B-103 11/1/66 ff.

NORTHERN DISTRICT OF ILLINOIS A-42
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO.
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

Reprinted from RADIO & TELEVISION WEEKLY

JFD Electronics Antenna Laboratory Employs Industry's Hidden Resource

Forms Alliance With the University of Illinois; New Laboratory Established Under the Direction Of Prof. Paul E. Mayes, an Antenna Authority

By ALBERT FINKEL
President
JFD Electronics Corp.

For too long, the field of TV antenna design has followed narrow limits set down decades ago by early developers. This is usually apparent to the trained eye. Behind many variations in element number and layout lies the familiar yagi.

Designers have displayed much in-

Prof. Paul E. Mayes

genuity to escape the yagi's inherent limitation, frequency and selectivity, and adapt it to broad-banded performance. But the attempt to widen response leads to compromise—the engineering dilemma in which gain is played off against bandwidth. Response curves show it. Peaks and valleys prove how elusive the ideal antenna can be.

Which route must the commercial antenna manufacturer travel? How can he pin down new concepts that lead to high antenna gain, constant impedance match and good front-to-back ratio distributed smoothly over large regions of the VHF and UHF bands?

The answer, for some, has been to expand an engineering staff and relegate it the task of producing something new. But doesn't the history of antenna design suggest otherwise? With talented engineers and fine facilities, innovations that touch off broad, fundamental change rarely spring from the commercially oriented lab.

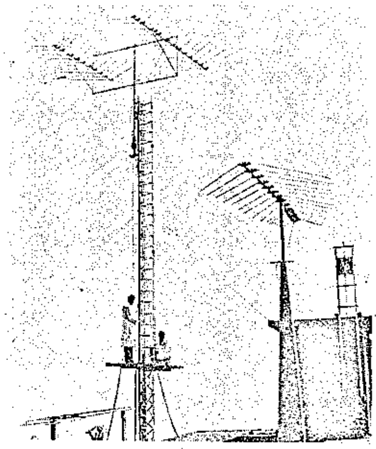
A Fresh Approach

We can only speculate on causes: the pressure to produce practical units ready for market or perhaps the formidable task of designing whole antenna lines based on known principles. Whatever the reason, it is clear that a fresh approach is in order.

It is no secret that many of today's fundamentally new concepts arise from basic research. Consider anything from the talking machine to the transistor, and chances are that original thinking for these valued devices sprang from the creative rambling that characterizes the research lab. For it is here that the engineer is free to abandon the convention of his time and strike out in untried directions.

Few will dispute the number of practical solutions and hardware derived from original thinking done in the research lab. Government and defense-based industry attest to this.

But consider private industry intent on improving products for consumer use. How can it tie into the engineering pipeline at the pure research level—unassisted by outside subsidy or government contract?



JFD Antenna Lab

Must it underwrite the vast expenditure that typifies the research program, or await shake-out from military and space developments that filter down to civilian industry years later? In JFD's search for antenna technology on the breakthrough level, we discovered what may be called a "hidden resource." It is the basic research program of a great university.

A Hidden Resource

This is not an exploration into the academic world in the usual sense. The alliance is not based on college courses for engineering personnel, attending seminars or surveying technical literaturs in the field of education. Far more dynamic in its ramifications, it prompted the creation of the JFD Research and Development Lab and a unique relationship with the University of Illinois.

It represents, for the first time, an effort by a TV antenna maker to probe utterly new areas of technology without the limitations imposed by the past.

Establishing the lab was not an overnight feat. It emerged from a sequence of events that drew together the university and JFD during a lengthy, evolutionary process. But first a look at why JFD directed its attention to the academic world at all.

Engineering Colleges

The engineering colleges have emerged as the hub of today's most advanced and exciting technology. This has long been recognized by the U. S. Government, which has expressed its confidence through sizeable R&D contracts.

This is suggested in the words of a leading educator, Provost Frederick E. Terman of Stanford. He says: "Education is perhaps the most significant factor affecting the future of electronics.

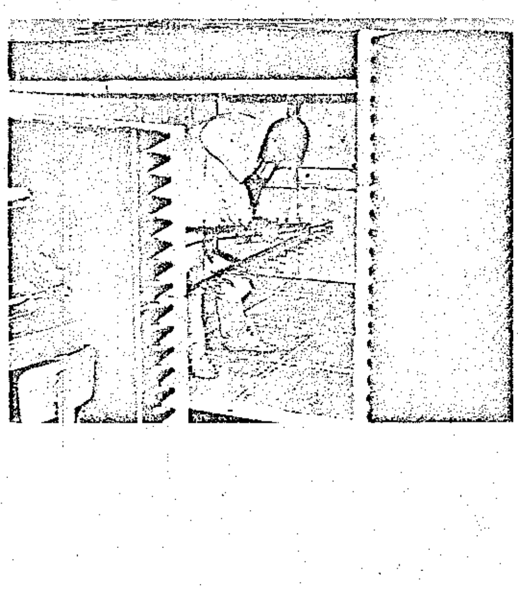
"Universities can provide intellectual leadership — a point of focus." Given these heady ideas, how could JFD translate them into working reality and apply them to the every day problems that yielded to no conventional solution?

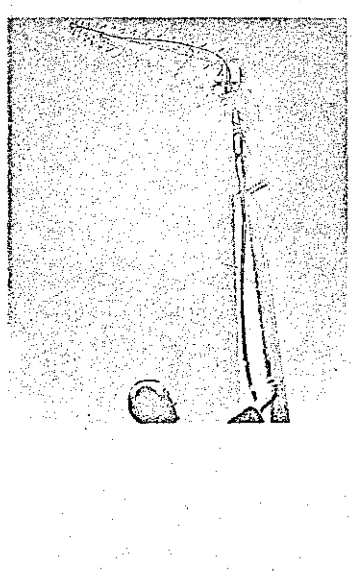
Point of Focus

It's easy to see why our "point of focus" came to rest at the University of Illinois. For years the university's Antenna Research Lab attracted the attention of professional engineering circles and the antenna field in general. It is ranked by many as one of the two top antenna research labs in the country, if not in the world. Impressive work was being done here—the kind of research that promised to upset existing concepts and establish the guide-lines for the much sought-after frequency independent antenna. The implications were enormous.

It is a matter of history now that the University of Illinois' antenna lab, working under Government contract, produced the log-periodic antennas that have significantly pushed forward the state of the art.

Here were techniques that broke the 2-to-1 frequency limits of early wide-band antennas. Indeed, the new designs suggested the theoretical pos-





JFD Electronics Antenna Laboratory Employs Industry's Hidden Resource

Forms Alliance With the University of Illinois; New Laboratory Established Under the Direction Of Prof. Paul E. Mayes, an Antenna Authority

(Continued from Page 12)

sibility of 20-to-1 bandwidths with no sacrifice in pattern, gain and impedance. If the log-periodic formulas could be applied to the TV engineer's problems, here would be the long-awaited break-through.

The university was not unaware of the considerable impact its findings might have on commercial antennas. Neither was JFD. After negotiating and winning exclusive rights to produce the log-periodic, JFD set its engineers to the task of producing commercially feasible designs.

After a year of lab and field testing, the LPV line of log-periodic TV antennas appeared on the market. Its unusual engineering fulfilled the early promise of a broad-band TV antenna with performance comparable to that of a 1-channel yagi of similar size.

So well did the cooperative venture with the University of Illinois succeed, that JFD decided to find a method of "priming" comparable breakthroughs in antenna techniques.

The answer materialized in December, 1962 with the opening of the JFD Research and Development Lab. This was no mere appendage to JFD's existing engineering facilities. The new lab was not intended to duplicate something already in existence. Rather, it sought to penetrate the technological wealth proved to exist at the academic level. The lab was situated on the University of Illinois' home ground; the Champaign-Urbana area.

The array of engineering talent now within easy reach was impressive. It was possible to secure the services of Dr. Paul E. Mayes, whose pioneering work as co-inventor of the log-periodic re-inforced his prominence as a distinguished antenna authority.

Named as consultant to the new JFD lab, Dr. Mayes' credentials are outstanding.

The project engineers selected for the JFD antenna lab were Marvin Fastman and Ronald Grant, also prominent in this field.

Under the direction of Dr. Mayes, both are now at work on further commercial developments of the LPV principle.

A significant advantage of situating the JFD lab near the university is reflected in the caliber of its technicians. Comprised of graduate students and seniors in electrical engineering, these men are the equivalent of junior engineers.

The staff is completed by several full-time engineering and management personnel.

As in any lab, continuity of research is a key factor. Thus, the lab's greatest resource—an imaginative and competent research group, headed by a prominent authority—had been welded into a team possible under no other set of circumstances.

The physical plant for the JFD lab is located at Champaign, it is equipped with the modern test apparatus needed for development of antennas in the VHF-UHF portion of the spectrum. It occupies 2,000 square feet of indoor floor space with a flat, elevated roof for outdoor tests. Atop the roof are three towers and rotators. One 71-foot tower supports a mast for mounting up to four antennas side by side during comparison tests. There is a positioner which holds antennas in a reflection-free position for taking such readings as input impedance and VSWR.

For outdoor tests, one or a combination of techniques determines significant characteristics of antenna performance. With an antenna held in a reflection-free position, lecher line, diagraph and slotted line yield information on VSWR and impedance, depending on antenna type.

Indoors, lab facilities are similarly extensive. Here is contained instrumentation for elaborate tests and measurements. There is a complement of woodworking and machine tools that enable the technician to fabricate actual-size or scaled-down antenna models.

The development of an antenna at the lab usually commences with a set of specifications. After study, the engineers decide on a configuration best suited for the application — TV, FM, or a combination type, for example.

A tentative design is drawn up and models are constructed. These will be used for pattern measurements in free space and to determine input impedance. With the lab's present equipment, tests can be conducted within the frequency range of 50 MC to 2750 MC. If the operating band of an antenna falls outside this range, scale factors can be applied to bring the model within the lab's test capability.

Next, is actual checking of free-space radiation to discover if the model will meet pattern and gain specifications. If these factors are satisfactory, impedance measurements follow.

After a series of tests prove that a full-scale antenna will meet specifications, engineering drawings are prepared. Construction of a prototype may follow, or drawings forwarded to JFD's main facilities for fabrication. From this point on, the new antenna type is advanced toward the production stage by the JFD engineering staff at other locations. Following an initial test run at the factory, samples are returned to the lab to check whether production units agree with the antenna's original specifications.

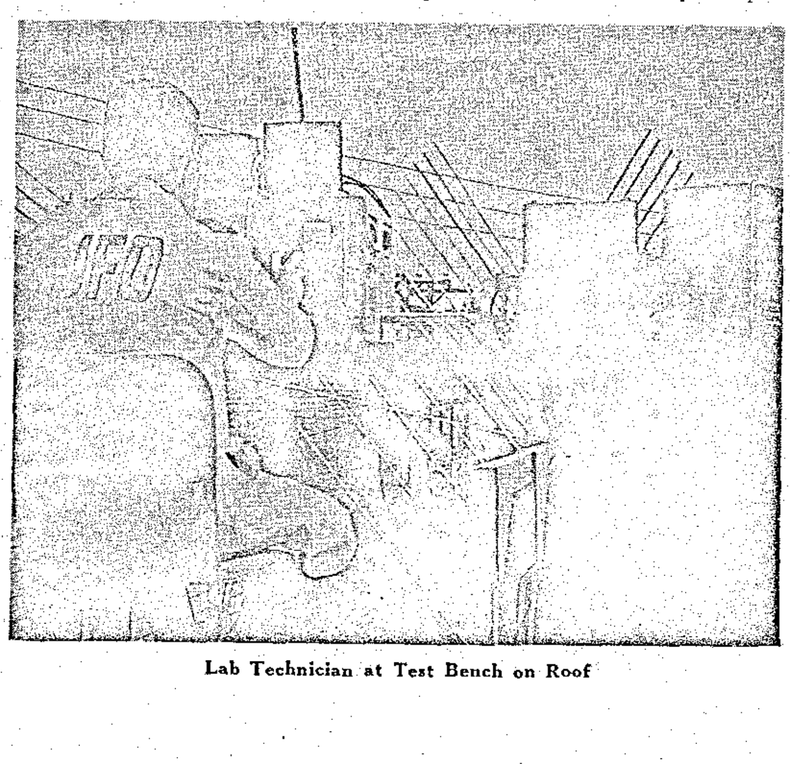
In the interest of accuracy, the lab has even developed a sophisticated instrument of original design.

Considering the lab's brief history, its work has already proved productive. The number of varied and diverse antennas to merge from the log-periodic formula is surprising. Initial work produced six LPV models designed to cover all existing conditions encountered in VHF-TV reception. A new generation has appeared. Intensive research has made possible the application of the log-periodic concept to new and specialized areas of reception.

One is FM multiplex stereo. The problems in stereo signal pickup are well known: deterioration due to multipath propagation and reduced range. A new LPV, expressly for multiplex stereo, has the sensitivity and directivity needed to counter these limitations.

And the growing field of UHF TV has similarly commanded the lab's attention. Six new UHF and UHF-VHF models will soon provide considerable flexibility in handling the elusive signals common to UHF reception. There is even an indoor LPV unit with gain comparable to that of a roof-top bowtie.

The lab's future looks promising. As it continues to translate basic research into practical design, its engineering sophistication further challenges the boundary defined by the state of the art. Judging by the lab's past performance, we can expect that the JFD-University of Illinois partnership will produce even greater breakthroughs in antenna technology during 1964.



Lab Technician at Test Bench on Roof

Form No. 705 Litho in U. S. A. 2-64

B-704 11/11/66

UNIVERSITY OF ILLINOIS FOUNDATION

October 14, 1964

Mr. Ed Finkel
JFD Electronics Corporation
15th Avenue at 62nd Street
Brooklyn, New York 11219

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO.________
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

Dear Ed:

I meant to answer your October 5 letter before this but I wanted to check the statements with both Professors Jordan and Mayes and they have been very much involved in an Electrical Engineering meeting this week which kept me from getting together with them.

I am sending you the combined opinion of Mr. Jordan, Mr. Mayes and Mr. Samuel B. Smith, in which I concur.

Page 1 of your letter, paragraph 1 is satisfactory.

We ask that you eliminate paragraph 2. I think it can be rephrased but Mr. Jordan objects to it because it indicates that the entire research program was designed for the benefit of JFD. Why don't you try this one over again?

Paragraph 3. Would you please change it to read, "Adapted from research results of the Antenna Laboratory of the University of Illinois."

Paragraph 4. This is troublesome because of the use of the word "patented" and Mr. Smith tells me there are legal reasons why this should not be used.

Paragraph 5. We should like you to change it to read, "LPV -- is designed from the Antenna Research Laboratory of the University of Illinois." The reason we suggest this is that, originally worded, it implies that the Foundation is in the manufacturing business.

Page 2, paragraph 1. We should like to have it changed to read, "The first TV/FM antenna based on the geometrically-derived Logarithmic-Periodic scale developed by the Antenna Research Laboratories of the University of Illinois and used in satellite telemetry."

Paragraph 2. We ask you not to use this one. It is good advertising copy. I think it could be rewritten and modified.

Paragraph 3 is satisfactory.

Paragraph 4 is untrue. The Log-Periodic LPV formula is not patented. Patents are issued only on the structure which was based upon the principle covered by the formula. This paragraph seems objectionable from a legal standpoint. Why don't you rewrite it and resubmit?

Paragraph 5 is satisfactory.

Paragraph 6. We should like to have rewritten as follows: "Significant New Principles Developed by the University. . . . .etc."

Paragraph 7 is not true. It wasn't the University which conceived the idea but the people in the Antenna Laboratory. You may want to resubmit a paragraph similar to this.

Page 3. The paragraph on this page is satisfactory.

Best regards!

Cordially yours,

James C. Colvin
Executive Director

JCC:pw

cc: Mr. Samuel B. Smith

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO. ____
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

B-105
11/1/66 H

April 21, 1964

Merriam, Smith & Marshall
30 West Monroe Street
Chicago, Illinois

Attention: Mr. Sam Smith

Re: University of Illinois
and LPV

Dear Sam:

In reply to yours of April 15th, I enclose two additional copies of the pamphlets requested. There are other pieces in work which are at the printers right now. As soon as they are available I will send them on to you.

In reading your letter, I am a little concerned about your reference to Paragraph 2 of the agreement, referring to patents. If you recall, at the beginning we had not used the patent phrase properly and it was on your instructions that I changed the phrase to read, "Licensed under one or more of U. S. Patents 2,958,081; 2,985,879; 3,011,168; 3,108,280 and additional patents pending in U.S.A. and Canada. Produced by JFD Electronics Corporation under exclusive license from the University of Illinois Foundation."

You explained that it was not necessary that each and every patent be applicable to the specific product on which this phrase was printed, but so long as it referred to one of the patents, it was permissible.

Mr. Sam Smith (Cont.)

At the present time we are not selling any products that come under the Dyson, DuHamel and Isbell patents. However, in the very near future, we intend offering a log periodic Trapezoid indoor antenna which Paul feels comes under the Isbell patent.

I trust this is the information you desired.

Kindest regards.

Sincerely,

Ed Finkel

EF/ss
cc- P. Mayes
J. Colvin
S. Faber

B-107
11/1/66 JH

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN

DEFENDANT EX. NO.________
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

Form No. 5715 litho in U.S

B-108 11/1/66 ff.

no question about it—

the JFD LPV $\frac{L_{(n+1)}}{L_n} = \tau$ IS A WINNER

"6 db BETTER THAN THE BEST!"

If you are installing *JFD Log Periodic* LPV's, no doubt you will agree with this report from R. L. Monroe, a leading TV antenna service-dealer of Charleston, West Virginia—a problem reception area.

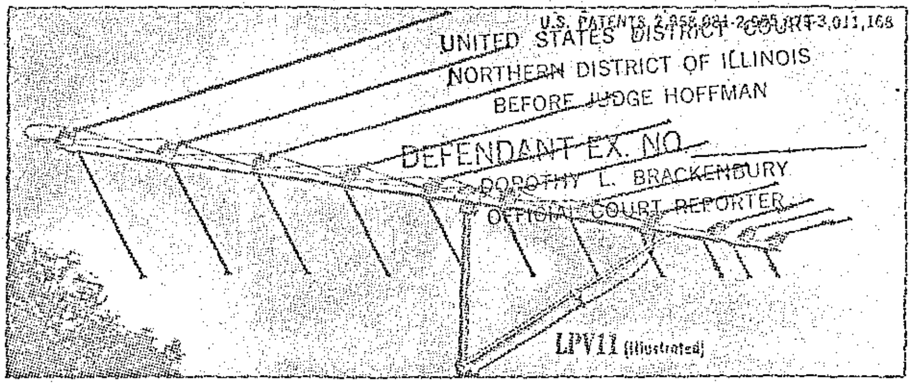
"It beats all, it beats everything that I have ever seen. Not only that, but this antenna is better than 6 db better than the best that I have installed. It pulled in a consistently clear picture from Columbus, over 130 miles away. *** *** **** *"It's just great on color—turns browns into real reds, faded bluish greens into brilliant greens, and completely eliminates the chronic ghost problems we have been suffering from in this area."*

****I have been in this business since 1948, which is a considerable time, particularly in the valley, and have yet to see any antenna, even near to this log periodic antenna in performance of the things I have wanted."*

Why the JFD Log Periodic LPV Outperforms Every TV Antenna Ever Made!

The log-periodic LPV blows the whistle on *cumbersome antennas* with their "Chinese puzzle" combinations of collectors, directors and reflectors. Now a single precisely-engineered antenna—the first based on a geometrically-derived *logarithmic* scale—actually *tunes* itself to the desired channel for unprecedented performance in crisp black and white or stunning color—plus FM STEREO. Is it any wonder that never before have so many installers and technicians so quickly acclaimed a TV antenna?

We would like to tell you more about the LPV, and how its *frequency independent* characteristics, have broken through distance, ghost and interference barriers to bring clear, steady pictures into previously "impossible" areas. Write today for your log periodic LPV Sales Kit. Better yet, call your JFD distributor and try one with our money-back guarantee of a better picture. You will prove it to yourself.

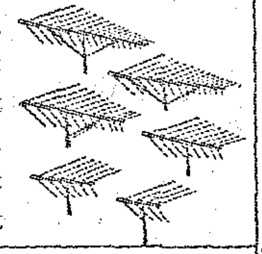


LPV11 (illustrated)

Developed by the University of Illinois Antenna Laboratory—Now Serving in Satellite Telemetry—Adopted to TV by JFD! THE LOG PERIODIC LPV ENDS THE ERA OF ANTENNA COMPROMISE! FOR THE FIRST TIME ONE SCIENTIFICALLY FORMULATED ANTENNA CONFIGURATION SATISFIES ANY LOCATION DEMAND:

Harmonically resonant V-element operate on the Log-Periodic Cellular Principle in the Fundamental and Third Harmonic Modes for unprecedented performance—in color—in black and white—plus FM STEREO

LPV17:	18 Active Cell and Director System—up to 175 miles	$59.95, list
LPV14:	15 Active Cell and Director System—up to 150 miles	$49.95, list
LPV11:	11 Active Cell and Director System—up to 125 miles	$39.95, list
LPV8:	7 Active Cell and Director System—up to 100 miles	$29.95, list
LPV6:	6 Active Cell System—up to 75 miles	$21.95, list
LPV4:	4 Active Cell System—up to 50 miles	$14.95, list



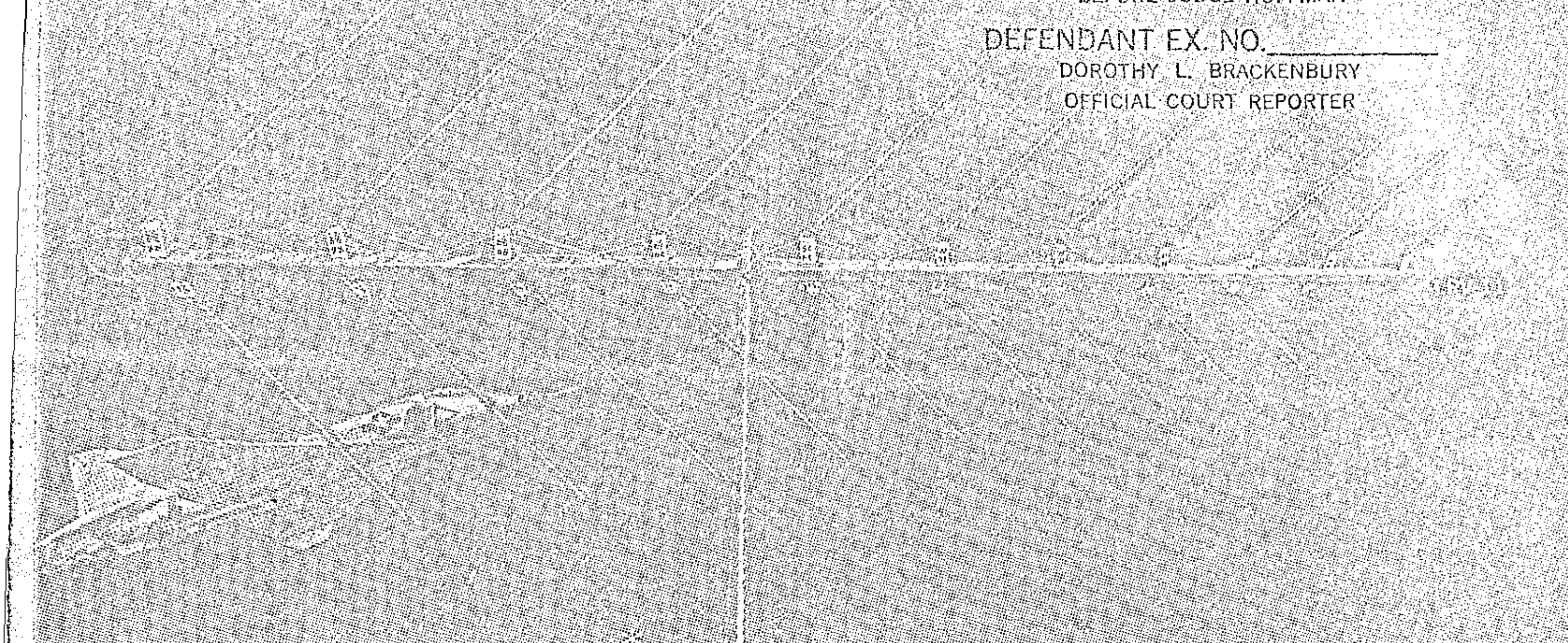
B-109 11/16/64

ERA OF COMPROMISE IS OVER!

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN

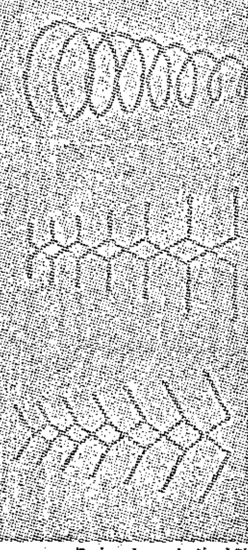
DEFENDANT EX. NO.__________

DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER



of the University of Illinois — Proved in Space Satellite Telemetry

HOW THE LOG-PERIODIC LPV MAKES ALL OTHER ANTENNAS OBSOLETE



The JFD LPV antenna is a direct descendant out of the logarithmic conical spiral antenna used on the Transit satellite. *This basic design* is FREQUENCY INDEPENDENT—it works like a conical waveguide to yield almost constant gain, matched impedance *and* a unidirectional polar pattern across an extremely wide band of frequencies.

Dipole version of spiral antenna has elements whose length and spacing is *determined by formula* derived from conical spiral geometry, so that antenna acts like a spiral with parts of coils missing. A *logarithmic scaling multiplier* ties the dipoles together into active multi-element cells for each frequency. Crossed phasing *harness inserts a 180 degree phase shift* between dipoles that cancels signals from rear, reinforces signals from front.

JFD's LPV antenna for TV and FM goes one step further—increases gain and *front-to-back ratio* while maintaining *frequency independence*. Forward V-ing of elements shrinks rear radiation lobes, narrows forward beam for sharp directivity, *helping to eliminate* ghosts and adjacent channel interference. *Forward V* also permits low band dipoles to contribute to *high band* gain by operating on the third harmonic mode.

For example: Operation of the JFD LPV-11 on the low band: The *larger dipole* cells resonate to the low band TV frequencies at their fundamental wavelength. Within each cell, one *dipole* absorbs the greatest amount of signal for any particular channel, adjacent dipoles pull in 60% *more* and the next two dipoles add *30% more* signal. Many active dipoles working on each channel with constant impedance guarantees high gain.

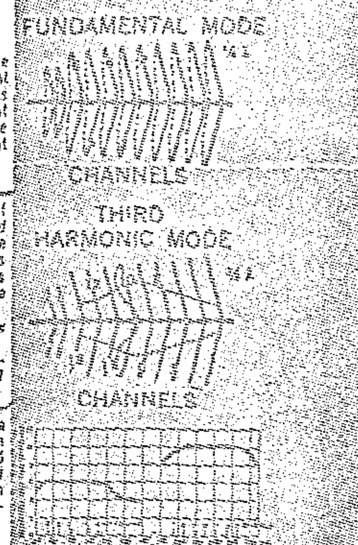
— — — — *indicates current distribution on fundamental mode.*

On the high band: The third harmonic cell forms at the rear of antenna for channel 7 and as the frequency *increases toward* channel 13, the active region moves toward the apex of the antenna. It is this third harmonic operation *which guarantees* as much as 3½ db. additional gain. Continuous and co-linear directors sharpen forward pattern and *give peak performance* across the entire VHF TV band.

— — — — *indicates the current distribution for the third harmonic mode which will be received on all elements.*

× × × × × × × *indicates the active region for channel 10, i.e., the different efficiencies with which the elements of the LPV-11 act on channel 10.*

The actual gain curves measured for the LPV-11 in the JFD Antenna Research Laboratories confirm this fact. Within the band for which *it is designed* (the principle will also be adapted for UHF and other uses), the log-periodic LPV's impedance, polar patterns and *front-to-back* ratio are virtually constant—with gain for each channel as high as that furnished by a comparable-sized single-channel Yagi.



Each antenna in the LPV series consists of an array of *resonant V-dipoles* and crossed phasing bars, constituting a group of "cells." *The size of each cell differs from the one before it by a Logarithmic factor.* For any particular frequency, the active portion *of the antenna centers* on the resonant dipole (equal to one-half wavelength at that frequency), with the adjacent elements also absorbing significant signal energy. The resonances of adjacent cells overlap, so that as the *frequency increases or decreases, it is transferred smoothly* from one cell to the next.

In effect, the signal is passed along as the frequency increases—the active area moving *toward the apex or small end—until*, as the fundamental harmonic reaches one end, the other end approaches resonance in the *third harmonic. Conventional wide-band* antennas are like rows of compartments, one for each channel desired, with sharp cutoffs. *The log-periodic antenna is* like a continually moving belt that accepts smoothly any frequency that hops aboard.

SEE THE JFD LOG-PERIODIC LPV AT YOUR *JFD DISTRIBUTOR NOW*—AND BE THE FIRST ONE IN YOUR AREA TO INTRODUCE AND PROFIT FROM THIS NEW ERA IN TV RECEPTION.

JFD

THE BRAND THAT PUTS YOU IN COMMAND OF THE MARKET

JFD ELECTRONICS CORPORATION
15th Avenue at 62nd Street, Brooklyn 19, N.Y.

JFD Electronics-Southern Inc., Oxford, North Carolina
JFD International, 15 Moore Street, New York, N.Y.
JFD Canada, Ltd., 51 McCormack Street, Toronto, Ontario, Canada

AS OF OCTOBER 22, 1962—THE

(*it ended the day JFD introduced the Log-Periodic LPV $\frac{L_{(n+1)}}{L_n} = \tau$ TV antenna)

Wave goodbye to all the Rube Goldberg contraptions with their "Chinese puzzle" combinations of collectors, directors, reflectors.

Now you can solve any reception problem with one compact, *precisely-engineered antenna—the first TV antenna* based on the *geometrically-derived* logarithmic-periodic scale developed by the Antenna Research Laboratories of the University of Illinois for the U.S. Air Force.

Because it is inherently frequency-independent, the JFD Log-Periodic LPV delivers the same superb performance on every VHF channel—performance comparable to that of a single channel Yagi. And delivers it not only in black-and-white, but in Color, and you get FM stereo too!

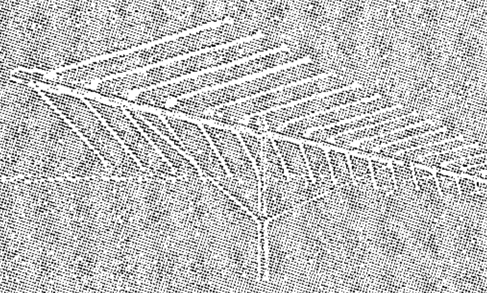
THE LOG-PERIODIC LPV ACTUALLY TUNES ITSELF TO EACH RECEIVED FREQUENCY—RESULTING IN:

- HIGHEST GAIN—as high as 14 db. in the LPV 17!
- SHARPEST DIRECTIVITY—on high bands as well as low!
- *HIGHEST FRONT-TO-BACK RATIO*—up to 35 db.
- LOWEST VSWR—as low as 1.2 to 1—with constant impedance across the full bandwidth!
- FLAT RESPONSE ACROSS BOTH VHF BANDS—with greater gain *on the high band, where it's needed most* (average increase of gain in high band over low band: 3¼ db.)!
- BROADEST BANDWIDTH—thanks to its unique *frequency-independent characteristics!*

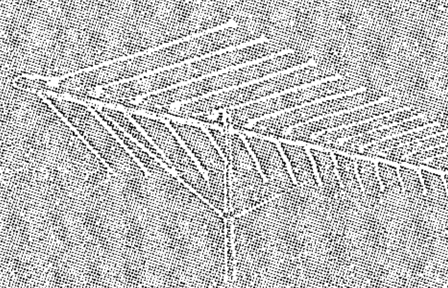
FOR THE FIRST TIME ONE SCIENTIFICALLY FORMULATED ANTENNA CONFIGURATION SATISFIES ANY LOCATION DEMAND:

Harmonically resonant V-elements operate on the Log-Periodic Cellular *Principle in the Fundamental and Third Harmonic Modes for unprecedented performance* —in color—in black and white—in FM STEREO

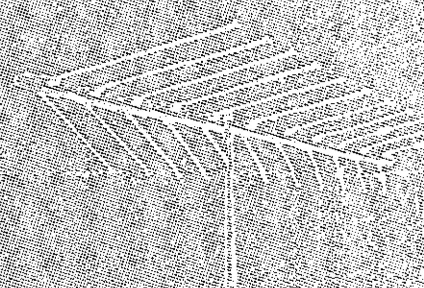
developed by the Famous Antenna Research Laboratories



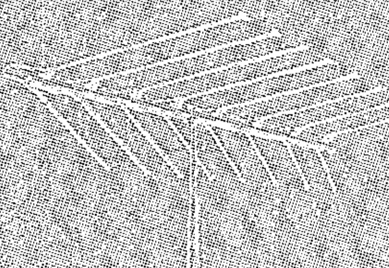
LPV-17: 15 Active Cells and Director System—up to 175 miles



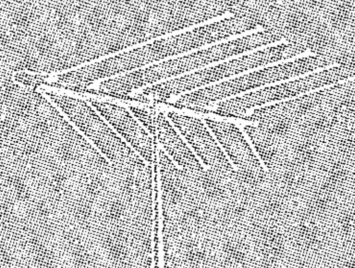
LPV-14: 13 Active Cells and Director System—up to 150 miles



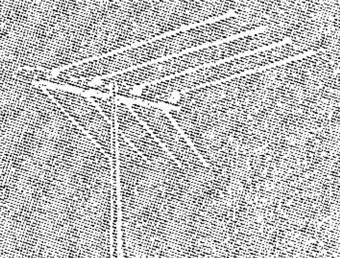
LPV-11: 9 Active Cells and Director System—up to 125 miles



LPV-8: 7 Active Cells and Director System—up to 100 miles



LPV-6: 6 Active Cells—up to 75 miles



LPV-4: 4 Active Cells—up to 50 miles

Adapted to TV and FM Stereo by JFD

✓ ELIMINATES THE NEED FOR AREA-DESIGNED ANTENNAS

✓ 100% PREASSEMBLED "FLIP-QUIK" ASSEMBLY

✓ MASSIVE TANK TURRET BRACKETS THAT DOUBLE-LOCK ELEMENTS

✓ AAA† GOLD BOND ALODIZED TO KEEP THAT BRAND NEW LOOK

✓ EXTRA-RUGGED, DOUBLE-REINFORCED IN EVERY DETAIL

✓ LIGHTEST IN WEIGHT PER DB GAIN

✓ WIND-TUNNEL TESTED CONSTRUCTION

†Attractive, Anti-corrosive Armor

B-111

11/2/66 ff

April 21, 1964

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO. ______
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

Merriam, Smith & Marshall
20 West Monroe Street
Chicago, Illinois

Attention: Mr. Sam Smith

Re: License Agreement Between
University of Illinois Foundation
and JFD Electronics Corporation

Dear Sam:

I had occasion to talk to Sid Faber on some legal matter on April 16th, at which time I mentioned to him having received your letter of April 16th, reviewing the meeting [redacted] had with the people at the University and the Foundation.

As my patent counsel, I sent him a copy of your letter and my accompanying view, copy enclosed, for his comments. He wrote me on April 20th, copy of which is enclosed. It is at his suggestion that I am enclosing all this information for your review.

It seems to me his points are well taken and are very much in accord with my own feelings about this whole matter. In essence, the Foundation is in business as a licensing organization to develop as much income for the University as possible. To foster that end the Foundation and the University must be prepared to support their licensee against tactics of the likes of [redacted]

Mr. Sam Smith (Cont.)

It also seems to me that while you are emphasizing the need of our conforming to Paragraph 10, you are neglecting the responsibilities of a licensor to a licensee, as well as our mutual benefit in establishing a stronger position in the antenna market to sell all LPV antennas.

Sincerely,

Ed Finkel

EF/es
encl.

cc-P. Mayes
J. Colvin

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN

DEFENDANT EX. NO.__________

DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

B-112

11/2/66 ff

LAW OFFICES
MERRIAM, SMITH & MARSHALL
THIRTY WEST MONROE STREET
CHICAGO, ILLINOIS 60603

TELEPHONE
FINANCIAL 6-5750

July 17, 1964

UNIV - ILL
FOUNDATION

Mr. Ed Finkel, Vice President-Sales
JFD Electronics Corporation
1462 Sixty Second Street
Brooklyn, New York 11219

Re: JFD "ZIG-A-LOG" Antenna

Dear Ed:

It is practically at the close of business today and I have just had the opportunity to look quickly at some of the promotions you sent me with your July 15 letter. Immediately my attention was directed to this type of antenna and the prominently displayed statement "Brings the acknowledged Log-Periodic design of the Antenna Research Laboratories of the University of Illinois to a new peak of performance!"

This material was never submitted to the Foundation nor to this office prior to its publication. It just happens that I was able today to see Mr. Colvin, and just a moment or two before dictating this letter. I am directed to state that this is not the type of publicity that can be approved by the Foundation or the University, and you have not complied with the provisions of paragraph 10 of the license. I can assure that if this policy and action on your part continues, the Foundation will cancel your license forthwith. This type of publicity does not appear to be anything except to use the University really as a gimmick, which cannot be sanctioned.

Sincerely,

Samuel B. Smith

SBS:mn

cc: Mr. James C. Colvin
✓ Mr. Sidney G. Faber

All-New JFD LPV Log-Periodic* Antennas

for the finest COLOR and black/white TV pictures on channels 2 to 83.

* the Log-Periodic is a totally new and different antenna adapted by JFD from the famous satellite tracking antenna design of the Antenna Research Laboratories of the University of Illinois

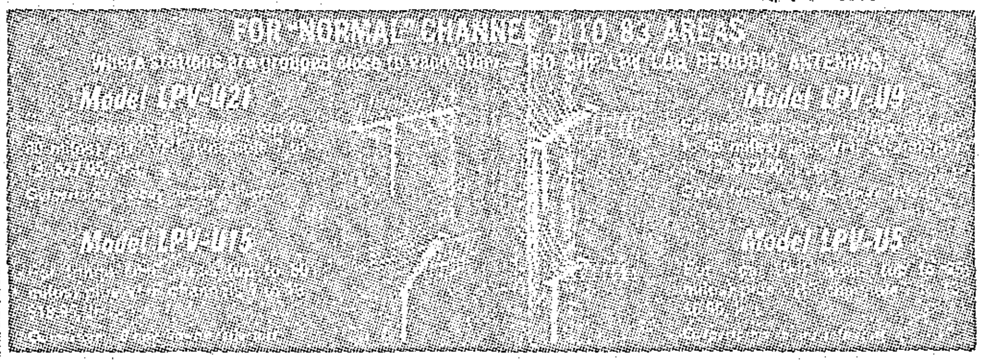
B-113
11/2/66

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO. ______
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

Wherever you live...whichever channels you want...JFD has the LPV Log-Periodic antenna you need for clearer, sharper pictures in glowing COLOR—or black and white.

JFD LPV Log-Periodics are more powerful because *all* its elements (not just some elements, as in other antennas) work on the channels *you* want.

Check below for the JFD Log-Periodic especially engineered for the channels you want.

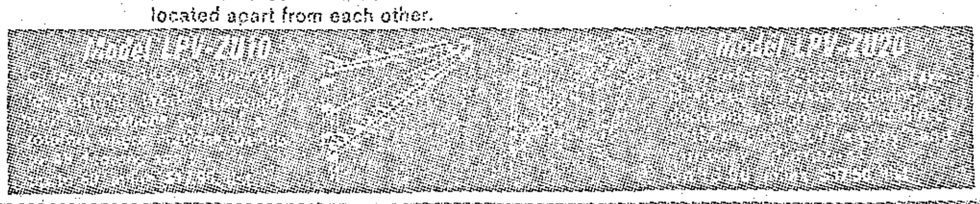


FOR "PROBLEM" CHANNEL 14 TO 83 AREAS

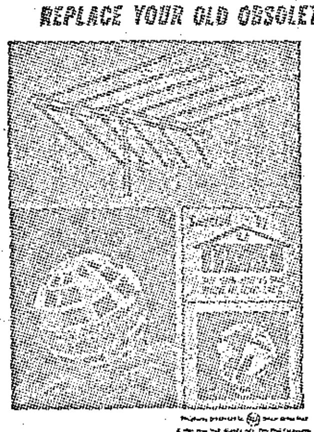
Where stations are not near each other—JFD UHF ZIG-A-LOG LOG PERIODIC TV ANTENNAS.

The new Zig-a-Log is based on one of science's newest approaches to microwave antenna design—**the vertically polarized Log-Periodic planar helical.**

As a result, the Zig-a-Log pulls in sharp pictures in weak signal areas . . . eliminates the need for a rotator in UHF areas where stations are located apart from each other.



-AND FOR THE BEST CHANNEL 2 TO 13 PICTURE IN SIGHT— COLOR, OR BLACK & WHITE— REPLACE YOUR OLD OBSOLETE VHF ANTENNA WITH THE—



LICENSED UNDER ONE OR MORE OF U. S. PATENTS 2,958,081, 2,985,879, 3,011,168, 3,108,280 AND ADDITIONAL PATENTS PENDING IN U.S.A. AND CANADA. PRODUCED BY JFD ELECTRONICS CORPORATION UNDER EXCLUSIVE LICENSE FROM THE UNIVERSITY OF ILLINOIS FOUNDATION

LOG PERIODIC

JFD VHF LPV

Developed from research performed at the University of Illinois Antenna Research Laboratories, and adapted for TV by JFD—the VHF Log Periodic LPV brings you the best possible reception on channels 2 to 13, plus FM. The secret of its power is its patented design—the same as that used in antennas to track satellites through space.

Six VHF LPV Log Periodics to choose from—suit any location needs.

model	range	list
LPV4	up to 50 miles	$14.95
LPV6	up to 75 miles	21.95
LPV8	up to 100 miles	29.95
LPV11	up to 125 miles	39.95
LPV14	up to 150 miles	49.95
LPV17	up to 175 miles	59.95

Form No. 730 Litho in U.S.A. 4/64

Directivity, front-to-back ratio

As important as high gain and constant impedance are in fringe-area reception, the antenna would be worthless without good directional sensitivity. Even in the heart of cities, directivity is needed to reject the ghost-causing interference signals that bounce from building to building. In fringe areas, interfering signals from adjacent channels picked up by the antenna from the rear and sides cause venetian-blind and herringbone effects, fading and other picture distortions.

Yagi antennas obtain good directional sensitivity and high front-to-back ratios with parasitic elements (directors and reflectors). The LPV obtains its sharp forward pattern from the V-ing of the elements and the phase-reversed feeder.

Consider Fig. 5, a simplified diagram of a four-cell LPV antenna, front-fed, using a twisted phasing harness. Note that because the elements of the adjacent dipoles are not fed in parallel, they are in phase opposition. This effectively cancels reception from the sides. Furthermore, the length of the harness plus the space between adjacent elements adds up to produce a 360° phase shift between the signals reaching the first and those being picked up by the second element (or between any two adjacent elements) in the forward direction (toward the feedline, at the small end of the antenna). This 360° phase shift actually puts both waves in phase for additive signal strength.

Toward the rear, on the other hand, there is only a single 180° phase shift, due to the crossed harness. This effectively cancels reception from adjacent elements towards the rear.

The signal finds itself in somewhat the position of a motorist going down an avenue that has phased traffic lights. Arriving at the front (small end) of the antenna, it finds each element in turn phased in its favor, and gives up a maximum of its energy to the antenna. If it arrives from the rear, it finds each alternate element phased against it, and is effectively cancelled out.

Directional sensitivity is increased and reception from the rear further reduced by V-ing the elements forward. A straight half-wave dipole receiving a signal three times its resonant frequency has a radiation pattern like that shown in Fig. 6-a. The signal sensitivity is dissipated in three forward lobes. If the elements of this same dipole are directed forward into a V, the pattern becomes Fig. 6-b. The two side lobes are brought together and merged with the center lobe as the elements are brought toward each other. The rearward lobes are "phased out" in the feedline.

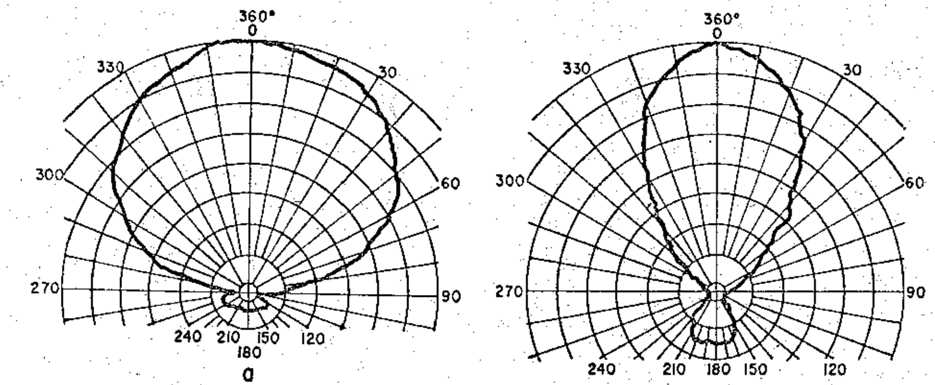


Fig. 7-a—Polar pattern of LPV on low TV band. b—Same antenna on high band.

Reception patterns for the complete LPV TV antenna are shown in Fig. 7-a for the low band, sharpening up to 7-b on the high band. This type of pattern is maintained through the FM band too. In actual tests the LPV-11 with 9 active cells and 2 directors maintained a front-to-back ratio of 35 db, with a gain of 8 db across the low band and 11½ db across the highs. In comparison, a somewhat longer Yagi antenna, adjusted to a front-to-back ratio of 25 db at the middle of its band, fell to 15 db at the edges, and more important, had a bandwidth of only 7%, at a gain equal to that of the LPV.

Although reflector elements are unnecessary for the LPV, directors are desirable to "peak up" the high end of the upper vhf band, particularly for fringe-area reception. The director spacing is determined experimentally since it must not affect the input impedance of the antenna itself. Laboratory tests recommended a spacing of approximately half the distance between the two shortest active elements of the antenna. Director length is shorter than the shortest active elements—theoretically, it should be 0.46 multiplied by the half-wavelength of the frequency to be "peaked".

City and far fringe

Since the frequency independence of the LPV depends on the scaling of the cells, any number of intermediate cells may be narrowed without affecting the essential characteristics of the antenna. To narrow an antenna, a smaller value of tau is chosen, so that the shortest element is approached faster, omitting some elements in between. Narrowing the cells will reduce the gain but will not affect the front-to-back ratio, directivity and constant-impedance characteristics, which do not depend on the number of elements used, only on the adherence to the proper scaling factors and equations.

When a shortened LPV is used in a strong-signal area, the increased signal strength will compensate for the fewer total signal-absorbing elements. At the same time, it is no less important that suburban and city viewers use an antenna with high front-to-back ratio and low vswr to eliminate ghosts caused by signal reflection from tall buildings.

There are presently six models in the LPV series made by JFD. The shortest, the LPV-4, contains 4 active cells and is recommended for use up to 50 miles from the TV transmitting antenna; in other words, in city and most suburban areas. The largest is the LPV-17 with 8 active cells and 10 passive elements. This one is designed for use up to 175 miles from the transmitter under virtually ideal conditions. Between these two are four other models for any reception area.

Since element spacing and V-ing are critical, special mechanical innovations were needed to assure antenna rigidity. The crossarm is made of extra-heavy-gage aluminum, 1 inch square. Every element has sleeve reinforcements to prevent bending. The phasing harness is made of ⅛-inch solid aluminum rod, cold-welded into position. Other mechanical features are "flip-quick" construction for ease in erection, gold alodizing and the inclusion of a double U-bolt assembly.

A fortunate dividend in the LPV design is its "compatibility" with uhf. When and if combination vhf-uhf antennas find an increasing market, it is almost certain that the LPV will be one of the leading all-band designs. END

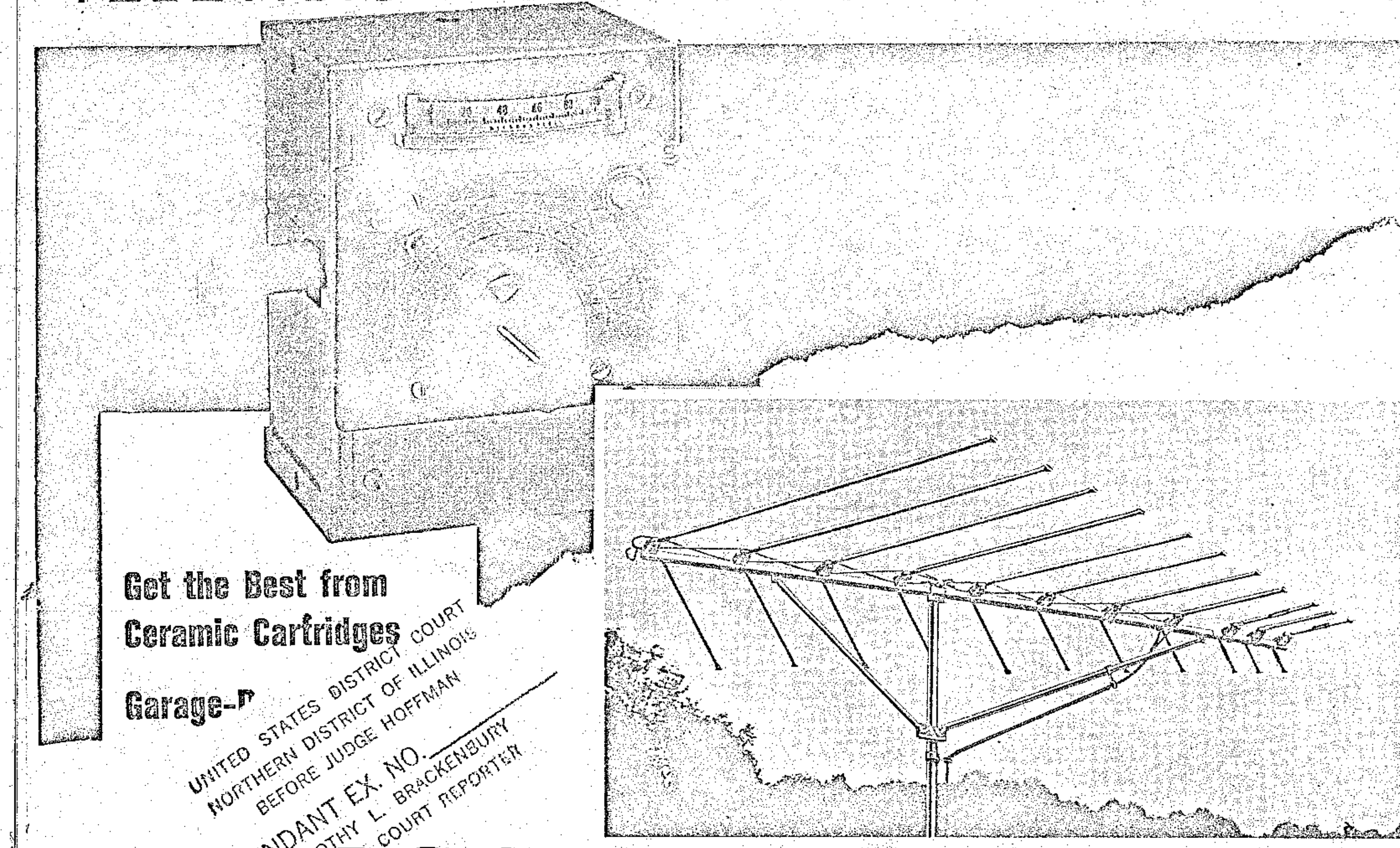
Reprinted From
Radio-Electronics
June 1963

Form No. 382LP litho in U. S. A.

The Log Periodic V Antenna

Radio-Electronics ■ JUNE

TELEVISION • SERVICING • HIGH FIDELITY



LOG PERIODIC V

Complete information on the new high-gain all-channel TV antenna concept

By EDWARD FINKEL*

CERTAIN LIMITATIONS HAVE BEEN INherent in TV antenna design for so long that they have been accepted as axiomatic. No commercial antenna has had uniform high gain over the complete vhf TV band. It has been assumed that an all-channel antenna is not possible except by a compromise design that gives up a little bandwidth to get a little gain, or vice versa. The gain curves of modern TV receiving antennas are studded with peaks and valleys that show, only too well, how they depend on frequency.

Most antennas for fringe-area reception are based on the Yagi design.

The Yagi has high gain and high front-to-back ratio. But it is essentially a narrow-band antenna—it cannot cover the entire vhf TV band from 54 to 216 mc. A simple Yagi is most effective for a single channel, a spread of only 6 mc. Modified Yagis, with dipoles cut for the center of the low and high bands and an array of various-size parasitic elements for broadening bandwidth, generally have good gain at the high end of each band and degenerate at the low end. This is the fate of *any* antenna burdened with a large number of parasitic elements. These lower the characteristic impedance at the low end of each band, and make for signal-sapping standing waves and impedance mismatches between the antenna and the transmission line.

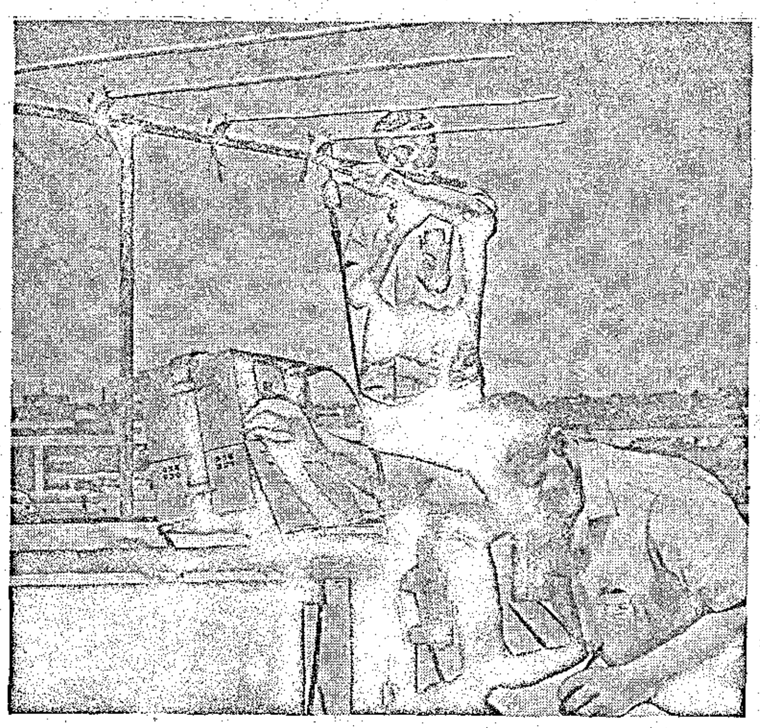
For more than 8 years, a group of antenna scientists at the Antenna Research Laboratory of the University of Illinois has been experimenting with vhf and uhf antennas that have no theoretical limitations on bandwidth—are frequency-independent. Various experiments led Profs. V. H. Rumsey and J. D. Dyson to the log spiral antennas. Out of this research came the sharply directional, yet broad-band, conical spiral antenna now being used for satellite tracking.

* Executive vice president, sales and engineering, JFD Electronics Corp.

Prof. R. H. Du Hamel next tried and succeeded in developing a linearly polarized antenna based on the conical spiral, and Prof. Paul Mayes with R. C. Carrel and D. E. Isbell further developed this design to the point where it was basically suitable for television. JFD antenna engineers worked with the University of Illinois scientists to develop the final versions of the *log periodic V*, or LPV, antenna for television. The LPV promises to revolutionize the TV antenna field. Although it is now designed to cover uniformly both the low and high vhf TV bands and the FM band in between, a frequency spread of 4 to 1, this antenna type can easily be extended to include uhf. The unique thing about it is that within each TV band its impedance, gain, reception pattern and front-to-back ratio are virtually constant. The gain for each channel is as high as that furnished by a comparable sized, single-channel Yagi.

Log periodic concept

Essentially, the LPV antenna incorporates two separate design concepts: the log periodic factor, which determines the size and spacing of the elements; the forward V shape of the elements, which permits multi-mode operation and determines its directionality. Let us first consider the periodic function.



Technicians checking characteristics of a prototype LPV antenna at the JFD laboratory in Brooklyn.

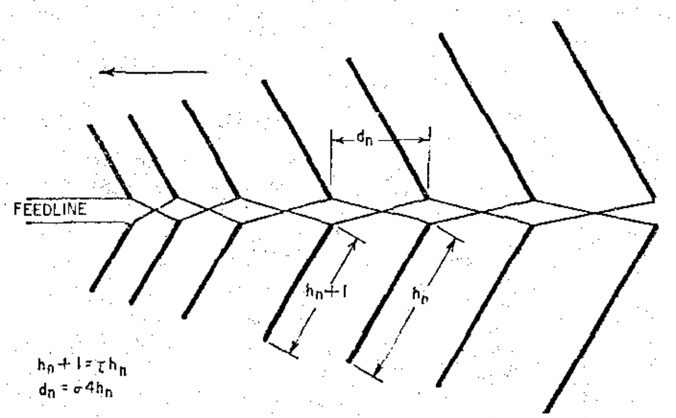


Fig. 1—Fundamental LPV. Bandwidth and directivity are controlled by length and spacing ratios of adjacent dipoles.

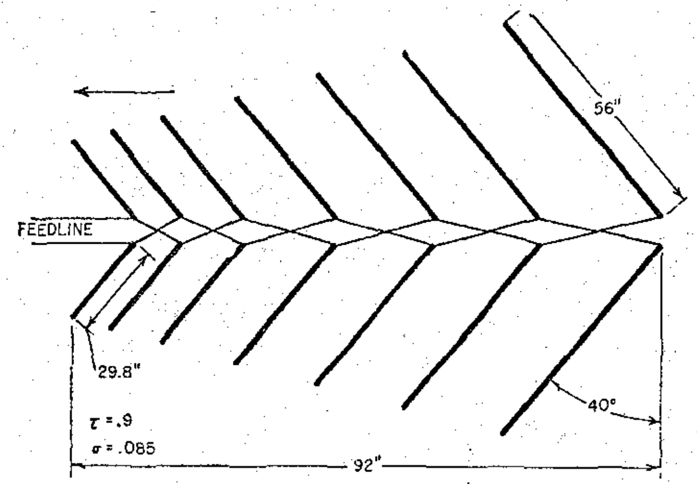


Fig. 2—An experimental LPV, showing relation of element length and spacing.

The basic planar log periodic antenna is an array of dipoles in which the length of each element bears a fixed ratio to the length of the preceding element. This ratio is called the *scale factor* and is designated by the Greek symbol τ (tau). The spacing between adjacent dipoles may also be fixed by a ratio, σ (sigma). These relationships are shown in Fig. 1, where h denotes element half length and d represents the spacing between dipoles.

The actual values of tau and sigma were derived from many experimental models and tests and finally selected from tables which combine these test results. The directivity of the antenna increases with increasing tau, and sigma must be small to obtain higher mode (harmonic) operation, important for high-band reception. (The mode desired multiplied by sigma should equal 0.2 to 0.4.) Since, for TV, the third mode is desired (as will be explained later), a good value for sigma is .085.

Each of the dipoles in the antenna is equal to an adjusted half-wavelength at a different frequency, making the dipole resonant to that frequency. The scaling factors τ and σ are so chosen that the desired frequency range is covered with elements whose resonances overlap. Thus, as the frequency changes, resonance moves smoothly from one dipole to the next.

Typical values of tau and sigma are 0.9 and 0.085, respectively. These in fact are the actual values used in one of the many experimental models developed in the JFD laboratories. This is a seven-element antenna, 92 inches overall, with h_1, the half length of the longest element, 56 inches, approximately one-quarter wavelength at channel 2. Lengths of all other elements are determined by the equation in Fig. 1. A diagram of this antenna is shown in Fig. 2.

In designing the larger LPV models it was necessary to depart slightly from the log periodic formula, to make the antennas commercially and mechanically practicable.

Fundamental operation

Just as the largest dipole of the LPV antenna corresponds to a half-wavelength on channel 2 many of the other dipoles more or less correspond to the half-wavelengths of the other channels in the low TV band. Although one particular dipole—the one closest to the resonant length—absorbs the greatest amount of signal at any particular received frequency, the adjacent elements also absorb signal energy. How much is shown in Fig. 3, a curve representing the distribution of current at the terminals of each dipole of a nine-element LPV antenna on channel 5. Note that while maximum energy is absorbed by one dipole, No. 5, two other elements, Nos. 4 and 6, absorb 60% as much, and even elements 3 and 7 absorb substantial amounts of signal (30%).

The resonant or near-resonant dipole together with those adjacent elements that contribute substantial signal energy at the received frequency, plus the crossed phasing harness, constitute the "active cell" for that channel. As the frequency of reception increases, the active region moves toward the front of the antenna; for each channel a different active cell is formed.

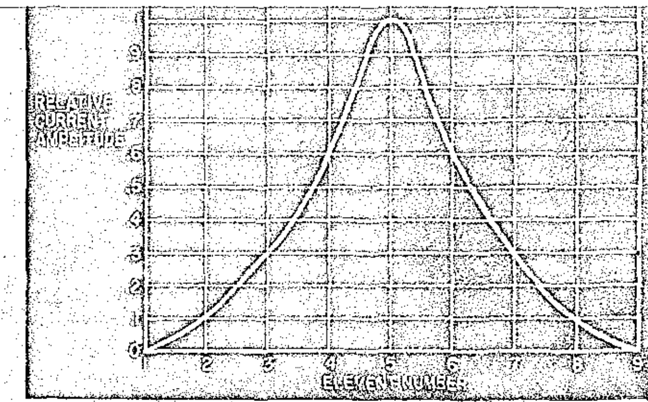


Fig. 3—Distribution of channel 5 currents on individual elements of a nine-element LPV antenna.

The tau and sigma used in the design of an LPV are the key in providing a wide active reception region for every channel. When these two factors are selected properly, the dipoles of the active cell present a low impedance at their terminals, resulting in high energy absorption. This low impedance results from a combination of element length and the spacing determined by the log periodic equations, as well as the thickness of the elements.

High-band operation

For channels 7 through 13, the large elements at the rear of the antenna constitute 3/2-wavelength dipoles. Therefore, they resonate to the received frequency at the third harmonic mode. The large elements at the rear of the antenna are 3/2 wavelength at channel 7. As the frequency increases toward channel 13, the 3/2 wavelength elements, and therefore the active region, shifts toward the apex of the antenna. The actual gain realized by third-harmonic operation is shown in Fig. 4, the vhf gain curves for the JFD LPV-11, an 11-element antenna. From these curves it is apparent that there is an average increase of 3½ db in gain on the high band vs the low band. This is in accordance with good TV antenna design, which requires greater gain on the high band because of the greater transmission signal losses at these frequencies.

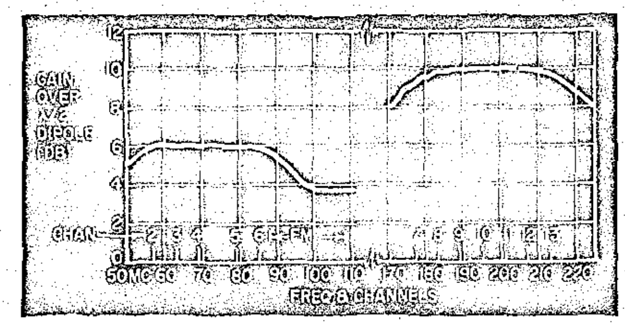


Fig. 4—Gain curves over TV and FM bands.

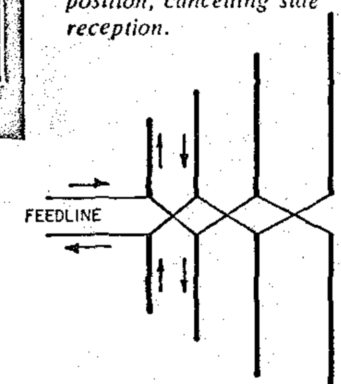


Fig. 5—Current on adjacent elements is in opposition, cancelling side reception.

In all other respects, operation is the same as on the low band. Active cells embracing several elements for each channel and low impedance at the received frequency are basic to the antenna.

A close inspection of Fig. 4 shows that the gain of the LPV-11 is uniform across all channels for each band. This guarantees good color TV reception. For color fidelity, the gain on the brightness and color carriers within each channel must be nearly the same. Obviously this can only hold true if the antenna has a flat gain response curve *for the entire channel*.

If the input impedance of an antenna varies appreciably from that of the transmission line at any point in the bandwidth of the antenna, a mismatch will exist between the antenna and downlead. Such as mismatch decreases signal power to the TV set and introduces standing waves along the line. This leads to further signal reduction and ghosts.

The LPV is unique in that it maintains essentially constant impedance across the full bandwidth of the antenna. An important reason for this is that the input impedance of the LPV depends primarily upon the impedance of the feeder network, which can be easily controlled. In the JFD LPV series, the feeder consists of a crossed network of solid bars whose diameter, length and spacing are determined to give an exact match to 300-ohm transmission line. That this is the case is proved by measurements of the vswr which are consistently in the area of 1.2 to 1.

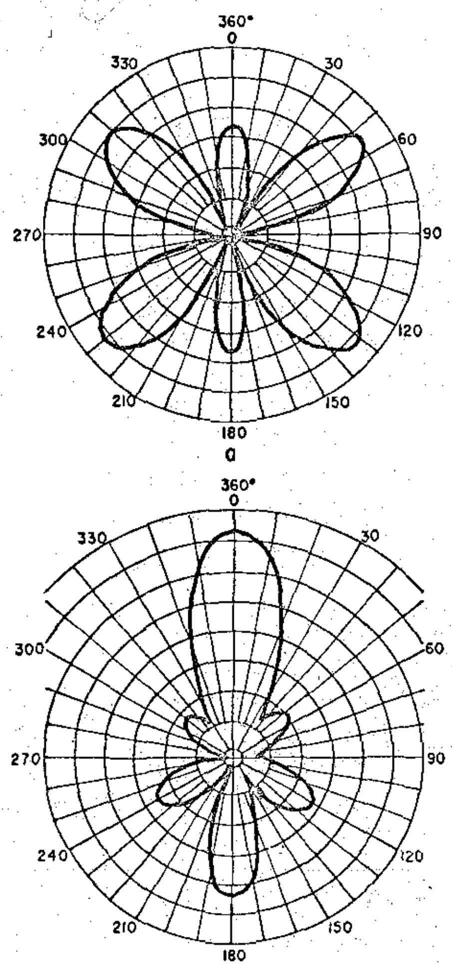
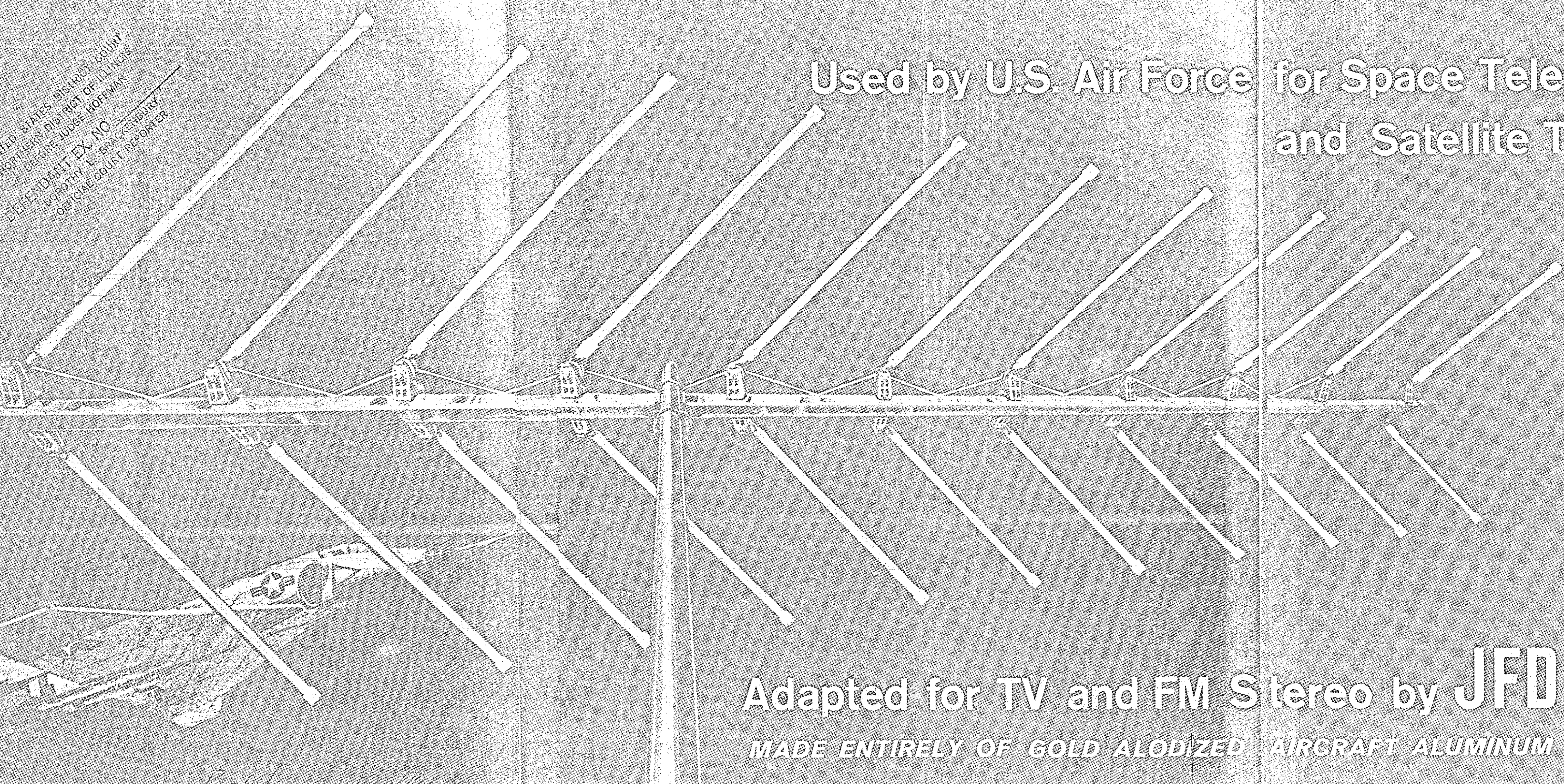


Fig. 6-a—Polar pattern of half-wave dipole at three times its fundamental. b—Pattern of same dipole with ends bent forward into a shallow V.

...ROM JFD—THE LPV "SPACE-AGE" TV ANTENNA!

...BY THE ANTENNA RESEARCH LABORATORIES OF THE UNIVERSITY OF ILLINOIS—

...ED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO. ________
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER



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Adapted for TV and FM Stereo by JFD

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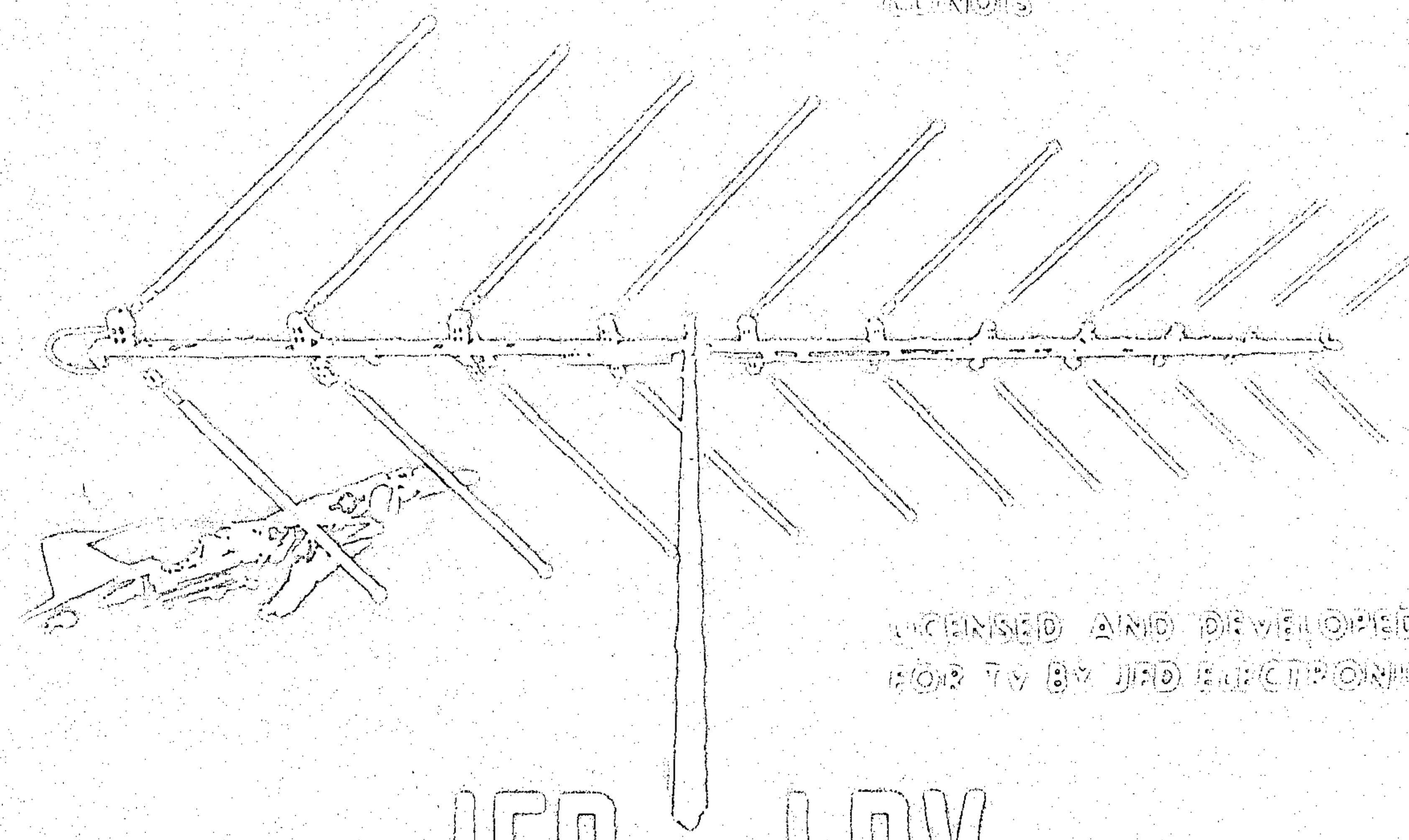
Revolution in the Air

DESIGNED BY THE ANTENNA RESEARCH LABORATORIES OF THE UNIVERSITY OF ILLINOIS



LICENSED AND DEVELOPED FOR TV BY JFD ELECTRONICS CORP.

JFD LPV

LOG PERIODIC TV ANTENNA

whatever your picture problems.... whatever the condition of your set....

THIS SPECTACULAR BREAKTHROUGH IN ANTENNA DESIGN* GUARANTEES CRISPER, CLEARER, MORE SPARKLING RECEPTION IN COLOR, BLACK-AND-WHITE, FM STEREO—ANYWHERE

The Big Breakthrough is here! The **JFD** LOG-PERIODIC **LPV** television antenna means better reception on virtually every count, because it outperforms previous antennas on virtually every count. Masses unprecedented power—to pick up every picture detail, without regard for distance or terrain. Focuses with unmatched precision, to go after the signal you're tuned to and no other—without noise, snow or ghosts. Wherever you're located, whatever the condition of your receiver—the LOG-PERIODIC **LPV must** improve your TV reception, in color and black-and-white (FM Stereo, too) on every channel. Call now—see the model designed for your location.

THE ANTENNA THAT ENDED THE "ERA OF COMPROMISE"

UP TO NOW "broad band" antennas those designed to receive all channels have simply been catch all conglomerations of narrow band elements, endlessly trimmed and modified to obtain maximum width without too great a quality loss Result piled on compromises that were enormous, cumbersome, expensive BUT NOW NO LONGER ANY NEED TO SACRIFICE QUALITY The log periodic LPV is inherently frequency-independent. You literally get all channels "best" with maximum sharpness, clarity, freedom from snow and ghosts

JFD LOG PERIODIC **LPV** TV/FM ANTENNA NOW AT...

*U.S. Patents 2,958,081–2,985,879–3,011,168 Additional Patents Pending Produced Exclusively by JFD Electronics Under License to University of Illinois Foundation

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Popular Science • Chicago Tribune • Microwave Journal • Electronic Industries • Home Furnishings Daily • Radio Electronics • PF Reporter • Electronic Technician • NEDA Journal • Radio and TV Weekly • Modern Electronic Service Dealer • Electronic Distribution • NATESA Scope • Electronic and Appliance Specialist

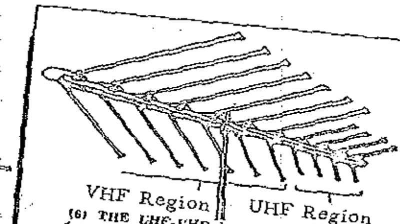
And that news is the JFD log periodic TV/FM antenna. News of its remarkable performance *is sweeping the country.* Servicemen, installers, engineers, and distributors by the tens of thousands have seen what the LPV can do—and now they are JFD log periodic LPV fans for *life.*

No wonder the editors of electronics publications have accorded the LPV more news coverage than any TV or FM antenna has ever received. *News stories, field reports,* full length technical articles are telling the world about the new antenna discovery and how the antenna research laboratories of the University of Illinois and JFD *helped design it.*

NOW'S THE TIME TO JOIN THE EVER-INCREASING NUMBER OF SERVICE DEALERS THROUGHOUT THE NATION WHO ARE FEATURING, PROMOTING AND SELLING JFD LOG-PERIODIC LPV ANTENNAS- FOR COLOR AND BW/TV-FM STEREO!

JFD LPV $\frac{L_{(n+1)}}{L_n} = \tau$

PROFESSOR PAUL MAYES . . . designs new TV antenna



(6) THE UHF-VHF is Buck Rogers antenna, an engineer's dream of the ultimate unit. It would be capable of excellent television and stereo reception in any area.

TV Antenna Designed By UI Men On Sale Soon

By DAVE YOUNG
News-Gazette Staff Writer

An improved television antenna, designed by a University of Illinois professor and one of his students, will be on the market in about two weeks.

Paul Mayes, UI associate professor of electrical engineering, said Saturday that one local distributor reported the antenna was promised from the manufacturer next week.

Mayes designed the antenna in cooperation with Robert L. Carrel, now with Collins Radio Co., Dallas, Tex. The invention was disclosed in the summer of 1959, he said.

The antenna is being manufactured by JFD Electronics Corporation, Brooklyn, N.Y.

According to Mayes, the antenna will be able to pick up signals from out-of-town stations. However, weather and antenna locations are important factors in distant reception, and signal strengths from distant stations vary widely with time of day.

The outstanding trait of the new design is the fact that the performance of the antenna does not depend upon the channel being received. Most fringe area television antennas in use today are patterned after the Yagi design which has only a few elements which are connected to the receiver, he said. The performance of the Yagi changes with frequency, however, so that it receives some channels better than others, he explained.

Mayes' and Carrel's invention is an outgrowth of research in frequency — independent antennas which has been under way at the University of Illinois Antenna Laboratory since 1954. In the new antenna most of the elements are connected to the receiver and vary in length in a way which minimizes variations in performance.

Under very favorable circumstances Champaign-Urbana viewers might be able to pick up signals from stations as far away as Chicago, Indianapolis, and Terre Haute. Mayes said, however, that such reception would be subject to many external conditions and will vary from day to day.

The new antenna is V-shaped. It consists of several aluminum ribs hooked into metal rods running down the center of the antenna. The antenna will sit on housetops like the varieties in current use.

Mayes said he is working on a new antenna for ultra high frequency signals. He said that frequency independent UHF antennas will be increasingly important in view of recent federal legislation which requires all newer television sets to be equipped for receiving both VHF and UHF channels.

The federal law becomes effective in 1964.

The VHF antenna was designed in the UI Antenna Laboratory, which is part of the electrical engineering department.

The UI Foundation has applied for patents and licensed the JFD organization to manufacture the antenna.

Reprinted from Chicago Daily Tribune: January 23, 1962

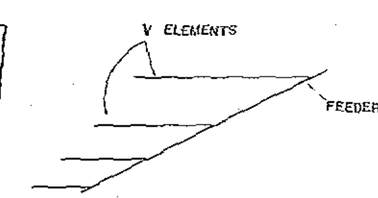


Figure 18 — Method of tilting elements in V arrays to achieve beam tilt in H-plane — side view of LPV array with elements tilted in H-plane.

(3) The half-length h_1 of the largest element should be approximately one-quarter wavelength at the lowest frequency desired. Lengths of all other elements are determined by using the scale factor τ and the spacings between elements are determined by σ.

(4) The nominal input impedance in the $\lambda/2$ mode will be 30 to 70 per cent below the impedance of the feed line depending upon τ, σ, and the thickness of the elements used. The impedance increases as the loading effect of the elements decreases, i.e., as the density of elements decreases. The impedance in the higher modes is higher than that in the $\lambda/2$ mode.

The LP resonant-V array provides essentially frequency-independent coverage of each of several frequency bands. If the desired bands are small in width, the frequency variations of the uniform periodic array may not be objectionable, thus permitting a simplification of the structure. Antennas designed according to these concepts should find application whenever coverage of several widely dispersed frequency bands is desired or when the additional directivity achieved in the higher mode operation is required.

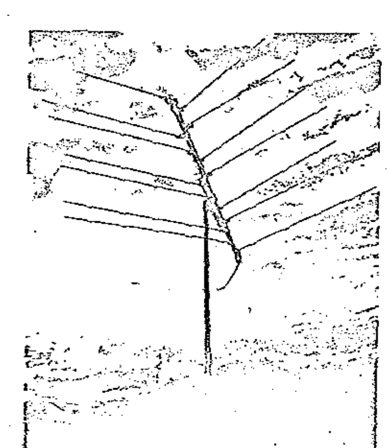


Figure 19 — An LPV antenna for all-channel VHF television receiving.

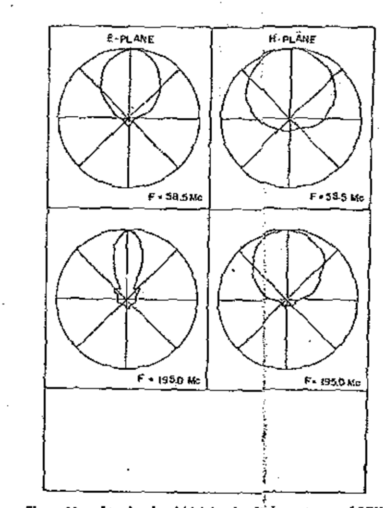


Figure 20.— Low-band and high-band radiation patterns of LPV antenna for VHF television.

Acknowledgment

Dr. Robert L. Carrel was associated with the author in the early investigations of the log-periodic resonant-V antennas. The basic work was supported by the USAF through contract AF33(616)-6079 with Wright Air Development Division. The design and construction of the television receiving antenna was made possible by a grant from the University of Illinois Foundation. Patents are pending.

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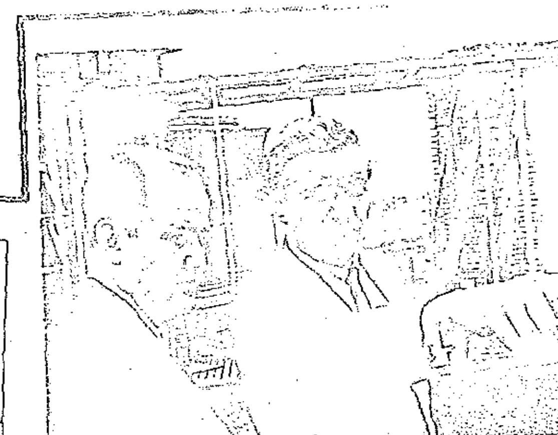
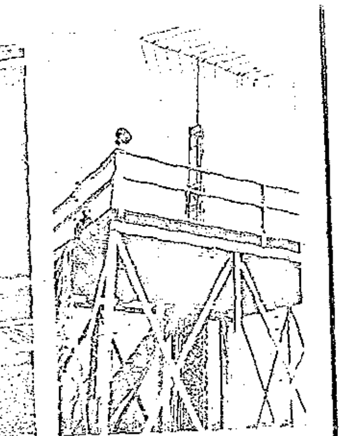
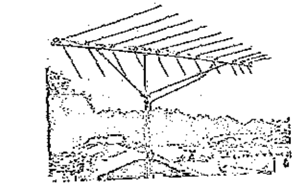




Above, Professor Paul E. Mayes of the University of Illinois and Ed Finkel of JFD Electronics inspect facilities of the JFD Antenna Research and Development Center. Above right, a long-periodic LPV-6 undergoes gain test atop 135-foot tower at Center. Right, a JFD log-periodic LPV-11 being field-tested in a Philadelphia suburb.

New Concept in Antennas



Log-periodic "LPV" antenna is result of JFD application of basic research developed at the University of Illinois

A series of radically new television antennas that offer high gain, sharp directivity, and constant impedance across the complete VHF television and FM bands have recently been introduced by JFD Electronics Corp., one of the world's largest producers of TV antennas.

The log-periodic "LPV" antennas reflect the first genuinely new concept *injected into the field of TV antenna* design in several years. Used in space *telemetry, satellite tracking and military* communications, the log periodic *principle is the result of over five* years of intensive research and development by scientists in the Antenna Research Laboratory of the University *of Illinois. Adapted for television by* the JFD antenna engineering staff, *the log periodic "LPV's" frequency* independent characteristic yields a *high level of gain uniformly over the* entire VHF and FM bands.

Verified gain measurements indicate that a single LPV antenna produces as much gain on all channels as a complete set of comparable sized single-channel yagis. Its impedance, polar patterns, and front-to-back ratios are virtually uniform. Unlike conventional antennas, the log periodic LPV uses a larger group or "cell" of driven dipoles actively engaged in stepping up gain on every low and high band channel.

Each antenna in the "LPV" series consists of an array of resonant V *dipoles interconnected by transposed* phasing harnesses, constituting a series *of "cells." The size of each cell (or* group of dipoles) differs from the one *before it by a logarithmic factor. In* operation, each received channel fur*nishes maximum signal to the cell cor*responding to its particular half wave*length. For the high band frequencies,* additional signal for each channel is *furnished by operation on the third* harmonic mode. The consequently *large number of dipoles contributing* their signals in proper phase and at *constant impedance, accounts for ab*normally high gain and expanded *bandwidth. In brief, more working* elements operate on every channel.

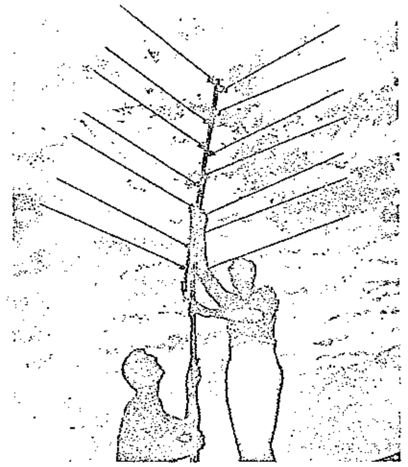
The constant impedance, regardless of frequency, is another unique feature of the log periodic concept. This frequency independent characteristic overcomes the heretofore incompatibility of high gain, high front-to-back ratio, narrow unidirectional polar pattern, and broad bandwidth.

Each of the JFD antennas in the LPV series has been designed for a *specific TV reception area, from city* locations to the farthest fringe. The *LPV-4 and LPV-6 have four and six* cells respectively and are recom*mended for use within 50 to 75 miles* from the transmitter. For 100 to 125 *mile reception, the LPV-8 and LPV-*11 with seven and nine active cells respectively, *are suggested. Each of* the latter include directors for a *sharper forward polar pattern at the* higher frequencies. Two more models complete the series: *the LPV-14 with* 13 active cells and one director, and *the LPV-17 with 15 active cells and* two directors for 150 and 175 mile reception, respectively.

All LPV antennas feature the exclusive JFD "Flip-Quik" construction by which all elements click into place on the cross-arm in minutes by means of new "tank-turret" brackets. An extra-heavy gauge, one-inch square aluminum boom provides the strength needed to withstand high winds and heavy snow and ice loading. All elements are gold anodized to prevent corrosion and are reinforced at vital bracket connections with heavy wall aluminum exserts.

ELECTRONICS

Powerful New Antenna for TV and FM, too



Early research model of the LPV is being adjusted here by the designer, Prof. Paul Mayes. This version worked fine, but turned out to be too expensive for mass production.

THE wraps have just come off a remarkable new antenna. It will give TV viewers and FM listeners the benefit of know-how engineers gained in licking the problems of communicating with satellites.

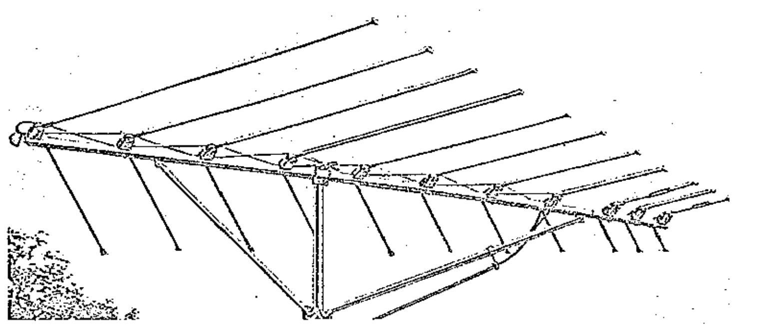
This relatively compact antenna, the LPV, will feed your TV or FM stereo receiver an exceptionally strong signal over the entire VHF band (Channel 2 through 13 and FM stereo). Furthermore, it rejects ghosts and interference reaching it from the back and sides, as positively as a long-john yagi (which can be made to work efficiently on only one channel).

New to consumer TV, but basic to many space-communications antennas, the principle of operation is known to engineers as the *log periodic* principle. (We'll get to the V in LPV in a moment.) In fact, the LPV was developed by some of the same scientists at the Antenna Research Laboratory of the University of Illinois who designed the conical spiral antenna used in the Transit satellite. It is, mathematically, a flattened version of that design.

The LPV looks like the skeleton of a streamlined flounder. The elements are longest at the rear and get successively shorter toward the front. They are tilted forward to make a V–that V in LPV.

Even if you're not a mathematician, you can get a rough idea of how the LPV works if you'll think of a long escalator with people hopping on at each of several floors. The signal picked up by each set of elements is continuously passed along a zigzag network of bars to the antenna terminals. The trick is to keep all the waves adding together in phase. The result is a whopping big signal sent down to the TV set. The LPV achieves this by arranging the elements according to a log-periodic formula that fools the signals into acting as though the separate elements were actually a huge, continuous spiral, constantly in phase.

JFD Electronics, Brooklyn, N. Y., makes the commercial version of the LPV in six models to suit different receiving conditions. The smallest and least expensive, the LPV-4, has four sets of elements—adequate for high signal areas close to TV stations. The largest is the LPV-17 with 17 sets of elements; it would ordinarily be used for far fringe reception or areas where there are particularly troublesome local conditions.—*Charles Tepfer.*



Production model of the LPV shown here is the LPV-11, designed for fringe areas. The 11 sets of elements (or cells) include two directors in front for sharper response on the high channels. The antenna is highly directional, with minimum response to the sides and back. Uniformity of gain over complete VHF band is said to give better color reception.

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U. I. RESEARCH TRIUMPHS IN ELECTRONICS

New Antennas Boost to Communications

(Fourth in a series of reports by a reporter who roamed the campus of the University of Illinois at Urbana to find out what is new in the world of scholarship.)

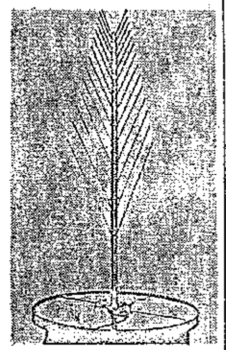
BY FRANK HUGHES

Scientific research at the University of Illinois has scored a major advance in the field of electronics.

The triumph came in the antenna laboratory at the college of engineering in Urbana. There, in the upper floor and on the roof of an old building tucked along the side of Burrell street, more than 10 years of research finally paid off in three unique antenna designs for radio and television.

Puzzles Since 1886

They solve problems which have baffled communications engineers since 1886, when Heinrich Rudolph Hertz discovered the existence of electromagnetic waves, the heart of all radio and TV communication.



A Vee log-periodic antenna.

The antenna laboratory was founded by Dr. E. C. Jordan, head of the electrical engineering department of the college, and is directed by Dr. Georges A. Deschampes. Among the professors who have contributed heavily to the creation of the new antennas are Doctors John D. Dyson, Paul E. Mayes, R. H. DuHamel, E. M. Turner, V. H. Rumsey, R. L. Carrell, and D. E. Isbell.

The designs they have created, unique and years ahead of anything previously conceived, are the log-periodic, the log-spiral, and the Vee log-periodic. These technical sounding names describe arrays of metal rods or wires which do things for radio waves better than they ever have been done before.

What They Accomplish

Among other things, accomplishments of the antennas are:

1. The log-spiral made possible creation of the U. of I. radio telescope near Danville, Vermilion county, which is tracking electronic emissions of the stars in a scanning pattern similar to that on the face of a television tube. Eventually it is expected to produce a picture just as good.

2. The log-periodic antenna gives a ten-fold gain over a single wire, and signals from the front are more than 100 times stronger than from the back of the array, either transmitting or receiving. While other broad-band antennas have been invented, this one has no limit in the spectrum of frequencies it will receive or transmit, except what is imposed by the space it occupies.

3. The Vee log-periodic, or Vee-periodic, which looks like the backbone and ribs of a fish, promises to revolutionize reception of television signals in fringe areas. It has enormous gain and perfectly flat resonance and impedance characteristics over the extremely wide band of television frequencies from VHF [very high frequencies] to UHF [ultra high frequencies].

Describes Their Work

Prof. Paul Mayes, who has had a hand in the creation of all of these designs, and with Prof. Carrell developed the Vee array in 1960, described how they work in an interview with THE TRIBUNE.

Wide band antennas in the past, he said, were limited to about a two-to-one frequency ratio, from 500 kilocycles to 1,000 or possibly 1,500 kilocycles in the broadcast range and 2 to 4 megacycles in high frequency, for instance.

"The log-periodic has no theoretical limitation," he said. "With reasonable size, a 20 to 1 bandwidth is possible, and the accuracy of construction is the only limitation. The radiation pattern remains the same, also the impedance."

Constant impedance over this wide range of frequencies is vitally important, because it eliminates the necessity of cumbersome tuning networks at many points on the antenna array, and frequent adjustment of them either by costly remote-control service systems or by hand.

Interest from Industry

The log-periodic is of tremendous interest to industry, and because of its range and simplicity many users of UHF and microwaves are testing it. The Vee-periodic, which not only will enhance the pleasure of TV listeners, but will expand the commercial market of television stations enormously, has even greater directivity and gain than the log-periodic.

The log-spiral is particularly adapted to radio telescope work. The antenna of the U. of I. radio telescope at Danville is a huge reflector trough—a ravine 600 feet long and 400 feet wide, dug to an eliptical pattern, paved, and lined with wire mesh. A 425-foot wooden truss has been erected 153 feet above the bottom of this reflector to hold 276 of the log-spiral antennas, each about two feet long and small enough to hold in both hands.

The antennas are rotated a certain number of degrees each day to cover a 15-minute arc of sky.

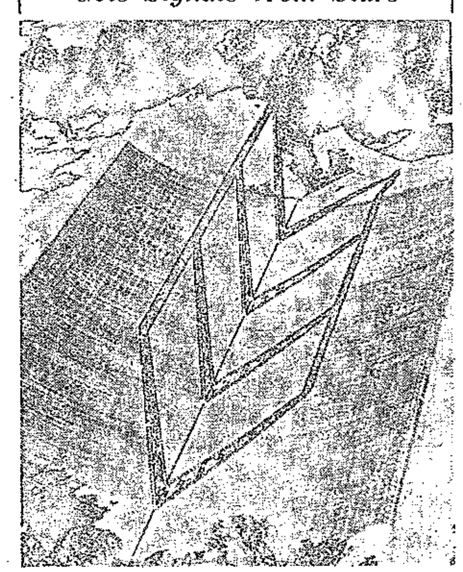
Signals from the stars strike the wire mesh reflector, are picked up by the powerful gain of the log-spiral antennas, and piped to low-noise parametric amplifiers.

276 Antennas Joined

A semi-conductor switch connects the 276 antennas in rapid alternation to a standard source of electrical noise, to measure the difference between the sources. The parametric amplifiers send the results thru a radiometer and into a graphic recorder. Eventually recording will be done on punched tape and processed in a digital computer.

Until Prof. Dyson, who received the patent, developed the log-spiral, and until Prof. Yuen T. Lo of the antenna laboratory designed the odd-looking cone, the radio telescope was only a dream in the minds of astronomers and engineers.

Gets Signals from Stars



University of Illinois radio telescope near Danville, whose wooden truss, 425 feet long, carries 276 log-spiral antennas developed by university scientists to receive signals from the stars. [UPI Telephoto]

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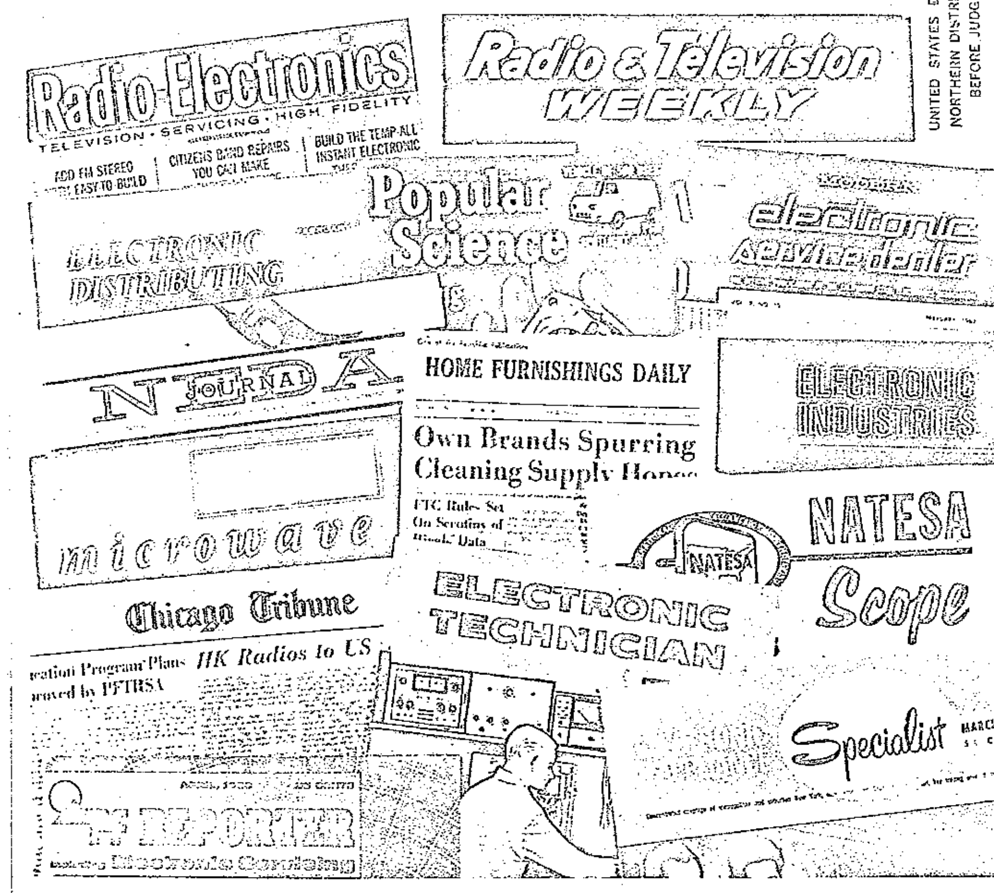
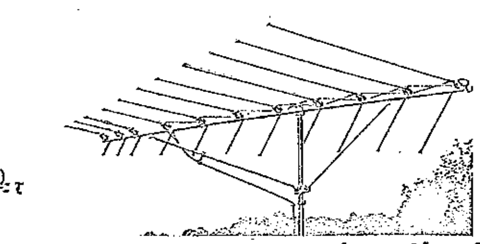


NEVER BEFORE HAVE SO MANY SO ACCLAIMED A NEW TV ANTENNA CONCEPT . . .

JFD

LOG-PERIODIC

LPV $\frac{L_{(n+1)}}{L_n} = \tau$



the antenna with the college education!

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