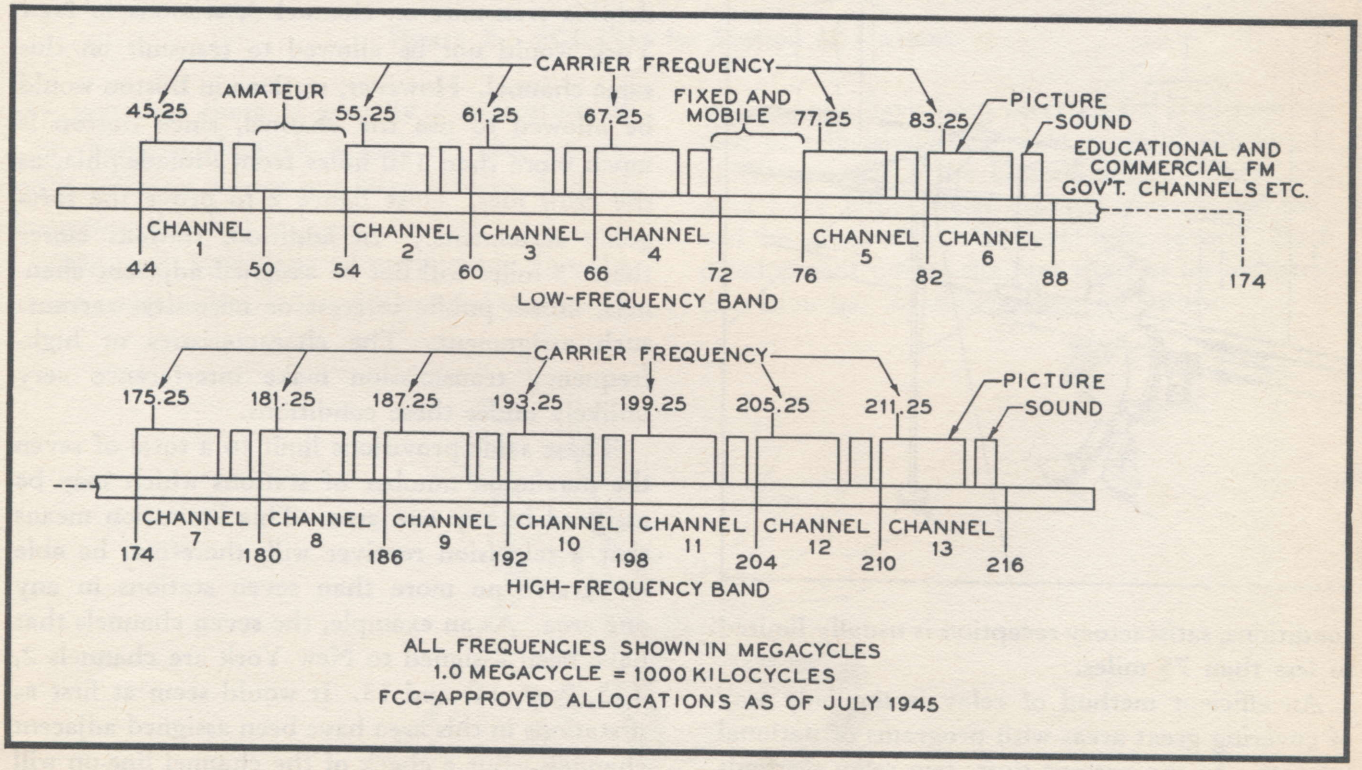


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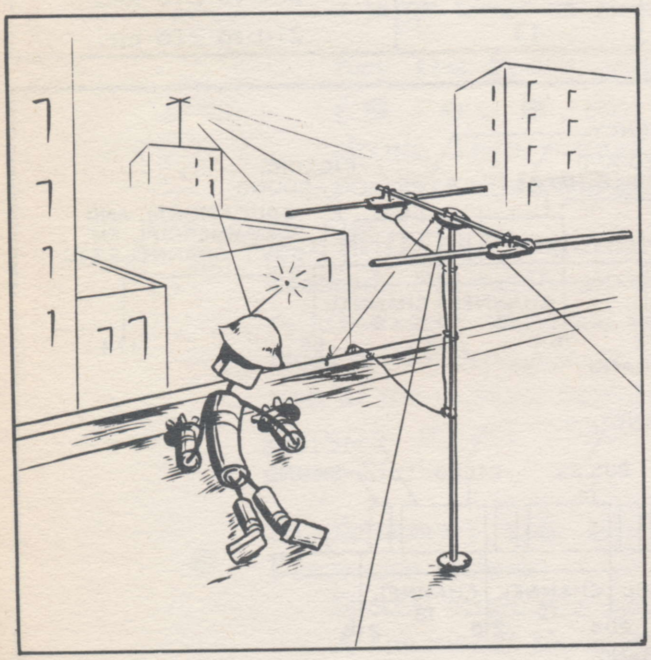
Figure 1. Television Channels

Both the sound and picture signals are transmitted within the limits of the 6 mc. channel. The picture signal occupies approximately 5.75 mc., and the sound signal, always at the high-frequency end of the channel, occupies approximately .25 mc. The sound signal is FM, and the picture signal is AM.

High-frequency bands are used in television because of the relatively wide band of frequencies required in each channel, in order to transmit the sound and picture signals. The use of high frequencies, however, confines transmission practically to line-of-sight, thus limiting the service area of the transmitter. For this reason, the aerial of the transmitting station must be as high as possible. The receiving aerial must also be high enough to clear surrounding objects — usually eight or ten feet above a roof — if a satisfactory signal is to be received over the greatest distance possible. High-frequency signals cannot be transmitted through such solid objects as a mountain or a building. This fact must be taken into consideration, in deciding how far satisfactory transmission can be obtained. Even under excellent



conditions, satisfactory reception is usually limited to less than 75 miles.

An efficient method of relay is the only way of covering great areas with programs of national interest. At the present time, two relay methods are being used. One is coaxial line, which is being used experimentally, with special television equipment, to link Washington and New York. Though this relay method appears to be sound technically, there has not yet been time to show whether its use will be widespread. The other method, becoming more and more popular every day, is the use of relay links which operate without attention. These links have two uses—one is for transmitting remote pick-ups to the main transmitter, and the other is for relaying programs between stations. A relay station is used almost daily in transmitting programs from New York to Philadelphia. This link is located at Mount Rose, New Jersey, a very high spot which is about halfway between the two large cities. See this location in figure 2.

FCC PLAN OF CONTROL

The FCC has divided the country into 140 metropolitan districts for the assignment of television stations, with the provision that stations will not be allowed to transmit on the same channel unless they are at least 150 miles apart. This means, for example, that since WPTZ in Philadelphia transmits on channel 3, stations in New York would not be allowed to transmit on this same channel. However, stations in Boston would be allowed to use the channel, since Boston is much more than 150 miles from Philadelphia, as the crow flies. (Use figure 2 to prove the foregoing statements.) In addition, stations closer than 75 miles will not be assigned adjacent channels, unless public interest or necessity warrants such assignment. The characteristics of high-frequency transmission make interference very unlikely under these conditions.

These same provisions limit to a total of seven the maximum number of stations which may be assigned in any one area. This limitation means that a television receiver will, therefore, be able to receive no more than seven stations in any one area. As an example, the seven channels that have been assigned to New York are channels 2, 4, 5, 7, 9, 11, and 13. It would seem at first as if stations in this area have been assigned adjacent channels. But a check of the channel line-up will

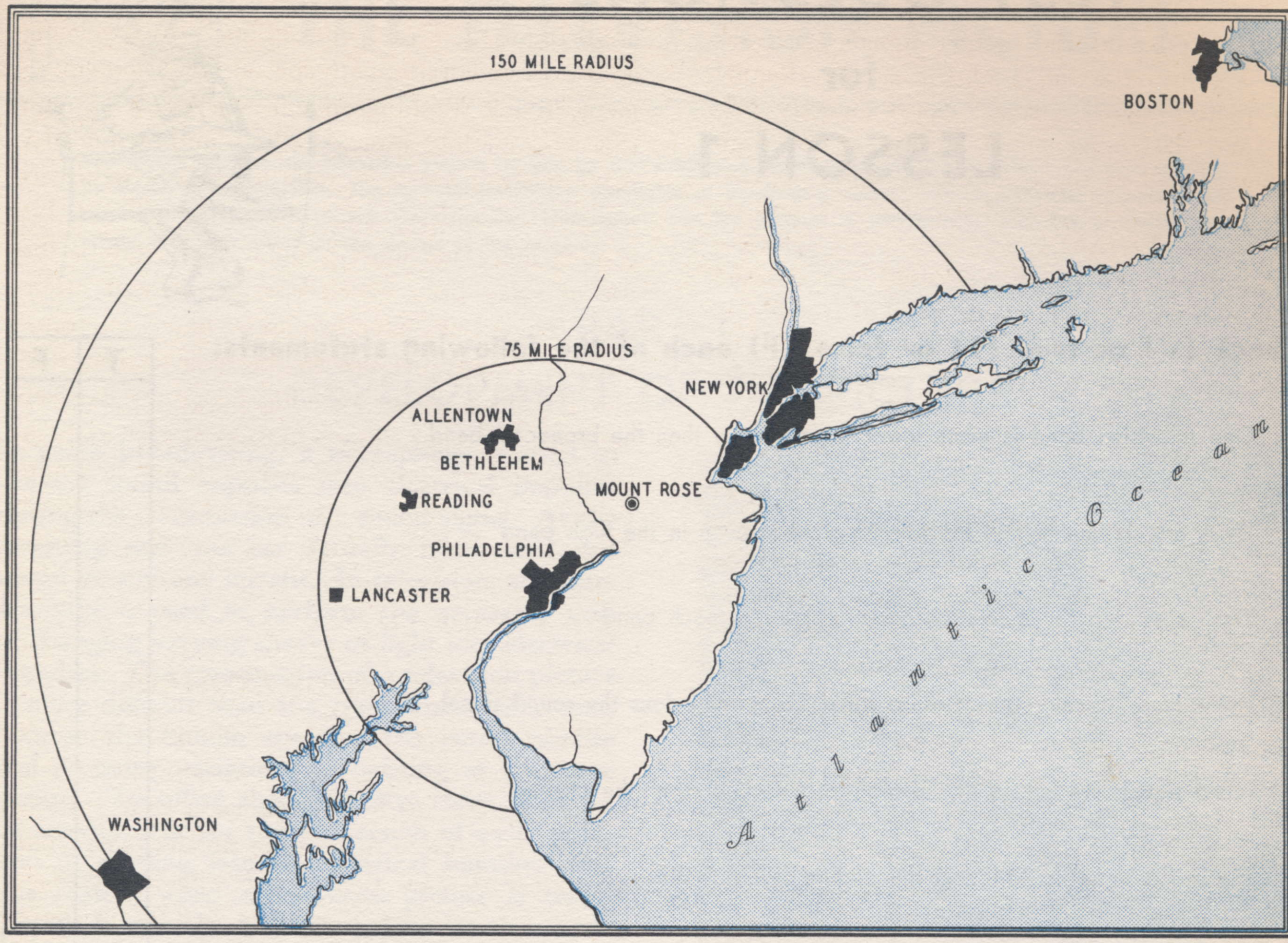
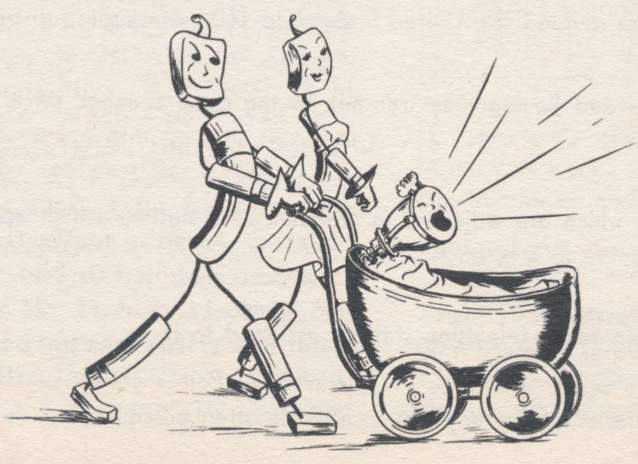


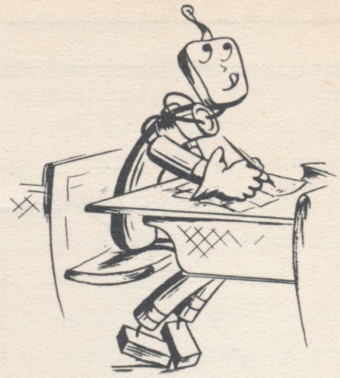
Figure 2. FCC Plan for Station Allocations

show you that there is actually a separation of 4 mc. between channels 4 and 5. This separation is sufficient to prevent interference. A chart illustrating this fact is shown in figure 1.

With such provisions already made for the control of television, it is quite natural that many applications have been received for the construction of television stations in most of the largest cities throughout the United States. These permits have either been granted already, or they will be granted in the very near future. Such development points the fact that, as an industry, television has an almost limitless future.



TEST QUESTIONS
for
LESSON 1



Check (√) as true (T) or false (F) each of the following statements:

	T	F
1. One television band is much lower in frequency than the broadcast band		
2. There are six channels in the low band and seven in the high band		
3. Two gaps, used for special purposes, appear in each band		
4. The picture signal requires more band width than does the sound signal		
5. Sound signals are always at the high-frequency end of the channel		
6. The sound signal is AM, and the picture signal is FM		
7. Line-of-sight transmission and reception are a natural result of the use of high frequencies		
8. The aerial of the transmitting station and the receiving aerial must have a clear space between them		
9. Satisfactory reception is usually possible only in distances under 75 miles		
10. Relay links represent an efficient means of extending television to distant points		
11. In a television sense, the FCC has divided the United States into 140 metropolitan districts		
12. Television stations in Philadelphia and Boston may transmit on the same channel, since these cities are more than 150 miles apart		
13. The FCC often assigns channels which are adjacent in frequency to stations which are less than 75 miles apart		
14. No one area may have more than seven television stations assigned to it		
15. Reception of more than seven stations from any one location is often possible		

LESSON 2

THE TELEVISION PICTURE

This lesson explains the television picture for you by first presenting the development of the picture and then relating its means of transmission. The material includes a discussion of breaking a picture into its elements; scanning; the number of frames each second; the composite video signal; and the systems of transmission, with the problems they create and their effect on the design of the receiver.

PART I
DEVELOPMENT OF THE PICTURE

In radio broadcasting, a microphone is used to convert sound impulses into electrical impulses during the transmission of a sound signal. At the receiving end, the ear actually hears only one sound at any one instant. In television, the camera tube is used to perform the necessary task of changing varying shades of light into electrical impulses. The transmission of a television picture is more difficult than the transmission of sound, because the human eye sees the entire picture and its many variations of lighting at the same instant. To offset this difficulty, there must be an arrangement for the conversion of each variation of shading into an electrical impulse. For this reason, when a television picture is transmitted, it must be broken up into its thousands of elements—each element representing an electrical impulse. The function of the transmitter is to divide the picture into these elements and to transmit them. The receiver reassembles the elements in the same sequence in which they were transmitted.

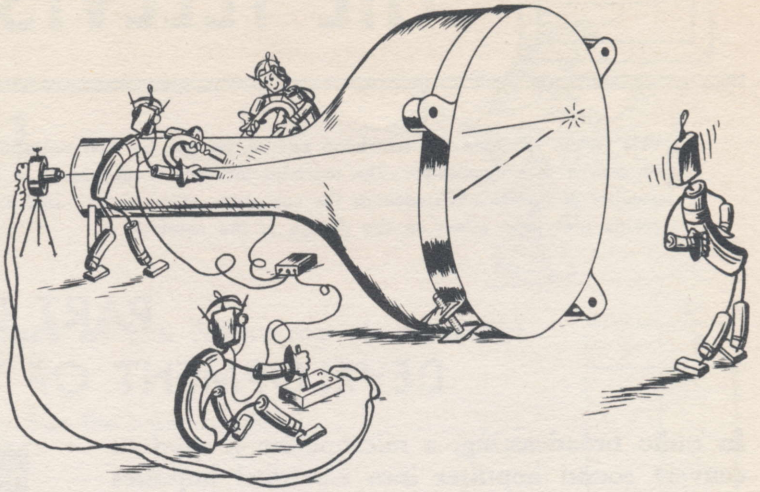
Figure 3. Structure of a Picture Divided Into Elements

PICTURE ELEMENTS

Figure 3 shows a scene that is separated into elements similar to those in a television picture. The elements in this illustration consist of evenly spaced dots. The quality of a picture will depend upon the number of dots, or elements, per square inch. The illustration in figure 3 consists of a picture of about 70 lines. When a picture of this type is viewed from a distance, the dots blend into a complete picture. As a result, it becomes impossible to see the individual elements. When this picture is being transmitted, each dot is transformed into a pulse of electricity. In television, a picture is made up of 525 lines, or elements, in the vertical direction, and approximately 700 lines in the horizontal direction. If the picture is viewed at a closer distance than 2 or 3 feet, its make-up is clear—that is, the lines composing the picture are distinguishable. A person with normal vision will be at the right distance to view a television picture, if he allows approximately one foot of viewing distance for each inch of picture height. If a person's vision is defective, the viewing distance will vary, of course, according to individual conditions of sight.

ASPECT RATIO

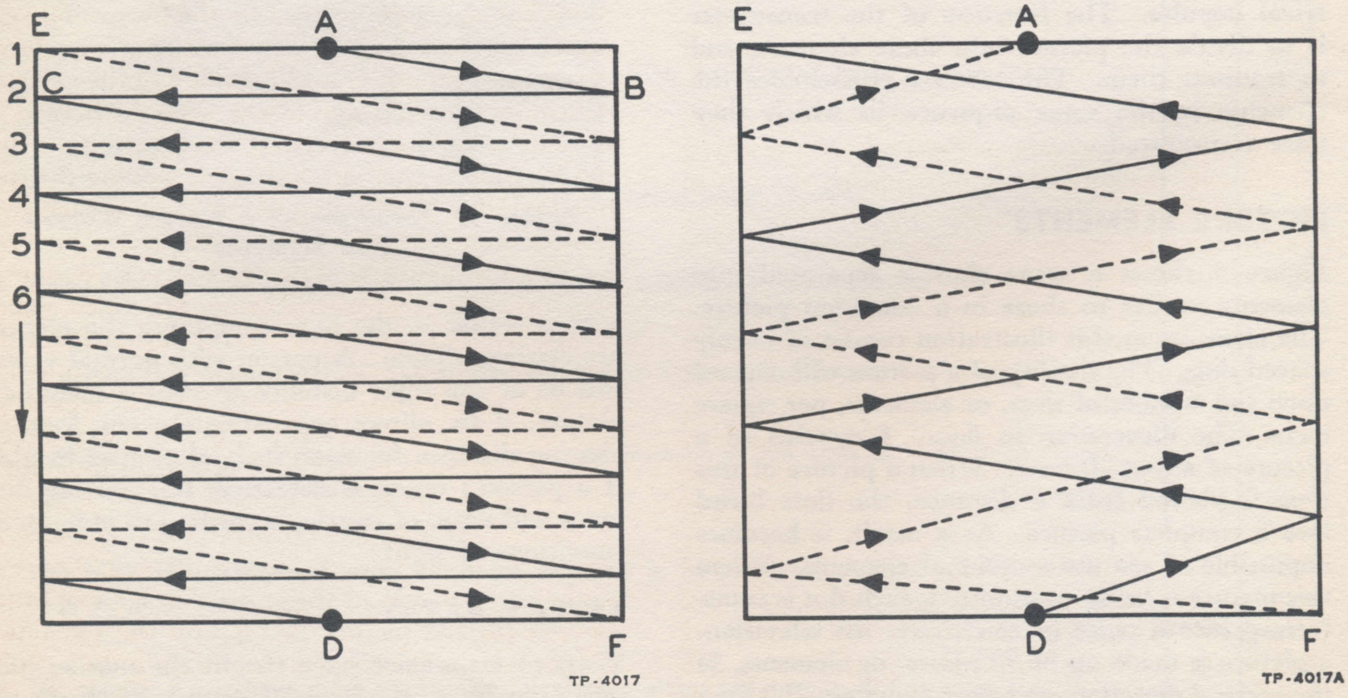
Years of experience have taught the motion picture industry that a ratio of 4 units of length to 3 units of height is most satisfactory for human vision. The dimensions for the television picture also follow this plan. This ratio of 4 to 3 is called "aspect ratio." The adoption of this aspect ratio makes it possible to use motion picture films in television broadcasting, without loss of any portion of the picture.



SCANNING

The actual breaking down of the television picture into pulses of electricity is done by means of scanning the scene with an electron beam from a cathode-ray tube. At the television broadcast station, the electron beam changes each element into an electrical pulse whose intensity corresponds to the shading of the scene. The process of exploring the scene with a cathode-ray spot, which traces each line from left to right, is called "scanning," because the breakdown of the picture is done in much the same manner as a person would read, or scan, a written page. In reading, a person starts at the upper left-hand corner and reads a line, and then his eyes return rapidly to read the next line. This return movement is much more rapid than the actual reading of the preceding line. In television, the function of the electron beam is like that of the human eye—except, of course, that the beam moves at a terrific speed, with the return time much shorter than the actual picture-information scanning line. The scanning beam, which develops the picture, moves downward in the same manner as a person's eyes move downward in reading a written page. The picture-tube spot moves back and forth constantly across the screen at the same time that it progresses downward. This continuous movement traces out a picture made up of parallel lines. The spot forming the picture moves continuously at such a great speed, that it gives the picture the appearance of having been formed instantaneously. This rectangle formed by the spot is called a "raster."

A diagram of scanning is illustrated in figures



A. Horizontal Spot Movement

B. Vertical Retrace

Figure 4. Interlaced-scanning Pattern

4A and 4B. In figure 4A, the scanning line starts at A in the middle of the picture and scans a half line to B. The spot then returns from B to C to start the second line. The slope from A to B is greater than the return from B to C. This difference in slope indicates that the speed from B to C is much greater than that from A to B. The A-to-B line contains the picture information, and the line from B to C is the retrace, or spot return, which is always blanked out. The even lines are traced out in a 2-4-6 succession, until they reach the bottom of the field at point D. Approximately 240 lines, plus a half line, have been scanned at the time the spot reaches D. The scanning from A to D, an action which is called a "field," takes place in 1/60th of a second. The return of the spot to the top of the raster at E is started at point D in figure 4B. By the time the spot has reached E, 262½ lines have been completed. The action of the horizontal oscillator, remaining in operation during the vertical retrace, causes the zigzag pattern. The scanning of the odd-numbered lines, starting at E in figure 4A, begins next. From E, the odd lines (1, 3, 5, etc.) are filled in, until the spot has moved to the bottom of the raster at F. Further reference to figure 4B again shows the retrace from F to A, which completes one picture. The completion of the picture formed by both the odd and even lines—an action which is called a "frame"—has taken place in 1/30th of a second. This system is called "interlaced scanning" because only every second line is scanned in each field.

In television or motion pictures, when as many as 15 complete pictures per second are presented to the eye, the rate of motion appears smooth in moving objects. There is, however, another factor which must be taken into consideration. If the picture is of normal brightness, it must be repeated at a much greater rate than 15 times per second, to overcome objectionable flicker. As in motion pictures, the whole operation of television is based upon the ability of the human eye to retain an image for a short time after it has been removed from view. The standard number of frames per second is 24. Motion-picture photography found that if each frame, or picture, is exposed twice, thereby giving two exposures for each picture, the eye could not distinguish any change in light. This discovery has eliminated flicker. In television, this exact procedure is not possible, but the same effect is obtained by the system of interlaced scanning which traces one-half of the picture at a time.

The repetition rate of complete pictures is standardized at 30 per second, primarily because 30 is a sub-multiple of the 60-cycle a.c., commonly used in this country. This relationship eliminates many of the difficulties that would arise, if motion-picture standards were also used for television. One example is that this standard eliminates the necessity of an abnormally large-sized filter in the power supply.

COMPOSITE VIDEO SIGNAL

The nature of television transmission demands that the transmitter and receiver remain in synchronization at all times. In order to achieve this synchronization, the FCC has specified the type of signal that must be used for accomplishing the requirements of the television picture. Figure 5 shows a diagram of this signal, called the "television synchronizing waveform." The diagram presents a graph of the voltage changes and of the sequence in which these changes must be sent, in order to attain a 525-line, interlaced-scanning picture.

A sawtooth voltage, applied to the horizontal-deflection circuits at the picture tube in the receiver, moves the spot horizontally across the face of the tube. The movement of this spot traces each line. The timing of the start of this sawtooth voltage is determined by the horizontal-sync pulses of the television synchronizing waveform. A second sawtooth voltage, applied to the vertical-deflection circuits, moves the spot downward at the rate of 60 fields a second, during the time that the horizontal sawtooth voltage is moving the spot horizontally. The timing of the start of each field is determined by the vertical-sync-pulse interval, as shown in figure 5. The receiver is so designed, that, when it receives the composite video signal, it will separate the picture information from the synchronizing signals. In turn, the horizontal and vertical synchronizing signals will be separated, and then they will be fed to the horizontal-deflection and vertical-deflection circuits, locking these circuits with the transmitter.

Part A of figure 5 illustrates the manner in which the modulating voltage is divided. Approximately 75 per cent of the entire voltage amplitude is used for the picture signal, and the remaining 25 per cent is for the synchronizing pulses. Note that the black level, or maximum black, in the picture is reached at 75 per cent above zero carrier, and the maximum white at about 15 per cent

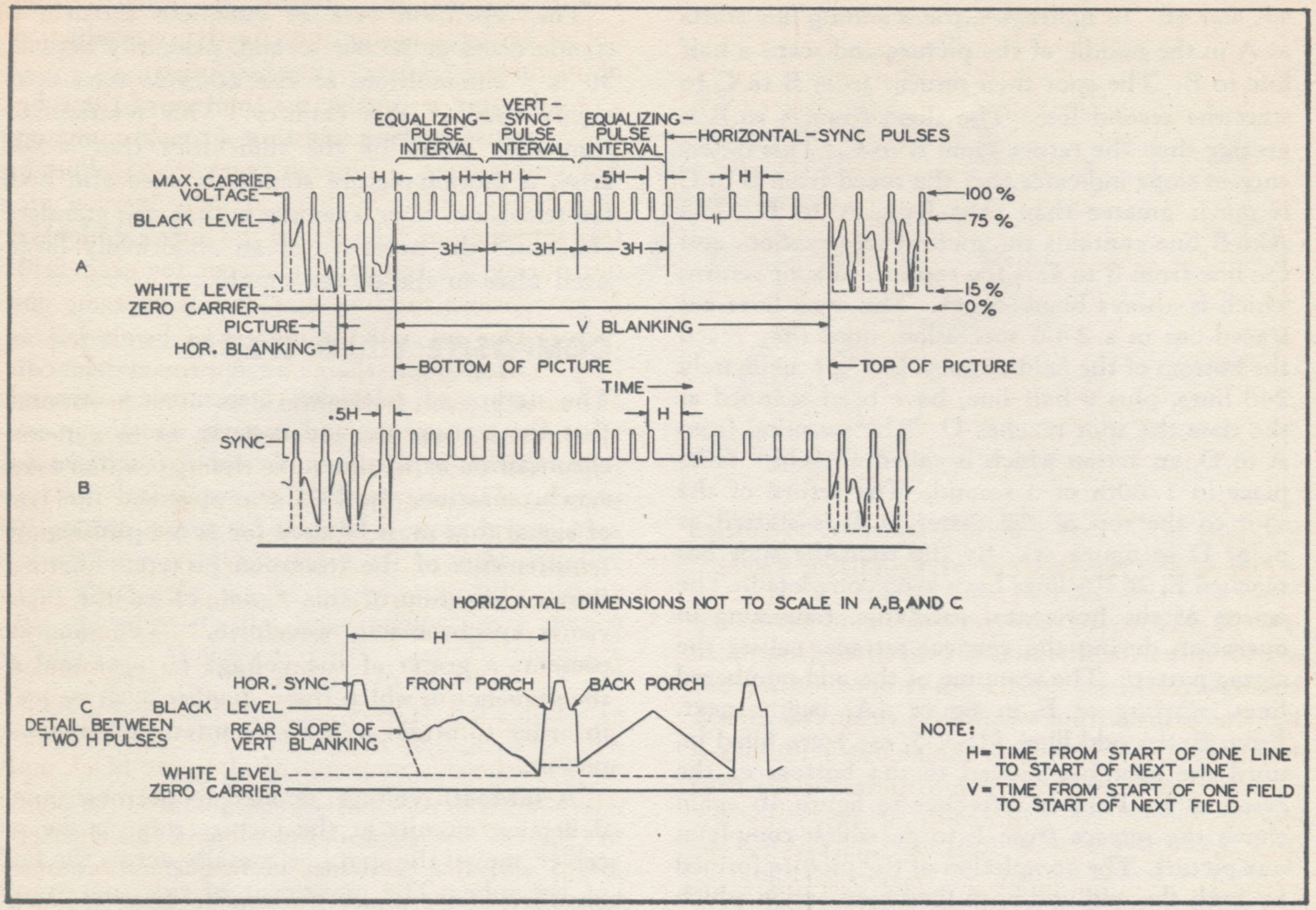


Figure 5. Television Synchronizing Waveform

above zero carrier. The 25 per cent of the carrier above the black level is used for sync purposes. This part of the carrier has no effect on the picture, because it is in the blacker-than-black section of the modulation. In part C of figure 5, the diagram of the picture signal between the last two horizontal pulses is that of a picture signal changing gradually from white through gray to black, and then back again through gray to white. This action represents a changing d-c voltage which is in proportion to the shading. A study of part C, figure 5, also reveals that the horizontal-sync pulse has a front and back porch, occurring at the blanking, or black, level. The purpose of this porch is two-fold: to prevent the sync from occurring at different times for different picture content; and also to blank out the return of the spot at the completion of each line, so that this return will not interfere with the picture.

At the end of 262½ horizontal sweeps, 240 of which are visible, one field has been formed. The picture-tube spot has moved to the bottom of the raster because of the action of the vertical-deflection circuits in the receiver. The spot must now be blanked out and returned, in its blanked-out state, to the top of the raster. The television transmitter sends a signal which will operate the vertical-deflection circuits of the receiver, thus determining the moment when the next field is to start at the receiver. The picture information is blanked out at the transmitter during a period of approximately 17 lines. This action compensates for the differences in blanking and spot-return times between various receivers. As you

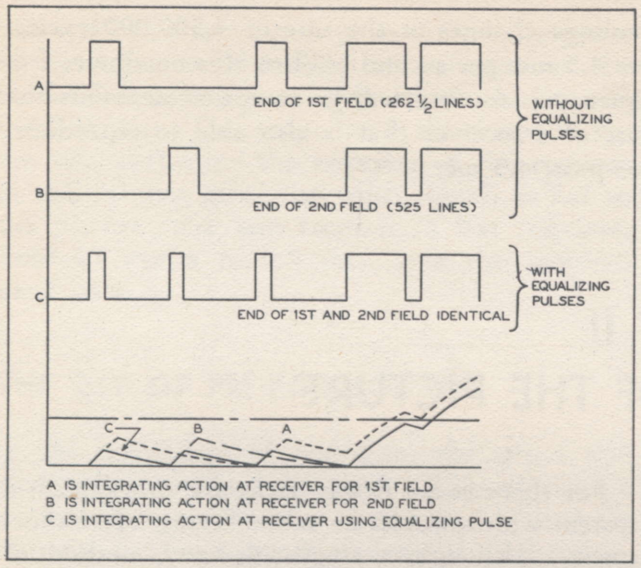


Figure 6. The Purpose of Equalizing Pulses

already know, the transmitted signal must also synchronize the horizontal-deflection circuits of the receiver in a way that must not be disturbed by the transmitting of the vertical-sync signal. For this reason, the vertical-blanking pulse is serrated—that is, broken up into pulses wider than the horizontal-sync pulse, but of twice the frequency. See figure 5, part A, marked as the vertical-sync-pulse interval. The serrations are such that the horizontal-deflection circuits in the receiver can synchronize on every other serration of the vertical-sync-pulse interval. Figure 5, part A, also shows that a series of equalizing pulses is sent, at half-line intervals, both preceding and following the vertical-sync-pulse interval. The purpose of this series is to have these pulses immediately preceding and following the vertical-sync-pulse interval the same for each field. A comparison of parts A and B of figure 5 will show that the equalizing pulses begin on a half line for one field, and on a whole line for the next field. This difference between the fields is sufficient to cause improper interlace, unless equalizing pulses are used. The action that would take place at the receiver, if equalizing pulses were not used, is illustrated in figure 6.

FREQUENCY RESPONSE NECESSARY FOR A QUALITY PICTURE

The most important part of the composite video signal, of course, is that part which makes up the picture information. This picture signal imposes definite conditions for the effective reproduction of pictures.

As the spot sweeps across the face of the tube, it forms a picture consisting of approximately 480 visible lines. Although there are 525 lines in each frame, only 480 lines actually contain picture information. The rest of the lines are blanked out during the return of the spot for each field. If we consider the spot diameter as covering one picture element and the picture as being 4/3 as long as it is high, there are approximately 640 elements in each horizontal line. The horizontal elements are not sharply defined, as in a newspaper half tone, because light changes cannot take place instantaneously. Multiplying the number of vertical lines by the number of horizontal elements shows a possibility of 300,000 picture elements in a single frame. Inasmuch as 30 frames are transmitted per second, a maximum of 9,000,000 picture elements must be reproduced per second, if good picture quality is to result. The most difficult picture to reproduce would be a checkerboard composed of alternate black and white squares, the size of the picture-tube spot. See figure 7 for an idea of one line of this checkerboard and the fundamental frequency response necessary to reproduce the signal. Since a black element is a voltage change in the positive direc-

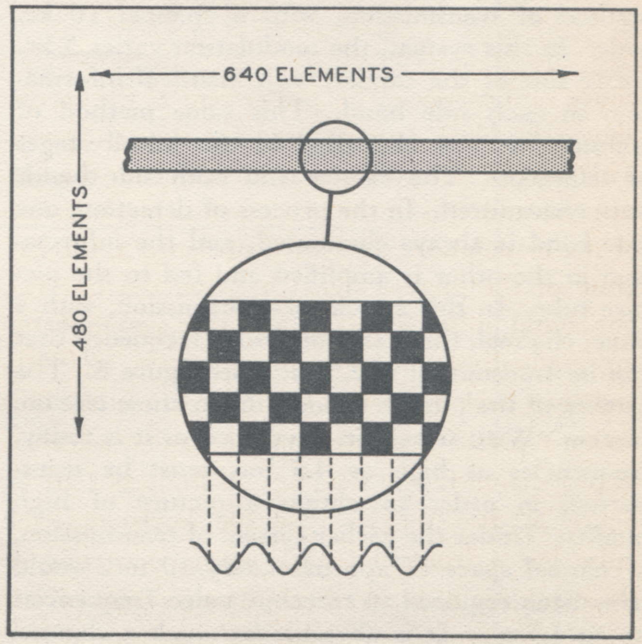


Figure 7. Electric Pattern Necessary to Reproduce a Checkerboard

tion and a white element is a change in the negative direction, one complete cycle obviously is necessary for each black and white element. Therefore, production of the entire 9,000,000 black and white elements each second would require voltage changes at the rate of 4,500,000 cycles, or 4.5 mc. per second. When this maximum frequency is transmitted, its reception demands the use of a receiver that is also able to reproduce, or pass, 4.5 mc.

PART II
TRANSMISSION OF THE PICTURE

In the United States, the standards for the video signal require that a decrease in light intensity cause an increase in radiated power. The chief advantage of this polarity of transmission is the fact that interference is much less noticeable, because noise pulses will cause dark spots, rather than white spots, on the picture-tube screen.

In order to understand the reason for some requirements in the receiver, you must also understand the conditions placed upon the receiver, by the system of transmission in use. There are three possible systems of transmission:

1. the double-side-band method;
2. the single-side-band method;
3. the vestigial-side-band method.

Radio broadcasting employs a double-side-band method of transmission, with a channel 10 kc. wide. In this system, the modulation varies 5 kc. either side of the carrier, with identical information in each side band. This same method of transmission was also used in the initial stages of television. The carrier and both side bands were transmitted. In the process of detection, one side band is always eliminated, and the information in the other is amplified and fed to the picture tube. In this system of transmission, with a 6-mc. channel, the maximum video frequency that can be transmitted is 2.5 mc. See figure 8. The quality of the picture is poor, under these circumstances. With television developed as it is today, frequencies as high as 4.5 mc. must be transmitted, in order to obtain a picture of high quality. Under the earlier system of transmission, a channel space of approximately 10 mc. would have been required to transmit video frequencies up to 4.5 mc. It is obvious that such a channel width would reduce the number of stations that could be accommodated in any one television band.

For this reason, it was necessary to establish a system which would be more saving of channel space. Although a single-side-band method of transmission is able to accommodate the greatest number of channels in the television frequency spectrum, this method is really impractical, because of the characteristics of the side-band filter that must be employed at the transmitter. The use of this filter introduces serious phase shift that results in a blurred image on the picture tube at the receiver.

The present system, which overcomes the problem of phase shift encountered in single-side-band transmission, is really a compromise between double-side-band and single-side-band transmission. This method conveys the information contained in the entire upper side band and part of the lower side band. Figure 9 gives an illustration of this method, called the "vestigial-side-band." Though the method would overemphasize the lower frequencies, as can be seen from a study of figure 9A, this overemphasis, which, incidentally, is a very important consideration in the alignment of the television receiver, is compensated for at the receiver. The radio frequency and the intermediate stages of the receiver are adjusted to reduce the amplification of the lower frequencies arriving at the receiver. The response is reduced at a linear rate, 1.25 mc. above and

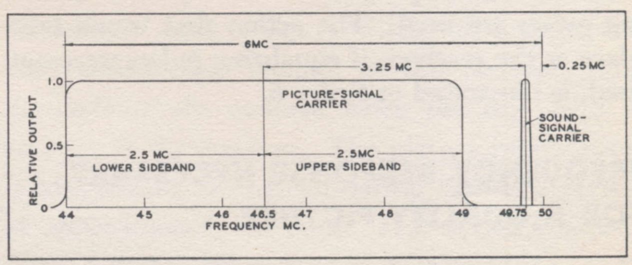


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Figure 8. Double-side-band Television Channel

below the carrier frequency, so that the response of the receiver is reduced 50 per cent at the carrier frequency, as compared with the over-all amplification. This reduction is illustrated in figure 9B. Adjusting the response of the receiver in this manner gives the video signal, as fed to the picture tube and receiver, a flat response, from 25 cycles to 4.5 mc., over the required band pass.

THE USE OF FM FOR SOUND

In the early days of television, the sound and picture were received separately. The sound used amplitude modulation at that time, in contrast with the frequency-modulated signal used today. As recently as 1941, plans were being made to use a receiver for the picture alone and to reproduce the sound separately by means of the regular broadcast receiver. For this reason, prewar push-button receivers had one push button set aside for television sound. In the television receiver, the sound signal was fed to an oscillator whose signal was radiated and, in turn, was picked up by the broadcast receiver. The push button on the broadcast band and the converter in the television receiver were tuned to a frequency somewhat below the low-frequency end of the broadcast band—usually at about 500 kc.—because it was necessary for this frequency to be at a point where there were no stations operating. The recent adoption of FM for the transmission of sound has made it impossible to use the broadcast receiver in this way. The television receiver is now complete unto itself, since it reproduces both the picture and the sound. The use of FM has resulted in better tonal fidelity and in freedom from interference—both man-made and atmospheric. In addition, the economy of using a broadcast receiver for sound becomes negligible in comparison with the actual advantages to be gained from the use of FM.

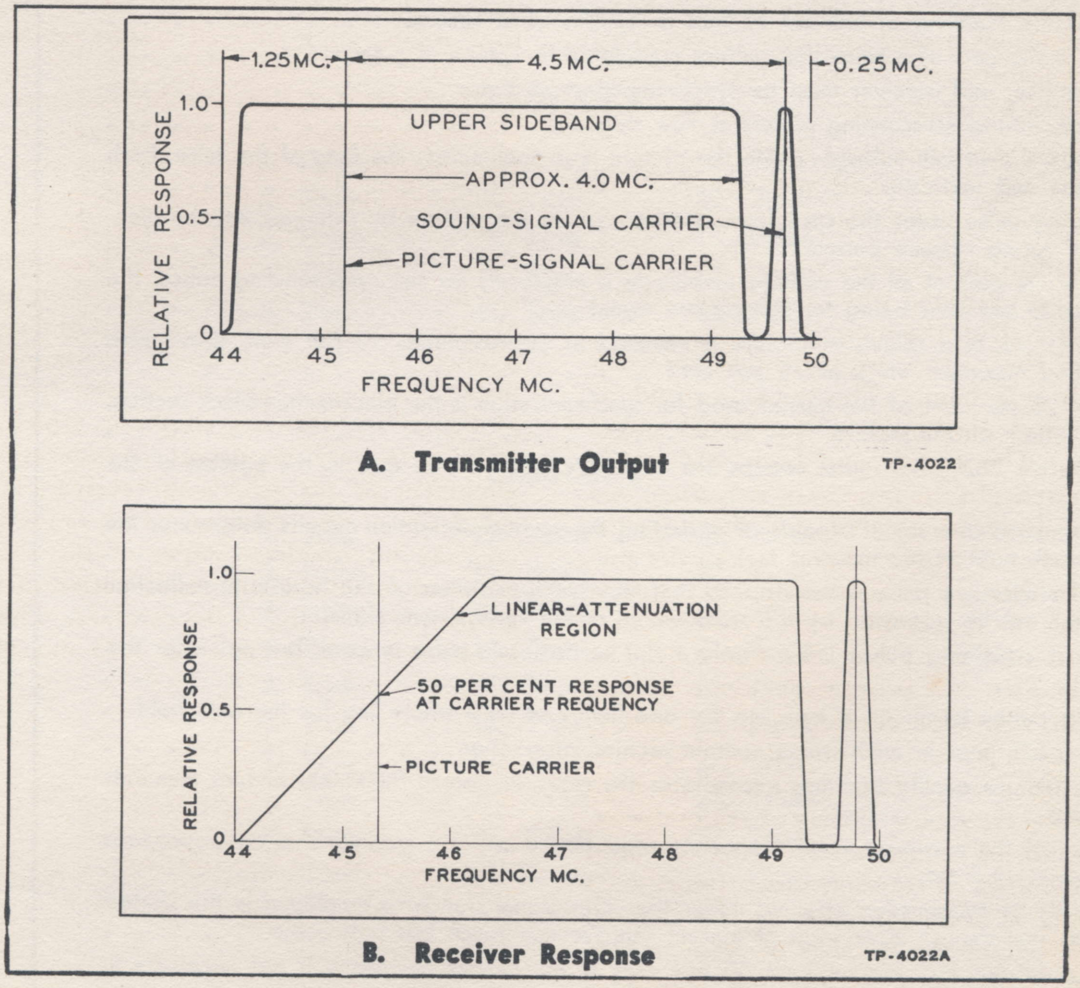
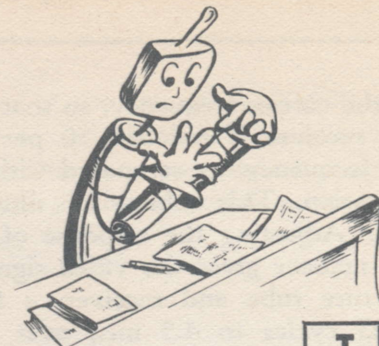


Figure 9. Vestigial-side-band Television Channel

TEST QUESTIONS for LESSON 2



Check (√) as true (T) or false (F) each of the following statements:

	T	F
1. The camera tube changes varying shades of light into electrical impulses		
2. A television picture does not have to be broken up into its elements at the time it is transmitted		
3. A television receiver is able to reassemble the elements of a picture, though not necessarily in the order of their transmission		
4. The quality of a television picture depends upon the number of elements per square inch .		
5. The aspect ratio employs four units of horizontal length for every three units of height . .		
6. Motion-picture films can be projected for television without losing any part of the picture .		
7. The continuous movement of the picture-tube spot across the screen traces the pattern of a television picture		
8. A raster is the rectangle formed by the movement of the picture-tube spot		
9. Scanning one-half of a television picture at a time has the same effect as giving two exposures for each picture in motion-picture photography		
10. A complete television picture is produced in 1/30th of a second		
11. Since every line is scanned in sequence, the system is named interlaced scanning		
12. A field is the scanning of one set of lines in 1/30th of a second		
13. A frame is the part of a television picture completed in 1/60th of a second		
14. The transmitter and receiver must be synchronized at all times		
15. A 525-line, interlaced-scanning picture is now standard		
16. Two separate sawtooth voltages move the picture-tube spot across the face of the tube, both horizontally and vertically		
17. The blanking pulse keeps the spot from interfering with the picture by extinguishing the electron spot during retrace periods		
18. About 75 per cent of all the voltage amplitude is employed for the synchronizing pulses, the remaining 25 per cent being for the picture signal		
19. Maximum black in a television picture is reached at approximately 15 per cent above zero carrier, and maximum white at 75 per cent		
20. Since the 25 per cent of the carrier used for synchronization is the blacker-than-black section, it has no effect on the picture		
21. Approximately 262½ horizontal sweeps are necessary to move the spot to the bottom of the raster		
22. The transmission of a signal capable of operating the vertical-deflection circuits determines the start of each field at the receiver		
23. The vertical-blanking pulse is serrated, so that the synchronization of the horizontal-deflection circuits will not be disturbed by the transmission of the vertical-sync signal		
24. A series of equalizing pulses is sent before the vertical-sync pulse interval, but not after the interval		
25. Equalizing pulses begin on a half line for one field and on a whole line for the next field .		
26. All of the 525 lines in each frame contain picture information		
27. Effective picture quality at times necessitates the reproduction of 9,000,000 picture elements per second		
28. Reception of the maximum video frequency requires the use of a receiver that can reproduce approximately 4.5 mc.		
29. The polarity of transmission attained under the video-signal standards employed in the United States has the distinct advantage of making interference much less noticeable		
30. Reduction of the receiver response 50 per cent at the carrier frequency is not necessary in receiving today's television picture		

ANSWERS TO TEST QUESTIONS

The correct answers to the True-False questions on Lessons 1 and 2 are listed below. (The True-False method of testing was purposely chosen as a speedy and sure way for you to find out how much you really know by now.)

You will notice that this answer sheet is inserted separately, so that it may either be removed or left in the book permanently. Thus, you may study the text alone and then use the questions as a self-administered test, rating your own results, directly from this sheet. On the other hand, if you are using this text in a group, perhaps in school, the instructor may want to be more formal: remove this answer sheet at the beginning of the work, teach you from this course, administer the test, and give you a numerical rating on your results.

LESSON 1

1. False	6. False	11. True
2. True	7. True	12. True
3. False	8. True	13. False
4. True	9. True	14. True
5. True	10. True	15. False

LESSON 2

1. True	11. False	21. True
2. False	12. False	22. True
3. False	13. False	23. True
4. True	14. True	24. False
5. True	15. True	25. True
6. True	16. True	26. False
7. True	17. True	27. True
8. True	18. False	28. True
9. True	19. False	29. True
10. True	20. True	30. False

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