BROADCAST ANTENNAS

RCA

Instructions

RADIO CORPORATION OF AMERICA, Industrial Electronic Products

Traveling Wave Antenna

IB-36334

mk(s)®

INSTRUCTIONS

Traveling Wave Antenna

RADIO CORPORATION OF AMERICA

BROADCAST AND COMMUNICATIONS PRODUCTS, CAMDEN, N. J.

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TECHNICAL DATA

VSWR

1.1 or better

Power Rating

50 KW

Circularity

±1 db

Method of Feed

Filterplexer or notch diplexer, single line

Input Impedance

50 ohms—Input can be supplied to connect to:
6⅛" dia.—50 or 75 ohms
or
3⅛" dia.—50 or 51.5 ohms

Wind Pressure

50 PSF on flats (33 PSF on cylindrical surfaces)

Wind Velocity

110 MPH true extreme (no ice)

Shipping lengths and weights are given on the assembly drawing furnished with the antenna.
Loads, reactions and moments are given on request.

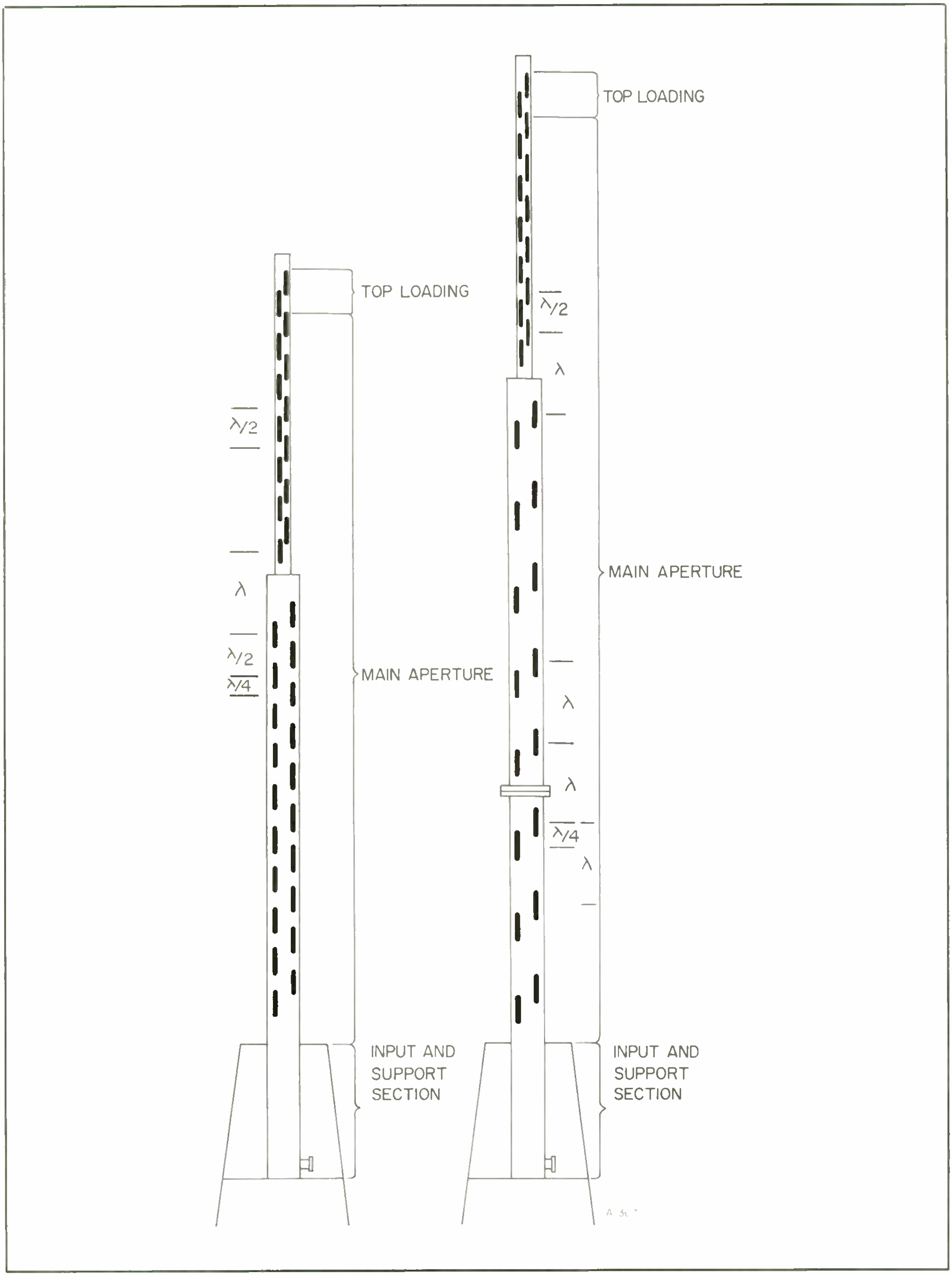

Figure 1. Outline of Traveling Wave Antenna

DESCRIPTION

General

The VHF Traveling Wave Television Antenna is designed to provide a null-free, omnidirectional pattern for channels 7 through 13 (174–216 mc) and is supplied with power gains of 9, 12, 15, and 18. The TWA is essentially a coaxial transmission line, formed by a hollow copper inner conductor and a tubular steel shell or outer conductor. Basically, the antenna consists of three parts: input and supporting section, main aperture, and top loading (see figure 1). Power is fed to the antenna near the base of the input and support end by a tee section. These details are shown in the exploded view, figure 27.

Along the main aperture area of the antenna are the radiators, four rows of longitudinal slots cut in pairs around the periphery of the outer conductor. The slots are used in pairs, one opposite another, and are capacitively coupled to the inner conductor by means of probes. Every other pair is in one vertical plane and the remaining pairs in another vertical plane at right angles to this.

In low gain antennas, the pairs of radiators are spaced (D) approximately a quarter wavelength apart (see figure 2A) along the main aperture. A different spacing arrangement may be used for high gain antennas. In these, the pairs of radiators are spaced (D) approximately a quarter wavelength apart along the upper section(s) of the main aperture and alternately about one-quarter wavelength and three-quarters of a wavelength apart along the lower section of the main aperture (see figure 2B). All slots in each section of the main aperture are alike and all coupling capacitors or probes are the same size.

In the top loading section of the antenna, the inner conductor is in the form of a transformer (see figure 3) and is short-circuited to the outer conductor. A gap at the butt end of this section allows for the differential expansion between the outer conductor and the inner conductor due to temperature variations. In this section are the last two pairs of slots which constitute the top loading. They differ in characteristics and also in dimensions from the other

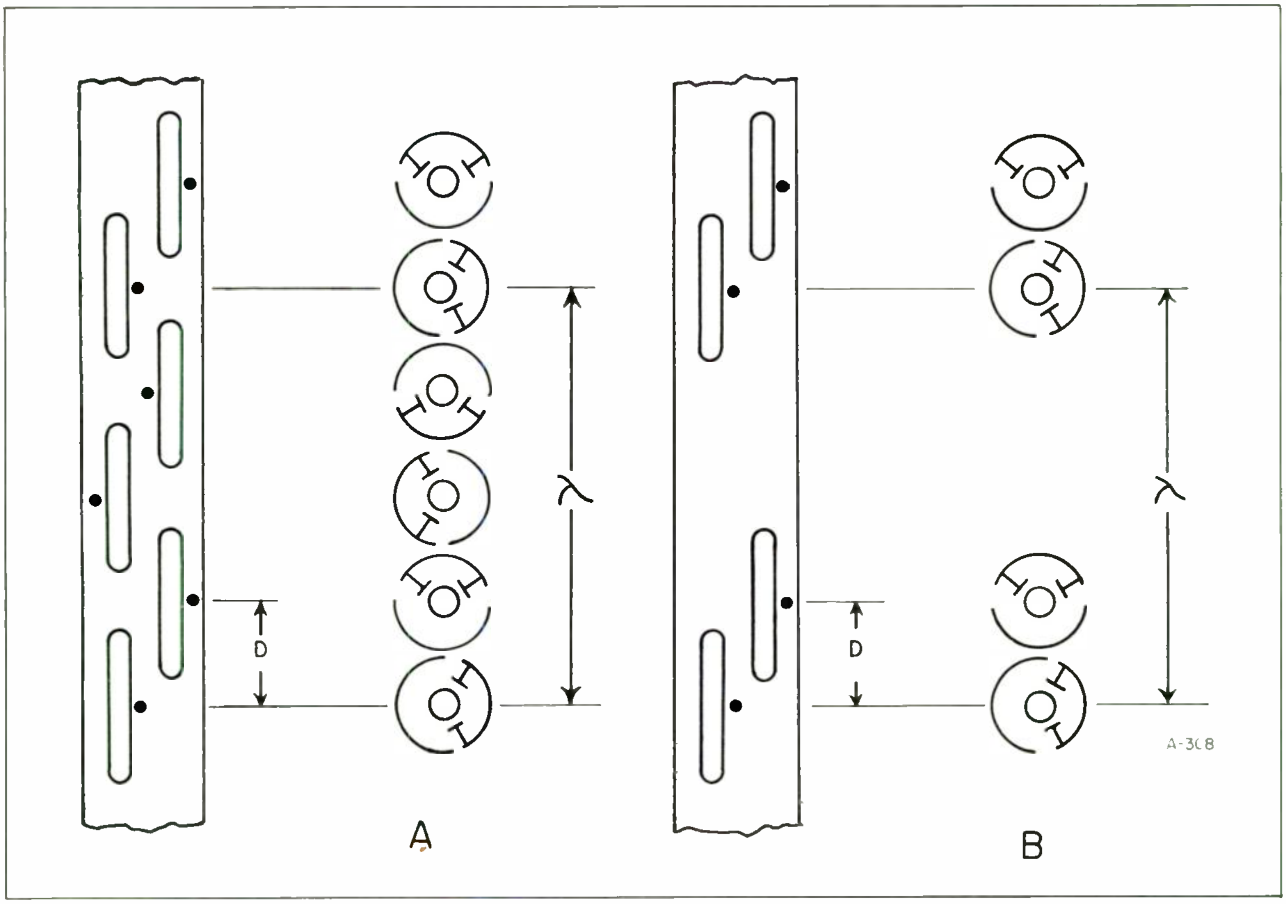

Figure 2. Slot Arrangement (A) Slots Spaced Every Quarter Wavelength; (B) Slots Spaced Alternately One-Quarter and Three-Quarters of a Wavelength

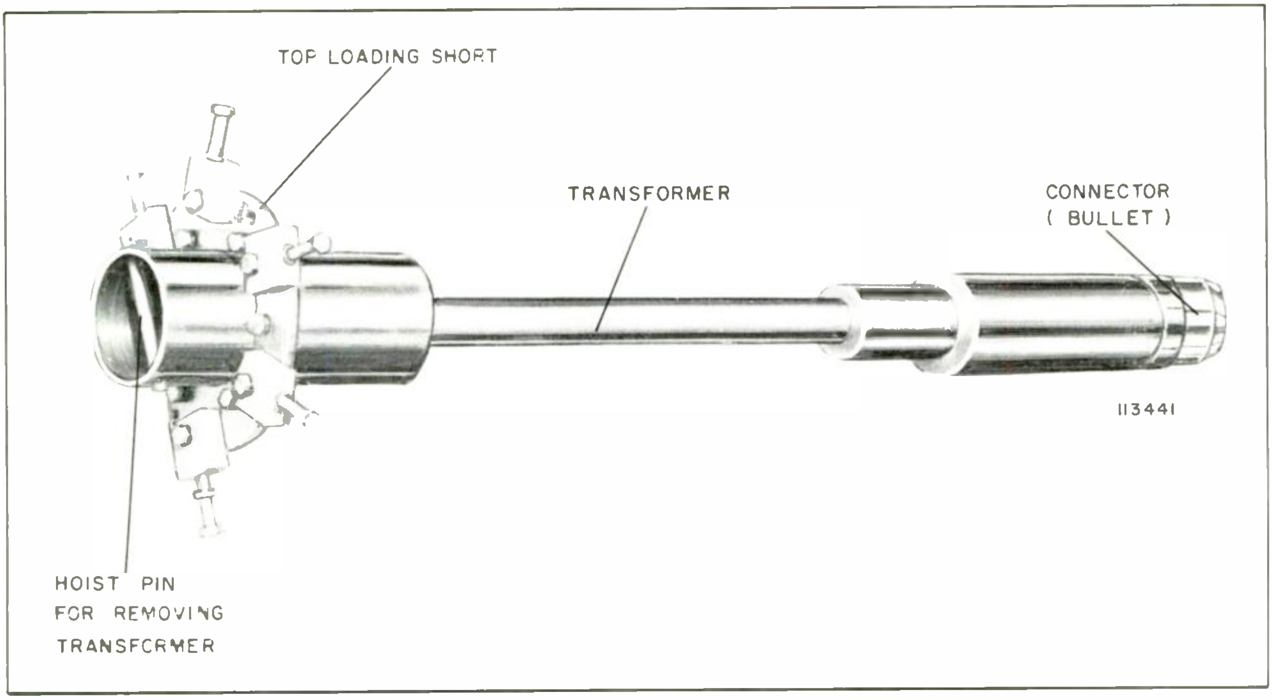

Figure 3. Top Loading Transformer

slots, as do the coupling networks used in conjunction with them. The difference between the main aperture slots and top loading slots is shown in figure 4.

The steel outer conductor consists of two to four pipe sections. Running the length of the interior of each outer section is a tubular copper inner conductor. The inner conductor is rigidly supported at the base of the bottom section of the antenna by a steel end plate (see figure 27). Centering support for the inner conductor is provided by insulator pins (figure 5A) which normally form a part of the dielectric of the coupling capacitor probes. When a reduced number of slots are used the supporting pins (figure 5B) are independent of the coupling capacitors. As shipped, the antenna is designed for one of two methods of mounting, either bury or pedestal. For bury mounting, the length of the bottom section is increased to provide the extra footage needed below the top of the tower, according to the length of the antenna.

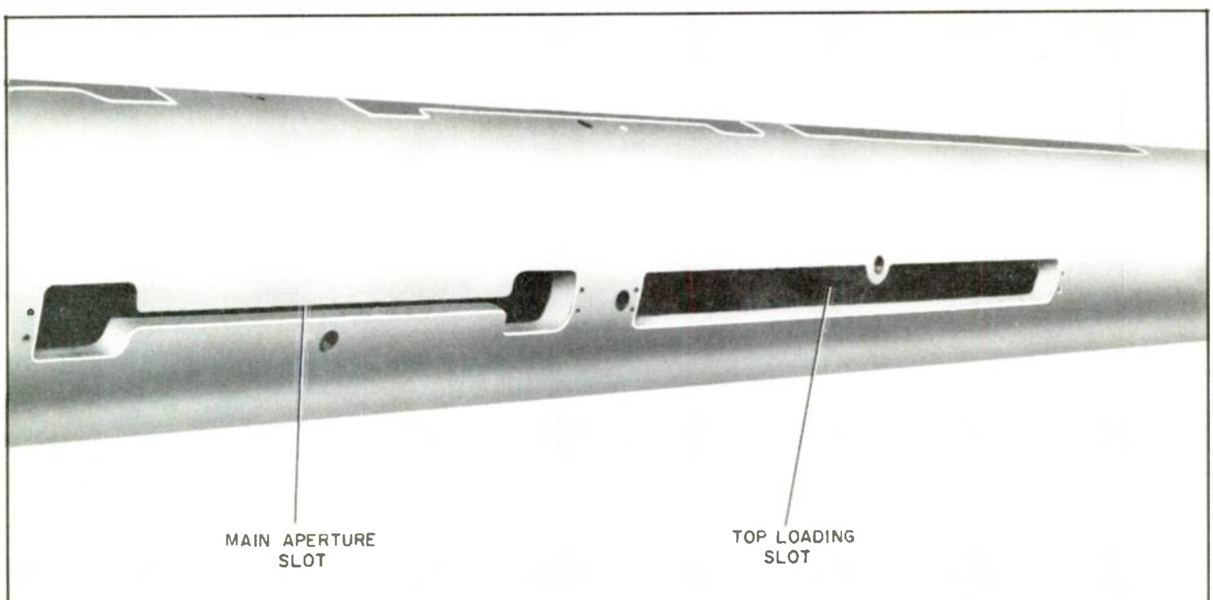

Figure 4. Section of Pole Showing Difference Between Main Aperture and Top Loading Slots

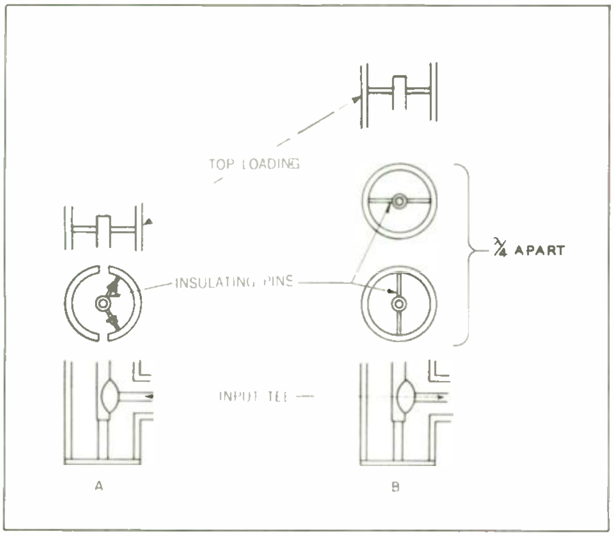

Figure 5. Outline Showing Details of Inner Conductor Support

The bury footage is then fixed as the distance between the guide flange and the pole socket. For pedestal mounting, the base of the bottom section has a flange that bolts to the top plate on the tower.

To protect the steel outer conductor from the elements, the steel pipe is hot dip galvanized. Slot covers, running the full length of each pipe section, are fastened to the pole over each vertical row of slots to protect the radiators from any foreign elements. The slot covers are made of special polyethylene that is not affected by the ultra-violet rays from the sun nor embrittled from the cold.

If ice collects on the antenna, the resonant frequency of the slots will be lowered. This will affect the performance of the antenna, mainly at the aural carrier region of the channel. Therefore, in areas where heavy and prolonged icing conditions prevail, deicers are recommended to prevent an excessive accumulation of ice. Drain holes are provided in the bottom plate of the antenna to prevent any accumulation of condensation inside the antenna. The materials used in the component items are such as to minimize corrosive effects from dissimilar metals and to prevent chemical action due to industrial gases or salt spray. All aluminum components are iridited.

The tubular shape of the antenna with no projecting elements, plus the shorting of the inner and the outer conductors at each end, make it unlikely that lightning will damage the antenna. However, to protect the 300-mm code beacon at the top of the antenna from lightning, a lightning protector assembly (see figure 29) is installed around the beacon. The bottom plate of the protector serves as the support for the code beacon.

Theory of Operation

The theory of operation can best be demonstrated by an explanation of the original concept and its eventual application to the design of the Traveling Wave Antenna.

The excitation current travels upward along the inner conductor and power is tapped off this at each radiator in the outer conductor. The principle of the feed system in which short rod radiators are used to illustrate the theory is shown in figure 6. A number of radiators per wavelength evenly spaced are loosely coupled to a coaxial line. Because of the number of radiators and the relatively slight reflections due to each, the effect is essentially that of uniform loading. The result is a uniformly attenuated traveling wave in the line. Since a traveling wave has a linear phase characteristic, the excitation of each successive radiator will lag the previous one by an amount which depends upon the spacing between the radiators and the velocity of propagation in the line. If the radiators are alike, their currents will have the same phase relationship as the excitation. Thus the radiating currents will be successively lagging, with repetition of phase occurring after every guide wavelength.

To produce an omnidirectional pattern, the radiators instead of being in a line are moved around the periphery of the outer conductor to form a spiral as shown in figure 7. For a horizontal main beam, the pitch of the spiral has to be equal to the guide wavelength in the transmission line, since all radiators in the same vertical plane must radiate in phase. The phase difference between radiators in one plane and those in another plane equals the azimuth angle difference between the planes, that is, the phase rotates about the periphery. The rotating phase causes a rotating field which, because of the relatively small amount by which the magnitude of current changes from layer to layer, produces an omnidirectional pattern.

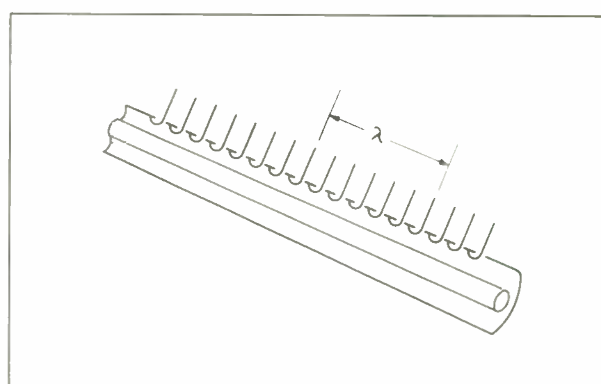

Figure 6. Principle of Feed System Using Short Rod Radiators

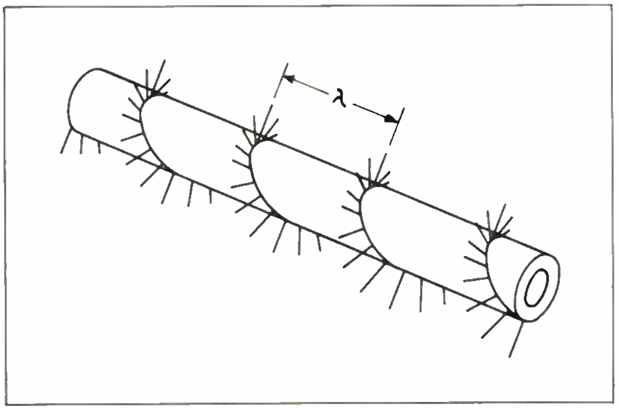

Figure 7. Spiral Arrangement of Radiators

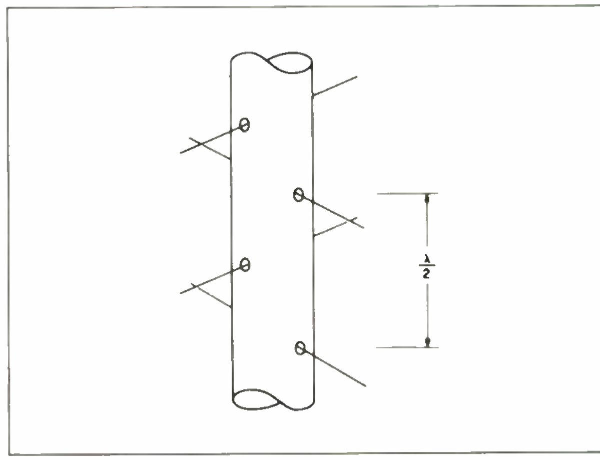

Figure 9. Resultant Dipoles Center Fed in Phase Quadrature

In actual practice, however, two modifications were made to insure proper operation. First, excitation was made symmetrical instead of asymmetrical to avoid undesired excitation of the pole itself (see figure 8). Second, mutual coupling between the radiating elements was minimized to maintain proper phase relationships. The required results were obtained by limiting the number of radiator pairs to four per turn of spiral. This reduced the antenna to two sets of center fed dipoles, the sets being confined to two perpendicular planes fed in phase quadrature (see figure 9). The traveling wave nature of the excitation current along the inner conductor remains, since the relatively small reflections produced by the radiator pairs still cancel each other for the most part. Cancellation, however, is not due to uniform loading any more, but due to the approximate quarter wavelength spacing between the radiator pairs. The result, then, is essentially a traveling-wave-fed turnstile antenna.

As a further refinement, the dipoles were replaced by slot pairs which are fed in opposite phase to produce a dipole type of radiating current (see figure 10).

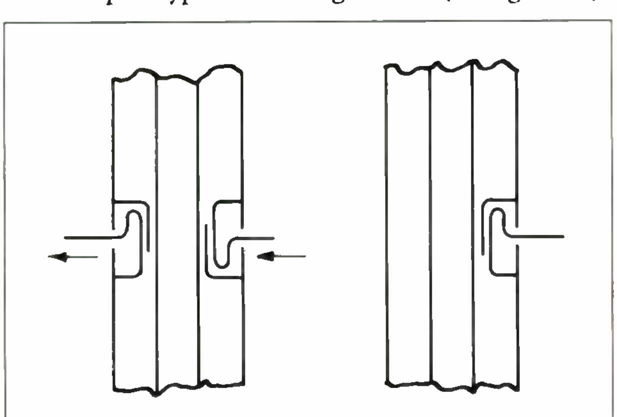

Figure 8. Symmetrical vs. Asymmetrical Excitation of Rod Radiators

The current distribution around the cylindrical surface of the pole is particularly favorable in forming a truly omnidirectional horizontal pattern. Two additional improvements also result from the elimination of protruding radiators: (a) wind loading is reduced and (b) the coupling circuit is simplified by allowing capacitive coupling. The final basic form of a section of the Traveling Wave Antenna is shown in figure 2A.

In some cases, especially in high gain antennas, the desired electrical characteristics for the slot pairs and the proper structural rigidity is easier to obtain simultaneously if the slots are spaced farther apart. This may be done by inserting a free-space half wavelength between every other pair of slots. When the location of the coupling capacitors is made to follow the original "spiral" concept, the principle of operation remains essentially unchanged. Thus in high gain antennas, the top section(s) follow the form shown in figure 2A, but the bottom section(s) may have the form shown in figure 2B.

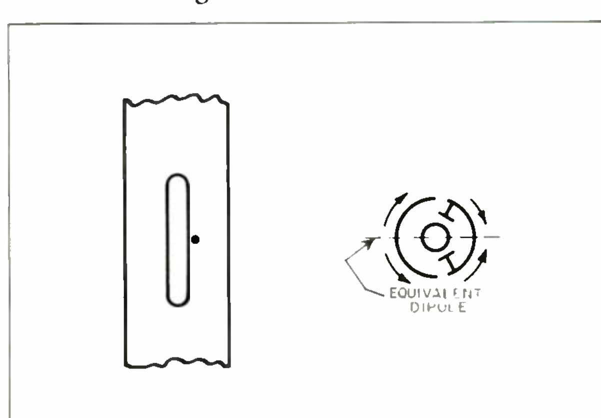

Figure 10. Slot Pair Fed in Opposite Phase to Produce a Dipole Type Radiating Current

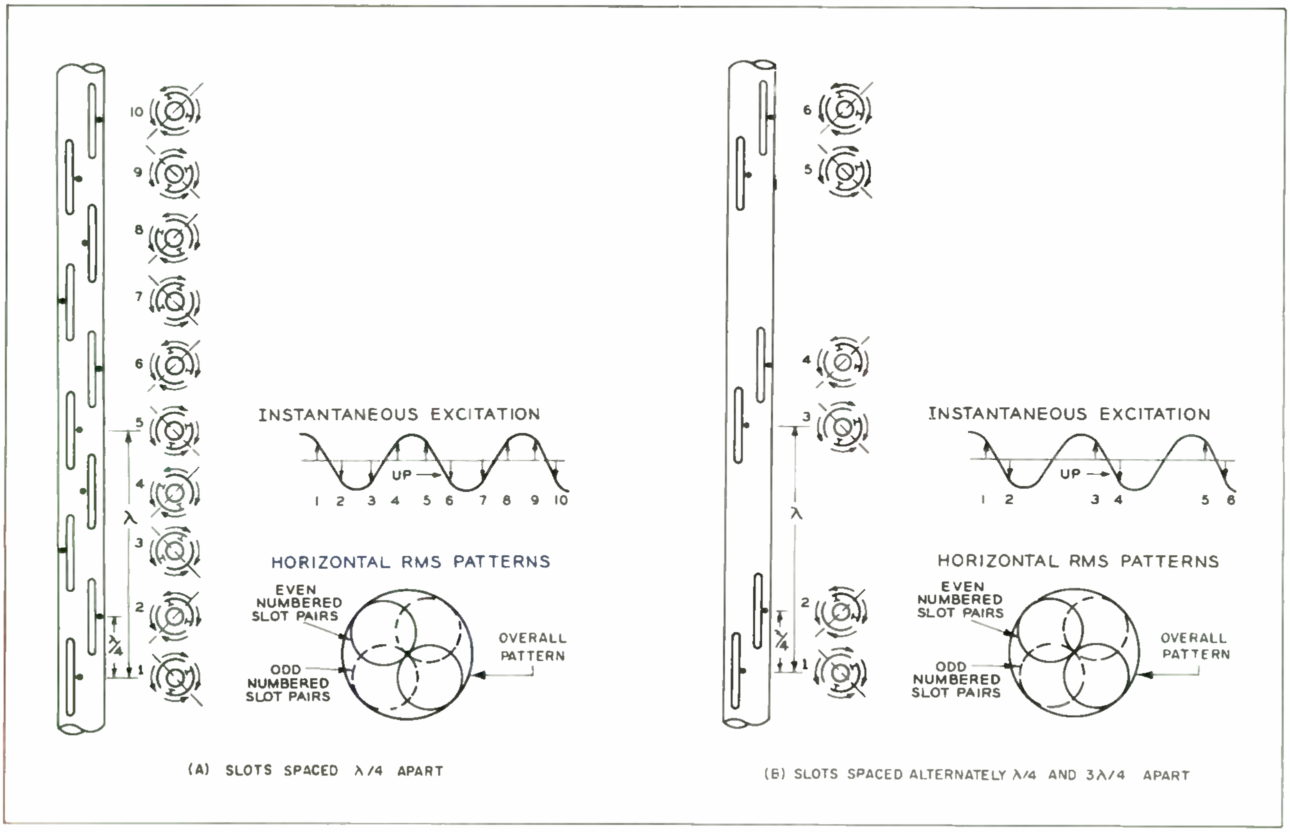

Figure 11. Final Excitation and Horizontal Pattern Formation

Circular Horizontal Pattern Formation

As the signal propagates upwards along the inner conductor, each slot pair in the main aperture successively extracts a portion from the traveling wave. Since the slots in each pair are fed in opposite phase, the radiating current on the outside of the antenna simulates that of a dipole radiator. Therefore, an approximately figure eight horizontal pattern is produced. The slot pairs in one vertical plane each form a figure-eight pattern at the same azimuthal orientation; for example, the odd numbered pairs, and the even numbered pairs as shown in figure 11A. These slot pairs are spaced a half wavelength apart, with the coupling capacitors arranged to counteract the reversal of the excitation voltage within the line. The result is the radiating currents as well as their fields are in phase. Thus all the fields from the slot pairs in one vertical plane form a combined figure-eight horizontal pattern. Similarly the slot pairs in the adjacent vertical plane 90° away radiate in a figure-eight horizontal pattern, but displaced 90° from the previous pattern. Since the spacing (D) between successive slot pairs is a quarter wavelength, the radiated fields are in phase quadrature. According to turnstile principle, these two figure-eight patterns add in phase quadrature to form a circular horizontal pattern. If a reduced number of slot pairs is used, an omnidirectional horizontal pattern is still obtained in the same manner described above. This is shown in figure 11B.

Although the pattern radiated is not a perfect circle, horizontal pattern measurements taken of Traveling Wave Antenna having gains from 8 to 18 show circularities from ±.25 db to ±.8 db.

Vertical Field Pattern

The Traveling Wave Antenna has an inherently excellent vertical pattern which produces a uniformly high field strength over the service area. A null-less pattern is achieved without resorting to any complicated phase or artificial power distribution networks along the aperture. As mentioned above, the signal traveling upwards within the antenna is uniformly attenuated along the line.

A wave illustrating the attenuated signal within the antenna, and thus also the distribution of illumination along the antenna, is shown in figure 12. The exponential decrease in the magnitude of both as they approach the top of the antenna provides an automatic power division. Ideally the antenna should be

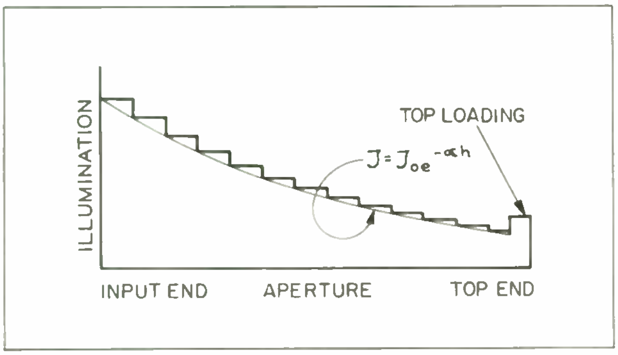

Figure 12. Relationship Between Signal Within Antenna and Illumination Outside of Antenna

long enough to allow the energy in the line to diminish to zero, with no discontinuities in the illumination. However, the length of the antenna can be shortened to practical limits without any appreciable reduction in performance or any loss in gain. This is done by the use of top loading, which collects and radiates all the small amount of remaining power, producing an increase of illumination at the top of the antenna in phase with the main aperture. How closely the measured field strength approximates the theoretical calculated values is shown by the graphs, figure 13, of two typical antenna patterns.

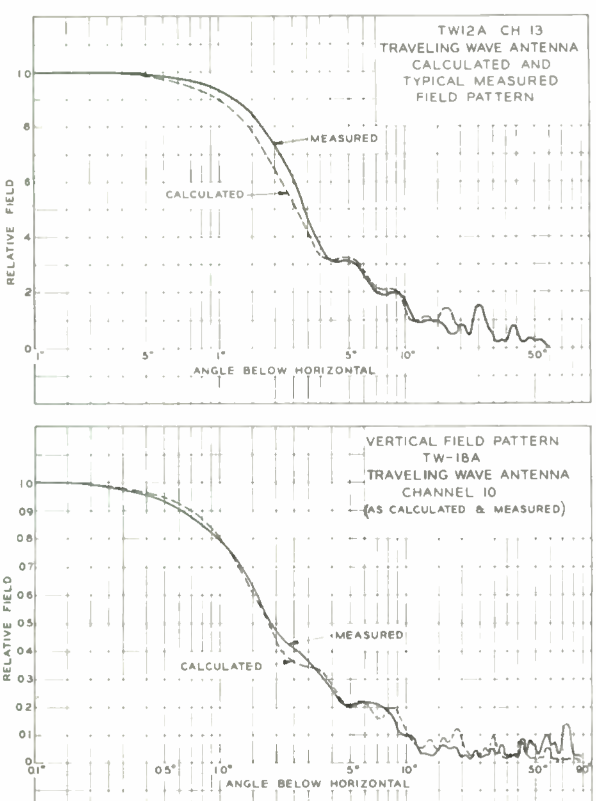

Figure 13. Typical Vertical Field Patterns

Low Voltage Standing Wave Ratio

The top loading section forms a relatively broad-banded low-power, low-gain portion of the antenna. It also furnishes the proper termination for the main aperture. This termination, in conjunction with the odd multiple of quarter wave spacing between the slots and the light coupling of the slot pairs into the line, keeps the reflections small. Thus the traveling wave property is maintained in the transmission line.

Measurements made on Traveling Wave Antennas indicate the VSWR to be well below the specified 1.1 to 1 across the channel.

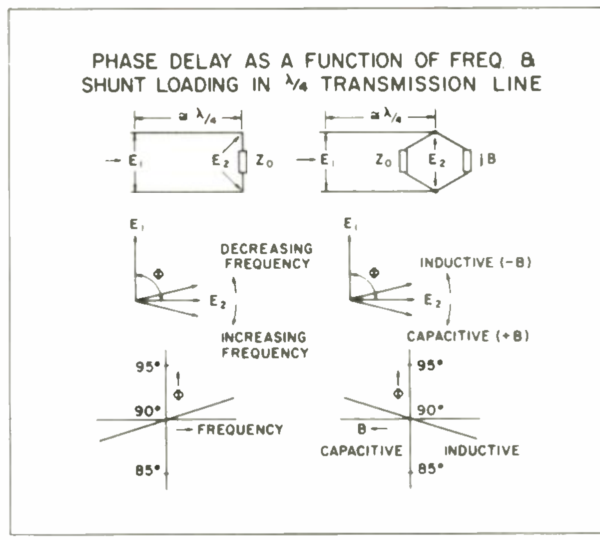

Figure 14. Phase Delay as a Function of Frequency and Shunt Loading in a Quarter Wavelength Transmission Line

Pattern Bandwidth

Because of the unique design of the Traveling Wave Antenna, the phase relationship of the radiating currents is maintained without the necessity of complex feed lines usually associated with a television antenna.

The principle used is based on two properties of transmission lines. If a quarter (or three-quarter) wave transmission line is terminated in its characteristic impedance (Z_0), the phase difference (ϕ) between the input voltage (E_1) and the output voltage (E_2) will vary linearly with frequency (figure 14, left). If in addition, it is also shunted with a varying susceptance (B) and at a fixed frequency the value of susceptance is varied, the phase difference between the input and the output voltages will again vary (figure 14, right). Within a certain range, the variation of the phase with respect to the variation of the susceptance is approximately linear.

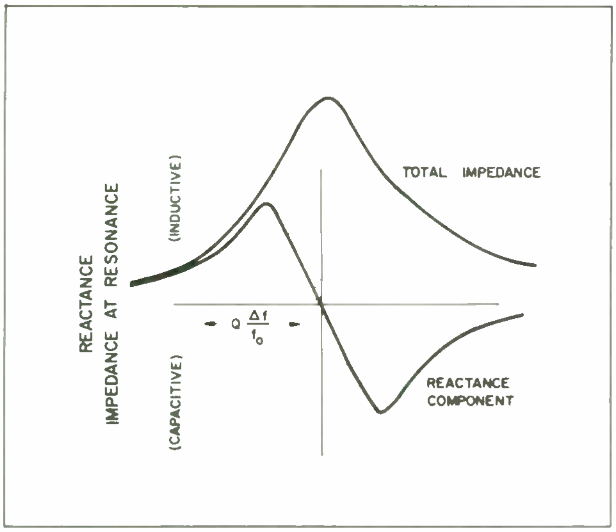

Figure 15. Universal Curve—High Q Parallel Resonant Circuit

By combining these two properties so that the phase changes caused by varying frequency and varying susceptance cancel each other, the result is that the distance between slots remains constant in wavelength over the channel for which designed. This requires shunt loading with a negative susceptance slope of proper magnitude versus frequency. This is achieved by use of a parallel resonance circuit (see figure 15). Near the resonance frequency, the reactance of a parallel resonance circuit has a relatively linear slope. When the parallel resonance circuit is capacitively coupled to the transmission line, the negative reactance slope results in a negative slope of the susceptance being imposed on the line (see figure 16). The magnitude of the susceptance slope is proportional to the square of the size of the coupling capacitor and to the Q of the circuit. The coupling capacitance is very closely determined by the gain of the antenna, therefore, the only independent variable is the Q of the circuit.

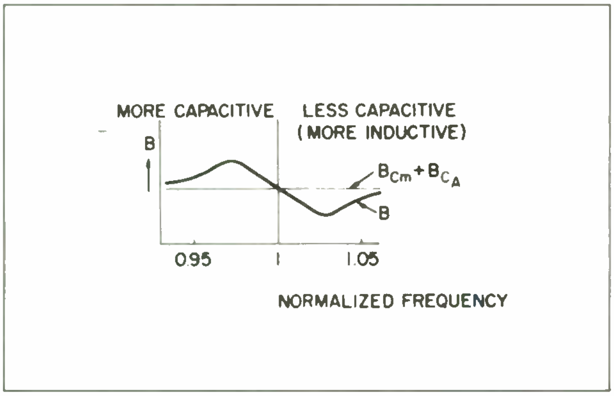

Figure 16. Negative Susceptance Slope Due to Negative Reactance Slope of Parallel Resonant Circuit

This type of capacitively coupled resonance circuit is obtained by utilizing capacitively coupled slot radiators. Figure 17 shows the equivalent circuits of the slot pairs equidistant from each other at intervals (D) slightly less than a quarter wavelength. The curve indicates the type of phase compensation obtained. The high slope linear phase delay of the slightly less than a quarter wavelength long transmission line is first modified by an approximately constant phase delay due to the coupling capacitors (C_m) and any additional shunt capacitors (C_A). Additionally, the varying susceptance of the parallel circuit changes the phase delay. By selecting the proper value of Q for the slot pairs, a constant delay about the desired frequency can be maintained. Thus a region with a compensated bandwidth is obtained, wherein the phase difference between the input and output voltages, that is from one slot pair to the next, remains constant, normally 90°.

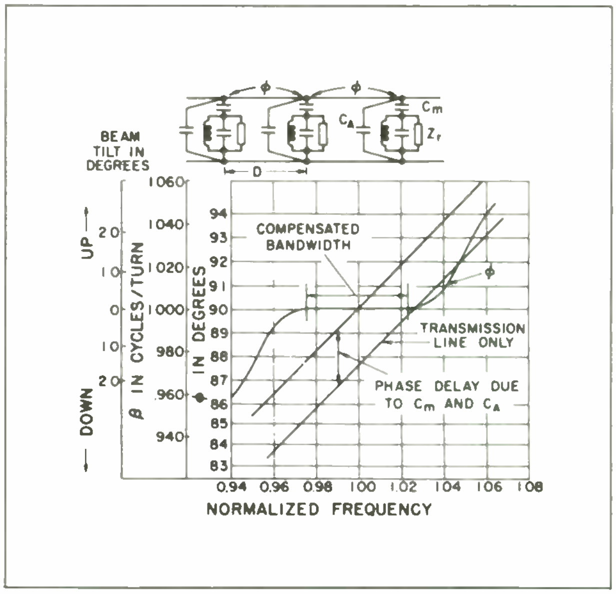

Figure 17. Equivalent Circuit of Slot Pairs Slightly Less Than a Quarter Wavelength (D) Apart and Phase Compensation Curve

A 90° phase delay per slot spacing results in a horizontal main beam. Increasing the phase delay causes the beam to tilt upwards and decreasing the phase delay causes the beam to tilt downwards.

The desired phase delay is obtained in the Traveling Wave Antenna by the use of a pair of phase com-

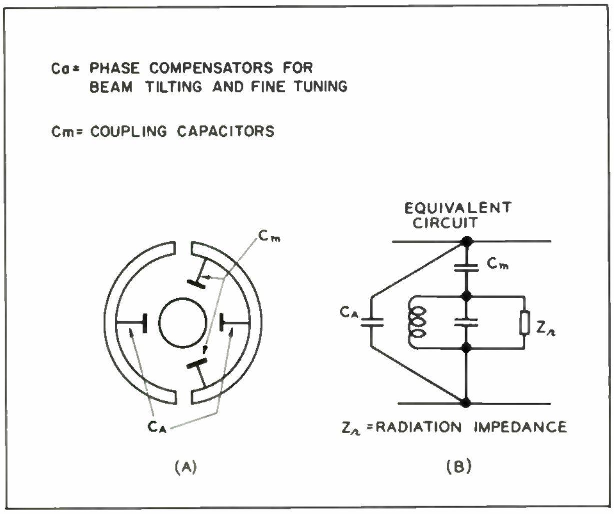

Figure 18. Coupling Capacitors, Beam Tilting and Fine Tuning Phase Compensators and Equivalent Circuit

pensators (C_A) in the neutral plane of each layer of the main aperture (see figure 18). These provide the necessary capacitance for beam tilting and fine tuning of the phase propagation function. When a reduced number of slot pairs is used, the compensation is obtained in a like manner. The main difference is in the numerical values because two slot pairs instead of four compensate for the full guide wavelength.

The shape of the slots controls the Q and the resonance frequency. Low Q slots are used in the top loading section to achieve proper operation of the antenna. These slots follow an oblong configuration and are longer than the high Q slots used in the main aperture section. By comparison, the high Q slots are narrow in the middle with wide square openings at each end. The difference between the two types of slots was shown previously in figure 4.

INSTALLATION

Tower Considerations

The transmission of television signals requires that the transmitting antenna be mounted as high as possible because field strength at the receiver location increases with antenna height. The antenna should also be mounted in the clear so that the transmitted signal will not be reflected by close-by objects.

Construction of towers upon tall buildings is often good planning. This normally results in smaller towers and shorter transmission lines, especially if the building is high enough to conform to the desired antenna height. Relatively flat country with low surrounding hills lends itself well to the installation of tall supporting structures. Mountain-top installations are, of course, ideal from the standpoint of non-interfering objects. Wind and ice conditions, however, as well as accessibility in bringing up equipment may present problems.

Specify to the tower manufacturer the type and spacing of transmission line hangers (usually direct mounting) that will be used, so that appropriate supporting members will be provided in the tower.

The planning and selection of television towers and antenna systems carries with it the responsibility of securing the services of competent tower manufacturers and erectors. Improper design and poor installation technique can prove very costly. RCA, through its field sales engineers, will gladly furnish assistance in selecting the tower and rigging personnel best suited to the customers' requirements.

Transmission Line Considerations

Before ordering transmission line or fittings, it is suggested that a dimensional layout be made of the tower with the antenna mounted. The proposed routing of the line can then be shown from the antenna to the transmitting room. From this layout an idea can be gained as to the length of line and fittings required. Roughing-in dimensional drawings are available for all type of transmission lines and these should be used when making a layout. These drawings are shown in the RCA Transmission Line Catalog.

The general practice for supporting the transmission line is to space the hangers at approximate 10-foot intervals. The line section at the tower top is firmly secured by two fixed hangers, and the lower sections are suspended by spring hangers to allow for differential thermal expansion and bending of the line.

Complete details on transmission line planning, ordering and installing may be found in the appropriate RCA VHF Transmission Line Instruction Book.

RCA Service Company Personnel

An RCA Service Company engineer should be present to supervise the assembly of the antenna. A nominal amount of engineering time for assembly supervision is included in the antenna contract. Arrangements should be made with the RCA Service Company to have the field engineer report to the installation site when the tower is erected and the antenna is ready to be installed.

General

Since each Traveling Wave Antenna is designed to meet the requirements of a particular installation, mention of exact dimensions has been avoided. Prints and drawings containing dimensional specifications and other pertinent data are furnished with the antenna. These sources should be referred to frequently during the process of assembly and erection.

The word *section* is used in the following text to indicate the separate pipe lengths which make up the antenna. The terms bottom section, center section, and top section do not in themselves necessarily indicate any electrical division along the length of the antenna.

As explained earlier in the text, slots in the smaller diameter sections are spaced a quarter wavelength apart along the full length of the section. When larger diameter sections are used, it is in certain areas desirable, in order to obtain an optimum Q, to space the slots alternately one-quarter and three-quarters of a wavelength apart. Thus, an antenna made up of several different diameter sections may have the closer spacing of slots in the upper (smaller) sections and the larger spacing in the lower (larger) sections.

In general the methods and facilities required for erecting a pedestal type or a bury type antenna are the same. Wherever necessary the installation instructions will differentiate between the two types.

Delivery

The Traveling Wave Antenna is shipped by common carrier on a flat bed trailer. A typical three-section antenna is shown ready for delivery in figure 19. The top and center sections are mounted on two steel trestles. The bottom section rests beneath the cross members of the trestles on two steel tees. The antenna is shipped with harness assembled in each section. Parts that require assembly at the site or that were removed to allow clearance for shipping chains, trestles, etc., are in boxes or packed separately on the trailer. Included among these are the lightning protector, beacon cable, lifting clamps, hardware, and spare parts.

Storage Area

A space approximately 20 by 50 feet on fairly level ground should be prepared to store the antenna until ready to erect it. Two lengths of timber approximately four feet long by six inches square are needed to support each pole section. The services of a crane (minimum capacity 15 tons) and riggers are required to remove the antenna from the trailer.

Each pole has two corsets made of 2″ by 4″ lumber strapped with wire. These protect the slot covers, slot cover clamps, tuning plates and deicers from the shipping chains and also serve as the lift points for the crane hoist. A choker should be used around each corset to lift the individual pole sections off the truck. Care must be exercised when removing the pole sections from the trailer to avoid crushing any component parts along the surface of the pole, particularly in the region of the slot covers which conceal the tuning plates. Before setting the pole sections on the 6″ by 6″ timbers, make certain that none of the component parts along the pole will be on that portion of the periphery resting on the timbers.

Inspection

The antenna should be inspected and checked for any damage resulting from shipping or handling. Examine the contents of all cartons. Check that the number of items agrees with the quantities shown on the bill of lading. After checking, replace all parts in their respective cartons until ready for use. Be careful not to lose or destroy any identifying tags attached to the various parts or items. If there is

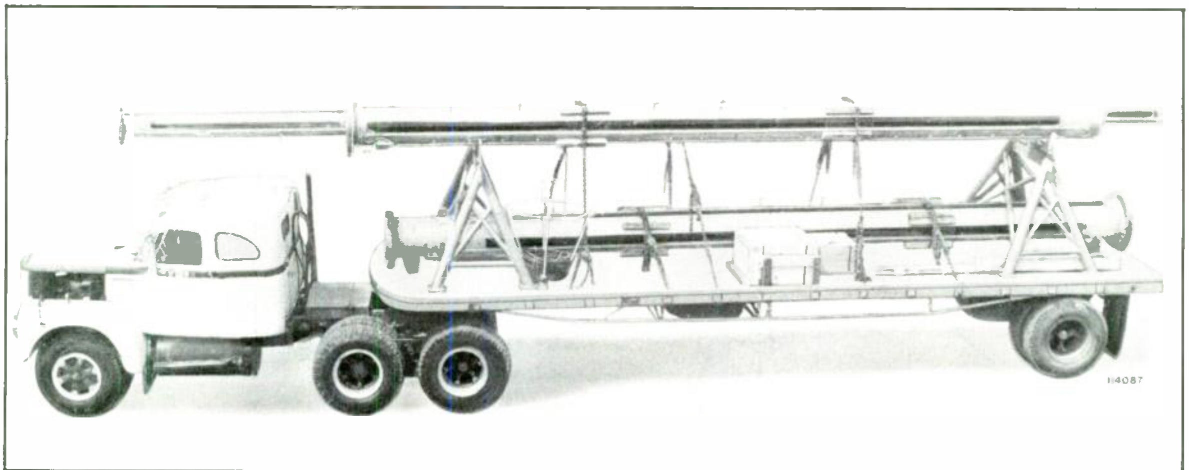

Figure 19. Typical Three-Section Traveling Wave Antenna Ready for Delivery

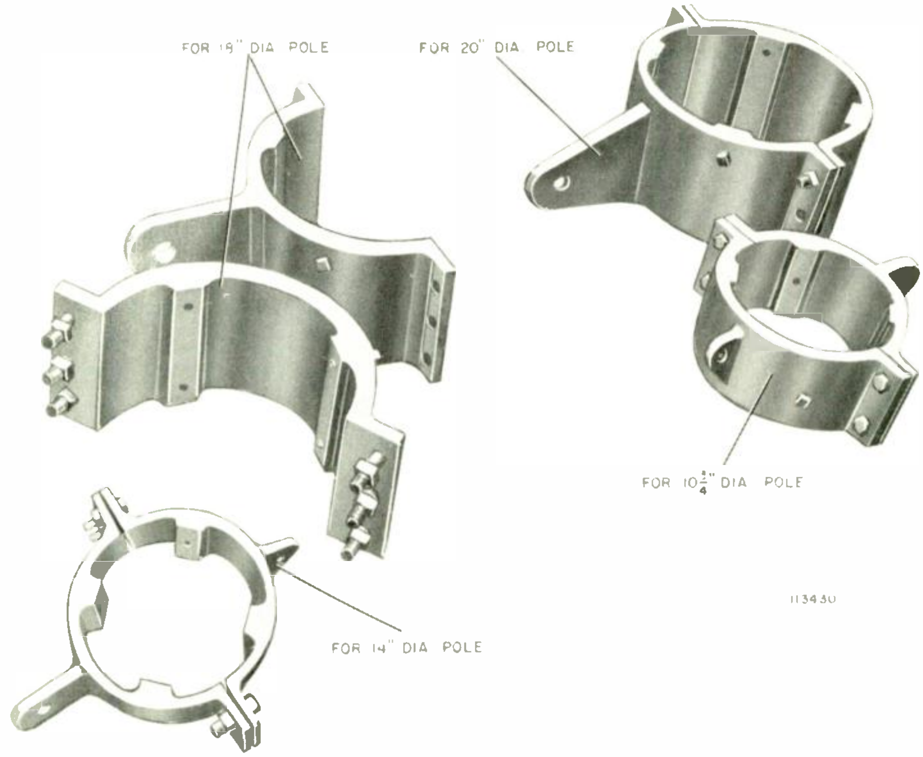

Figure 20. Lifting Clamps

reason to suspect that any of the tuning plates might have been bent during shipment or handling, the slot covers should be loosened so that the tuning plates can be inspected and repaired if necessary.

The antenna was thoroughly developed and tested at the factory. Normally no adjustments need be made to any of the compensators, probes, or tuning plates. However, if examination indicates any discrepancies that require corrective adjustments, reference should be made to the *Tuning Plate and Capacitor Information Drawing* which is supplied with the antenna. This drawing gives the correct settings of these components. If there appears to be any damage to the probes, communicate with

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Lifting Clamps

Up to three different-size lifting clamps are furnished to raise the antenna, depending on the number of pole sections and the diameter of each. If the antenna consists of two sections, each the same diameter, a single lifting clamp is supplied. For an antenna having three sections, each different in diameter, three separate clamps are supplied, one for each pole diameter.

Several sizes of clamps are shown in figure 20. Each clamp is formed by two semi-circular steel bands with four steel blocks welded around the inside. A series of set screws spaced equidistant apart around the clamp hold the clamp firmly in place against the pole. In most instances the blocks provide sufficient clearance between the clamp and the components mounted on the pole section. The clamp bolts around the pole in such a manner that the steel blocks rest on the pole surface that is in between the rows of slot covers and other components. If it appears that the clamp will interfere with any of the antenna components, the components must be removed from the pole before the clamp is fastened in place.

Tapered Aligning Pins

Two sets of tapered pins (see figure 21) are furnished for aligning the ends of adjoining pole sections. Each set contains four pins. One set is threaded; the other set is unthreaded. The unthreaded pins are for use with poles having a flange on either end. These poles have four locking set screws spaced equally apart around the periphery of the flange. The set screws protrude into the holes in the flange. The aligning pins are inserted in these holes (see figure 26) and then fastened in place with the set-screws.

The threaded tapered pins are for use with pole ends without a flange. These pins are screwed into the face of the end of the pole (see figure 25).

Pre-Raising Preparation

Before raising any of the pole sections up to the tower, remove the corsets used for lifting the pole sections in a horizontal plane. The red wooden covers at both ends of each section must also be removed.

The antenna must be painted in accordance with CAA regulations. While it is usually more convenient to paint the antenna before it is erected, it may be painted after it is erected, if desired. DO NOT under any circumstances paint the slot covers, and do not obscure the match-marking arrows.

The nuts, bolts, and washers supplied for assembling the pole sections are made of high tensile steel. To prevent them from becoming brittle during manufacture, they have no surface plating or finish. A special rust-preventive called Slip-plate is supplied. Apply a coating of Slip-plate to all hardware not already coated with it, according to the instructions on the container.

Use a washer the appropriate size under the head of each bolt or stud and under each nut. A torque wrench must be used to tighten the nuts and studs. Torque required in relation to the diameter of bolts and studs is listed in the following chart.

Torque in Foot Pounds	*Diameter of Bolts and Studs*
960	1⅛ inches
1350	1¼ inches
1500	1⅜ inches
1620	1½ inches

If a pedestal type antenna is being installed, the tower top plate should be already drilled and mounted in place on the tower, before raising the bottom pole section.

If a bury type antenna is being installed, the mounting holes required in the tower structure for the guide flange assembly and the pole socket assembly should be drilled prior to their installation.

The pole socket consists of a steel ring welded to a steel base plate (see figure 22). Four re-inforcing gussets are welded in place around the ring and base plate. The base of the bottom pole section fits into the pole socket. Set screws are provided around the ring to clamp the pole in place until it is ready to be welded in the socket.

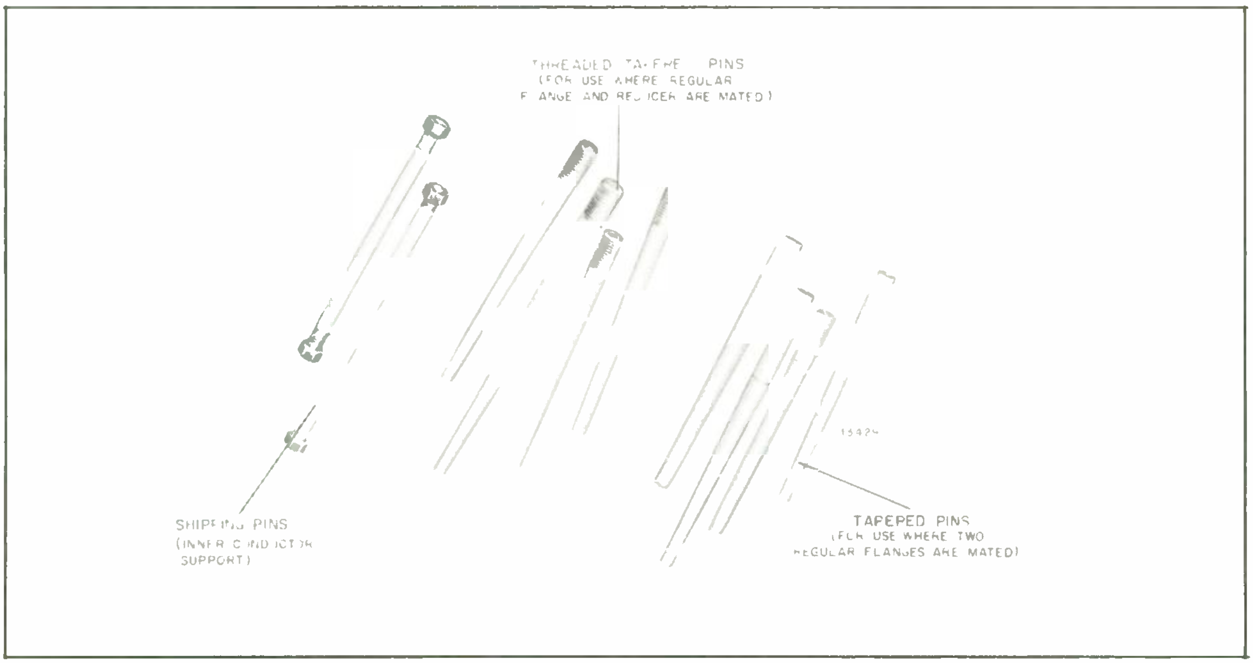

Figure 21. Shipping and Tapered Aligning Pins

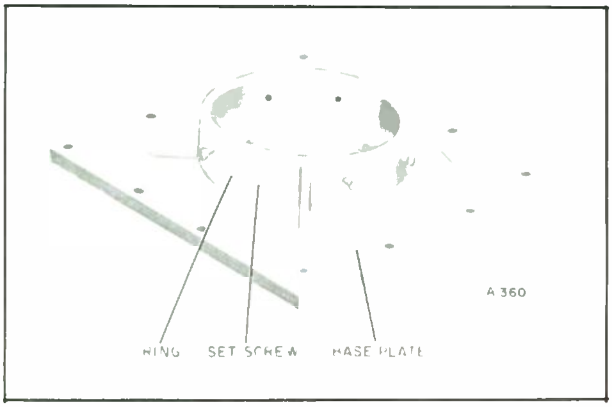

Figure 22. Pole Socket Assembly (Bury Type Mounting)

The guide flange (see figure 23) is made up of two steel plate sections that mount on top of the tower to form a clamp around the bottom pole. Each section has a semi-circular cutout along the edge that fits against the antenna pole. Four adjustable steel wedges with slotted holes and four locking plates are mounted on top of the steel plates. The pole side of the wedges are cut to follow the contour of the cutout in the steel plates. One section of the flange has two fixed steel plates in addition to the locking plates. The fixed plates are welded in place with half their surface area extending beyond the edge of the flange, so that they will overlap the other flange section when both are joined. The wedges are temporarily held in place by means of the locking plates and bolts. After the antenna is completely assembled they are welded to the flange plates.

Only one half of the guide flange is to be mounted on top of the tower until after the bottom pole has been lowered into the tower and the base of the pole seated in the pole socket. Then the remaining half of the guide flange can be mounted. Otherwise the miter elbow input flange on the side of the pole will not pass through the hole formed when both sections of the guide flange are joined.

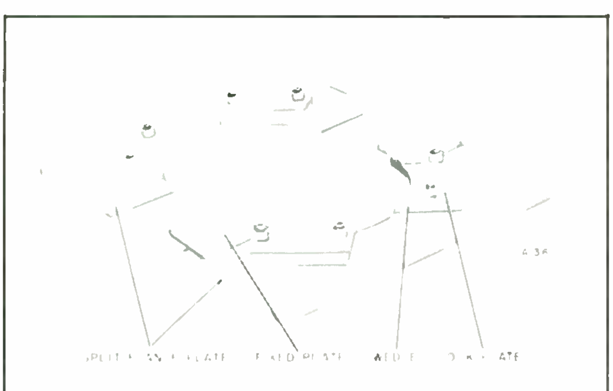

Figure 23. Guide Flange Assembly (Bury Type Mounting)

Erection Procedure

In the typical erection procedure described below, a 3-section antenna has been selected for purposes of illustration. If a 2-pole antenna is being erected then the second section rather than the third section becomes the top section. Where this is the case, refer to the instructions covering the erection of the third section for information on the installation of the lightning protector and the code beacon which are mounted on top of the antenna.

Because of the mechanical differences between the bottom pole of the pedestal type mount and the bottom pole of the bury type mount, separate instructions are given for erecting each of these poles. The remainder of the instructions covering the erection of the second and the third poles applies to both types of antennas.

Each pole has a match-mark or arrow on the end or flange that forms a junction with another pole. The match-marks on the mating section must coincide, in order for the poles to be correctly aligned for proper electrical operation. An inspection of the alignment should be made when the antenna is erected and a note made of the fact. The relationship required between the slots from pole-to-pole and the procedure for checking this relationship follows the last step of the actual pole raising operations under *Section-To-Section Slot Alignment Check.*

The following assembly instructions call for the installation of a flange ring between the flanges of adjoining pole sections. Modifications in the flange design have eliminated the need for flange rings in later models of the antenna. If they are not supplied, ignore the step indicating the installation of such rings and proceed directly to the next step.

WARNING

NEVER CLIMB OR WORK ON THE ANTENNA WHILE RF POWER IS BEING FED TO IT. ARRANGEMENTS SHOULD BE MADE WHICH WILL GUARANTEE THAT RF POWER WILL NOT BE APPLIED WITHOUT SPECIFIC INSTRUCTIONS FROM PERSONNEL ON THE TOWER. FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN A SERIOUS, PERHAPS FATAL, ACCIDENT.

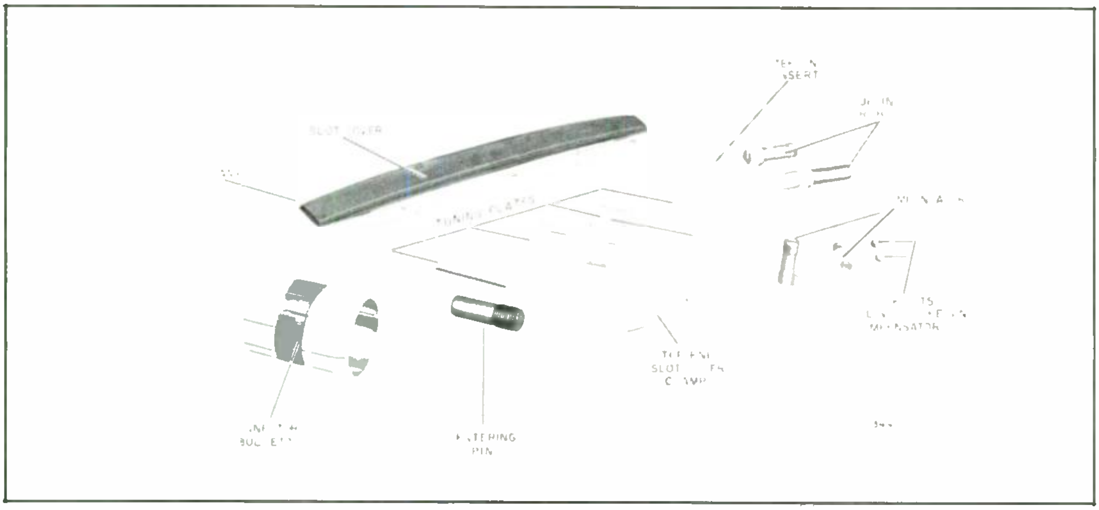

Figure 24. Identification of Basic Component Parts

Bottom Section, Pedestal Type Mount

1. *Flange Ring.* Select a flange ring that is the same diameter as the flange at the base of the bottom section, and place it on the tower top plate. Align the holes in the ring with the holes in the top plate.

2. *Connector (Bullet).* Select a connector or bullet (see figure 24) whose diameter is equal to that of the inner conductor at the top end of the bottom section. Insert the bullet into the upper end of the inner conductor (see figure 25).

3. *Threaded Tapered Pins.* Screw four threaded tapered pins (see figure 21) spaced equally apart into the tapped holes at the upper end (reducer end) of the pole (see figure 25).

> *CAUTION: If heaters are part of the antenna, avoid using holes in the region of the heater junction boxes. Otherwise when holes in the flange of the adjoining pole section are slipped over the pins, the junction boxes will block the pins from coming all the way through.*

4. *Flange Ring.* Select a ring whose circumference is the same as the circumference of the flange at the top end of the pole. Slip the ring down over the tapered pins against the flange.

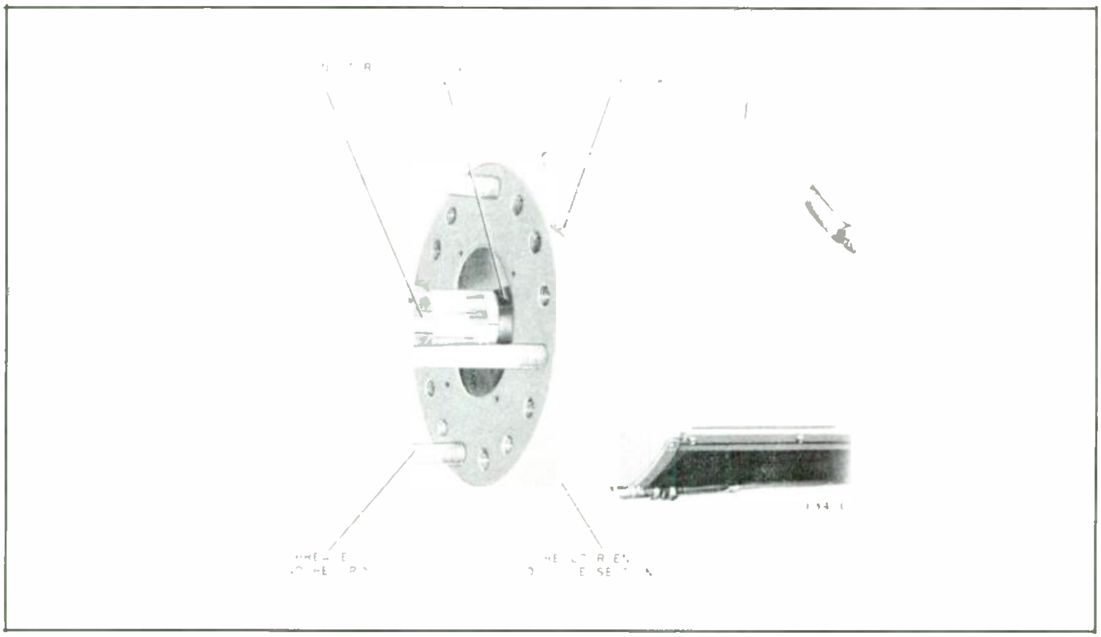

Figure 25. Reducer End of Pole Ready for Assembly to Adjoining Pole

5. *Lifting Clamp.* Select a lifting clamp the appropriate size. Separate the two halves to fit around the pole. Place the clamp slightly above the center of gravity toward the top end of the pole. Bolt the clamp in place, keeping the lifting lug of the clamp in line with the arrow or match-mark on the pole, provided it does not interfere with the gin pole. Tighten the clamp set screws against the pole to prevent the clamp from sliding along the pole as it is being raised. Raise the pole, being extremely careful that it does not strike against the tower while it is being lifted. When the pole is being lowered in place on the tower, make certain that the input flange is properly oriented in relation to the transmission line input. A miter elbow and gas stop assembly (see figure 27) is to be installed in the input at the base of the antenna, later. After the pole is seated on top of the tower, bolt it in place to the tower plate. Use the studs, nuts, and flat washers called for on the assembly drawing furnished with the antenna.

Bottom Section, Bury Type Mount

1. *Connector (Bullet).* Select a connector or bullet (see figure 24) whose diameter is equal to that of the inner conductor at the top end of the pole. Insert the bullet into the upper end of the inner conductor.

2. *Tapered Pins.* Some poles have four Allen screws spaced 90° apart around the flange on the top end. If this is the case, select four tapered pins that are not threaded (see figure 26). Insert the pins (tapered end pointing outward) into the holes having the set screws, then clamp them in place with the set screws. If the flange doesn't have set screws, use four threaded tapered pins. Space the pins equally apart around the flange and screw them into the holes.

> *CAUTION: If heaters are part of the antenna, avoid using holes in the region of the heater junction boxes. Otherwise when the holes in the flange of the adjoining pole section are slipped over the pins, the junction boxes will block the pins from coming all the way through.*

3. *Flange Ring.* Select a flange ring whose circumference is the same as the circumference of the flange at the top end of the pole. Slip the ring down over the tapered pins against the flange.

4. *Lifting Clamp.* Select a lifting clamp the appropriate size. Separate the two halves to fit around the pole. Place the clamp slightly above the center of gravity toward the top end of the pole. Bolt the clamp in place keeping the lifting lug of the clamp in line with the arrow or match-mark on the pole, provided it does not interfere with the gin pole. Tighten the clamp set screws against the pole to prevent the clamp from sliding along the pole as it is being raised.

> *CAUTION: There is only 1/32 of an inch clearance between the pole socket and the diameter of the base of the bottom section. Extreme care must be exercised when lowering the pole so that it enters the socket in a true vertical plane. If the base of the pole is burred or marred, the roughened area must be burnished before inserting the pole in the socket. Failure to exercise caution during this operation will result in binding and misalignment.*

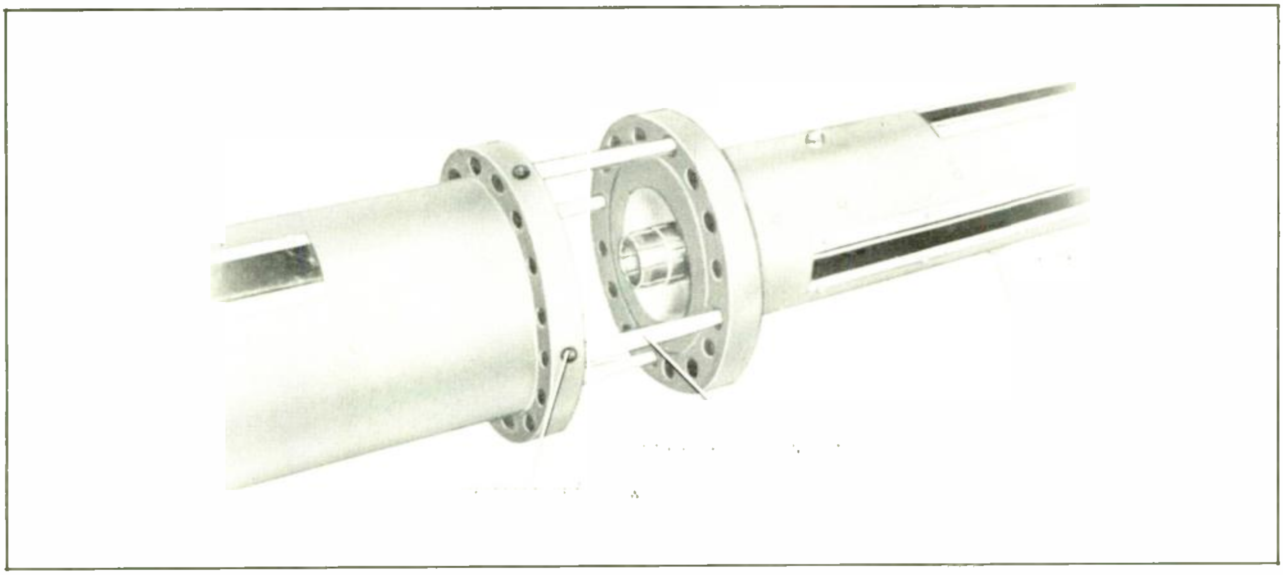

Figure 26. Unthreaded Aligning Pins Used in Assembling Flanged Ends of Adjoining Sections

Raise the pole, being extremely careful that it does
Raise the pole, being extremely careful that it does
not strike against the tower while it is being lifted. When the pole is being lowered into the tower, make certain that the input flange is properly oriented in relation to the transmission line input. A miter elbow and gas stop assembly (see figure 27) is to be installed in the input at the base of the antenna, later.

5. *Pole Socket.* Eight set screws radial to the axis of the antenna are supplied for clamping the pole to the pole socket. Make certain that the protruding plate (see the assembly drawing supplied with the antenna) on the bottom of the antenna is in the clearance hole in the pole socket before tightening the screws. Install the twelve steel blocks on the underside of the pole socket. These lock the pole and prevent shifting.

6. *Guide Flange.* Install the second half of the guide flange on top of the tower. (Refer to the assembly drawing supplied with the antenna.) Adjust the wedges to fit against the pole and then fasten them in place with the bolts. Do not weld the wedges to the flange plate until the antenna has been completely erected and checked for straightness.

Second Section

1. *Connector (Bullet).* Select a connector or bullet (see figure 24) whose diameter is equal to that of the inner conductor at the top end of this section. Insert the bullet into the upper end of the inner conductor (see figure 25).

2. *Tapered Pins.* Screw four threaded tapered pins (see figure 25) spaced equally apart into the tapped holes at the upper end of the pole. If there is a flange on the end of the pole with four recessed Allen screws, insert the four unthreaded pins into the holes with the set screws, then clamp them in place with the set screws. *As previously cautioned, avoid using holes in the region of heater junction boxes.*

3. *Flange Ring.* Select a flange ring whose circumference is the same as the circumference of the flange at the upper end of the pole. Slip the ring down over the tapered pins against the flange.

4. *Lifting Clamp.* Select a lifting clamp the appropriate size. Separate the two halves to fit around the pole. Place the clamp slightly above the center of gravity toward the top end of the pole. Bolt the clamp in place, keeping the lifting lug of the clamp in line with the arrow or match-mark on the pole, provided it does not interfere with the gin pole. Tighten the clamp set screws against the pole to prevent the clamp from sliding along the pole as it is being raised. Raise the pole to join the bottom pole, being extremely careful that it does not strike against the tower while it is being lifted. Use the tapered pins in the top of the bottom pole to guide the second pole as it is being lowered in position on top of the bottom pole.

> *CAUTION: Make certain that the bullet (connector) previously inserted in the inner conductor at the upper end of the bottom pole, enters the inner conductor of the bottom pole as it is lowered in place.*

Insure that the match-marks at the junction of the
Insure that the match-marks at the junction of the
two poles are in line, before assembling the two sections together. Refer to the assembly drawing supplied for the appropriate hardware. Leave the four tapered pins in place temporarily. Bolt the two poles together, using a flat washer under the head of each bolt. Then replace the four tapered pins with the nuts, bolts, and flat washers.

Top Section

NOTE: Whether the beacon cable and lightning protector are installed before or after the pole is erected, is optional. If they are to be installed while the pole is on the ground, refer to the installation instructions on page 22. Otherwise proceed with erecting the top pole.

1. *Lifting Clamp.* Select a lifting clamp the appropriate size. Bolt the clamp to the pole in the same manner previously described. Raise the pole and set it in position on top of the second pole. Use the same technique previously described in assembling the two poles together. Observe that the match-marks on the junction ends of the two poles are in line, and make certain that the bullet enters the inner conductor of the top pole before bolting the pole flanges or ends together. Bolt the sections together, using the appropriate hardware. Remove the lifting clamp and any other appurtenances used in erecting the pole sections.

2. *Replacing Components.* Replace any slot covers, tuning plates, brackets or hardware that were removed during the process of raising the antenna. (Refer to the appropriate drawings and illustrations.)

3. *Deicers (Optional).* If the antenna is equipped with deicers. install the fittings necessary to complete the heater wiring between the antenna pole sections. Refer to the deicer information furnished with the antenna.

4. *Perpendicularity Check.* Check the antenna for straightness with a surveyor's transit, taking into account the prevailing wind. Triangular steel wedges are supplied to correct any slight tilt in the pole

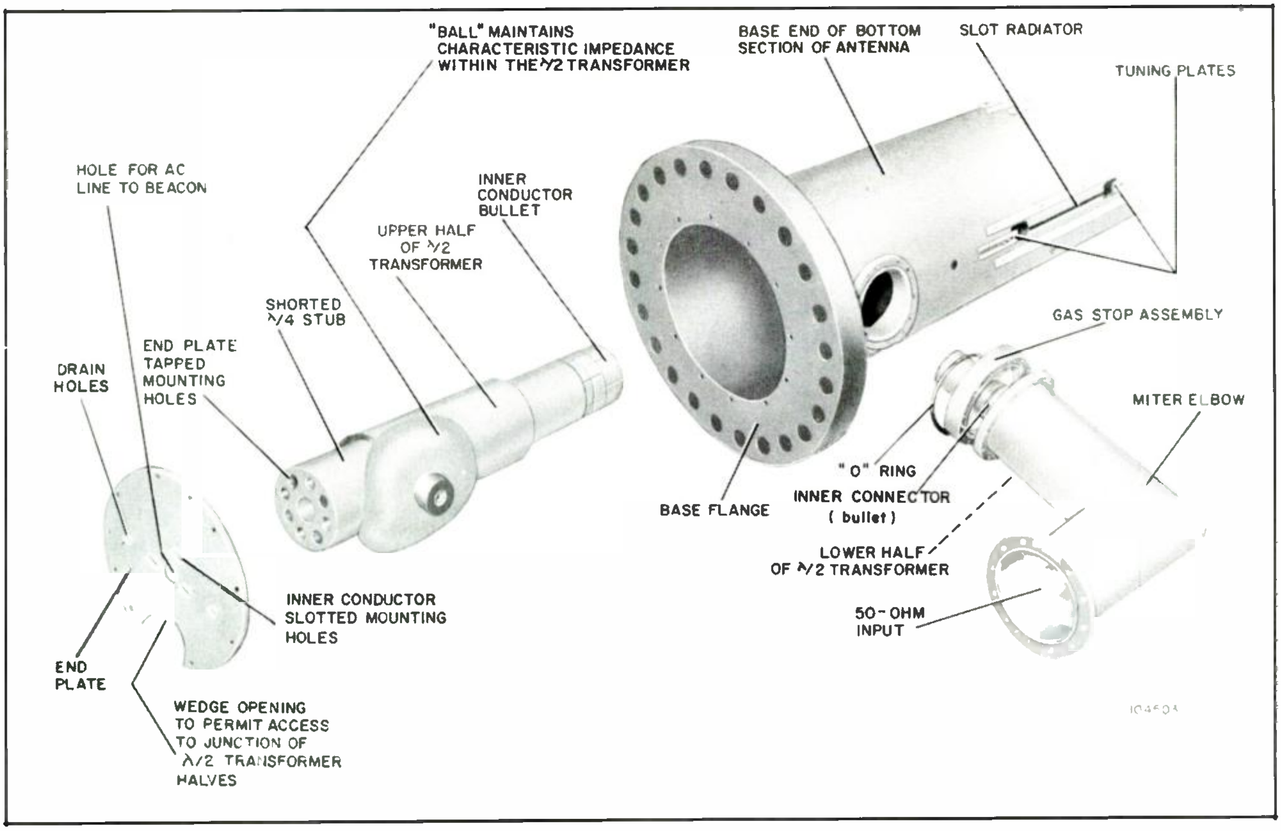

Figure 27. Exploded View, Input End of Antenna

sections. In case a pole is not straight, slide the wedges between the bolts until the pole is perpendicular. This must be done before the erectors leave the site. If there is any doubt about the antenna being in a true vertical plane, make a report immediately to:

RADIO CORPORATION OF AMERICA
BROADCAST ANTENNA MARKETING
ENGINEERING SECTION
BLDG. 53C-1
CAMDEN, N. J.

5. *Shipping Pins.* There are two shouldered steel pins with nuts on each end painted red (see figure 21). One pin is located near the base of the second pole and the other pin is located near the base of the top pole. *REMOVE THESE PINS AND NUTS.* Plastic cap plugs are furnished to plug the holes left in the poles. Use a metal or wood rod to push the cap plugs into the holes.

6. *Input Flange.* Remove the wooden cover painted red from the input flange, near the base of the bottom pole.

7. *Miter Elbow.* Install the miter elbow (see figure 27 and the assembly drawing supplied) by inserting the inner conductor of the gas stop, which is mounted on the input flange, into the inner conductor of the elbow. Bolt the elbow to the gas stop and pipe flange using the appropriate hardware. If a "watchband" connector is used around the inner conductor between the gas stop and the flange on the miter elbow, a slight turning movement in one direction about the axis during insertion will facilitate the entry. Make certain that the spring does not become twisted during the assembly operation. Check that all "O" rings are properly assembled before bolting the miter elbow in place.

8. *Welding.* (Refer to the assembly drawing supplied.)

NOTE: All welding procedures should comply with the American Welding Society qualification procedure publication B-3.0-41T or equivalent. Only operators that have qualified with this procedure should be employed. Use electrodes equivalent to classification No. E-6010 in accordance with A.S.T.M. designation A-233-48T.

(a) *Guide Flange*—Weld the three straight sides of each wedge to the flange plate. Do not weld the curved edge that is against the pole. Half of each fixed plate overlapping the two flange plates is already welded to one section of the flange plate; weld the remaining half to the adjoining section of flange plate.

(b) *Pole Socket*—Weld the top of the pole socket ring to the pole.

Section-To-Section Slot Alignment Check

Select the slot covers closest in line to the match-marking arrows on the poles. Remove the slot covers far enough on each pole to expose the first slot. For pole sections to be properly joined, three conditions should be met: (1) The arrows should be opposite each other; (2) The distance from coupling capacitor to coupling capacitor across the flange(s) of the slots most nearly in line should be slightly less than a wavelength, as shown in figure 28. (This may be somewhere on the order of 90% of a wavelength but not less than this.) (3) The coupling capacitors may be on either the left or the right side of the slots, as long as both are on the same side. It is possible that the rows of slots will not be perfectly aligned, but may be one or two holes either CW or CCW from coincidence, as shown on the *Tuning Plate and Capacitor Information* drawing, which is supplied with the antenna.

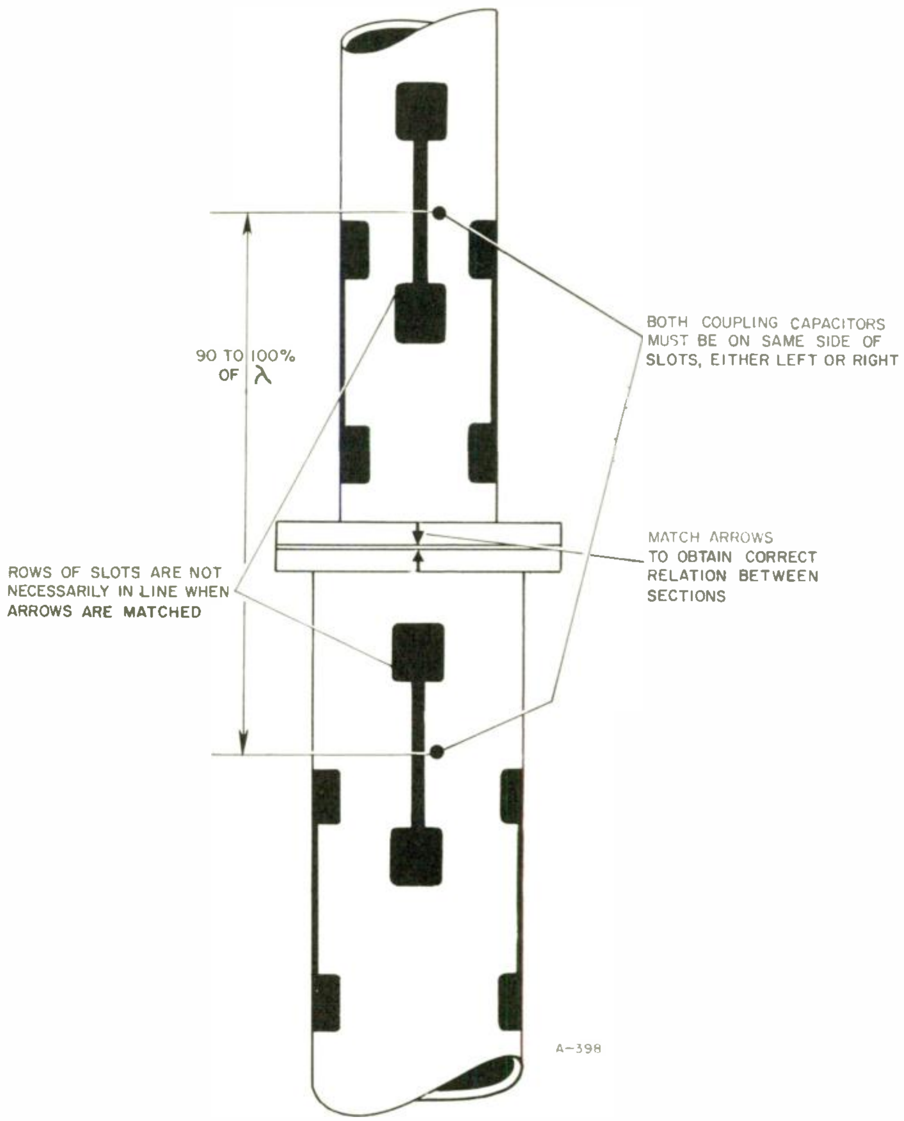

Figure 28. Relationship of Slots Between Sections When Antenna is Erected

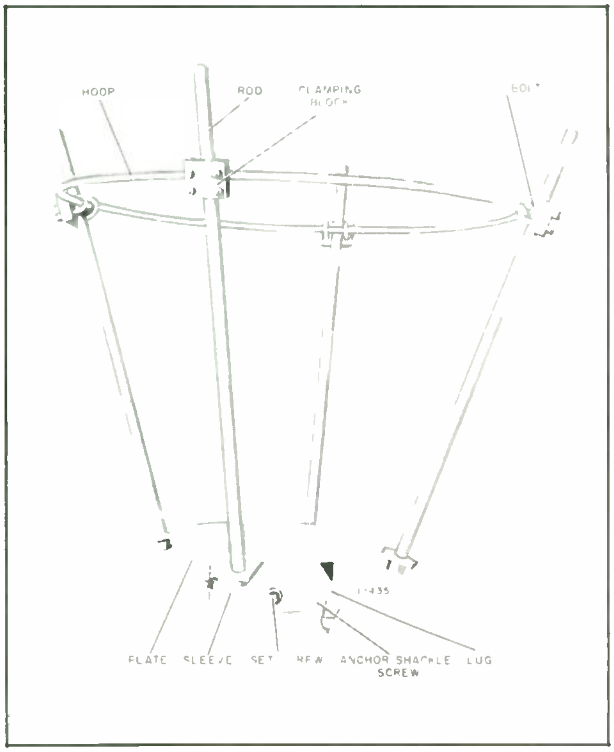

Figure 29. Lightning Protector Assembly

Lightning Protector and Beacon Cable Assembly

The lightning protector (see figure 29) is shipped assembled. Holes for mounting the beacon are located in the plate of the lightning protector. Set screws are provided around the sleeve below the plate to bolt the lightning protector assembly on top of the pole. An anchor shackle, to which supporting tackle for a bosun's chair can be attached, is fastened to the lug or ear protruding from the sleeve.

If the beacon cable and lightning protector are mounted on the top pole before it is raised, *extreme care must be exercised when lowering the pole section so as not to damage the beacon cable.*

A 3-conductor Neoprene covered beacon cable is supplied. The length of the cable is determined by the height of the antenna. Sufficient cable is supplied so that approximately 20 feet extends below the bottom of the antenna after the cable is installed.

A sectional view of the top of the antenna, figure 30, shows the beacon cable installation details.

On the outside of the top pole near the upper end is the cable clamp assembly. The clamp assembly supports the section of cable leading out of the pole and up to the beacon. Inside the pole, slightly below and on the side opposite the clamp, is a shoulder eye bolt. The eye bolt is used to support the cable running *through the hollow of the copper tubing inner conductor* and to prevent it from rubbing against the rim of the top loading transformer.

Beacon Cable Installation

1. Unscrew the nut and remove the rubber grommet from the cable clamp assembly.

2. Take one end of the cable and from inside the pole feed approximately three feet of cable through the cable opening in wall of the pole. This length of cable will run from the cable clamp up to the beacon.

3. Thread the other end of the cable through the loop of the eyebolt inside the antenna. Run the cable down *through the inside of the copper tubing inner conductor* and out of the hole in the center of the base plate on the bottom pole section.

4. Slide the rubber grommet over the three-foot length of cable and insert it in the bushing. Slide the nut down over the cable and tighten the cable clamp in place.

Lightning Protector Installation

1. Slide the sleeve of the lightning protector assembly down over the top of the antenna.

2. Orient the lightning protector assembly so that the hinge of the beacon will be on the side opposite the pole steps. This will make the beacon more convenient to reach when servicing the lamp. Use the set screws around the collar to bolt the lightning protector in place.

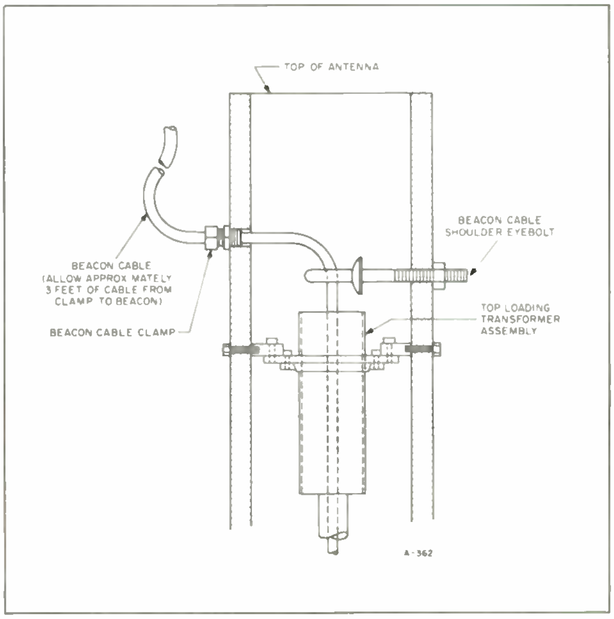

Figure 30. Beacon Cable Installation

3. Make a complete and thorough test as to the tightness and rigidity of all climbing and rigging fixtures. *The safety of personnel servicing the antenna and the beacon depends upon the soundness of these fixtures.*

Returnable Hardware Items

After the antenna has been erected, the lifting clamps, the tapered steel pins, and the shouldered steel pins are to be returned to:

RADIO CORPORATION OF AMERICA
BROADCAST ANTENNAS
ENGINEERING SECTION
BLDG. 53C-1
CAMDEN, N. J.

OPERATION

General

Before applying power to the antenna, the installed system should be thoroughly checked by the RCA Service Company representative. If after a "cold" check no apparent irregularities are encountered, rf power may be applied to the antenna. It is recommended that the transmitter be operated at a reduced power level initially, until it has been made certain that all positions of the system are functioning properly. Once normal operation has been ascertained, full-power and routine operation may be started.

Deicer Operation

Ice forms between about 10° and 35° F. depending upon the location of the antenna. The deicers should not be in operation when the temperature is above 35° F. A saving in cost can be realized if the deicers are not operated below 10° F. The operation of the deicers may be controlled either manually or automatically. The Automatic Deicer Control Unit, MI-27369, is supplied with the antenna. Use of the Automatic Deicer Control is strongly urged, since atmospheric conditions at the top of the tower may be different from those at ground level. This unit provides a more accurate and effective means of governing deicer operation, than does manual control.

CAUTION: Make certain the control equipment is functioning properly, and avoid operation of the deicers when air temperature exceeds 40 degrees F. or after heavy ice accumulations. Operation under these conditions will cause overheating and damage the heater elements and the slot covers.

MAINTENANCE

Painting. The antenna should be repainted at regular intervals. How often repainting is necessary depends upon local atmospheric conditions. *DO NOT under any circumstances paint the plastic slot covers.*

Inspection. Inspect the transmission line and antenna system twice a year. This requires the service of riggers and should be done by qualified maintenance crews who are experienced on television antennas. Check all hardware for evidence of looseness or corrosion. All electrical connections should be checked, with particular attention being given to connections between deicers and to junction boxes. Make certain that the seals on these connections are still watertight. Check the outside only of the miter elbow assembly, gas stop and transmission line input for indications of leaks or other damage.

FIRST AID

WARNING

OPERATION OF ELECTRONIC EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH VOLTAGE SUPPLY ON. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES, ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

Personnel engaged in the installation, operation and maintenance of this equipment or similar equipment are urged to become familiar with the following rules both in theory and in the practical application thereof. It is the duty of every radioman to be prepared to give adequate First Aid and thereby prevent avoidable loss of life.

ARTIFICIAL RESPIRATION

(Courtesy of the American Red Cross)

If victim is not breathing, begin some form of artificial respiration at once. Wipe out quickly any foreign matter visible in the mouth, using your fingers or a cloth wrapped around your fingers.

MOUTH-TO-MOUTH (MOUTH-TO-NOSE) METHOD

Fig. 1

Tilt victim's head back. (Fig. 1). Pull or push the jaw into a jutting-out position. (Fig. 2).

Fig. 2

If victim is a small child, place your mouth tightly over his mouth and nose and blow gently into his lungs about 20 times a minute. If victim is an adult (see Fig. 3), cover the mouth with your mouth, pinch his nostrils shut, and blow vigorously about 12 times a minute.

Fig. 3

If unable to get air into lungs of victim, and if head and jaw positions are correct, suspect foreign matter in throat. To remove it, place victim in position shown in Fig. 4, and slap sharply between shoulder blades.

Fig. 4

Rescuers who cannot, or will not, use mouth-to-mouth or mouth-to-nose technique should use a manual method.

THE BACK PRESSURE-ARM LIFT (HOLGER-NIELSEN) METHOD

Place victim face-down, bend his elbows and place his hands one upon the other, turn his head slightly to one side and extend it as far as possible, making sure that the chin is jutting out. Kneel at the head of the victim. Place your hands on the flat of the victim's back so that the palms lie just below an imaginary line running between the armpits (Fig. 5).

Fig. 5

Rock forward until the arms are approximately vertical and allow the weight of the upper part of your body to exert steady, even pressure downward upon the hands (Fig. 6).

Fig. 6

Immediately draw his arms upward and toward you, applying enough lift to feel resistance and tension at his shoulders (Fig. 7). Then lower the arms to the ground. Repeat this cycle about 12 times per minute, checking the mouth frequently for obstruction.

Fig. 7

If a second rescuer is available, have him hold the victim's head so that the jaw continues to jut out (Fig. 8). The helper should be alert to detect any stomach contents in the mouth and keep the mouth as clean as possible at all times.

Fig. 8

RELATED INFORMATION FOR BOTH METHODS

If vomiting occurs, quickly turn the victim on his side, wipe out his mouth, and then reposition him.

When a victim is revived, keep him as quiet as possible until he is breathing regularly. Keep him from becoming chilled and otherwise treat him for shock. Continue artificial respiration until the victim begins to breathe for himself or a physician pronounces him dead or he appears to be dead beyond any doubt.

Because respiratory and other disturbances may develop as an aftermath, a doctor's care is necessary during the recovery period.

BURNS

FIRST DEGREE BURN

SKIN REDDENED. Temporary treatment—Apply baking soda or Unguentine.

SECOND DEGREE BURN

SKIN BLISTERED. Temporary treatment — Apply baking sode, wet compress, white petroleum jelly, foille jelly, olive oil, or tea.

THIRD DEGREE BURN

FLESH CHARRED. Temporary treatment — Apply baking soda, wet compress, white petroleum jelly, or foille spray. Treat for severe shock.