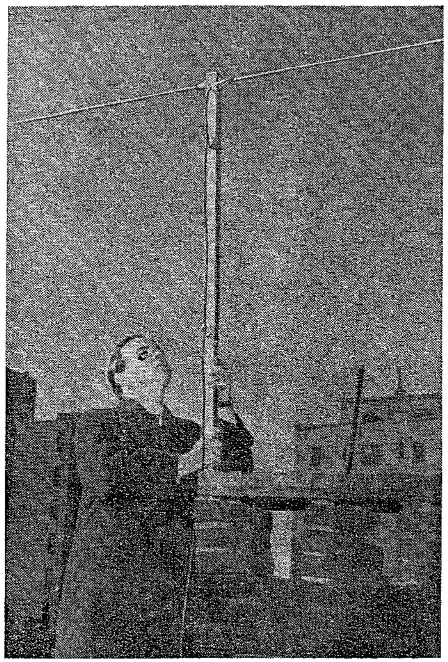
Antennas for FM and Television

Signal strength may be good on the rooftops, but for good sound and video reception you have to pull it in and get it downstairs.

THE TWO most important parts of your television picture are your antenna and receiver—in that order.

Sure, there are differences in set design and construction. Some are better than others. But any modern set is capable of putting together a good image. All it needs is enough broadcast signal to work on. It's the job of the antenna to provide the signal.

Even if you have a professionally installed rig on your roof, it will pay you to know a few basic facts about FM and TV antennas. They will help you to add to or modify your existing arrangement to improve your set's operation and bring in difficult stations.



For best results the half-wave dipole should extend as high as possible above the building. A simple dipole and coaxial-cable transmission line is shown in Fig. 1. You can use other types of low-loss feeders in place of coax. Dipoles are directional; they favor signals coming from the direction of blocked arrows.

Electromagnetic waves are basically alternating currents that travel through space at the uniform speed of 984,000,000 feet a second. The thing that distinguishes them is their *frequency*, or the rate at which they alternate.

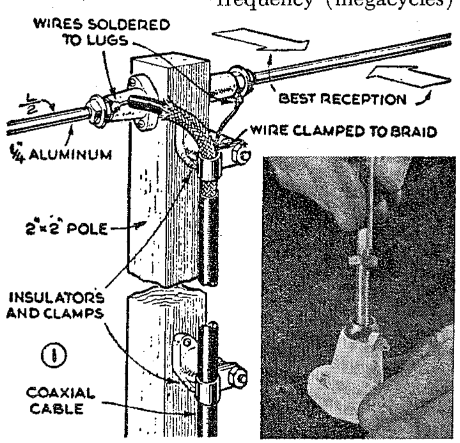
The distance that a wave travels in one complete alternation—or cycle—is called its wavelength. It follows that the more rapidly a current alternates—that is, the higher the frequency—the shorter its wavelength will be.

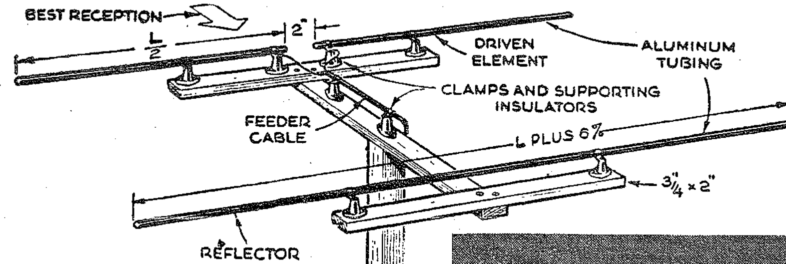
Now, the reason wavelengths are so important is simply this: as a radio signal is broadcast into space, it showers its energy all about. Any rod, wire, or other conductor it meets absorbs some of that energy. But maximum energy is transferred when the length of the conductor corresponds to the length of the transmitted wave.

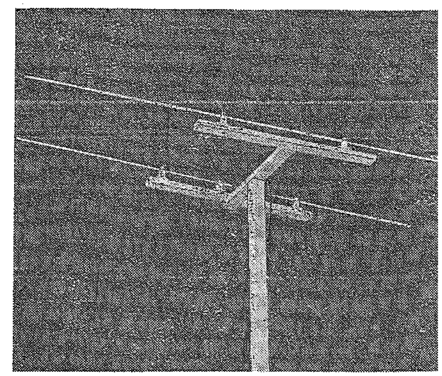
It is known that the most practical and efficient length for an antenna is half the length of the wave. In practice antennas are made 5 to 7 percent shorter than a half wave to compensate for certain undesirable effects.

From the above figure you can derive a handy formula for calculating proper antenna length. The one commonly used is:

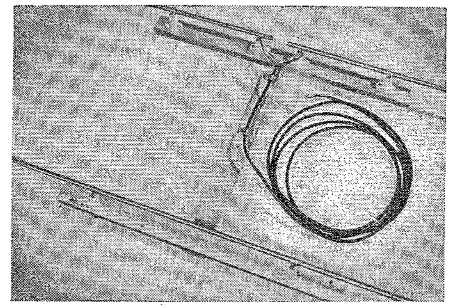
$$\text{Length (feet)} = \frac{468}{\text{frequency (megacycles)}}$$







As can be seen in the drawing above, the two-element beam antenna consists of a half-wave dipole, now called the driven element, and a reflector. The latter isn't connected.



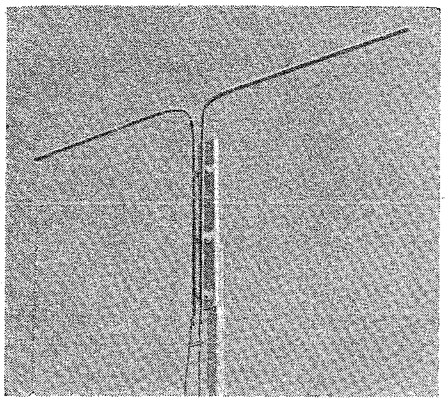
A two-conductor feeder cable is illustrated at the left. One conductor is soldered to each half of the dipole; the other ends go to set.

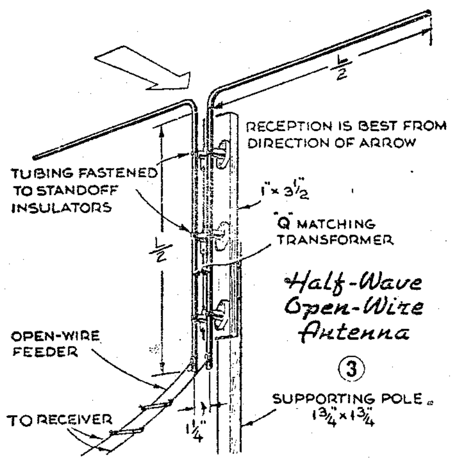
The basic form of the TV and FM antenna is the half-wave dipole shown at the left. As you can see, the half wavelength is made up of two equal arms extending outward from the center. Each arm, then, is equal to the corrected half wave divided by 2. The table at the right gives the length for various channels; "L" represents the total length of both arms.

It is convenient to use the total length in the table because other elements of an antenna, such as reflectors and directors (which will be discussed below) can also be calculated as fractions of "L".

Proper length is one key factor in antenna construction. Another is the way in which high-frequency waves travel. They move in straight lines and are reflected by flat surfaces. When it comes to building an antenna, you also want to take into account such things as elevation, neighboring buildings, distance from transmitters, and strength of the signal in your location. If you live

Channel or band	Frequency (mc.)	"L" (Total length of both rods of dipole —inches)
2	54-60	98
3	60-66	88
4	66-72	80
5	76-82	70
6	82-88	65
7	174-180	31
8	180-186	30
9	186-192	29
10	192-198	28
11	198-204	27
12	204-210	26
13	210-216	25
low band (2-6)	54-88	78
high band (7-13)	174-216	28
all band (2-13)	54-216	60-65
FM	88-108	56



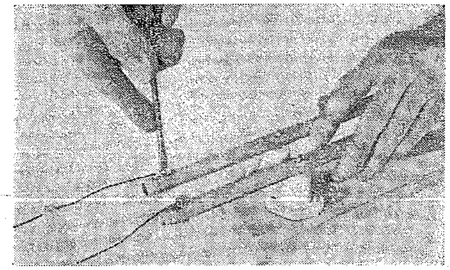


close to a broadcasting station you'll find the easily constructed half-wave dipole efficient.

The dipoles are made of ¼" aluminum rod. After cutting them to length, thread one end of each ¼"-20. Use two nuts to clamp the end into an insulator as shown in the inset of Fig. 1. Mount the insulators on opposite sides of a 2"-square wooden pole. Several types of feeders, or connecting wires, may be used between roof and receiver.

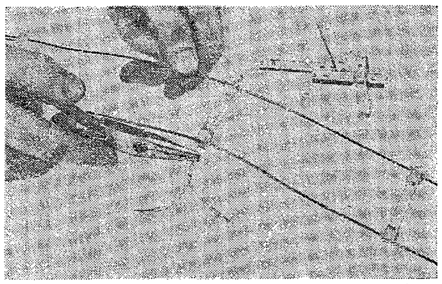
Most high-frequency antennas must be correctly aimed for best performance. To position your antenna, rotate it slowly while a helper tunes the receiver and signals to you when all stations come in best.

Farther from the center of a service area the antenna must be more sensitive to signals coming from the chosen direction and capable of cutting off noises from the rear. The two-element antenna of Fig. 2 is designed for that job. The addition of a re-



The half-wave open-wire antenna is constructed from two lengths of ¼" to ⅜" aluminum tubing. Make a 90° bend at the midpoint of each tube to form the Q-matching transformer.

Space the open-wire line with a sufficient number of 2" plastic spreaders. Use insulators to keep the wire from touching the building.



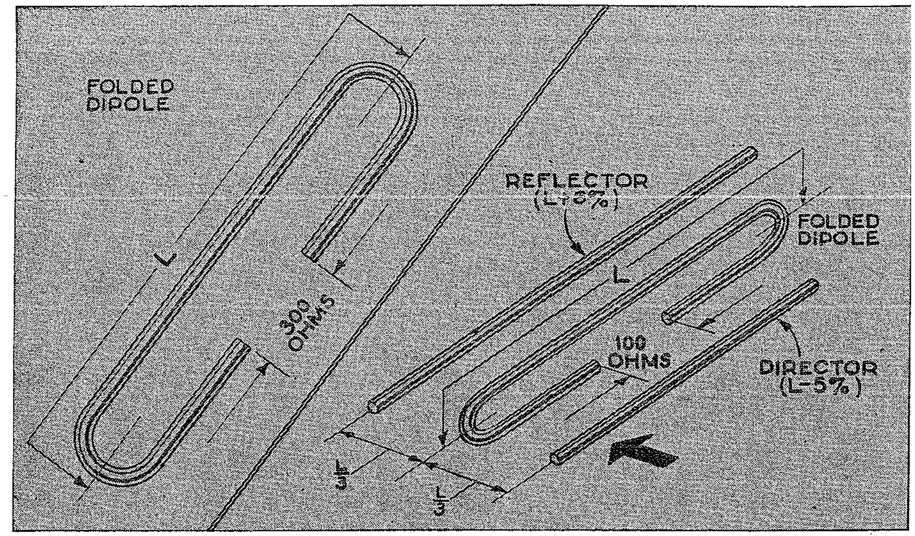
flector behind the dipole gives a much higher ratio in the favored direction. It can be made of aluminum rod or tubing from ½" to ¾" in diameter.

Transmission lines from antenna to set generally drop off in efficiency as a result of age and weather. While coaxial cable is quite durable, it may prove to be a bit expensive, especially if the receiver is located at any great distance from the roof.

You can make a low-cost, long-lasting feeder line of ordinary No. 14 enameled copper wire, but to link it to the antenna you will need a simple Q-matching transformer. This is nothing more than two vertical legs. The combination is the half-wave antenna, open-wire line shown in Fig. 3. Bend two aluminum tubes and bolt them to standoff insulators through 3/16" holes drilled in the tube walls. The vertical portions of the tubes must be perfectly parallel and spaced 1¼" from center to center.

Another popular and efficient transmission line is the flat ribbon-type lead. For difficult reception, the choice is almost always between this and coaxial cable.

It isn't always easy to know what feeder



The folded dipole has a broad directional pattern, which is desirable in localities that have several stations. The terminal impedance is higher than that of a conventional dipole.

to select, but the first things to consider are the input impedance of the receiver and the radiation resistance of the antenna.

A properly made antenna is essentially a tuned circuit. That is, it is *resonant* at the particular frequency for which it is cut. For its own frequency, a dipole almost always has an impedance of 72 ohms at the center.

Now, if a receiver has an input circuit matched for 72 ohms and it is connected to a properly tuned antenna by 72-ohm coaxial cable, you will obtain the most efficient transfer of energy from the roof to the set. Impedance matching thus becomes a vital consideration when you're dealing with such elusive things as television waves.

The most common receiver input circuits are matched for 72 or 300-ohm lines. You should know which yours is.

In virtually all cases you can get by with a certain amount of mismatch—say up to 100 percent. Beyond that you begin to pay for it in weaker signals.

Coaxial or flat-ribbon transmission lines are available in a number of ratings from about 50 to 300 ohms, with stops at 72 and 150 ohms. The higher values are usually ribbon types.

Now consider a dipole that is cut to half wavelength of television channel 2. Under ideal conditions it will have an impedance of 72 ohms—*for the signal of channel 2.* The same dipole has quite a different value when it is receiving channel 6. Thus, even though you may match your transmission line correctly, it will remain correct only under specific conditions.

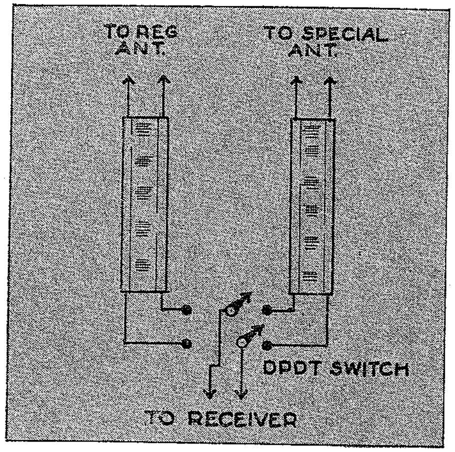
The terminal impedance of an antenna is affected also by its design. For example, a folded dipole (Fig. 4) broadens the response of the antenna, and also raises its impedance to about 300 ohms. Adding a reflector to a dipole, as in Fig. 2, sharpens its directional sensitivity and simultaneously lowers the radiation resistance. Using a reflector in back and a director in front (Fig. 5) drops the terminal impedance to a still lower figure (20 to 30 ohms for a plain dipole; about 100 for a folded type) while giving very high gain in the favored direction.

Directional sensitivity is an important consideration in antenna design. Let's assume there are three stations in your locality. Your present antenna may be bringing in two of these very well but giving only poor results on the third. It could then be well worth your while to erect a separate antenna for the single hard-to-get station. In this case the more directional you can make it the better it will be, since you can point it straight at the desired transmitter. You can also cut it to correspond exactly with the wavelength of the station.

Additional or special-purpose antennas

such as this may be mounted on the same mast as the existing ones. Bring the feed line down separately and connect it to the receiver through a selector switch, as shown in Fig. 6.

Until you've tried it you won't know how much or what kind of antenna you need. The unpredictable factors such as natural and man-made obstructions, radiated interference, as well as the considerations discussed above, make it practically impossible to know in advance what your reception is going to be like.



Where an extra antenna is used to bring in a weak station, use a separate transmission line and connect it to the receiver as shown. The antennas below and at right are indoor types for use in strong-signal localities.

You can, however, make certain guesses. Look into the experience of your close neighbors, ask the broadcasting stations about field strength in your location, and find out about the direction and distance of the transmitters.

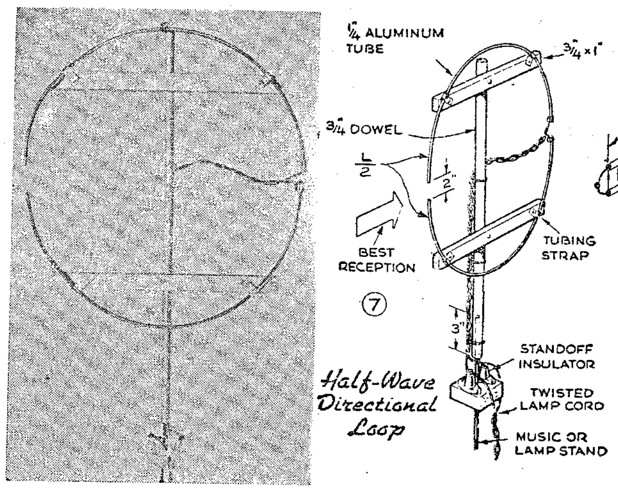
All this information will provide you with a starting point. Then, whether you build or buy your equipment, start with the minimum reasonable amount. Try it out, and if necessary you can always add to it.

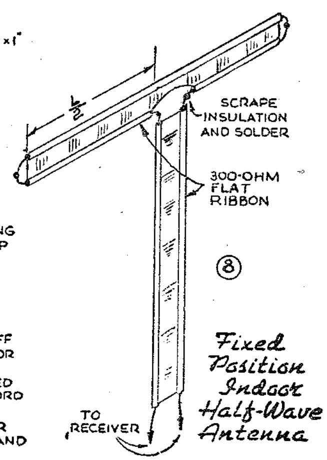
This applies even to commercial antennas, for most of them are so constructed that you can add additional elements as needed.

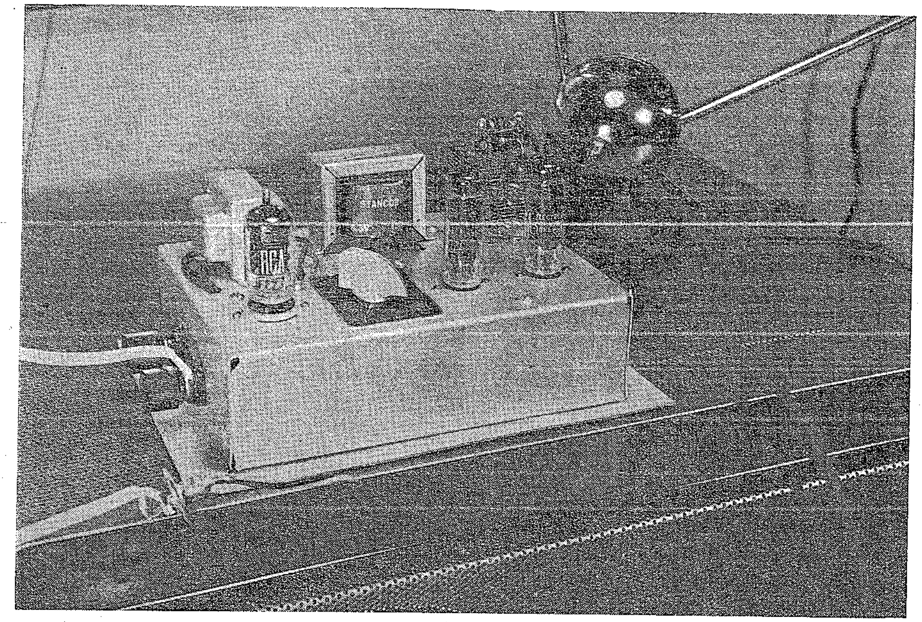
If you are located close to the broadcasting stations you may find that an indoor antenna gives adequate receptions. This can be important if you are an apartment dweller, for landlords are often reluctant to permit antennas to blossom out all over the roof.

One of the most satisfactory indoor antennas is the half-wave directional loop, (Fig. 7), since it can easily be turned to favor any station. Drill a hole 3″ in one end of a dowel. Make the hole large enough to permit a free fit on top of a music or lamp stand. Twisted lamp cord or flat ribbon feeder is clamped to the ends of the aluminum semicircles. If twisted cord is used, keep the length under 12″.

Where home decoration calls for a less conspicuous type of indoor aerial, the fixed-position half-wave antenna (Fig. 8) may do the trick. The flat wire can be concealed behind a bookcase, under drapes, or in a closet. If any choice of position is possible, make tests to determine which is the best.







Amplifier is placed on top of TV set for tryout before being placed in its separate cabinet.

Improving Sound on TV Sets

Special audio amplifier lets you get maximum FM quality from the sound part of a television signal.

MOST television sets are bought on the basis of picture rather than sound, and both buyers and sellers have paid surprisingly little attention to the quality of the audio-output circuits. In the average set the sound is heard through an output tube and speaker such as you'd find in a small AC-DC receiver.

The sound part of a video show is broadcast and received by frequency modulation. That means it is capable of noise-free, full-frequency reproduction. All you need is a good speaker and a little extra power to drive it.

Works with All Sets

The audio unit shown here, consisting of a phase inverter and two output tubes in push-pull, can be attached to any TV set without touching the under-chassis wiring. It has a tone control for reducing some of the objectionable high notes that you sometimes get on the sound track of old-time movies.

Parts for this 3-tube push-pull amplifier are mounted on a 2″ by 5″ by 7″ chassis. As the photos show, there is ample room on top for the three miniature tubes, two transformers, and two selenium rectifiers. The under side is a little more cluttered chiefly because the half dozen electrolytic condensers are a trifle bulky. You may be able to save a little space and cost by using a dual unit for C8 and C9.

Mount Parts Carefully

The input transformer is the type used in intercoms. It is a shielded unit and has a primary of 4 ohms and a secondary of 25,000 ohms. A good place to mount it is right behind the 12AU7 phase inverter. The filter choke beneath the chassis is mounted directly below the input transformer. In fact the same two screws are used to hold both