The Corkscrew

A New Type of Polarized Antenna

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Combined vertically and horizontally polarized antennas are not new but th method described to achieve dual polarization is new. It is adapted from commercial broadcast antenna design and although it can be used on an band, it is particularly suitable for use on the v.h.f. bands and on the h.f DX bands.

DUAL polarization is of value in many circumstances since, due to reflections and other effects, a transmitted wave is rarely received with exactly the same polarization. For instance, a vertically polarized signal from the mobile unit can be received on a horizontally polarized fixed station antenna, although, theoretically, there should be no signal coupling between precisely polarized waves and antennas of the opposite polarization. Of course, there would be a considerable average increase in the signal level (20 db or more) between the mobile and fixed stations if both used antennas of the same polarization. Many v.h.f. mobile operators, of course, realize this and us horizontally polarized antennas of th "halo" type. Nonetheless, the signal di advantage due to antenna polarization sti exists if one desires to work a mobile un with a simple whip antenna or a portabl unit.

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Dual Polarization

Almost exactly the same polarizatio problem was faced by f.m. broadcaste due to the increasing popularity of aut mobile f.m. receivers using simple whip a tennas, since their transmitting antenn were horizontally polarized. Many anten designs were developed to allow broadcas

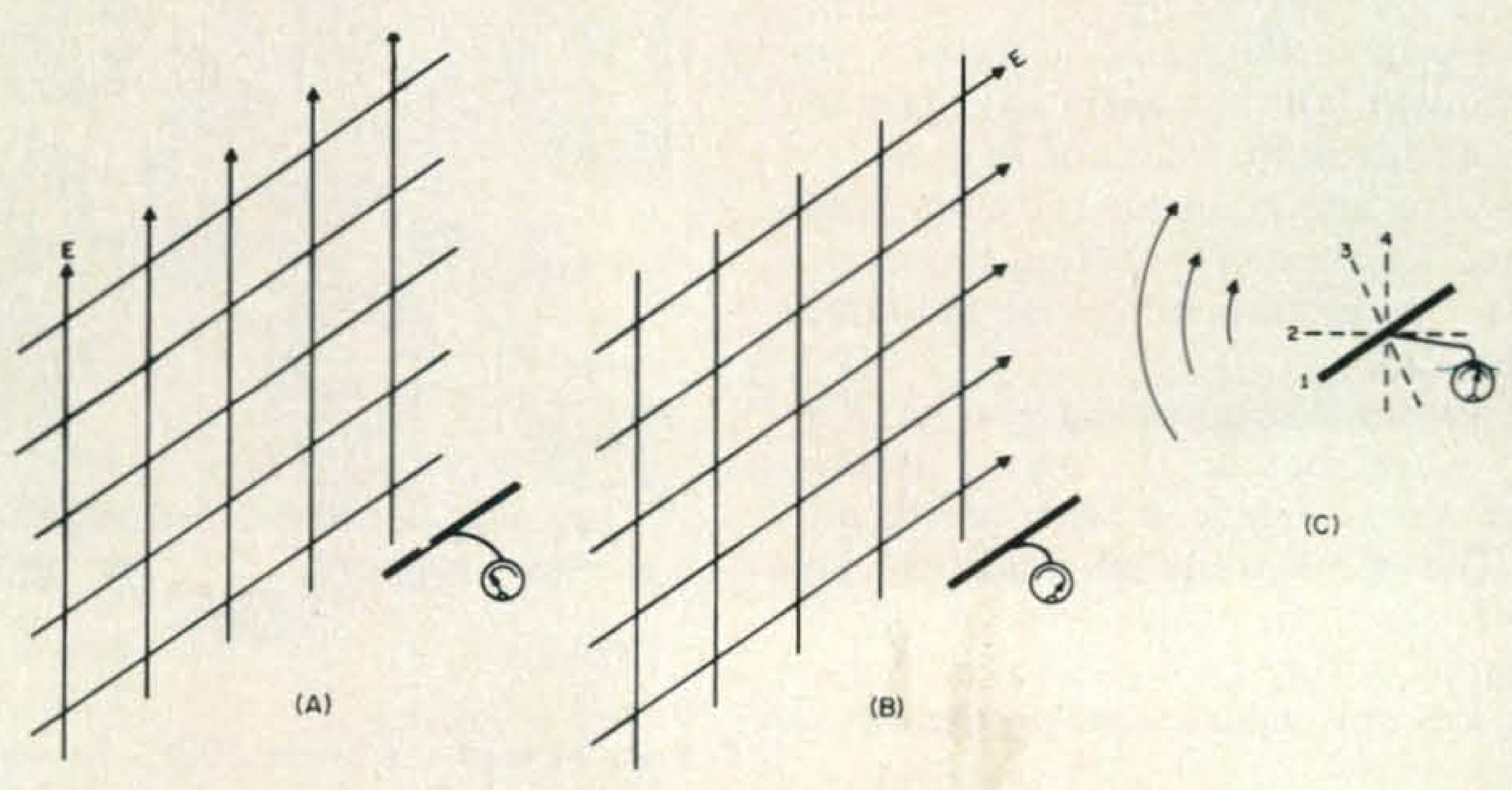

Fig. 1—Theoretically no coupling exists between vertically polarized wave and horizontally polarized electric dipole (A) while full coupling exists when polarizations are the same (B). Combination horizontally and vertically polarized, or circularly polarized wave, will couple to any dipole orientation (C) except, of course, end on.

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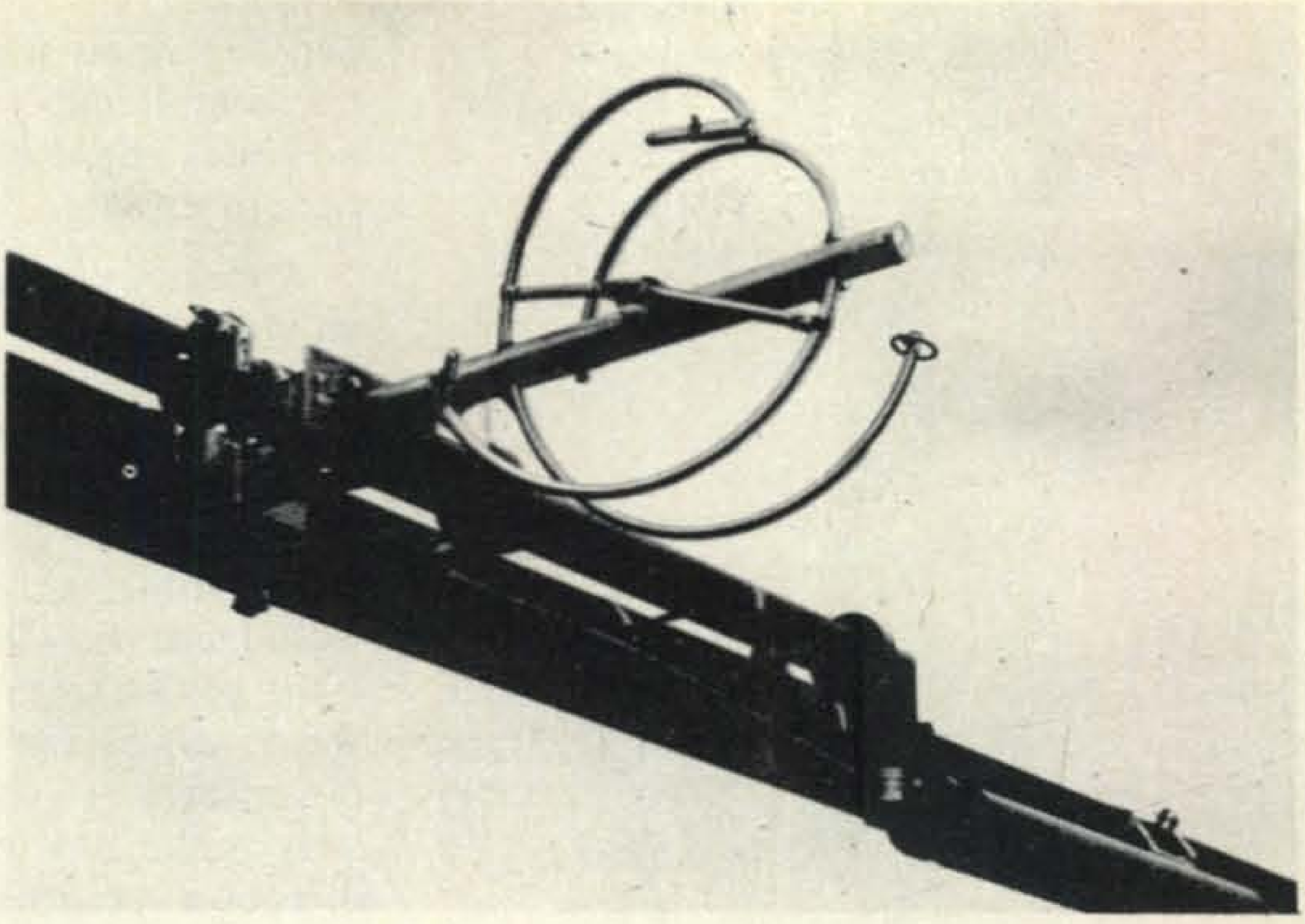

single section of RCA's
nmercial "BCF" antenna
f.m. stations which the
hor nicknamed a "cork-
ew" antenna. Note the
ta match arms to each
ix. The large center sup-
rt arm is the coaxial trans-
sion line. Photo courtesy
of RCA.

g a signal with dual polarization. Com-
nations of conventional vertical and hori-
ntal antennas can be used, but the com-
ned feed systems and the total size is
ten a disadvantage. RCA, however, in
eir BCF type antenna developed a so-
lled circularly polarized design that is
th simple to feed, reasonably small and
echanically sturdy and simple. Fortunate-
the design is readily adapted to amateur
eds for either mobile or home station use.
radiates equal power level vertically and
rizontally polarized signals with a hori-
ntal plane omnidirectional pattern. Single
its can be used in a mobile installation
units may be stacked to provide gain, in
e vertical plane, for home station instal-
tions. The circular polarization means
at the receiving antenna (assuming the
rcularly polarized antenna is used for
ansmitting) can have *any* orientation, not
st vertical or horizontal, and still provide
e same received signal level.

The theory on which the antenna is
sed allows the construction of various
pes of circularly polarized antennas, not
st the dual-dipole form which RCA uses
nd which we nick-named the "cork-
rew" antenna) which is described later.
hen one looks at the latter antenna, it
ppears to be two "halo" antennas inter-
vined with their ends spread apart. Ac-
ally, although the physical form does re-
mble the "halo," the electrical operation
completely different. The electrical oper-
ion is described in some detail in the fol-
wing paragraphs and should be under-stood, especially if one desires to experiment with other forms of the basic antenna. However, even if one does not care to worry about the theory of operation, the antenna can still be easily constructed and adjusted using the information presented later.

Theory of Operation

Most of us are used to the terms vertical and horizontal polarization, where polarization is defined as the orientation of the electric field of an electromagnetic wave, as shown in fig. 1. The simple flat vertical

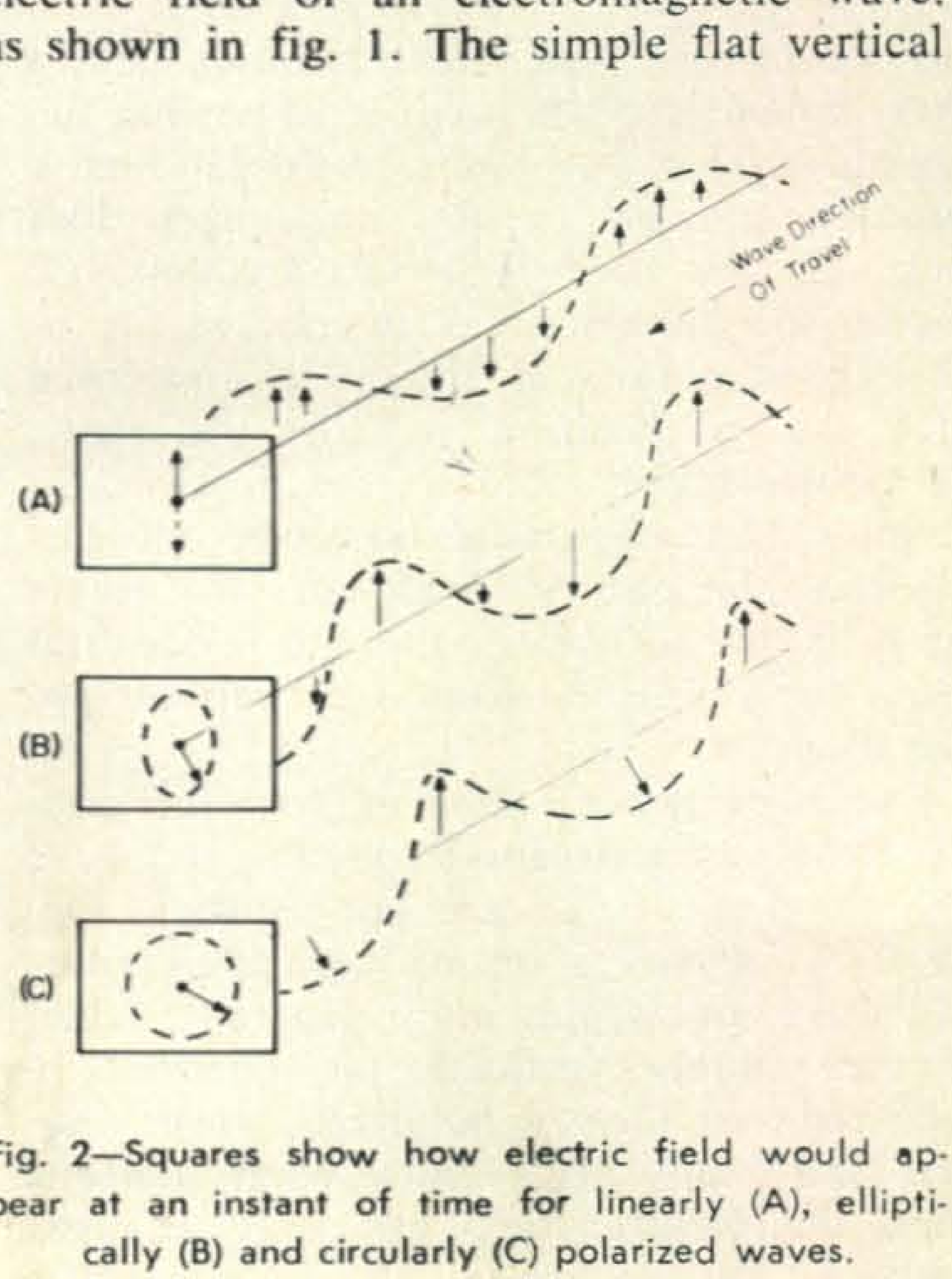

Fig. 2—Squares show how electric field would appear at an instant of time for linearly (A), elliptically (B) and circularly (C) polarized waves.

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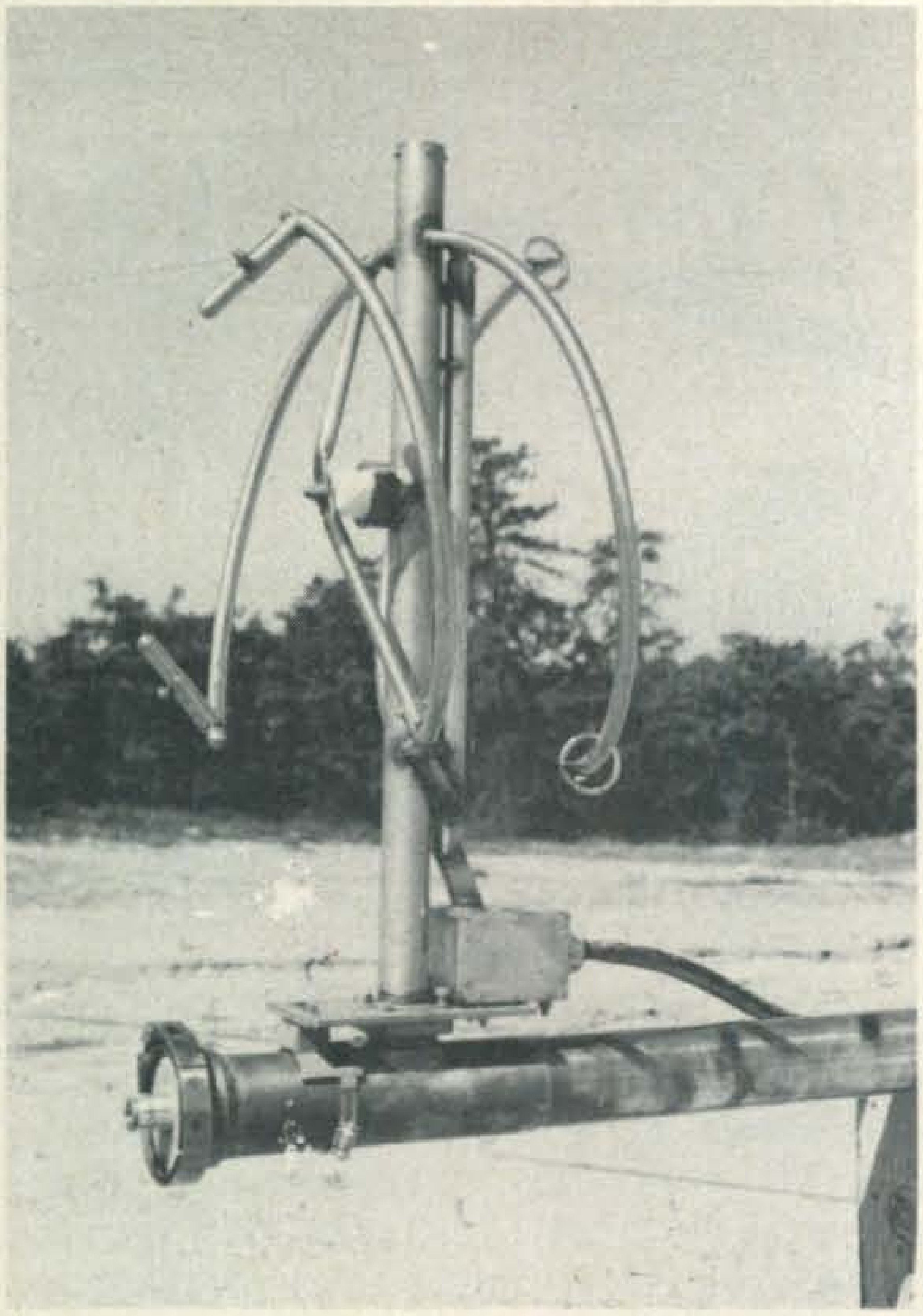

Another view of the construction of the BCF antenna. In this commercial version adjustable stubs are visible at the end of the dipole elements for fine tuning. Generally, for amateur use, such stubs are not necessary as the low antenna Q (about 13) permits easy broadband operation.

and horizontal line representation of a wave, which is often used, is somewhat deceiving in that one tends to forget that a constant reversal occurs, once each half cycle, of the electric field direction. Of course, this makes no difference as far as the representation in fig. 1 is concerned since the polarization remains the same, the arrows simply point in the opposite direction. More important, however, one forgets that the electric field can also rotate about its line of travel, although it does not do so for simple horizontal or vertical polarization.

The more general case of how the electric field can perform is shown in fig. 2 (the magnetic fields are not shown). Figure 2(A) shows a simple vertically polarized wave, or as it is more generally called whether purely vertically *or* horizontally polarized—*a linearly* polarized wave. Figures 2(B) and 2(C) show what happens when the electric field not only changes direction but rotates about its axis. Depending upon whether the excursion in th horizontal and vertical planes are unequa or equal, the polarization is said to be ellip tical or circular.

Although a dipole or other linear anten na would extract some power from an ellip tically polarized wave, the level would vary because of the non-uniform nature of th wave, with dipole orientation. The powe that a dipole of *any* orientation would ex tract from a circularly polarized wav would not vary (as long as the dipole is a right angles to the direction of travel of th wave) since the wave's power distributio is uniform. It should be noted that circu larly polarized waves do have a specifi direction of rotation. It is of no conse quence when a linear antenna (dipole whip, etc.) is being used but if two circu larly polarized antennas are used each mus produce and respond to the same directio of rotation.

Circularly polarized waves can be produced in a number of ways, including th combining of signals from separate vertically and horizontally polarized antennas (dipoles mounted at right angles to eac other). The separate antennas must be fe equal power and with a specific phase difference. A 90° phase difference will produce a circularly polarized wave. A 0° phase difference will produce a *linearl* polarized wave at an angle of 45°. Othe phase differences will produce variou forms of elliptically polarized waves. I should be noted that placing dipoles at right angles and directly connecting them together (no phase difference) does *no* produce an antenna that will most effectively respond to signals of random polarization. A phasing line between the dipoles of ¼ λ is required.

To avoid the need for a phasing line, another way to produce the 90° phase difference between antennas would be to feed the antennas in phase but physically separate the current elements in each antenna by 90° or ¼ λ. This is the basic idea behind the RCA design, but they added a unique twist. As shown in fig. 3(A), the two current elements produce a circularly polarized wave. If each element is rotated in its plane, fig. 3(B), the resultant wave is still circularly polarized. If one adds another pair of current elements and places one each of the original elements at each end,

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g. 3(C), a circularly polarized signal in *l* horizontal directions results and the an-nna form becomes a single turn helix.

Certain dimensions must be observed for e helix form to produce circular polari-ation, however, as shown in fig. 3(D).

The foregoing discussion mentioned urrent elements," all of which were in hase and of constant amplitude. To trans-te this requirement into a practical an-nna form, one can use various forms of poles. The simple single turn ½λ dipole fig. 4(A), however, is *not* usable be-use of its sinusoidal current distribution. he simplest form of ½λ dipole that is able is the two turn antenna of fig. 4(B). he total lineal length of the antenna is λ, the diameter is .08λ and the spacing be-een turns (from the formula of fig. 3 (D) only .03λ. Such an antenna *will* work, en though its diameter is only about 3')" and its height about 3' on 15 meters. he *Q* of such an antenna will be rather gh, however, and although acceptable on e lower frequency bands would be too strictive on the v.h.f. bands.

To produce an antenna form with great-bandwidth[1] and achieve a constant cur-nt condition around the elements, two e-turn elements, each having a total lin-l length of ½ λ was used, as shown in . 4(C). The spacing between the tips of ch element is .13 λ. The current elements t as though two separate one-turn ele-ents were present in fig. 3(C) and the *tal* effect is an omnidirectional pattern th circular polarization.

Construction and Adjustment

As might be apparent from the dimen-sions of fig. 4(C), the total space occupied by the antenna is little more than that required for a "halo" antenna of ½ λ construction and much less than that needed for a 3/2 λ "halo." What might not be immediately apparent is the ease with which the dipole elements can be mounted and fed from a transmission line. The general feed system can be seen in the photograph and is outlined in fig. 5. Basically, a Delta match is used to each dipole element with the two Delta arms simply paralleled where they are connected to the transmission line. The Delta arms are moved equally along each dipole element until a match to the transmission line is obtained. Since the impedance can be varied as desired using the Delta arms, a perfect match should be possible to any coaxial transmission line. For absolute balance, one could first match

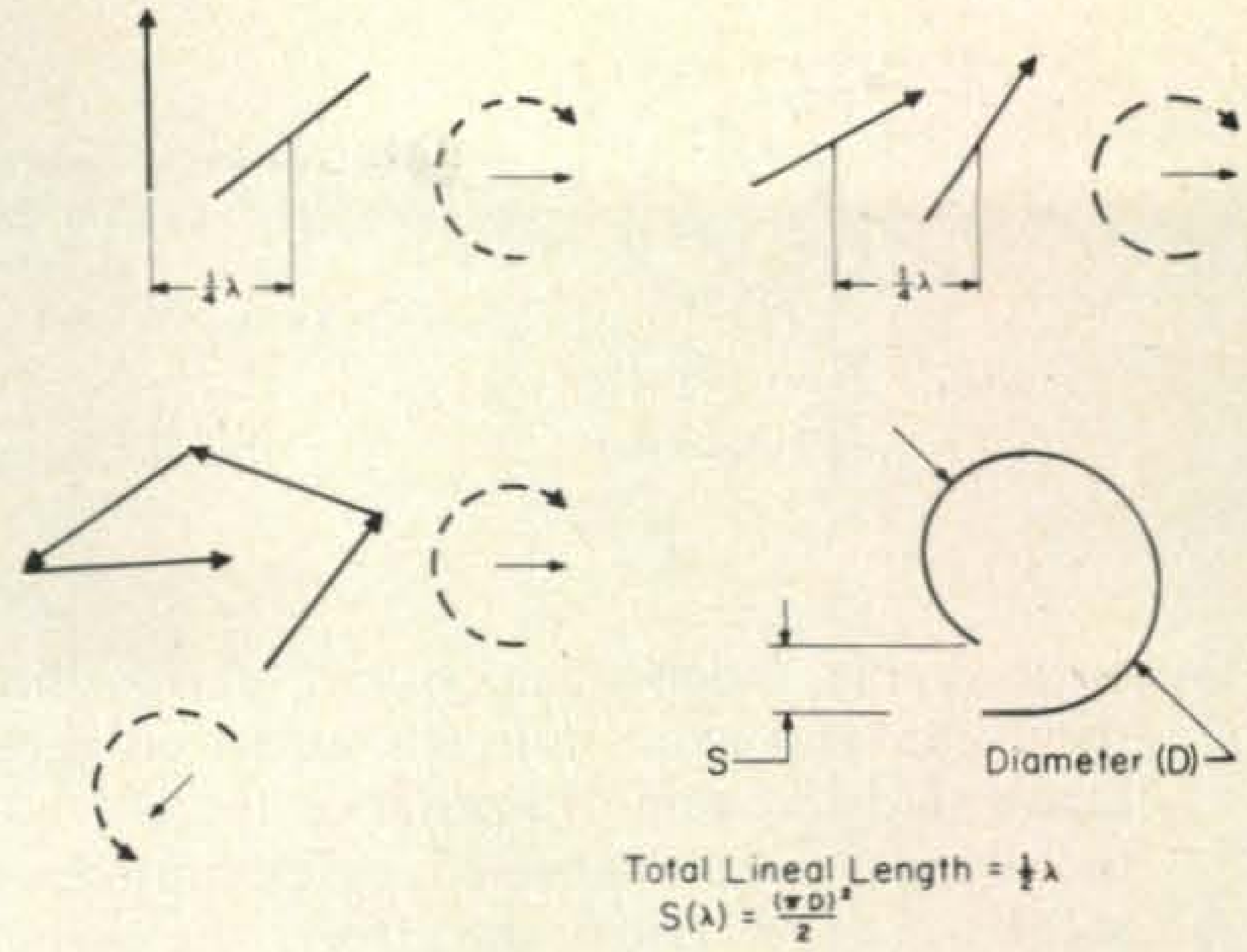

Fig. 3—Current elements fed in phase and spaced ¼ λ produce circular polarization (A) and (B). Adding additional current elements (C) produces omnidirectional circular polarization and gives helix form to antenna. Helix current element dimensions are shown at (D).

mc within a 1.3:1 \/ s.w.r. for the commercial f.m. band model.

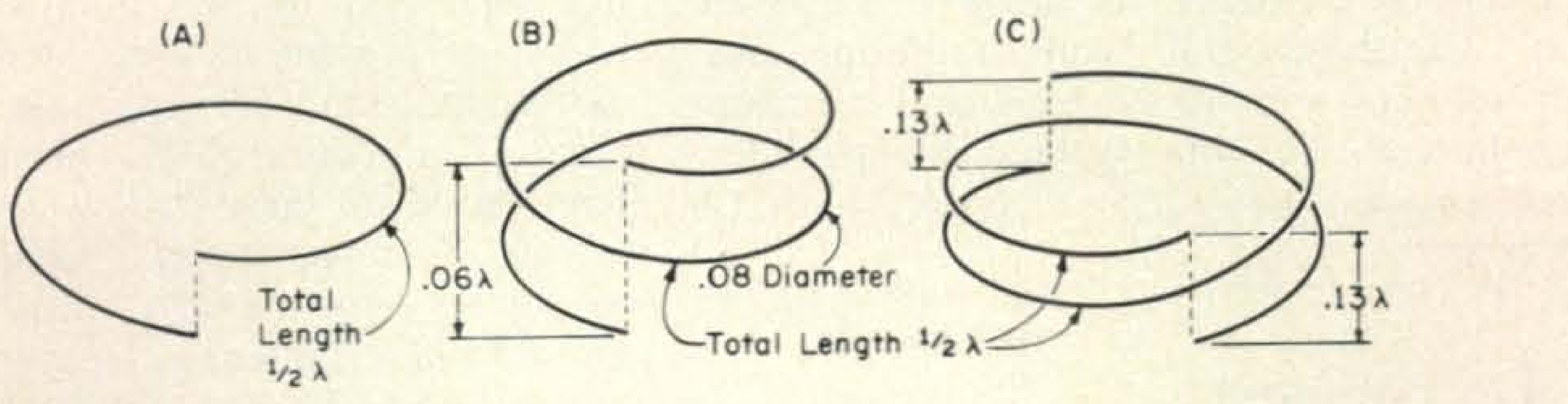

Fig. 4—For practical ½ λ helix (A) will not produce circular polarization because of its current distribution. A two-turn ½ λ helix (B) will work, although the dual-dipole helix (C) is preferred because of its better bandwidth.

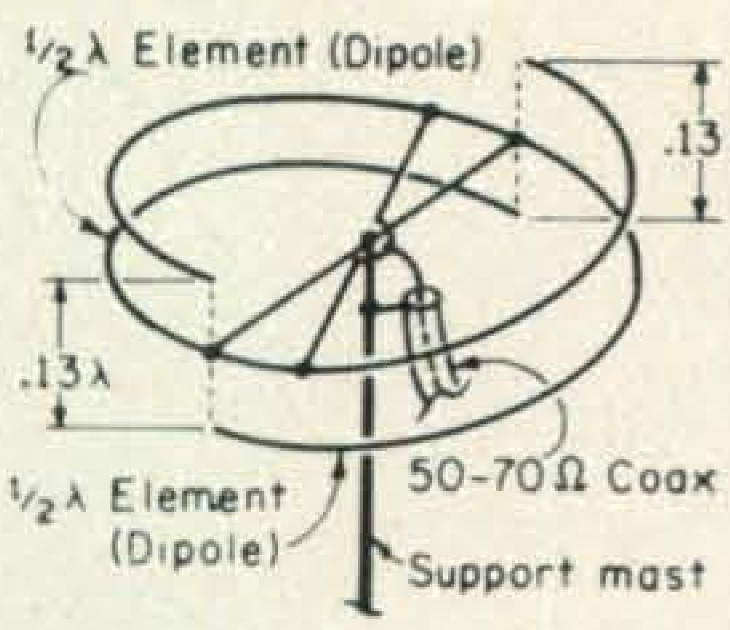

Fig. 5—Delta match and feed system for a single element "Corkscrew" antenna.

each dipole independently and check that the Delta arm excursions are equal on each dipole for the same impedance match, but the improvement obtained in performance will hardly ever justify the effort.

It should be mentioned that the Delta feed system using a single arm would, of course, also be applicable if one wanted to experiment with the two-turn antenna shown in fig. 4(B) on one of the lower frequency bands.

The physical construction of the antenna for use on the v.h.f. bands employs the same materials and techniques as that for normal "halo" antennas and so need not be mentioned in great detail here. Generally, 7/16" - 1/2" aluminum tubing is suitable and can be packed with sand and shaped to the proper diameter around some convenient form. On 2 meters, the end tips will not normally require support but on lower frequency bands provision should be made for a plexiglas spacer to maintain the proper spacing. It is also a good idea to have a small amount of the next smaller size of aluminum tubing that can be firmly press-fitted into the end of the dipole elements on hand in case the elements are cut slightly short and some extra length is required to resonate the elements.

Multiple Element Array

As is done with the broadcasting antenna, it is possible to "stack" a number of dual-dipole elements to achieve a power gain. The horizontal plane radiation pattern remains omnidirectional and circularly polarized, but the vertical plane radiation pattern is compressed towards lower radiation angles in order to achi gain. Elements are "stacked" by spac them 1 λ and feeding individual eleme in phase. Figure 6 shows the dimensi required for "stacking" of two elements 2 meters and the basic idea may be tended to "stacking" as many elements desired.

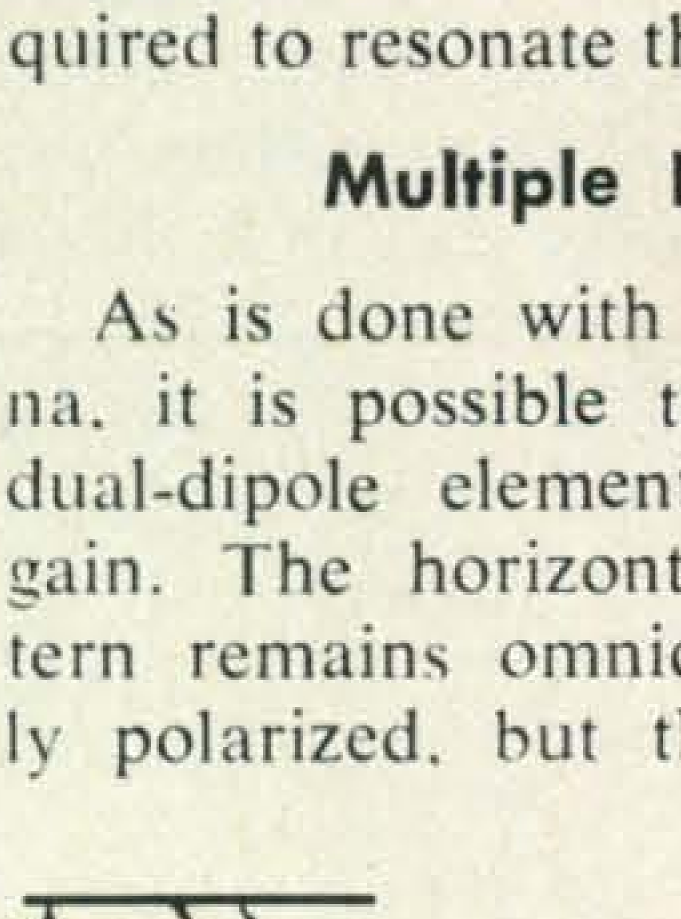

Fig. 6—Stacking dimensions for two "corkscrew" arrays on two meters. Similar arrangement of one wavelength spacing and in-phase feed may be followed on other bands.

A word should be mentioned about ga both as regards to single elements and "stacked" elements. At first, it may app as though one is getting "something nothing" since the corkscrew antenna w perform as well as a separate vertical horizontal antenna simultaneously. Nat ally, this cannot be the case but the pr one does pay for the simultaneous horiz tal and vertical performance of the anten is very small indeed. Compared to a dip properly oriented for maximum perfor ance, the greatest loss of the corkscrew only ½ db, a figure hardly noticeable any practical situation and more of a t oretical significance than a practical o As elements are "stacked," the gain referenced to a dipole) does increase very roughly ½ db per added dual-dip element. Thus, a 4 element array has gain of about 2 db.

Summary

The corkscrew antenna design, as have decided to nickname it, is definit something new in antenna configurati Yet, it is *not* a theoretical concept, but c that has already been *proven* in comm cial performance for f.m. transmitters.

The possibilities for the adoption of t type of antenna design, especially the tv turn ½λ model, to frequencies as low 14 mc open up a new range of designs reasonably compact DX antennas that a not restricted by the polarization requi ments of present antenna designs. One c easily envision, for example, the repla ment of a conventional ground plane a tenna with its large radial system by a r atively inconspicuous "corkscrew" th would be only about ¼ the height of ground-plane antenna, require no radi and still be effective for both horizonta and vertically polarized signals! If De fed, the antenna also offers the advanta of a d.c. grounded system that should

(continued on page 90)

Ostermond-Tor *[from page 63]*

puter, on a purely chance basis, would co nect the S.S.S. phone to another S.S.S. pho anywhere in the world, ONIT planned establish this service for about $5 a mont No licence would be required to opera S.S.S., technical knowledge would not be prerequisite and there would be no need learn the Morse Code.

Tor spotted this as a plan that could sp the end of amateur radio as we know it tod and immediately set out to expose it, at co siderable personal risk to himself.

Well, dear readers, I believe you see no why amateur radio can be proud of profess Jerzy Ostermond-Tor.

Expressions of congratulations to Pro Tor can be sent to him c/o *CQ*.

★ **PLEASE include your ZIP code number on all correspondence** ★

Corkscrew Antenna *[from page 60]*

free of such annoying effects as precipit tion static and provide inherent lightni protection.

Naturally, the most uniform circular r diation pattern will be obtained if the a tenna is mounted on top of a tower, buil ing, etc. The antenna, however, has bee used commercially, mounted on the side o antenna towers and still will perform ve well in this manner if the separation fro the tower is made as great as possible (least ½ λ).

Special thanks are due Dr. M. Siukol ex OH2OA, of RCA for information pro vided about the design of this antenna. ■

DX *[from page 68]*

tionals will continue to use the DU prefix.

FO8, Clipperton – French licensing au thorities say that no licenses have been issued for any operation from this rare island.

GUS – Frequencies Gus will use on his DXpedition are as follows; for c.w.: 28025 kc, 21025 kc, 14025 kc, 7025 kc, 3525 kc, & 160 meter not yet known. For s.s.b.: 28495 kc, 21395 kc, 14195 kc, 7195 kc, 3795 kc, and 160 meter not yet known. He will tune up and down the dividing frequencies separating advanced/extra class from the generals. Oc-

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