



ATCO NEWSLETTER

VOLUME 5 NUMBER 2

APRIL 1988

1988 ATCO TECHNICAL SYMPOSIUM APRIL 14th AT DeVRY

Plan now to attend the ATCO Technical Symposium to be held at the DeVry Institute of Technology.

The program and a map to help you get there are included in this issue of the ATCO Newsletter.

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The ATCO Newsletter is the official publication of a group of television amateurs known as "AMATEUR TELEVISION IN CENTRAL OHIO" and is published in January, April, July, and October.

Membership in ATCO is open to any FCC licensed radio amateur who has an interest in amateur television.

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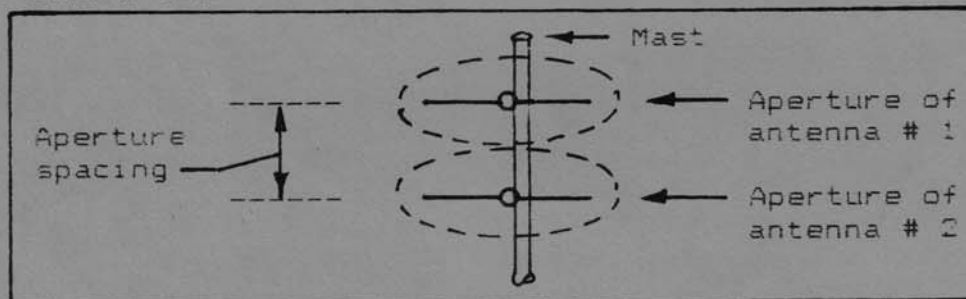
ANTENNA STACKING DISTANCE

What determines just how far apart two antennas should be spaced or stacked? To find out, several physical and electrical properties need to be taken into consideration. A few of the important parameters to be considered are as follows: the length of available rotatable mast above the tower, the number of ham bands to be utilized, the type of antennas selected, the gain of the antennas chosen, and the wavelength of the operating frequencies.

Another consideration when stacking antennas is which axis of the antenna array should exhibit the narrowest or widest angular acceptance - vertical or horizontal? Also, the wind loading of the completed multi-antenna multi-band arrays must not be ignored for the survival of the mast, tower, and antennas.

When stacking two equal antennas, impedance matching or a power divider is required. Otherwise, the 3 dB gain improvement sought for will not be obtained.

Antennas have a physical aperture and an effective electrical aperture, sometimes referred to as a capture area. A Yagi antenna has an effective aperture considerably larger than its physical size; a parabolic dish has an effective aperture somewhat less than its physical aperture. In order to obtain the possible 3 dB gain from stacking two identical antennas, the effective electrical apertures must not overlap. Space or stack the two antenna arrays so the effective apertures are tangential or just touching as shown in the illustration below. This allows maximum gain consistent with minimum stacking distance. If the electrical apertures overlap, the total power gain obtained will be less than 3 dB.



The effective aperture (A_e) of an antenna is a function of its power gain (G_i) and its operating wavelength (WL) as follows:

$$A_e = \frac{G_i \times (WL)^2}{4 \times \pi}$$

The antenna gain (G_i) is the power gain referenced to an isotropic source. If the antenna gain is in decibels, it must be converted. If the antenna gain is referenced to a dipole, then the antenna power gain (G_d) must be multiplied by 1.64 before using it in the equation. (Submitted by Bill, W8DMR.)

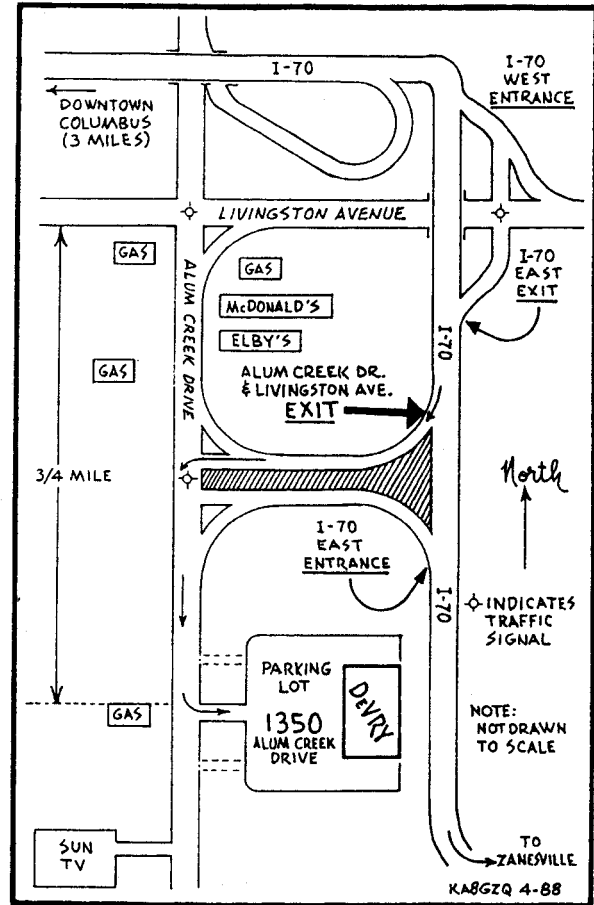
1988 ATCO TECHNICAL SYMPOSIUM

WHEN? - Thursday 14 April 1988,
7:30 to 9:30 p.m.

WHERE? - DeVry Technical Inst.,
1350 Alum Creek Drive.

WHAT? - A technical comparison of the advantages and disadvantages of amplitude or frequency modulation applied to the transmission of fast scan amateur television. The formal part of the program will last about 100 minutes followed by a short break. Then there will be an open discussion of the material presented which will complete the technical session. The symposium will adjourn for a buy-your-own- refreshments social hour at Elby's on Alum Creek Drive.

HOW? - Just follow the ATCO Newsletter map at the right. There's plenty of free parking in a well-lighted parking lot and easy access from the nearby I-70 East Freeway. If you are planning to attend, please check-in on the Tuesday Night ATCO Net and tell us!



FUN! - Bill, W8FRQ, plans to present the black and white 14 inch TV (which he donated) to the winner of the January Arithmetickler Contest. And last but not least, there will be some door prizes for lucky ATCO members in attendance.

***** YOUR ATCO DOLLARS

We thought you would like to know how your ATCO money was used during 1987 - so here goes.

On 23 October 1986, ATCO had \$72.01. Dues for 1987 were received from 40 members through 31 December (two members had already paid just before ATCO inactivity in 1986).

All ATCO members as of the last day of December 1987 received the January 1988 issue of the ATCO Newsletter. Therefore, each member got the January, April, July, and October 1987 publications and the January 1988 newsletter. In addition, a Special Antenna Party Edition was printed in August.

(continued on page 13)

YAGI ANTENNA FOR 900 MHz

Here's a 900 MHz Yagi antenna that can be made from readily available materials. The basic antenna measurements were taken from a F9FT Tonna which uses a single boom with 2-inch insulators to keep the elements well out of the field of the boom.

A double boom is used for the antenna described in this article. One boom is half-inch PVC plumbing pipe, and the other boom may be of either half-inch aluminum or rigid copper plumbing pipe. Each boom length is eight feet three inches, and PVC snap-in pipe hanger clamps back-to-back space the booms apart (see Fig. 1).

Small electric fence wire, welding rods, or similar material can be used to make the elements. Element lengths and spacing are indicated in Table 1. Dimensions for constructing the driven element are shown in Fig. 2. The same type of PVC clamps as mentioned above is used for mounting the elements on the PVC boom (see Fig 5). After drilling the PVC mounts, the elements are forced into each drilled hole. A drop of quick setting epoxy is put in the top hole to hold each element in place. Then, the elements are mounted on the PVC boom. When the elements are properly aligned, small self-tapping metal screws are driven through the clamps into the boom to keep the elements in place.

Any type clamp available is satisfactory for mounting the metal boom to a plastic pipe mast. A suggested means of mounting the antenna to a cross arm on the turning mast is illustrated in Fig. 3. A perspective view of the metal bracket is shown in Fig. 4. The antenna should be mounted on the bracket at its balance point.

Three hundred ohm flat twin-lead is used to feed the antenna. Caution: do not have any mast in line with the elements! (Tonna feeds their F9FT antenna with 50 ohm coax. Jack, WBVSY, has information from Tonna that they were able to arrive at 50 ohms by the spacing of the elements.)

Dale, WABKQQ (Greenville), has been receiving signals with this homebrew antenna from Jack, WBVSY (West Milton). Jack transmits video on 910.25 MHz using .8 watts. To date, no video has been seen, but when video is transmitted, a definite change in the noise pattern occurs on the screen. Dale is using his Yagi with 60 feet of twin-lead into his shack and a short piece of RG-58 foam and a balun going to a PL-259 then to a SO-239 to a BNC adapter resulting in several "lumps" in the line. A varactor tuner is used with a 12 inch black and white TV set. Audio is received from a 30 to 50 MHz police radio with a short piece of wire dropped into the monitor. Soon, Dale will be using a homebrew preamp made from a MMIC-MAR6 chip in front of the tuner and hopes such an arrangement will allow him to see Jack's video. (Submitted by Dale, WABKQQ.)

(continued on page 7)

**SOLUTION TO JANUARY
ARITHMETICKLER**

This must have been a tough one to figure out because we had only four entries in the contest. Congratulations to Dick, WBRVH, for submitting the only correct answer and, therefore, being declared as the official winner of the 14 inch black and white TV monitor!

OUR WINNER - WBRVH!

The solution:

At one time, Bill's transmitter was three times as old as Dave's - so let's call the age of Dave's transmitter at that time X and Bill's 3 X. When Dave's will be three times as old as Bill's was at that time, then its age will be 9 X. Then, when Bill's was half as old Dave's at that time, its age would be 4-1/2 X and Dave's would be 2-1/2 X. Bill's transmitter is now twice as old as Dave's was at that time or 5 X, and Dave's must be 3 X. Their transmitters' combined ages equal 44 years; therefore, we have the equation 8 X = 44 and X = 5-1/2. For that reason, Bill's transmitter, 5 X, equals 27-1/2 years, and Dave's transmitter, 3 X, equals 16-1/2 years of age.

[Let's all take a couple of aspirins and forget it! - Ed.]

NEW ATCO MEMBER

We welcome Doc, WBJDL, who recently joined our group.

FIVE INCH TV SET MODIFICATION

A Multitech portable five inch black and white TV set can be modified to receive ATV on the 440 and 900 MHz bands. The modifications described below are for sets manufactured in August 1987.

First, locate the 2200 ohm resistor (R110) on the circuit board between the tuner and the neck of the picture tube. By shorting this resistor, the tuner will go down to about 426 MHz. Next, check the voltage from this shorted resistor to the center pin of VR101 which is a potentiometer located right next to resistor R110 - the voltage should read about 23 to 24 volts. Adjust VR101 so that the voltage is approximately 30 volts, and you should be able to tune as high as 915 MHz. Multitech sets with other manufacture dates can be modified for 439 MHz but not for 900 MHz. (continued on page 13)

VIDEO MODULATOR FOR 2C39 FINAL

Here is a schematic diagram (see Fig. 1) for a video modulator built from obtainable parts that works well with a 2C39 tube final. This circuit modulates a 2C39 in the T44 transmitter with good video quality.

Adjust R6 to obtain proper video modulation level. (Submitted by Guy, KBHVA.)

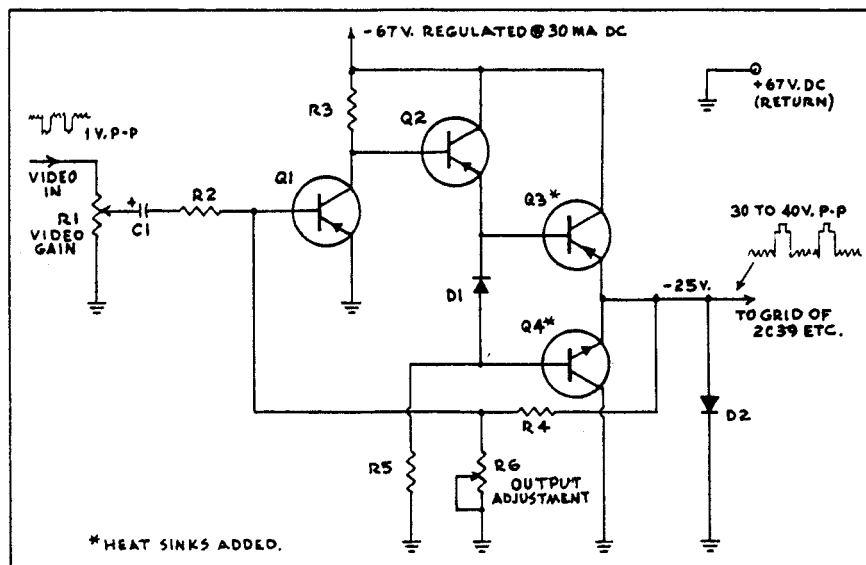


Fig 1. - SCHEMATIC FOR VIDEO MODULATOR FOR 2C39 FINAL.

- | | |
|---|-----------------------------------|
| C1 - 500 uF, 15V dc, electrolytic | R1 - 100 ohms, video gain |
| D1, D2 - diode (RS-276-1011) | R2 - 82 ohms |
| Q1, Q2 - transistor (GE-221) | R3, R5 - 4.7 ohms, 1 watt |
| Q3 - transistor (RS-276-2026), with heat sink added | R4 - 20 k ohms |
| Q4 - transistor (RS-276-2018), with heat sink added | R6 - 2500 ohms, output adjustment |

COMING IN THE JULY NEWSLETTER

John, W8E0Y, describes a crystal controlled AM modulated 1.2 GHz ATV transmitter. All necessary construction details will accompany his article.

HELPFUL HINT

Have you ever made up a coax cable only to find it was shorted? Here's a way to to make a quick fix. Place a high current source, such as a storage battery, between the center conductor and the shield. By so doing, the short should be burned out and thus eliminated. (Submitted by Dave, W8AER.)

YAGI ANTENNA FOR 900 MHz

(continued from page 4)

Table 1

<u>Element Lengths</u>	<u>Element Spacing</u>	
R 6-1/2"	R to DE 2-1/4"	D11 to D12 5"
DE see Fig. 2	DE to D1 1-7/8"	D12 to D13 5-1/8"
D1 5-5/8"	D1 to D2 1-1/8"	D13 to D14 5"
D2 5-1/2"	D2 to D3 3-3/4"	D14 to D15 5-1/8"
D3 5-3/8"	D3 to D4 3-7/8"	D15 to D16 5"
D4 5-5/16"	D4 to D5 3-3/4"	D16 to D17 5-1/8"
D5 5-1/4"	D5 to D6 4-7/8"	D17 to D18 5"
D6 5-3/16"	D6 to D7 5-1/2"	D18 to D19 5-1/8"
D7 5-1/8"	D7 to D8 4-5/8"	D19 to D20 5"
D8 thru D10 5-1/16"	D8 to D9 5-1/8"	D20 to D21 5-1/8"
D11 thru D15 5-1/32"	D9 to D10 5"	
D16 thru D21 5"	D10 to D11 5-1/8"	

Note: D = director; DE = driven element; R = reflector.
 Length of 1/2" PVC pipe boom = 8'3"

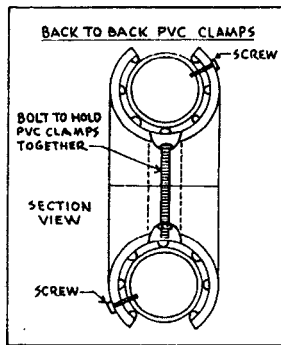


Fig. 1

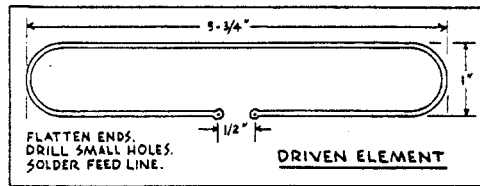


Fig. 2

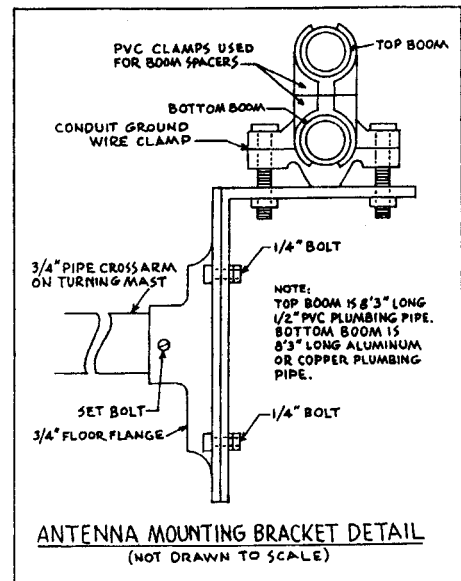


Fig. 3

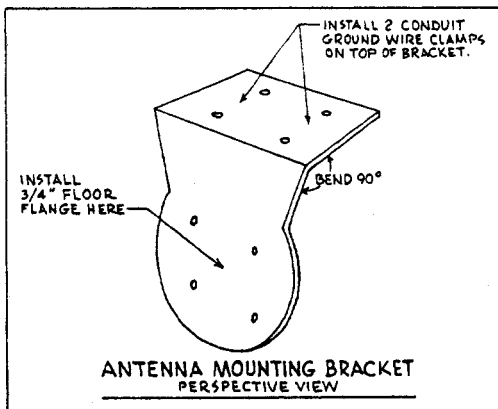


Fig. 4

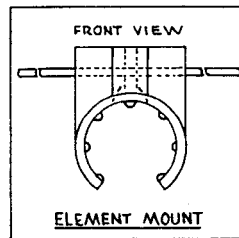


Fig. 5

MATCHING ANTENNAS

A quarter-wave length of line has the ability to transform the input impedance to another impedance in accordance with this formula:

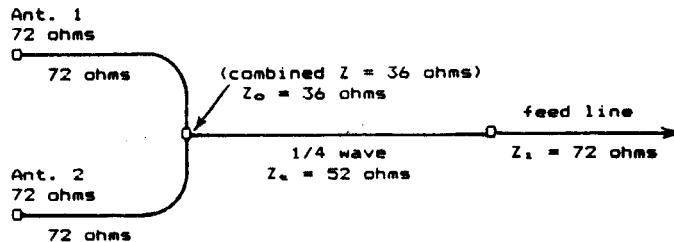
$$Z_e = \sqrt{Z_o \times Z_i}$$

Where: Z_e is the characteristic impedance of the line needed for the matching section
 Z_o is the impedance of the load (antenna)
 Z_i is the impedance of the feed line

The two examples below show the application of this formula.

EXAMPLE NUMBER 1

If a pair of antennas each having 72 ohm impedance are stacked, the combined impedance will be one-half of 72 ohms or 36 ohms. This may be transformed back to 72 ohms by the use of a quarter-wave section of 52 ohm coax.



$$Z_e = \sqrt{Z_o \times Z_i}$$

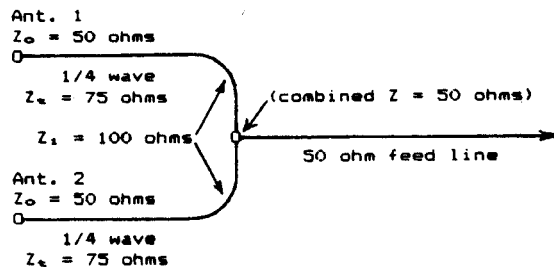
$$Z_e = \sqrt{36 \times 72}$$

$$Z_e = \sqrt{2592} = 50.9 \text{ or } 52 \text{ ohms}$$

EXAMPLE NUMBER 2

Match two antennas each having an impedance of 50 ohms to a 50 ohm feed line.

Transform the 50 ohm impedance of each antenna to 100 ohms by using a quarter-wave section of 75 ohm coax, then parallel the two to obtain the required 50 ohm feed line impedance.



$$Z_e = \sqrt{Z_o \times Z_i}$$

$$Z_e = \sqrt{50 \times 100}$$

$$Z_e = \sqrt{5000} = 70.71 \text{ or } 75 \text{ ohms}$$

After the impedance and dimensions of the quarter-wave matching section have been determined, any number of half-wave sections may be added to attain the required physical length - each half-wave section of line will repeat the impedance at its input. The half-wave lines may be of any impedance.

(continued on page 11)

ATV NEWS ITEMS OF INTEREST

By Bill, W8DMR

1988 DAYTON HAMVENTION ATV FORUM SCHEDULE - Tom, W6ORG, reports the speakers and their subjects for the ATV Forum to be held at the Dayton Hamvention on Saturday 30 April from 3:15 to 5:00 p.m. are as follows:

Bill Brown, W8BELK - Balloon Launch Recap
Tom O'Hara, W6ORG - ATV Basics and 905 MHz ATV
A. N. Emmerson, G8PTH - European ATV
Steve Goode, K9NG - Shuttle Proposal

The exact order of presentation is yet to be determined.

1254 MHz TEST BEACON, CENTERVILLE, OHIO - Bruce, W8BUGV, has a wide lobe corner reflector antenna fed with one watt of rf pointed toward Dick, W8RVH. The transmitter is a modified APX-6 oscillator which is amplitude modulated with an audio tone. If you wish to hear the full quieting CW tone, contact Dick who will rebroadcast it on 147.45 MHz.

CRYSTAL FOR 434.0 MHz - A letter received from P.C. Electronics indicates that a price break is not available for the purchase of a quantity of ten crystals. This item may be purchased from Jan Crystals (open for business Monday through Thursday only), Fort Myers, Florida, in single quantities for \$10.00. This is a \$5.00 savings, and three weeks should be allowed for first class postpaid delivery. When ordering, request a 5th overtone, a frequency of 108.5 MHz, and a HC25/U holder.

FIRST 1.2 MHz ATV FM RECEIVER IN FRANKLIN COUNTY! - John, W8E0Y, has his new WR-FM4912 receiver with external preamp from Wyman Research checked out and operational. He is watching for anyone transmitting an FM modulated ATV signal with at least +/- 4 MHz deviation and 6 MHz subcarrier audio.

BLACK AND WHITE 5-INCH TV SET MODIFICATIONS - Several ATCO members have changed the lower limit of the varactor tuning voltage on these sets thus reaching the 439.25 MHz ATV frequency. By increasing the tuning voltage, the tuner will tune as high as 915 MHz for the upper limit (see page 5 for details). Sun has these units in stock for approximately \$35.00; an optional car cord is available for an additional \$9.00.

USING A 1278 MHz TRIPLER AS A LINEAR AMPLIFIER FOR ATV - W8E0Y is currently accomplishing this heretofore impossible feat. An ATCO Newsletter article giving details is in the works. How it actually operates is unusual, to say the least!

WANTED, ARTICLES FOR THE ATCO NEWSLETTER - Send 'em to the ATCO Newsletter Editor now!

IN-BANDERS, OUT-BANDERS

Oh how nice ATV could be
 If I could receive a picture
 Without in-band interference
 Caused by a link in the community.

They argue, "440 is theirs!".
 Who really cares,
 As my reception unacceptably tears?

They claim, "A 440 link is OK!"
 Day after day.
 Will the interference ever go away?

They proclaim, "We were here first!",
 But the situation continues to get worse.

Crosshatch...
 Video Bars...
 Loss of Color...
 Loss of Sound...
 Loss of Picture...

Look around -
 Is there no band plan to be found?

Oh why can't the coordinators come and see
 What all this is doing to my TV!

- By an anonymous ATV ham

(Submitted by Dave, KB2ARL.)

COAXIAL CABLE LOSSES DB/100 FEET

<u>CABLE TYPE</u> AND <u>DESCRIPTION</u>	<u>FREQUENCY IN MHZ</u>					
	<u>144</u>	<u>220</u>	<u>440</u>	<u>905</u>	<u>1296</u>	<u>2304</u>
0.14 In. SEMI-RIGID.....	4.1	5.1	7.4	11.0	13.0	18.0
RG-58/U.....	6.5	8.5	12.0	17.8	21.0	32.0
RG-8,-11,-213,-214.....	2.4	3.4	5.0	8.0	10.7	15.9
B-9913, C-1180.....	1.5	2.0	2.9	4.2	5.1	7.3
1/2 In. FOAM FLEX.....	0.9	1.3	1.9	2.9	3.7	5.4
RG-17/U.....	1.2	1.7	2.4	4.0	4.9	8.0
1/2 In. FOAM HELIAX.....	0.8	1.1	1.5	2.2	2.6	3.8
7/8 In. FOAM HELIAX.....	0.5	0.6	0.8	1.2	1.5	2.0
7/8 In. AIR HELIAX.....	0.5	0.6	0.8	1.1	1.4	2.0
1.0 In. HARDLINE.....	0.5	0.6	0.9	1.3	1.6	--
1-5/8 In. FOAM HELIAX.....	0.3	0.4	0.5	0.8	1.0	1.4

NOTE: B = BELDEN; C = CARROLL (FORMERLY COLUMBIA).

MATCHING ANTENNAS

(continued from page 8)

To calculate a quarter-wave line:

$$\begin{aligned}\lambda/4 &= 246 / f \text{ (in MHz)} \times V \text{ (velocity factor)} \\ V &= .66 \text{ for solid dielectric coax} \\ V &= .80 \text{ for foam dielectric coax}\end{aligned}$$

Example using a quarter-wave length of RG-8U solid dielectric coax for 439.25 MHz:

$$\lambda/4 = 246 / 439.25 \times .66 = .369 \text{ feet} = 4.435 \text{ inches}$$

To calculate a half-wave length section:

$$\lambda/2 = 492 / f \times V$$

Quarter-wave sections may be paralleled to obtain lines of one-half the impedance of the single line. (Submitted by Guy, KBHVA.)

APRIL ARITHMETICKLER

Here's a brain teaser that may tantalize your puzzle solving talent. If you can figure it out, you will prove that 2 does equal 1!

1. Let $A = B$
2. Multiply both sides by A : $A^2 = AB$
3. Subtract B^2 from both sides: $A^2 - B^2 = AB - B^2$;
factor, $(A+B)(A-B) = B(A-B)$
4. Divide both sides by $(A-B)$: $(A+B) = B$
5. Given, $A = B$, therefore: $B + B = B$
or, $2B = B$
so, $2 = 1$
WHY???

OUR CONTRIBUTORS

Our thanks to the following ATCO members for submitting articles published in this issue of the ATCO Newsletter!

Dale, W8KQQ - "Yagi Antenna for 900 MHz."

Bill, W8DMR - "Antenna Stacking Distance" and "ATV News Items of Interest."

Guy, KBHVA - "Video Modulator for 2C39 Final" and "Matching Antennas."

Dave, W8AER, offers a "Helpful Hint."

Bob, W8TV - His "Arithmetickler" will exercise your brain.

Dave, KB2ARL - "In-Bander, Out-Bander" a bit of poetry.

Bill, W8BELK, Tom, KBZNY, and Bill, W8BURI, for the "Five Inch TV Set Modification" article.

ATCO MEMBERS AS OF 31 MAR 1988

KBAEH	Wilbur Wollerman 1672 Rosehill Road Reynoldsburg 43068	WB8JEN	Bob Mills 6834 Halligan Avenue Worthington 43085
WBAER	David Sears 1678 Kaiser Drive Reynoldsburg 43068	KBJGY	Fred Yost 330 Dellfield Way Gahanna 43230
KB2ARL	Dave DiGiuseppe 3841 Evanston Drive Columbus 43232	WABKQQ	Dale Waymire 225 Riffle Avenue Greenville 45331
WABATF	Emmett McDonald 14120 Flintridge Rd. SE Glenford 43739	KABLWR	Marlin Alberty 1645 Olentangy Road Bucyrus 44820
W8BBW	Joe Schumann 5418 Marietta Road Chillicothe 45601	W88MMR	Mike Knies 1715 Winding Hollow Dr. Columbus 43223
W8CCW	John Ferrell 3722 Wagner Court Grove City 43123	W88OBT	Tom Camm 1267 Arkwood Avenue Columbus 43227
KN8DMK	Bill Delker 8460 Bowers Road Amanda 43102	W88OTH	Perry Yantis 1850 Lisle Avenue Obetz 43207
W8DMR	William Parker 2738 Floribunda Drive Columbus 43209	W88RMC	Arthur Towslee 180 Fairdale Avenue Westerville 43081
N8DUK	Ron Reynolds 4642 Glengate Drive Columbus 43232	W88RVH	Richard Goode 9391 Ballentine Road New Carlisle 45344
W8EHW	Foster Warren 124 East Clark Street North Hampton 45349	W88RZG	Corwin Miller 4966 Haughn Road Grove City 43123
W8EQY	John Schlaechter 3199 Lewis Road Columbus 43207	W88TTE	Phil Morrison 154 Llewellyn Avenue Westerville 43081
W8FRQ	William Ennis 146 South Weyant Avenue Columbus 43213	W88TV	Bob Dye 6118 Sedgwick Road Columbus 43235
W88FWQ	Christopher Vojsak 2050 Ellington Road Columbus 43221	N88BU	Philip Brooks 412 Franklin Street Piqua 45356
K88GZQ	Warren Dummel 3488 Darbyshire Drive Hilliard 43026	W88UGV	Bruce Jaquish 193 Cherry Drive Centerville 45459
K88HRR	Ira Bickham 260 Tiki Drive Merritt Is., FL 32953	W88URI	William Heiden 4435 Kaufman Road Plain City 43064
K88HVA	Guy Cunningham, Jr. 31 Birchfield Street Plymouth 44865	K88UU	William Rose 439 S. Murray Hill Road Columbus 43228
K88ISM	Steve Iacono 1075 Virginia Avenue Columbus 43212	W88VSY	Jack Schmermund 401 North Main Street West Milton 45383
W88JDL	Doc Althaus 2619 Love Drive Columbus 43221	K88YAH	Ronald Vanke 5094 Longrifle Road Westerville 43081
W88JDV	George Martini 3027 Inn Road Columbus 43232	W88ZVN	Willard Mathews 221 Black Run Road Chillicothe 45601

BUY, SELL, OR TRADE?

Place your ad in the ATCO Newsletter for items related to amateur radio and television - there's no charge to ATCO members. Publication is subject to space availability.

 THE ATCO TUESDAY NIGHT NET MEETS EVERY WEEK AT 8 EST AND 9 EDT

ATCO FINANCIAL STATEMENT

CASH BALANCE:
As of 31 December 1987.....\$243.13

RECEIPTS:
Dues.....\$290.00

EXPENDITURES:
Printing charges for January 1988 ATCO Newsletter....\$ 59.08
Postage for January 1988 ATCO Newsletter..... 16.38
Misc. costs incidental to publication of newsletter.. 21.58

Total expenditures.....\$ 97.04

SUMMARY:
Cash Balance as of 31 December 1987.....\$243.13
Receipts..... 290.00
Expenditures.....- 97.04

Balance as of 31 March 1988.....\$436.09

22 CENT POSTAGE STAMP INVENTORY:
Stamps on hand as of 31 December 1987..... 23
Stamps used..... -18

22 cent stamps on hand as of 31 March 1988..... 5

The above financial report was prepared as of 31 March 1988 by Warren G. Duemmel, KABGZQ, Acting ATCO Treasurer.

YOUR ATCO DOLLARS

(continued from page 3)

Newsletter printing charges and miscellaneous costs (printer paper, printer ribbons, photo copies, drawing supplies, etc.) incidental to publication amounted to \$268.39. Postage charges were \$83.37. The total of these two items was \$351.76.

Lunch and refreshments for The Antenna Measuring Party on 19 September required a cash outlay of \$53.82.

So, our total expenses from the treasury were \$405.58 or \$9.66 for each member.

FIVE INCH TV SET MODIFICATION

(continued from page 5)

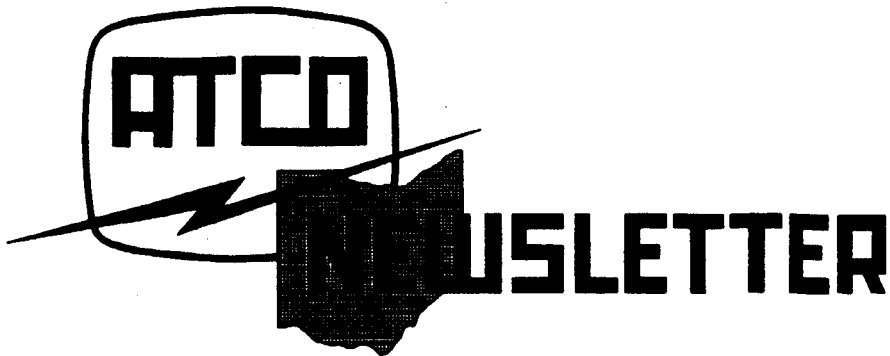
Ten Kai manufactures a similar unit with a February 1987 date. To modify this set, substitute R702 for R110 and SVR704 for VR101 above and proceed as instructed.

Tuners for both TV sets with part numbers CAE 5-724 and CAE 5-717 can be modified for 439 and 900 MHz. (Technical information supplied by Bill, WBSELK, and Tom, KABZNY. Article submitted by Bill, WBSURI.)

Editor: Warren, K86ZD
Technical Editor: Bill, W8DMR

FIRST CLASS MAIL

ATCO NEWSLETTER
c/o Warren G. Duemmel
3488 Darbyshire Drive
Hilliard, Ohio 43026



PLAN TO ATTEND
THE ATCO TECHNICAL SYMPOSIUM

PROGRAM AND MAP ON PAGE 3
