A New Approach To The ZL Special

BY E. M. WAGNER*, G3BID

The mechanical problems that faced the builder of a ZL Special frequently stopped the project cold. G3BID's approach eliminates the problems and permits this unusual antenna to be built "plumbers delight" style.

THE ZL Special has been in existence for a long time but it has never been very widely used. This is probably due to certain difficulties which arise in its practical construction. In effect the ZL Special is a two element beam in which the elements are fed 135° out of phase. This is achieved by placing the two elements ⅛ of a wave length apart and feeding them through a delay line of ⅛ of a wave length which has 180° twist in it. This feeds them 180° out of phase minus the 45° delay imposed by the delay line.

The Problem

Certain practical difficulties arise. The spacing of the elements being ⅛ of a wave length they would have to be connected together by a delay line with a velocity ratio of unity. As no such cable exists, the delay line—an electrical ⅛ of a wave length long—is physically shorter than the ⅛ of a wave length in free space which separates the two elements and, therefore, it doesn't reach.

Various compromises have been used. The simplest and least effective is to use a delay line which is slightly too long in order that it should reach between the two elements. This normally does not give the correct phase relationship.

The other method used is to make the elements folded dipoles and increase the spacing between the two conductors of each folded dipole so that if they are placed in the horizontal plane with the split portions nearest each other, the distance between these two feed points is appreciably less than ⅛ of a wave length. Thus the feed line of the correct *electrical* length will reach. The spacing between the two conductors of each element is arranged so that the *center line* is still ⅛ of a wave length apart in free space.

This means that the beam must be constructed of wires supported on insulators on a wooden framework. This causes the ZL Special to be a clumsy device compared to other rotary beams and may well account for its lack of popularity in the past, particularly as its performance, electrically, is extremely satisfactory. It provides a gain of 7 db and, in my experience, is a very much better beam than any other two-element type and approaches the performance of a three-element beam.

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The Cure

It is possible to overcome this difficulty in the following way. The two elements can be made of aluminum or duraluminum tubing as in any ordinary plumber's delight beam. The split portion or feed points hang vertically underneath the solid portion which can be mounted solidly on the boom in plumber's delight fashion.

The delay line is then connected between the two elements as shown in fig. 1. As explained above, the delay line will now be too long electrically if the array is fed at one end. However, a feed point can be chosen so that the distance

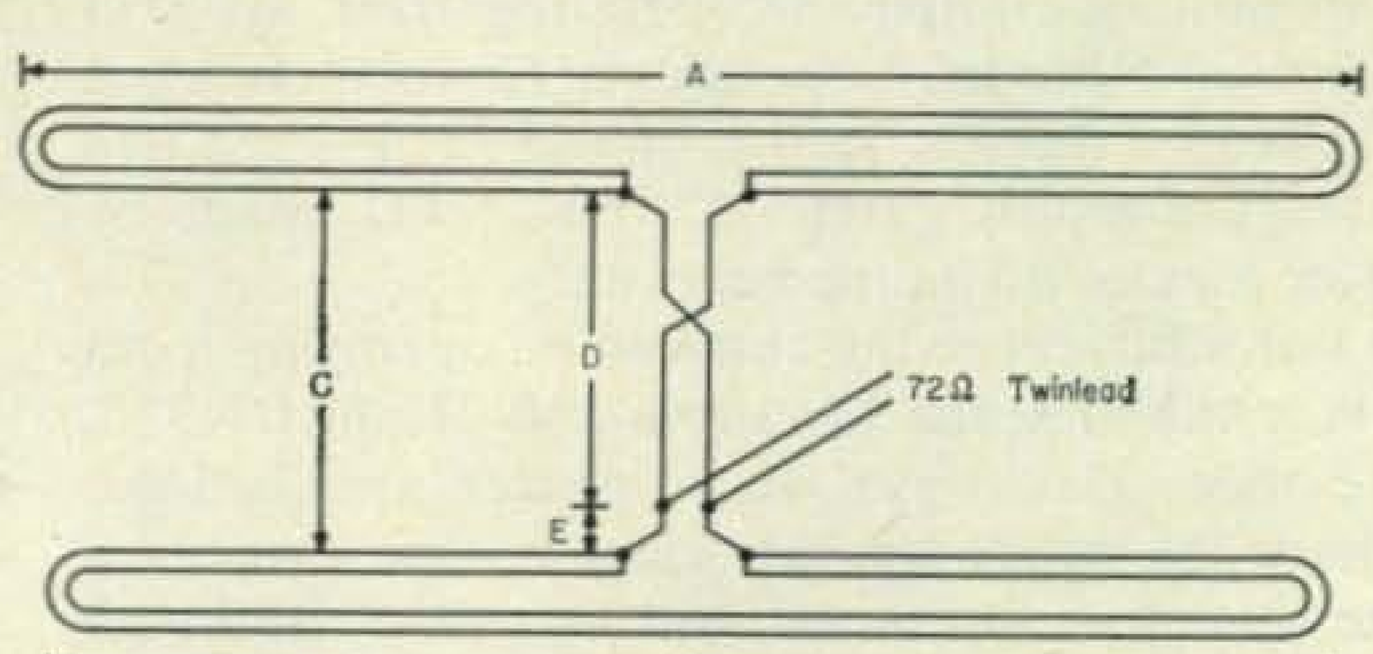

Fig. 1—Configuration for the improved ZL special. Note that the phasing line has one twist only for phase reversal. Telcon 150 ohm cable was used for the phasing line and it has a velocity ratio of 0.79. The dimensions for various frequencies are shown in the chart below.

Mc	A	B	C
14.1	33′ 1.8″	31′ 4.8″	8′ 8.6″
14.2	32′ 10.9″	31′ 2.1″	8′ 7.9″
14.25	32′ 9.6″	31′ 0.8″	8′ 7.3″
14.3	32′ 8.3″	30′ 11.6″	8′ 7.2″
14.35	32′ 6.8″	30′ 10.3″	8′ 6.8″
14.4	32′ 5.5″	30′ 9.0″	8′ 6.5″
21.2	22′ 0.75″	21′ 1.0″	5′ 8.75″
21.3	21′ 11.5″	21′ 0.0″	5′ 9.5″
21.4	21′ 11.0″	20′ 11.25″	5′ 9.0″

from the feed point to one element *minus* the distance from the feed point to the other element is 1/8 of a wave length multiplied by the velocity factor.

Thus in fig. 1 where distance C is 1/8 of a wave length in free space, distance D (from the feed point to the rear element) minus distance E, the distance from the feed point to the forward element, equals 1/8 of a wave length multiplied by the velocity factor of the cable concerned.

It may be shown mathematically as:

$$D + E = C$$
$$D - E = C \times k$$

where k is the velocity factor of the line used. From the above, the following formula is derived.

$$E = \frac{C}{2}(1 - k)$$

As an example we might wish to operate at 14.1 mc using Telcon K24 150 ohm line. From the data in fig. 1, $k = 0.79$ and $C = 8' \, 8.6''$. Convert C to inches, plug into the formula and we have:

$$E = \frac{104.6''}{2}(1 - 0.79)$$
$$E = 52.3'' \, (0.21)$$
$$E = 11''$$

[Continued on page 86]

A Transistorized D.C. Voltmeter

BY DON ROWLAND*, K5DVI

HERE is a short, simple construction article written for the solid-state enthusiast and for the many amateurs who have found a need for an ultra-small portable electronic d.c. voltmeter which combines accuracy with low cost.

The unit described is a transistorized version of the v.t.v.m., but without the disadvantages of that instrument. This one requires no warm-up time and is independent of the a.c. line.

The only critical parts are the multiplier resistors, where only precision units should be used. However, since these are readily available in 1% tolerances, at small cost, they should present no difficulty.

Circuit Description

The circuit utilizes an inexpensive d.c. milliameter connected to a direct coupled d.c. amplifier consisting of two Raytheon p.n.p. transistors. This provides a full scale sensitivity of 10 microamperes.

The input resistance of the device is 100,000 ohms per volt and compares favorably with or exceeds that of commercial units.

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Fifteen voltage ranges are shown, but any number less than that may be used merely by eliminating the multiplier resistors for the unwanted ranges and selecting a switch with fewer positions.

The test lead for J_1 is made from thin coax or shielded wire.

To calibrate the instrument, zero the meter, set the range switch to the 1-volt position. Apply an accurately known source of 1 volt and set the CALIBRATE pot for full-scale deflection.

The entire unit can be built into a standard meter case if desired. Layout is not critical. ■

Multiplier	Resistance (megohms)	Range (volts)	Multiplier	Resistance (megohms)	Range (volts)
R_1	.10	0-1	R_9	5	0-50
R_2	.25	0-2.5	R_{10}	10	0-100
R_3	.30	0-3	R_{11}	25	0-250
R_4	.50	0-5	R_{12}	30	0-300
R_5	.75	0-75	R_{13}	50	0-500
R_6	1.0	0-10	R_{14}	75	0-750
R_7	1.5	0-15	R_{15}	100	0-1000
R_8	2.5	0-25			

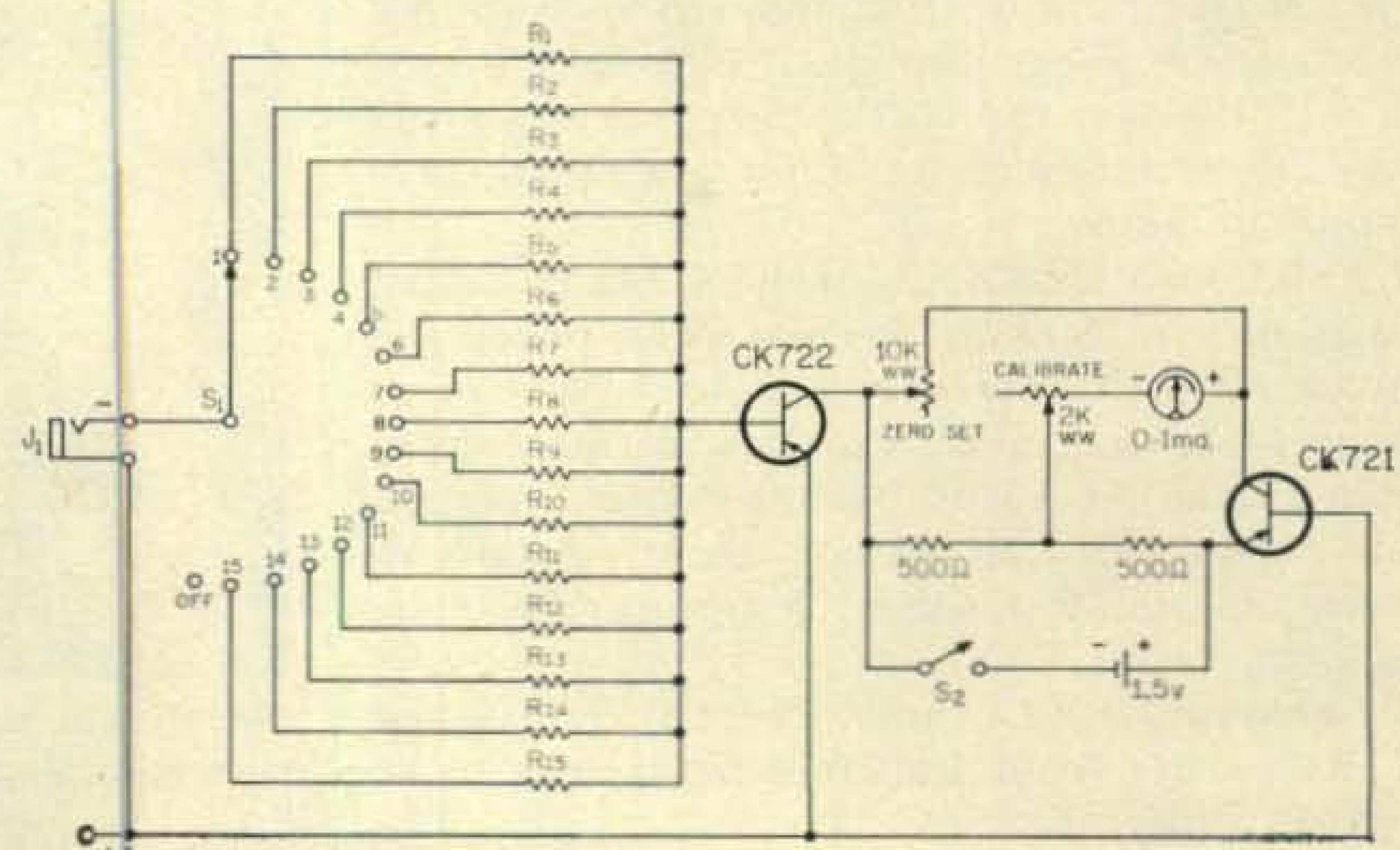

Fig. 1—Circuit of a simple transistorized d.c. voltmeter.

Space [*from page 84*]

the interplanetary space between the planets and the earth, as man takes giant steps forward in unlocking the secrets of the Universe.

While it was not technically possible for radio amateurs to receive MARINER's signal from deep space, the circuitry developed to accomplish the record-breaking DX transmissions will eventually find their way into the design of amateur equipment. The equipment design which made it possible to hear the MARINER II spacecraft from 37 million miles in space may someday make it possible for radio amateurs to establish new v.h.f. and u.h.f. DX records on the surface of the earth, and in space by means of moonbounce and communication satellites.

73, George, W3ASK

Field Strength Meter [*from page 81*]

of 10 at opposite ends of a frequency band.

This points up again that response of the simple f. s. meter is not the same at all frequencies within the operating range. But this vagary is automatically corrected if a separate calibration is made at each operating frequency, as previously advised.

Summary

So much, then, for the reasons why the simple field strength meter often shows such aggravating eccentricities. What corrective measures can be taken? Here they are:

1. Use the exact components specified by the designer.

2. Calibrate the f. s. meter at as many points on the microammeter scale as possible, using an r.f. signal generator having direct-reading microvolts output. Make this basic calibration at the lowest frequency to which the f. s. meter may be tuned. On the basis of this calibration, preferably draw a special volts scale for the meter; or if this cannot be done, prepare a calibration curve or chart.

3. Repeat the calibration procedure at each frequency at which the f. s. meter is to be used. And on the basis of these calibrations, either (a) prepare a separate calibration curve or chart for each frequency or (b) work out correction factors for the various frequencies (for example, your correction figure might show that you must multiply the basic calibration by 0.5 at 50 mc, 0.2 at 100 mc, etc.).

Carefully attend to these matters and you will have a useful, dependable instrument instead of a toy.

Finally, something should be said about maximum sensitivity of the instrument. The very best diode-type f. s. meter will not respond to signals weaker than about ½ millivolt r.m.s. The germanium diode just does not rectify at lower a.c. voltages; this, unfortunately, is the nature of the beast, and little is to be gained by inserting a tremendous d.c. amplifier between the diode and microammeter. ■

ZL Special [*from page 40*]

Since *C* equals 104.6" and *E* equals 11", *D* equals the difference, 93.6".

In this way a perfectly normal aluminum tube structure can be built, like any other beam, with the delay line stretched from one element to the other, and yet the two elements are fed with the correct phase relationship.

Figure 1 gives the dimensions and the spacing of the elements for various frequencies in the 15 and 20 meter band. The length of time that I have been using this beam will be obvious from the fact that I have made the calculations to include 14.4 mc, clearly indicating that I constructed this beam before we lost the top 50 kc of the 20 meter band.

Impedance Matching

Lastly there is the question of impedance matching. In most descriptions which I have seen the delay line is made of 300 ohm cable. I do not think this is necessarily the best solution. Although a folded dipole has an impedance of 300 ohms, when two folded dipoles are placed within an ⅛ of a wave length of one another, the impedance falls considerably and is probably in the neighborhood of 180 ohms. Thus the 150 ohm cable which I used as the delay line is a fairly good match.

The feed line from the transmitter "looks into" two 150 ohm lines in parallel (one line to each element). Thus a 75 ohm feed line is the perfect match for the feed point into the 150 ohm delay line which in itself is a pretty good match for the two folded dipoles whose impedance has been appreciably reduced by their mutual coupling. This beam, therefore, needs very little adjustment and has a low s.w.r. Clearly, as the beam is a balanced array, it is better to feed it with balanced twin-lead using a balun at the transmitter end. ■

VHF Transistors [*from page 45*]

db at 200 mc which will compete on equal footing with the Nuvistor. The price is still a bargain at some $30.00, however.

The new Texas Instruments Dalmesa series is a popular transistor. Some of these devices, with a several hundred megacycle alpha cutoff frequency, sell for less than 50 cents in manufacturing quantities.

Silicon is a tough nut to crack because of the high processing cost. However most companies, such as Hoffman, Rheem, Pacific Semiconductors, Radio Corporation of America, etc., have a gradeout line of silicon transistors which may be purchased for less than $5.00.

One silicon transistor (not a gradeout) which did not make the list, due to its price tag of $5.60, should also be mentioned. The 2N706 is capable of producing several hundred milliwatts power output on two meters. The price given was for the Texas Instruments 2N706 and should be typical of other manufacturers. ■