Bet My Money on a Bobtail Beam

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Let's revive 40-meter DX. A good antenna is a big help. Here is a simple one that really does a job.

WHAT WITH THE HIGH average MUF the last couple of years, most of the DX work has been confined to the 10 and 20-meter bands. And the 40-meter band (except during the DX contest) has more or less fallen into the discard for such work. A listen on 40 will show that most of the current activity on this band is confined to medium haul traffic handling and rag-chewing.

In view of the fact that 40 *can* be used for real DX work a good portion of the time even during a year of high sunspot activity and high average MUF, the current lack of popularity of this band for DX work probably can be explained by the fact that a "DX" antenna is much more readily constructed for 20 and 10 than for 40 meters. A 40-meter three-element rotary array a wavelength up in the air undoubtedly would produce wonderful results on DX, but physically such an array is not practical for amateur work. On 20 and 10 such arrays are commonplace.

A listen on one of the rhombic arrays of W6GRL a short time ago convinced the writer that there is plenty of "stuff" to be worked with ease nowadays on 40, *if* one has a good "DX" antenna. Even with something short of a well designed rhombus there is a lot of stuff to be worked if one has a little patience and is willing to grub for it. However, the better the antenna, the easier it is to work. This is true of any band, of course, but it is especially true of 40. Oftentimes the signal is "getting there" or "coming through" on 40, but is just a little too weak, and hides down in the background noise.

It is the writer's belief that we had better start taking full advantage of the DX potentialities of 40, or otherwise at the next world conference our adversaries undoubtedly will uncork the argument that the U. S. amateurs don't use 40 meters for DX anyway, and that all of the boys on 40 could just as well move up into some of the holes on 80.

And while on the subject of our propaganda pushing protagonists, the best way to make use of the shared portion of the band after the fateful day (or before then if they should jump the gun) is to run as much legal power as one can afford and feed it into the best array one is in a position to put up.

7-Mc Propagation; a Recap

Forty shows up to best advantage for DX when the wave path is all or nearly all in darkness. Under these conditions the 7-mc absorption on "undisturbed" days is not much greater than when a frequency near the MUF is used, even though the MUF may be as high as 18 or 20 mc. This of course does not apply when a substantial part of the path between the two 1250 mile "control points" is not in darkness. In the latter case there will be a rapid increase in absorption as the frequency is lowered below the MUF. However, this is a less serious limitation than is imposed by the vagaries of the MUF with respect to the currently popular 28-mc band, the latter ordinarily being useful for DX only when there is daylight between the 1250 mile control points (even during a period of high sunspot activity).

Strictly speaking, "daylight" at a control point must be considered as occurring from roughly 1 to 3 hours after sunrise until roughly zero to 3 hours after sunset, because of the variable "lag" in the ionization density of the F_2 layer with respect to the intensity of the sun's rays. Also, the effect of the presence of the E layer must be considered. But

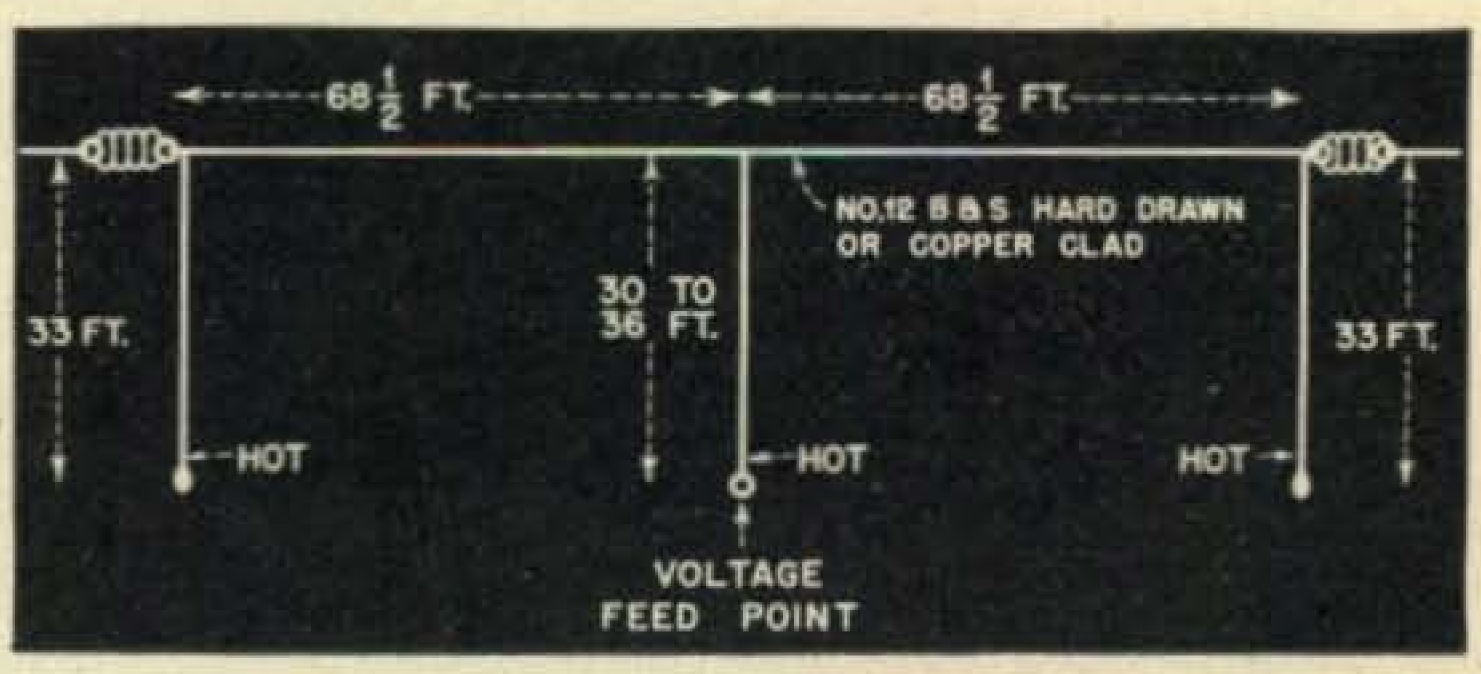

Fig. 1. Schematic of the "Bobtail" bi-directional broadside curtain for the 7-mc band. In spite of its simplicity, it really does a job on DX. For 75-meter phone, just multiply the dimensions by 1.82 (provided you have the room and can get a couple of 70-ft. sticks).

the foregoing gives a good idea of the general considerations involved.

The really important thing to remember in working DX on 40, assuming that the receiver has sufficient selectivity to pull the DX out from under the skirts of the omnipresent domestic "bone crushers," is that *the antenna must be a low angle job*. Most of the radiation and response should be confined to angles below 15 or 20 degrees.

While a higher angle can be used more successfully on 40 than on 20 and 10, the *optimum* angle for distances beyond 2500 miles generally is below 15 degrees, and at times may be as low as 5 degrees. This statement must be qualified in order to be strictly accurate, because when the atmospheric noise level is high as a result of static originating at great distances (usually the tropics), a somewhat higher wave angle may be just as effective or even

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more so. This is explained by the fact that under certain conditions a receiving antenna which has poor response at very low angles will discriminate strongly against such static. And if the receiving antenna has poor response at very low angles, the most effective angle of radiation at the other end of the circuit will be somewhat higher than would be the case for identical antennas at both ends of the circuit.

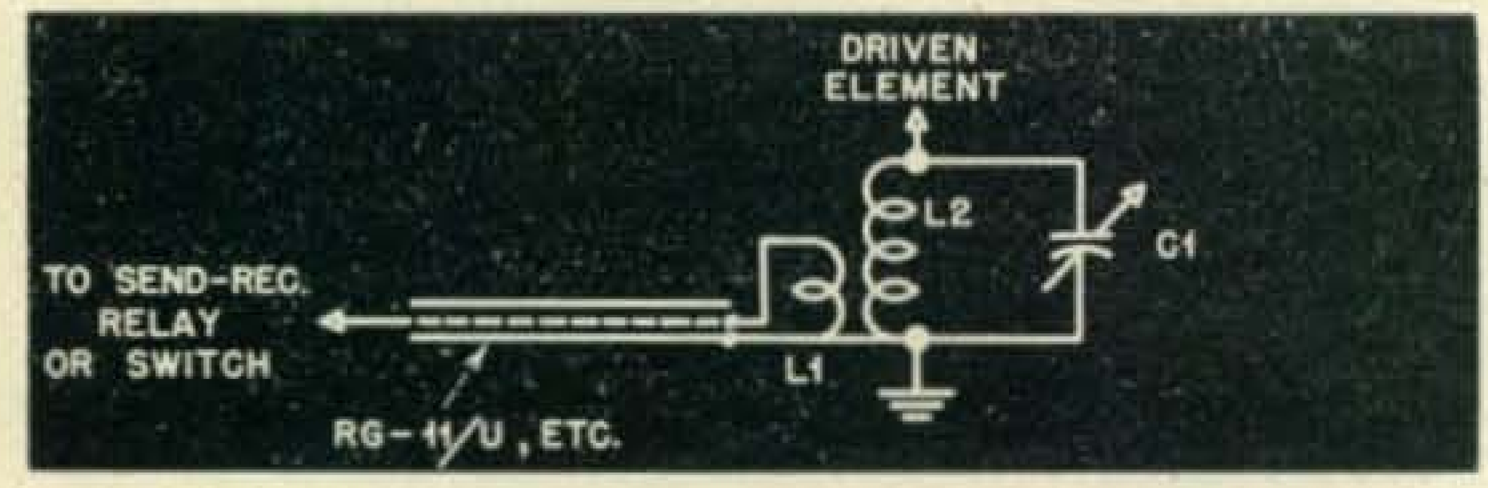

Fig. 2. Recommended feed method for the Bobtail curtain. This arrangement discriminates strongly against harmonics and keeps the "hot" lower end of the driven element away from the transmitter. The antenna tank circuit is described in the text.

But considering day in and day out performance, a "low angle" antenna at both ends of the circuit will provide the best signal over a DX path.

Remember the "30—30"?

This was brought home to the writer quite forcefully back in 1928, when a "30 up and 30 out" or "30–30" was taken down and a horizontal Zepp about 40 feet off the ground substituted. For the benefit of those comparatively new to the fold, a "30 up and 30 out" consisted of a 30 foot (or slightly longer) vertical radiator worked against a 30 foot (or slightly shorter) horizontal counterpoise, the latter usually suspended only a few feet off the ground. The vertical element often was terminated with a copper toilet ball, which was supposed by the more superstitious to possess some magical DX raising powers. The antenna resembled a directly-fed Brown ground plane antenna, placed low to the ground, but with only one lone radial (see *Fig. 3*).

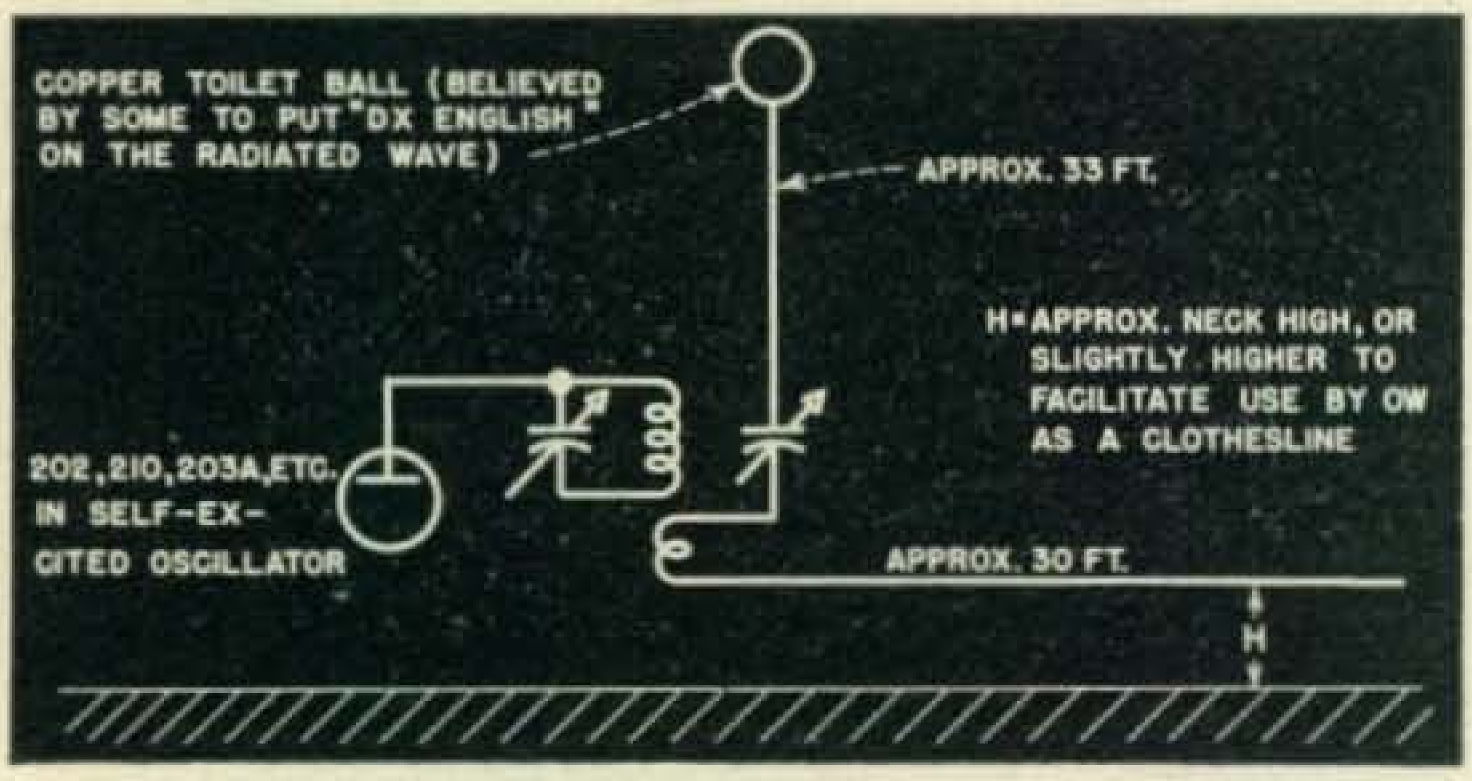

Fig. 3. Newcomers are cautioned not to snicker at this rather unpretentious 40-meter antenna. Widely popular in an era fondly referred to by old-timers as the "good old days," it was responsible for numerous 40-meter W.A.C. certificates. The "Bobtail" of Fig. 1 is about two "S" points better.

This one-leg radial system undoubtedly had an appreciable effect upon the horizontal pattern, but the antenna had the reputation of being a pretty good DX performer in all directions, the horizontal directivity not being sufficient to prevent working "stuff" over the entire 360 degrees. In fact, it was fairly common to work the world with such an antenna on 40, using nothing larger than a 210 or a venerable "five watter" running with from 25 to 50 watts input in a self-excited oscillator.

The writer's version of this old time favorite antenna (complete with toilet ball; he wasn't taking any chances) did a pretty good job of snagging some fairly good DX on 40 from a location that was nothing to brag about. In fact, the results were good enough that the reason for switching to a horizontal Zepp is beyond memory. But anyhow, after the Zepp was put up, DX was called unsuccessfully for nearly a month. Finally an Aussie (ordinarily duck soup on the 30–30) was raised and a very unflattering report received.

Yes, the Zepp was tuned up properly, because daylight reports from stations out to about 250 miles were from two to five 1928 "R" points (or 1948 "S" points) better than with the 30–30. Also, the results with the horizontal Zepp on DX were typical of those experienced by other amateurs not blessed with an elevated location or a pair of 70 or 80-foot sticks.

Briefly, it boils down to this: For the most *consistent* DX work on 40 meters, a "low angle" antenna is required. And the only way to achieve a low angle with modest pole heights and ground space is to use vertical polarization. A further increase in gain can be realized by utilizing an array of vertical elements, in order to provide some horizontal directivity.

The "Bobtail" Curtain

A highly effective array for 40-meter DX work, one which requires only a moderate amount of ground space and two poles of modest height, is illustrated in *Fig. 1*. Excellent results will be obtained with pole heights as low as 40 feet, though a few more feet of height is desirable in order to protect against accidental contact with the "hot" lower ends of the two outside elements. The ground space required for this simple array is approximately the same as for a horizontal half-wave radiator on 80, and while prohibitive for the amateur confined to a small city lot, should offer no problem to the amateur who has access to one or more adjacent lots or else lives in the suburbs or in the country.

The effective elements, so far as radiation and response are concerned, are the three vertical quarter-wave elements. Therefore the line of the bidirectional beam is at *right angles* to the flat top. The current relationships in the flat top sections are such that the radiation and response are pretty well cancelled. The cancellation in the flat top is not perfect, however, and while the radiation and response are not great enough to produce a significant reduction in gain, they do deteriorate the discrimination slightly. However, this is not serious, and is a cheap price to pay for such simplicity of construction.

The current in the center radiating element is considerably greater than that carried by each of the two outside radiating elements. This reduces the gain and directivity slightly from that which would be obtained with all three vertical elements fed equal currents. However, the reduction is very slight, and the "tapered" current distribution helps minimize radiation and response along the direction of the flat top.

Performance

The beam width at the half power points is approximately 60 degrees, and the *directivity* power gain over 1 element is approximately 5 db. Thus the beam width is great enough to cover a lot of DX territory (an important item when a single, fixed array is employed), yet the power gain due to the horizontal directivity is quite worth while, being equivalent to an increase in power of nearly four times. In connection with the latter, it should be noted that the practical DX signal gain will be substantially *greater* than 5 db over a conventional ground plane antenna utilizing the same pole height of 40 to 45 feet, because in the Bobtail curtain the current loop in each radiating element occurs at the *top* of the element, rather than at the bottom. This increases the vertical directivity somewhat over that obtained with the ground plane job. There also are other advantages to having the current loop at the top rather than at the bottom of the vertical elements, but suffice it to say the net result is to make the practical DX signal gain over a ground plane antenna still more pronounced. And as mentioned before a 40-meter ground plane vertical (which may be considered a more highly engineered, symmetrical version of the old reliable 30-30) is nothing to be sneezed at when it comes to performance on DX.

Three or four feet of sag can be tolerated at the center of the flat top. This allows the lower end of the outside elements to be elevated at least 8 feet above ground (thus precluding the likelihood of accidental contact) while still permitting some useful leeway in the location of the feed point (the lower end of the center section). The leeway is made greater by the fact that the length of the center section is not especially critical, and by the fact that it need not be exactly vertical. Thus, if the transmitter or at least part of the operating room can be located approximately under the center of the flat top, feeding the array should offer no problem.

The impedance is high at the lower end of each of the three elements. Therefore good insulation should be employed at these points in order to avoid losses, and in the case of high power to avoid flashover. This is especially true of the center element, where it is brought into the operating room. Only a good quality lead-in insulator should be employed, and if the power is high the leakage path should be at least three inches.

The dimensions of the array are not extremely critical, and good results usually will be obtained over the 7000–7300 kc. range with the dimensions designated in *Fig. 1*. However, variations in the shunt capacity of the two outside lower insulators and the unpredictable effect of nearby surrounding wires and buildings may make it desirable to optimize the dimensions with the aid of a field strength meter. The latter should be placed along the line of

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Solar Static Investigation

The limiting factor in v-h-f reception can be the background hiss of the receiver. In the daytime a basic component of this hiss is solar static. With the better design of receivers the problem of solar noise becomes increasingly important. To study the intensity variations of the frequency range, a new project has been announced by the National Bureau of Standards propagation laboratory.

Two giant wartime radar antennas are being installed at the laboratory's station in Sterling, Va. These radar dishes will intercept the solar radiation and feed it into ultra-sensitive 480-megacycle receivers where intensity records will be made. The basket-type reflectors are about 25 feet in diameter and will automatically track with the sun throughout the daylight hours. At frequent intervals the reflector is oscillated about an axis through the ends of the supporting arms to correct for the north-south migration of the sun.

Solar static exists in two different forms. One is the type to be recorded particularly by the National Bureau of Standards, the other is the sudden bursts often associated with radio fadeouts. The latter ones sometimes pass through the radio spectrum in the form of a "puffing" sound or a "swish" lasting for one or two seconds. During great sunspot activity it is believed that the "swishes" occur so frequently that they overlap and give rise to the "grinder" which is a type of static well known to many of the old-timers. The combination of both of these forms of solar static will limit FM and television reception in the rural areas, not to mention 6 and 2-meter ground wave work in the daytime

The parabolic reflector from a German Giant Wurzburg being used to catch solar static.

ment shows in the lead photo. The control Selsyn is mounted in a convenient spot on the operating desk. It is very desirable to remove the a-c voltage from both Selsyn motors except when changing frequency. When this is done, however, it becomes necessary to prevent movement of the control wheel which would otherwise be free to turn and get out of synchronism with the driving motor in the v-f-o unit. Probably each constructor will have his own ideas as how best to accomplish this. In our unit a mechanical brake inside of the control box is used. The details of this brake are shown in *Fig. 7*.

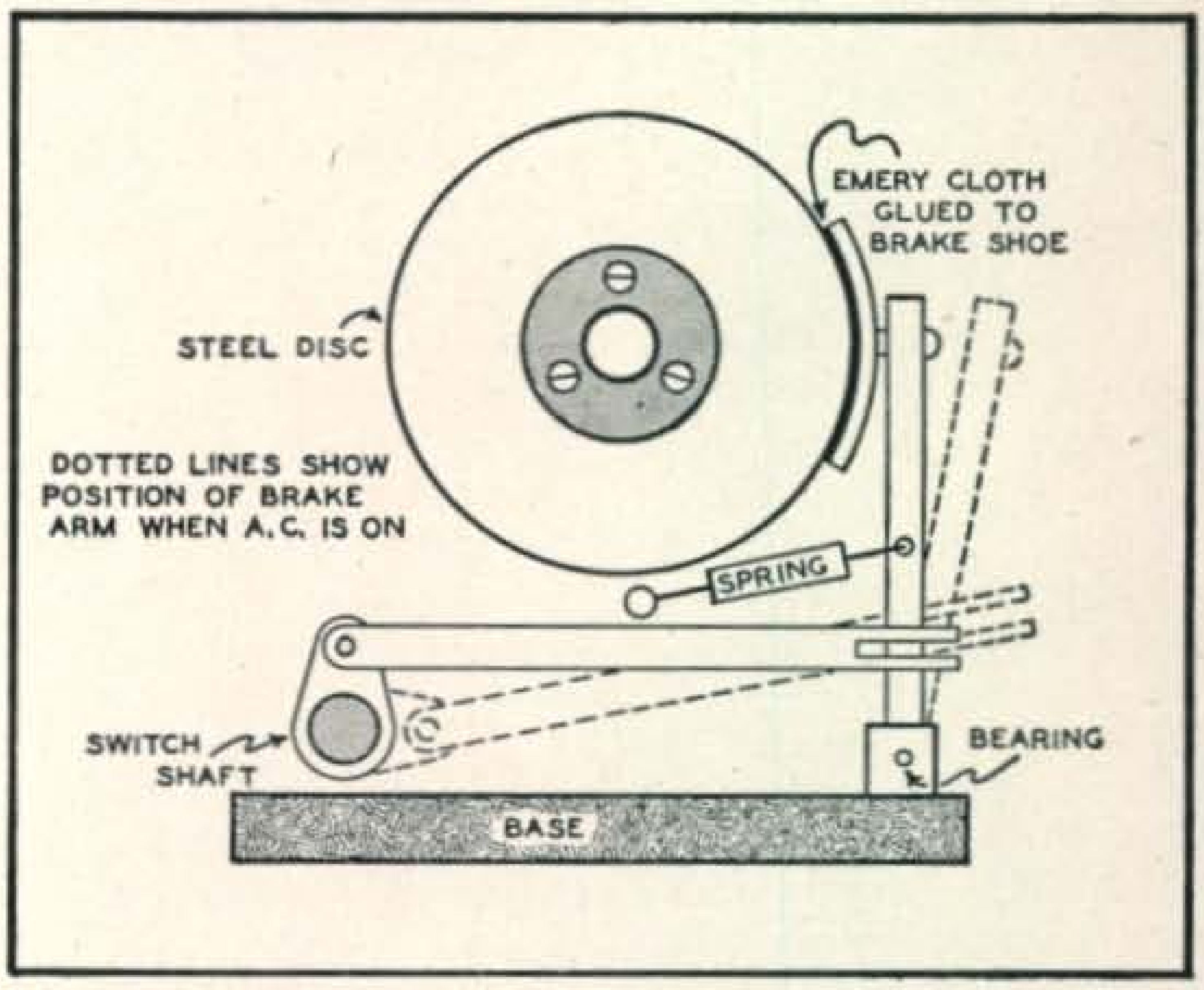

Fig. 7. Detail of the Selsyn brake at the operating position.

The brake consists of a ¼" thick steel disc about 2½" in diameter. This is attached to the shaft of the transmitting Selsyn. A brake shoe is actuated by a small crank and rod assembly fitted to the shaft of the a-c power switch. Turning on the a-c voltage lifts the brake shoe from the steel disc allowing the Selsyn shaft to be rotated freely. Turning off the a-c power releases the brake shoe which is pulled down on the disc by the coil spring. Several alternative methods might be used, according to the initiative and the facilities at hand. Among these is an external clamp to the control knob, or a solenoid operated brake shoe wired in parallel with the Selsyn rotors and the a-c power switch.

While this is certainly not the simplest type of "crystal substitute" by any means, the results obtained seem to have justified the work of building it. The signal is always extremely stable and has never failed to get a T9X report with no trace of chirp or click.

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maximum radiation at the greatest practicable distance (and in no case closer than one wavelength).

The array can be "pruned" to frequency simply by altering the length of the two outside vertical elements, as it is possible to compensate for other dimension errors (over a limited frequency range) by adjusting just these two elements. The two should be trimmed together, so that they always are of the same length. However, as noted above, good results will be obtained in almost every case if the array simply is cut to the specified dimensions and left alone.

Feed Methods

The simplest method of feed is to locate the array so as to permit bringing the feed point (the lower end of the center vertical element) right in to the transmitter, and then voltage feed it by means of a suitable Pi or L network. For best suppression of harmonics and other spurious radiations, however, the arrangement of *Fig. 2* is recommended. It also is preferable if one has hopes of getting on phone, as it keeps the "hot stuff" well away from the transmitter, a necessity on phone if high power and a high-gain speech amplifier are employed.

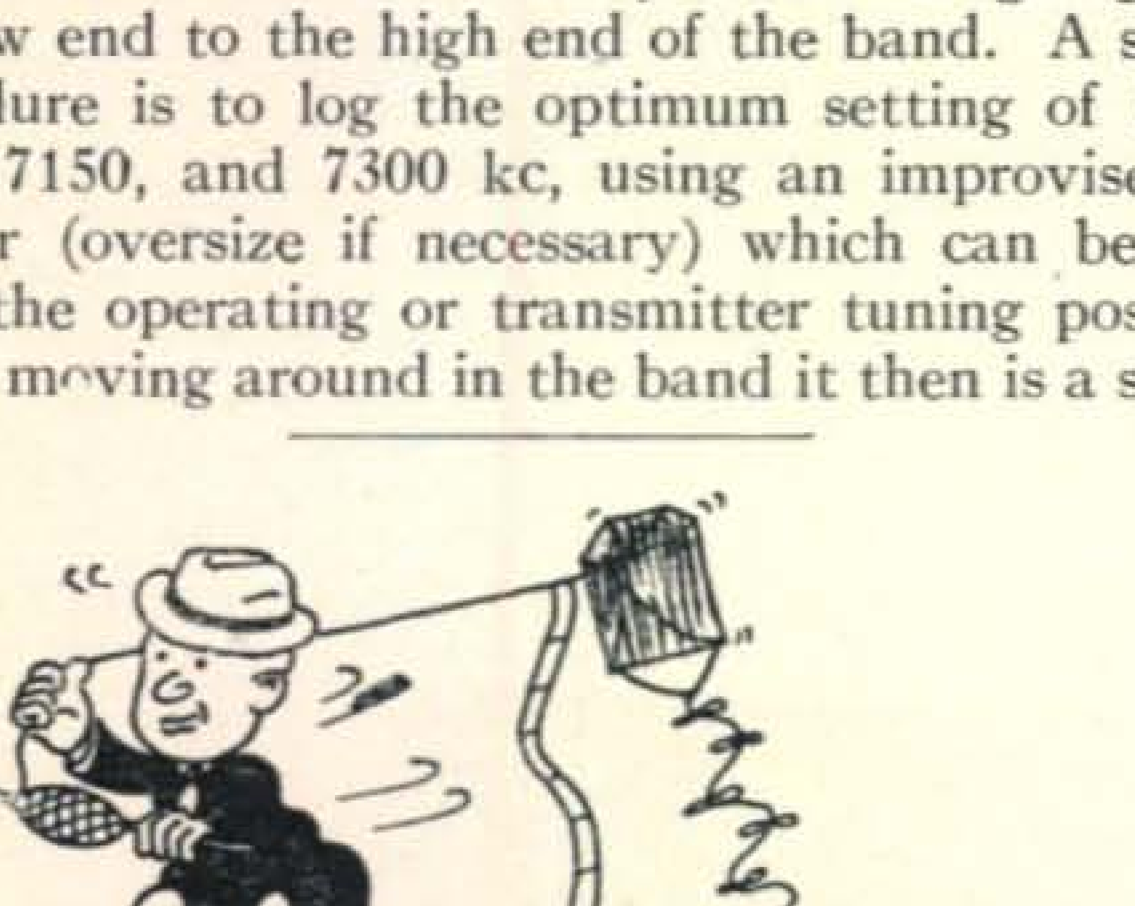
This arrangement also is recommended if a 36-foot center element will not reach the transmitter, as the coax can be any reasonable length and the antenna tank therefore placed anywhere in the room (or even elsewhere, though this makes it awkward when the antenna tank must be retuned).

Seventy-ohm coax is slightly preferable to 50 ohm, as its use cuts down the impedance transformation ratio a bit and makes it easier to obtain the proper loading with good efficiency. However, either type is satisfactory.

Condenser $C1$ should have a maximum capacity of about .00025 μf, and the inductance of $L2$ should be such that $C1$ resonates with the plates nearly all the way meshed. If the tank is made too low C, it will be difficult or impossible to load the coaxial line properly, regardless of the number of turns on $L1$. The minimum safe spacing for $C1$ can be determined by taking the square root of the maximum *peak output* power in watts and multiplying by 10. The answer is in thousandths of an inch.

The number of turns in $L1$, and the coupling between $L1$ and $L2$, should be adjusted so that when $C1$ is resonated the load on the coaxial line is approximately equal to the surge impedance of the line. All further loading adjustments are made by varying the coupling at the transmitter end of the line. In this manner the coax is operated under substantially "flat line" conditions.

A large portion of the band can be covered with one setting of $C1$. However, for proper operation the condenser should be readjusted when going from the low end to the high end of the band. A simple procedure is to log the optimum setting of $C1$ at 7000, 7150, and 7300 kc, using an improvised indicator (oversize if necessary) which can be read from the operating or transmitter tuning position. When moving around in the band it then is a simple



matter to note whether *C1* should be touched up, and if so to optimize it without "fishing around" for the correct setting.

The ground connection for the antenna tank coil need not have low resistance, and need not be especially short, as the current flowing in the ground lead is comparatively low and a moderate amount of reactance in the ground connection can be tolerated. The reactance can be minimized by using a heavy conductor for the ground lead.

If the coaxial line from antenna tank to the transmitter is not over about 10 feet long, no ground connection on the antenna tank is required. Grounding the outer conductor of the coax to the transmitter frame and to the bottom of *L1* usually will suffice. A simple check on the adequacy of the ground arrangement can be made by testing the bottom of *L1* for "fire." When the system is working properly, the bottom of the antenna tank will be "stone cold" with respect to r-f voltage.

It should be emphasized that when using coaxial line and a common antenna system for both transmission and reception, only the center conductor need be switched, all outer conductors being common. If the relay is of the double pole type, the contacts can be paralleled to increase the power handling capability.

Of possible interest to amateurs short on ground space for antennas is the fact that a 40-meter Bobtail does a creditable job as a *general coverage* antenna on both 20 and 80. On either 20 or 80 the antenna will perform better in some directions than others, but nevertheless will put out a usable signal over most of the compass. The antenna tank constants must be altered, of course, to hit 20 or 80. If the antenna is to be used on 80, a .0005 variable is recommended at *C1*. The L/C ratio should be about the same on 20 and 80 as that recommended for 40-meter operation.

75-Meter Adaptation

The Bobtail also will do an excellent job of laying down a DX signal on 75-meter phone if cut for fundamental operation on that band, though the required ground space and pole height makes it prohibitive for many amateurs. The dimensions for 75-meter operation can be determined by multiplying those of *Fig. 1* by a factor of 1.82. An antenna of this type at each end of the circuit, in conjunction with a moderate amount of transmitter power, makes transcontinental 75-meter QSOs a possibility if not actually a probability almost the year around, provided the operator is adept at dodging QRM from stations in the same area, or else stays up till they have given up and gone to bed.

The One Fly

It is only fair when expounding the merits of an array to mention also the shortcomings and disadvantages. The one fly in the ointment as far as the Bobtail is concerned is the fact that its vertical polarization makes it a "stinker" from the BCI standpoint. So unless you have an isolated location, you can expect to get a few calls. The method of disposing of these to the satisfaction of all concerned will be left to your own ingenuity. The author has found that unless one can talk fast, disarmingly, and convincingly, the best bet is a batch of wave traps and line filters all made up and ready to install.