BENT ANTENNAS

Modifying the Horizontal Half-Wave Radiator Where Space Is Limited

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Bent antennas will work and work well—often without any apparent rhyme or reason. The worst we ever saw was a compromise between a hair-pin and a wash-drier strung in some memory-defying manner between the garage and house at W4DVO-WLRB, Tampa, Florida. We doubt if any part of this sky-hook-or-by-crook was more than 25 feet above ground. It was end-fed on 80, 40 and 20 meters, and the shack was so plastered with cards that half the radiation went into the thumb tacks!—Ed.

To many amateurs, especially those living in the city, the erection of a suitable antenna presents a major problem. Putting up a half-wave antenna in limited space is often impossible. Where sufficient room for a horizontal straight wire is not available, a compromise radiation system can be used. It is not claimed that the compromise will be as efficient as an antenna constructed "according to Hoyle," but if intelligently considered and built, good results can be expected.

Before erecting an antenna in restricted space it is well to consider first some fundamental antenna characteristics. Almost anything connected to a transmitter will radiate some energy. Even a dummy aerial or a very short piece of wire will radiate sufficient energy to be picked up at a near-by location. The main differences between antennas are efficiency and radiation pattern. For the ham without the room, the radiation pattern will usually have to be what it turns out, but the efficiency can be worked on and in most cases made reasonably good.

The Half-Wave Antenna

The fundamental antenna is a straight wire one-half wave long electrically. The formula for calculating such an antenna is —

$$\text{Length (in feet)} = \frac{468{,}000}{\text{frequency (in kilocycles)}}.$$

The antenna can be coupled to the transmitter at either end of the wire, which is known as voltage feed, or current-fed to the center. In both cases, as a characteristic of the half-wave antenna, maximum voltage occurs at either end of the wire and the current is maximum at the center. Theoretically, maximum radiation occurs at the point of the most current. It is therefore important in any antenna system to have the point of maximum current (the center in the instance

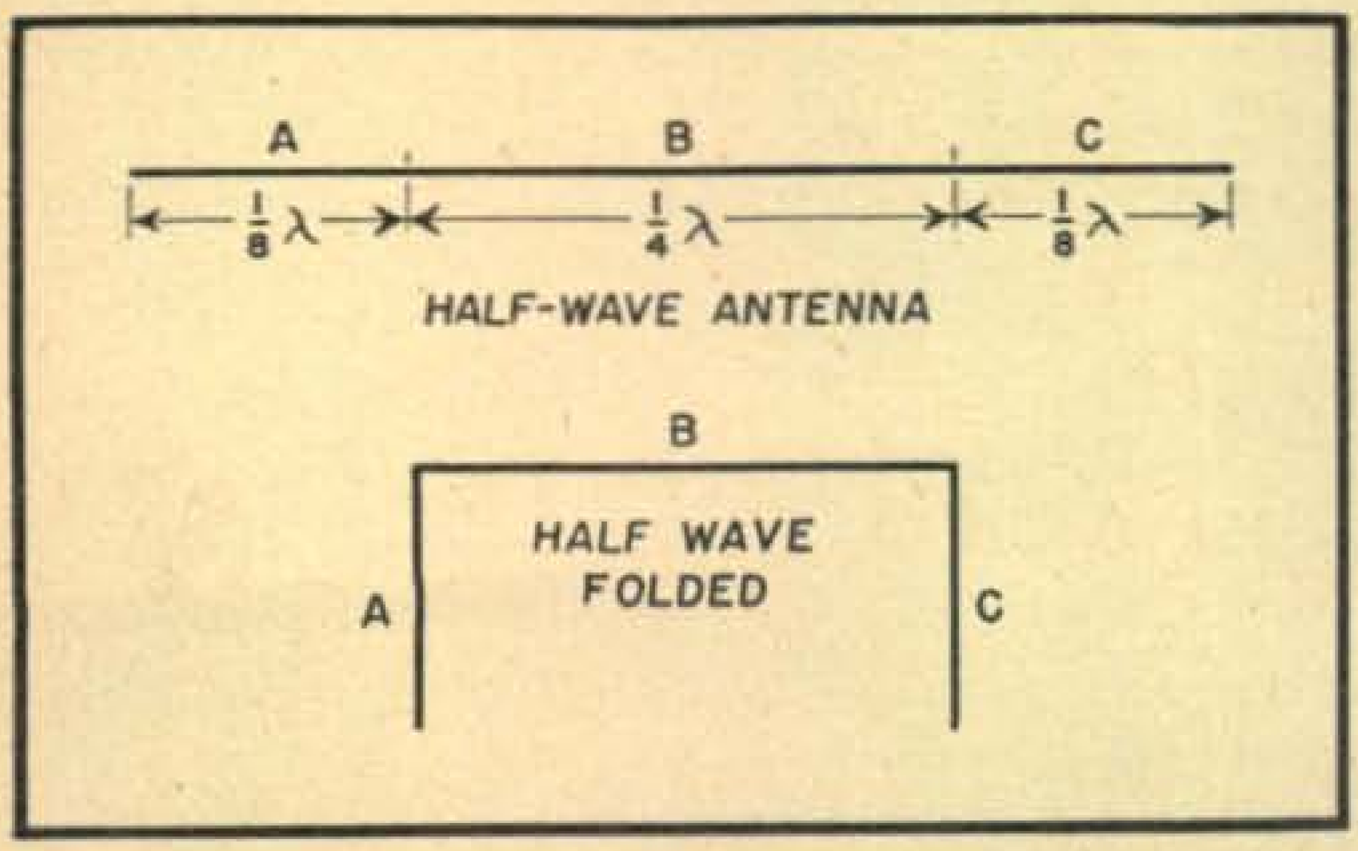

Fig. 1. the half-wave antenna, with the preferred dimensions for folding. Half the horizontal space is saved

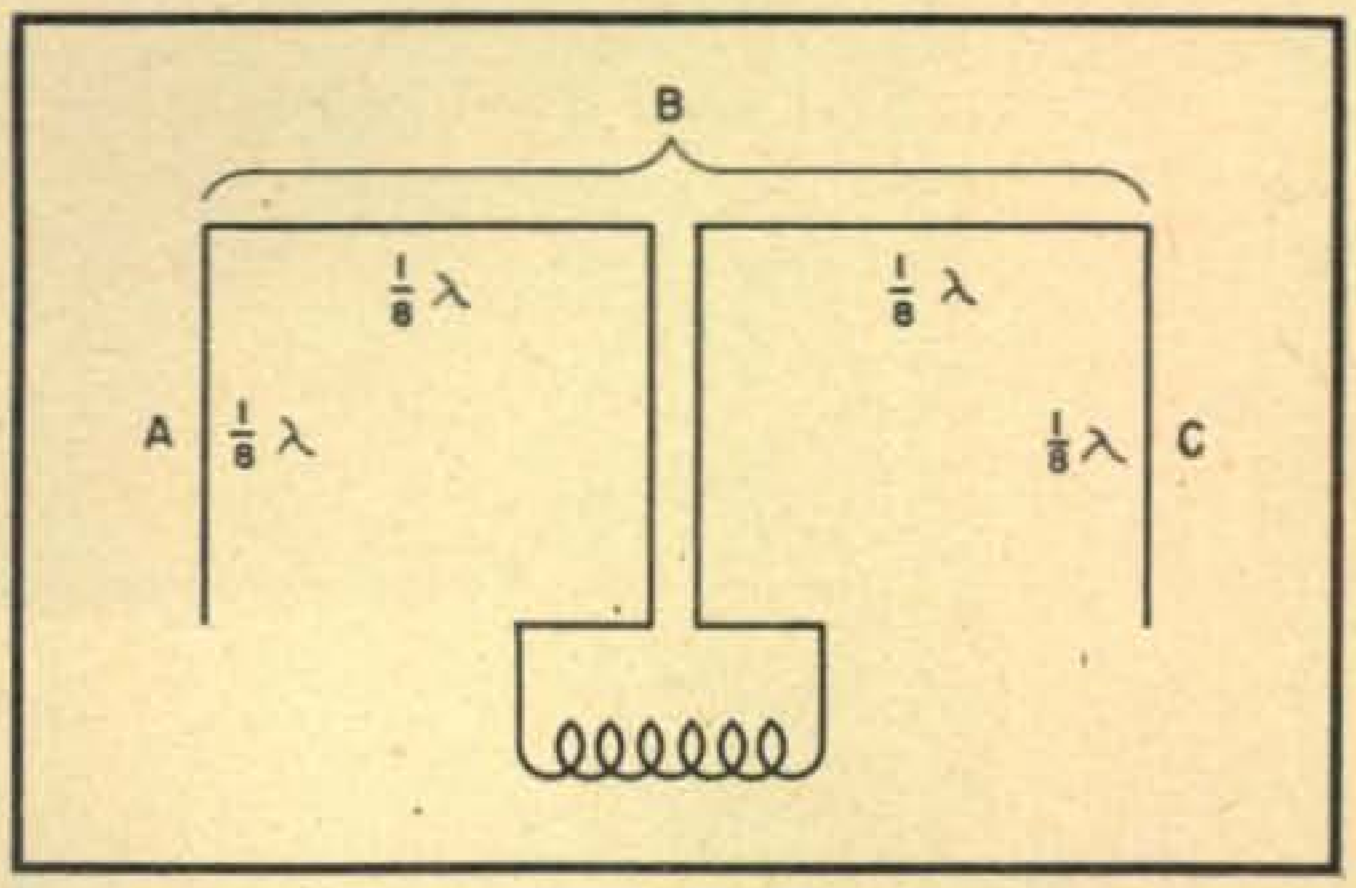

Fig. 2. Current feed to the bent half-wave antenna. Keep the center in the clear

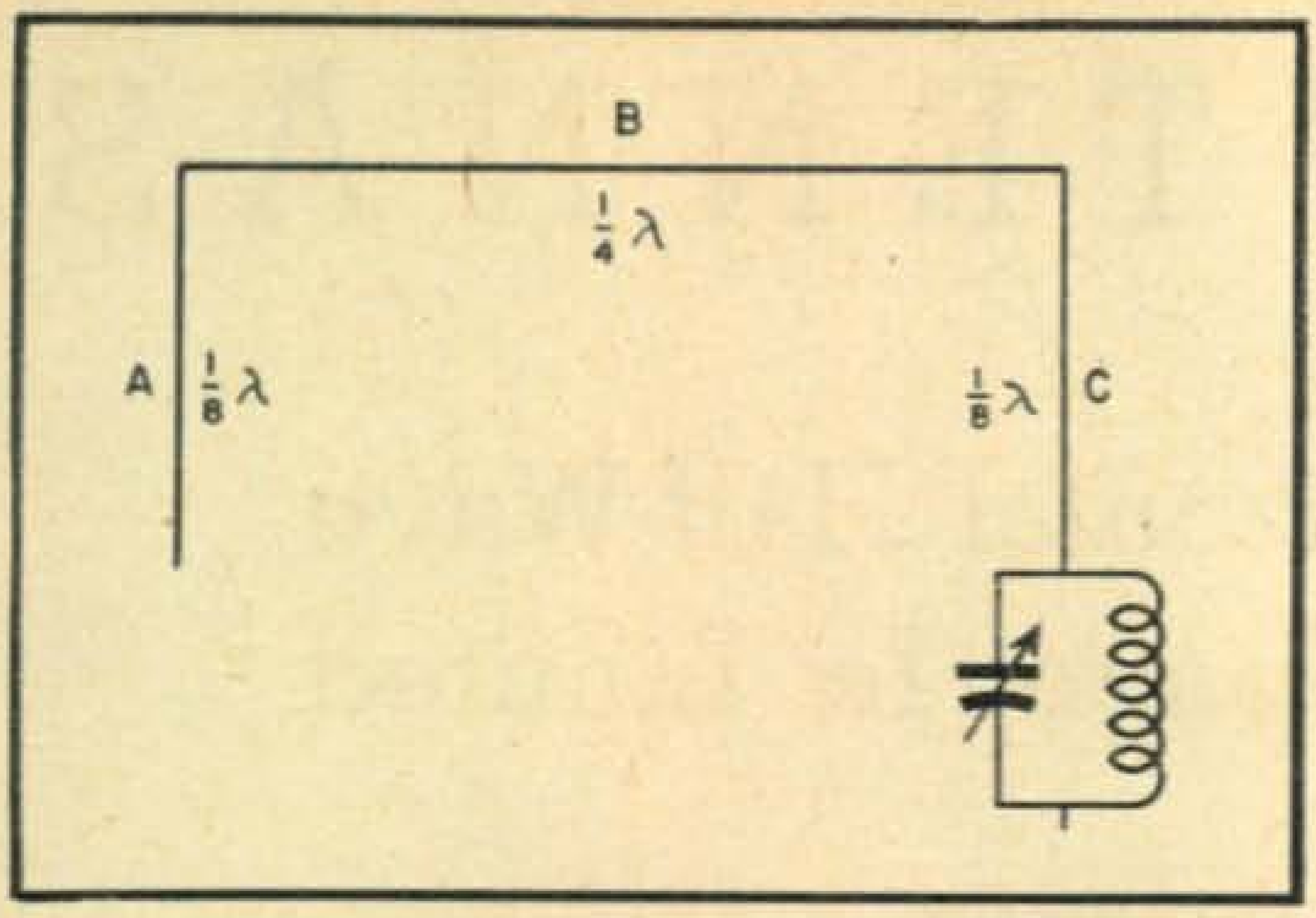

Fig. 3. End or voltage feed can also be employed with the bent antenna

of the half-wave) as much in the clear as possible. Should the point of maximum antenna current be close to surrounding objects, much of the radiation is absorbed and less energy will be available for its intended work.

The Bent Antenna

A half-wave bent antenna can be approximately as efficient as a straight wire and also have about the same radiation pattern. Where space will not permit a straight half-wave wire this is probably the most efficient type of antenna that can be constructed.

Generally, the best method of "folding" the wire is to bend both ends down, leaving the center section straight and horizontal. The bent antenna should be one-half wave long overall with the ends bent down. The folded ends are each one-quarter of the total length (or ⅛ wavelength) leaving the center section a quarter wave (*Fig. 1*). It can be seen that this antenna will only require half the horizontal space of a half-wave straight wire. Since this is a half-wave antenna, maximum current will occur in the center where the wire is straight and horizontal—thus the similarity of radiation patterns of the straight and bent antennas.

The transmitter can be connected to this antenna in any of the conventional methods (*Figs. 2* and *3*.) It may be possible to conserve more space by using end-feed—i.e., connecting the transmitter to one end of the radiator.

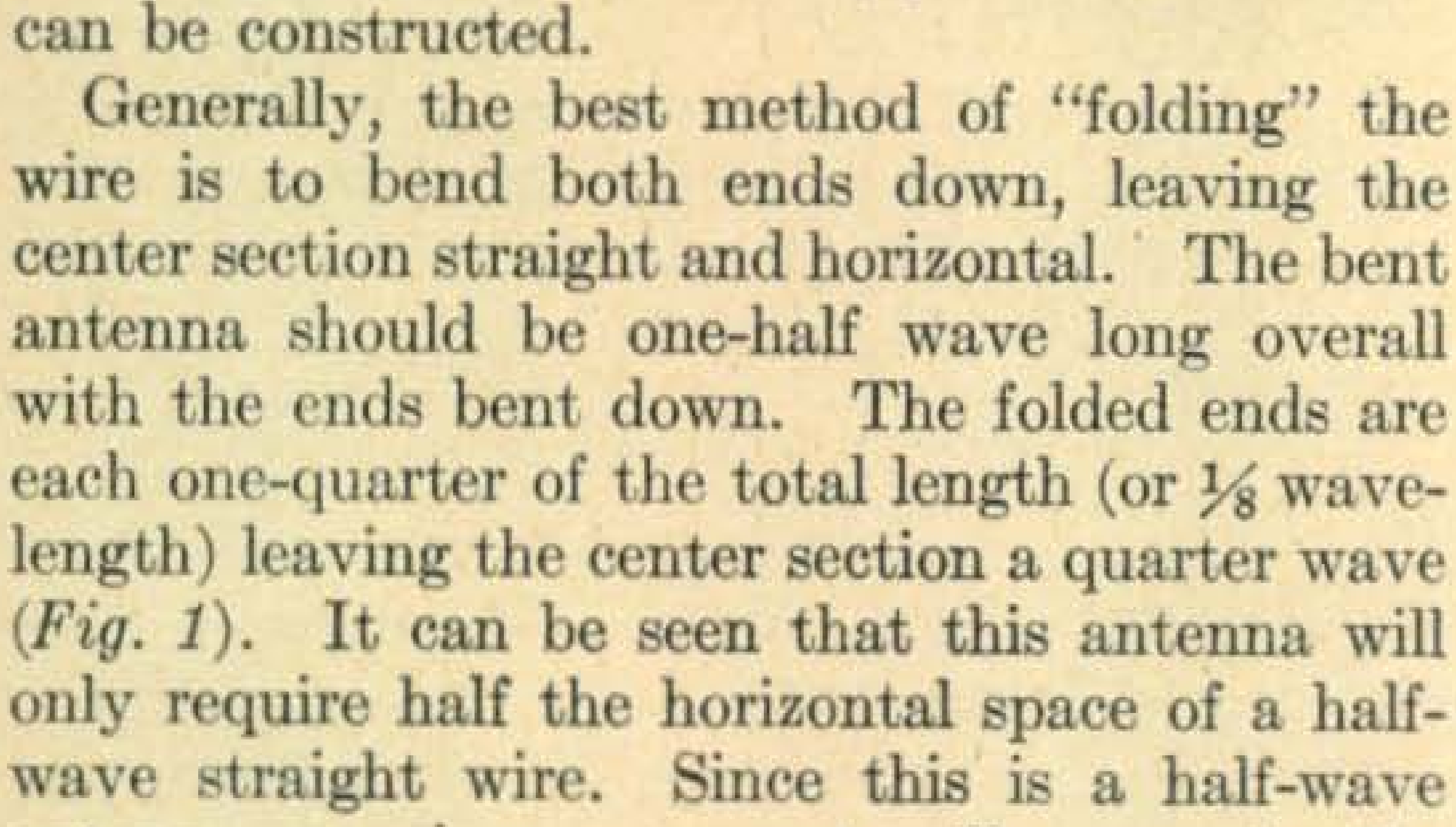

Fig. 4. The folding or bending pattern actually used at station W2HSY—with good results

If the bent antenna suggested will not fit into the available space, then the ends or the whole wire can be folded to conform with conditions. However, the radiation pattern will most likely be different and the efficiency may suffer as well, due to probable cancellation of radiation lobes. But in any case it would be difficult to predict the radiation pattern and only experimentation with any set-up would determine it.

In general, when bending an antenna, keep the center point of the half-wave wire straight and horizontal and as much in the clear as possible. Avoid sharp curves and do not fold the antenna back on itself and run portions of the wire parallel and close together. These precautions should be heeded to prevent field cancellation. The fields around two parallel a-c lines tend to cancel each other. If the half-wave antenna is strung out and then back on itself, this parallel condition will exist with limited radiation. As the two free ends are spread apart, cancellation becomes less and less. In some cases of bending an

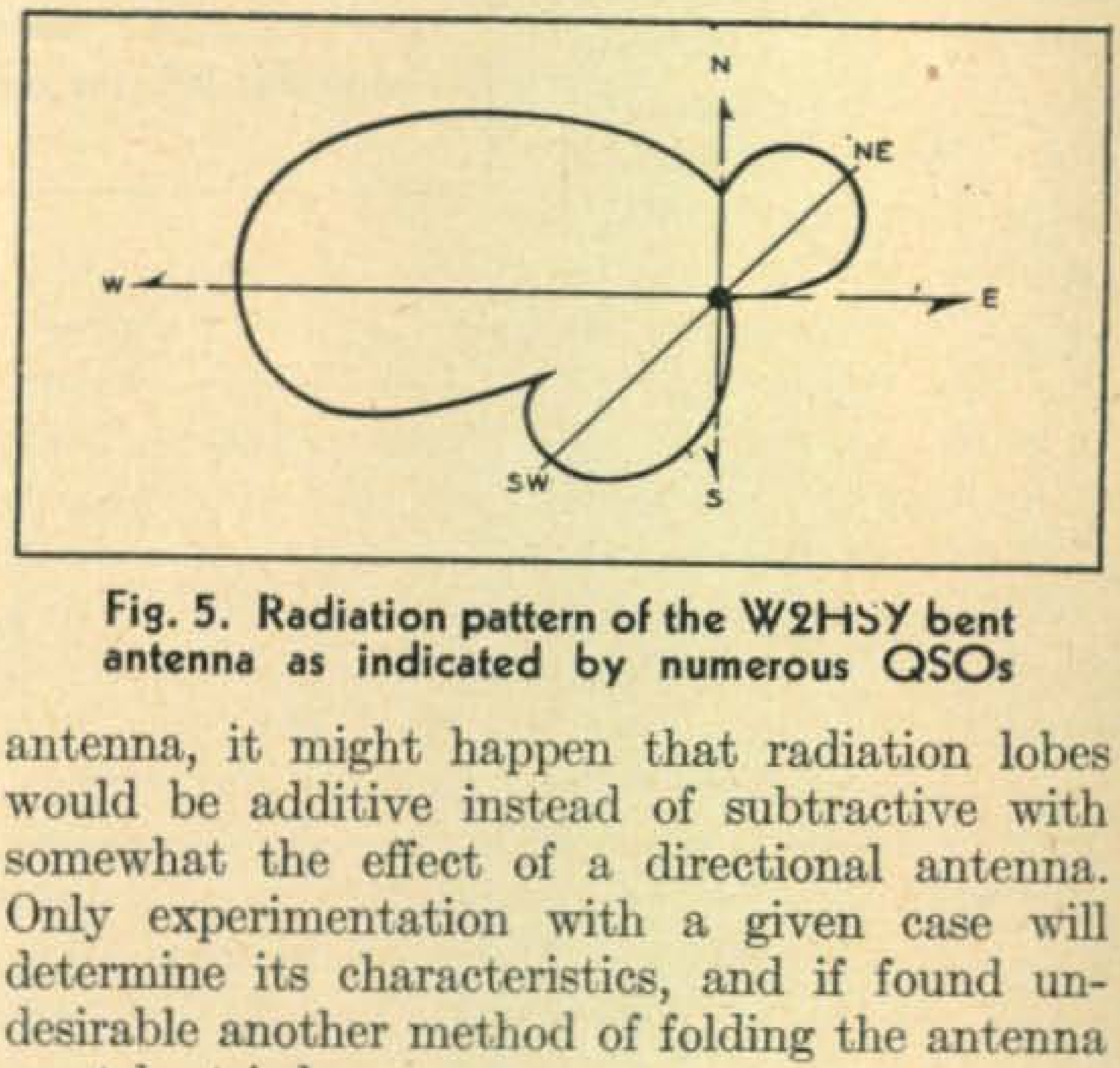

Fig. 5. Radiation pattern of the W2HSY bent antenna as indicated by numerous QSOs

antenna, it might happen that radiation lobes would be additive instead of subtractive with somewhat the effect of a directional antenna. Only experimentation with a given case will determine its characteristics, and if found undesirable another method of folding the antenna must be tried.

Antenna at W2HSY

The writer's interest in bent antennas was the result of living in an apartment where there was not space for a conventional 40 meter half-wave wire in a straight line. Even a Marconi antenna was considered out, due to the ground connection. A 66-foot wire (*Fig. 4*) was finally strung out and with two bends in it to squeeze into the back yard. The antenna was coupled directly to the transmitter, as using feeders would have required additional and unavailable space in this case. The bending was as follows: From transmitter northerly 6 feet to first bend; thence 20 feet westerly to the second bend; and finally 40 feet southwesterly. Nowhere could any literature be found on the behavior of such a radiator—which

[Continued on page 40]

are 1″ x 1″ redwood. The sag, which may be noted in the photos, has no bearing on the performance of the array, but if it were to be used out of doors, it would be a good idea to make the cross-members not less than 2″ x 2″. Larger 2″ x 4″ spreaders, set in an upright position, would be better.

The insulators, for attaching the line between the four elements of the antenna proper, were made from the regular polystyrene spreaders, formerly used for a 600-ohm transmission line. For connection between the elements, number 14 tinned copper wire, spaced two inches and transposed as shown in *Figs. 3* and *4*, was used.

In passing, it may be of interest to note that our particular beam was rotary and that 15 degrees of arc resulted in the signal level dropping from S9 to S7, while a change of 30 degrees reduced it to S6; 45 degrees to S4; 90 degrees, to S3 and 180 degrees to zero.

BENT ANTENNAS

[*Continued from page 23*]

perhaps was part of the fun in trying it. While this antenna was not quite so successful as a conventional half-wave of a local ham who worked more states than I with an identical transmitter, it was certainly better than none (probably superior to a Marconi) and resulted in many enjoyable QSOs.

The radiation pattern plotted in *Fig. 5* gives an idea of how it actually worked out. However, as the Canadians and others were off the air at that time (in 1941) the northerly and easterly lobes may be somewhat smaller than complete field measurements would show.

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