In use world-wide, **TENNADYNE** antennas are state-of-the art frequency-independent LOG-PERIODIC DIPOLE ARRAYS. Arrays that give you full operational capabilities on all five of the 14-30 MHz ham bands. They do it with both electrical and mechanical efficiency.

TENNADYNE antennas are designed to be light-weight and strong and to fully match the functional capabilities of your modern rig. Our LPDA's offer the same outstanding performance on each of the 14-30 MHz ham bands PLUS, they allow equally efficient browsing functions at any other points outside of the ham bands, within their frequency parameters. **FIVE HAM BANDS++.**

For simplicity and mechanical ruggedness, our LOG-PERIODICS use the dual-boom type of feed system. The booms are insulated from each other and the mast, the elements pass directly through the booms. With this type of feed system, we eliminate the need for a cantilevered truss system to support the sagging ends of the boom and also do away with any problems associated with the criss-crossed wire/tube feed systems. Our antennas offer a DIRECT 50-52 ohm match!

TENNADYNE antennas need no tuning! We offer a user-friendly antenna that is easy to assemble (3-5 hours), has excellent performance without being costly, unwieldy or heavy. **TENNADYNE** antennas don't have any gimmicks or gadgets, they're straight textbook!

TECHNICAL SPECIFICATIONS

ELECTRICAL	**T5 HAWK**	**T10 EAGLE**
SCALE FACTOR T	.8321	.9040
SIGMA	.0560	.0498
FORWARD GAIN	5.1 dBd	6.4 dBd
F:B RATIO	14-24 dB	17-25 dB
FREQUENCY COVERAGE	14-29.7	13-30 MHz
NOMINAL MAX SWR	2.1:1	1.6:1
FEEDPOINT IMPEDANCE	50-52	50-52 ohms
POWER	COAX LIMITED ONLY	
MECHANICAL		
BOOM LENGTH	12 FT	24 FT
ALUMINUM ALLOY	6061-T6	6061-T6 UNPOLISHED
HARDWARE	SS	SS
WEIGHT	31 LBS	56 LBS
WIND AREA	5.1 SQ FT	11.0 SQ FT
WIND LOAD @ 80 MPH	82 LBS	176 LBS
MAXIMUM MAST	2"	2"
LONGEST ELEMENT	33.8 FT	38.5 FT
TURNING RADIUS	20.2 FT	22.7 FT
MAXIMUM WIND	100 MPH	100 MPH
# ELEMENTS	5	10

NOTE: Specifications are subject to change at any time without notice.

	$339.95	**$559.95**

ASSEMBLY INSTRUCTIONS

TENNADYNE

HAWK

MODEL T5

DESIGN: 11014A

MANUFACTURED BY

TENNADYNE CORPORATION
1361 KENNEDY DRIVE
DENVER, CO 80234
(303) 451-7100

WARRANTY

We warrant our products to be free of defects in material and workmanship for one year from date of original purchase. While we make every effort to carefully manufacture our products to the highest standards of quality, occasionally parts may be found to be missing, defective, or damaged.

If you have a defective part, please furnish us with proof of purchase and written explanation of the trouble. During the warranty period, we will, at our option, either repair or replace the defective material free of charge.

This warranty does not cover damage due to improper installation or use, lightning, negligence, accident, or unauthorized service, or to incidental or consequential damages beyond the **TENNADYNE** products themselves. Implied warranties are limited in duration to the life of this limited warranty.

Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental and consequential damages, so the above limitations may not apply to you. This warranty gives you specific legal rights. You may have other rights, which vary from state to state.

INSTALLATION TIPS

1) LPDA antennas **DO NOT** like other antennas in close proximity, especially antennas that operate on the same frequency as the LPDA. Two (2) wavelengths of separation for these, please. Dissimilar frequency antennas should be mounted under the following rule-of-thumb: use a minimum spacing of at least .15 wavelength at the **lowest** operating frequency for separation. .2 wavelengths is better! This does not seem to apply to lower frequency dipoles arranged beneath the LPDAs.

2) LPDA antennas like insulated guys for towers.

3) It is recommended that a **"COLLINS BALUN"** be used with the LPDA antennas manufactured by **TENNADYNE**. This is a simple coil (6-8" OD) of coaxial cable (same Z as your feed line) wound into 6-10 turns. Foam coax is not recommended for this purpose, the center conductor will migrate to the shield and a short will occur. This 'balun' should be placed at the feedpoint of the antenna. The purpose of this coil is to remove the current from the shield of the cable.

4) We have found that the lower boom of our antennas can be grounded with a resulting overall improvement in SWR. When you stop to consider this, it's at a ground potential anyway, one way or another. If you have a coax connector at the top of the tower, grounding can be accomplished here as an alternative, by grounding the outside of the connector.

5) When running the sheet metal screws in, stop and back them out when the twisting gets tough. Back out a bit and then go forward again. At times, running them straight in will cause them to break off. They are made of stainless steel but, even then, they can only take so much.

6) SWR bridges that are built into today's transceivers are notorious for their inaccuracy. To save yourself many missteps, use a decent bridge external to the transceiver. Even then, placement of the bridge at different points in the feed line will result in different readings. Should you encounter SWR problems, look at the antenna to determine if assembly is correct. Everything should be in balance. If such is the case, since this is such a simple device, your problem lies elsewhere. Prior to installation on the tower, I recommend a check of the feed line into a known load with a meter placed at each end. You should get approximately the same meter scale deflection if the cable is OK. To check an SWR bridge or wattmeter, reverse the leads. The forward and reverse meter readings should remain the same, no matter which way it's placed in the line.

GOOD DX! CALL IF YOU HAVE A PROBLEM! 303-451-7100

ADDENDUM: When testing this or any other antenna, remove all coax switches, scopes, etc., from the signal path. Readings can be very erroneous with these in line.

ASSEMBLY INSTRUCTIONS

MODEL: T5 HAWK
DESIGN: 1014A

You will need the usual assortment of small hand tools to assemble this antenna but, you will also need:

WD40
Powdered graphite
Drill with 1/8" bit

Spray the WD40 and graphite onto each and every tubing joint surface during assembly. This enables easier assembly and, you'll be able to disassemble the antenna in the future. Spray the WD40 and then the graphite onto the end of every tube section that is to be inserted into another tube.

GET ORGANIZED!

Organize the tubing into groups, first by tube OD and then by length. Please note that there may be some differences in tubes of the same lengths, this difference being that the hole in one end may be larger and, through both sides of the tube. This larger
hole end always goes toward the boom.

ASSEMBLY OF ELEMENTS

Assemble the elements per **FIG. 1**, you'll end up with two full sets of each. Use the sheet metal screws as indicated and, when finished, lay these aside.

ASSEMBLY OF BOOM

Boom assembly consists of only 8 parts plus hardware. Lay out the boom per **FIG. 2**. Insert the splice per this diagram into the element section kto the right only, to a depth of about 3". Drill a 1/8" hole through this boom section and the splice, about 1½" in from the end of this boom section. Secure these parts with #10 SMS.

Insert the remaining free end of the splice into the other appropriate boom section but, do not yet drill the securing holes. Line up the sections so that the 3/8" holes at 90° to the element holes face upward.

Place the plastic spacer rods into their holes in the center of each of the two boom sections, from the top, securing them with the 10-24 x 2" bolts and 10-24 nuts. Tighten securely but do not severely dent the boom by over-tightening. See **FIG. 4**.

ASSEMBLY OF ELEMENTS TO BOOM

At this point, you should have all of the elements plus half of the boom assembled. Now assemble the other half of the boom through the step calling for securing the splice to the boom with the #10 x ½" SMS. Lay these two sections on the ground, not connected, in the exact same manner as the other half of the boom.

See **FIGS. 3 & 4.** Insert the elements into the completely assembled half of the boom, starting with element #1, the largest, at one end and element #5, the smallest, at the other end. Secure the elements into place with the 10-24 x 2" bolts and nuts, per **FIG. 4.** The result should be per **FIG. 3.**

If all has gone as planned, half of the antenna is now complete!

Now, in the same manner, fabricate the other half of the antenna. When completed and as seen from above, the two halves of the antenna should appear to be identical.

FINAL ASSEMBLY

Pick up the loose boom section with elements 1 & 2, flip it over so that element #1 in the loose boom is now pointing in the opposite direction of element #1 in the other assembled boom. Push the 1" hole in the center of the loose boom section down onto the plastic spacer rod in the completed assembly and secure with 10-24 hardware, per **FIG. 4.**

Pick up the loose boom section with elements 3, 4 & 5, slip the boom over the boom splice in the boom section with elements 1 & 2 and push the center 1" hole down over the corresponding boom spacer rod. Secure with 10-24 hardware according to **FIG. 4.**

Start with the top boom, make sure that the boom sections at the splice are snugged tight one-to-another and drill the holes for the #10 SMS. Install the hardware as you go. Do the same now with the bottom boom.

Per **FIG. 5**, secure the boom-to-mast plastic plate to the booms now, in the center, using the U-bolts and hardware.

CHOKE COIL

We use, at the antenna feedpoint, a choke coil made up of about 20' of 50-52 ohm coaxial cable feedline (do not use foamed cable for this application). Wind this into a 6-8" coil and secure it, one end of this coil is to be attached to the antenna feedpoint per **FIG. 6.** The braid is attached to the lower boom and the center conductor is attached to the top boom in the same manner. Use 10-24 x ½" hardware in both of these attachments.
The other end of this choke coil is attached to the cable (same Z_o) coming from your shack.

LONG LIFE

For the sake of long life in your antenna installation, it is recommended that any coax outside of the jacket be coated with a sealant that will stand up to both moisture and sunlight (UV). I've used roof sealant (tar-like) for years and years with great success. See FIG. 6.

ANTENNA TO MAST

The remaining two U-bolts are used when attaching the antenna to your mast, see FIG. 5B.

It is recommended that the loose coaxial cable coming from the choke coil at the feed point be attached to the lower boom with a dielectric material of some sort (tape/cable ties, etc.), this will hold it up out of the way and deliver it back to the center of the antenna at the mast where it can be connected to the cable coming from your station.

SHORTING STUB & GROUNDING

Attach the U-shaped shorting stub per FIG. 7. You can ground the lower boom of the antenna to the mast if you choose or, you can ground the coax shield (at a connector) at any point at random on the tower. Grounding the antenna at the top of the tower yields a capacity hat should you want to feed the tower as a vertical radiator. It also yields a completely grounded antenna system.

==

FIG. 1: ELEMENT CONSTRUCTION

EL #	1.000"	.875"	.750"	.625"	.500"	.375"	.250"
1	42"*	24"	24"	24"	24"	30"	48"
2	14.2"	18"	24"	24"	24"	30"	48"
3			24"	24"	24"	30"	48"
4			12.4"	18"	24"	24"	48"
5					24.9"	30"	48"

*Tube with a factory installed insert.

APPLICATION OF SMS

#6 x ¼" Between all .500" to .375" and .375" to .250" tubes
#8 x 3/8" Between all other tubes

FIG. 2: ELEMENT PLACEMENT v. BOOM SECTION

EL #	DISTANCE FROM LEFT END OF BOOM	
1	2.000"	BOOM SECTION p/n 1070
2	47.125"	
3	12.625"	
4	44.000"	BOOM SECTION p/n 1071
5	70.000"	

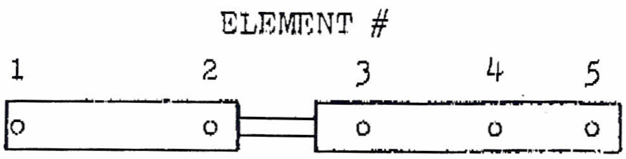
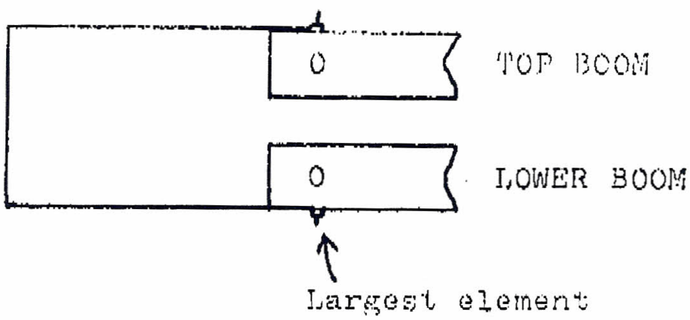


FIG. 7: SHORTING STUB ATTACHMENT



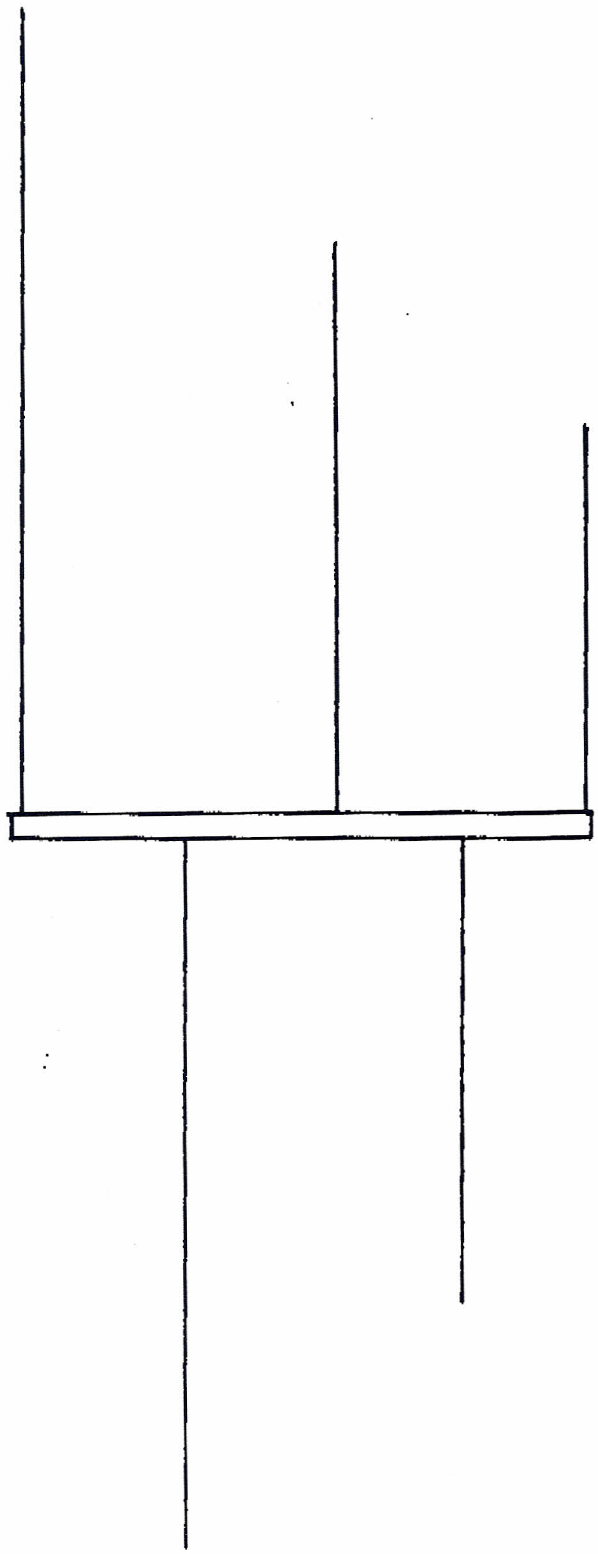
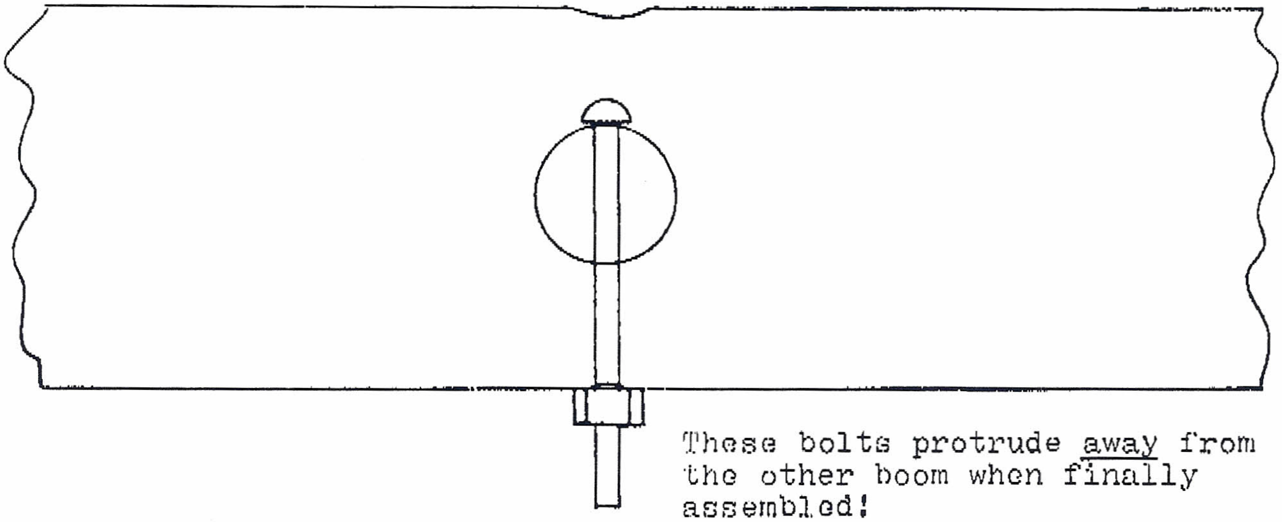


FIG. 4

To assemble elements or spacer rods to boom, insert either into proper hole and secure by placing 10-24 x 2" hardware through 3/8" boom hole through element or spacer and out through smaller hole. Then secure with lock-nut.



These bolts protrude away from the other boom when finally assembled!

FIG. 5A

Boom-to-mast plastic block is secured with 2" U-bolts per drawing. Boom is on one side of block and mast will be on the other side.

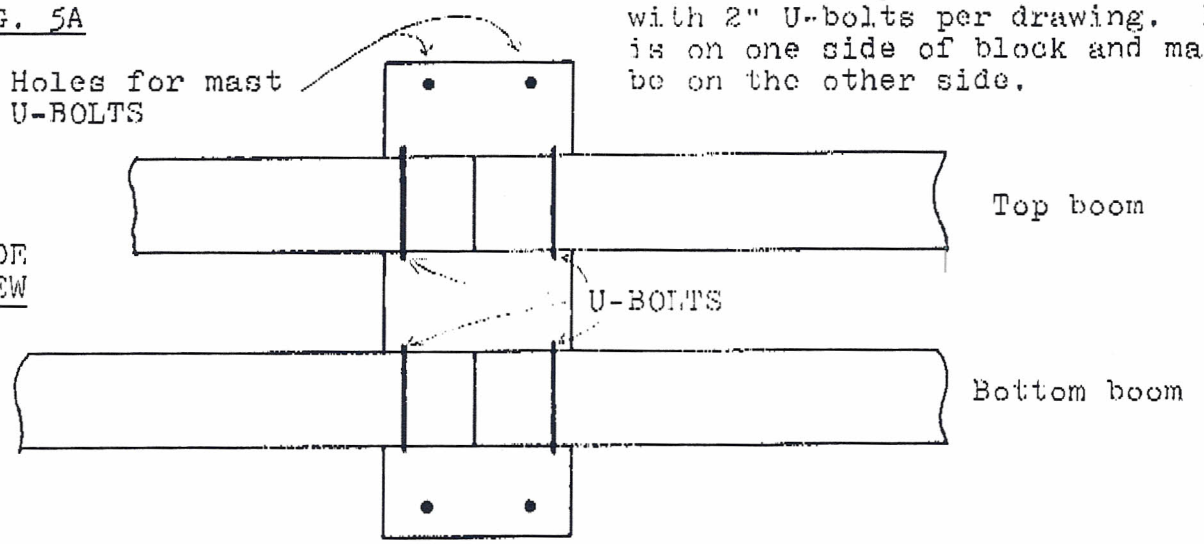


FIG. 5B

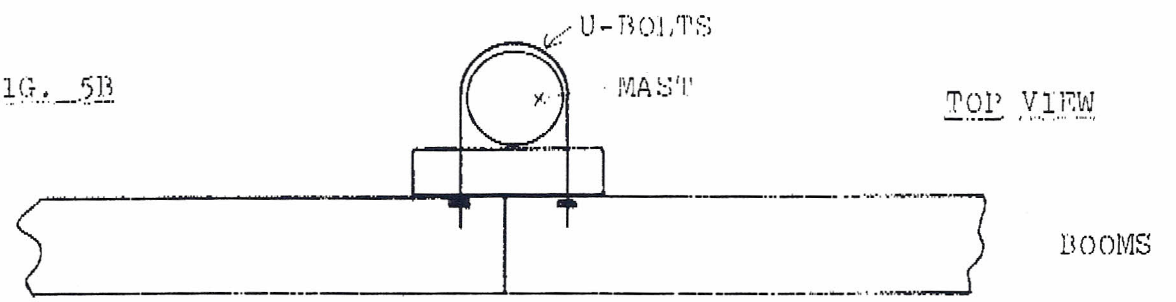
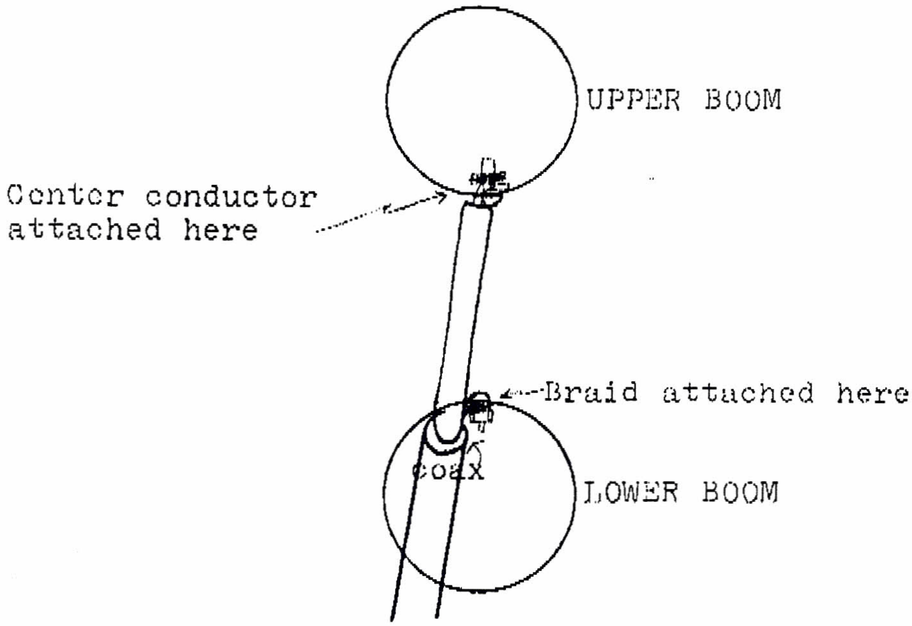


FIG. 6


UPPER BOOM
Center conductor
attached here
Braid attached here
coax
LOWER BOOM

C-TECH (TENNADYNE)

1361 kennedy drive
denver, colorado 80234
(303) 451-7100

17 JUL, 1991

WOODY LINWOOD

The entire comment on the COLLINS BALUN was contained within the two pages that I FAXed to you yesterday. However, I feel that about 10 turns with a diameter of 1' would be adequate. Let me know.

It seems to me that if you want to eliminate shield currents, you should do so as close to the source as is possible. Put the coil at the antenna feed point!

Chuck

WOODY LINWOOD
FAX: 488-6015

What you have done is to decouple the antenna to a greater degree than the 'natural' balun of the antenna itself. It's called the COLLINS BALUN, see the following. RG213/8 at 30 MHz has a loss of 1.13 Db. As you will wee from the following, you don't need 100'.

chuck

This article shows how to build and design broadband rf transformers and baluns without magnetic cores.

problems with magnetic cores

Amateurs build or buy highly linear SSB equipment and effective lowpass filters to avoid TVI. We then subject our clean, harmonic-free signals to the uncertainties of ferrite-core transformers or baluns in our antenna systems. The cores in these devices are subject to saturation and, therefore, nonlinearity. High permeability ferrite cores are also susceptible to permanent damage at flux densities of a few hundred gauss.[5] Tune up your linear into the wrong antenna just once and the damage is done.

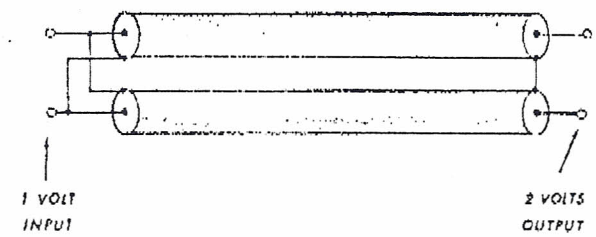


fig. 1. Broadband transmission-line transformers are made of two or more transmission lines connected in parallel at one end and in series at the other. One volt applied to two coax lines in parallel at the input results in 1 volt across *each* of the lines at the output. If these two lines are connected in series at the output as shown, the output will be 2 volts. In this way a 1:4 impedance stepup is achieved. Sufficient impedance must be provided over the length of the outside conductors to prevent the connections at one end from shorting the other end.

Magnetic materials such as ferrite, powdered iron, and specialty steel tapes have added greatly to the performance of components available to circuit designers. However, these materials should not be used in high-power circuits or antenna systems unless they are adequately characterized regarding power-handling capability and saturation effects. This is necessary so that interaction of the material with your system can be thoroughly understood. Put another way, sufficient core material must be used to keep the flux density well below the saturation level. Data on harmonic distortion measurements, taken at high power on a popular commercial ferrite core balun, are presented in part 2 of this article.

Ferrite baluns and transformers are usually wound with copper wire coated with thin enamel insulation. Pairs of wires are placed close together or twisted to make transmission lines, which are wound tightly onto the core. The conductors must be close, because the surge impedance of the wire pairs must be correctly related to the impedances to be matched.

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ne output end of each of the two lines. If the output ends are connected in series so that the two voltages add, the output is 2 volts, thus creating a 1:2 voltage increase (1:4 impedance transformation). Fig. 1 also can be used to describe a 4:1 impedance reduction; for example, from 50 ohms to 12.5 ohms.

Sufficient rf impedance must be provided between the input and output ends of the transformer of fig. 1 to prevent the connections at one end of the lines from shorting the other end of the lines. The impedance is usually provided by wrapping the transmission lines around magnetic cores.

the Collins balun

By far the best balun I've ever used is the Collins balun which, to my knowledge, was first described in a book published by the Collins Radio Company entitled *Fundamentals of Single Sideband*.[6] The Collins balun derives its name from this reference. I believe the earliest reference to an Amateur application was in an article by K2HLT in *G.E. Ham Notes* in 1960.[7] The Collins balun is rarely mentioned in Amateur literature, which is surprising in view of its superb performance. However, Bill Orr, W6SAI, describes one in his *Radio Handbook*.[8]

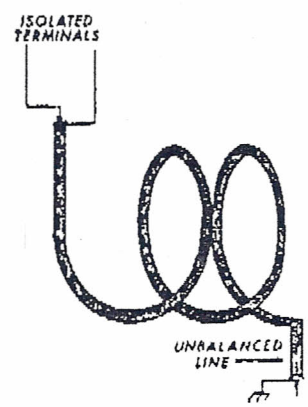

fig. 2. Simple coiled length of coaxial line isolates output terminals from ground.

Perhaps the reason the Collins balun hasn't gained popularity with Amateurs is that it's quite bulky when made with RG-8/U. The balun is extremely simple. No exotic materials are used in its construction; only coaxial cable and insulated wire. I've used these baluns for years with various antennas and never had a failure. One has been on my three-element 10-15 meter quad for eight years with no sign of deterioration. There are only two disadvantages to the Collins design: 1) when made with RG-8/U, the balun is bulky — too large for installation on a clean-design antenna system; and 2) the balun is useful only at 50 ohms. This article shows how to eliminate these disadvantages.

balun theory

Baluns convert energy from unbalanced coaxial line to balanced two-wire line by isolating the two balanced terminals from ground. As in the transmission-line transformer, this is often accomplished by coiling transmission lines around magnetic material so the impedance to ground from both output terminals is high compared with the characteristic impedance of the input coaxial line. By using this technique, shown in **fig. 2**, the two balanced terminals are "floated" with respect to ground by the isolation provided by the coiled-line impedance. However, a simple coiled length of transmission line is often not adequate because it doesn't contribute to the balance of the system.[9] For a balun to make this contribution, the impedance ground from both terminals must be nearly matched.

Accordingly, in the Collins balun, a dummy length of coax is wound as a continuation of the isolating winding, so that the coil consists of the original length of coiled coax of **fig. 2** plus an equivalent length of dummy line, as shown in **fig. 3**.

The dummy-line center conductor is unused and is left floating, or both ends may be shorted to the outer conductor if desired. The dummy length of line causes the impedance to ground, from each of the two output terminals, to be nearly equal. The isolation impedance (common-mode impedance) is held higher than the coax-line characteristic impedance over a wide frequency range by the distributed capacitance and inductance of the combined coil. The coil must have sufficient inductance so the impedance, at the lowest operating frequency, is higher than the line surge impedance. As the frequency is increased, the impedance increases through parallel self-resonance, then decreases as the frequency is further increased.

Because the self-resonant circuit consisting of the distributed capacitance and inductance of the combined coil is loaded by the low characteristic impedance of the line, the impedance versus frequency curve is broad. Balun performance therefore is not critical with respect to frequency. Data taken on measurements of the common-mode impedance on a typical Collins balun are presented in Part 2.

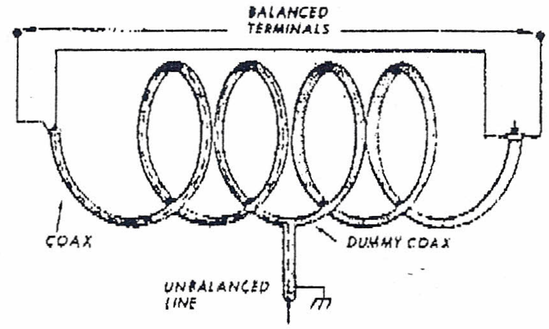

fig. 3. Broadband coil balun is evolved from the coiled coaxial line of fig. 1.

The symmetry provided by the dummy line makes balun performance less dependent on common-mode impedance and is therefore often essential in baluns and balanced systems.[9] The isolation, balance, and impedance match of this class of balun are superb over the hf Amateur bands. Specific designs, performance data, and a systematic design procedure are presented in Part 2.

new class of transformers

Faced with the need to match a very low-impedance antenna system, I decided to try to develop a 4:1 transmission-line transformer based on the principles of the well-proven Collins balun. The transformer was successfully developed; in fact, a new class of wideband transformers evolved from this work.

One of the nice things about an avocation — as compared with a vocation — is that you're not on a time schedule. I found that the performance of the 4:1 transformer was so good that the idea of other transformer designs based on the same principles looked interesting. I shelved the phased-array project long enough to enjoy the freedom to explore the possibilities of these transformers. The result was a series of broadband balanced and unbalanced transformer designs that are extremely simple, made entirely of coax, and, most important, don't depend on ferrite or powdered-iron materials.

design concept

Because the Collins balun so successfully isolates the balanced output terminals from the unbalanced coaxial line input, it seemed reasonable that a similar broadly resonant configuration would provide the isolation necessary to the series and parallel lines of **fig. 1**. From previous experience I'd found that it's unnecessary to wind the Collins balun on a cylindrical

7/17/91

Chuck:

Worked with the "Collins Balun" again last night (see attached chart). It didn't make any difference where the coil was... at the radio in the shack, at the base of the tower, or hanging on the tower directly below the T5... the SWR checks showed that there are only very minor variances.

Do you think potential for TVI/RFI (by reducing current flow on the shield) might be better checked by installation at the antenna or would it really make much difference?

One thing I did discover, however, was that I was more than a little off when I supposed my coil of RG213u to be about 100-feet... I stretched it all over the yard last night and measured it. Right at 200-feet! What a balun.

You made a statement that I wouldn't need 100-feet to see these SWR readings and referred me to the article.

The two pages you sent me were interesting but the article was incomplete. I read the parts of the article that you faxed but it said the design and measurement details of the balun construction were in Part Two.

If you have both Parts One and Two of the article, could you fax or send them to me?

How many feet of coax do you figure would be required to assure these present (or better) statistics? Cut in any quarter wavelength, etc segments?

Thanks...

Woody
WR0S

488-6188 office
488-6015 fax
980-0006 home

HF LOG PERIODIC ANTENNAS

Winter, 1991

	SABRE 610	TENNADYNE T10 EAGLE	TENNADYNE T5 HAWK	KLM 10-30-7lpa	KLM 7.2/10-30lpa	CUSHCRAFT A3S	A3WS
PRICE	3100	540	325	830	1070 1099	410	360
FREQ	10-30	14-30	14-30	10-30	7-30	10-30	ham
FWD GAIN	9 @10mhz 13 @14-30	7.9dbi 5.6dbd	7.2dbi 5.0dbd	9.1dbi 7.0dbd	3 @7mhz 1 dB 7 @10-30 6 dB	8	8
F/B	12db	17db	14db	15db	10 @7mhz 3 15 @10-30 15	25	25
WORSE SWR	2.2:1	1.6:1	2.0:1	1.5:1	1.5:1 1.8	not rated	
BOOM LENGTH	30	24	12	30	42 30	14	14
# ELE	11	10	5	7	8 8	3	3
LONGEST ELE		38	33	43	46 46	36	32
WIND LOAD	16	9	5	9	12 13	5	5
WEIGHT	225	52	30	70	100 100	30	25

Thanks for requesting information about the TENNADYNE EAGLE.

The EAGLE is state-of-the-art, a Log-Periodic Dipole Array for 14-30 MHz, utilizing the dual-boom type of feed system to avoid the need of a balun and also avoiding the problem of multi-resonant points so common in the criss-crossed wire feed system.

The EAGLE was developed by a ham to meet the need for a single, efficient antenna that could cover all of the available ham bands in the 14-30 MHz frequency range. Design of the EAGLE has achieved the goals of manufacturing simplicity, ease of assembly, good performance and, light weight, without being costly or, unwieldy.

The EAGLE is light-weight, strong and efficient, yet, it has withstood the rigors of high-mountain Colorado weather for many, many months without so much as a screw coming loose. When tested head-to-head with a popular 7 element trap tri-band antenna, the EAGLE came through with flying colors, the measured beamwidths of the two antennas were exactly the same (this determines gain) but, the EAGLE showed superior F:B, by 3 Db! The EAGLE also exhibited better overall rejection of signals from undesired directions.

The thru-boom feed system balances the feeding of the antenna just like a balun would but, doesn't require one! The EAGLE has no gimmicks or gadgets, it's just straight textbook!

TECHNICAL SPECIFICATIONS - TENNADYNE EAGLE (Model KA1300-A10)

ELECTRICAL

T10 6.4 dbd
T5 5.1 dbd

Forward Gain	7.89 Dbi (Theoretical)
F:B Ratio	17 Db minimum*
Frequency Coverage	14-30 MHz
SWR	1.6:1 maximum
Feedpoint Impedance	50/52 ohms unbalanced (Coax)

MECHANICAL

Weight	60 LBS
Wind Area	7.3 SQ FT
Longest Element	38 FT
Boom Length	24 FT
Turing Radius	22.3 FT

*This 17 Db F:B ratio was recorded at 14.225 MHz with the antenna at 60 FT. LPD antennas typically show the F:B ratio to rise with frequency.

MEASURED SWR (Antenna at 60 FT, guys broken up with insulators)