Technical Correspondence

THE "ARMY LOOP"

Technical Editor, *QST:*

Having just read the article "The Army Loop in Ham Communication" in March 1968 *QST*, I would like, speaking as the designer of the "Army Loop," to offer a few comments.

First, I note with regret that the loop tested was not a reasonably accurate electrical duplicate of the Army version. Consequently, the "Tests in Comparison with Other Antenna Types" are of questionable validity. To substantiate this statement I submit the following:

1) At the test frequency, 3980 kHz., the value of C_2 was probably in the order of 450 pf. under matched conditions. This is based upon the fact that a maximum of the capacitor is 500 pf., and good engineering practice would allow a minimum range of about 10 percent above and below the optimum value.

2) Not being absolutely certain in my memory regarding details of work performed three years ago, I have just checked one of our Army antennas, one which has been out in the weather for the past nine months. (I freely concede that in our portable models we have had a problem due to deterioration of contact conduction as a result of exposure to the elements. Consequently, this antenna is not likely to be truly representative of a new one. Nevertheless, it is the only one we presently have left here in Aberdeen so I measured what we have.) My measurement verified what I had suspected. When operating at 3980 kHz. our antenna matches to a 50-ohm line with a value for C_2 of about 2300 pf. This is a very significant differential. Let us look a little closer and see what this does to the performance of the two antennas.

3) Since both of the two loop conductors are of the same size, shape and material they probably have essentially identical inductance values. Consequently, to provide resonance at the same frequency, the two capacitive matching networks must provide very nearly the same total capacitance across the loop terminals. Since in the Army model C_2 is about five times as great as the equivalent in the ARRL version, C_1 (the effective value of C_{1A} and C_{1B} in series) in the Army network is approximately 0.8 times the value of C_1 in the ARRL equivalent. The relationship for the capacitative matching networks

$$\textit{Impedance offered to input} = Z\left(\frac{C_1}{C_1 + C_2}\right)^2$$

where Z is the parallel impedance of the antenna. If we plug into this equation a reasonably realistic value of 200 pf. for C_1 in the ARRL network (giving about 160 pf. for the Army equivalent) we can — since each antenna is matched to a 50-ohm line — readily calculate the impedance of each antenna. This gives about 527 ohms for the ARRL loop and about 13,700 ohms for the Army antenna. Very significantly, the Army antenna has an impedance which is greater than that of the ARRL version by a factor of 26!

4) From the fundamental relationship between the impedance, Q and loss characteristics of parallel-resonant tank circuits (as represented by our loops), we can readily conclude that the Army antenna is less lossy than the ARRL counterpart by the same factor, 26.

5) If we further assume, quite realistically, that both antennas have (at the test frequency) a radiation resistance of 0.1 ohm and, further, that the efficiency of the Army antenna is about 50 percent, we can compute the ARRL antenna to have an efficiency of about 3.7 percent. We may then conclude that the difference between the ARRL loop antenna and the original Army version is (within the limits imposed by the assumptions which have been made) from 11 to 12 db. in favor of the Army version. I am certain that you can visualize the difference which would have been made in the results of your tests if an additional 11 db. of signal had been radiated by the loop.

6) I regret I cannot offer positive suggestions regarding the exact nature and location of the losses in your loop. A good general rule is that *any* mechanical joint in the entire loop is a prime suspect. This includes not only the corners of the octagon but also the connections to the adapting brackets and the feedthrough insulators. Basically, the *sum* of *all* looses must be (and can be) low compared to the radiation resistance, 0.1 ohm.

I also wish to clarify a misunderstanding regarding the mica capacitors used in the Army loop. Contrary to the impression I have erroneously conveyed in the past, these mica capacitors, though certainly of high quality, are not special military components but are ordinary commercial (current rated) components. Incidentally, with the exception of your experience, I am not aware of any overheating in these components.

The final comment I wish to submit is in regard to a statement made in the conclusions. It is stated that the dipole will do as good a job or better, is much cheaper and can be used on all bands. Regarding the first claim, whether the loop or the dipole does the better job depends greatly upon the loop. My experience (45 years) is that if the loop is average in its performance the dipole (60 feet high) will usually outperform the loop. But if the loop is a good one (such as the Army version) this is no longer true. The second part of the statement ("the dipole is much cheaper") is also, I believe, open to question. Just which of the two antennas is cheaper will depend upon the individual user's circumstances. In costing a dipole 60 feet high, such as was used in your tests, I feel that the expense of acquiring at least two poles, each close to 70 feet long, plus rigger's fees must be, for most of us, included in the cost of the dipole. As for being used on "all" bands, I agree. Certainly I do not recommend a single individual loop for use over more than a 2-to-1 frequency range. On the other hand, neither would I advise the use of a single, individual dipole on more than one band. In fact, the very concept and definition of a true dipole limits its use to a single band. However, I recognize, of course, that with appropriate modifications single physical-dipole-type antennas can be made to perform over several bands.

I wish to emphasize that none of the foregoing comments are intended to be critical of the ARRL. The ability of its members to effectively improvise is legend the world over. I only regret that in my previous efforts on loop antennas I have failed to place sufficient emphasis on the absolute necessity of reducing *all* losses, whether they are due to skin resistance or to joint and contact resistances, to an extremely low value. This is the basic concept of the Army's loop antennas. The sum of all losses must be, can be and *is* well below 0.1 ohm.

Since I am confident that the ARRL and *QST* have a keen desire to present the true facts in a straightforward and impartial manner, I am looking forward to a future loop article reporting on a loop which is truly comparable to the Army version. — *Kenneth H. Patterson, Department of the Army, U.S. Army Limited War Laboratory, Aberdeen Proving Ground, Maryland 21105.*

[Editor's note: A new loop using copper pipe, with soldered joints, is under construction for the purpose of making further tests along the lines suggested by Mr. Patterson. Results will be reported in *QST* as soon as possible.]

Technical Editor, *QST:*

Recently, a single-turn loop transmitting antenna developed at the Army's Limited War Laboratory was described by Kenneth Patterson (*Electronics*, Aug. 21, 1967).[1] This antenna was developed for use in Southeast Asia to boost m.f. and h.f. signals out of narrow valleys and heavy forests. Inasmuch as this also describes most recreational camping spots, the antenna should be of interest to hams who like to combine hamming and camping. It is relatively small and can be placed directly on the ground, but requires no ground plane nor ground connection.

To check out the possibilities, an experimental version was whipped up and tested on 80 meters.

The large-diameter conductor required presented a problem until I remembered the ever-handy roll of aluminum foil available at all grocery stores. The foil was crumpled loosely together as it was drawn from the roll to form a rope-like conductor 2 or 3 inches in diameter and about 30 feet long. The resulting conductor when strung up has surprisingly good wind resistance.

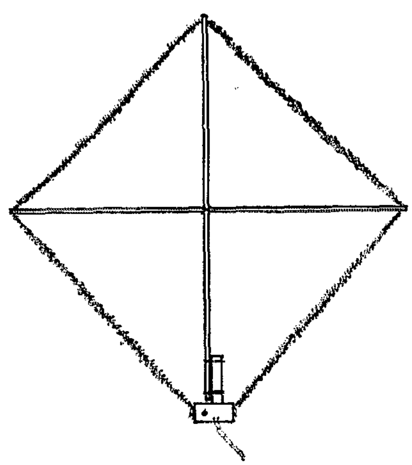

Fig. 1

Two 10-foot pieces of bamboo rod were lashed together to form a cross as shown in Fig. 1. The middle of the aluminum "rope" was secured to the top of the bamboo cross with a loosely-tied loop of twine. The halves were tied out to the ends of the crosspiece. The whole assembly was then raised to a vertical position and the bottom of the upright member lashed to a convenient post in the back yard.

The tuner, mounted in an aluminum box, was set on the ground at the base of the cross. The two loose ends of the conductor were drawn in and clipped to the tuner as shown in Fig. 2. The diamond-shaped loop thus formed is roughly 7 feet on a side. The tuner was fed with 300-ohm TV lead laid on the ground and into the shack.

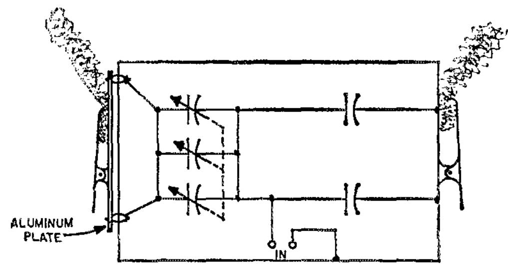

Fig. 2

The loop resonating capacitor is a three-gang receiving type with paralleled sections totalling about 1100 pf. It was found by trial that 0.003 μf. is about the right value for the matching capacitor on 80 meters. To reduce resistance it was made up of two 0.0015-μf. transmitting micas, the kind with heavy lug terminals, that were in the junk box. Ideally, the matching capacitor should be a series of switch-selected units to permit closer matching of the feed line as in the Army version, but a low-resistance, high-current switch was not at hand.

Internal connections were made with lengths of copper braid. The loop connectors were made of wide spring clips taken from dime-store note boards. The ends of the aluminum conductor were simply slipped under the clips, which then held them in tight contact with the end of the box on one end and to the insulated aluminum contact plate on the other end. Excess conductor length was simply torn off and discarded.

The experimental loop and tuner were driven by a transmitter having an input of 12 watts. Tune-up was done by adjusting the pi-net output capacitor until some loading was indicated, then tuning the loop to resonance as indicated by a neon bulb held on the insulated end plate, after which the pi network was adjusted for normal plate current.

In a week of intermittent operation, during midday hours only to avoid QRM, several contacts up to a maximum of 90 miles were made. All reports were R5, S7-9. As an experiment, the loop was shortened to 3 feet on a side during the 90-mile contact. The report dropped to R5, S3. For comparison, a random wire about 40 feet long and 8 to 10 feet high could not be heard.

Results were good enough to indicate this may be a quick and convenient antenna for many temporary operating locations. Ingenuity and a roll of fishing line will suggest many other ways of stringing up the aluminum foil. Inasmuch as the only high-voltage point is at the insulated connection plate, you don't have to be too careful about insulating the loop support points. When you are done, the aluminum foil can be discarded (in a proper refuse container, of course). — *S. A. Sullivan, W6WXU, 20505 Fifth St. East, Sonoma, California 95476.*

[1] See March 1968 *QST* for a report on this antenna.