CATJ
OCT.
1976
#165 Copper Lightning Protection Wire, soldered to Transmission Line Pipe
Guy Strap "S"
3/4" x 14" Bent Thimble Eye Bolt
3 Bolt Guy Clamp
Retard Coil when specified
1/4 x 2 1/2 Drive Screws.
Antenna Coupling Transformer as specified
10M Guy
See Dwg. #709 for Gas Seal and Termination.
3" thick Wood Block with Cable Strap
1/2" x 4 1/2" Drive Screw
Pole Step
5/8 Ca. Susp Bolt
1 3/8 O.D. Copper Pipe Transmission Line
6M Guy
#0 Porcelain Strain Insulator Spaced 15' with first Insulator 5' from Pole
Hubbard Balcony #9045
3 Bolt Guy Clamp
64' Average Height of Antenna above Ground
1/2" x 4 1/2" Drive Screw
1 1/2 Cable Strap
3" thick Wood Block with Cable Strap
1 1/2 Cable Strap
255' To Side Corner
#162 Copperweld Antenna Wire
#21279 Isolantite Insulator
#346 Shackle (Special 3")
See Detail 9
Antenna Transformer Coupling as specified
Front Pole See Details 3 & 4
REAR POLE TOP VIEW ASSEMBLY DETAIL 5
1 to 1 Lead
Wire Length
1-#162 Copperweld High Tension Wire 40% Conductance
205.32'
238.65
476.30
237.65
Side Pole Lead 2 Height 3
Side Pole See Details 7 & 8 Lead 2 Height 3
Bearing of Antenna N.16°-38'E.
Tilt Angle
Wire Length
251.4' to Side Corner
.162 Copperweld Antenna Wire
See Detail 10
10' Rad.
4.64'
.162 Copperweld Wire
ANTENNA LAYOUT DETAIL 2
.165 Copper Wire
40.0
Rear Pole See Details 5 & 6
.162 Copperweld Wire
Ground Line
#21580 Isolantite Insulator.
.162 Copperweld Antenna Wire
FRONT POLE TOP VIEW ANTENNA ASSEMBLY. DETAIL 3
Radiator Wire Length - 255
Tilt Angle - 67 1/2°
Average Height of Antenna above Ground
Wire Sag
REAR POLE SIDE VIEW DETAIL 6

CATJ

OCT. 1976

VOLUME 3 — NUMBER 10

PUBLISHED MONTHLY, AS ITS OFFICIAL JOURNAL, BY THE COMMUNITY ANTENNA TELEVISION ASSOCIATION, INC. OKLAHOMA CITY, OKLAHOMA AS A SERVICE TO ITS MEMBERS AND OTHERS PROVIDING CATV/MATV SEVICE TO THE TELEVISION VIEWING PUBLIC LOCATED THROUGHOUT THE WORLD.

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DEPARTMENTS

— OUR COVER —

RHOMBICS AND FALL — Twenty pages of rhombic antenna design material begins on page 10 here this month. Fall began several weeks ago. With the weather cool and signals headed down to winter-type low levels, what better time to up-grade your distance channels with 27.5 dB of antenna gain!

CATA-TORIAL

KYLE D. MOORE, President of CATA, Inc.

MIRROR, MIRROR ON THE WALL... WHO'S THE DUMBEST FOOL OF ALL?

The waning days of the 94th Congress provided the setting for a first-class show of cable industry dumbness unmatched by any recent era of this small industry. For the record, before the House of Representatives were a pair of bills guaranteed to make any free-marketplace-cableman lose his lunch all over his headend.

First there was HR 10620, a bill introduced back in July at the urging and pleading and pushing of (1) FCC Chairman Richard E. Wiley, and, (2) the always friendly "NAB". HR 10620 would create Congressional authority for the FCC to "modernize" its fine and forfeiture scheme. For more than a decade (or since January, 1962 to be exact) the FCC has enjoyed some form of "fine authority", wherein the Commission could move in on a licensee and issue monetary fines against the "licensee" if he was found to be operating contrary to the applicable Commission rules and regulations. HR 10620, a companion bill to one approved by the Senate back in June, would extend the Commission's fine and forfeiture authority into the cable television industry.

Back earlier this year the Senate version of this bill had received only token hearings, and after the hearings the bill was tucked away in a non-conspicuous "pigeon-hole". The bill's sponsor, Senator Pastore was waiting for a lull in the Senate activity, and when it came along towards the end of spring the bill slid through the floor of the Senate as one of those "quickie jobs". Nobody really ever knew what it was all about.

To his credit, Congressman Lionel Van Deerlin of the House Sub-committee on Communications promised to hold open hearings on the House version of the bill, and on July 29th the hearings were held. **At that point only CATA seemed concerned with HR 10620.** Over at the NCTA, there were 'bigger fish to fry'. Specifically, the NCTA was working hard on getting the same Communications Sub-committee to consider another piece of 'emergency' cable legislation...this one to grant to the FCC "statutory jurisdiction over pole attachment agreements between cable companies and the joint pole owners (i.e. telco and the power utility)". The NCTA was working very hard on this proposed bill, and crying "wolf" at every opportunity. The NCTA message was that "unless Congress gave the FCC necessary authority to regulate pole attachment disputes, cable was about to be put out of business from coast to coast by unfriendly power and telco operators."

Clearly, at least an important handful of Sub-committee members did buy this "story" because in mid-August a draft of such a bill appeared and it received the immediate backing of two of the Sub-committee members (Van Deerlin of California and Wirth of Colorado). To back up the call for action, the NCTA was rallying troops from coast to coast urging them to contact their own Congressmen and spread the word that "without this emergency legislation the cable industry would fall before the snows fell".

Hundreds of operators got all worked up in this campaign, as demonstrated by a meeting that produced 100-plus operators from the State of Washington who called upon the offices of Senate Commerce Chairman Magnuson. The message to Magnuson was plain, simple, and sincere. Cable was having a "going out of business" sale.

Now the legislation drafted for the Van Deerlin Sub-committee by the NCTA legal staff would grant to the FCC the clear authority to step into cable/utility pole disputes and resolve (1) rate dis-agreements; (2) attachment dis-agreements, and, (3) cost sharing dis-agreements. But introducing a bill of such complexity and with more than its share of controversy (obviously the power and telephone companies did not want the FCC to have this 'authority' and they were already at work 'lobbying' their own position) at this late date in the waning hours of the 94th Congress almost guaranteed that such a bill would simply not make it through this session. Time was against the bill, no matter how meritorious it might be. So the NCTA staff and the Van Deerlin staff looked around for another bill, **one further along in the legislative steps** and one sure to pass this year. The pole language would be attached to such a piece of legislation. Such 'riders' are frequently employed in Congress, especially in the waning days of a session; and as a consequence you end up with some mighty strange bill titles under such circumstances.

The 'pole bill' plus 'X' might have read: **"HR 20,000 — A Bill To Establish Public Urinals In All Federal Parks, and, To Authorize the Federal Communications Commission To Adopt Regulations For Cable Television Pole Attachment Rights"**. Nobody could be against free public urinals in federal parks.

Finding no convenient public urinal bill hanging around, the NCTA did find HR 10620, the cable TV (and other) FCC fines and forfeiture bill. This bill already had hearings, and it looked to NCTA that it was going to pass Congress. So why not attach the 'pole legislation' to HR 10620? And it was done, and there upon we saw HR 10620 wed with HR 15268 and we got **"HR 15372 — A Bill To Authorize The Federal Communications Commission To Adopt Regulations For Cable Television Pole Attachment Rights, and, To Authorize The Federal Communications Commission To Establish New Rules And Regulations For Monetary Fines And Forfeitures."**

The NCTA really turned on the heat at this point and their members in turn went to work on their congressmen. On the fines and forfeiture bill, at July 29th hearings, only CATA really opposed the principal of fines. The NCTA sent up former Board Chairman Rex Bradley who by in large said the NCTA approved of "the principal of fines". Clearly in the marriage between HR 10620 (fines) and HR 15268 (poles), poles were the "male partner" because in the NCTA's frontal attack on their members, the industry and Congress, the new dual-purpose bill became simply... **"the pole bill"**. Everyone at NCTA "forgot about" the fines and forfeitures. So effective was the "pole bill" ploy that when an officer of the Wisconsin CATV Association telephoned a Wisconsin CATA member in mid-September to urge the CATA member to send off a series of "nightwires" to Congress, the Wisconsin CATV officer was dumbfounded when he was told by the CATA member "No...I cannot support this bill because it includes fines and forfeitures."

"Come again...HR 15273 includes what!" responded the exec.

"Fines and forfeitures...you know, the FCC power to come into your system and fine you say $2,000.00 because you have some DT's radiating more signal than FCC rules allow."

"Man...you are crazy. This is the pole bill!!!" responded the exec., and after several minutes of heated discussion the exec. hung up without ceremony with a parting **"Boy...you CATA people are really crazy...you people need to find out what these bills are really all about!"**

And so the telegrams and letters poured in. At NCTA direction. Meanwhile, back at the farm, this writer and a handful of other CATA people took a different tack. We rounded up a half dozen politically well placed CATA supporters and we quietly, without fanfare, traveled to Washington to see four important, key Congressmen. We also went in to visit with several members of the staff of the Sub-committee on Communications. At our stops we discussed with each the real impact of the fine and forfeiture portion of this "marriage."

For example:

(1) The bill, as written and as presented to the Sub-committee for mark-up would allow the FCC to put the fines and forfeitures into effect within thirty days of passage and the President's signature;

(2) We pointed out that one of the critical aspects of the fines was that FCC field vans would be out roaming the countryside inspecting CATV systems for technical (i.e. performance) compliance; under rule sections 76.605 (a) (1-12). We saw the following scenario developing:

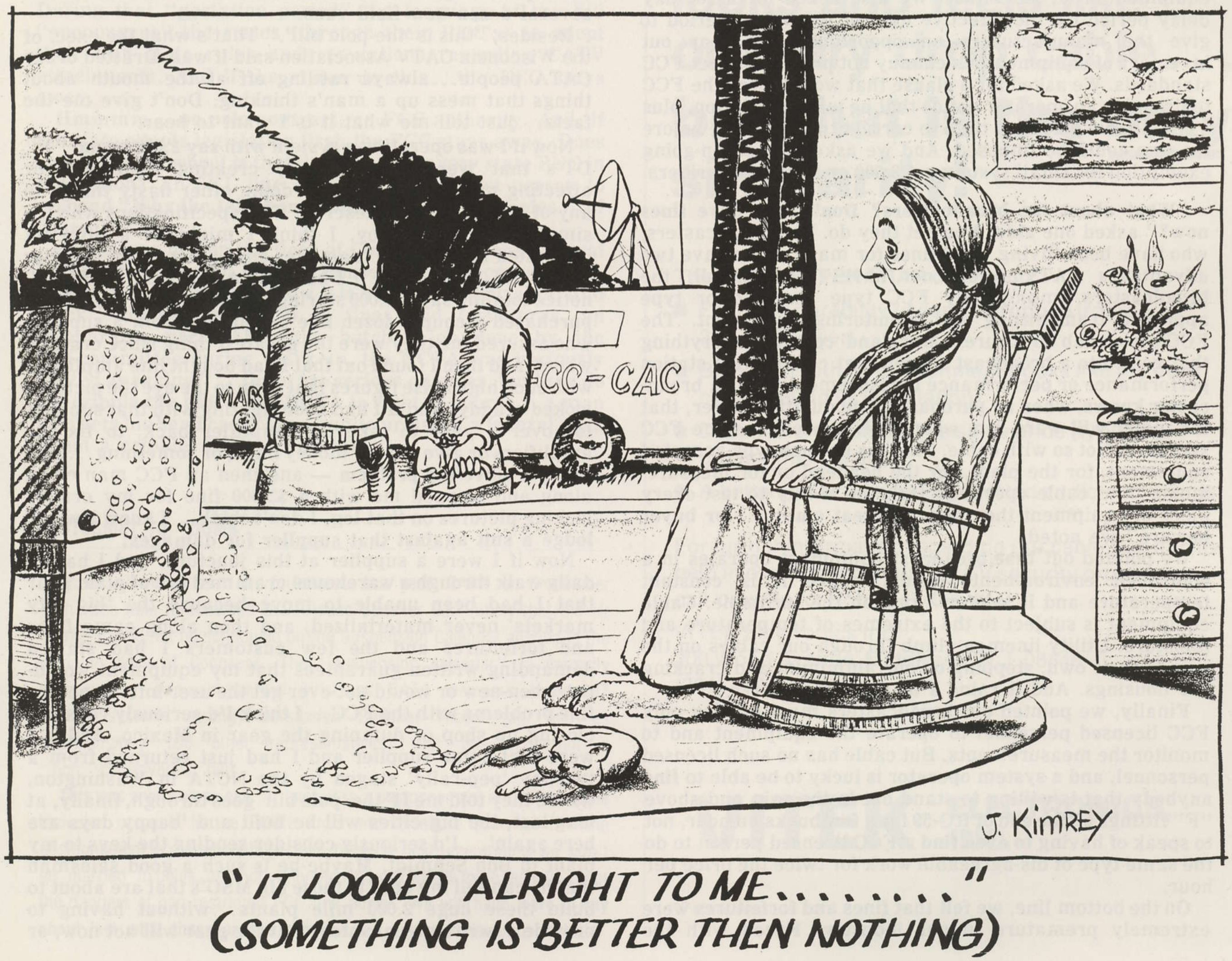
The plainly marked truck pulls up in front of your office, having already spent several hours 'nosing' around your town. The man walks in and announces **"I'm from the FCC regional office and I am here to inspect your system's records and technical compliance."** So you show him your test records for the most recent year, and after some small talk and coffee he says **"Come out with me to the field truck and let's take a look at some sections of your plant."** You can hardly refuse to go along.

At the corner of Oak and First streets he pulls up the van and sets up some equipment. Then he points to his $13,000 HP analyzer and says, "**I see we have some radiation here, twice the permissible levels.**" You mutter something about an entrance fitting not being properly tight, or you wiggle a little and comment that the "so-called radiation-proof plates" on the DT's have to be torqued up 'just right' or there is a problem, and he smiles, while writing down some notes in his field book.

Then he shuts the gear down and pulls the van out into the street heading for the edge of town. You are decidedly uncomfortable and the small talk has long since stopped. The van stops at the end of your longest trunk and feeder cascade and the FCC man asks **"Can we get a test point drop out of that amplifier?"** You nod your head and start up the pole with a piece of 59 he provides. By the time you are back on the ground he is in front of the HP analyzer. And he is humming to himself. **"Got a little co-channel here on 5"** he says. You respond that the weather conditions are poor today and agree the level is high, "higher than normal" you offer. "**Hmmm... only 31 dB down. Isn't the spec 36 dB down?**" he asks. You agree with him about the spec. **"What's this 6% hum mod on channel 11?"** he asks. You try to explain about the intermittent in the processor power supply that you have been chasing for several weeks, but he is too involved in placing more notes into his field book to pay much attention.

Several hours later he leaves town. You have gone through sixteen separate tests with the man, who was always very professional and who filled up seven pages of his notebook with his observations. In all, your visit with him resulted in the determination that channel 11 had hum mod throughout the plant (1 offense), one leg of your plant had hum mod after the last power supply (2nd offense), channel 5 had co-channel higher than the limits prescribed by the rules (3rd offense), fourteen DT's were spotted that were radiating (offenses four through 17), a temporary house drop using a pressure tap had only 15 dB of isolation (18th offense), and, two end-of-line subscribers had set input levels of less than 0 dBmV (offenses nineteen and twenty).

Then in a couple of weeks you receive a formal looking letter, with a return receipt requested, from the FCC. It is a "Notice of Apparent Violation" and an "Assessment of



"IT LOOKED ALRIGHT TO ME........"
(SOMETHING IS BETTER THEN NOTHING)

Fines" totaling $2,050. broken down as follows:

(1) Channel 11 hum-mod...$250.00

(2) Hum-mod on one plant leg...$50.00

(3) Channel 5 co-channel...$100.00

(4) Fourteen DT's that radiated signal...14 x $100 = $1,400.00

(5) Improper drop isolation...$50.00

(6) Two subscriber drops with low levels...2 x $100 = $200.00.

You thank your lucky stars he didn't have time to check out all 782 DT's in your system.

As we related this scenario to the four key Congressmen and the aides to the Sub-committee, we asked "How in the world can Congress authorize the FCC to assess such fines when the FCC's technical rules are in such a state of flux? How can a cable operator, who purchased 782 DT's from a supplier in 1975 or 1969 be held responsible because it turns out that after a year or seven years of operation the DT won't seal properly and the housings radiate? Or perhaps the entrance fittings, which appeared well designed from every test the operator can make, have a critical-torque-point above and below which there is radiation."

"Is it right to give an industry with over a billion dollars invested in hardware only thirty days to comply with the rules? Should there not be some consideration given to the operators of these systems who have purchased the equipment they needed for their systems in good faith, but who are now stuck with equipment that **seems** to perform properly in all respects **except** that the equipment somehow does not meet FCC standards first adopted in 1972? Should there not be some allowance for human error, weather conditions, and the weathering which all CATV equipment is subjected to?"

So CATA suggested that there be a grandfather clause in the bill. A clause that would exempt any existing, installed equipment from FCC fines. We also asked for a 180 day delay period for the effective date of the bill, a period to give the manufacturers an opportunity to clear out inventory of equipment which may not presently meet FCC standards. We asked for a clause that would force the FCC to first give an operator notice that he was in violation, plus a reasonable period of time to correct the violation, before the fine could be imposed. And we asked for an on-going exemption for small systems of 3,500 or fewer subscribers.

"What about the broadcasters? Don't they have fines now?" asked one aide. You bet they do. The broadcasters, who have been 'living with' fines for many years have two advantages CATV would not have. First of all, the broadcasters employ only FCC type accepted or type approved transmitting and monitoring equipment. The FCC's own lab in Laurel, Maryland certifies everything that goes into a broadcast station that could affect station performance or performance measurement. Thus a broadcaster knows, when he purchases a modulation meter, that the meter will warn him when he is exceeding some FCC standard. Not so with cable. There is no such type accepted equipment, for the plant, for the headend or for measurements. And cable operators lack the ability to test every piece of equipment they buy. **"Caveat emptor...or buyer beware"** we noted.

We pointed out that broadcast equipment operates in a controlled environment. Inside, where it is constant temperature and it seldom rains on the turntable. Cable equipment is subject to the extremes of temperature and moisture. Utility linemen climb through our cables on the way to their own, stepping on our aluminum and cracking our housings. And it rains a lot on cable gear.

Finally, we pointed out broadcasters must employ only FCC licensed personnel to operate the equipment and to monitor the measurements. But cable has no such licensed personnel, and a system operator is lucky to be able to **find anybody** that is willing to stand out in the rain and shove "F" fittings on the end of RG-59 for a few bucks an hour, not to speak of having **to even find** a FCC licensed person to do the same type of dis-agreeable work for twice the price per hour.

On the bottom line, we felt that fines and forfeitures were extremely premature in our industry. Faced with the reality of fines, we felt two things would happen:

(1) Many one-man (owner/operator) CATV systems would close down, either out of fear of fines or within minutes of the departure of the first FCC field van visit.

(2) Thousands, perhaps hundreds of thousands of rural Americans would lose their only television reception.

Small systems run on a shoestring, and even larger systems, frozen into 1950'ish monthly rate structures by local politics, provide the best service they can. If they did not, there would be no customers there and they wouldn't be there long either. But however good the service is, **it is not now nor can it ever be as good as 76.605 (a) (1-12) mandates.** It is simply not financially possible to provide service to 76.605 technical specifications with the kind of gross revenues smaller or financially depleted systems have to work with.

But alas this is the "pole bill". That's what the telegrams and letters to Congress call it. That's what NCTA calls it. And besides, everyone knows that big systems have lots of lawyers, so they have nothing to worry about.

Worried that this **just might be** a 'small system' problem, we returned from Washington's visit late in August and decided to take a new VSM-2 analyzer out into a large 600 mile-plus metropolitan system nearby to us. We didn't announce we were there, we just played like the FCC. After visiting a mile or so of feeder plant with out radiation test dipole and the analyzer, we decided to make some additional system measurements at several customers of the big 25-operational-channel system. We found 19 violations. Based upon the present size of the plant (about 30% built), we computed there may be up to 2,400 FCC violations in the present plant alone. At $100.00 a pop, that would be a mind-boggling $240,000. liability. But who is to worry. This is a big system with plenty of lawyers and money. **They can afford** fines like that. A few visits to the metropolitan systems of the world and **the FCC could afford** several dozen new field vans.

Besides, "this is 'the pole bill'." That's what the exec. of the Wisconsin CATV Association said it was. Dratted crazy CATA people...always rattling off at the mouth about things that mess up a man's thinking. Don't give me the facts...just tell me what it is I want to hear.

Now if I was operating a system with say 2,000 brand "X" DT's that were radiating, or creating hum-mod, or affecting my signal levels, or doing other nasty things to any of a total of eight descrete FCC specifications which a simple DT can destroy, I think I might be a little bit interested in lodging a 'damages suit' against the supplier of that DT. Especially if I had an "Assessment of Fines" notice totaling say $10,000 staring me in the face. Or, if I had purchased a couple dozen line amplifiers from a supplier who assured me they were the greatest thing since cracked wheat, and then I found out that I had bought line amplifiers with such high noise figures that even to the eye the pictures looked cruddy; and if I had been fighting with that supplier for over a year to take the amplifier back, to fix the amplifiers or give me my money back, or something...**anything to solve my problem** — and then an FCC man came along and slapped me with a $2,000 fine for my cruddy looking pictures on that leg, I don't think...**I know I would lodge a suit against that supplier for damages!**

Now if I were a supplier at this juncture, and I had to daily walk through a warehouse crammed full of plant gear that I had been unable to move because the 'big city markets' never materialized, and then along came fines and forfeitures and the few customers I had started demanding written guarantees that my equipment would-not-when-new or would-not-ever get the user into monetary fine problems with the FCC...I think I'd seriously consider closing up shop or dumping the gear in Mexico. And if I were that same supplier and I had just returned from a two-day 'pep-rally' staged by the NCTA in Washington, where they told me **IF** the 'pole bill' goes through, finally, at long-last, the big cities will be built and 'happy days are here again'...I'd seriously consider sending the keys to my plant to Bob Schmidt. Maybe he is such a good salesman that he can sell my gear to those big MSO's that are about to build these huge 2,000 mile plants...**without** having to provide a 'written guarantee' that the gear will not now, or ever, get the buyer-user into FCC monetary fine problems.

'The pole bill'. Good grief.

Now when all is said and done, what happens when 'the pole bill' gets into mark-up at the Sub-committee level? Congressman Louis Frey of Florida, who was willing to offer the CATA (grandfather, etc.) amendments never brought them up. He did say, at the close of the mark-up session, that he had intended to offer some amendments **"but it was made clear to me by the majority** (those are the Democrats) **that if we modify this bill so that it is different from the Senate passed language of S.2343, the House version will have problems in the conference committee. So I have decided against offering these amendments..."** Congressman Frey tried...but he was outmanuevered in the backroom.

We hope that the 211 NCTA Associate Members appreciate this bit of footwork on their behalf. Nobody wants to destroy 'the pole bill', right?

So guess what happens to the pole portion of 'the pole bill' **in its own mark-up!** Naturally the utility company lobbyists have also been at work, and they have been persuasive enough that the language of the originally-drafted-by-NCTA pole provisions are in danger. And the language **is** modified. In fact, the bill leaves the Sub-committee with two interesting 'restrictions' on FCC power in the CATV pole attachment area.

Number one — The FCC **will not have** the authority to **force** a telephone or power company to grant a CATV company pole attachment space. In other words, if the power company or telco says to the operator "Sorry, Charlie...we feel no compulsion to grant you any attachment space", **the FCC could not force them to do so.** So if there is no pole attachment agreement, there are no FCC powers granted in the bill!

Number two — The 'effective date' of the FCC's new "pole-power" will be 9 months **after** the adoption of the law. During that "gestation period" the language of the bill "encourages" the states (through their PUC's) to adopt their own state rules and regulations regarding CATV attachments. **And if** the states do this...the FCC stays away.

Hmmmm...no pole contract, no FCC authority. And, if the state adopts legislation first, the FCC stays away. Does anyone recall who it is that literally runs every state PUC in the nation? An SKL line amplifier to the first person to respond **"Why the telephone and/or power companies...of course!"**

So here we are on the floor of Congress with the original NCTA bill mangled by the House Communications Sub-committee so badly that now it is hardly recognizable. And stuck "along side" of it is fines and forfeitures, an inseparable part. After the butcher job done by the Sub-committee during mark-up, the NCTA was variously quoted as saying "...**these are serious changes, but they do not cripple the bill**". The NCTA is right of course...a man who gets his head caught in a public urinal in a federal park is not a cripple. **He is a vegetable.**

POSTSCRIPT TO "DUMB"

There will be no fines and forfeitures; **this year**. CATA, on September 20th, was able to convince U.S. House Speaker Carl Albert that bill Hr 15372 should not be scheduled on the Suspension Calendar agenda in the wanning days of Congress. The "suspension calendar" is normally reserved for **non**-controversial bills and CATA members (now 587 member-systems strong) persuaded Speaker Albert (as well as approximately 100 other representatives) that this was not a "non"-controversial bill!

This was a very close call. At best, it is a postponement of the inevitable inclusion of cable in the FCC's fines and forfeiture scheme. But the postponement is extremely important, because next-time around we won't be 'married' to poles, and hopefully the industry will be more realistic about the dangers of non-restricted FCC fine power. **We will have more to say about just what those precise dangers are**...in the November CATJ.

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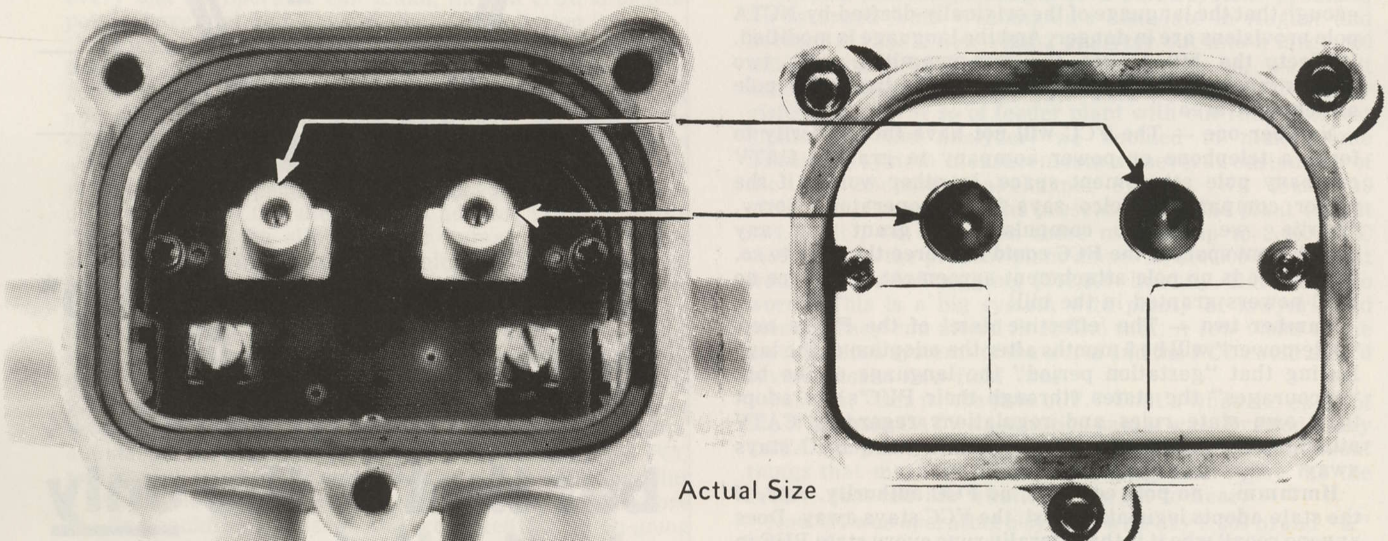

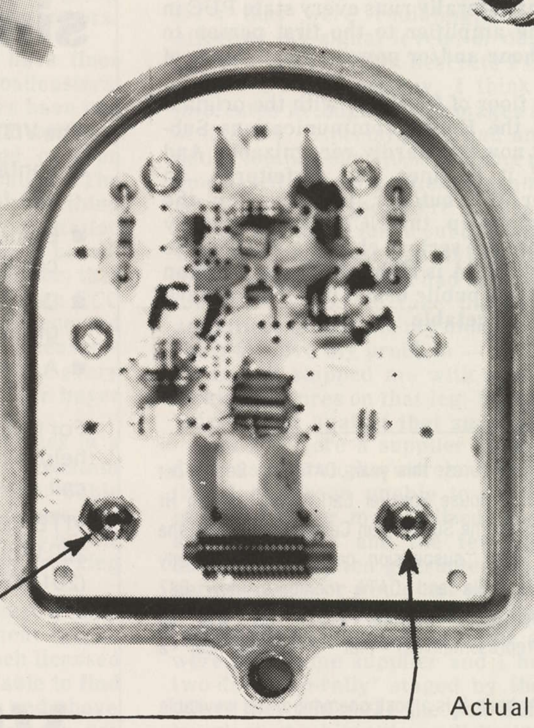

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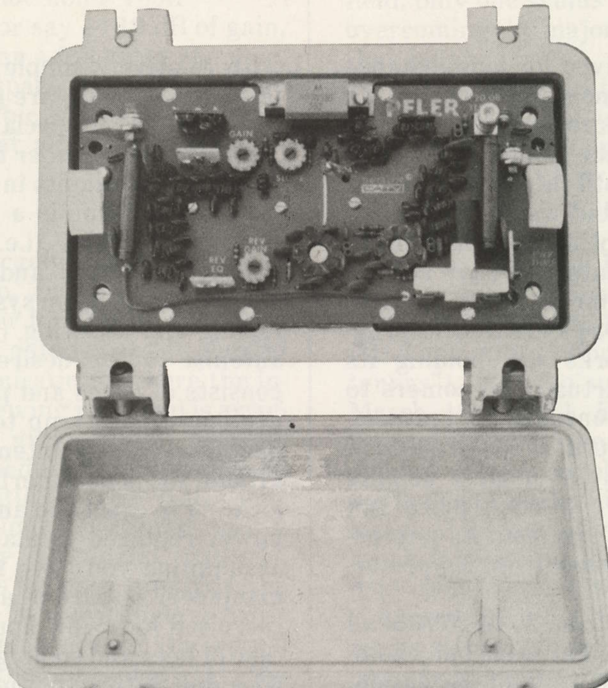

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LOST ART OF RHOMBIC ANTENNAS
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Big And Old

Of all antennas ever conceived for long-distance communications (and that includes transmitting and receiving), none has endured so long nor has retained its aura as well as the fabled "rhombic". *The rhombic is legendary.* Until the birth of ocean-hopping satellites, the rhombic was the sophisticated workhorse of inter-continental communication circuits. And where the satellites have not yet gained a toe-hold, the rhombic antenna remains the only ingredient of the 1930's created international communication networks still holding its own, original form against virtually all comers to come down the pike in the ensuing 40 years.

The rhombic, for all of its aura, is constructed of wire. It is supported typically at modest heights above ground by unobtrusive wooden poles and the rhombic gains its respect not from its impressive physical features but rather from its performance.

It has been estimated that from 20 to 25% of all early CATV systems employed at least one rhombic antenna for their early-day off-air reception. Remnants of rhombics at early-50's headend sites are still visible in places like Fayetteville, Arkansas and Marathon, Ontario and Sonora, California. Yet inspite of the fabled advantages of the rhombic antenna, surprisingly little hard-design data has appeared in print over the period 1931 (when the rhombic was introduced by a man named Bruce) to the present time.

The rhombic has three primary advantages, even today, over virtually any other antenna system a CATV system or other off-air receiving system for VHF-UHF signals can create. It also has at least one substantial dis-advantage, and a secondary dis-advantage that is primarily a problem at low-band VHF.

Advantage number one is gain. We will explore in construction detail rhombics that offer gain over tuned reference dipoles as high as 27 dB. To put that number into perspective, if you set out to construct a 27 dB gain array utilizing 10 element, 12 dB gain single channel yagi antennas, you would need no fewer than 64 of the ten element yagis to reach the 27 dB gain level.

Advantage number two is pattern. Rejections of unwanted signals can be "tailored" with a rhombic antenna, and nulls can be placed more at less at will where they are required. It is not easy to do, but it can be done, and rejections in excess of 34 dB over the forward direction can be achieved with relatively simple rhombics, while rejections in excess of 50 dB are possible in most-dis-favored directions with specialized rhombic designs.

Advantage number three is price. There are five primary ingredients in the construction of a rhombic antenna. One is a relatively small amount of copper-weld wire (i.e. copper plated or coated steel cored wire) and some ceramic insulators. Two is a suspension system to provide a method of raising and lowering (i.e. installing) the rhombic antenna to the desired location (this primarily consists of ropes and pulleys). Three is a support system, typically up to four utility poles of some height to get the antenna the design-height above ground for proper performance. Four is a suitable location to erect the antenna. And five is the manpower required to make the installation. On the assumption you have the land available, and the manpower is part of a regular payroll or can be recruited for a few hours work in exchange for a case of beer and some good fellowship on an otherwise dull Saturday, the balance of the ingredients can usually be put together for around $50-$100.00, plus the cost of the support poles. For gains of up to 27 dB, that is an extremely cost-effective antenna system!

Then there are the dis-advantages.

Dis-advantage number one is the care and skill required to make the antenna system perform to specification. The rhombic, for its apparent simplicity in form, is a very sophisticated antenna. One reference source calls the rhombic "the highest development of the long wire antenna". Those who believe a long wire antenna is itself not much of a development may believe otherwise when we have finished. The rhombic is extremely sensitive to ground reflections, and to obtain the design-pattern in real life (versus getting it on paper) requires more than a small bit of skill and probably a great deal of patience.

In talking with dozens of "old-timers" in CATV who have had occasion to try a rhombic or two, it is our belief that probably only one or two of the hundreds constructed by CATV operators in the 1950's ever worked within even a couple of dB of their theoretical gain capacity. We'll try to see why that might be so here.

Dis-advantage number two is the space required for a rhombic. Perhaps to be more precise, not just the space required, but the "lay of the land required" to erect a rhombic. If you are in the mid-west or south, finding a plot of ground at a suitably quiet location where you can mark-off an area say 400 feet long by 175 feet wide for installation of the rhombic support poles might not present a problem. But if you are on a mountain peak in Oregon or a hilltop in West Virginia, finding *that much flat-ground* could be a problem. However, the space requirement diminishes with frequency, and a full sized rhombic at high band requires an area around 130 feet long by 60 feet wide. And at UHF, well, you could almost put 27 dB gain of antenna above a typical suburban lot home roof!

And you may find that, for say 14-19 dB of gain, you can get by with less than a full sized rhombic, and thereby reduce the space requirements so that even a low band rhombic will fit into a much smaller space. We'll look at all of this here.

The Art of Design

Designing a rhombic is largely a matter of knowing what you want it to do, and then fitting the pieces of the puzzle together for that end achievement. Most rhombic design data is heavily slanted towards shortwave communications, where the incoming wavefront (to a receiving rhombic) is arriving at some vertical angle greater than zero degrees (the horizon is assumed to be zero degrees). Shortwave propagation utilizes the reflection/refraction medium of the ionosphere and once a shortwave signal (typically 3-30 MHz) exits the transmitting antenna, it is beamed towards the intended receiving location at some angle greater than zero degrees with reference to the actual horizon, so as to enter the ionosphere at the proper point between the transmitting and receiving location to produce signal reflection/refraction to the desired receiving point.

Therefore a great deal of conventional rhombic design data is needlessly (for our purposes) wrapped up in producing an antenna design which concentrates the antenna's pattern say 12.5 degrees *above* the horizon, 8 degrees *above* the horizon, and so on, but seldom if ever, *on the horizon itself.*

Inspite of the multiple-thousands of commercial rhombics in service throughout the world even today for communication purposes, there remains a dearth of material for reference. There are, in fact, but four generally referenced sources for rhombic design data, and none are generally available to the casual practioner of the art. CATJ was successful in running down three of these for our own use here, but the fourth never was found except by reference.

During the evolutionary days of television, or the 50's, there were a number of articles published by magazines such as *Radio-Electronics*, *Radio-TV News* (and later *Electronics World*) which provided some very basic rhombic design data. Unfortunately, much of that data was either incomplete or inaccurate and while such publications had universal circulation in those days (and were considered the only reference works of that era), the data they published was sufficiently lacking as to leave a reader desirous of constructing his own rhombic system with inadequate data to do the job *correctly.* Consequently, many of the rhombics constructed in that era, by TV (and CATV) desirous people probably never functioned as well as they might have. A listing of the material in print in that era along with the major reference works in this antenna field is included at the end of this report.

Of all of the serious workers in the rhombic field, only one seems to have been concerned with overcoming the major shortcoming of the rhombic, that being...

"...*long wire antennas always radiate large numbers of sidelobes*...".

A sidelobe in a long-wire antenna is not unlike a sidelobe in a yagi or a log; it is simply antenna-gain-response in a (side) direction, which is *undesired.*

That worker was Edmund A. Laport of RCA's international division; who published his work initially in the March 1952 edition of *RCA Review* ("Design Data For Horizontal Rhombic Antennas"), and who subsequently came back in the March 1960 *RCA Review* with "Improved Antennas Of The Rhombic Class". It was his improved design developed in the late 1950's and published in 1960 which resulted in his name being attached to the now cadillac of the rhombic antenna family, the "Laport Rhombic". This 27 dB gain (plus) version will be studied carefully here.

Laport in 1952 wrote "...*most engineering methods provide information on the main lobe at one frequency...but omit(s) consideration of other lobes that can be, and often are, very large and which greatly compromise* (rhombic) *antenna performance*...".

Laport in 1960 wrote "*Sidelobe reduction is a matter of finding conductor configurations and current distributions that provide an exceptional degree of destructive interference in all directions except that desired for the main beam*...".

Rhombic design data is filled with phrases which are not readily recognized for their true meaning. *Destructive interference* to Laport, was a design handle that allowed the rhombic antenna designer to purposefully create antenna currents in *each* of the four legs of the rhombic antenna so that natural radiation from any single leg could be "corrected" when it headed off in some direction other than the single-desired "main beam" design direction. To understand what Laport was saying, it is necessary to go back to just a little bit of basic long-wire antenna design theory.

A Hank Of Wire

Virtually any conductive-wire can be made to radiate a signal, if there is a way to couple transmitter energy into the antenna-wire-load. This is essentially a match-problem, *and it reciprocates for receive-only antennas*. That is, virtually any conductive-wire can be made to receive a signal, if there is a way to match the impedance of the antenna-wire to the input impedance of the receiver.

A simple dipole antenna (diagram 1) is an example of a resonant length of wire (although at VHF a dipole is usually constructed for mechanical convenience out of aluminum tubing). Because the dipole is a precise length that corresponds to the electrical half-wavelength at the designed (and desired) operating frequency, there are certain known current-flow-characteristics associated with such an antenna. Matching such a *resonant antenna* to a transmitter or receiver operating at the same frequency as the antenna is a fairly simple task and the energy from one transfers to the other with little difficulty.

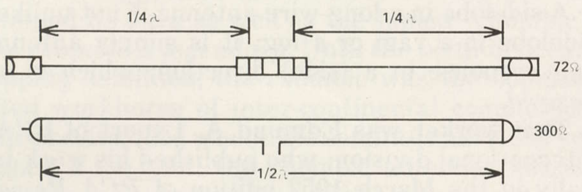


DIAGRAM 1

In such an antenna, the current distribution along the full half-wavelength form is well known (diagram 2). Now as the physical and electrical length of the (resonant) dipole antenna is increased, while the operating frequency of the equipment connected to the "length-extended-dipole-antenna" remains the same as the purely resonant condition, the antenna assumes a *new* radiation pattern, the "new" pattern being created by the *multiplicity* of harmonic-antenna patterns created by the "series connected" half wave length segments. See diagram 3.

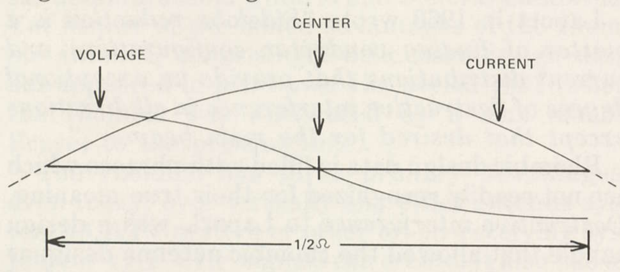


DIAGRAM 2

What happens (in diagram 3) is this. Each half-wave segment of the "wire" antenna has current (i.e. signal) flowing in it. In adjacent half-wave segments of wire, the current flows in opposite directions and this fact causes the antenna lobes to be split up from the *basic* half-wave dipole "donut" pattern (diagram 3A) into a number of lobes. If there are an *even* number of half wave segments, then there is always a *null* in the antenna pattern (i.e. lobe[s]) at right angles to the antenna wire axis. On the other hand if there is an *odd* number of half wave segments in the wire, alternate sections cancel one another in the *perpendicular* (i.e. right angle) direction, but the "odd" or "*end*" segment radiates perpendicular (or at right angles) because there is no alternate segment to cancel its perpendicular radiation.

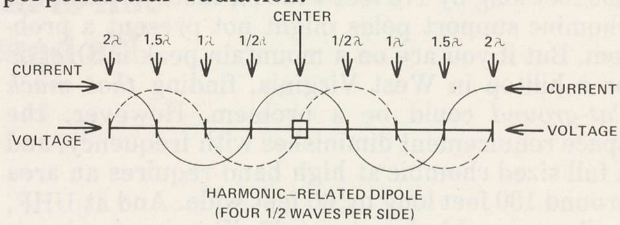


DIAGRAM 3

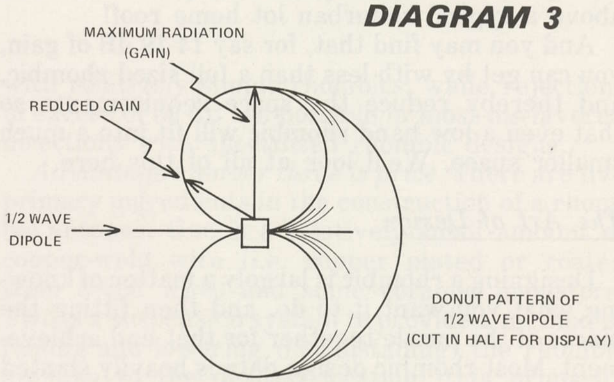


DIAGRAM 3A

The *more* half wave segments to the antenna (wire), the more lobes there are created. And that means a greater number of splits of the original half-wavelength antenna pattern. The lobes are not strictly the function of individual half-wave segments, rather they are the *composite* result of the *total number* of half wave segments in the wire, with some segments adding in phase and some segments canceling out of phase the half wave segment *individual patterns*. This becomes a very complex antenna in a big hurry, when you study it from the radiation pattern aspect.

Finally, the strongest or most potent lobe in a multiple-half-wavelength antenna is *always* the one which forms the *smallest angle* with the axis of the wire (diagram 4), and this "main lobe" gets closer and closer to the axis of the antenna wire as the number of half wavelengths increase (i.e. as the antenna gets longer and longer).

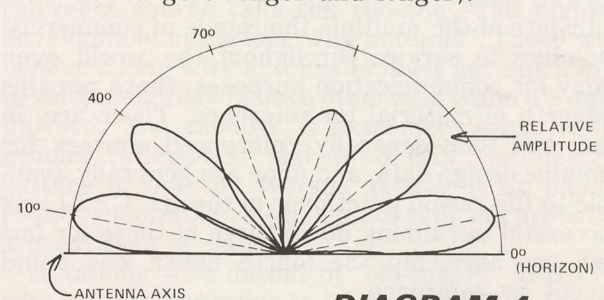


DIAGRAM 4

So suppose, without regard to impedance matching for now, you took a long (more than one halfwavelength) dipole-*type* antenna and rather than stringing the wire out in a straight line (i.e. singular axis), you bent it into a "V", as shown in diagram 5. Then what?

If the two sides of the "harmonic-dipole" are formed into a "V" so that the *apex angle* of the "V" is at least *twice the angle* created between the major lobes (i.e. those closest to the axis) and the axis-wire orientation of the "harmonic-dipole", the radiation patterns *combine* so that the pattern portion bisecting the "V" tends to add together from the two separate half-lengths (not wavelengths), and the pattern or lobes in the opposite directions tend to cancel (out of phase).

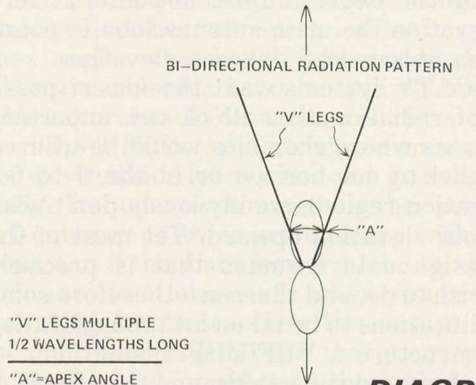


DIAGRAM 5

All of this can be worked out on paper for various lengths and various "apex angles", and in the case of two "V" antennas back to back (i.e. a rhombic), with the aid of stereographic charts originally designed for this exercise by Edmund Laport. But at some point the designer has to get out of the design room and build the antenna, and that is where the real fun begins!

Ground Reflections

As many and as varied as the lobe structure may be for four separate, but combined lengths of wire (i.e. in a rhombic) in real life the problem is "times 2". This is because when a length of wire (or four *coherent* lengths of wire as in a rhombic) is placed above a *ground reflection surface*, there is created by the presence of the ground an almost "mirror image" lobe pattern that approaches the antenna from the underside. In a word, there is no such thing in real life as the "free space" antenna patterns laboriously worked out on paper by the rhombic antenna designer. The performance of the rhombic, particularly with respect to its directive properties, is often considerably modified by the presence of the earth beneath it.

In everyday CATV language, "as high as practical" is not the total answer. *There are good and bad heights for a rhombic above ground.* For practical CATV installations, you cannot go high enough to *totally* escape the effects of ground reflections (or ground loading as it is sometimes called), and this is probably the key area where many CATV rhombics constructed to date fall down. And this problem is complicated by the fact that the height above ground we are concerned with is height above electrical ground or "reflection ground", which almost never corresponds to the real physical ground. In the case of dry earth, the electrical or reflection ground may be up to several wavelengths below the physical ground surface. Only when the installation is over

RHOMBICS — NOT HIGH ENOUGH?

Many systems dismiss the rhombic concept on the theory that because of the support poles required, a "**rhombic cannot be placed high enough above ground to get the gain needed for beyond horizon paths**"

There are, of course, two ways to get gain. One is to raise the height of the antenna array. Another is to make the array larger, at the "same" height. Let's assume we have a (large) four bay log array with 17 dB of gain at 500 feet above ground. How would such an antenna array compare with say a Laport rhombic at 60 feet above ground?

(1) Let us assume the path length is 100 miles, give or take 20 miles either way.

(2) If we lower the four bay array to 250 feet, we will have lost 2 dB of our height gain (i.e. the difference in received level for a 100 mile path is 2 dB for halving the height of the four bay array).

(3) If we lower the four bay array from 250 feet to 125 feet, we will lose another 2 dB from our 500 foot heigh level.

(4) If we lower the four bay array from 125 feet to 62.5 feet, we will lose yet **3 dB** more; or a total of **7 dB** of "height-gain-loss" by dropping from 500 feet to 62.5 feet.

Now if we install a 27 dB gain 60 feet above ground, this antenna has **10 dB more gain** than the four bay log. Seven of this ten dB has been lost when the four bay array dropped from 500 feet to 62.5 feet. But we are still 3 dB ahead of where we were, with the rhombic at 60 feet. Plus, the downline loss from the rhombic's 60 foot height has got to be less than the downline loss from the four bay log array's height of 500 feet. So we probably pick up an additional 2-3 dB of real signal voltage (i.e. level) here. **Sometimes antenna gain is a good trade for height!**

a very (i.e. constantly) moist ground is the electrical or reflection ground *near* the physical ground surface. A swamp, or along or over a (constant level) water surface such as a lake would be an example of a dependable and coincidental real ground and electrical ground. But there are ways to handle this, as we shall see.

Ground reflections, then, *modify the pure lobe structure* of the "paper rhombic". They create side lobes where no side lobes previously existed, and this means a loss of control over co-channel (or adjacent channel) sources. We'll re-visit this later.

The Rhombic Design

The basic rhombic design is not unlike an aperiodic configuration. The key word here is the *periodic* portion of aperiodic. This means that when the antenna is terminated in its characteristic impedance at the forward (i.e. towards transmitter) end, the antenna is useful over a wide band of frequencies. In other words, the antenna, when properly terminated, if it presents a match of say 20 dB at channel 2 will present pretty much the same match at channel 6 and probably only a tad worse at channels 7 or 13.

That says the rhombic is a broadband antenna. If you dig back into past antenna articles in *CATJ*, one of the things we learned is that the usefulness of an antenna was always pretty much determined by the portion of the bandwidth covered where the antenna match is acceptable to the receiving equipment downline. *This is not the limiting factor for a rhombic.*

Unfortunately, *there is no relationship between the antenna's input impedance characteristics and* *the radiation characteristics* (i.e. pattern or lobe structure). It is the *latter* which determines the range of frequencies over which the rhombic antenna may be utilized.

The rhombus(bic) has two controlling parameters, the length of the individual (four) leg(s) . . . diagram 6 . . . and the acute (or apex) angle "A" (also diagram 6).

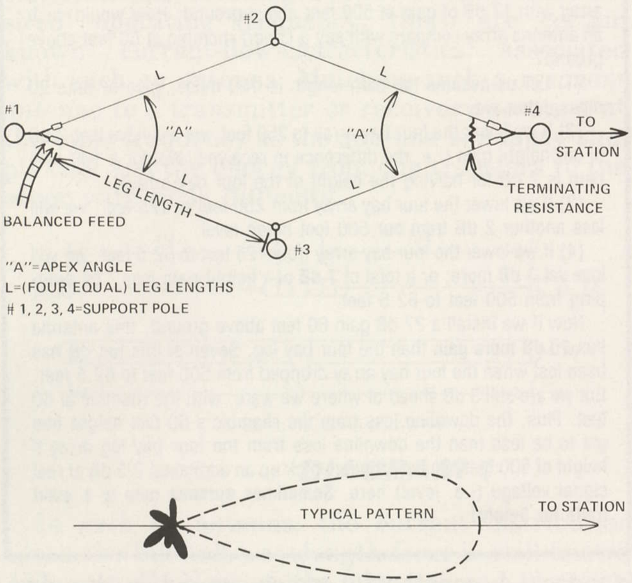


DIAGRAM 6

The total lobe pattern of the antenna is a composite of the patterns of the four individual legs and the geometry of the rhombus. The radiation pattern of each leg (which becomes 1/4th of the contribution to the total pattern) is a function of the length of the leg (remember diagram 3).

Laport in 1952 said "*The composite free-space pattern for a* (traveling wave) *rhombus is the result of interference between the patterns for the individual legs as a result of their spacial separations, and their mutual orientations. The multiplicity of lobes in the* individual *leg patterns causes a large number of lobes in the composite pattern, and interference effects in space give each lobe a different orientation in azimuth* (i.e. left and right of axis) *and elevation* (i.e. from the horizon which is always zero degrees to dead overhead which is 90 degrees). *When the rhombus is placed above a reflecting surface, such as the earth, interference with the image pattern further complicates and modifies the basic pattern. If arrays of horizontal rhombics are used, still higher orders of complication are introduced by additional interference effects.*"

Laport also noted "*The complete solution of such patterns for practical antenna designs by conventional methods* (i.e. without a computer program) *involved an enormous amount of skillful computation, and is seldom attempted.*"

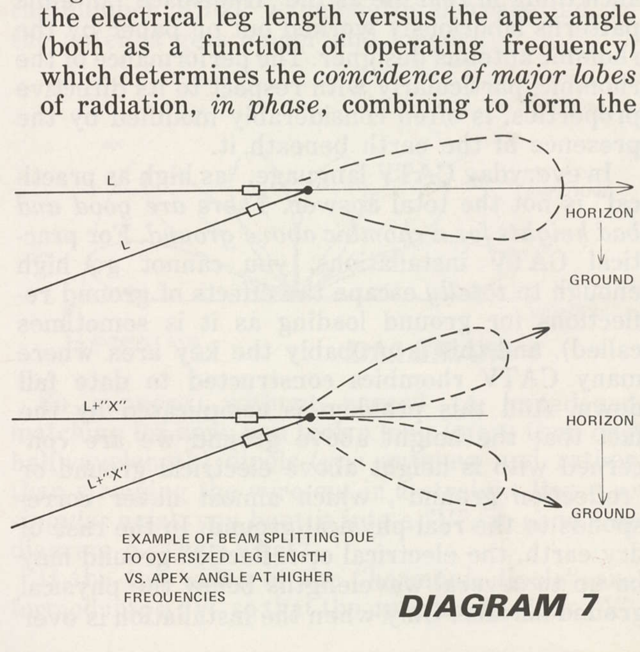
As noted initially, most if not all of the skillful work on rhombic design has been done for antennas designed to operate in the 3-30 MHz region, where ionospheric reflections (i.e. "skip") are the normal communication mode. And as noted, such communication circuits rely on wavefronts arriving at the receiving antenna at angles above the horizon, typically in the 8-13 degree region with respect to the horizontal plane of the antenna. It is worth noting that a horizontally polarized rhombic, with all of its elements parallel to the earth (i.e. pointing at the horizon at zero degrees elevation) can be "electrically steered" by the designer so that while the *physical antenna* points at zero degrees elevation the main antenna lobe is pointing *upwards* at say 12.5 degrees elevation.

Because CATV systems want the *lowest* possible angle of radiation (i.e. all of our important signals in areas where rhombics would be utilized arrive parallel to our horizon or in the 0 to 0.5 degree elevation region), we obviously don't wish to "steer" our elevation upward. Yet most of the rhombic design data assumes that is precisely what you wish to do, and there are therefore some design modifications to be taken into consideration when you structure a VHF-UHF system.

Because of ground reflections, and the effects of the acute angle (diagram 6) and leg length as a function of frequency, *there is an optimum design frequency* for any rhombic, and then as the use-frequency deviates lower than and higher than the design frequency, *two things happen* to the radiation characteristics of the antenna. Remember that the impedance stays quite constant, even as frequency changes, because of the 'traveling-wave' or aperiodic (like in log-periodic) design of the antenna.

Number one — The carefully controlled minor (or side, rear) lobes, reduced to practical minimums on the design frequency, begin to pop-up at un-expected places (i.e. in directions not totally predictable . . . as the operating frequency changes away from the design frequency.)

Number two — the apex angle (see diagram 6 again) becomes very critical when the rhombic designer is attempting to achieve very low angles of radiation. It is the careful *balance* of the electrical leg length versus the apex angle (both as a function of operating frequency) which determines the *coincidence of major lobes* of radiation, *in phase,* combining to form the



EXAMPLE OF BEAM SPLITTING DUE TO OVERSIZED LEG LENGTH VS. APEX ANGLE AT HIGHER FREQUENCIES

DIAGRAM 7

singular main lobe at the front of the antenna. As Laport notes "...*this implied that there is almost no tolerance in the direction of higher frequencies* (as the frequency increases and the leg length is physically constant, each leg becomes the equivalent length of more electrical wave-lengths)...*and the main forward beam tends to split*...". See diagram 7.

Therefore, because of the balancing act which must be done between electrical leg length and the apex angle, what is the proper design approach when the rhombic is to be utilized over a fairly wide excursion of frequencies (such as channels 2, 6, and 8)? If the lobe structure creates multiple non-desired side lobes when you go away from the design frequency optimum (whether you go higher in frequency or lower in frequency with the operation), and if the main forward lobe tends to try to split into two lobes only when you go *higher* in operating frequency than the design frequency, the *logic* would seem to be that your optimization of the antenna *should be* at the highest frequency to be utilized. In this way you maintain a singular front lobe (i.e. non-split) throughout the antenna's use-range, with maximum gain (i.e. smallest number and lowest level side lobes) *at that frequency*, but accepting lower gain (and larger, more numerous side lobes) *for lower frequencies*. There may be another option or two, as we shall see.

How Long / How Much Gain?

If the apex or acute angle is optimized for the chosen frequency (frequency here means television channel, at VHF or UHF, the 6 MHz wide television channel is insufficient change in frequency to create any lobe variations or frontal lobe split over a single channel bandwidth, even at channel 2, when the antenna is *optimized* for the video carrier frequency) and the electrical leg length is similarly optimized for that apex or acute angle, there are known gain maximums to be achieved with a "simple" four-wire rhombic.

The amount of forward gain depends on the number of electrical wavelengths of the leg (and array), with numbers like this to be expected (a *range* of numbers is shown, to reflect variations in design parameters):

Wavelengths Per Leg	*Gain Range*
2	10-12 dB
4	12-14 dB
6	13-15 dB
8	14-16 dB
12	15-17 dB

Additional gain can be achieved by stacking the rhombic array, either vertically (i.e. one stack above the other), horizontally (side by side arrays), or by one of several techniques unique to the rhombic design (i.e. the Laport Rhombic, etc.). There is also additional gain to be had by utilizing multiple wires per side, in conical format. Let's begin by looking at the basic Rhombic for VHF-UHF.

Basic Construction Techniques

For all of the rhombic-variations to follow, there will be certain parameters which will apply to each. We will run through them at this point so you will understand how they apply to *any* rhombic design:

(A) *Directional Heading* — The front pattern beamwidth, at the 3 dB points, will be a function of leg length *and* the companion apex angle. In any case, regardless of the rhombic format chosen, it is exceedingly important that the rhombic's axis lies directly towards the transmitter source. In the worst case (i.e. sharpest front pattern rhombic) to be described here, we will be dealing with a 3 dB front beamwidth of 11 degrees. This is roughly 4 times as "sharp" as a ten element yagi antenna, and 2 times as sharp as two ten element yagi antennas stacked side-by-side in a horizontal array.

However, unlike the yagi which can be manually re-directed to the maximum signal level heading with only minor effort, there is no *easy way* to pick up the four support (utility) poles and re-plant them to correct for initial errors in heading. It is very important that when the initial array is planned that the front and rear support poles (#1 and 4 in diagram 8) be precisely on-a-line that starts at the back pole location and runs *directly towards* the transmitter location. This usually involves obtaining a set of USGS (United States Geodetic Survey) maps for the region, and laying out a straight edge line from your precise receiving site to the *actual transmitter location.* Note that many transmitter sites are from several to 40 miles outside of the town of license, and often off to the side in such a direction that if you chose the license *town* for a bearing, you might end up being tens of degrees off of the proper heading. With a narrow beam rhombic, that could cost you 3-10 dB of realized signal gain.

NOTE: In the process of establishing your own front and back pole locations (diagram 8, poles 1 and 4) you will undoubtedly utilize a compass to locate magnetic north and either a surveyor's transit and/or an engineering protractor to establish the true headings. Any USGS map contains a correction factor for the difference across the map between magnetic north and true north. Note that on USGS maps *true* north is indicated, but your compass will be plotting *magnetic* north. The USGS maps indicate the compensation required to *correct for the difference* between true north and magnetic north, and this correction must be included in your calculations or the antenna will end up off-heading. Corrections of 8-10 degrees are common for the mid-western portion of the U.S.A., for example.

(B) *Support Poles* — Some method of supporting the rhombic wire legs above ground, and a proper distance apart, is required. In the CATV business, where access to various grades and sizes of utility type wooden poles is commonplace, these would seem to be the best solution to the support prob-

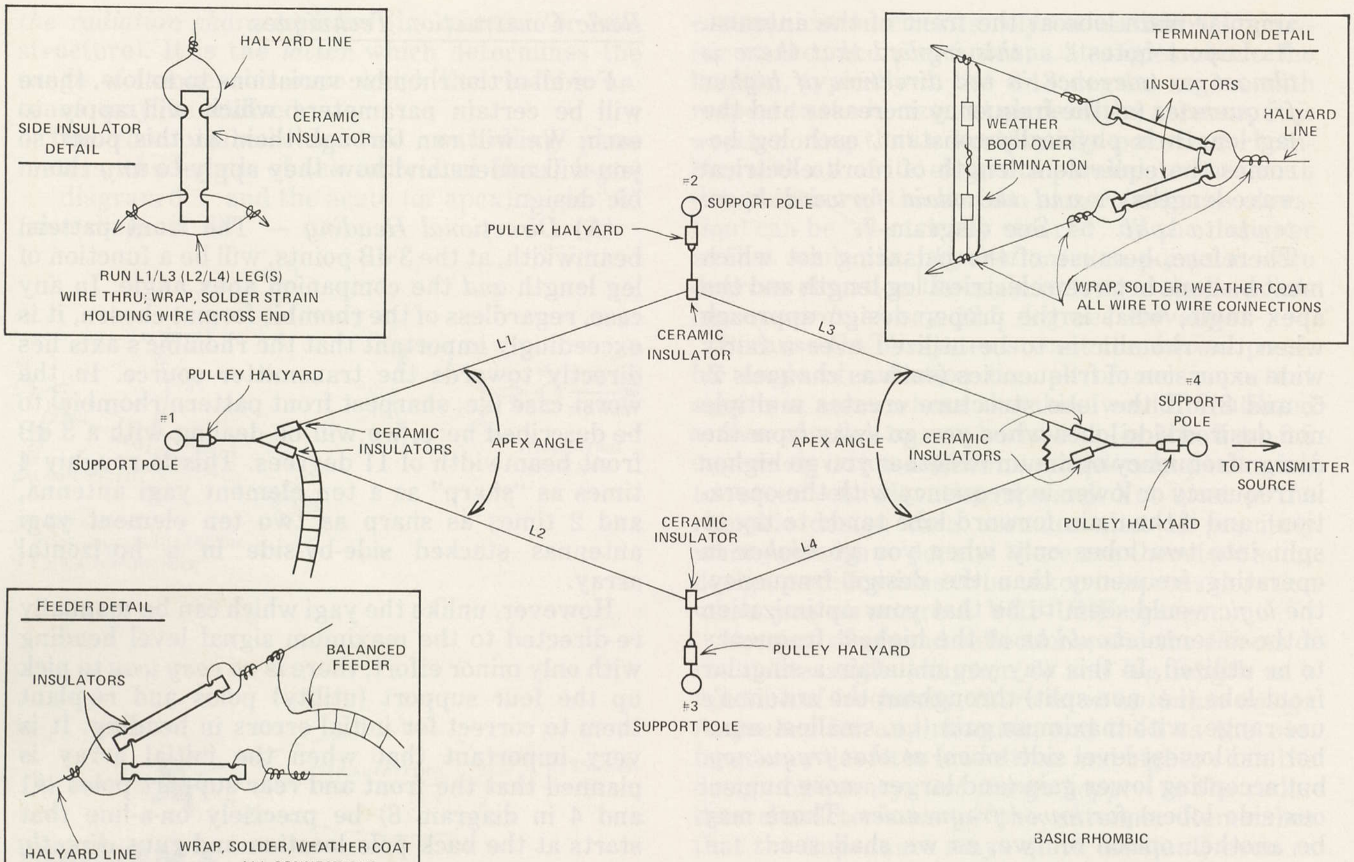


DIAGRAM 8

TABLE ONE — MINIMUM HEIGHTS

To escape devasting ground-reflections, the rhombic must be installed at least high enough so that ground reflections do not distort the antenna's pattern. The actual height should always be as high as possible, to create the highest average signal level. For rhombics 6 wavelengths per leg length and smaller, the minimum height is 3 wavelengths. For rhombics over 6 wavelengths in length (per leg), the minimum recommended height is 6 wavelengths above ground. A 3 wavelength high rhombic will have its maximum radiation angle centered approximately 5 degrees above the horizon. An antenna with a vertical pattern of 10 degrees would therefore have all lobes plus or minus 5 degrees 3 dB down from the maximum lobe. In this example situation, the at-horizon response would be 3 dB lower than the antenna response 5 degrees above the horizon.

Note: Minimum heights are for **physical distance** between electrical ground reflection surface and **lowest bay** of rhombic (i.e. bottom bay if two or more stacks high). Electrical ground is either at physical ground (in very moist soil or over water), or some distance **below** earth-ground surface. **To be safe, measure from earth-ground surface.**

Channel/Frequency		
2 (55.25 MHz)	53'55''	106'10''
3 (61.25 MHz)	48' 2''	96' 4''
4 (67.25 MHz)	43'11''	87'10''
5 (77.25 MHz)	38' 3''	76' 6''
6 (83.25 MHz)	35' 6''	71' 0''
FM (100 MHz)	29' 6''	59' 0''
7 (175.25 MHz)	16'10''	33' 8''
8 (181.25 MHz)	16' 4''	32' 8''
9 (187.25 MHz)	15' 9''	31' 6''
10 (193.25 MHz)	15' 3''	30' 6''
11 (199.25 MHz)	14'10''	29' 8''
12 (205.25 MHz)	14' 5''	28'10''
13 (211.25 MHz)	14' 0''	28' 0''
14 (471.25 MHz)	6' 3''	12' 6''
30 (567.25 MHz)	5' 2''	10' 4''
50 (687.25 MHz)	4' 4''	8' 8''
70 (807.25 MHz)	3' 8''	7' 4''

lem. Actual height above ground is a function of electrical wavelengths at the operating frequency, with table I here listing the minimum heights tolerable for various channels. Metal poles or tower sections are satisfactory if there's some method of ensuring that the down-guys for the tower/poles do not create interference (through resonances) with the antenna proper. Most rhombic workers agree that the two *side* supports (#2 and #3 in diagram 8) can be metal(lic), provided they are at least 6 feet removed from the nearest rhombic leg wire conductor. It is also generally agreed that the front and rear supports (poles #1 and #4 in diagram 8) are best if wooden or some other non-conductive material.

If metal towers or metal poles that require guying are utilized, the down guys should be broken up with insulators so that there are no 1/4, 1/2 or 1 wavelength (or multiples thereof) resonant lengths in the down guys at *any* of the desired receiving channel frequencies.

(C) *Erection Procedures* — Typically, a rhombic is laid out on the ground and all soldered, wrapped, etc. connections made at that point.

Then utilizing ropes or other non-metallic materials, each of the four support points is lifted or raised to the design height using halyard line/pulley arrangements (see diagram 9). This affords more than an easy *ground-up system* for erection, it also provides a way to fine-adjust the antenna for maximum received signal level (i.e. gain), by playing one halyard against the others.

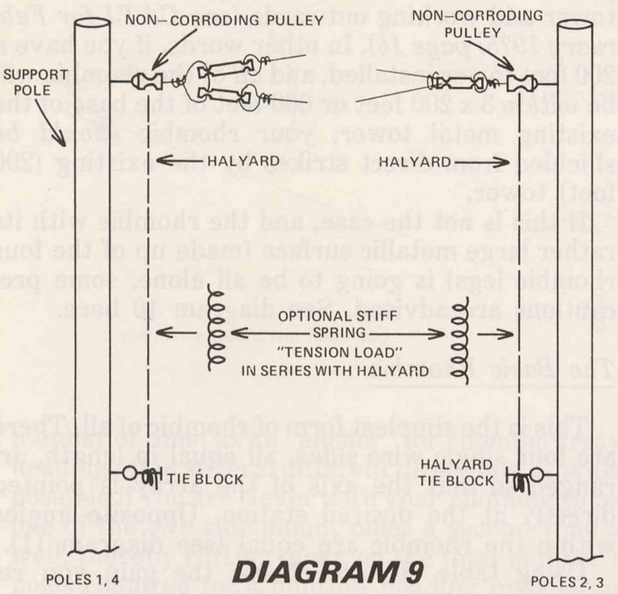


DIAGRAM 9

It may be, because of a design error, construction error, or path abnormality, that the rhombic exhibits maximum gain when the front is (*for example*) lower than the rear (and side support points). This can be determined through maneuvering the four sets of halyards/pulleys and simultaneously observing a signal level meter on the most critical channel received. If the two side poles (#2, #3 diagram 8) are set *far enough back*, the apex angle can be adjusted for optimum signal level performance and optimum minor-lobe structure (as deduced by monitoring a receiver for minimum co-channel levels) by gently releasing the halyards on supports #1 and #4 (rear and front) while simultaneously pulling up on the halyards on supports #2 and #3 (*both* sides). This "pruning" of the apex is not a *normal* field-adjustment procedure, but it is an option you have, especially if the side supports are far enough back to allow you room to "play".

(D) *Termination Procedure* — The basic rhombic is a bi-directional antenna, that is, it has equal signal gain in two directions, even though the transmission or downline is connected to a single end. To create a front-to-back ratio (*typically* in the high 20's to low 30's in *real* life), the *front* of the antenna (where the sides join in the apex formed at pole #4 in diagram 8) is *terminated* with *carbon* resistors. It is exceedingly important that the resistor(s) chosen for this termination be *carbon* resistors, *not* wire-wound. A large percentage of the 2 watt resistors commonly available in this ohmage range *are* wire wound, and you are advised to take one apart before making up your own termination to determine whether there is a wire

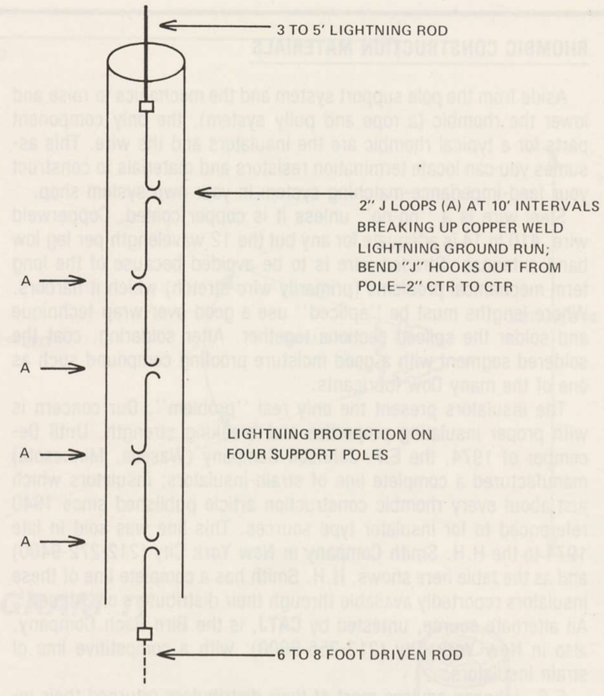


DIAGRAM 10

spiral inside of the resistor core. If there is, the resistor should *not* be utilized for this purpose.

A simple single-wire-per-leg rhombic has a characteristic feed impedance of approximately 800 ohms. This is the value of the termination resistor, and two 390 ohm carbon 2 watt resistors in series will create the termination needed. It is recommended that after the terminating resistor(s) has been soldered in place that a piece of heat-shrink tubing or plastic hose be placed *over the termination* to keep moisture and corrosion out of the connection. A liberal coating with a common CATV line insulating compound (Dow, etc.) will also be useful.

The (optional — to be discussed) *multiple-wire-per-leg* rhombic design utilizes two or three wires in a fan arrangement. This does several good things for the rhombic design, incluing *lowering* the feed impedance of the overall antenna to approximately 600 ohms. We'll have more to say about multiple wire sides shortly, but keep in mind that if you choose to go this way, the terminating resistor(s) must still be carbon (i.e. low in inductive and capacitive qualities), but now will be approximating the 600 ohm feed impedance of the antenna, not the simpler design 800 ohm feed impedance.

(E) *Line Matching Procedure* — The rhombic antenna is a *balanced* antenna (as in a 300 ohm dipole antenna), and our own low-loss downlines are typically 75 ohms, unbalanced. It is therefore necessary to make an impedance transformation from either the 800 ohms or 600 ohms (or impedance presented by a stacked array) down to 75 ohms, and to also transform our balanced feed antenna to the unbalanced input of either the downline coaxial cable or the input to our typically 75 ohm unbalanced signal preamplifier.

There are numerous techniques for accomplish-

RHOMBIC CONSTRUCTION MATERIALS

Aside from the pole support system and the mechanics to raise and lower the rhombic (a rope and pully system), the only component parts for a typical rhombic are the insulators and the wire. This assumes you can locate termination resistors and materials to construct your feed-impedance-matching system in your own system shop.

Steel wire is a ''no-no'' unless it is copper coated. Copperweld wire, #10 to 14 is adequate for any but the 12 wavelength per leg low band antennas. Straded wire is to be avoided because of the long term mechanical problems (primarily wire-stretch) which it harbors. Where lengths must be ''spliced'' use a good over-wrap technique and solder the spliced sections together. After soldering, coat the soldered segment with a good moisture proofing compound such as one of the many Dow lubricants.

The insulators present the only real ''problem''. Our concern is with proper insulating properties and breaking strength. Until December of 1974, the E.F. Johnson Company (Waseca, Minnesota) manufactured a complete line of strain-insulators; insulators which just about every rhombic construction article published since 1940 referenced to for insulator type sources. This line was sold in late 1974 to the H.H. Smith Company in New York City (212-272-9400) and as the table here shows, H.H. Smith has a complete line of these insulators reportedly available through their distributors or ''direct''. An alternate source, untested by **CATJ**, is the Birn Bach Company, also in New York City (212-255-6600); with a competitive line of strain insulators.

E.F. Johnson advises most of their distributors returned their in-stock strain insulators to Johnson in 1974, when Johnson announced they were shutting down that product line. Thus the chances are not good that you will find dusty strain insulators at former E.F. Johnson distributors. Some ''wholesale houses'' that handle ''amateur radio equipment'' may still have these insulators in stock, however, in as much as hams still build their own antennas and they probably represent the largest users of strain insulators in electronics today in the United States and Canada.

H.H. Smith insulators now available are as follows:

Antenna Strain Insulators —

H.H. Smith #9604 (E.F. Johnson 136-0104-001)...5/8'' square dry process, glazed porcelain; 400 lbs. breaking strength, **4 inches long overall**...$0.43 each.

H.H. Smith #9607 (E.F. Johnson 136-0107-001)...1'' diameter (round), wet process glazed porcelain; 800 lbs. breaking strength, **7 inches long overall**...$2.20 each.

H.H. Smith #9612 (E.F. Johnson 136-0112-001)...1'' diameter (round), wet process glazed porcelain; 800 lbs. breaking strength, **12 inches long overall**...$2.50 each.

Feedline Insulators

H.H. Smith #9662 (E.F. Johnson 136-0122-001)...3/8'' x 1/2'' cross section, silicone impregnated porcelain, **for 2'' feeder spacing**...$0.48 each.

H.H. Smith #9624 (E.F. Johnson 136-0124-001)...3/8'' x 1/2'' cross section, silicone impregnated porcelain, **for 4'' feeder spacing**... $0.48 each.

H.H. Smith #9626 (E.F. Johnson 136-0126-001)...3/8'' x 1/2'' cross section, silicone impregnated porcelain, **for 6'' feeder spacing**...$0.60 each.

The H.H. Smith Company home office is located at 812 Snediker Avenue, Brooklyn, New York 11207.

ing this transformation, and the technique you choose will be largely dictated by the actual antenna design you choose. Suffice to say that unless some form of transformation is employed, very large signal losses are going to occur at the entrance to the downline/pre-amplifier if any 75 ohm device is tied directly to the much higher (balanced) feed impedance of the rhombic array.

(F) *Lightning Protection* — A large rhombic array is a sitting duck for lighting strikes. Now if the array is installed in and around and under a typical CATV tower, the risk for additional lightning strikes (to the rhombic itself) are minimal as long as the rhombic is "shadowed" by the presence of the larger metal tower (with antennas). The generally accepted "cone of protection" for such an installation is roughly 3-4 times the height of the prominent metal tower, starting at the base of the tower and working outwards (*see CATJ for February 1975; page 14*). In other words, if you have a 200 foot tower installed, and *all* of the rhombic will be *within* 3 x 200 feet or 600 feet of the base of the existing metal tower, your rhombic *should be* shielded from direct strikes by the existing (200 foot) tower.

If this is not the case, and the rhombic with its rather large metallic surface (made up of the four rhombic legs) is going to be all alone, some precautions are advised. See diagram 10 here.

The Basic Rhombic

This is the simplest form of rhombic of all. There are four single wire sides, all equal in length, arranged so that the axis of the array is pointed directly at the desired station. Opposite angles within the rhombic are equal (see diagram 11).

Using table II here choose the gain you require at the *highest channel* the rhombic is to be utilized for. Lower channels, on the same axis heading, will have corresponding lower amounts of gain. The maximum frequency spread recommended is on the order of 1.8 of an octave (i.e. 50-90 MHz, 174-313 MHz and so on), to avoid front-lobe "beam splitting" on the *high* frequency end of the range and to avoid excessive unpredictable lobes on the low frequency end. *This is not to say* that a 6 wavelength per leg high band antenna will prove *useless* on low band (it turns out that 6 wavelengths on high band is roughly 3 wavelengths on channels 5 and 6); but it is to say that superior performance would be achieved with a designed-for-low band array.

Keep in mind that a set of four support poles selected for a particular axis heading (such as the transmitter tower cluster in Philadelphia, or the Sears Tower in Chicago, etc.) can support *multiple-layers of rhombics*, such as *one set* for channels 2 and 5 (in the case of Chicago) and *another set* for channels 7, 9 and 11 (also in the case of Chicago). The high band rhombic could be hung above, below *or even inside-of* the low band array; although hanging it inside of the low band array might be the least advisable technique for both mechanical and electrical reasons. Once the support poles are in place, the additional expense of specialized wire arrays for the various channel combinations sought is minimal, as long as the axis-heading path from your rhombic receiving site to the distant transmitters is the same or within a degree or two of being the same.

Another suitable technique, if you have stations in different directions, is to utilize at least the base pole (i.e. the pole located at the feedline point) a

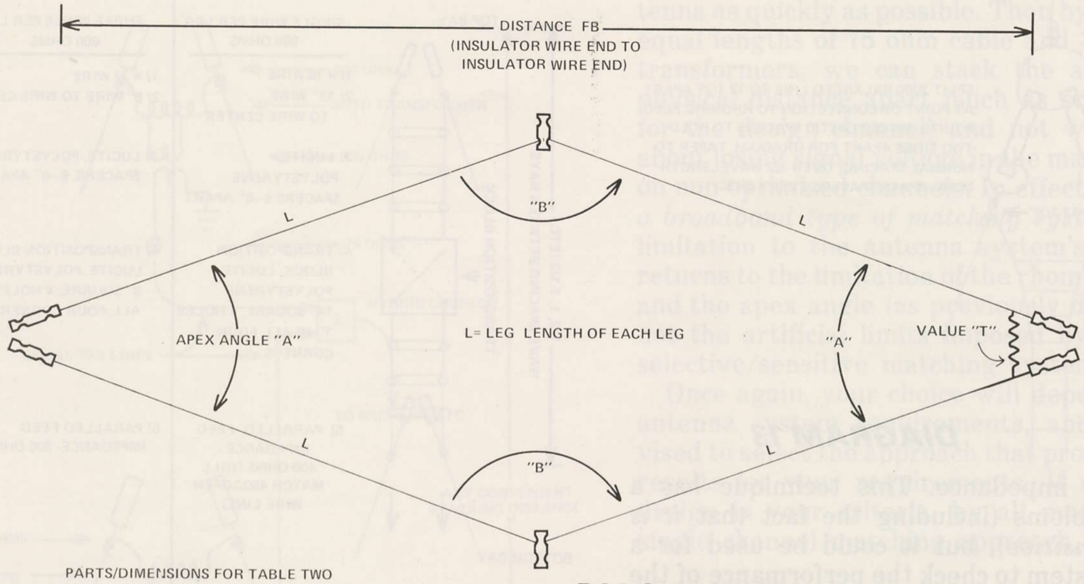


DIAGRAM 11

number of time; as an "anchor" for rhombic arrays heading off in several different directions. It is also possible if you are clever with your planning to use one of the two side-mount poles a second time as well, thereby cutting down on the total number of poles required for a multiple-heading installation.

The UHF versions are very small. So small in fact, that back in the 50's a firm in Central California manufactured an aluminum-tubing (side leg) version which many people had mounted on rotators. If you have a marginal UHF channel in your area, a UHF version might well be the place to *start* experimentation. If you have a UHF path with ghosting on it, one of the rhombic variations (such as the Laport Rhombic to be described) with its extremely narrow 3 dB beamwidth (11 degrees) *might be* the answer to ridding yourself of ghosts.

Stacking The Basic Rhombic

A rhombic, as almost any other antenna, can be stacked for additional gain. There are a couple of specialized rhombic designs, such as the Laport design, which will be covered separately here. For now, let's look at two (and four) stacking the basic rhombic.

There are some arguments about how far apart you should stack a two-bay array. Most decisions seem to have been based upon the desire to capitalize on parallel antenna impedances, which creates a better (i.e. easier) impedance matching network to 300 or 75 ohm feed impedances.

If a single bay rhombic has a feed impedance of 800 ohms, then two 800 ohm rhombics connected in parallel have a feed impedance of 400 ohms (diagram 12). If a single bay of a multi-wire rhombic has a feed impedance of 600 ohms, two such antennas connected up in parallel have a feed impedance of 300 ohms.

Thus for convenience of creating a 300 ohm balanced feed (which can be transformed to 75 ohms unbalanced by using a 300 to 75 ohm CATV transformer), *two multiple-wire rhombics* connected in *parallel* the appropriate stacking distance apart creates the *easy*-to-use 300 ohm balanced condition we would like to see.

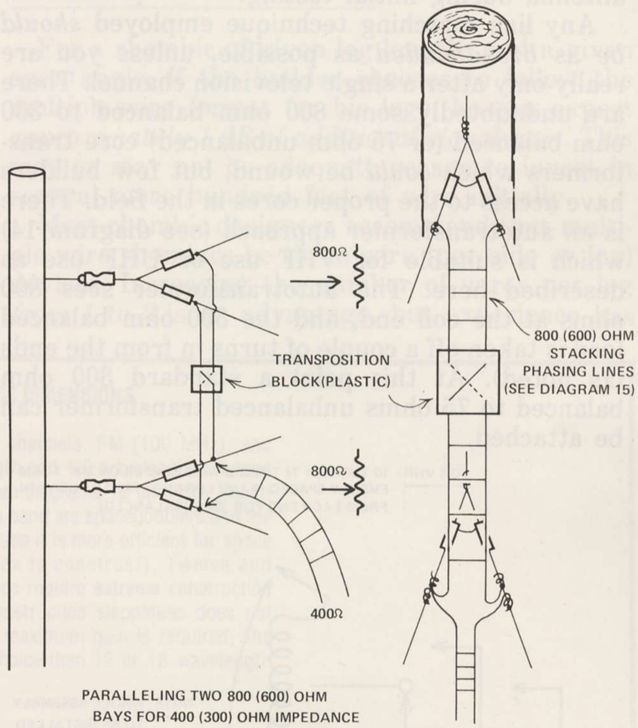


DIAGRAM 12

Let's deal with the 800 ohm impedance basic rhombic first. One approach is to take a length of 300 ohm twinlead (non-shielded variety) and connect one side to each of the two rhombic feed points. Then take a sharp knife and split the twinlead so that at the rhombic feedpoint you have the two halves of the twinlead spread apart 12.5 inches, and then allow it to fan back to the normal (non-split) 300 ohm width at a distance of 1/2 wavelength back down the line. This impedance matching section (*a tapered line*) will transition the 800 ohm antenna impedance to the 300 ohm

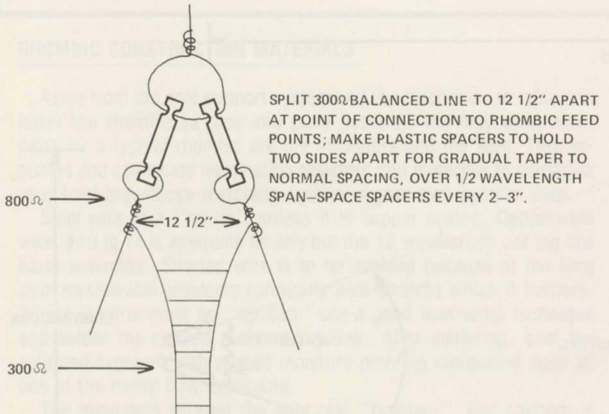


DIAGRAM 13

balanced line impedance. This technique has a bunch of problems (including the fact that *it is frequency sensitive*), but it could be used for a *temporary* system to check the performance of the antenna during initial testing.

Any line matching technique employed *should be* as *broadbanded* as possible, unless you are really only after a single television channel. There are undoubtedly some 800 ohm balanced to 300 ohm balanced (or 75 ohm unbalanced) core transformers which *could* be wound, but few builders have access to the proper cores in the field. There is an autotransformer approach (see diagram 14) which is suitable for VHF use or UHF use as described here. The autotransformer sees 800 ohms at the coil end, and the 300 ohm balanced feed is taken off a couple of turns in from the ends (as noted). At this point a standard 300 ohm balanced to 75 ohms unbalanced transformer can be attached.

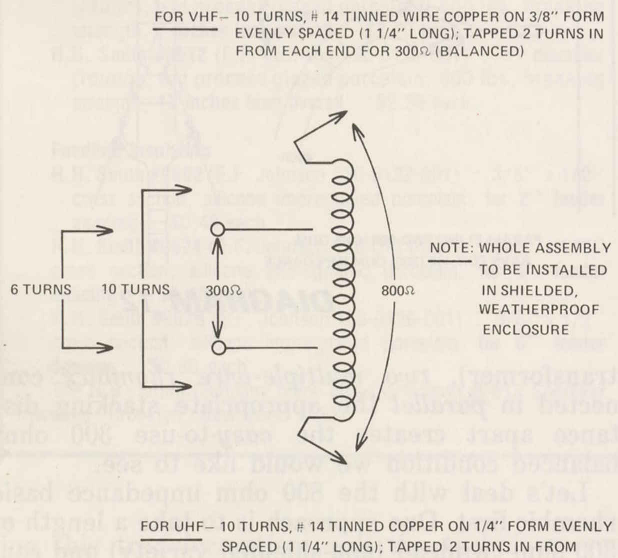


DIAGRAM 14

NOTE: If your antenna is to be used for UHF, *any* 300 ohm balanced to 75 ohm unbalanced transformation must be made with a transformer *known* to be good for the UHF range. *Normal* back-of-set matching transformers are *not good* at UHF, and have excessive losses. Check your

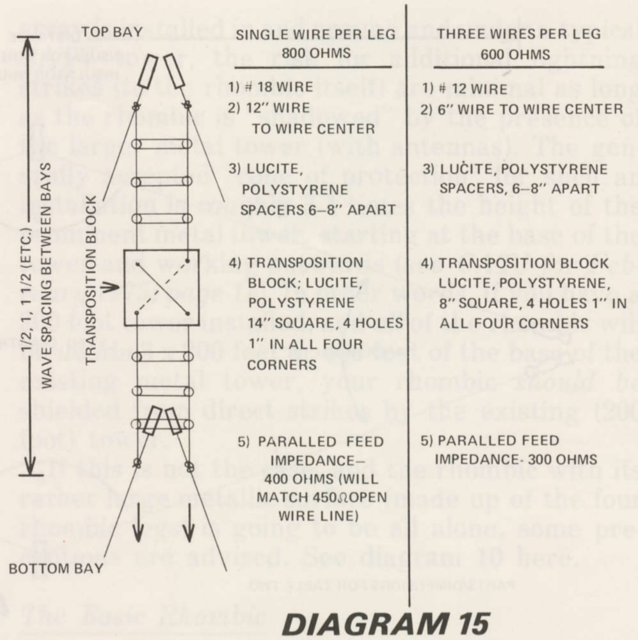


DIAGRAM 15

supplier for a 300 to 75 ohm balanced to unbalanced transformer that is manufacturer-rated *for UHF service*.

Now if you stack a two-stack array (of the 800 ohm variety rhombic), you can reasonably expect to pick up additional gain. The "book" says to expect 2.5 to 3.0 dB additional gain over the single bay. However, because of the excessive capture area of the rhombic, there will be *times* when the extra gain netted by the second bay will be much greater than the 2.5/3 dB expected (i.e. during heavy fading conditions). The long term average, on the other hand, should be in the 2.5 to 3dB region.

By stacking the antennas a half-wavelength apart, or multiples thereof (i.e. 1 wavelength, 1.5 wavelengths and so on), and interconnecting the feed points of the two (or more) stacks as shown in diagram 15, we can use some system-constructed 800 ohm line (or 600 ohm line for multi-wire rhombics) for stacking purposes. The principal is that *at 1/2 wavelength intervals, the feed impedance of the antenna repeats itself*. Therefore, if you stack two bays of 800 ohm impedance rhombic 1/2 wavelength in space apart, and tie the top bay to the bottom bay with a length of 800 ohm line, the impedance at the bottom bay is the combination of two 800 ohm impedances in parallel; *or 400 ohms*. Conversely, if you stack three identical rhombics at 1/2 wavelength (or multiples thereof) spacing, you have three 800 ohm impedances in parallel, which would result in a feed impedance of 267 ohms (*close enough* to 300 ohms). A four stack array results in a feed impedance of approximately 200 ohms (balanced).

In diagram 15 here we have a two-stack array tied together at 1/2 wavelength spacing by a homebrew section of 800 ohm line. Note that *in the middle of the stacking line* there is a *transposition block* alternating the balanced antenna feeds to maintain phase parity.

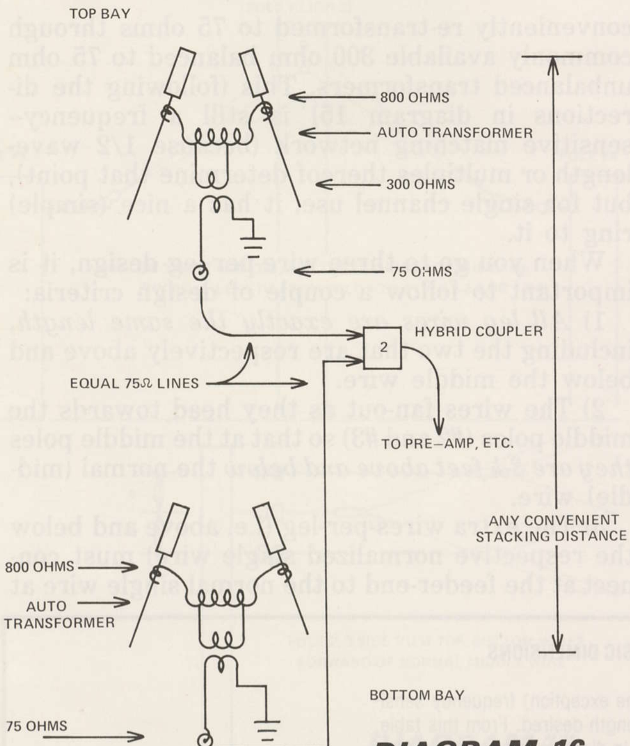


DIAGRAM 16

Unfortunately, again, *this is a frequency sensitive arrangement*, because of the half wavelength functions which must be tied to some particular desired frequency/channel. An alternate approach is found in diagram 16 where we use the autotransformer to get to 300 ohms balanced at each antenna as quickly as possible. Then by using exactly equal lengths of 75 ohm cable and 300 to 75 ohm transformers, we can stack the antennas some physical distance apart (such as one wavelength for the design channel) and not worry so much about losing signal voltage in the matching process on non-optimized channels. In effect, this becomes *a broadband type of matching system* where the limitation to the antenna system's effectiveness returns to the limitation of the rhombic leg lengths and the apex angle (as previously discussed); and not the artificial limits imposed by a frequency-selective/sensitive matching system.

Once again, your choice will depend upon your antenna system requirements, and you are advised to select the approach that produces the best results for your requirements. If single channel design is your criteria, by all means stick to a single channel matching approach.

The Multiple Wire Rhombic

For a rhombic of given leg lengths and a given apex angle, if the builder chooses to follow the multiple-wire format for his legs, he can expect *approximately 1 dB of additional signal gain.* This may or may not be adequate reason to invest in several more hundred feet of wire initially.

Most rhombic designers recommend that multiple wire rhombics be three wire (per side or leg) devices. Increasing the number of wires per leg *from 1 to 2* is an advantage, but experience has

TABLE TWO — BASIC DIMENSIONS

Dimensions are given for all VHF channels, FM (100 MHz), and four UHF channels. The .5 wavelength and 1.0 wavelength columns are for vertical stacking purposes (see diagrams 12 and 15). Rhombics larger than 6 wavelengths at low band are spacegobblers and the Laport design is recommended because it is more efficient for space consumed (although more complex to construct). Twelve and eighteen wavelength per leg rhombics require **extreme** construction care at **any frequency** to insure construction sloppiness does not create undesired side lobes. When maximum gain is required, the Laport design is typically a better choice than 12 or 18 wavelength designs.

Channel	½ Wave (*)	1 Wave (*)	2 Wave	3 Wave	6 Wave	12 Wave	18 Wave
2	8'11''	17'10''	35' 8''	53' 5''	106'10''	213'8''	
3 (**)	8' 0''	16' 0''	32' 1''	48' 2''	96' 4''	192'8''	
4	7' 4''	14' 8''	29' 4''	43'11''	87'10''	175'8''	
5	6' 4''	12' 9''	25' 6''	38' 3''	76' 6''	153'0''	
6	5' 8''	11'10''	23' 8''	35' 6''	71' 0''	142'0''	
100 MHZ	4'11''	9'10''	19' 8''	29' 6''	59' 0''	118'0''	
7(**)	2' 9''	5' 7''	11' 2''	16'10''	33' 8''	67'4''	101'6''
8	2' 8''	5' 5''	10'10''	16' 4''	32' 8''	65'4''	98'0''
9	2' 7''	5' 3''	10' 6''	15' 9''	31' 6''	63'0''	94'6''
10	2' 6''	5' 1	10' 2''	15' 3''	30' 6''	61'0''	91'6''
11	2' 5''	4'11	9'10''	14'10''	29' 8''	59'4''	89'0''
12	2' 4''	4' 9''	9' 6''	14' 5''	28'10''	57'8''	86'6''
13	2' 3''	4' 7''	9' 2''	14' 0''	28' 0''	56'0''	84'0''
14	1' ½''	2' 1''	4' 2''	6' 3''	12' 6''	25'0''	37'6''
30(**)	0'10½''	1' 9''	3' 6''	5' 2''	10' 4''	20'8''	31'0''
50	0' 8½''	1' 5''	2'10''	4' 4''	8' 8''	17'4''	26'0''
70	0' 7½''	1' 3''	2' 6''	3' 8''	7' 4''	14'8''	22'0''

***—Stacking distances, vertical; **—compromise design LB, HB, UHF**

shown that 3 wires is optimum for most designs.

In addition to the *slight* extra gain, here is what a three-wire-leg does for you:

1) The feed impedance of the rhombic goes down from the 800 ohm region to approximately 600 ohms;

2) The broadband nature of the antenna gets even better (i.e. it covers an increased frequency range).

However, the increase in frequency range is without regard to what happens with split-main-lobes or an increase in some (usually unpredictable) sidelobes, so that factor may not prove to be a "net" improvement at all.

Focus then on the 1 dB additional gain, and, the lowered feed impedance. If the (now) 600 ohm rhombic is terminated with some close value of non-inductive (i.e. carbon) resistors, we have an antenna which if double stacked ends up with a parallel(ed) feed impedance of 300 ohms; which is conveniently re-transformed to 75 ohms through commonly available 300 ohm balanced to 75 ohm unbalanced transformers. This (following the directions in diagram 15) is still a frequency--sensitive matching network (because 1/2 wavelength or multiples thereof determine that point), but for single channel use, it has a nice (simple) ring to it.

When you go to three wire-per-leg design, it is important to follow a couple of design criteria:

1) *All leg wires are exactly the same length,* including the two that are respectively above and below the middle wire.

2) The wires fan-out as they head towards the middle poles (#2 and #3) so that at the middle poles *they are 3-4 feet above and below* the normal (middle) wire.

3) The extra wires-per-leg (i.e. above and below the respective normalized single wire) must connect at the feeder-end to the normal single wire at

TABLE TWO-A MORE BASIC DIMENSIONS

Dimensions given here are (with one exception) frequency sensitive. From Table Two, select the leg-length desired. From this table, select the front to back distance (F/B in diagram 11) and the side to side distance (S/S in diagram 11). Note F/B and S/S are rhombic edge to rhombic edge (i.e. wire perimeter to wire perimeter) and are **not pole to pole spacings** (i.e. #1 to #4 for F/B and #2 to #3 for S/S). See text for instructions regarding back-setting poles proper distance to allow antenna "tweeking".

The "Apex Angle" (angle "A" diagram 11) and the "Side Angle" (angle "B" in diagram 11) are leg-length sensitive but not frequency sensitive.

Channel	Three Waves Per Leg		Six Waves Per Leg		Twelve Waves Per Leg		Eighteen Waves Per Leg	
Angle "A"	63°		44°		28°		14°	
Angle "B"	117°		136°		152°		166°	
	F/B	S/S	F/B	S/S	F/B	S/S	F/B	S/S
2	91' 0''	55' 9''	198' 0''	80' 0''	414' 6''	103' 4''		
3 (*)	82' 1''	50' 4''	178' 8''	72' 2''	373' 9''	93' 2''		
4	74'11''	45'11''	162'11''	65'10''	351' 5''	85' 0''		
5	65' 3''	40' 0''	141'11''	57' 4''	296'10''	74' 0''		
6	60' 6''	37' 1''	131' 7''	53' 2''	275' 5''	68' 8''		
100 MHz	50' 3''	30'10''	109' 4''	44' 2''	228'11''	57' 1''		
7(*)	28' 8''	17' 7''	62' 6''	25' 3''	130' 8''	32' 7''	201' 6''	24' 9''
8	27'10''	17' 1''	60' 8''	24' 6''	126' 8''	31' 7''	194' 9''	23'11''
9	26' 9''	16' 5''	58' 4''	23' 7''	122' 4''	30' 6''	187' 4''	23' 0''
10	26' 0''	15'11''	56' 6''	22'10''	118' 4''	29' 6''	181'10''	22' 4''
11	25' 3''	15' 6''	55' 1''	22' 3''	115' 0''	28' 8''	176' 5''	21' 8''
12	24' 7''	15' 1''	54' 5''	21' 7''	112' 0''	27'11''	171' 8''	21' 1''
13	23'11''	14' 8''	52' 0''	21' 0''	11' 6''	27' 1''	166'11''	20' 6''
14	10' 7''	6' 6''	23' 1''	9' 4''	48' 5''	12' 1''	74' 8''	9' 2''
30(*)	8'10''	5' 5''	19' 2''	7' 9''	40' 1''	10' 0''	61' 9''	7' 7''
50	7' 4''	4' 6''	16' 1''	6' 6''	33' 9''	8' 5''	51' 7''	6' 4''
70	6' 3''	3'10''	13' 7''	5' 6''	28' 5''	7' 1''	43' 5''	5' 4''

*** — Compromise frequency for respectively LB, HB or UHF designs.**

Note that as the leg length increases, **the apex angle decreases** and the side angle increases. This results in a longer, skinnier antenna as the individual leg antenna lobes come closer and closer to the tangent point of the individual leg wires. The front (azimuth) lobe of the rhombic also decreases (in width) resulting in more precise forward pattern directivity as the antenna size increases. Offsetting this desirable feature is a tendency for minor (non-desired) lobes to pop up at unexpected points.

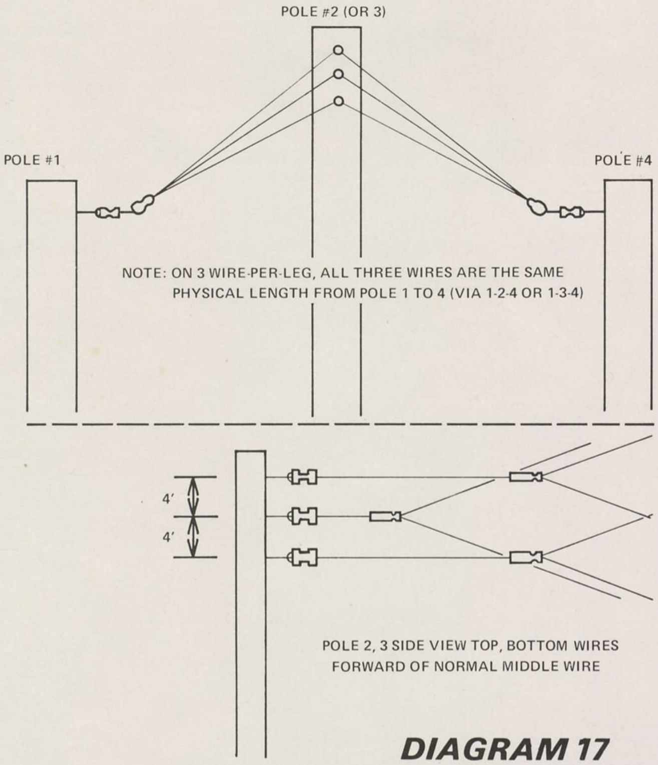


DIAGRAM 17

the strain-insulator, and, at the termination leg at the strain insulator. Because, all wires must be the same length, it follows that the wires above and below the normal single wire will, at the side support poles, be closer to the center of the rhombus than the single wire. See diagram 17.

Infinite Front To Back Ratio

The individual antenna construction layouts and their associated tables list various leg lengths and apex angles for various amounts of gain. As touched upon briefly earlier, in practice front-to-back ratios of the high 20's to the low 30's (in dB) *are realizeable* in normal installations.

In theory, it is possible to have an *infinite* front-to-back ratio with a *terminated* rhombic. This is possible *only at the design frequency*, however, because the ability to achieve an "infinite front to back ratio" depends upon the leg lengths being an *odd* multiple of a quarter wavelength in overall length. For example, 1/2 wave and full wave multiples of the wavelength are considered *even* multiples of the quarter wavelength, while 1/4, 3/4, 1-1/4 and so on are considered *odd* multiples.

Therefore, for *any* of the dimensions given, there is a notation of the length of the leg for the table-given-data, and then a second column indicating the leg length for the same general-size antenna for "infinite front-to-back" ratio. In this column, we have provided the leg length as a function of the length at the nearest (larger) odd-multiple of a quarter wavelength. We have *not corrected* the *other dimensions* given for *this* condition; the apex angle(s) remains as given for each adjacent size (i.e. normalized) antenna; but the pole #1 to pole #4 and pole #2 to pole #3 spacings would move out slightly for the additional leg length added for infinite (*in theory*) front-to-back rejection.

The actual amount of rejection, front to back, which might be expected in a situation such as this is in the mid 40's to low 50's (in dB); the exact number will depend upon your construction techniques and the surroundings.

There is one other technique worth commenting on, particularly because it may have real practical applications for CATV use. If you should happen, *on purpose*, to *decrease* the front-of-rhombic termination impedance, *below* the proper value, you will in turn create an on-purpose mis-match for signals entering the antenna from the rear and flowing (as a current) towards the termination. *This mis-match creates a reflection*, which cancels out at the input end the residual response. There is of course a balance point between *lowering* the front termination impedance (with its attendant effects on the downline match and power transfer), and the purposeful mis-match created to create reflections for rear of antenna signal paths. If you have a 6 wavelength or larger rhombic array, you can often experimentally change out the terminating impedance (checking both higher and lower termination values in say 25-30 ohm steps) *while simultaneously observing* (1) the desired signal level on a field strength meter, and, (2) the co-channel pick-up from the rear of antenna source on a TV receiver. *Purposeful mis-matches of a hundred ohms or more at the termination end* will cause the minor rhombic lobe *to the rear to split*, and then "steer" first one direction and then another. By this technique, you may be able to "steer" *the rear lobe into a null* in the direction of the rear-of-antenna co-channel source, *creating in excess of 50 dB* of direction-sensitive pick-up *attenuation* reference the front lobe pattern. This technique can usually be made to apply (through termination value experimentation) to signals that are +/— 20/25 degrees off of the directly-to-the-rear heading (i.e. 155 degrees through 205 degrees with 0 degrees being the antenna's axis heading).

The Laport Rhombic

The ultimate in the rhombic art is a highly developed rhombic design created by Edmund A. Laport of RCA in the late 1950's. There is no special black magic in the design. Rather, Laport has laboriously worked out the many hundreds of computations associated with raw rhombic design to effectuate a final design that does more for *the control of un-wanted sidelobes* than any other rhombic (and wire) antenna design ever offered.

Recall from basic antenna theory that the only way one obtains superior forward gain is by (1) reducing unwanted radiation in non-desired directions, and, (2) by narrowing the front horizontal beamwidth of the antenna so that all of the gain is "packed" into as narrow a beamwidth as possible. The same general thesis dictates antenna design for all microwave frequencies, and *if there is a comparitive* antenna to the Laport Rhombic, it

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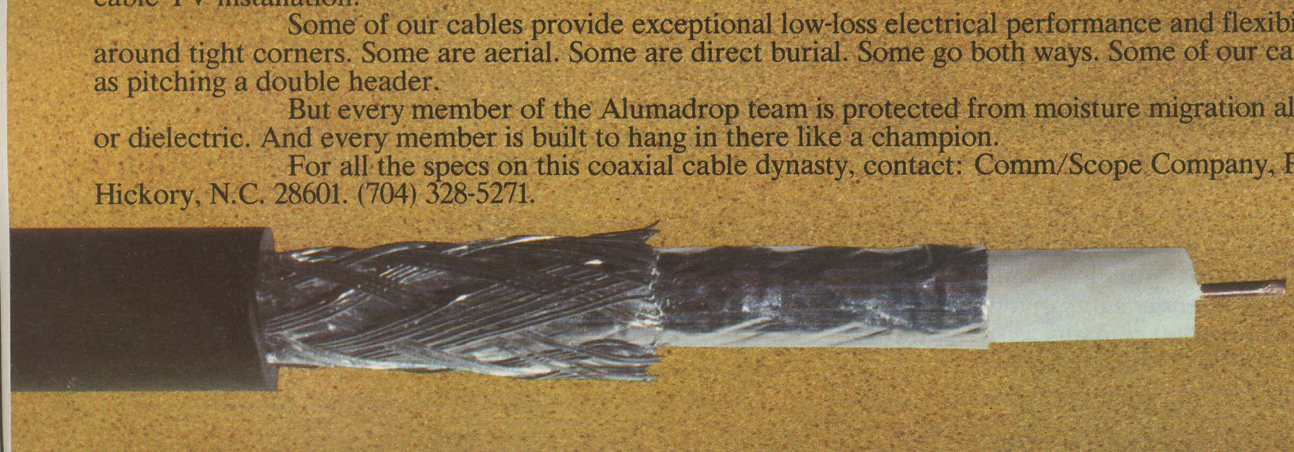

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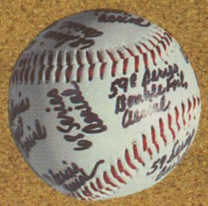

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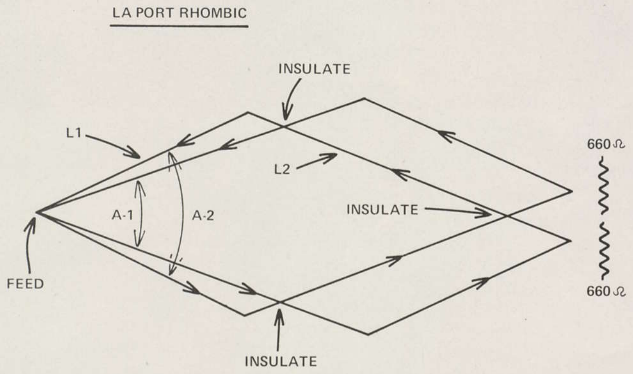

NOTE:

1) ALL "SHORT" SIDES—SEE L1 DIMENSION

2) ALL "LONG" SIDES— SEE L2 DIMENSION

3) NOTE ANGLE A—1 (FROM TABLE III) IS BETWEEN TWO "LONG" SIDES CONNECTED TO FEED POINT POLE (#1)

4) NOTE ANGLE A—2 (FROM TABLE III) IS BETWEEN TWO "SHORT" SIDES CONNECTED TO FEED POINT POLE (#1)

DIAGRAM 18

would have to be the prime focus feed parabolic utilized (for example) in the TVRO service at 4 GHz.

Laport Rhombics have been utilized with considerable success by any number of services, although they have not previously had wide exposure to an industry group such as CATV. Amateur radio operators have utilized the Laport Rhombic to direct 144 MHz signals to the moon, utilizing the moon as a passive reflector for communication with other amateurs here on earth. Very long haul voice and data 99.9% "reliable" tropospheric scatter circuits in the VHF range utilize the Laport Rhombic for paths as long as 500 miles at 200 MHz in various parts of the world. And at shortwave frequencies, where they were first employed by RCA Communications, Laport Rhombics standing side by side stacked multi-wire-per-leg optimized rhombics on the same trans-atlantic circuit at the same time have proven to be 42-43% more effective than the best non-Laport Rhombic installations.

The Laport Rhombic construction is not complicated, but to achieve the type of sidelobe control (and therefore the gain theoretically possible) will require more than the usual amount of "slap it together" skill often practiced around CATV antenna installation sites. Remember the Laport Rhombic design is a *refinement* of all past Rhombic experience and while it appears to the eye to have a substantial design variation from a more normalized rhombic configuration, *the secret of its performance* is not so much in the uniqueness of "a" design as it is the care and pains the duplicator goes to insure that his Laport Rhombic is as close as humanly possible to the design parameters set forth here.

The gain possible is 27 to 27.5 dB, reference a dipole at the same height. Again, that is the equivalent of an array of 64 12.0 dB gain yagis (or logs).

The other general parameters at the design frequency are as follows:

Vertical beamwidth (i.e. elevation beamwidth either side of the axis line, which should be on the horizon)...6.0 degrees; horizontal beamwidth (azimuth width at 3 dB points)...11 degrees. Because the Laport Rhombic is usable over a fairly wide frequency range, (Laport Rhombics in use at RCA with a center design frequency of 8.5 MHz cover the useful range of 5 to 12 MHz, or from Fo of .59 to an Fo of 1.41) it is interesting to note what happens at Fo (i.e. operating frequencies) as low as .58(%) of the operating frequency and as high as 1.41 (141%) of the operating frequency.

If we assume a design frequency of channel 2 (visual), or 55.25 MHz, channel 6 aural represents an Fo of 1.58 (or 158%). The Laport Rhombic *may* be useful *that far above* the Fo, but there is no readily available data to confirm nor deny this. However, if we change the design frequency to 62.25 MHz (channel 3 visual is 61.25 MHz), we have a 1.41 (141%) Fo of 87.77 MHz, or past the channel 6 aural carrier frequency. At the same time, our .58(%) Fo becomes 36.1 MHz, obviously adequate to cover channel 2 visual at 55.25 MHz.

For high band, if we assume an Fo of 175.25 MHz, we find that our 1.41 (141%) Fo is 247 MHz; well beyond the 215.75 MHz requirements of channel 13 aural.

Finally, for UHF if we assume an Fo of 471.25 MHz (channel 14 visual carrier), our 1.41 (141%) Fo becomes 664 MHz, or channel 43. However, if we select an Fo of 630 MHz, our 1.41 Fo becomes 888 MHz (channel 83 visual is 885.25 MHz). And, with a 630 MHz Fo, our .58 Fo becomes 365 MHz, well below channel 14's visual carrier frequency of 471.25 MHz.

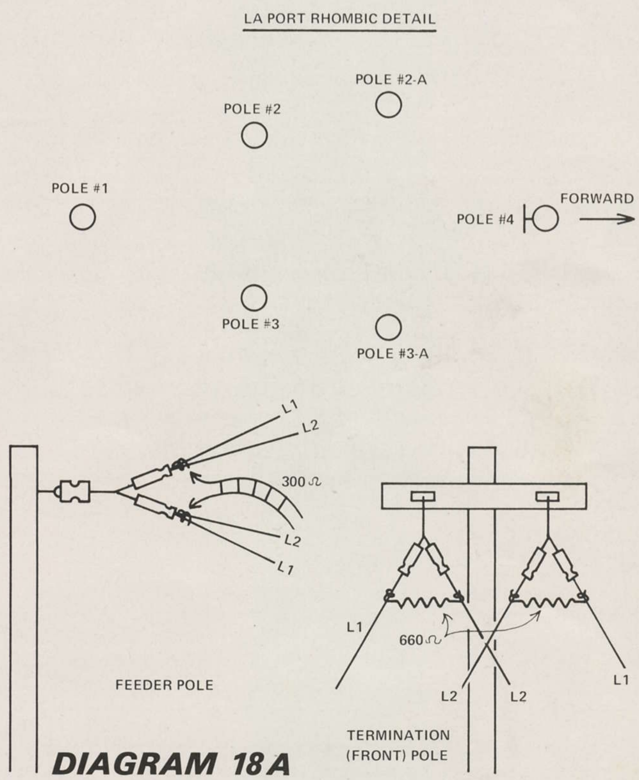

DIAGRAM 18A

TABLE THREE — LAPORT DIMENSIONS

The Laport rhombic is shown in diagrams 18 through 18-B. Note that each individual rhombic has four sides, and the four sides are made up of **two sets of equal legs**. Overall, there are four equal-length legs in the two-stack rhombic, **but only two legs per stack** are the **same** length. This results in the front or nose being offset as shown in diagram 18 and 18-B. Leg lengths (L1 and L2) are shown here, along with the **approximate** front-to-back (F/B) and side-to-side dimensions. Because the rhombic requires six support poles (or seven if two are used at the front termination point), we have side to side dimension Bk/Ss (the dimension between poles #2 and #3 in diagram 18-B) and side to side dimension Ft/Ss (the dimension between poles #2-A and 3-A in diagram 18-B). We also have the dimension between the two individual noses of the two stacks (dimension F/Nn in diagram 18-B).

L1, L2 and angle dimensions given here **are exact**. Dimensions F/B, Bk/Ss, Ft/Ss and F/Nn **are approximate** to serve as **guides only** in determining your ground space requirements. The Laport rhombic should be laid out initially on 1/10th inch square graph paper, to scale, for your own site. Construction should begin by laying out the antenna bearing line from pole 1 through 4 to the transmitter site. Then use a surveyors transit to stake poles #2, 2-A, 3 and 3-A following the X and Y angles given.

Angle X = 52.2 degrees
Angle Y = 37.7 degrees

Channel	L1	L2	Approximate F/B	Approx. Bk/Ss	Approx. Ft/Ss	Approx. F/Nn
2	62' 5''	106'10''	160' 6''	57' 1''	71'4''	14' 3''
3	56' 0''	96' 4''	144' 0''	51' 2''	64' 0''	12'10''
4	51' 4''	87'10''	131'11''	46'11''	58' 8''	11' 9''
5	44' 8''	76' 6''	114' 9''	40'10''	51' 0''	10' 2''
6	41' 5''	71' 0''	106' 6''	37'10''	47' 4''	9' 6''
100 MHz	34' 5''	59' 0''	88' 6''	31' 6''	39' 4''	7'10''
7	19' 6''	33' 8''	50' 3''	17'10''	22' 4''	4' 6''
8	19' 0''	32' 8''	48' 9''	17' 4''	21' 8''	4' 4''
9	18' 5''	31' 6''	47' 3''	16'10''	21' 0''	4' 2''
10	17' 9''	30' 6''	45' 9''	16' 3''	20' 3''	4' 1''
11	17' 3''	29' 8''	44' 3''	15' 9''	19' 8''	3'11''
12	16' 8''	28'10''	42' 9''	15' 2''	19' 0''	3'10''
13	16' 0''	28' 0''	41' 4''	14' 8''	18' 4''	3' 8''
14	7' 3''	12' 6''	18' 9''	6' 8''	8' 4''	1' 8''
30	6' 2''	10' 4''	15' 9''	5' 7''	7' 0''	1' 5''
50	5' 0''	8' 8''	12' 9''	4' 6''	5' 8''	1' 2''
70	4' 5''	7' 4''	11' 3''	4' 0''	5' 0''	1' 0''

Leg length L1 is 3.5 wavelengths, leg length L2 is 6.0 wavelengths.

Thus for our purposes here, we can design three separate Laport Rhombics, one to cover low band, one to cover high band, and one to cover UHF. See table III here.

The Laport Rhombic design is shown in diagram 18. It requires some explanation, since in schematic form it may *appear* to be a double stack array with an offset front end. *That is not the case.*

At the *rear* of the antenna, there are four legs coverging, two on each side. Overall, there are eight actual legs, but four of them are one length (3.5 wavelength long at Fo) and the remaining four are another length (6.0 wavelength at Fo). Note that in both cases the total leg lengths are multiples of 1/2 wavelengths, so the in-phase symmetry is maintained.

With two 3.5 wavelength legs and two 6.0 wavelength legs tied together at the rear feedpoint (i.e. one each 3.5 and 6.0 wavelength leg *to each* of the ceramic insulators), we in effect have placed in parallel the two separate but equal rhombics at the feedpoint.

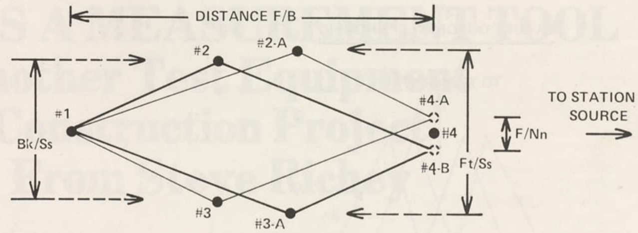

DIAGRAM 18B

The Laport Rhombic is an "equivalent" *two wire per leg* design, meaning the actual impedance is *lower* than the single wire per leg 800 ohm variety, but *not as low as* the afore mentioned *three wire per leg* variety. It turns out that the feed impedance of each four-leg-rhombic, because of the influence of the companion four-leg rhombic, is around 660 ohms. The front of each individual rhombic is terminated, then, with an equivalent resistance (*series a pair of 330 ohm 5% carbon two watt resistors*). However, at the rear where two descrete four-leg-segments are joined for balanced feeding, we have two 660 ohm impedance antennas in parallel, which not suprisingly creates a balanced feed at the antenna of 330 ohms. This is sufficiently close to 300 ohms (10%) to allow us to hang a 300 ohm to 75 ohm balanced to unbalanced transformer across the feed points and come out of the Laport Rhombic with our desired 75 ohm unbalanced line. Alternately, we *could* feed the antenna with a long length of 300 ohm open wire line if we had a fair distance to go before getting to pre-amplification and a coaxial network.

Because both four-leg segments are in the *same plane*, there are going to be *three points* where the same-plane wires will want to rub *against* one another. At these points you install a durable all-weather insulating sleeve over both of the wires, tieing them down so that the wind and weather don't move them about and leave the respective leg wires shorting together at that point.

Again the caution of Laport. *"All dimensions, and angles must be as precise as possible to maintain sidelobe control"*. You will note that we are dealing with fractional angles (accurate in Laport's instructions to .2 of a degree). This may be difficult to duplicate *precisely* in the field using less-than-RCA construction techniques. It should go without saying, however, that very precise planning go into such an array *if* you expect to obtain the 27 dB forward gain numbers experienced by Laport and others, and that more than casual planning go into the method by which the suspended legs will be *held in position* under varying winds and ice loading.

Four Is Better

Laport suggests the theoretical improvement of a four-wire-per-leg quadruple-rhomboid system (see diagram 19). The antenna would (in theory) have *in excess of 30 dB gain* and a front lobe

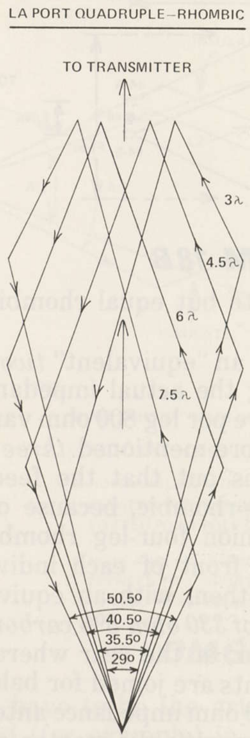

DIAGRAM 19

pattern with 3 dB points *under* 6 degrees wide.

Apparently, although his March 1960 *RCA Review* paper described this "Quad-Rhombic" such an antenna had *not* been constructed and subsequent interest in rhombics for its principal users (short-wave communication paths) has waned since that date because of the introduction of satellites for trans-oceanic communication paths.

In theory, such an array would have a paralleled feed impedance of around 140 ohms (balanced) at the rear feed point.

Relay Rhombic

Finally, there was a flurry of interest in a *"passive-booster"* system published in the April 1953 *Radio Electronics* magazine. As shown in diagram 20 here, two rhombic antennas (each was originally indicated to be common garden variety rhombics, 4.5 wavelengths per leg on the design channel) are connected "back-to-back" with a length of 600 ohm open wire line. The principal was that the substantial signal voltages developed across the receiving rhombic were transferred (less line loss and match loss) to the feed terminals on a second rhombic, which re-radiated the signals "on channel" to yet a third antenna several miles away.

As installed at a location 55 miles from Denver, the signal voltage built up on the receiving antenna ("A" in diagram 20) was sufficient to allow reception up to a couple of miles further on by yet a third rhombic.

Assuming the presence of +10 dBmV at the receive terminals of antenna "A", less 3 dB of transmission line and match loss in getting the signal to antenna "B", a 4.5 wavelength per leg rhombic as a transmitting antenna ("B") could be expected to produce a re-radiated signal "power" of +19 dBmV (roughly 1/100th of a volt). Allowing for spread losses, it is conceivable that with an identical rhombic at the antenna "C" (i.e. valley-floor) receiving location, there *might be* as much as —10 dBmV level possible at a distance of a mile, decreasing to a level of —20 dBmV at a distance of approximately two miles. In such a situation antenna "B" should be directed *down* into the desired valley receiving location and antenna "C" should be directed back "up" at the antenna "B" location.

If the theory behind all of this escapes you, try this on for size. The first rhombic (receive rhombic "A") has gain, and because of the gain, it builds up some known level of signal voltage across the feed point. This signal voltage is transported to "transmit" rhombic "B" through a piece of impedance-matched-to-antennas low loss open wire line. The second rhombic also has gain, and thus the signal "voltage" delivered is "amplified" by that gain, and radiated in the forward direction. *It is not exactly getting something for nothing, but it is close.*

There is no requirement that both antennas be identical, although no pre-amplifiers, converters, etc. may be introduced into the system *unless* you are willing to go through the hassle of licensing the "system" as an "on-channel-booster". As long as the "system" remains totally passive, no FCC license is required.

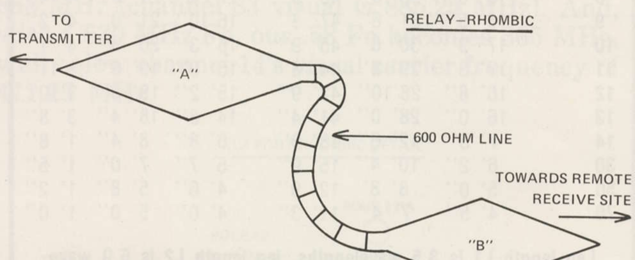

DIAGRAM 20

Rhombic References

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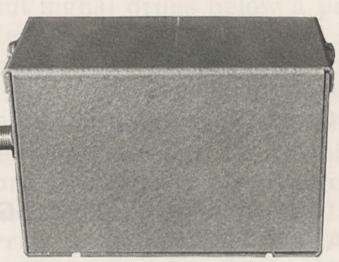
NOISE AS A MEASUREMENT TOOL
Another Test Equipment Construction Project From Steve Richey

Noise As A Tool

As anyone who has "read" (or calculated to be more exact) signal-to-noise ratios with a field strength meter is well aware, noise is amplified by active CATV equipment and can be read on an FSM. . . if the level is sufficiently high. Therefore a system that has a broadband noise source (i.e. a noise generator that covers the required broadband spectrum), a field strength meter and an accurate signal generator can measure FCC-required in-channel flatness specifications without the usual wagon-full of tag-along equipment.

As noted last month (see September CATJ, page 46), we are here in the process in a multi-part-*CATJ* series to show you how you can, on your own in your own shop, construct all of the test equipment required to make the FCC-mandated technical compliance tests. The assumption for this month's part of the series is that you have an FSM, and a signal generator. If you do not have the signal generator portion, come back again next month and we'll show you how to build one with sufficient accuracy to handle that requirement as well.



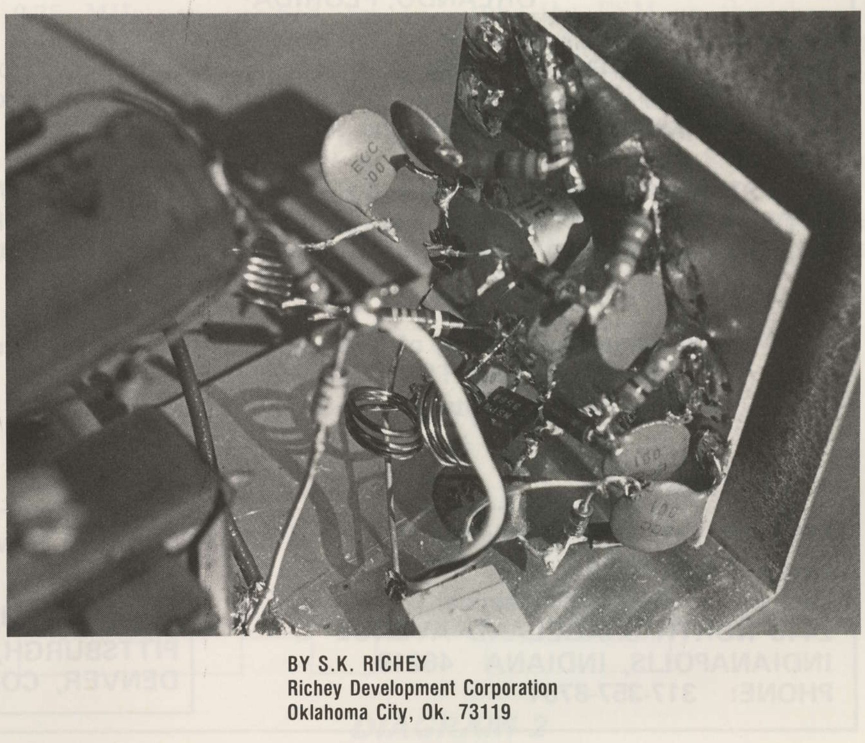
Zener Diode Source

The heart of our broadband noise generator is a fairly common variety of zener diode. A zener diode, when biased properly, is one of the greatest noise generators ever to come down the pike. A couple of preamplifer manufacturers have discovered this fact when they attempted to install zener diodes as protection devices in their pre-amps, and found the pre-amp noise figures promptly went to the dickens in a hand basket!

Sure that the world had at least one super-zener-noise-diode waiting to be discovered, we set out to check out the noise generating characteristics of several dozen common (and not so common) zener diodes. We ended up selecting one of the most common of all employed units, the 1N758. This is a 100 mW 10 volt zener and it has the capability of generating — 35 dBmV of wideband noise all by itself without any after-amplification. To boost that level to a more suitable level for our testing requirements, we followed the 1N758 with 15 dB of broadbanded amplifier using the also common 2N3564 family of bi-polar transistors.

As you can see from the photo illustrations, the broadband noise generator is constructed in a mini-box with built-in AC supply. The noise generator proper is mounted on a small piece of copper clad (PC) board. When constructing the circuit, short lead lengths are essential, especially the emitter leads on both transistors.

Although the 2N3564 (or 2N3563) transistor is about as common as one can find in CATV, they are not crucial to the circuit. Any TO-39 configuration CATV type transistor can be substituted in the second stage of the amplifier, and in a pinch most types will also work in the first amplifier stage. If the unit is properly constructed, the only alignment required should be setting the 10K pot for maximum noise output, as measured with your FSM *at channel 13.* After doing this, if you have a way to check for noise output versus broadband output, you should find the level at the output is +/— 1.5 dB maximum from 50 through 220 MHz.



BY S.K. RICHEY
Richey Development Corporation
Oklahoma City, Ok. 73119

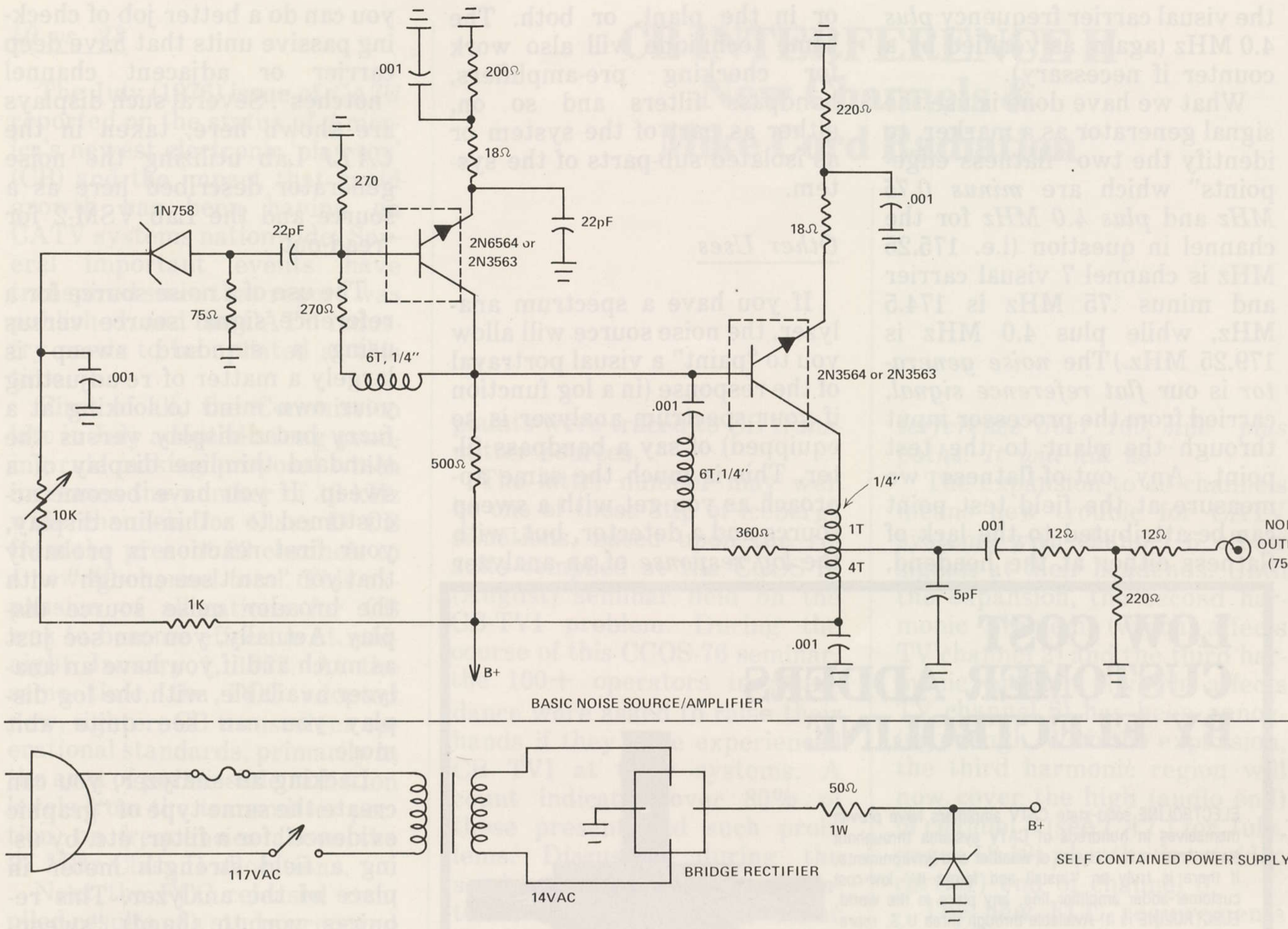


DIAGRAM 1

Test Procedures

If your processor has a kill ("squelch") circuit, or a standby carrier that flips on when the input signal drops below a predetermined point, it will be necessary to defeat this circuit(s) before attempting noise-analysis of the processor (this is due to the low level of the noise source and the lack of a descrete frequency RF carrier to key the carrier control circuit 'on'). If your processor is a heterodyne type unit, it will also be necessary to turn the sound control all the way down (i.e. to minimum sound carrier response or level). Set up the system as shown in diagram 2.

To check the in-channel response flatness from the input to the processor (at the headend) to one of the in-plant test points will require two people, and some form of communication between the two (a telephone if one is available at both ends of the circuit, otherwise two-way radio).

Step One — set up the signal generator so that it is on the proper input frequency (i.e. visual carrier frequency minus 0.75 MHz, as verified by a counter if necessary).

Step Two — Have the field-end of the circuit locate that carrier frequency on the FSM, and determine the noise level at that point (turn off signal "marker" generator). The signal generator output should be more or less — 15 dBmV (to the processor), at the headend.

Step Three — Now have the field end of the circuit slowly tune the FSM up the channel (i.e. towards the audio) making *written* notations of the maximum and minimum levels found.

Step Four — While the field-end of the circuit is tuning "up the channel", the headend portion of the test team should have *moved* the signal generator to

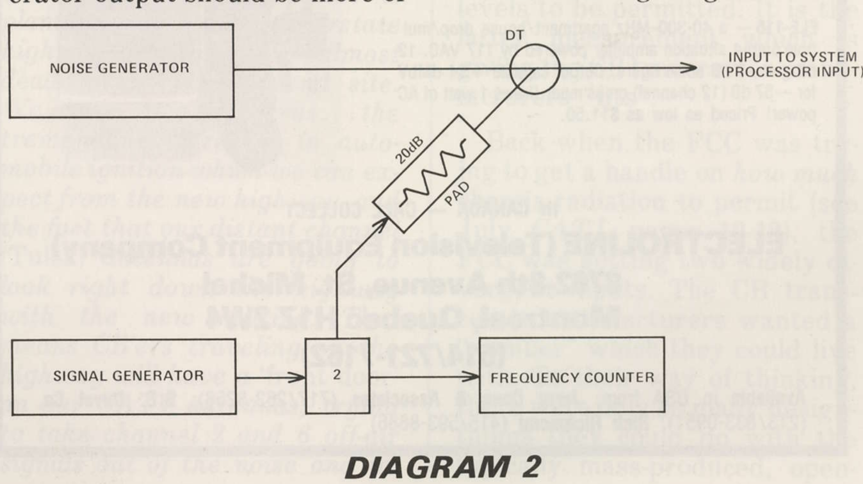


DIAGRAM 2

the visual carrier frequency *plus* 4.0 MHz (again, as verified by a counter if necessary).

What we have done is use the signal generator as a marker, to identify the two "flatness edge-points" which are *minus 0.75 MHz* and *plus 4.0 MHz* for the channel in question (i.e. 175.25 MHz is channel 7 visual carrier and minus .75 MHz is 174.5 MHz, while plus 4.0 MHz is 179.25 MHz.) The *noise generator* is our *flat reference signal*, carried from the processor input through the plant to the test point. Any out-of-flatness we measure at the field test point can be attributed to the lack of flatness either at the headend, or in the plant, or both. The same technique will also work for checking pre-amplifiers, bandpass filters and so on, either as part of the system or as isolated sub-parts of the system.

Other Uses

If you have a spectrum analyzer, the noise source will allow you to "paint" a visual portrayal of the response (in a log function if your spectrum analyzer is so equipped) of say a bandpass filter. This is much the same approach as you get with a sweep source and a detector, but, with the *log response* of an analyzer you can do a better job of checking passive units that have deep carrier or adjacent channel "notches". Several such displays are shown here, taken in the *CATJ* Lab utilizing the noise generator described here as a source and the Lab VSM-2 for "read-out".

The use of a noise source for a reference signal source versus using a standard sweep is largely a matter of re-adjusting your own mind to looking at a *fuzzy* broad-display versus the standard thin-line display of a sweep. If you have become accustomed to a thin-line display, your first reaction is probably that you "can't see enough" with the broader noise source display. Actually, you can see just as much and if you have an analyzer available, with the log display you can see quite abit more.

Lacking an analyzer, you can create the same type of "graphic evidence" for a filter, etc. by using a field strength meter in place of the analyzer. This requires you to (hand) "sweep-tune" the FSM across the band writing down the FSM "numbers" as you move through the frequency range of the channel(s) in question. Then transfer the written numbers to a piece of graph paper to create your own "sweep-display" hard copy. This is rather extensively covered by SADELCO in the manual for their *Spectrum Analyst*; the originator of the broadband noise source technique for CATV tests.

Finally, the noise-source approach has one advantage over sweeping, because there are no line-power-related "sync" problems, the noise source can be plugged into the system at any point where you need a signal, and the detection unit (an FSM or spectrum analyzer) can be plugged in at any further-downstream point. Without the "sync-matching" requirement, a noise source and a detection system are actually considerably more flexible for system sweeping than a traditional (low cost) sweep/detector system.

CB INTERFERENCE II
New Channels & Mike Cord Radiation

40 vs. 23

The July (1976) issue of *CATJ* reported on the status of America's newest electronic 'play-toy' (CB) and the impact that rapid growth has been having on CATV systems nationwide. Several important events have transpired since that report was published, and the CATV industry needs to be updated at this time.

First of all, the Commission late in July adopted a long pending rule making proposal which increases the number of 10 kHz wide channels for Class D CB from the present 23 channels to a new 40 channel total. This expansion of allocations for CB was to become effective at midnight January 1, 1977. At the same time, the FCC adopted new, tighter, CB transceiver operational standards, primarily in the area of permissible radiation levels from the transmitter portion, on frequencies above the 27 MHz Class D allocations.

Next the FCC released compiled results of a study prepared by the FCC's Field Operations Bureau which investigated television and radio reception interference complaints during fiscal year 1976 (ending June 30, 1976) In that study, the FCC revealed their offices received reception-complaints from 80,816 sources during the preceding 12 month period, and the FOB determined that 77% of all complaints received were associated with CB transmissions. The same study reveals that of the 80,816 interference complaints, 53,292 were complaints of reception *interference to television* services, and that of these TVI complaints, 83% were traced to CB interference sources.

The same study broke out the number of CATV system complaints, i.e. the number of CATV systems reporting CB TVI prolems during the preceding 12 month period. A total of 373 CATV companies complained of interference to the FCC (roughly 12% of all CATV systems), and of those 373 CATV systems receiving interferences, 239 (64%) of the complaints were traced to CB transmitter sources.

The latter number may well be one of those "tip of iceberg" situations, based upon the results compiled at the CCOS-76 (August) seminar held on the CB-TVI problem. During the course of this CCOS-76 seminar, the 100+ operators in attendance were asked to raise their hands if they have experienced CB TVI at their systems. A count indicated over 80% of those present had such problems. Discussion during the seminar indicated that most system operators had never "bothered" to file a complaint with the FCC, primarily "because we knew the FCC has their hands full and we felt we might be able to handle it better here".

One operator in southwestern Missouri indicated he would welcome any and all help, however. Dean Petersen of Carthage, Missouri reported "*After nearly ten years of operating our CATV system from a headend that is in a typically rural setting, we now learn that the state highway department is planning a major interstate highway interchange almost dead under our headend site. We have two concerns... the tremendous increases in automobile ignition which we can expect from the new highway, and the fact that our distant channel* (Tulsa) *antennas are going to look right down the highway with the new routing. That means CB'ers traveling on the highway will have a* 'front door' *on our CATV antennas, trying to take channel 2 and 6 off-air signals out of the noise and interference over 100 mile plus paths. It will kill us.*"

The expansion to 40 channels means new trouble for CATV systems with channel 6 off-air signals at their headends. Until the expansion, the second harmonic problem (which affects TV channel 2) and the third harmonic problem (which affects TV channel 5) has been annoying enough. With the expansion, the third harmonic region will now cover the high (audio end) of channel 5 (see *CATJ* for July, pages 18-19) *plus* the low (video carrier) end of channel 6.

The new FCC requirements for CB transmitter radiation should help out this situation somewhat, if they stick. The FCC's approval of the channel expansion was predicated on the fact that CB transmitters type accepted for sale after the effective date of the new channels must conform to new, tighter standards. The standards affect not only the permissible levels of second, third (etc.) harmonic energy (i.e. they are reduced below present values), but the standards also affect the CB transceiver chassis radiation levels to be permitted. It is the latter measurement which is giving the CB transceiver manufacturers "fits".

Back when the FCC was trying to get a handle on *how much* chassis radiation to permit (see July *CATJ*, pages 12-13), the FCC was getting two widely divergent inputs. The CB transceiver manufacturers wanted a "number" which they could live with. To their way of thinking, there were only so many design-things they could do with the typically mass-produced, open-chassis transceiver to cut down on radiation from the chassis itself. To go beyond a certain point in radiation level would require that CB manufacturers scrap all existing production techniques and adopt newer, more extensively - filtered - designs. The bottom line of this was that the typical CB transceiver would go up in price, perhaps by as much as 50% across the board. Naturally the CB manufacturers did not want to be put into a position of having to adopt standards which would restrict their abilities to produce low-end (i.e. low cost) transceivers.

At the same time the broadcast interests, largely represented by the NAB, AMST and others of a similar ilk, wanted the CB transceivers to have radiation levels so low that to meet them the CB manufacturers would have had to build the units into double-shielded lead boxes! And as one astute observer noted, the FCC's present TV set (i.e local oscillator) radiation standards are much more lenient than the radiation specs the broadcasters were then proposing for CB transceivers. On the bottom line, if a TV set's local oscillator can radiate with a so many microvolts per meter signal level, and be "legal", then why should CB transceivers have had to meet a standard that was *more rigid than that.* Radiation, regardless of its source, is radiation. And the CB manufacturers were incensed that they should be given the full burden of cleaning up the environment.

So some standards for the new sets were established. Only someplace between the proposed standards and the CB industry's support of those proposed standards, and reality, stood a new problem. Under the standards the FCC adopted (and which the CB manufacturers largely supported as 'their acceptable numbers'), it turns out, very few (probably none) of the present CB transceivers can comply. Or to put it another way, the standards which the CB manufacturers opted for, and supported, in June and July, *turn out to be standards they cannot meet.* The big problem is with the microphone cord when it is pulled taunt and held up high above the radio on a test stand, RF induced into the mike cord cable radiates at levels higher than the FCC standards allow.

At the moment this suggests that perhaps . . . *just perhaps* . . . the January 1 start date for the new channel expansion may not come off as planned. Something has got to give . . . either the CB manufacturers discover some breakthrough that allows them to meet the standard they supported, or the FCC backs off on the standard. AMST and NAB are pushing the FCC to raise the standards even higher, on "reconsideration", so the pressures are on at the FCC to not give in to the CB manufacturer's problem.

All of this intra-industry squabbling has not gone unnoticed by the CB buying public. When word leaked out that there would be 40 channel radios, sales on 23 channel models fell off. Perhaps the reason for the decline in sales was not related to the expansion . . . nobody can say for sure. But CB license applications dropped from a 500,000/600,000 per month rate in May and June to around 300,000 for the month of August. *Something happened* . . . that everyone agrees upon.

So the CB situation, as it impacts upon CATV, and as it impacts on the growing explosion in "personal communications", stays fluid, unpredictable and difficult to categorize. If and when it settles down, *CATJ* will have additional reports.

IF YOU CAN'T BEAT 'EM...
Preparing Your House For March 1977

Counsel's Council

One might wonder where the CAC phrase comes from, if one had little else to be thinking about at the time. I've heard so many variations (including C O C) that it might be useful to clear the air on this point before we look at the process and procedure.

The first "C" in CAC stands for Cable Television Bureau. The "A" in CAC stands for Application. And finally the last "C" in CAC stands for Certificate. So what we have here is a *Cable Television Application* [for a) *Certificate.*

The CAC procedure has an interesting history as well. When the Commission adopted its rules in 1972, there was no way for the Commission to insure that the various rules relating to access, signal carriage, franchising, technical standards and so on were going to be complied with. The Commission had first attempted to get Congress to grant them the authority to assess fines and forfeitures for cable television back in 1971. But when that failed, at that time, they then had to look for some other way to "insure compliance". Thus the CAC process was "invented".

Now other wards of the Commission have something called licenses. But the FCC felt that because the 1934 Communications Act expressly prohibits them from "licensing receivers" that they would do well to stay clear of the phrase "license" with CATV systems. So the phrase "certificate" surfaced.

It is worth noting that in the Gridley case now before the Commission, we have gotten the Commission to admit for the first time that a "certificate" is really a "license" *after all*, that the clever play on words attempted in 1972 was really just that. This has been one of the most significant outgrowths of the Gridley Test Case to date, although it hardly can be called a victory. At the best we have an agreement of terms, and hopefully when the Gridley Test Case finally finds its way into court, that agreement of terms will be useful to us.

Now one of the key elements of the CAC application is the franchise; your franchise to operate in your town, city or rural area. For the Commission's purposes a franchise does not have to be a franchise. That is, it can be called any number of things, and in fact it doesn't even have to have a name at all. It can be a permit, an ordinance with a permit, a right of way agreement, and so on. A franchise is a word of "convenience" in the FCC's rules, and in fact the rules state that you shall have "a franchise or other appropriate authorization..." *So whatever it is* that allows you to do (cable) business in your community...*that is what the Commission is talking about.*

In those states that now have state CATV regulation we are then talking about not one but two separate "appropriate authorizations", one from the local level and one from the state level. What the Commission is asking for is that "package of paper", however it is made up that you must have locally *before* you can start stringing wire, or hooking up customers. And the rules at the Commission apply to that *total* "package of paper".

System Types

We really have several different types of systems, when we begin to talk about meeting the requirements of the CAC process. And within some of these "categories" we have subcategories as well. For example:

1) *New Systems* (constructed after March 31, 1972) — these systems must comply with all of the 1972 rules from day one;

2) *Pre 1972 Systems* (constructed prior to March 31, 1972) — These are the so-called Grandfathered Systems, which as of right now must have full compliance with the 1972 rules by March 31, 1977;

3) *Pre 1972 Systems With Interim Franchise Expiration* (systems constructed prior to March 31, 1972 but whose franchise has expired or will expire prior to March 31, 1977) — If you have such a system, technically you should have gone through the CAC process *already.* In theory you should have gone to the Commission by now. Technically, *you are already in violation* of the Commission's rules if you renewed your franchise *but did not* go to the Commission for a CAC;

4) *Franchised But Not Operating Pre 1972* (systems that had local authority to construct prior to March 31, 1972, but which had not begun operation by that date) — Again, technically, you should have gone to the Commission and asked for a CAC based upon what the Commission terms "substantial com-

This is Part One of a several part **CATJ series** prepared from audio-tapes of the CCOS-76 Seminar on **Preparing For March 1977** (and completing FCC Certificate of Compliance applications). The subsequent portions of this series will continue in November, December and January **CATJ**.

With this seminar session, CATA supplied a detailed Seminar Workbook. As announced between pages 8 and 9 of this issue of **CATJ**, there will be a series of regionalized "Mini-CCOS" meetings throughout the United States during this same period. **The best way for you to have your own questions answered is to attend the "Mini-CCOS" when it is in your area.** Lacking that opportunity, you may find the audio-tape-transcripts (in edited form) as reported here in **CATJ** plus the CCOS Seminar workbooks will answer many of your own system questions. **Note that "Mini-CCOS" meetings will have limited registration, and that registration is being handled in advance of the meetings only.**

pliance". Obviously, if you got your franchise prior to March 31, 1972 (the effective date of the new rules), there was no way you could have known what the new rules said or required in the way of franchise compliance. Recognizing this, the Commission set up a 'short-form' certificating process wherein they granted you a certificate to operate only *until* March 31, 1977, provided your pre-March (31) 1972 franchise was in 'substantial compliance' with the new rules.

The basis for such short-form certificates was that if your franchise 'looked reasonable', that is it was not 'way out in left field', the FCC would put its stamp of approval on it for a CAC (so you could go ahead and construct the system and begin operating without having to go back for a new or modified franchise), and operate *until* March 31, 1977 with that CAC. But at that time, like other "grandfathered systems" you would be required to return to the Commission for a "full compliance" CAC with a "full compliance" franchise.

Some people believe that they have until their franchise expires with such 'substantial compliance' CAC's before they have to return to the Commission. *This is not true.* You have until March 31, 1977, even if your franchise runs beyond that date.

Automatic Renewals

Floor question: "*We have a franchise with an automatic renewal clause. How are we affected?*"

"This will not fly at the FCC because at any franchise renewal there must be a full public proceeding, offering due process before the franchise renewal can be granted. The Commission will not accept a franchise that allows the operator to simply file a letter with the local authority stating in effect 'I am exercising my option to renew this franchise.' Anytime there is any renewal of your franchise, any change in your franchise, or a new franchise granted, there must be a full public proceeding."

There is a special type of problem in some states, such as Iowa, which are known technically as 'Code States'. Here there are provisions for referendums, that is, there is a state rule that says that before a local authority can grant you a franchise for "a term of years", the matter must be brought before the local population in a referendum vote. The key phrase in such state rules is "term of years", and in most states this is generally a twenty-five year term.

Now first of all, the twenty-five years is generally not acceptable at the Commission, so that has to be knocked back to fifteen years.

There is another rule in most "Code States" which states that you can obtain a franchise or agreement with a local authority, sort of in perpetuity, which gives your franchise or permit a "year-to-year" term. In this sort of arrangement, the theory is that every year the local authority "*could* take it away from you" if they wanted to do so (most of these are not called franchises, but rather are called permits). The reason local authorities have taken this approach is that they wanted to get away from (or around) the state codes that require referendums for everything from cable to garbage collection "franchises".

Now it is interesting to note that the Commission *has accepted* these permits, for a CAC, but with conditions:

1) That you obtained the permit initially in a full public proceeding, affording proper due process, before an open, regular meeting of the city council, town board or whatever;

2) That in the process of granting you this permit the local authority studied your financial qualifications, your technical qualifications, and so on;

3) And that inspite of the fact that your "permit" is in perpetuity, the Commission will only grant you the CAC for a 15 year term.

Now the 15 year CAC term is for a reason. The Commission is saying that while the franchise or permit in theory can be revoked at any of the annual renewals, they want to be assured that no less often than once every 15 years there will be a full public proceeding with due process afforded. The whole Commission concept is to insure that the public does have some say, even if only every 15 years, in the way the franchise is granted and administered. The classic no-no example is a 99 year franchise.

Renewing Now or Soon?

Now let's suppose you are presently facing a renewal, that is, your present franchise is about to run out and you want to keep your skirts clean with the FCC. You are supposed to notify the Commission, through the Cable Television Bureau, 30 days or more prior to the expiration of your franchise that your franchise is expiring and that you are "in the process of renewing and modifying the franchise for submission to the Commission". Then the Commission should come back to you with a letter granting you a 90 day "extension" on your CAC (with new franchise attached) filing date. *You have to ask for this extension,* however, in your notification letter, *and you have to state that as soon as the franchise re-working is completed,* you will file your CAC application.

At the end of 90 days, if you still have not gotten your new franchise the situation may get a little touchy. Of course there are legitimate situations where it cannot be completed, but the Commission has been burned by the procedure a few times by people simply trying to stretch out their filing dates "a little longer", so they are suspicious when a second request for an extension comes in.

If you file such a request,

make certain you do this at least 30 days *prior to* the expiration of your present franchise and make certain you state that you are "in the process of negotiating for a renewal of your franchise".

Whole Versus Part

March 31, 1977 does one thing that hurts every operator who has a franchise that runs beyond *that date.* It might require opening up your franchise prior to its normal and natural expiration date. This creates a situation which CATA is dealing with in a rule making petition currently before the Commission, the so-called Hugo situation. Now actually Hugo (it turns out) was up for franchise renewal anyhow, and the old system operators were before the city for a renewal on just *normal* renewal proceedings. But there have been other situations where during the course of seeking modifications to an existing franchise, prior to its natural expiration date, the existing operator was faced with one or more competing applications filed by others desirous of the franchise. This has coined the phrase "Franchise Raiding", and this understandably has many operators with unpaid mortgages a bit worried.

The first thing you need to understand is that the 1977 modifications *do not require you* to start all over again with a *totally new* franchise, except in the very rarest of situations. The Commission's rules simply state that your franchise must be in compliance with the Commission's franchise standards in 76.31. There *were* seven such standards but with the recent relaxation of the rate making procedure, there are now six standards remaining. Therefore, what you need to do is to take your present franchise and lay it side by side the requirements of 76.31 (a) and (b) and determine where your franchise is at variance with the provisions found there.

For example, let's assume your franchise does *not have* a provision which requires you to have a "local cable office" (76.31 [a] [5]). In this one standard-area, your franchise is "out of spec". So what you need to do here is to amend the existing franchise or permit so that it specifies that you do in fact have a local office.

This does not mean that your local franchising authority must open up the whole or total franchise to accomplish this change. There is no requirement that the local authority open up the franchise for new bids or bidders. You have a franchise, permit or whatever that says you have a right to be doing (cable) business in your town. *That portion of your franchise*, permit or whatever, *must be held intact* by you and by your attorney if you use one, and by the city attorney, as you work through the modifications or amendments you need to make. Don't jeopardize that key language which granted you the right to be in the cable business in your town. Work around it, or through it, or over it. But leave

it intact.

Now there is a complication in all of this. If in fact there is one or more others (or groups) desirous of getting your franchise, and they believe they see the opportunity to do this while you are before the local authority seeking modifications or amendments, you have to be very careful with how you allow the amendments to proceed. If your franchise is way out of line with the FCC standards, there may come a point in the meetings and discussions where somebody proposes that the whole franchise be thrown out, as too unworkable for amendment, and they may suggest "starting all over". *That is the red flag.* It is a matter of local law, local rules and local authority to determine when such a point comes up. At some point the city attorney may say *"We have so amended and so modified this original franchise* (permit, etc.) *that as a contract it has now been abrogated; or destroyed. We are going to have to change it so much that in the end it will not even look like the instrument we started with."* This is a very dangerous situation, and this is where the tables can turn on you very quickly if you are not prepared to stop the tide.

This is a local question. It depends largely on the state laws governing the city or town, the charter for the community, and the way the local city attorney advises the council or board. There is a point where the character of the franchise or permit changes to the point where they feel they must re-write from the ground up. And if they do that, then this is where they could call for new bids for a new franchise; having reached the point where they believe the old franchise has been abbrogated or destroyed by the modifications. This is a very sticky point, and you are well advised to be watching for it and to have local counsel you can count on to keep the modifications procedure from reaching this point. If there are others after your franchise, you can be sure they may be working just as hard to get you into that posture.

Protective Public Hearing

The requirement that all such franchise questions be decided in public hearing or meeting. Is there not a measure of protection for the existing operator in such a procedure?"

"The public hearing affects everything you want to do or need to do. Let's take the situation where only one provision, the local office requirement, has to be added to the franchise."

This has to be done at a full public hearing afffording the citizens, the town and you due process. It is a big mistake to go to the city council or county board and get your franchise amended at one of those quickie midnight meetings at the local cafe. First of all, if the Commis- finds out about this handling of the amendment, it is curtains for your CAC. If you have somebody around who wants to cause you trouble, and they find out about it, you can be sure the Commission will also find out.

Local vs. Federal Pre-Emption

Floor question: "*I cannot understand how the federal government can step into my contract with my city, a private contract, a legal contract still in force. It was a twenty five year contract. So far the city has lived up to their responsibilities and so have I. The contract is valid and in no local danger of being destroyed. Now the FCC comes along and tells both of us that portions of our contract are pre-empted, and must be re-written to federal guidelines. Can you explain to me how this can be done to me, and my city?*"

"In theory, federal regulations (as adopted by a federal regulatory agency) have the same force as law. If they are pre-emptive regulations, which is the case the Commission claims with the cable television rules, then they do indeed have the power to pre-empt local or state law."

It may be easier to think of this in terms of a non-cable situation, since the emotions of the cable situation cloud the issue. Let's assume you have a contract with a city or county to build and operate a strip mine there. And then a federal law comes along outlawing strip mining. That is the end of your local strip mine and that is the end of your contract with your city or county. And the courts have time and time again upheld this type of pre-emptive power of the federal government.

However, and here is where the cable emotion enters the picture, this procedure becomes more questionable with the FCC's cable television rules because of the very shakey base that the Commission has utilized to write and enforce the cable rules. The jurisdiction base for the cable rules is at best 50-50. The decision, when there ultimately is one in the courts, could go either way. When Kyle Moore first came along with the jurisdictional question in the pending Gridley, Kansas case, the instant reaction at the Cable Bureau was "Hey look here at what this crazy Kyle Moore and his co-horts are doing! There is no chance that CATA will win this case."

The current belief is that it can go either way. . . if it can get into a court of law. The Commission is plainly worried about this case and the question you ask is at the root of their concern.

Constant Compliance

Floor question: "If your franchise states that it is continu*ously compatible with the FCC rules, that is it has language in there which states that whenever the FCC changes the rules the local ordinance where in conflict comes into compliance, why should I have to go back formally before the local authorities for modifications to the franchise? I have ten more years to run on the franchise and I am not anxious to go back at this time, if I can help it. The city has already granted the FCC carte blanche rights.*"

"In theory, yes you are right. In practice, you are not home free." Section 76.31 (a) (6) says any franchise is supposed to have a provision in it which states that the franchise will be modified to satisfy new FCC requirements within one year of passage of any new rule or an amendment of an old one, by the Commission.

There are a lot of cities that balk at this provision. If someone has some difficulty with the local city accepting that kind of delegation of local authority to a federal body, the best advice is to "not fight city hall". In other words, let the city pass the ordinance *without that provision* in there if they are determined to do so, and don't worry too much about it. The Commission recognizes they are on very thin ground here, and to date they have not made a big deal about that provision missing from the franchise instrument.

"In your own franchise, you apparently have a question about it complying as it now stands. Is your problem a 'term problem'?

Floor answer: "*Yes, the initial term was twenty years and we* *have ten more years to run."*

"From what we can tell today, and we will know more and with a greater degree of certainty before this year is over, the Commission is still trying to figure out just what to do about this entire 1977 mess."

It is possible, one of the reasons being CATA's petition to put off or dismiss 77 requirements, that they will do one of several things, or even a combination of different things.

Number one — They might just put off 1977. Now we would all cheer if that happened, but I wouldn't hold my breath.

Number two — Or, they might put it off for say ten years, and this was one of the suggestions which CATA's filing made.

Number three — Or, they might allow any existing franchise to run until its natural expiration date, as long as there is no unreasonable term such as 99 years. And then the operator would have to come in for a CAC and be in compliance.

Number four — Or, and this seems on the front burner at the moment although these concepts have a way of changing overnight, they might take the 76.31 franchise standard rules and select those which the Commission feels are most important to them. And they would go to the cable operators and say to you "Instead of opening up your franchise and re-negotiating some or all of it towards full compliance, we want you to 'warrant' certain things."

For instance, they would ask you to 'warrant' that you do in fact have a local business office. They would have you attest to the fact that you do comply with 76.31 (a) (6), for example, but not require that you re-open your franchise to stick that requirement into the actual franchise instrument. At least not at this time. Not until the franchise ran out and you renewed it anyhow.

Now you would still file a CAC application, but rather than filing with that application a franchise that conforms as the rules now state, you would file your existing franchise, and then where your franchise was at variance with the rules, you would warrant that while the franchise was in variance, *your actual operation was not.* This would be done under penalty of law, and that is dangerous. When you sign your signature on something that goes to the federal government, and you attest to certain facts being true to the best of your knowledge ...and than it is found that what you have sworn to is not in fact true, then the Commission has you. They have you for falsely swearing and this is punishable by monetary fines of up to $10,000. and/or a jail term. So there are good and bad sides to the 'warrant' approach. The bad side is obvious. The good side is of course that you might or would avoid the renegotiation portion of the CAC process. There is also the possibility that in addition to getting *you* to warrant the various facts that attach to your franchise that the commission might also require *your local franchising authority* to also warrant the facts.

This 'warrant approach' deals with most of the 76.31 problems, except for the term problem. One of the now being talked about, but by no means set concepts is that you will have a maximum of 15 years from March 31, 1977 on your CAC grant. Should your franchise expire in the interim, it would be up for renewal at the CAC office when the franchise *actually* expires. But if the present expiration date is *beyond* March 31, 1992 (15 years), then that would be the maximum period authorized for the CAC to be valid for.

There is no place like the Bureau for a wide range of views. *Not everyone* likes *any* of these proposals. Many think you should be held to March 31, 1977, as the rules now state, and if you lose your franchise as a result, good riddance to you. These people say the theory behind the March 31, 1972 rules was to provide (by federal mandate) an assurance that the local cable public had an opportunity, at reasonable time intervals, to be a part of the "due process" of your receiving a franchise. These people feel you would receive the new 15 year term *if you were doing a good job anyway. They object to your getting fifteen years plus what you have already run up; because this weakens the original concept.*

There is no decision here yet...the FCC has simply not made up its mind.

Signal vs. Franchise Compliance

Floor question: *"I have already filed my CAC application and my franchise for my grandfathered system. I did this to add some additional signals which became available after March 31, 1972. But when the CAC was issued, it had an expiration date of March 31, 1977. I got the additional signals I requested, but the Commission was so wrapped up in my signal carriage request that they did not even deal with my franchise. Now I have to go back again for my franchise compliance. Why did they ignore the franchise portion?*

"Is the franchise in compliance?"

"No...it has a few problems."

"You in all likelihood filed your application under the signal carriage provisions of the rules and when you do that, technically, what you are asking for is not a *full* CAC based upon *full compliance*, but rather for signal carriage certification *only*. As a grandfathered system, all the Bureau did was to look at the franchise and as long as it was not 'wildly' out of compliance, they went ahead and granted you the signals that were allowed. They did this with the 'understanding' that you *would come back* before March 31, 1977 and re-apply to bring the balance of your operation into compliance with the rules."

Next Month

The Novemer CATJ will continue this series with a look at the following problems, among others:

1) Advertised public meetings
2) State limits on franchise terms
3) State control in the federal void
4) The state PUC and telco problem
5) Educating the city attorney
6) The "six" rules

Coop's cable column

bob cooper editor in chief CATJ

The 40 dB Overpass

In March of 1964 while I was cavorting around central California with my partner John Markovich of Fresno, looking for CATV franchises to pick up, we often hauled along a then-popular GE black and white portable receiver with its ever-in-attendance battery pack and cigarette lighter DC connector. In those days of franchise hunting, battling and in-fighting, a person trying to corner CATV franchises often found himself at two of three city council meetings a week and as many Kiwanis or Rotary or other civic group meetings "talking up cable." So while John and I would prowl Los Banos, Merced, Atwater, Turlock and dozens of other familiar central California towns, the ever faithful GE portable receiver would sit on the front seat of his or my Impala humming away on its built-in loop antenna (for UHF) or its rod antenna for VHF.

It was on one of those nameless nights while heading out of Merced after yet another City Council meeting that I turned on the GE seat-set and switched to channel 30 from Fresno on the continuous tuner. We were about 55 miles out but the high elevation and power of then KFRE-TV was always reliable along highway 99 as we started driving back north to our home base in Modesto. Reaching over to fiddle with the continuous tuner to sharpen up the picture, I noticed an adjacent channel beat; which was channel 29 in Bakersfield, some 150 miles south. It locked into sync and had almost no snow on the picture but before I could point it out to pilot John the signal was gone. I swept the continuous tuner back and forth looking for the picture for a couple of miles more and every 60 seconds or so there it was, often almost snowfree, and then in a second or so it was gone.

A few nights later as we were heading back into Merced I repeated the channel 29 search and sure enough, every mile or two it popped in for a few seconds and then went out just as fast. On a hunch, I asked John to slow down when he approached the next overpass (that went over highway 99). John had learned to live with my idiosyncrasies many years before (he once obliged me by dis-mantling his entire ham station and packing it into the back of my station wagon for a trip to a mountain peak in Yosemite National Park, **never asking why?**) and so as we approached the next highway bridge he slowed to a crawl.

"Pull over on the center median," I directed. Signs posted everywhere said "Do Not Stop On Center Median" of course. At a snails pace we crept under the bridge and headed out the opposite side.

"Back up," I directed, with some apparent excitement in my voice.

John obliged, backing against the traffic.

"Stop!" I shouted. **"Now move ahead...just a few feet."**

We moved ahead. **"Hold it right there,"** said I, crawling out of the stopped car and into the fast traffic lane with a dangling power cord trailing after me back to the cigarette lighter. Moving the TV set around and playing with the loop antenna on channel 29 (which was still at least 150 miles south of us) I probed the region under the underpass, muttering as I did **"Look at this..."** or **"Wow...just a few inches and look at the difference."**

John, never one to complain stayed in the car probably wondering how long it would take the state hospital to realize I had escaped. Presently we were both brought back to reality by the flashing red lights of a California Highway Patrol car.

"You fellows got car trouble?" asked the big guy.

John beckoned to me to respond, and I did by launching into a detailed explanation of who we were, why we were in Merced that night to pursue the cable television franchise, and then I motioned for the officer to **"come and see channel 29 in Bakersfield."**

He declined and recited section this and statute that of the California penal code, or something equally unimaginative and ended by telling us to **get our** $%&* off of the center median.

We obliged. The middle of highway 99 would have made a lousy headend site anyhow.

In the ensuing months I outfitted my Impala with every imaginable form of car-top antenna for VHF and UHF, and I went into the underpass searching business. I found that if the underpass "more or less" faced towards the desired station (i.e. the road going through the underpass more or less pointed at the desired station), there were situations where UHF signals were enhanced by as much as 40 dB if the "probe antenna" was situated in the area of maximum excitation. In some highly favorable situations, high band signals came up by 30 dB and in the best cases, depending on the design of the underpass, the low band signals would be 20-22 dB stronger in the underpass-excitation area as they would be anyplace else in the region.

The effect was not limited to underpasses. I once found a farmer's barn (constructed of metal) which produced 35 dB of enhancement for an optimum-directed UHF signal; but the farmer was less than understanding about my probing in his milk stalls.

Not all underpass (or overpass which depends upon where you are when you name it) bridges have the same gain figures; even when the direction is optimum or near optimum. There is, I learned, a definite relationship between the bridge **design** and the **gain** figure. A bridge with a center support to the ground in the center median is actually two separate "antennas" I learned. An under/over pass with metal super structure is always good for several more dB than a straight re-bar cage reinforced concrete under/over pass. But...a totally metal bridge is not as good as a combination metal super structure and concrete constructed unit.

Soon I developed a "Bridge Figure of Merit" system, based upon **gain** of the bridge and the sharpness of the "focal point." For the most part, the "focal point" was not a point at all; it was more of an "enhanced region" often several wavelengths wide and a couple of wavelengths deep. The point of maximum signal level, as often as not (and this was affected by the bridge's design) was about half-way through the underpass and in the center. In some situations the enhanced level maintained within a couple of dB right back to the back-end of the underpass (i.e. the end furthest back from the signal source), **followed** usually by a 10-15 dB **dip** in level, and this would in turn be followed by wavelength-separated sub-peaks in level, each progressively weaker as you exited out the back of the underpass and moved away from the signal. Out in front of the underpass (i.e. just **ahead** of the bridge between the signal source and the bridge proper) there was **typically** no enhancement present.

For a number of year I harbored the youthful belief that "**someday I would go into the Underpass Antenna Construction Business.**" This was about the time in our industry when Hosken Dew Line Parabolic antennas were springing up all across the nation, and the industry was "turned on to" big, monstrous antennas. I even looked into the price tag California was then paying for the typical highway four-lane-wide under/over pass on the theory that one might simply build a Japanese copy overpass in the middle of a suitably chosen (i.e quiet location) grape vineyard. Would you believe that California was spending up to a quarter of a million dollars for a simple over/under pass ten years ago. Boy, I'd hate to have to build one today!

But alas, times changed and while my six months of bridge-searching never really wore off, the enthusiasm for the project slowly waned. I still ride around the country side with my FM radio tuned to distant FM stations, and when I approach a likely bridge I still slow down to check out the signal enhancement. Once while hauling a group of Ham radio operator friends to a Ham-fest some years ago I made twenty dollars by betting the group I could pick a spot and call into the Pittsburg, Kansas two meter (144 MHz) Ham repeater (we were about 125 miles out and the normal range is about 50 miles). After the money was put up I pulled up under the first 30 dB underpass I saw and proceeded to collect my twenty dollars. After we pulled out from under the underpass I was accused of knowing in advance where **the** high spot was for the Pittsburg repeater, and for another ten dollars I was challenged to find another spot within **the next** five miles. I did, at the next underpass. My fellow hams never did catch on.

On a few brave occasions I have ventured into the subject of bridge-enhancement with a few people whom I felt in advance would be at least understanding enough to hear me out. One suggested I had a parabolic effect (not so) while the second suggested the bridge was really a horn antenna in disguise. I didn't buy that one either.

On quiet nights in mid-winter when the snow has been falling outside, I have on a couple of occasions buried myself in the basement workshop with copies of Jasik and crew antenna engineering handbooks; looking for **some logical explanation** to the observed effect. After all, 40 dB of gain at UHF is not to be sneered at, nor is 30 dB at high band or 20-22 dB at low band. I have **yet** to find the explanation, and thus there is no (pardon the pun) "concrete theory" to back up the observations. As the President of Siliconix, Inc. once said to me about an active-JFET amplifier I had designed, "(you) **certainly have a great deal of empirical evidence there... now if we can just figure out what it is you have done and how you are doing it!**"

Alas, as I approach forty years of age the dreams of my youth ("Every CATV system in the nation will need at least one underpass antenna") have also matured. I no longer expect one day to retire to a concrete plant to turn out CATV underpasses. Which is of course why I relate this story now ...perhaps someplace out there we have a young man with visions, riding around in his Impala just looking for something to set the CATV world on its ear. To this young man I offer the following advice:

"Purchase a battery/DC operated portable receiver. Set it on the front seat of your car. And start driving in and around underpasses. Make notes of all you observe and then design yourself (our) underpass antenna. There is at least 40 dB of gain at UHF out there waiting for some enterprising person with a few hundred tons of concrete and some metal super structure to invest in the project."

And now if you could just figure out a way to hang an underpass several hundred feet above ground... boy, what **signals you would get!**

TECHNICAL TOPICS

"Just sat down with the survey from the back inside cover of the CCOS-76 Program and found it to be totally inadequate. There is absolutely no way that I could provide my comments about CCOS-76 in the small space provided by that form.

CCOS-76 was just what the CATV industry, and the small system operator in particular, needed. The state, regional, and national CATV conventions are geared toward the management aspect and almost totally ignore the technical areas. Training seminars sponsored by a limited few of the industries suppliers are very good, are also greatly oriented toward their particular product. They give relatively little "hands on" or "practical solution to problem" support, concentrating on theory and ideal principles which are, once again, directed to their own product. It was refreshing to attend a technical seminar where the instructors kept their information at a level that brought the abilities of the least knowledgeable to the level of those who had a fair technical background and then proceeded on with the information as far as possible and practical. In the sessions that I was able to attend Raleigh Stelle and Tony Bickel did an outstanding job with Spectrum Analyzer Basics and Antenna Designs/Test Range. These individuals did not actively push their products in their presentations, yet they probably received more product interest than the industry suppliers that I mentioned before. I think the reason they received this product interest was because they showed their technical competance and knowledge through information and assistance they provided which built confidence from the attendees in both the individual and his product.

I want to be very specific in stating that I did not waste my time at any meeting I attended as I learned something, regardless of how small or its level of importance, at every session. The meeting that gave me the least amount of usable application of information was Signal Propagation, but it may have been more signficant to others and, as I said before, it was not wasted time as I learned something from the course.

The display area was simple, adequate, and non-partisan, which I heartily approve of. Every supplier had his fair opportunity to display his latest wares and I felt the interest and response from the cable operators was better than I have seen in my regional area or state. The hours for display were ideal as they were not competitive with the rest of the program which allowed the displayers to have a reasonably timed day where they were not tired out and could present their product with enthusiasm. I also liked the ability to do some "hands on" procedures with some of the display equipment, particularly the test equipment, where the displayers made me much more aware of his product, how it worked, and what it could do for me.

The Lab Room concept was outstanding and will prove to be a big success. The only problem was that it was in an area too small for what was being done. You need to expand the facility and man it with at least one or two more experts like Hansel Mead, Steve Richey and Glyn Bostick.

Hope I've got your head up in the clouds after all the complimentary comments because it's time to sell you on the next idea — **Let's do it again!** Keep the fees low as you did this year to encourage the "little guy" to come. I would like to see more on different types of test equipment theory/construction/operation. There are a lot of small system owners and technicians who could use this type of information to improve their service and learn how to make and meet the FCC Performance Requirements. Keep the sessions on Head End Practices, Low Cost Construction Techniques and Small Earth Terminals for at least one more year because a lot of attendees missed these when they had to make their choice. I think it would help to repeat those sessions that seem to generate the most interest so that everyone would have an opportunity to attend most of them, i.e. have the Antenna Test Range on two consecutive days and Small Earth Terminals on the same two days. Also, if you can obtain enough instructors, you could break a group into two units and have one teach theory of Spectrum Analyzers and the other run a practical lab with analyzers. Each of these would be 1/2 day long and attendees would switch courses at noon.

The suggestions I have made will probably cause you to have to extend the duration a day or two, but at the registration and accommodation prices I doubt if anyone would object to a five day technical seminar. I also recommend that you **do not** try to expand to accommodate more participants. The fact that you kept the sessions small and personal is the key to your success with CCOS-76. It is also a good idea to hold the seminars in a locale such as The Western Hills Lodge because it keeps it small and personal, keeps the people together after the daily sessions are over, is better for the displayers because they don't have to compete with the shows, night clubs, etc., and it keeps the costs down while providing an adequate and peaceful atmosphere.

Enclosed is our membership application for CATA. I'm impressed with your staff members, attorneys, and officers.

Ralph Haimowitz
Manager
Indian River Cablevision, Inc.
Sebastian, Fl. 32958

CCOS-76 AND VAN DEERLIN

"Enclosed is a copy of a letter received from Representative Lionel Van Deerlin, a response to one written by Robert M. White, II, owner of our SEE TV Company.

From this letter and your comments at CCOS-76, the cable industry may have a chance at regulatory relief, at least the small system operators.

Please accept our thanks for creating CCOS-76. I hope there will be more Seminars of this type. Small systems need the leadership you provide and an annual forum for the exchange of ideas, and practices, such as CCOS-76. I enjoyed all of the meetings, speakers, and talking 'shop' with other operators. The contributions of the exhibitors during the satellite program were especially helpful in outlining the possibilities of the 4.5 meter antenna.

In the franchise renewal discussions, CATA's Associate Counsel Steve Effros gave numerous practical guidelines during his all day session. Yet, I felt we needed a 'second day' just to answer more unanswered questions.

Our thanks to all of the staff and the Western Hills Lodge for providing an excellent seminar and facilities.''

Larry Wright
Manager
See TV Co.
Mexico, Mo. 65265

The Representative Van Deerlin letter to Mr. White reads as follows:

''Thanks you so much for writing to me concerning the uses of cable television in Mexico.

As you know, the Subcommittee on Communications has just completed several weeks of cable television oversight hearings, the purpose of which was to examine the basis for the Federal Communications Commission's cable rules.

Although I do not believe we will see comprehensive cable teleivison legislation in the current Congress, I have instructed the staff of the Subcommittee to prepare legislative alternatives for the consideration of the Subcommittee in the next Congress.

Ultimately, I believe the American people should be able to choose for themselves the most desirable programming from the range of alternatives available.

Thank you for your interest.''

Lionel Van Deerlin, Chairman
Subcommittee on Communications
U.S. House of Representatives
Room B-331
Rayburn House Office Building
Washington D.C. 20515

LIKED CCOS-76

''I would like to take this opportunity to thank you, the CATA staff, and all of the participants for the very warm welcome I received while attending CCOS-76. The three days were full of activity and very interesting sessions were available from morning to late at night.

''There were times when I would have liked to attend two seminars that were being held at the same time. CCOS-76 also gave me the chance to see communications by satellite for the first time, and I was very impressed with the 4.5 meter dish performance.

''As mentioned at my departure, next year I would like to see some 'Canadian touch' to CCOS-77. Again, 'merci' to all connected with CCOS-76.''

J.A. Andre Lamarre
Comm-Plex Electronics, Ltd.
Montreal Quebec
H4P 1V4

ANALYZER 'GOOD-SHOW'

''After doing all of the work necessary to catch-up for the four day 'vacation' with all of the great CATA members at CCOS-76, I finally have time to drop a note of thanks.

Thanks for showing me the greatest show in cable television. Thanks for introducing me to the REAL cable men of this industry. Thanks for putting on a Seminar pure and simple; no frills or glamour, just plain cable facts.

I was one of the fortunates who was able to construct my own elementary analyzer; and the work I have done with the analyzer in my own system has already justified the expense of the entire trip. This is a great piece of test equipment!

I am eagerly awaiting the announcement of next year's Seminar, at a place of similar isolation!''

S.P. Streeter
Storm Antenna Service
Siletz, Oregon 97380

Steve—

There has to be an end to our taking up valuable CATJ Technical Topics space with laudatory letters. This is that end. **To all who have written after CCOS-76, we say thank you. But the real success of CATA's first 'national' gathering is the success you people made of the opportunity to participate and learn. You came, and you got involved. We pledge not to lose sight of that criteria at CCOS-77!**

SURVEY CARD COMMENTS

''Attached is my Reader Survey Card, and I must say, CATJ is just great. I often have the opportunity to recommend your publication in our MATV seminars.

''Since I am technically oriented, I find all your technical articles of very high interest. So far I have noticed that the MATV technician has fallen by the wayside. Interfacing MATV and CATV can be a problem; and there are many schools, apartments and multi-unit dwellings fed by CATV systems. Hopefully you will treat this area in the future, for the benefit of both the CATV and MATV personnel.

''The only problem I have with CATJ is that my copy many times grows legs and walks away before I have the opportunity to read it!''

Helmut Hess
Systems Engineer
Distributor Sales Division
Jerrold Electronics Corp.
Horsham, Pa. 19044

Helmut—

You are right. . .**the CATV/MATV interface has never gotten much editorial space from us. Same thing is true with the newly emerging low-cost video character generator area. And we** are working **on both. As for CATJ-with-legs**. . .**we heard a story recently about an MATV type who had come to Jerrold for some seminar classes. Someone** (perhaps yourself), **in response to the MATV type's question** ''Where do I go for technical literature?'' **showed several guarded copies of CATJ but forced the MATV type to stand by the desk of the Jerrold fellow and read same with the understanding that copy was** not **to leave the immediate area**. . .period!

cata ASSOCIATE MEMBER ROSTER

In recognition of the untiring support given to the nation's CATV operators, and their never-ending quest for advancement of the CATV art, the COMMUNITY ANTENNA TELEVISION ASSOCIATION recognizes with gratitude the efforts of the following equipment and service suppliers to the cable television industry, who have been accorded ASSOCIATE MEMBER STATUS in CATA, INC.

Andrew Corp., 10500 W. 153rd St., Orland Park, IL. 60462 (**M2, M3, M9** Satellite Terminals)
Anixter-Pruzan, Inc., 1963 First Ave. S., Seattle, WA. 98134 (**D1**)
Avantek, Inc., 3175 Bowers Avenue, Santa Clara, CA. 95051 (**M8**)
Belden Corp., Electronic Division, Box 1327, Richmond, IN. 47374 (**M3**)
BLONDER-TONGUE LABORATORIES, One Jake Brown Rd., Old Bridge, N.J. 08857 (**M1, M2, M4, M5, M6, M7**)
BROADBAND ENGINEERING, INC., 535 E. Indiantown Td., Jupiter, FL. 33458 (**D9, replacement parts**)
CALIFORNIA MICROWAVE, INC., 455 West Maude Ave., Sunnyvale, CA. 94086 (**M9 Satellite Terminals**)
CATEL, 1400-D Stierlin Road, Mt. View, CA. 94043 (**M4, M9**)
CCS HATFIELD/CATV DIV. 5707 W. Buckeye Rd., Phoenix, AZ. 85063 (**M3**)
C-COR ELECTRONICS, Inc., 60 Decibel Rd., State College, PA. 16801 (**M1, M4, M5, S1, S2, S8**)
COMMUNICATION EQUITY ASSOCIATES, 8200 Normandale Blvd., Suite 323, Bloomington, MN. 55435 (**S3**)
COMM/SCOPE COMPANY, P.O. Box 2406, Hickory, N.C. 28601 (**M3**)
ComSonics, Inc., P.O. Box 1106, Harrisonburg, VA. 22801 (**M8, M9, S8, S9**)
CORAL, INC., 400 Ninth Street, Hoboken, N.J. 07030 (**M1, M4, M5, M6, M7, D3**)
DAVCO, INC., P.O. Box 861, Batesville, AR. 72501 (**D1, S1, S2, S8**)
DELTA BENCO CASCADE INC., 40 Comet Ave., Buffalo, NY. 14216 (**M4, M7, M8, D3, S8**)
EAGLE COM-TRONICS, INC., 8016 Chatham Dr., Manlius, N.Y. 13104 (**M9 Pay TV Delivery systems & products**)
FARINON ELECTRIC, 1691 Bayport, San Carlos, CA. 94070 (**M9, S9**)
GILBERT ENGINEERING CO., P.O. Box 14149, Phoenix, AZ. 85063 (**M7**)
HOME BOX OFFICE, INC., 7839 Churchill Way—Suite 133, Box 63, Dallas, TX 75251 (**S4**)
ITT SPACE COMMUNICATIONS, INC., 69 Spring St., Ramsey, N.J. 07446 (**M9**)
Jerry Conn & Associates, 550 Cleveland Ave., Chambersburg, PA. 17201 (**D3, D5, D6, D7**)
JERROLD Electronics Corp., 200 Witner Road, Horsham, PA. 19044 (**M1, M2, M4, M5, M6, M7, D3, D8, S1, S2, S3, S8**)
LARSON ELECTRONICS, 311 S. Locust St., Denton, TX. 76201 (**M9 Standby Power**)
LRC Electronics, Inc., 901 South Ave., Horseheads, N.Y. 14845 (**M7**)
Magnavox CATV Division, 133 West Seneca St., Manlius, N.Y. 13104 (**M1**)
Microwave Filter Co., 6743 Kinne St., Box 103, E. Syracuse, N.Y. 13057 (**M5, bandpass filters**)
MID STATE Communications, Inc. P.O. Box 203, Beech Grove, IN. 46107 (**M8**)
MSI TELEVISION, 4788 South State St., Salt Lake City, UT 84107 (**M9 Digital Video Equip.**)
OAK INDUSTRIES INC./CATV DIV., Crystal Lake, IL. 60014 (**M1, M9 Converters, S3**)
Pro-Com Electronics, P.O. Box 427, Poughkeepsie, N.Y. 12601 (**M5**)
PRODELIN, INC., 1350 Duane Avenue, Santa Clara, CA. 95050 (**M2, M3, M7, S2**)
Q-BIT Corporation, P.O. Box 2208, Melbourne, FL. 32901 (**M4**)
RICHEY DEVELOPMENT CORP., 1436 S.W. 44th, Oklahoma City, Ok. 73119 (**M1, M4, M8, S8**)
RMS CATV Division, 50 Antin Place, Bronx, N.Y. 10462 (**M5, M7**)
Sadelco, Inc., 299 Park Avenue, Weehawken, N.J. 07087 (**M8**)
Scientific Atlanta Inc., 3845 Pleasantdale Rd., Atlanta, GA. 30340 (**M1, M2, M4, M8, S1, S2, S3, S8**)
SITCO Antennas, P.O. Box 20456, Portland, OR. 97220 (**D2, D3, D4, D5, D6, D7, D9, M2, M4, M5, M6, M9**)
Systems Wire and Cable, Inc., P.O. Box 21007, Phoenix, AZ. 85036 (**M3**)
TEXSCAN Corp., 2446 N. Shadeland Ave., Indianapolis, IN. 46219 (**M8, bandpass filters**)
Theta-Com, P.O. Box 9728, Phoenix, AZ. 85068 (**M1, M4, M5, M7, M8, S1, S2, S3, S8, AML MICROWAVE**)
TIMES WIRE & CABLE CO., 358 Hall Avenue, Wallingford, CT. 06492 (**M3**)
Titsch Publishing, Inc., P.O. Box 4305, Denver, CO. 80204 (**S6**)
Tocom, Inc., P.O. Box 47066, Dallas, TX. 75247 (**M1, M4, M5, Converters**)
TOMCO COMMUNICATIONS, INC., 1132 Independence Ave., Mt. View, CA. 94043 (**M4, M5, M9**)
Toner Cable Equipment, Inc., 418 Caredean Drive, Horsham, PA. 19044 (**D2, D3, D4, D5, D6, D7**)
Van Ladder, Inc., P.O. Box 709, Spencer, Iowa 51301 (**M9, automated ladder equipment**)
VITEK ELECTRONICS, INC., 200 Wood Ave., Middlesex, N.J.
WAVETEK Indiana, 66 N. First Ave., Beech Grove, IN. 46107 (**M8**)
WEATHERSCAN, Loop 132 - Throckmorton Hwy., Olney, TX. 76374 (**D9, Sony Equip. Dist., M9 Weather Channel Displays**)
Western Communication Service, Box 347, San Angelo, TX. 76901 (**M2, Towers**)

NOTE: Associates listed in bold face are Charter Members

Distributors:

D1—Full CATV equipment line
D2—CATV antennas
D3—CATV cable
D4—CATV amplifiers
D5—CATV passives
D6—CATV hardware
D7—CATV connectors
D8—CATV test equipment

Manufacturers:

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M7—CATV connectors
M8—CATV test equipment

Service Firms:

S1—CATV contracting
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S3—CATV financing
S4—CATV software
S5—CATV billing services
S6—CATV publishing
S7—CATV drop installation
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