LAW OFFICES

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
STANLEY C. DALTON
RICHARD S. PHILLIPS
LLOYD W. MASON
TED E. KILLINGSWORTH
CHARLES L. ROWE
W. E. RECKTENWALD
DILLIS V. ALLEN
WM. A. VAN SANTEN
RONALD L. WANKE

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1845-1969

December 4, 1972

RECEIVED
DEC 6 1972
RINES AND RINES
NO. 10 POST OFFICE SQUARE, BOSTON

Mr. Basil P. Mann
Merriam, Marshall, Shapiro & Klose
Two First National Plaza
Chicago, Illinois 60670

RE: University of Illinois Foundation
v. Blonder-Tongue Laboratories

Dear Pete:

Thanks much for the check for the Foundation's share of the costs. I took the liberty of modifying your
* certificate to specify that the Foundation had paid the costs awarded against them. I am still working on JFD. I hope we don't have to sue them in New York in order to collect.

Very truly yours,

Richard S. Phillips

RSP:iag

* Enclosure

Mr. R. H. Rines (*)

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNIVERSITY OF ILLINOIS FOUNDATION, Plaintiff and Counterclaim Defendant, - v - BLONDER-TONGUE LABORATORIES, INC., Defendant and Counterclaimant, - v - JFD ELECTRONICS CORPORATION, Counterclaim Defendant.	Civil Action No. 66 C 567

CERTIFICATE OF SATISFACTION OF COSTS

Defendant, Blonder-Tongue Laboratories, Inc., by its attorney, do hereby certify that the judgment for costs totaling $3,918.19 in this action, awarded by the Court against plaintiff, The University of Illinois Foundation, has been paid and satisfied in full, and we do hereby request this Certificate of Satisfaction of Costs be entered in the official case docket.

This _____ day of December, 1972.

BLONDER-TONGUE LABORATORIES, INC.

By______________________________
Attorney for Defendant
20 North Wacker Drive
Chicago, Illinois 60606

APPEARANCE FORM

SUPREME COURT OF THE UNITED STATES

No. 72-626, October Term, 1972

UNIVERSITY OF ILLINOIS FOUNDATION
(Petitioner or Appellant)

vs.

BLONDER-TONGUE LABORATORIES, INC.
(Respondent or Appellee)

The Clerk will enter my appearance as Counsel for the Respondent

Signature [signature]

Type or Print Name Robert H. Rines

Address 10 Post Office Square, Room 1318

City and State Boston, Massachusetts 02109

NOTE: This appearance must be signed by an individual Member of the Bar of the Supreme Court of the United States.

The Clerk is requested to notify counsel of action of the Court by means of:

[ ] Collect Telegram

[ ] Airmail Letter

[x] Regular Mail

NOTE: When more than one attorney represents a single party or group of parties, counsel should designate a particular individual to whom notification is to be sent, with the understanding that if other counsel should be informed he will perform that function.

In this case the person to be notified for is:

[ ] Petitioner(s)

[x] Respondent(s)

[ ] Appellant(s)

[ ] Appellee(s)

[ ] Amicus

Robert H. Rines, Esquire
(Name—Type or Print)

10 Post Office Square, Room 1318
(Street Address)

Boston, Massachusetts 02109
(City, State and Zip Code)

CO-73

GPO : 1969 O - 360-371

11/6/72 - Mailed

LAW OFFICES

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
STANLEY C. DALTON
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CHARLES L. ROWE
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DILLIS V. ALLEN
WM. A. VAN SANTEN
RONALD L. WANKE

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

November 15, 1972

Mr. John F. Pearne
McNenny, Farrington, Pearne & Gordon
450 Tower East
Cleveland, Ohio 44122

Dear John:

* I enclose a copy of the Blonder-Tongue brief in the Supreme Court.

Very truly yours,

Richard S. Phillips

RSP:iag

* Enclosure

cc: Mr. R. H. Rines

LAW OFFICES

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
STANLEY C. DALTON
RICHARD S. PHILLIPS
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DILLIS V. ALLEN
WM. A. VAN SANTEN
RONALD L. WANKE

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

November 14, 1972

RECEIVED
NOV 16 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. Robert H. Rines
Rines and Rines
No. Ten Post Office Square
Boston, Massachusetts 02109

RE: University of Illinois Foundation
v. Blonder-Tongue

Dear Bob:

* Enclosed are two copies of the printed brief, which was served last Friday.

Very truly yours,

Richard S. Phillips

Richard S. Phillips iag

RSP:iag

* Enclosures

cc: Mr. I. S. Blonder (*)

LAW OFFICES
HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

November 7, 1972

RECEIVED
NOV 9 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. John F. Pearne
McNenny, Farrington, Pearne & Gordon
450 Tower East
Cleveland, Ohio 44122

RE: University of Illinois Foundation
v. Blonder-Tongue

Dear John:

* I enclose a copy of the respondent's brief.

Very truly yours,

Richard S. Phillips

RSP:iag

* Enclosure

cc: Mr. R. H. Rines

LAW OFFICES

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD

20 NORTH WACKER DRIVE

CHICAGO 60606

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

October 31, 1972

Mr. E. Robert Seaver, Clerk
Supreme Court of the United States
Washington, D. C. 20543

RE: University of Illinois Foundation
v. Blonder-Tongue Laboratories, Inc.
No. 72-626, October Term 1972

Dear Sir:

* I enclose my appearance on behalf of Blonder-Tongue Laboratories, Inc. in connection with the above.

Very truly yours,

Richard S. Phillips

RSP:iag

* Enclosure

cc: Mr. R. H. Rines
Mr. C. J. Merriam

LAW OFFICES

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD

20 NORTH WACKER DRIVE

CHICAGO 60606

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
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RONALD L. WANKE

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

October 31, 1972

RECEIVED
NOV 3 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. Robert H. Rines
Rines and Rines
No. Ten Post Office Square
Boston, Massachusetts 02109

RE: University of Illinois Foundation
v. Blonder-Tongue

Dear Bob:

* I enclose a notice from the Supreme Court together with a couple of copies of an appearance form. I have filed my appearance.

Very truly yours,

Dick

Richard S. Phillips

RSP:iag

* Enclosures

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1972

UNIVERSITY OF ILLINOIS FOUNDATION Appellant—Petitioner *vs.* BLONDER-TONGUE LABORATORIES Appellee—Respondent	No. 72-626

To HOFGREN, WEGNER, ALLEN, STELLMAN &McCORD, Counsel for Appellee—Respondent:

YOU ARE HEREBY NOTIFIED that ~~an appeal~~—a petition for a writ of certiorari—in the above-entitled and numbered case was docketed in the Supreme Court of the United States on the 24th day of October, 1972

At the request of the Clerk of the Supreme Court, we are sending attached hereto an appearance form to be filed by you, or other counsel who will represent your party, with the Clerk at or before the time you file your response to our petition or jurisdictional statement.

Merriam, Marshall, Shapiro & Klose
Counsel for Appellant—Petitioner

2 First National Plaza - Suite 2100
Number and Street

Chicago, Illinois 60670
City, State and Zip Code

NOTE: Please indicate whether the case is an appeal or a petition for certiorari by crossing out the inapplicable terms. A copy of this notice need not be filed in the Supreme Court.

CO-75

APPEARANCE FORM

SUPREME COURT OF THE UNITED STATES

No. 72-626, October Term, 1972

______________________ ______________________

vs.

~~UNIVERSITY OF ILLINOIS FOUNDATION~~
(Petitioner or Appellant)

~~BLONDER-TONGUE LABORATORIES, INC.~~
(Respondent or Appellee)

The Clerk will enter my appearance as Counsel for the Respondent

Signature ______________________

Type or Print Name ______________________

Address ______________________

City and State ______________________

NOTE: This appearance must be signed by an individual Member of the Bar of the Supreme Court of the United States.

The Clerk is requested to notify counsel of action of the Court by means of:

[ ] Collect Telegram

[ ] Airmail Letter

[x] Regular Mail

NOTE: When more than one attorney represents a single party or group of parties, counsel should designate a particular individual to whom notification is to be sent, with the understanding that if other counsel should be informed he will perform that function.

In this case the person to be notified for is:

[ ] Petitioner(s)

[x] Respondent(s)

[ ] Appellant(s)

[ ] Appellee(s)

[ ] Amicus

Richard S. Phillips
(Name—Type or Print)

20 North Wacker Drive
(Street Address)

Chicago, Illinois 60606
(City, State and Zip Code)

CO-73

GPO : 1969 O - 360-371

LAW OFFICES
HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
STANLEY C. DALTON
RICHARD S. PHILLIPS
LLOYD W. MASON
TED E. KILLINGSWORTH
CHARLES L. ROWE
W. E. RECKTENWALD
DILLIS V. ALLEN
WM. A. VAN SANTEN
RONALD L. WANKE

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

November 1, 1972

RECEIVED
NOV 3 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. Jerome M. Berliner
Ostrolenk, Faber, Gerb & Soffen
10 East 40th Street
New York, New York 10016

RE: UIF v. BT v. JFD

Dear Jerry:

In August costs in the amount of $2130.72 were taxed against JFD. I understand from Mike Cass that you have agreed that this figure is correct.

I would appreciate your arranging for payment of these costs by JFD.

Very truly yours,

Richard S. Phillips

RSP:iag

cc: Mr. M. C. Cass
Mr. R. H. Rines) Pete Mann called today and apologized
Mr. I. S. Blonder) for the Foundation's not yet having paid their share of the costs. He said that he and Bill Marshall each had thought the other had attended to it. We should have a check from them shortly.

file

November 3, 1972

Richard S. Phillips, Esquire
Hofgren, Wegner, Allen,
Stellman & McCord
20 North Wacker Drive
Chicago, Illinois 60606

Dear Richard:

RE: New Petition for Supreme Court By University of Illinois Foundation

Enclosed is our draft for your final touches and revisions of the proposed reply to the Petition for Writ of Certiorari.

Very truly yours,

RINES AND RINES

Robert H. Rines

RHR:la
Enclosure
cc: Mr. Ben Tongue
Mr. Ike Blonder

LAW OFFICES

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD

20 NORTH WACKER DRIVE

CHICAGO 60606

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

file

November 7, 1972

RECEIVED
NOV 9 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOST.

Mr. Robert H. Rines
Rines and Rines
No. Ten Post Office Square
Boston, Massachusetts 02109

RE: University of Illinois Foundation
v. Blonder-Tongue

Dear Bob:

I took the liberty of making a few editorial changes. * I enclose respondent's brief as I have sent it to the printer.

Very truly yours,

Dick

Richard S. Phillips

RSP:iag

* Enclosure

cc: Mr. I. S. Blonder (*)

LAW OFFICES

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
STANLEY C. DALTON
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CHARLES L. ROWE
W. E. RECKTENWALD
DILLIS V. ALLEN
WM. A. VAN SANTEN
RONALD L. WANKE

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

August 3, 1972

RECEIVED
AUG 7 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. Robert H. Rines
Rines and Rines
No. Ten Post Office Square
Boston, Massachusetts 02109

RE: University of Illinois Foundation
v. Blonder-Tongue

Dear Bob:

I presented the cost bill on Wednesday, August 2. In our court, these are generally handled by the minute clerk for the individual judge. Judge Hoffman's minute clerk passed away about six weeks ago and he does not yet have a new one. Accordingly, the bill was presented to the clerk for Judge Will, who is the emergency judge during this portion of the summer vacation.

There is no objection made on behalf of JFD. The Foundation did not object to the amount, but did question when it must be paid. Pete Mann advised me that they plan to file a petition for certiorari.

Judge Will's clerk was unsure what should happen and we ended up talking with the Chief Deputy Clerk. He said the bill would be entered and that the Foundation would have to file a supersedeas bond and have it approved by Judge Hoffman in order to avoid immediate payment of the costs.

I believe they plan to file such a bond.

Very truly yours,

Dick

Richard S. Phillips

RSP:iag

cc: Mr. I. S. Blonder

LAW OFFICES

HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD

20 NORTH WACKER DRIVE

CHICAGO 60606

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
STANLEY C. DALTON
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W. E. RECKTENWALD
DILLIS V. ALLEN
WM. A. VAN SANTEN
RONALD L. WANKE

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

June 22, 1972

File
RSV [illegible]

RECEIVED
JUN 26 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. Robert H. Rines
Rines and Rines
No. Ten Post Office Square
Boston, Massachusetts 02109

Dear Bob:

You mentioned an accounting problem when you were here for the Blonder-Tongue argument. I suggest you take a look at a recent District Court decision reported at 173 USPQ 652 concerning the difference between a royalty paid by a licensee and the royalty to be assessed against an infringer.

Very truly yours,

Dick

Richard S. Phillips

RSP:iag

LAW OFFICES

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
BRADFORD WILES
JAMES C. WOOD
STANLEY C. DALTON
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HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1946-1969

July 27, 1972

RECEIVED
JUL 31 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. Robert H. Rines
Rines and Rines
No. Ten Post Office Square
Boston, Massachusetts 02109

Dear Bob:

* I enclose a copy of the cost bill which I will present to the clerk next week.

Very truly yours,

Dick

Richard S. Phillips

RSP:iag

* Enclosure

cc: Mr. I. S. Blonder (*)

Form A. O. 133 (1-63) BILL OF COSTS

United States District Court
for the
NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNIVERSITY OF ILLINOIS FOUNDATION,
Plaintiff and Counterclaim Defendant,
- v -
BLONDER-TONGUE LABORATORIES, INC.,
Defendant and Counterclaimant,
- v -
JFD ELECTRONICS CORPORATION, Counterclaim Defendant.

CIVIL ACTION FILE No. 66 C 567

Judgment having been entered in the above entitled action on the 25th day of July, 19 72, ~~against~~ in favor of BLONDER-TONGUE LABORATORIES, by the Court of Appeals for the 7th Circuit, the clerk is requested to tax the following as costs:

BILL OF COSTS

Fees of the clerk	$
Fees of the marshal	
Fees of the court reporter for all or any part of the transcript necessarily obtained for use in the case	
Fees and disbursements for printing	
Fees for witnesses (itemized on reverse side)	
Fees for exemplification and copies of papers necessarily obtained for use in case	
Docket fees under 28 U. S. C. 1923	
Costs incident to taking of depositions	
Cost as shown on Mandate of Court of Appeals	
Other Costs (Please itemize)	
SEE ATTACHED	
Total	$

State of ILLINOIS ,
County of COOK : } ss:

I, RICHARD S. PHILLIPS do hereby swear that the foregoing costs are correct and were necessarily incurred in this action and that the services for which fees have been charged were actually and necassarily performed. A copy hereof was this day mailed to Basil P. Mann for the University of Illinois Foundation and Myron C. Cass for JFD Electronics Corporation, with postage fully prepaid thereon.

Please take notice that I will appear before the Clerk who will tax said costs on Wednesday August 2, 19 72 at 10:00 A.M.

[signature]

Attorney for Blonder-Tongue Laboratories Inc.

Subscribed and sworn to before me this 27th day of July A. D. 19 72 at Chicago, Illinois.

[signature]
Notary Public.

Costs are hereby taxed in the amount of $ this day of , 19 , and that amount included in the judgment.

Clerk.

By
Deputy Clerk.

NOTE: SEE REVERSE SIDE FOR AUTHORITIES ON TAXING COSTS.

The Court of Appeals for the Seventh Circuit in its decision dated February 13, 1970, awarded Blonder-Tongue one-third of its costs on appeal, to be taxed against University of Illinois Foundation. The costs were $5362.42, one-third of which is $1787.47.

The Supreme Court in its decision dated May 3, 1971, awarded Blonder-Tongue one-half its costs, to be taxed against both respondents, each to pay one-quarter. The total costs in the Supreme Court were $8522.90, one-fourth of which is $2130.72.

Costs taxed against University of Illinois Foundation $3918.19

Costs taxed against JFD Electronics 2130.72

United States Court of Appeals
For the Seventh Circuit
219 South Dearborn Street
Chicago, Illinois 60604

Kenneth J. Carrick
Clerk

Mr. H. Stuart Cunningham, Clerk
United States District Court
219 South Dearborn Street
Chicago, Illinois 60604

August 31, 1972

RECEIVED
SEP 5 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Re: UNIVERSITY OF ILLINOIS FOUNDATION, Plaintiff-Appellant,

vs.

BLONDER-TONGUE LABORATORIES, INC., Defendant-Appellee.

U.S.C.A.-7 No. 71-1879

District Court No. 66 C 567

Dear Sir:

*Herewith is the mandate of this Court in the above entitled appeal. I am returning the original rec*ord of your District Court, which was transmitted to this office for use on appeal. **

Please acknowledge receipt on the enclosed copy of this letter.

Sincerely yours,

KENNETH J. CARRICK, *Clerk*

By: Carmella I. Von Thaden

Deputy Clerk

Date: ______________________

Received above mandate and record from the Clerk of the United States Court of Appeals for the Seventh Circuit.

____

Clerk

Copies mailed to:

Mr. Robert H. Rines, 10 Post Office Square, Boston, Mass. 02109
Mr. Richard S. Phillips, 20 N. Wacker, Chicago, Ill. 60606
Mr. Charles J. Merriam, Two First National Plaza, Chicago, Ill. 60670
Mr. Myron C. Cass, 105 W. Adams, Chicago, Ill.
Mr. Jerome M. Berliner, 10 E. 40th St., New York, New York

** 1 Vol Pleadings; 1 Vol Decisions

Gentlemen:

If any physical and large documentary exhibits have been filed in the above entitled cause, they are to be withdrawn within ten days from the date of this notice. Exhibits not withdrawn during this period will be disposed of.

March 7, 1968

Touche, Ross, Bailey and Smart
744 Broad Street
Newark, New Jersey

Attention: Mr. Charles Bloom

Dear Mr. Bloom:

We have been requested to inform you of litigation involving Blonder-Tongue Laboratories, Inc. of which we are aware, and its possible financial impact upon the company.

The suit was filed by the University of Illinois against Blonder-Tongue Laboratories, Inc. in Chicago for infringement of certain antenna patents. The trial has been held, and we are now in the briefing stage.

In our opinion, this suit is without merit, and we do not anticipate any liability on the part of our client.

We did, however, counterclaim against the University of Illinois Foundation and JFD Electronics Company in this suit, for unfair competition, anti-trust violation and infringement of a Blonder-Tongue patentt. This counterclaim has also been tried, and is in the briefing stage, and we hope there may be some recovery by Blonder-Tongue Laboratories, Inc.

Very truly yours,

RINES AND RINES

By____________________

RHR:H
cc: Mr. Ben Tongue

LAW OFFICES
HOFGREN, WEGNER, ALLEN, STELLMAN & McCORD
20 NORTH WACKER DRIVE
CHICAGO 60606

AXEL A. HOFGREN
ERNEST A. WEGNER
WILLIAM J. STELLMAN
JOHN B. McCORD
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JAMES C. WOOD
STANLEY C. DALTON
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DILLIS V. ALLEN
WM. A. VAN SANTEN
RONALD L. WANKE

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

December 11, 1972

RECEIVED
DEC 15 1972
RINES AND RINES
NO. 10 POST OFFICE SQUARE, BOSTON

Mr. Isaac S. Blonder
Blonder-Tongue Laboratories Inc.
One Jake Brown Road
Old Bridge, New Jersey 08857

Dear Ike:

I had written Jerry Berliner recently about the payment of costs by JFD. He called me Friday afternoon and said that he understood Finkle had sent a check directly to you at your old address in Newark on November 22. Please let me know whether you have received it. If not, I'll work on getting a new one issued.

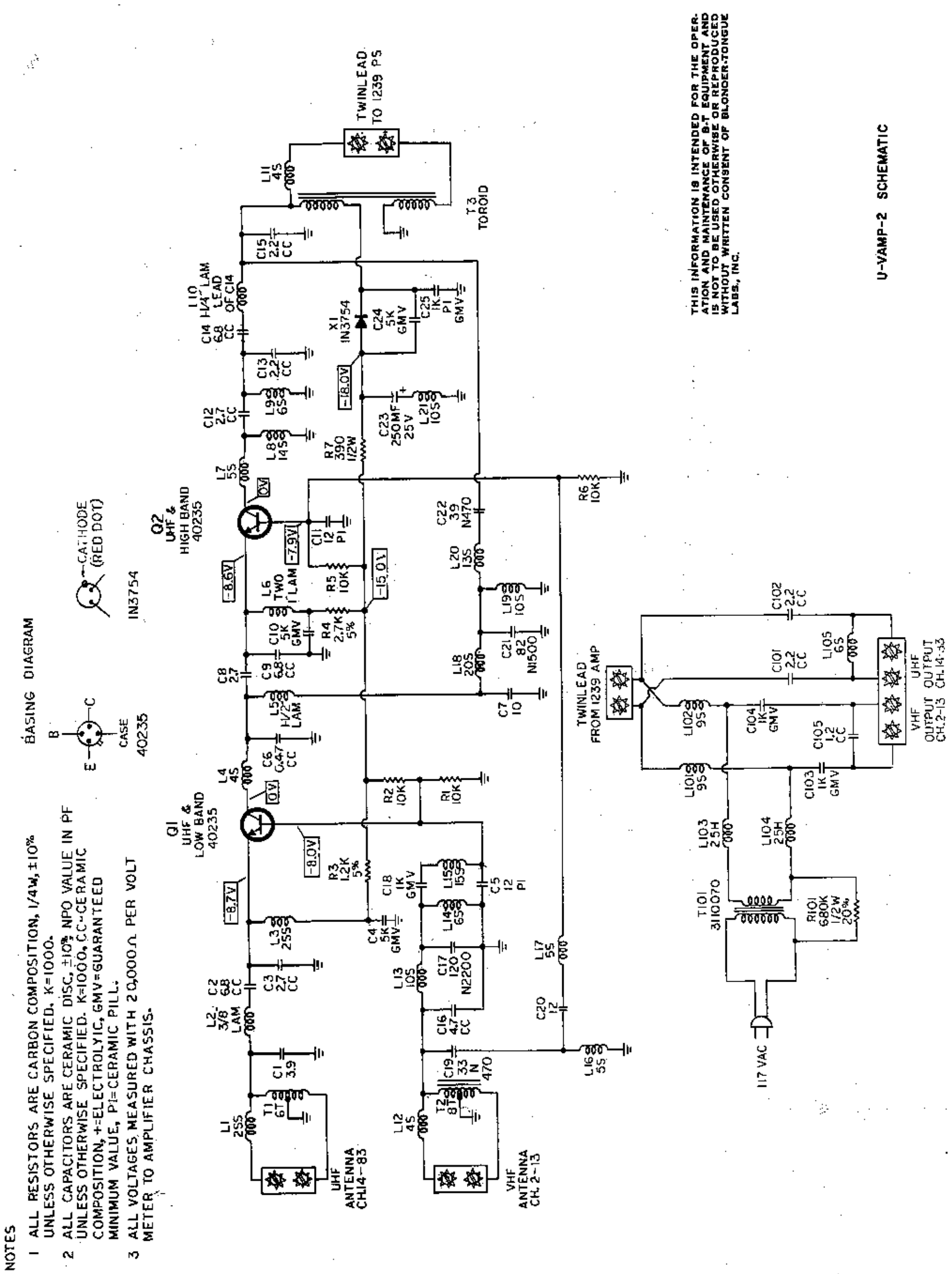
Sincerely yours,

Richard S. Phillips

RSP:iag

cc: Mr. R. H. Rines

PS: I imagine you could get Abbie Hoffman, Tom Hayden and several others to contribute to your monument for the judge. They are probably no worse company than patent lawyers.



BLONDER - TONGUE

LABORATORIES INC., NEWARK, N. J.

TWO TRANSISTOR
UHF/VHF AMPLIFIER
CH 2 TO CH 83

MODEL U/VAMP-2

INSTRUCTION MANUAL

DESCRIPTION

The U/Vamp-2 is a high quality two transistor amplifier designed to improve color and black and white reception on all TV channels, both VHF and UHF (channels 2-83).

The U/Vamp-2 consists of two compact units, the amplifier which is designed to be mounted outdoors on the antenna mast and the power supply which can be mounted at any convenient indoor location. Only one twinlead is required to connect the amplifier to the power supply. A safe 15 volts is fed up the twinlead to the amplifier while at the same time the amplified TV signal is transmitted down the twinlead to the TV receiver.

MOUNTING AMPLIFIER

Mount the amplifier unit to the mast below the lowest antenna with the U-bolt provided. If the mast is mounted to a chimney, position the amplifier below the top of the chimney where it will not be exposed to gases and excess heat.

Note: Make connections to the amplifier before attaching to the mast. See Installation Section

Power Supply: The power supply unit can be mounted on the back of the TV set or any other convenient place using the wood screws provided. If mounted on the back of the TV set, avoid blocking the ventilation holes.

U. S. Patent 3,016,510, Foreign Patents Applied For
PRINTED IN U.S.A.
6510651

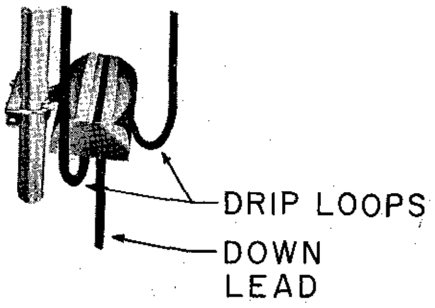


Figure 1

INSTALLATION

Connect the UHF and VHF antennae to the appropriate terminals on the amplifier unit. Terminals are marked on the label. Refer to the enclosed instruction card for making connections to the stripless screw terminals. Leave some slack on the twinleads to form a "drip loop" as shown in Figure 1, but do not allow them to come closer than two inches from the output downlead.

Connect the downlead to the amplifier. For best performance in the UHF range, and under rain or salt spray conditions, the use of encapsulated foam twinlead (Belden #8285 or Amphenol #214-103) is recommended.

Caution: Keep twinlead away from house wiring or metal. Use standoffs when running twinlead outside the house.

Connect the downlead from the amplifier to the appropriate power supply terminals (refer to label on power supply). Connect the UHF and VHF outputs on the power supply to the appropriate TV set or UHF converter antenna terminals.

After installation is complete, plug in power supply to any 117V AC outlet (this unit cannot be used on DC). The unit draws very little power (less than an electric clock) and thus can be left on continuously.

INTERFERENCE

On rare occasions an exceptionally strong local station may cause interference on other channels. (Bars moving across screen, cross hatching, etc). This can often be cured by aiming the antenna away from the strong station. Severe cases of VHF interference can be cured with filters, such as B-T series FR.

SERVICE

The advanced solid-state circuitry employed in this unit is designed to give you long, trouble free service. Should trouble arise, check all connections to the antenna, amplifier, power supply and TV set. If the problem is not solved by securing all connections, Blonder-Tongue provides reliable, low cost service. Pack the unit carefully, enclosing a slip describing the trouble and your return address, then send it prepaid to:

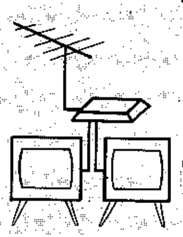
SERVICE DEPARTMENT
BLONDER-TONGUE LABORATORIES
9 ALLING STREET, NEWARK, N. J. 07102

The unit will be returned by parcel post, C.O.D.

MODEL A-102 U/V BLONDER-TONGUE UHF/VHF/FM 2-SET COUPLER

APPROVED FOR COLOR

- Top rated . . . allows one antenna to serve two TV and/or FM sets
- For true all-channel TV reception — obsolescence-proof
- Low through-loss and high isolation — minimizes interference between sets
- Also can couple two antennas to one downlead — any combination of VHF, UHF or FM antennas
- Lasts longer in all high moisture areas — stainless steel terminal teeth maintain positive electrical contact — self-sealing connection



Model A-102 U/V is an all-channel VHF/UHF/FM two-set coupler, featuring low loss and high isolation between sets. Its advanced design makes it ideal for use in color television installations.

INSTALLATION

Loosen stripless screws. Do not strip flat twin-lead; slide it under the screws and tighten so that the saw-toothed washers pierce the insulation. Excessive pressure is not required.

NOTES: Narrow twin-lead should be angled as shown by the dotted lines (Figure 1 below), to make proper electrical connection with the saw-toothed washers.
Tubular twin-lead should be trimmed for use with the stripless screws as shown in Figure 2.

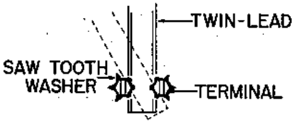


FIGURE 1

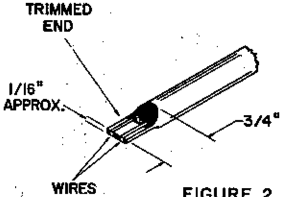


FIGURE 2

Pat. Nos. 3016510 and 2977553

TO COUPLE TWO SETS

Connect the lead carrying the signal to be split to the terminals marked ANT, and the leads from the sets to the terminals marked SET.

TO COUPLE TWO ANTENNAS

Connect the antenna leads to the SET terminals, then connect the downlead (to the set) to the ANT terminals.

MOUNTING

The Miracle-Mount accessory (available separately) permits quick, easy, rugged mast-mounting. Two wood screws are supplied for mounting indoors.

Blonder-Tongue manufactures a complete line of home distribution equipment, including UHF converters, antennas, signal amplifiers and matching transformers for TV and FM. Below is a partial list:

U/V-2 — All-channel 2-set coupler
A-104 U/V — All-channel 4-set coupler
V/U-All-2 — Indoor UHF/VHF amplifier
U/VAMP-2 — Outdoor UHF/VHF amplifier
Golden Dart — High-gain outdoor UHF antenna
Golden Arrow — Log-periodic indoor UHF antenna
A full line of solid-state UHF converters

See your dealer for further information on these products, as well as specific recommendations to meet the particular requirements of your own installation.

B) Insert the cable into the auto type plug passing the center conductor between the neoprene insert and the prod. (See Fig. 5.)

C) Slide the holding ring over the long toothed leaves of the plug and under the short leaves. Solder the toothed leaves to the copper braid. Finally cut off the neoprene insert and center conductor leaving about 1/32" extending beyond the prod. (See Fig. 5.)

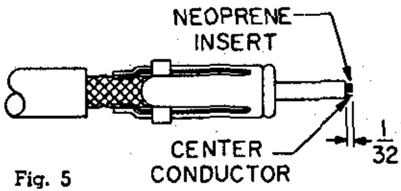


Fig. 5

See these other Blonder-Tongue products at your local dealers . . .

MT-283	Indoor/outdoor UHF/VHF/FM matching transformer. Matches 300-ohm antenna impedance to 75-ohm impedance of coaxial cable.
A-107	Indoor/outdoor UHF/VHF coupler/splitter. Use to connect separate UHF and VHF antennas to a single downlead, or to separate UHF and VHF signals for connection to separate TV set inputs.
UV-C/S	Economy version of A-107, for indoor use only.
MDC-2VU	Indoor UHF/VHF/FM 2-way splitter. 75-ohm impedance.
A-102 U/V	Indoor/outdoor UHF/VHF/FM 2-way splitter. 300 ohm impedance.

6510581☆

BLONDER-TONGUE CABLEMATCH U/V ALL-CHANNEL MATCHING TRANSFORMER

MODEL 3370

- **Designed for lowest loss on all channels 2-83 and FM (obsolescence proof)**
- **Matches 75Ω cable to 300Ω TV set, FM set or UHF converter with low VSWR.**
- **Mounts on back of TV set or converter.**
- **Insulated case and DC isolation for safety.**
- **Includes solderless plug for RG 59/U, convenient lugs on output twinlead.**
- **High unbalance rejection eliminates local pickup.**
- **Can be used with V-1P17-VU, V-2P17-VU or any other UHF/VHF tapoff.**
- **May be used in conjunction with Model A-107 splitter for sets having separate UHF/VHF input terminals.**

INSTRUCTIONS

1. Connect twinlead of Cablematch U/V to 300 ohm TV input terminals. If desired, case may be attached to back of TV set with #4 screws or a wire hook.

2. Connect solderless auto plug to cable. See inside for instructions.

3. Insert the plug into the Cablematch U/V jack to complete the installation. The plug allows simple disconnection if it is desired to move TV set.

INSTRUCTIONS FOR SOLDERLESS AUTOMOBILE TYPE PLUG

Connect RG-59/U Coaxial Cable to Solderless Automobile Type Plug as follows:

A) Refer to Figure 1 and with a B-T Model S-1 Cable Stripper cut the cable as shown and place the holding ring over the cable.

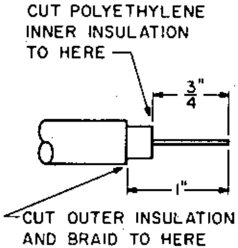


Fig. 1

B) Insert the cable into the Auto Type Plug passing the center conductor between the neoprene insert and the prod. See Figure 2.

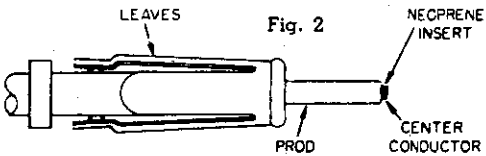


Fig. 2

C) Place the B-T Model CR-2 Crimping Pliers directly over the toothed portion of the long "leaves" (see Fig. 2) and squeeze until the teeth bite firmly into the cable insulation. Without releasing the pressure on the crimping tool, slide the holding ring over the "leaves." Remove the crimping tool and slide the holding ring over the teeth. Crimp the holding ring as shown in Fig. 3. Finally cut off the neoprene insert and center conductor leaving about 1/32" extending beyond the prod.

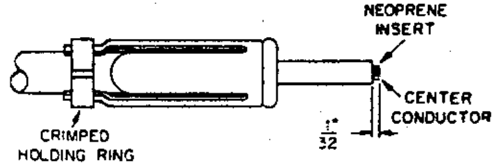


Fig. 3

D) For severe cases of local pickup the leaves of the plug should be soldered to the cable braid. (Strip cable jacket back as necessary.)

If a crimping tool is not available the solderless automobile type plug may be connected as follows:

A) Refer to Fig. 4 and with a B-T Model S-1 cable stripper cut the cable as shown and place the holding ring over the cable.

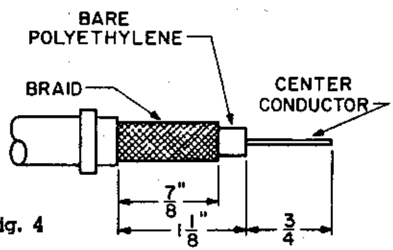


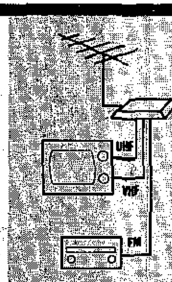
Fig. 4

MODEL UVF-C/S BLONDER-TONGUE

APPROVED FOR COLOR

UHF/VHF/FM COUPLER/SPLITTER

- Obsolescence-proof — for true UHF/VHF TV and FM reception
- Low through-loss and high isolation for superb pictures; true fidelity stereo
- Couples UHF, VHF and FM antennas to a single downlead
- Provides separate UHF, VHF and FM outputs from a single twinlead carrying all three types of signals
- Weatherproof — may be used indoors or out



MODEL UVF-C/S

is a quality UHF/VHF/FM coupler/splitter which enables connection of separate UHF, VHF and FM antennas to a single downlead, as well as the connection of a UHF/VHF TV and FM set to a single antenna cable.

ATTACHING CABLE: Slide twinlead under screws, as shown in Figure 1 (narrow, flat twinlead — not recommended — must be angled as shown), and tighten so saw-tooth washers pierce insulation, making contact with wires inside. Tubular twinlead should be trimmed as shown in Figure 2.

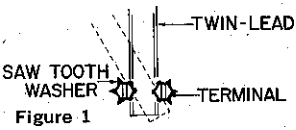


Figure 1

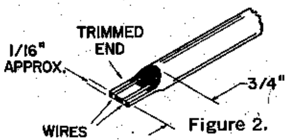


Figure 2.

TO FEED TV AND FM SETS FROM A SINGLE DOWNLEAD:

Attach cable from antenna to U/V/F ("combined") terminal. Connect cable from VHF terminal of UVF-C/S to VHF terminal of TV set, and another from UHF terminal of UVF-C/S to UHF terminal of TV set. Connect a third cable from the antenna terminal of the FM set to the FM terminal of the UVF-C/S.

TO CONNECT UHF, VHF AND FM ANTENNAS TO A SINGLE DOWNLEAD:

Connect separate cables from antennas to the UVF-C/S (connect UHF to UHF terminals, VHF to VHF, and FM to FM). Connect the single downlead to the U/V/F ("combined") terminal of the UVF-C/S.

MOUNTING: Two screws are supplied for indoor mounting. An outdoor mast-mount, the Jiffy Mount, is available from your dealer.

NOTE:

When mounting the unit outdoors, be sure that the terminals are facing **downwards**, to prevent moisture from entering the unit. Run cables as short and direct as possible.

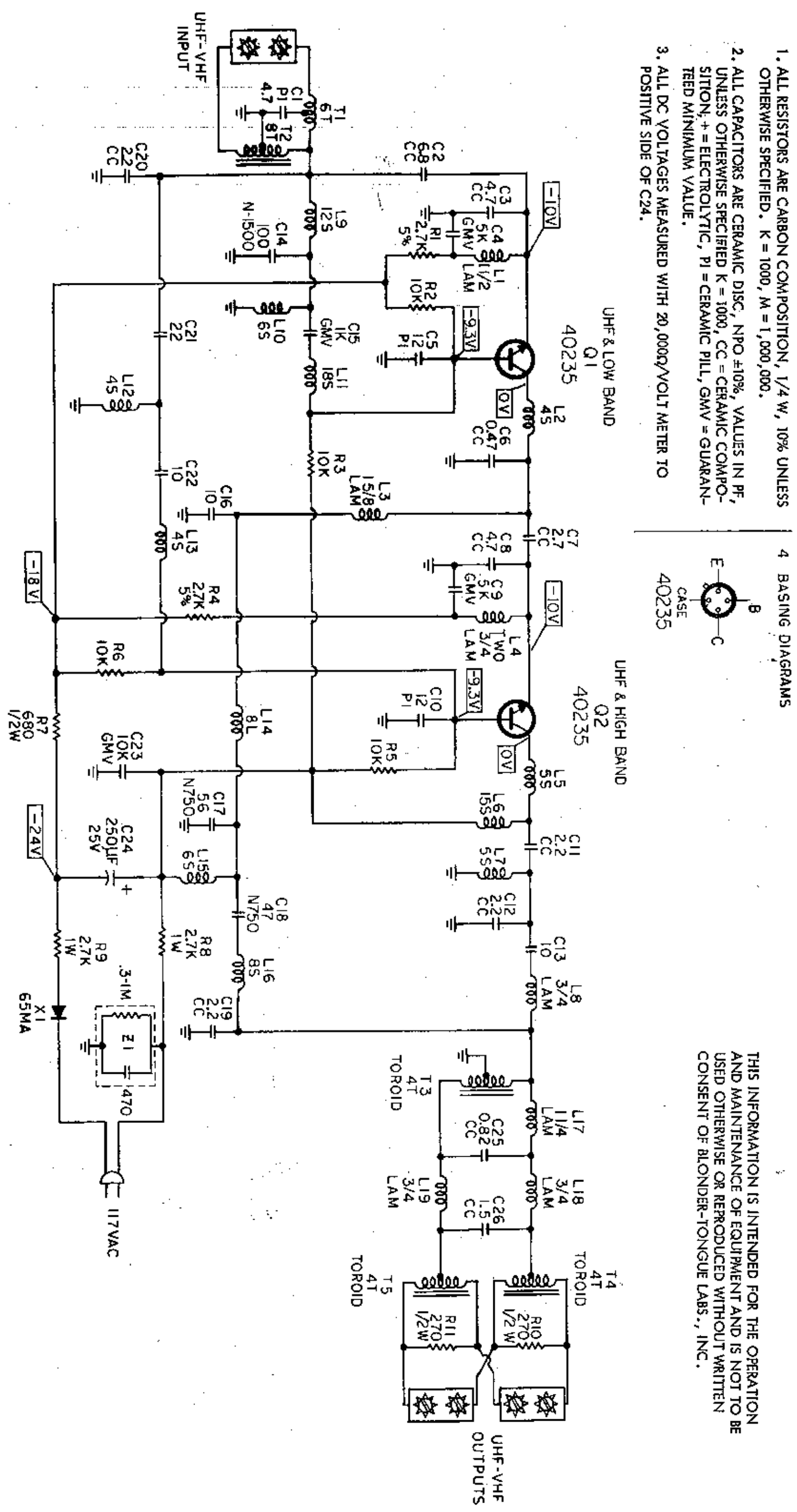
In rare cases, which can occur because of twinlead lengths employed, you may improve TV reception by changing the length of the twinlead to your FM set by approximately one to two feet.

ACCESSORIES

Blonder-Tongue manufactures a complete line of home distribution equipment, including UHF converters, antennas, signal amplifiers, multi-set couplers and matching transformers for TV and FM. Below is a partial list:

- **A-102 U/V** — All-channel TV/FM 2-set coupler
- **A-104 U/V** — All-channel TV/FM 4-set coupler
- **UV-C/S** — UHF/VHF coupler/splitter
- **V/U-All-2** — Indoor UHF/VHF amplifier
- **U/Vamp-2** — Outdoor, mast-mounted UHF/VHF amplifier
- **Golden Dart** — High-gain log-periodic outdoor UHF antenna
- **Golden Arrow** — Log-periodic indoor UHF antenna
- **A Full Line** of solid-state UHF converters

See your dealer for further information on these products, as well as specific recommendations to meet the particular requirements of your own installation.



V/U ALL-2 SCHEMATIC

ED-283 G

BLONDER - TONGUE

LABORATORIES INC., NEWARK, N. J.

TWO SET - TWO TRANSISTOR

UHF/VHF AMPLIFIER

CH 2 TO CH 83

MODEL V/UALL-2

INSTRUCTION MANUAL

DESCRIPTION

The V/U All-2 is a high quality two transistor indoor amplifier designed to improve color and black and white reception on all TV channels both VHF and UHF (channels 2-83) from a single antenna. The V/U All-2's solid state circuitry first amplifies the signal it receives from the antenna. Then, acting as a high quality two set coupler, it provides the proper impedance match and isolation to supply two TV sets.

MOUNTING AMPLIFIER

The V/U All-2 may be mounted at any convenient indoor location by means of the two wood screws provided. Connections to the amplifier are to be made before mounting (see installation section).

For best results in the UHF range, locate the amplifier where the length of the twinlead between the antenna and the amplifier is as short as possible. For long term, trouble free performance, avoid mounting the amplifier in locations where ambient temperatures may rise above 145° F. (unventilated attics sometimes reach temperatures exceeding this figure).

If mounted on the back of a TV set, avoid blocking ventilation holes.

INSTALLATION

All Channel Antennas

If an all channel (UHF/VHF) antenna is used, simply connect the antenna to the appropriate terminals on the amplifier (terminals are marked on the label). Refer to the enclosed instruction card for making connections to stripless screws.

U.S. Patent 3,016,510, Foreign Patents Applied For

6510621

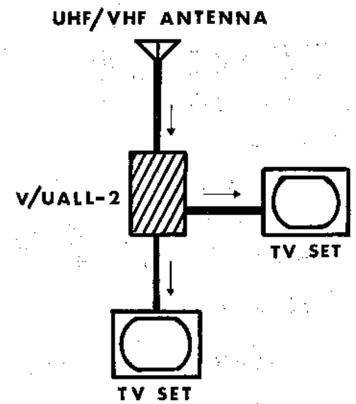


Fig. 1
Use of V/U All-2 with All Channel Antenna

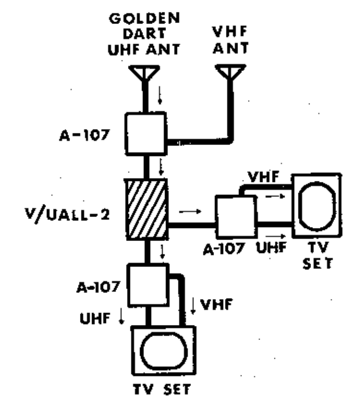


Fig. 2
Installation showing use of A-107 units to combine UHF and VHF Antennas and to split UHF and VHF signals for TV sets

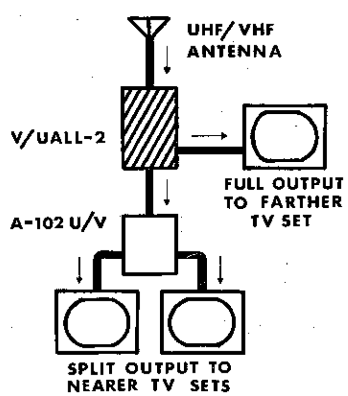


Fig. 3
Three TV Sets

Separate UHF and VHF Antennas

In strong signal areas, some types of VHF antennas may work satisfactorily in the UHF range. For optimum results however, an all channel antenna or separate UHF and VHF antennas are required. Separate antennas can be combined into a single downlead by means of a B-T Model A-107 UHF/VHF coupler.

Recommended Twinlead

For best performance at UHF, and under rain or salt spray conditions, the use of encapsulated foam twinlead (Belden #8285 or Amphenol #214-103) is recommended. Keep twinlead away from house wiring or metal and use standoffs when running twinlead outside the house. Do not run two twinleads together but keep at least 2″ separation between them. If coaxial cable connection is desired, use the MT-283 balun outdoors and the Cablematch U/V indoors.

One TV Set with separate UHF and VHF Antenna Terminals

Connect either output of the V/U All-2 to the UHF antenna terminals of the TV set or UHF converter. (Both UHF and VHF are combined in either output terminal). Connect the other amplifier output to the VHF antenna terminals. Alternatively, somewhat higher output may be obtained by combining both outputs as described in the next section and separating the UHF and VHF signals from the combined outputs by means of a B-T model A-107, or Model UV-C/S UHF/VHF Combiner/Splitter.

One TV Set with a single set of Antenna Terminals

TV sets with one set of antenna terminals can utilize the full capabilities of the V/U All-2 by connecting both outputs of the amplifier together with two 4″ lengths of twinlead. (See Figure 4). Connect the two lengths of twinlead together and place a ½″ piece of tin foil approximately 1½″ from the junction of the two 4″ lengths of twinlead and the lead to the TV set. If no signal is obtained, disconnect one of the 4″ lengths of twinlead from the V/U All-2 and reverse the connections. If full output is not needed, you may simply connect the TV set to one of the amplifier outputs and leave the other output unused.

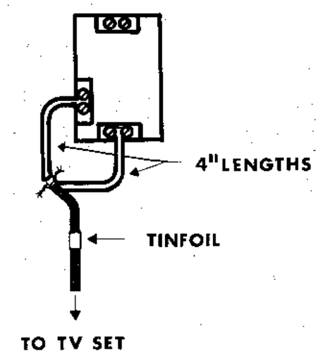


Fig. 4
Full output connection for 1 set

Two TV Sets

Connect one amplifier output to the antenna terminals of each TV set. If the TV set or UHF converter has separate UHF and VHF antenna terminals, the signals can be separated at each set by means of a B-T Model A-107, or Model UV-C/S UHF/VHF Combiner/Splitter.

More than Two TV Sets

The signals from the V/U All-2 amplifier may be coupled to additional sets by using a B-T Model A-102 U/V, or additional V/U All-2 amplifiers. (See Figure 3).

OPERATION

After installation is complete, plug in line cord to any 117V AC outlet. (This unit cannot be used on DC). The unit draws very little power (less than an electric clock) and can thus be left on continuously.

Note: When receiving very weak fringe area signals, a small improvement may sometimes be obtained by placing a small piece of tin foil on the twinlead from the antenna near the amplifier and sliding the tinfoil along the twinlead until the best picture is obtained

INTERFERENCE

On rare occasions an exceptionally strong local station may cause interference on other channels (bars moving across screen, cross hatching, etc.). This can often be cured by aiming the antenna away from the strong station. Severe cases of VHF interference can be cured with filters, such as the B-T series FR.

SERVICE

The solid state circuitry employed in this unit is designed to give you long, trouble free service. To insure your continuing satisfaction, Blonder-Tongue provides reliable, low cost, service. Should a problem arise pack the unit carefully, enclosing a slip describing the trouble and your return address, and send it prepaid to:

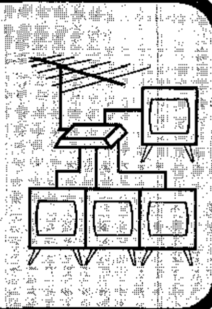
Service Department
BLONDER-TONGUE LABORATORIES
9 Alling Street
Newark, New Jersey 07102

The unit will be returned by Parcel Post, C.O.D.

MODEL
A-104 U/V
BLONDER-TONGUE
UHF/VHF/FM 4-SET COUPLER

APPROVED FOR COLOR

- Top rated . . . allows one antenna to serve four TV and/or FM sets. True all-channel TV reception
- Low through-loss and high isolation — minimizes interference between sets
- Simple to install — patented stainless steel terminals — no stripping of twin lead required
- For long life in high moisture area — stainless steel terminal teeth maintain positive electrical contact — self-sealing connection
- Wood mounting screws provided



Model A-104 U/V is an all-channel VHF/UHF/FM four-set coupler, featuring low loss and high isolation between sets. Its advanced design makes it ideal for use in color television installations.

INSTALLATION

Loosen stripless screws. Do not strip flat twin-lead; slide it under the screws and tighten so that the saw-toothed washers pierce the insulation. Excessive pressure is not required.

NOTES: Narrow twin-lead should be angled as shown by the dotted lines (Figure 1 below), to make proper electrical connection with the saw-toothed washers.
Tubular twin-lead should be trimmed for use with the stripless screws as shown in Figure 2.

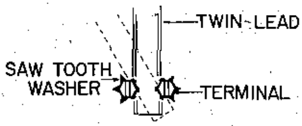


FIGURE 1

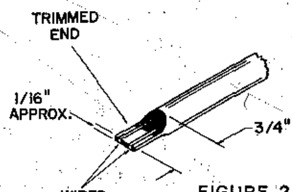


FIGURE 2

Pat. Nos. 3016510 and 2977553

Connect the lead carrying the signal to be split to the terminals marked ANT, and the leads from the sets to the terminals marked SET.

MOUNTING

The Miracle-Mount accessory (available separately) permits quick, easy, rugged mast-mounting. Two wood screws are supplied for mounting indoors.

Blonder-Tongue manufactures a complete line of home distribution equipment, including UHF converters, antennas, signal amplifiers and matching transformers for TV and FM. Below is a partial list:

- **U/V-2** — All-channel 2-set coupler
- **V/U-All-2** — Indoor UHF/VHF amplifier
- **U/VAMP-2** — Outdoor UHF/VHF amplifier
- **Golden Dart** — High-gain outdoor UHF antenna
- ***Golden Arrow*** — *Log-periodic indoor UHF antenna*
- A full line of solid-state UHF converters

See your dealer for further information on these products, as well as specific recommendations to meet the particular requirements of your own installation.

Power Feed Through: 1 amp maximum AC or DC. 250 volts maximum

Recommended Male Connector: Standard mica filled PL-259 type (see related equipment)

CONNECTIONS

To use as a splitter: connect the input cable to jack J1 and the output cables to the jacks J2 and J3. All input signals will appear at each output jack less than 4.0 db down.

To use as a combiner: Connect the two input cables to jacks J2 and J3 and take the combined signal out of the jack marked J1.

RELATED EQUIPMENT

Male plugs — use the following plugs for connecting this unit to 75 ohm coaxial cable:

P-59T for RG-59/U or RG-59/U foam cable

P-11T for RG-11/U or RG-11/U foam cable

BLONDER - TONGUE

LABORATORIES, INC., NEWARK, N. J.

Model MDC-2VU

Masterline UHF/VHF Two Way Hybrid Splitter/Mixer

The Model MDC-2VU can be used to split or combine all signals from 10 to 216mc **and** 470 to 890mc. It is thus suitable for use in all channel UHF/VHF systems and in sub-channel systems. In addition to operating as a directional coupler for VHF, UHF and sub channel signals, the MDC-2VU also passes AM radio signals and DC or AC power. It utilizes an improved UHF connector for better UHF performance.

SPECIFICATIONS

Bandpass: 10 - 216mc, 470 - 890mc

Impedance: 75 ohms, input and output

Input VSWR:

- 10 - 54mc — 1.36 max
- VHF (54 - 108mc) — 1.25 max
- VHF (174 - 216mc) — 1.30 max
- UHF (470 - 890mc) — 1.30 max

Output VSWR:

- 10 - 54mc — 2.5 max
- VHF (54 - 108mc) — 1.28 max
- VHF (174 - 216mc) — 1.4 max
- UHF (470 - 890mc) — 1.45 max

Total Loss (insertion plus splitting):

- VHF (10 - 216mc) — 3.5 db max
- UHF (470 - 890mc) — 4.0 db max
- AM radio — 4.5 db max

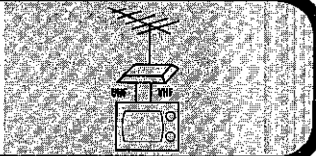
Isolation between branches:

- 10 - 54mc — 10 db minimum
- VHF (54 - 216mc) — 12 db minimum
- UHF (470 - 890mc) — 12 db minimum

MODEL UV-C/S
BLONDER-TONGUE
INDOOR UHF/VHF COUPLER/SPLITTER

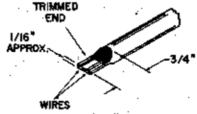
APPROVED FOR COLOR

- Low through-loss and high isolation for superb pictures
- Provides separate UHF and VHF outputs from a single twinlead carrying both types of signals



MODEL UV-C/S is a UHF/VHF coupler/splitter which enables connection of a UHF/VHF TV set with separate UHF and VHF inputs to a single antenna cable carrying UHF and VHF signals.

ATTACHING CABLE: Remove insulation from about ½" of the twinlead (tubular twinlead must be tapered first, as shown in the illustration). Insert wires under appropriate screws and fasten, making sure wires do not contact adjacent screws.



CONNECTION: Connect cable from antenna to screws marked U/V. Connect cable from UHF screws to UHF antenna terminals of TV set, and VHF screws to VHF antenna terminals.

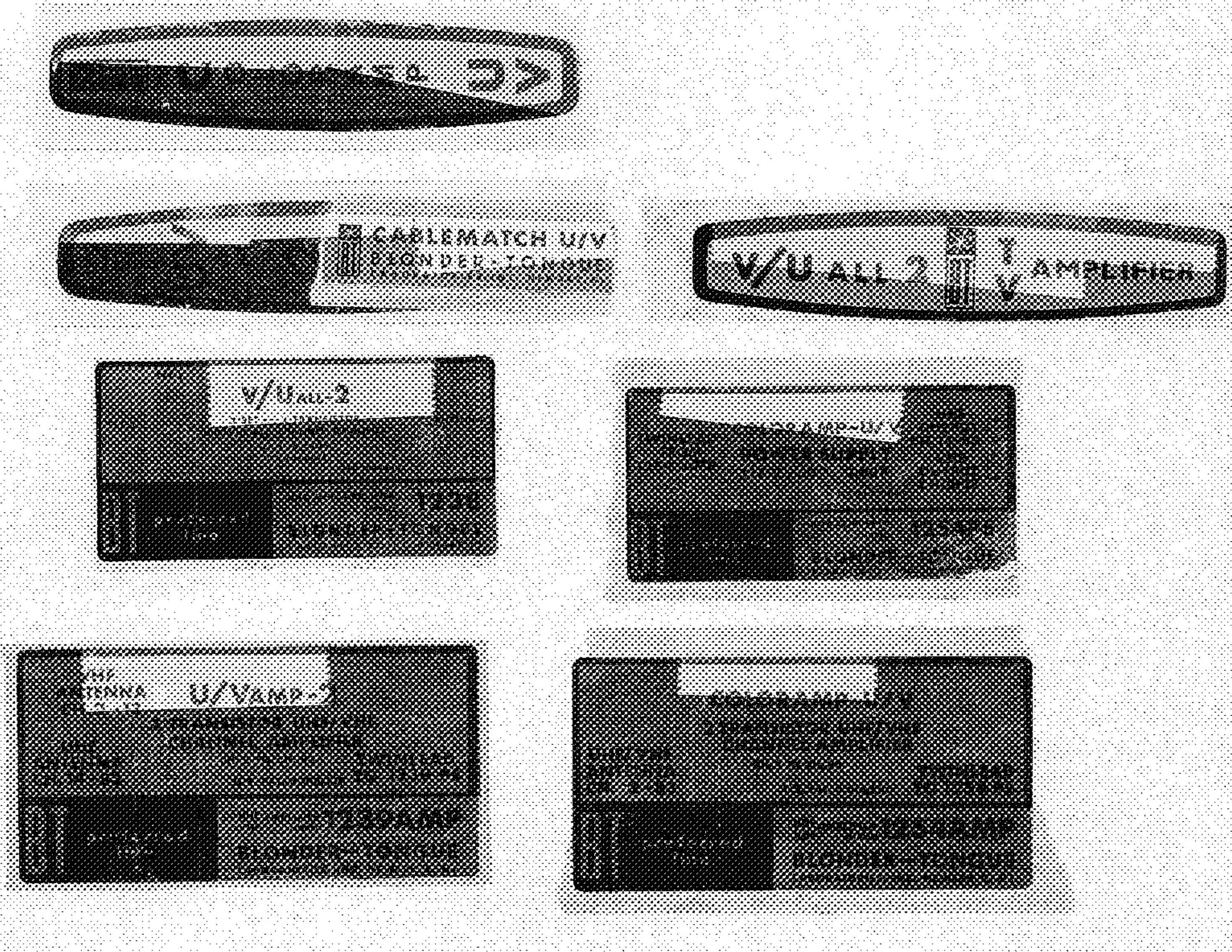
The UV-C/S can be secured to the rear of the TV set, or in any other convenient location. Keep all cables as short and direct as possible.

ACCESSORIES

Blonder-Tongue manufactures a complete line of home distribution equipment, including UHF converters, antennas, signal amplifiers, multi-set couplers and matching transformers for TV and FM. Below is a partial list:

- **A-102 U/V** — All-channel TV/FM 2-set coupler
- **A-104 U/V** — All-channel TV/FM 4-set coupler
- **UVF-C/S** — UHF/VHF/FM coupler/splitter
- **V/U-All-2** — Indoor UHF/VHF amplifier
- **U/Vamp-2** — Outdoor, mast-mounted UHF/VHF amplifier
- **Golden Dart** — High-gain log-periodic outdoor UHF antenna
- **Golden Arrow** — Log-periodic indoor UHF antenna
- **A Full Line** of solid-state UHF converters

See your dealer for further information on these products, as well as specific recommendations to meet the particular requirements of your own installation.

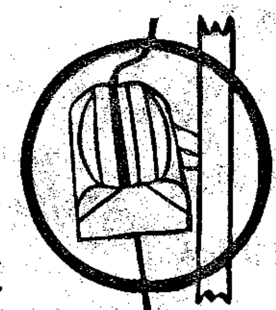

CABLEMATCH U/V
BLONDER-TONGUE
V/U ALL-2
AMPLIFIER
ANTENNA

U/VAMP-2

TWO TRANSISTOR
UHF/VHF AMPLIFIER

APPROVED FOR COLOR

- WORLD'S FIRST ALL CHANNEL HOME TV AMPLIFIER
- AMPLIFIES ALL TV CHANNELS 2 THRU 83
- WEATHERPROOF ALUMINUM CASE
- REMOTE AC CONTROLLED



BLONDER-TONGUE

® LABORATORIES, INC. NEWARK, N. J.

U/VAMP-2

TWO TRANSISTOR
UHF/VHF AMPLIFIER

® BLONDER-TONGUE LABORATORIES, INC.

V/U ALL-2

TWO TRANSISTOR

INDOOR ALL-CHANNEL AMPLIFIER

APPROVED FOR COLOR

- AMPLIFIES ALL UHF & VHF CHANNELS
- FOR ALL-CHANNEL SETS AND CONVERTERS
- LOW COST DEPENDABLE OPERATION
- BUILT IN 2-SET COUPLER

BLONDER-TONGUE

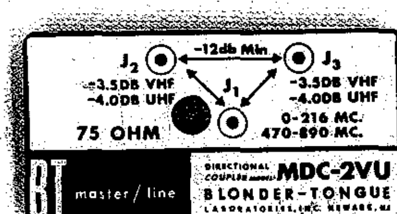
® LABORATORIES, INC. NEWARK, N.J.

V/U ALL-2

TWO TRANSISTOR

INDOOR ALL-CHANNEL AMPLIFIER

BLONDER-TONGUE LABORATORIES, INC.



LAW OFFICES

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RONALD L. WANKE

TELEPHONE
FINANCIAL 6-1630
AREA CODE 312

JOHN REX ALLEN
1945-1969

June 7, 1972

File
BT v Unnd Del

RECEIVED
JUN 9 1972
RINES AND RINES
NO. TEN POST OFFICE SQUARE, BOSTON

Mr. Robert H. Rines
Rines and Rines
No. Ten Post Office Square
Boston, Massachusetts 02109

Dear Bob:

There was a Technograph class action pending before Judge Will in the Northern District of Illinois in which a motion was made by defendants setting up an estoppel plea based on Blonder-Tongue. Judge Will has just granted this motion. I enclose a copy of his memorandum decision. *

Very truly yours,

Dick

Richard S. Phillips

RSP:iag

* Enclosure

UNITED STATES DISTRICT COURT, NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

Name of Presiding Judge, Honorable HUBERT L. WILL

Cause No. 63 C 142 Date May 31, 1972

Title of Cause Technograph Printed Circuits, Ltd et al

vs

Brief Statement of Motion Cvonsme, Incorp.

The rules of this court require counsel to furnish the names of all parties entitled to notice of the entry of an order and the names and addresses of their attorneys. Please do this immediately below (separate lists may be appended).

Names and Addresses of moving counsel

Representing

Names and Addresses of other counsel entitled to notice and names of parties they represent.

Reserve space below for notations by minute clerk

Will, J.

Pursuant to Court's memorandum opinion this day filed, order defendant's motion to dismiss cause is granted. Order cause dismissed with prejudice and without costs.

Hand this memorandum to the Clerk.
Counsel will not rise to address the Court until motion has been called.

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

FILED

MAY 31 1972

H. STUART CUNNINGHAM
At.................. o'clock..............
CLERK

TECHNOGRAPH PRINTED CIRCUITS, LTD., and TECHNOGRAPH, INC. (Formerly Technograph Printed Electronics, Incorporated), Plaintiffs,

vs.

METHODE ELECTRONICS, INC., Defendant.

Civil Action No. 62 C 1761

TECHNOGRAPH PRINTED CIRCUITS, LTD., and TECHNOGRAPH, INC. (Formerly Technograph Printed Electronics, Incorporated), Plaintiffs,

vs.

AUTOMATIC ELECTRIC COMPANY, Defendant.

Civil Action No. 63 C 36

TECHNOGRAPH PRINTED CIRCUITS, LTD., and TECHNOGRAPH, INC. (Formerly Technograph Printed Electronics, Incorporated), Plaintiffs,

vs.

WEBCOR ELECTRONICS, INCORPORATED, Defendant.

Civil Action No. 63 C 111

TECHNOGRAPH PRINTED CIRCUITS, LTD., and TECHNOGRAPH, INC. (Formerly Technograph Printed Electronics, Incorporated), Plaintiffs,

vs.

CRONAME, INCORPORATED, Defendant.

Civil Action No. 63 C 142

MEMORANDUM OPINION

Each of these four actions was filed by the plaintiff against a defendant having a regular and established place of business in the Northern District of Illinois. They all involve one or more of United States Patents Nos. 2,441,960, issued May 25, 1948; 2,706,697, issued April 15, 1966 and Reissue Patent No. 24,165, reissued June 12, 1956. All of the patents relate to methods for the manufacture of printed electric or magnetic circuits. Such circuits are widely used in manufacturing electric and electronic devices.

A complete history of these patents from the initial filing of the original application on February 3, 1944 is set out both in Technograph Printed Circuits, Ltd., et al. v. Bendix Aviation Corp., 218 F.Supp 1 (D.Md. 1963), aff'd 327 F.2d 497 (4th Cir. 1964), cert. den. 379 U.S. 826 (1964), and Technograph Printed Circuits, Ltd. v. United States, 177 Ct.Cl. 919, 370 F.2d 571 (1966). Accordingly, we will not repeat it here.

On December 30, 1964, Judge Igoe of this Court granted defendants' motions for summary judgment which action was reversed by the Court of Appeals for the Seventh Circuit, 356 F.2d 442 (7 Cir. 1966), cert. den. 384 U.S. 950, 1002 (1966). Subsequently, the cases were consolidated for purposes both of discovery and trial and declared to be class actions so far as the defendants were concerned, the defendant class being defined to include all manufacturers of printed circuits.

The consolidated class action was tried to the Court without a jury and a post-trial briefing schedule established. Before a final argument was heard, the United States Supreme Court, on its own motion, instructed the parties in Blonder-Tongue v. University Foundation, then pending before the Court, to include and brief the question of whether Triplett v. Lowell, 297 U.S. 638 (1936) should be reexamined. On May 3, 1971, the Supreme Court entered its opinion in Blonder-Tongue, 402 U.S. 313 (1971), holding that, while a final determination of patent invalidity in a prior suit did not automatically estop the patent holder from bringing a second action against a different alleged infringer, "the court in the second litigation must decide in a principled way whether or not it is just and equitable to allow the plea of estoppel in the case before it." (402 U.S. at 334)

Thereupon, the defendants moved to dismiss these four suits on the ground that the earlier decision of the United States District Court for the District of Maryland in Technograph Printed Circuits, Ltd., et al. v. Bendix Aviation Corp., supra, which had been affirmed by the Court of Appeals for the Fourth Circuit and certiorari denied by the Supreme Court and in which the patents here involved had been found invalid constituted a bar to these actions under the doctrine of collateral estoppel as enunciated in Blonder-Tongue. At about the same time, similar motions were made in four actions then pending in the Maryland District Court which had been brought by Technograph against Martin-Marietta Corp., Westinghouse Electric Corporation, International Telephone and Telegraph Corp. and McDonnell Aircraft Corp., respectively, all of whom had opted out of the defendant class in the consolidated action in this Court.

In a careful and comprehensive analysis of Blonder-Tongue, his earlier ruling in the Bendix case, and the application of both to the four cases before him, Judge Watkins has concluded that those cases must be dismissed. His opinion finds that Technograph had a "full and fair" opportunity to establish the validity of its patents in the Bendix suit and that "it is just and equitable to allow the plea of estoppel" in the four cases before him. We agree.

Technograph, in addition to the urging that the courts in Bendix "wholly failed to grasp the technical subject matter and issues in suit," a contention which Judge Watkins' opinions fully refute, also urges that (1) since it spent a great deal of time, energy and money in pursuing the cases before this Court in reliance on Triplett and the Seventh Circuit Court of Appeals' reversal of Judge Igoe's grant of summary judgment in which that Court held, applying Triplett, that the Bendix decision was no bar, and (2) since the defendants did not urge that the Bendix decision was res judicata but conceded before the Court of Appeals that it was not, it would be inequitable and unjust to apply the Blonder-Tongue modification of Triplett in the instant case.

It certainly is true that much time, money and energy have been expended on these cases and that everybody involved, counsel and judges alike, with the exception of Judge Igoe, accepted Triplett as permitting unlimited relitigation of the validity of a patent found invalid in a prior trial or trials so long as putative infringers could be found. Blonder-Tongue, however, does not suggest that its application involves any such considerations. All those same factors were there present, in fact, the issue of collateral estoppel was raised by the Court and not by the defense who, as here, were apparently content to go on litigating indefinitely over the validity of a patent no matter how frequently it had been found invalid. These factors were apparently not persuasive to the Supreme Court. We are not persuaded either.

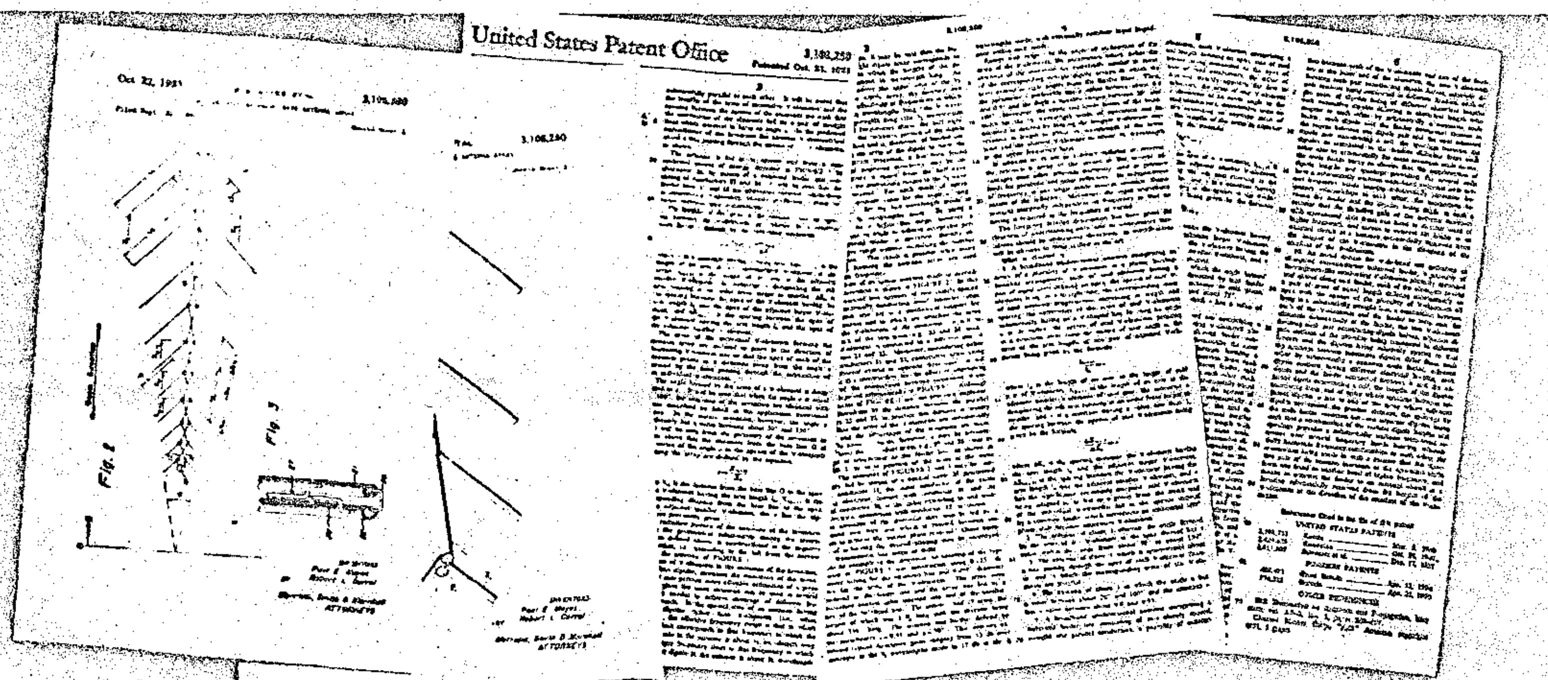
What the Court in Blonder-Tongue enunciated as the criterion to be applied is "whether a patentee has had a full and fair chance to litigate the validity of his patent in an earlier case." It then went on to discuss various factors which would be relevant to such a determination. Judge Watkins' opinion examines each of these factors and others and concludes that Technograph has indeed had its day, or, more accurately, weeks in court during which it had a full and fair chance to establish the validity of its patents and failed to do so.

The pleas of estoppel under the principles enunciated in Blonder-Tongue are, therefore, sustained and the consolidated cases dismissed. An appropriate order will enter.

United States District Judge

Dated: May 31, 1972

UNIVERSITY OF ILLINOIS MAYES- CARRELL PATENT ON LOG-


United States Patent Office

...G PERIODIC BACKWARD WAVE ANTENNA ARRAY U.S. PAT. 3,108,280 OF PAUL E. MAYES AND ROBERT L. CARRELL ...SIGNORS TO THE UNIVERSITY OF ILLINOIS FOUNDATION

U.S. PATENT DISCLOSES THAT NEW LOG-PERIODIC

(Col. 1, lines 10-12 of Log-Periodic Patent)

Has Unidirectional radiation patterns that are essentially independent of frequency over wide bandwidths."

(Col. 2, lines 62-66 of Log Periodic Patent)

"increases directivity*** permits more effective utilization of antenna since the same structure can be used in several frequency modes to achieve coverage of different frequency bands."

(Col. 3, lines 73-75; Col. 4, lines 1 and 2)

"This antenna exhibited typical directivity gains ranging from 12 db over isotropic in the 3/2 wavelength mode to 17 db in the 7/2 wavelength mode with essentially constant input impedance within each mode."

(Col. 4, lines 21 and 22)

"Moreover, the input impedance remains essentially independent of frequency."

(Col. 4, lines 40-43) "****given by the formula $\frac{L_{(n+1)}}{L_n} = \tau$

ONLY THE JFD LOG PERIODIC LPV OPERATES ACCORDING TO THE PATENTED LOG PERIODIC CELLULAR FORMULA $\frac{L_{(n+1)}}{L_n} = \tau$ TO PROVIDE FLAWLESS COLOR BLACK AND WHITE TV, & FM STEREO

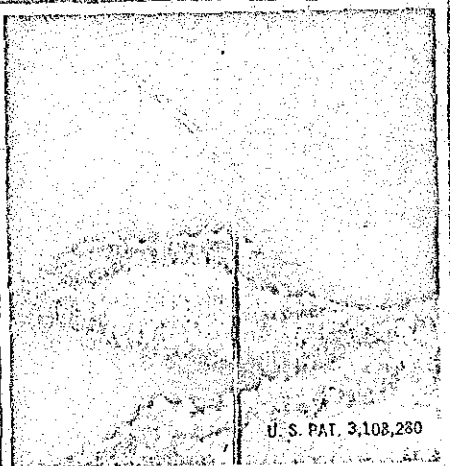
MODEL LPV ... | MODEL LPV8 | MODEL LPV6 | MODEL LPV ... UP TO 50 MILE RANGE

12

DEFENDANT'S EXHIBIT BU-A

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO. 3433A
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

FOUNDATION AWARDED PERIODIC V-ANTENNA—JFD LPV



FOR THE RECORD

[illegible]

U.S. DEPARTMENT OF COMMERCE
PATENT OFFICE
WASHINGTON

Paper No. 9

[illegible]

Applicant:	Harry Greenberg
Ser. No.	63,[illegible]
Filed	October 19, 1960
For	DUAL BAND TELEVISION ANTENNA

MAILED [illegible] 1962 DIV. 65

Please find below a communication from the EXAMINER in charge of this application.
Commissioner of Patents.

Responsive to amendments filed January 2, 1962 and September 12, 1962.

References made of record:

Kandoian 2,429,629 Oct. 28, 1947 [illegible]

IRE Transactions on Antennas and Propagation by D. E. Isbell May 1960 Vol. Ap-8 No. 3 pages 260-267 Copy in Scientific Library

Claims 2, 6, 7, 11-18, 20 and 2[illegible] are rejected as substantially met by the Isbell log periodic antenna shown in Fig. 3 of the above cited IRE article. Fig. 3 shows a coplanar array of dipoles of decreasing length in a direction towards the feed with a transposition harness interconnecting the dipoles. The proportional energy radiation away from the feed vertex is described on the top of page 3 of the reference and this action is considered the equivalent of the proportional energy feature stressed in the claims. Regarding claim 11, the limitation "substantially equally spaced" is too vague to set [illegible] invention over the Isbell antenna.

Claims 23-27 are rejected as unpatentable over the Isbell [illegible] of Fig. 3 [illegible]

Claims 2, 6, 7, 11-18, 20, and 23-27 are rejected.

Examiner

DO NOT BE MISLED BY LOG-PERIODIC IMITATIONS OR MISLEADING PATENT CLAIMS

Professor Paul Mayes of the Antenna Research Laboratories of the University of Illinois, originator of the log-periodic V-dipole antenna concept.

THERE IS ONLY ONE GENUINE PATENTED LOG-PERIODIC V-ANTENNA—THE JFD LPV!

JFD LPV

Only JFD is licensed exclusively by the University of Illinois Foundation to make the patented Log-Periodic LPV and all other Log-Periodic type TV and FM antennas. No other so-called Log-Periodic antenna can work like the **JFD** Log-Periodic LPV because **only JFD** uses the original **patented** Log-Periodic design [illegible] of the *Antenna Research* Laboratories of the University of Illinois. Rely on the JFD LPV and see why At the Moment of Truth, The Picture is the Proof—that the LPV works **best!** Now in stock at your JFD distributor.

JFD will be glad to send you a copy of the official Log-Periodic Antenna U.S. Patent for [illegible] study and comparison.

JFD

JFD ELECTRONICS CORPORATION
15th Avenue at 62nd Street, Brooklyn, N. Y. [illegible]
JFD Electronics Southern Inc. [illegible]
JFD International, 64-14 Woodside Ave., Woodside [illegible]
JFD Canada, Ltd., 51 McCormack Street, Toronto, Ontario, Canada
401 144 W. Hastings Street, Vancouver, B.C.

LICENSED UNDER ONE OR MORE OF U.S. PATENTS 2,958,081 2,985,879 3,011,168 3,108,280 AND ADDITIONAL [illegible] ELECTRONICS CORPORATION UNDER EXCLUSIVE LICENSE FROM THE UNIVERSITY OF ILLINOIS FOUNDATION

(13)

Swearing back of Isbell

Q Do you remember the circumstances under which that affidavit was brought to you for signature?

A What do you mean by circumstances?

Q The reason for an affidavit having been prepared for your signature.

A This was done during the course of pursuing the application for this patent during the course of that action before the patent office, and there were any number of times when amendments or other types of documents were prepared at the request of the patent attorneys in pursuit of this application.

Q Do you remember that this affidavit was prepared for the purpose of establishing that the V-dipole invention of the particular Mayes, et al. application was made by a certain date or by some date in 1959?

A I didn't remember that until I just this moment read the affidavit.

Q That was one of the objectives of the affidavit?

A Yes.

Q Were you aware at the time the affidavit was prepared or presented to you for signature that the purpose of it was to show that the V-dipole invention of the application was made prior to the May, 1960 date of the Isbell article in Plaintiff's Exhibit 25?

Go to next page

A I think that's apparent from reading the affidavit.
Q And it is also apparent from the reading of the affidavit, is it not, that that was done by attaching to the affidavit and referring in the affidavit to a quarterly engineering report bearing a date 31-12-59, and purporting to cover work during the period from 1-9-59 to1-12-59?
A Yes.
Q And does not that attached report disclose the V-dipole invention of this Mayes and Carrol application we have been discussing?
A Yes.
Q Isn't it also the case, as I recall your prior testimony, that you and Mr. Carrol actually made the V-dipole development considerably prior to the period covered by that report, namely about June of 1959?
A That's correct.
Q And that you had actually made a model of the V-dipole antenna by June 23, 1959 as indicated by the invention record, Plaintiff's Exhibit 14? Perhaps that question had better be reread.
(Question read by the reporter.)
A Yes.
Q Do you know why the quarterly engineering report dated

31-12-59 was used to show that this invention anti-dated the Isbell IEE transactions article rather than someother material of an earlier date of invention?

A No.

Q At the time you made the affidavit on January 4, 1963, you were aware, of course, that the invention or subject matter of the Isbell 767 Patent involving log periodic dipole arrays had been the subject of applications considerably earlier than 31-12-59 as shown in Quarterly Engineering Report #2, plaintiff's Exhibit 4, and Antenna Laboratory Technical Report #39, plaintiff's Exhibit 17, copies of which I show you?

MR. MANN: Is that a question?

MR. PEARNE: Yes.

MR. MANN: May I hear it?

(Question read by the reporter.)

MR. PEARNE: Is that correct?

A Yes, sir.

Q And just as a comment on the record, I would like to note it has been stipulated that a copy of the latter of those two reports, Technical Report #39, Plaintiff's Exhibit 17, had actually been deposited in the Library of Congress on September 21, 1959.

Dr. Mayes, diverging now for a moment, are you generally aware of the requirement for patentability of an invention in the United States that the application for the patent must be filed within one year of the date of first public use of the subject matter of the application?

MR. MANN: I'll permit an answer to that question but if this line of inquiry continues, I'll object to the whole line.

A Yes. Let me qualify that. You said public use. I am familiar with the requirement that the application must be made within one year of date of publication; I am not sure about the use of the term "public use."

MR. PEARNE: All right, that answer is satisfactory.

Do you know the date on which your application of the Mayes, et al application, serial #59671, on which the original Mayes, et al V-dipole patent was based, was filed in the patent office?

A It's a matter of record; I don't remember it.

Q As indicated by a copy of the patent, I believe that date was September 30, 1960, is that correct?

A That's correct.

Q Then isn't it also correct that the subject matter disclosed in the IRE transactions article of Isbell, Plaintiff's Exhibit 35, was published in Technical Report #2, Plaintiff's Exhibit 4, and Technical Report #39, Plaintiff's Exhibit 17, more than a year prior to that filing date of September 30, 1960?

A Yes.

Q And that affidavit that we have been discussing appears to have been filed inthe patent office to show that Mayes and Carrel made the V-dipole invention prior to the May, 1960 date of that publication, of that Isbell IRE transactions publication, isn't that correct?

A Would you restate the question?

(Question read by the reporter.)

A Yes.

Q Is there anything in the affidavit that discloses that the same material of that Isbell May, 1960 article was published well more than a year prior to your own filing date and well more than a year prior to the publication of the article that the affidavit was filed to overcome?

MR. MANN: I object to the question. I think the contents of the affidavit are self evident and you seem to be implying a need which was not satisfied by the affidavit, which in my opinion was nonexistent.

Sept. 18, 1934. P. S. CARTER 1,974,387

ANTENNA

Filed June 11, 1930 4 Sheets-Sheet 1

Fig. 1a

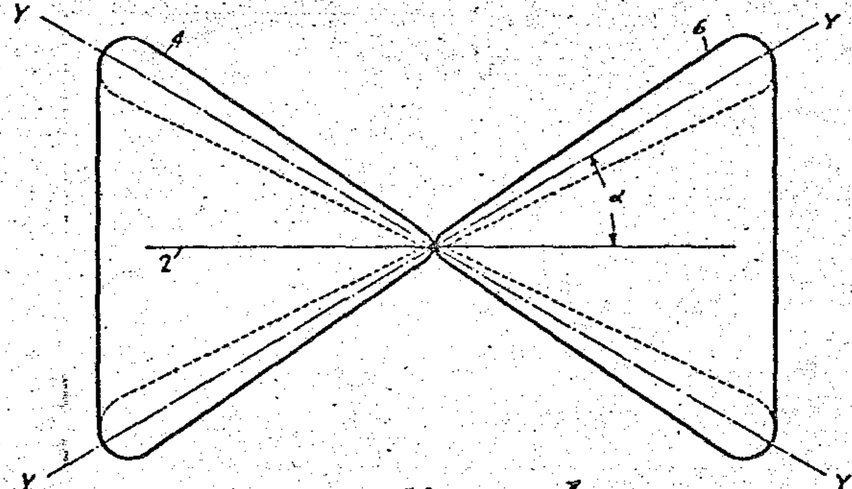


Fig. 1b

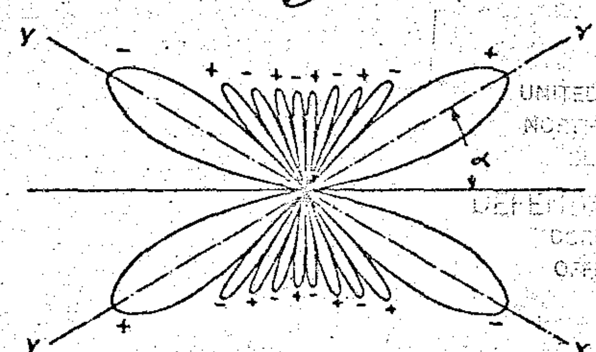


Fig. 2b

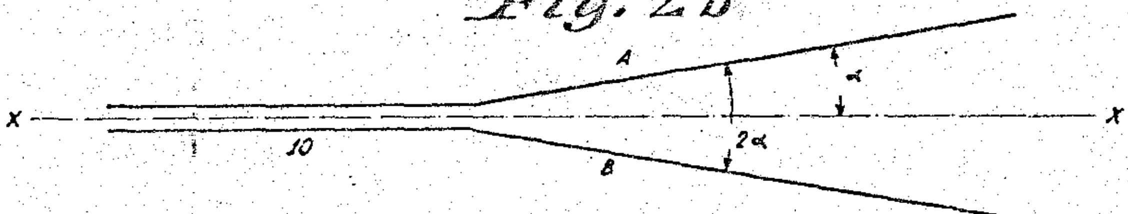


Fig. 2a

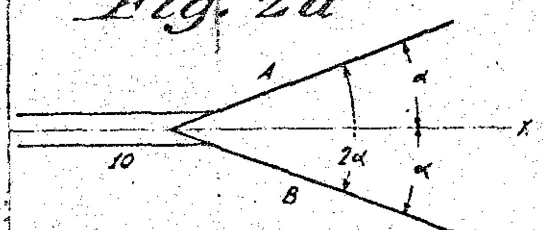
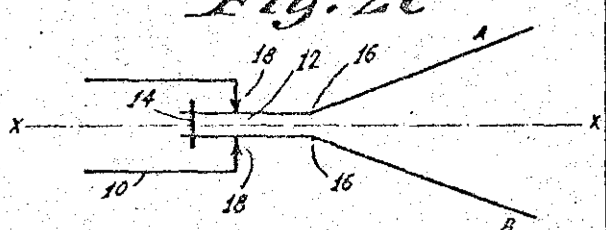


Fig. 2c



INVENTOR
P.S. CARTER
BY H. G. Grover

Sept. 18, 1934. P. S. CARTER 1,974,387

ANTENNA

Filed June 11, 1930 4 Sheets-Sheet 2

Fig. 3

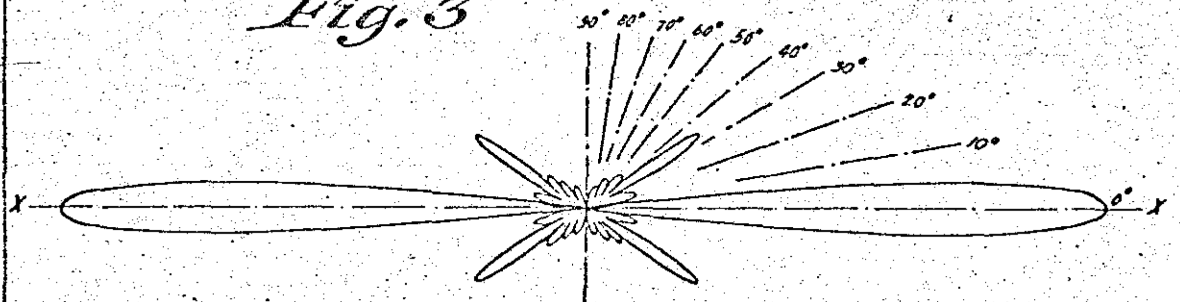


Fig. 4

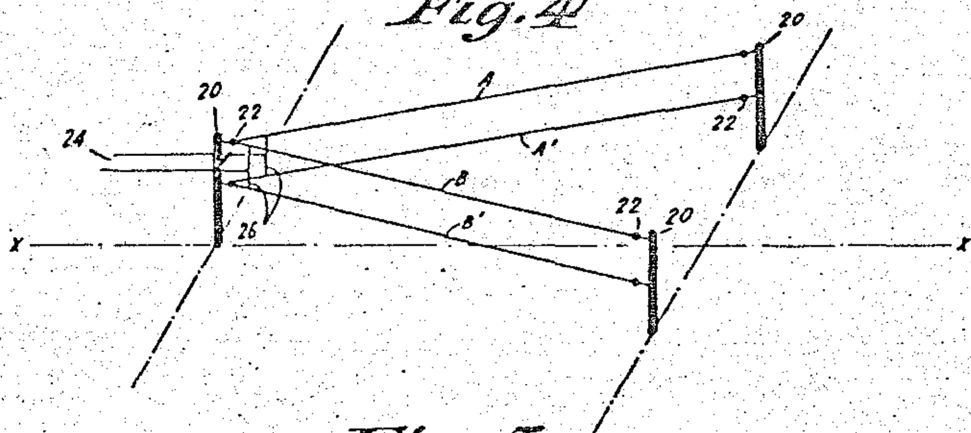


Fig. 5

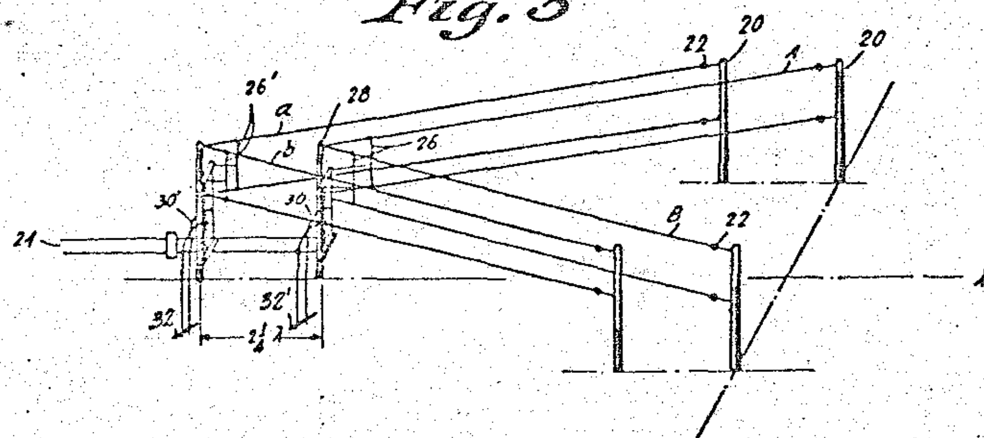


Fig. 7

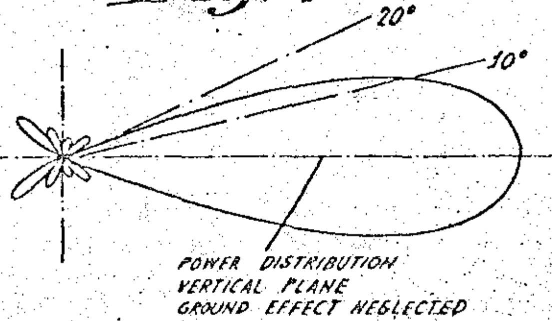
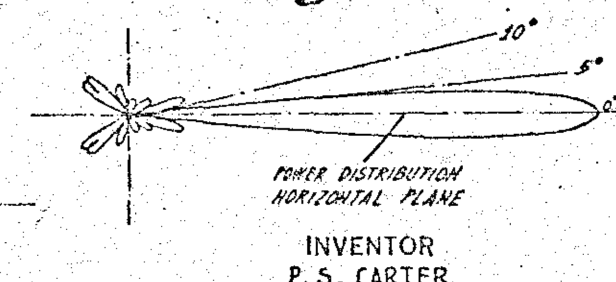


Fig. 6



INVENTOR
P. S. CARTER
BY [signature]
ATTORNEY

Sept. 18, 1934. P. S. CARTER 1,974,387

ANTENNA

Filed June 11, 1930 4 Sheets-Sheet 3

Fig. 8

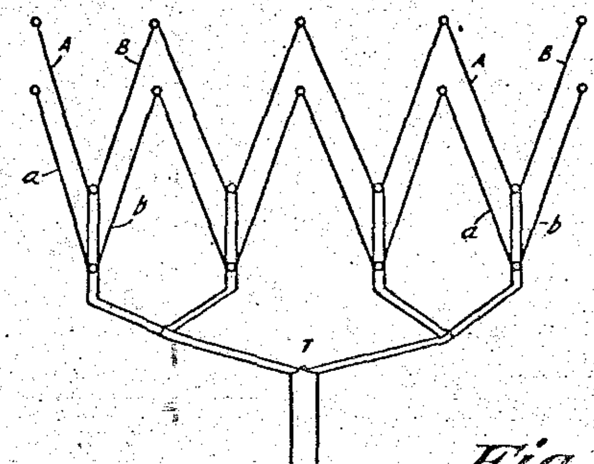


Fig. 10

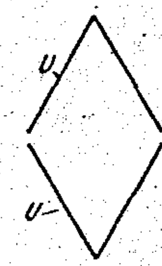


Fig. 10a

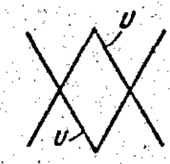
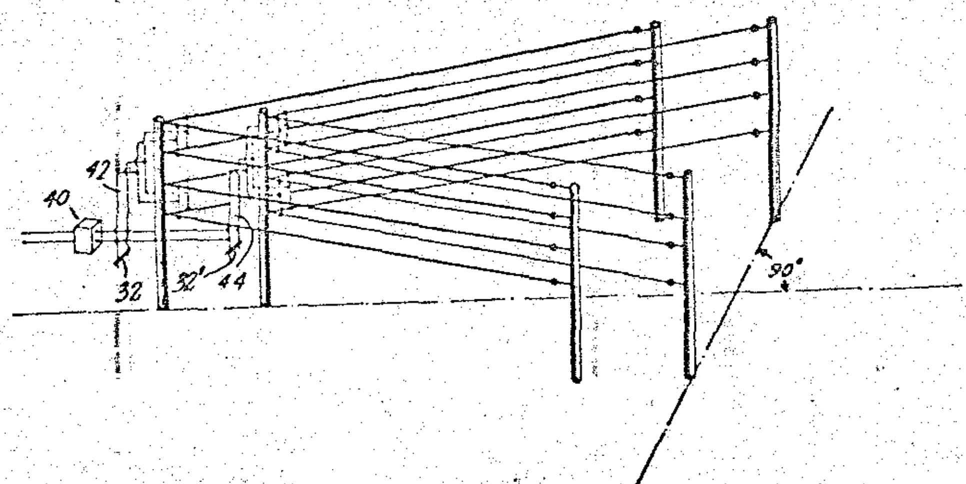


Fig. 9

Fig. 11



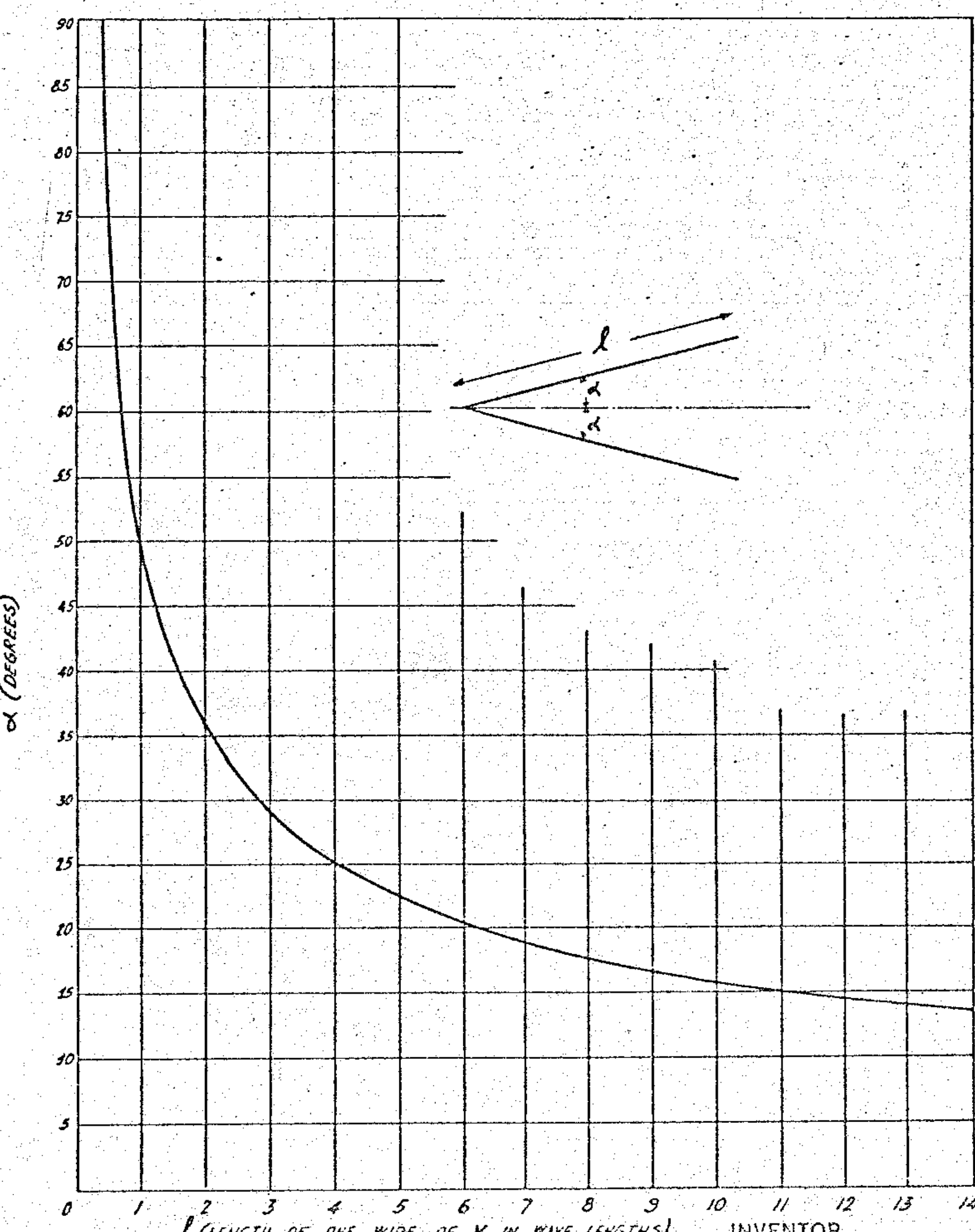
INVENTOR
P. S. CARTER
BY H. G. Grover
ATTORNEY

Sept. 18, 1934. P. S. CARTER 1,974,387

ANTENNA

Filed June 11, 1930 4 Sheets-Sheet 4

Fig. 12



INVENTOR
P. S. CARTER
BY H. G. Grover
ATTORNEY

Patented Sept. 18, 1934

1,974,387

UNITED STATES PATENT OFFICE

1,974,387

ANTENNA

Philip Staats Carter, Port Jefferson, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application June 11, 1930, Serial No. 460,467

41 Claims. (Cl. 250—33)

This invention relates to directive antenna systems, and has for its primary object to provide a simplified and highly efficient antenna system utilizing standing wave phenomena.

It is known that when a wire having a length greater than the operating wave length is excited in such manner that standing waves are produced thereon, radiation will occur principally in the direction of symmetrical cones having their apices at the center of the wire. Such is the case with a wire having a length equal to a plurality of one-half wave lengths at the operating frequency. The radiation pattern produced in such instance appears, in cross section, in the form of symmetrical cones about the wire. The present invention, which makes use of these phenomena, in its most simple aspect employs a pair of open-ended wires energized in phase opposition to have standing waves throughout the length of the wires, the wires having such angular relation with respect to each other as to obtain a highly directional, efficient and simple antenna system. It is proposed to place these wires at an angle with respect to each other so that principal radiation takes place along the bisector of the angle. This angle, in general, corresponds to the angle of the principal cone of radiation of one of the conductors.

Another object of the invention is to disclose the angle for the best directional propagation for open-ended wires of any finite length, preferably longer than the operating wave length, having standing waves thereon and arranged in the manner proposed.

Since a pair of wires of the type above described having standing waves of opposite and instantaneous polarity thereon which are angularly disposed with respect to each other, radiate equally well in two directions, i. e., towards the diverging ends of the wires and towards the converging ends of the wires, such an arrangement is bidirectional.

A further object of the present invention therefore is to provide a unidirectional arrangement. This may preferably be accomplished by placing a similar parallel pair of wires an odd number of quarter wave lengths away from the wires forming the antenna proper in a direction taken along the bisector of the angle formed by the wires. The second pair of wires may be left unenergized or floating, or they may be energized in proper phase such that for one direction radiation cancellation occurs, whereas in the other direction there is a strengthening of propagated electromagnetic waves.

A still further object is to concentrate the beam in planes transverse to the plane of the wires. These transverse planes usually include the vertical plane, since the wires are ordinarily disposed in horizontal planes. This may be effected by placing similar arrangements of wires above or below a given arrangement of wires. To increase horizontal directivity, the arrangements of wires may be duplicated side by side.

Other objects and features will appear in the subsequent detailed description referring to the various embodiments of the invention disclosed in the accompanying drawings.

Figure 1*a* illustrates, generally, the principal conical radiational characteristic of a long conductor upon which standing waves are produced,

Figure 1*b* illustrates in cross section, the radiation characteristic of a wire five wave lengths long,

Figures 2*a*, 2*b* and 2*c* indicate various forms of the fundamental unit of the present invention wherein long linear conductors having standing waves thereon are disposed at an angle such that principal radiation occurs along the direction of the bisector of the angle,

Figure 3 indicates the bidirectional characteristic of one of the units shown in any of the Figures 2*a*, 2*b*, or 2*c*,

Figure 4 illustrates an antenna system for concentrating the directional beam radiated from one of the units shown in Figures 2*a*, 2*b*, and 2*c*,

Figure 5 illustrates the arrangement of a plurality of units such as shown in Figure 2 for obtaining unidirectional propagation,

Figures 6 and 7 illustrate, respectively, the power distribution in the horizontal and vertical planes from one antenna system of particular dimensions of the type shown in Figure 5,

Figure 8 illustrates a broadside arrangement of unidirectional units for further increasing the directivity of a propagated beam of electromagnetic waves,

Figure 9 indicates schematically in plan view, an end-on or in line arrangement of units for increasing the directivity of a beam of waves,

Figures 10 and 10*a* indicate diamond shaped arrangements of units for obtaining unidirectional propagation,

Figure 11 illustrates a preferred form of the invention for concentrating a unidirectional beam of energy horizontally and vertically, when the length of wires is of the order of 6 to 12 wave lengths, and,

Figure 12 is a graph showing the relationship between the length of one of a pair of conductors and half the angle between them for obtaining maximum radiation along the bisector of said angle. As indicated by the sketch of the antenna system in the upper right hand corner of this figure, this relationship holds most strictly when the wires are of equal length.

In general, as shown in Figure 1*a*, there are two principal hollow cones 4, 6 of radiation about a wire such as indicated by the reference character 2, which is long relative to the working wave length. The cones are symmetrical about the wire 2, and the axis of the cones coincides with that of the radiator 2. For a given length of wire measured in wavelengths, the angle α between the axes Y—Y, of each lobe or ear of the cone which appears as such in cross section, and the wire 2 is constant.

More specifically, a cross section of the solid polar diagram of the radiation from a wire, which wire is a number of wave lengths long and has standing waves thereon, contains as many ears per quadrant as there are wave lengths in the wire. Thus, as shown in Figure 1*b*, there are five ears in each quadrant for a wire five wave lengths long, the principal ears or lobes of radiation occurring along the axes Y—Y. As indicated, the instantaneous directions of the field represented by adjacent ears are reversed.

Now, if it is desired to radiate energy principally in the direction of axis X—X of Figures 2*a*, 2*b*, and 2*c*, the conductors, shown in Figure 1, should be turned an angle α relative to the direction X—X; and, in order to increase still further the directional characteristic along the axis X—X, according to the present invention, two wires are used each of which makes an angle α with the axis X—X on opposite sides of the axis in a fashion such that the axis and the pair of wires lie in a single plane. In directions other than along the axis X—X, addition of radiation from the two wires is imperfect, and at certain angles radiation cancellation will occur. Consequently, a pair of wires disposed at the angle α with respect to the X—X axis will have a radiation characteristic in the plane of the pair of wires of the general type shown in Figure 3.

By considering a long wire the equivalent of a very large number of very short, (Hertz) oscillators and by adding up the field components at any point P having a direction angle θ relative to the axis of the wire, where the point P is a great distance from the wire as compared to the length of the wire such that all lines from point P to any point on the wire are essentially parallel, it can be shown that the field strength H is given by the following proportionality for a conductor an odd number of half wave lengths long:

$$H \propto \frac{\cos\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

The letter "*n*" indicates the number of half wave lengths contained in the wire.

For a wire an even number of half wave lengths long, in similar fashion, the field strength "H" is given by the following proportionality:

$$H \propto \frac{\sin\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

Where n as above indicates the number of half wave lengths on the wire.

The value for which the angle θ in either of the above equations makes the expression a maximum value gives the value for the angle α at which each wire of the V should be disposed relative to the direction X—X of desired wave propagation. Obviously the critical value of θ for either of the above equations may readily be determined; its value for wires up to fourteen wave lengths long is given graphically in Figure 12. For practical purposes the empirical formula

$$\alpha = 50.9\left(\frac{l}{\lambda}\right)^{-0.513} \text{degrees}$$

is sufficiently accurate where l equals the length of the wire and λ the wave length, both in the same units of measurement. Where a pair of wires of substantially equal length are used to form the V antenna of the present invention, they should be spaced apart at an angle substantially equal to twice the angle α as determined in any of the ways described above.

In order to obtain a bidirectional unit having a characteristic such as shown in Figure 3, as already indicated, any of the arrangements shown in Figures 2*a*, 2*b*, or 2*c* may be utilized. The fundamental unit is shown in Figure 2*a* where a transmission line 10 supplies high frequency energy to a pair of wires A, B forming the angle 2α with each other. The angle α is the angle made by one of the conductors with the X—X axis along which it is desired that the radiators A, B, propagate energy. The conductors A, B, are joined together at their apex which falls in the axis X—X as shown. The wires may be fed intermediate their ends in a fashion similar to that in which a half wave length oscillator is fed intermediate its ends. If desired, as shown in Figure 2*b*, the radiating wires may be terminated on a transmission line 10 instead of being connected together at the apex as shown in Figure 2*a*.

The arrangement shown in Figure 2*c* is preferred since it facilitates tuning of the antenna unit comprising the pair of wires A, B. The transmission line 10 feeds energy to a U-shaped loop 12, the legs of which are short circuited by an adjustable short circuiting strap 14, representing a voltage nodal point. The ends 16 of the loop 12 supply energy obtained from line 10 to the conductors A, B whereby the conductors are excited in phase opposition. Adjustment of impedance is accomplished along the legs of the loop by suitable adjustable tapping points 18 in order that reflection along transmission line 10 may be reduced.

Use of the loop allows of completion of the tuning of the antenna wires by making the total effective tuning length of each wire of the V or radiating unit substantially equal to an odd number of quarter wave lengths. The effective radiating length is the length of wire included in the V only, since the loop itself is substantially non-radiating and can be made to be any length.

When tuning of the V is properly accomplished by the U-loop, the system presents a pure resistive load to the transmission line. By tapping the transmission line to the legs of the U at a suitable distance from the short circuiting strip, the effective resistance of the antenna system can be made equal to the surge impedance of the line, which is a necessary condition for maximum transmission efficiency.

It should be noted that energy should be fed so as to energize the radiators A, B in phase opposition, otherwise at a distant point P along the axis X—X there would be radiation cancellation instead of addition. It is also to be distinctly understood that the unit, so far described, is not only useful for radiation purposes in a transmitting arrangement but may be utilized equally as well for reception. That is, the antenna system according to the present invention is equally well suited for any type of radiant action whether it be collection of radiation energy or the transmission thereof.

It is to be further understood that the wires of each unit can be of any desired length provided they are placed at the correct angle for their particular length. For best tuning, the total overall length of both of the wires and the U loop terminating them should be effectively an integral number of half wave lengths, although the portion forming the radiation element can be of any length. The law giving the correct angle for lengths between odd and even number of half wave lengths is not given herein due to its complexity but the empirical formula and the curve of Figure 12 will be found accurate for all practical purposes, whether or not the length of wire dealt with corresponds to an integral number of half wave lengths.

In order to prevent undesired high angle radiation, and in order to concentrate the desired beam in elevation, the scheme shown in Figure 4 may be utilized. In Figure 4, pairs of wires A, B and A', B' are placed in parallel horizontal planes and supported by masts 20 and suitably insulated therefrom by suitable insulators 22. Both pairs of wires or units are fed cophasally from a transmission line 24 through conductors 26, the wires of each pair or unit being fed in opposite phase. In order to increase the elevational concentration of radiated energy, the pair A, B and the pair of wires A', B' are placed apart in horizontal planes by a substantial spacing of preferably not less than one-half wave length. The lower pair should be at least one-half wave length above ground. Bidirectional propagation ensues along the axis X—X but in a much more concentrated form relative to the use of a single unit.

The vertical spacing of the units one above the other need not be made an integral number of half wave lengths. For wires whose lengths approach the order of magnitude from 6 to 10 wave lengths, a spacing greater than one-half wave length is preferred.

In practice, where the height of the antenna is limited by economic considerations and wherein it is desired to make ground absorption as low as possible, a good compromise is a half wave length spacing. For transmission of energy having a wave length of 17 or 18 meters, a good practical antenna may be had wherein the lower wires are about three-quarters of a wave length above ground, and the spacing between wires is one-half wave length. Eighty foot poles or masts may be used to support the wires.

In order to obtain a unidirectional radiation characteristic, pairs of parallel units such as shown in Figures 2*a*, 2*b*, and 2*c* may be spaced apart a distance along the axis X—X, which in effect is the bisector of the angle formed by each pair of wires in each unit. This distance may, in the preferred arrangement, be equal to an odd number of quarter wave lengths.

Such a system combined with means for concentrating the beam in a direction traversing the plane of the wires of each unit is shown in Figure 5. That is, Figure 5 illustrates a system such as shown in Figure 4 duplicated in a direction along the X—X axis whereby, in a horizontal plane, a directional characteristic is obtained such as that shown in Figure 6 and, in a vertical plane a power distribution characteristic such as shown in Figure 7.

The system of Figure 5, comprising the pair of wires A, B paralleled by similar pairs *a, b* spaced apart along the direction X—X an odd number of quarter wave lengths and, as shown nine-quarters of a wave length behind the apex 28 of wires A, B, is excited so that the wires *a, b*, have standing current waves thereon 90 degrees ahead in phase of the standing current waves on wires A, B. Consequently, energy will be propagated principally along the axis X—X towards the diverging ends of the radiators. In order to concentrate the beam of energy so radiated, similar pairs of radiators are placed below the pairs A, B and *a, b* in planes suitably spaced from the first mentioned pairs of radiators to obtain the desired vertical or elevational concentration. The lower pairs of radiators are excited cophasally with respect to the upper pairs through conductors 26, 26' fed by transmission line 24. In order to tune the various units, there are provided U-shaped loops 30, 30' which are short circuited by straps at 32, 32', similar to 14 at Figure 2*c* and as shown in Figure 11.

By exciting wires *a, b* 90 degrees lagging relative to radiators A, B, unidirectional propagation may be obtained in an opposite direction, or, towards the converging ends or apices of the units.

If greater concentration of the radiated energy is desired, several systems such as shown in Figure 5, for example, comprising an effective radiating unit A, B and an effective reflecting unit *a, b* may be placed in broadside with other units, and the several units excited cophasally. Thus, in Figure 8 each of the radiating units A, B shown in plan view is provided with a reflecting unit *a, b*. By means of branched transmission lines, as shown diagrammatically at T, each system is fed cophasally as a result of which an extremely concentrated beam of energy in the plane of the units is transmitted in a direction from the reflecting units towards the radiating units or the reverse, depending upon the relative phase of the standing waves on the units.

The units may be arranged in end-on fashion or coaxially as shown in Figure 9 where each of the units U is spaced apart in the direction of desired propagation. By making the phase difference between each of the units equal to

$$2\pi\frac{S}{\lambda}$$

where S is a spacing of each unit measured along the axis, concentrated unidirectional propagation may be obtained in either direction along the X—X axis depending upon whether or not the standing waves on the succeeding units lag or lead each other by the phase difference given according to the foregoing expression.

Other combinations will readily suggest themselves to those skilled in the art, for example, the units U may be placed diamond shaped fashion such as shown in Figure 10, or, they may be superimposed as shown in Figure 10*a*, the wires of each unit traversing each other.

In order to obtain greater concentration of the radiated beam of energy in a direction traversing the plane of each unit, the systems may be extended in the fashion shown in Figure 11. Here, the system of Figure 5 has been duplicated in a vertical direction, giving increased concentration of the beam in elevation. Energy is fed to the system through an impedance matching device 40 and thence cophasally to the reflecting units through a suitable connection 42. Energy is similarly fed to the radiating units through a suitable connection 44. By suitable tuning and by suitable spacing of the radiating pairs of wires and reflecting pairs of wires, unidirectional propagation may be obtained in either direction along the bisector of the angle formed by the wires of each pair.

The spacing of the antenna and reflector, of the system shown in Figure 11 where the wires are 6 to 12 wave lengths long, is made preferably nine-quarters of a wave length. For wires longer than ten waves lengths, the preferred form should have a greater spacing between the antenna and reflector such as two and three-quarters or three and one-quarter wave lengths. For wires on the order of three or four wave lengths long, the reflector spacing from the antenna may be one and one-quarter wave lengths or less. In general, as the lengths of wires in terms of wave lengths increase, the reflector and antenna spacing should be increased.

In each of the systems for reception, the transmission line would simply be coupled to a suitable receiver, the antenna being directed upon a transmitting station.

The wires, though preferably placed in horizontal planes may be placed at any desired angle without departing from the scope of this invention, and, during transmission it may often be found desirable to have the plane of the wires tilted away from the earth and towards the direction in which the beam of energy is to be propagated.

By the term "plurality of wave lengths", or "plurality of half wave lengths", or "several half wave lengths", it is not intended that the wires so described shall necessarily be an exact or approximate integral number of such lengths, unless so specified, but rather that each of the wires so described shall be sufficiently long to include the lengths specified.

Having thus described my invention, what I claim is:

1. A directional antenna comprising a pair of angularly disposed linear conductors said conductors being angularly disposed with respect to each other, each of a length including substantially a plurality of half wave lengths, means for exciting the radiators in phase opposition whereby standing waves of opposite instantaneous polarity are formed thereon whereby radiant action of the antenna is predominantly along the direction of the bisector of the angle formed by the conductors, and another pair of conductors parallel and similar to said first mentioned pair of conductors and spaced therefrom an odd number of quarter wave lengths measured in a direction along the bisector of the angle of the conductors.

2. A directional transmitting antenna comprising a pair of angularly disposed linear conductors said conductors being angularly disposed with respect to each other, each of a length including substantially a plurality of half wave lengths and being open-ended; means for exciting the radiators in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the radiators; and, another pair of conductors similar and parallel to said first mentioned pair of conductors and spaced therefrom in a direction along the bisector of the angle of the conductors, an odd number of quarter wave lengths.

3. A directional antenna comprising a pair of angularly disposed linear conductors said conductors being angularly disposed with respect to each other in a horizontal plane, each of a length including substantially a plurality of half wave lengths, means for producing standing waves thereon whereby radiant action of the antenna is predominantly along the direction of the bisector of the angle formed by the conductors, and, another pair of conductors similar and parallel to said first mentioned pair of conductors and spaced therefrom in a direction along the bisector of the angle of the conductors by an odd number of quarter wave lengths.

4. A directional transmitting antenna comprising a pair of angularly disposed linear conductors said conductors being angularly disposed with respect to each other, each of a length including substantially a plurality of half wave lengths and being open-ended and disposed in a horizontal plane; means for exciting the radiators in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the radiators; and, another pair of conductors similar and parallel to said first mentioned pair of conductors and spaced therefrom in a direction along the bisector of the angle of the conductors by an odd number of quarter wave lengths.

5. A directional antenna comprising a pair of angularly disposed linear conductors said conductors being angularly disposed with respect to each other, each of a length including substantially a plurality of half wave lengths, means for producing standing waves thereon whereby radiant action of the antenna is predominantly along the direction of the bisector of the angle formed by the conductors, and, another pair of conductors similar to said first mentioned pair of conductors spaced apart from said first mentioned pair in a direction traversing the planes of each pair.

6. A directional antenna comprising a pair of angularly disposed linear conductors said conductors being angularly disposed with respect to each other, each of a length including substantially a plurality of half wave lengths, means for producing standing waves thereon whereby radiant action of the antenna is predominantly along the direction of the bisector of the angle formed by the conductors; and, another pair of conductors similar to said first mentioned pair of conductors spaced apart from said first mentioned pair, in a direction perpendicular to the plane of the pair of conductors a number of half wave lengths.

7. An antenna comprising parallel pairs of angularly disposed conductors, said conductors being angularly disposed with respect to each other, spaced apart along the direction of the bisector of the angle formed by the conductors an odd number of quarter wave lengths, and, similar pairs of conductors in planes parallel to and spaced apart vertically from the planes of the first mentioned pairs of conductors.

8. A transmitting antenna system comprising parallel pairs of angularly disposed conductors, said conductors being angularly disposed with respect to each other, arranged in a horizontal plane having their apices spaced apart along the direction of the bisector of the angle formed by the conductors an odd number of quarter wave lengths, and similar pairs of conductors disposed in a parallel horizontal plane a vertical distance away from said first mentioned plane, equal to one or more half wave lengths.

9. An antenna system comprising a pair of linear conductors, said conductors being angularly disposed with respect to each other, each substantially an odd number of half wave lengths long and angularly disposed with respect to each other at an angle substantially equal to the angle for which the field strength at a distant point lying in the direction of the bisector is a maximum, said field strength being proportional to

$$\frac{\cos\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

where n is the number of half wave lengths contained in each conductor and θ is the half angle between the wires, and means in circuit with said antenna for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors throughout their length.

10. An antenna comprising a pair of linear conductors each substantially an even number of half wave lengths long and disposed with respect to each other at an angle substantially equal to the angle for which the field strength at a distant point lying in the direction of the bisector is a maximum, said field strength being proportional to

$$\frac{\sin\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

where n is the number of half wave lengths contained in said conductor and θ is the half angle between the wires, and means in circuit with said antenna for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors throughout their length.

11. An antenna comprising a pair of linear conductors, each substantially an odd number of half wave lengths long and angularly disposed with respect to each other at an angle equal to twice the angle for which the expression

$$\frac{\cos\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

is a maximum, n being the number of half wave lengths contained in each conductor, and, a similar pair of conductors spaced from said first pair by an odd number of quarter wave lengths in a direction along the bisector of the angle of the conductors.

12. An antenna comprising a pair of linear conductors each substantially an even number of half wave lengths long and disposed with respect to each other at an angle substantially equal to twice the angle for which the expression

$$\frac{\sin\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

is a maximum, n being the number of half wave lengths contained in each conductor, and a similar pair of conductors spaced from said first pair by an odd number of quarter wave lengths in a direction along the bisector of the angle of the conductors.

13. An antenna comprising a pair of linear conductors, each substantially an odd number of half wave lengths long and angularly disposed with respect to each other at an angle equal to twice the angle for which the expression

$$\frac{\cos\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

is a maximum, n being the number of half wave lengths contained in each conductor, and a similar parallel pair of conductors away from the first mentioned pair in a direction perpendicular to the planes of the pairs.

14. An antenna comprising a pair of linear conductors each substantially an even number of half wave lengths long and disposed with respect to each other at an angle substantially equal to twice the angle for which the expression

$$\frac{\sin\left(n\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

is a maximum, n being the number of half wave lengths contained in each conductor, and a similar pair of conductors away from the first mentioned pair in a direction perpendicular to the planes of the pairs.

15. An antenna comprising a pair of relatively long conductors disposed with respect to each other at an angle substantially equal to twice

$$50.9\left(\frac{l}{\lambda}\right)^{-0.513}$$

degrees, l being the length of the wire and λ the operating wave length in like units, and means in circuit with said antenna for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors throughout their length.

16. An antenna comprising a pair of relatively long conductors disposed with respect to each other at an angle substantially equal to twice

$$50.9\left(\frac{l}{\lambda}\right)^{-0.513}$$

degrees, and, a similar parallel pair of conductors spaced an odd number of quarter wave lengths away from said first mentioned pair along the bisector of the angle of the conductors, l being the length of each wire and λ being the operating wave length in like units.

17. An antenna comprising pairs of long conductors, the conductors of each pair disposed with respect to each other at an angle substantially equal to twice

$$50.9\left(\frac{l}{\lambda}\right)^{-0.513}$$

degrees, and the pairs being placed in parallel planes substantially an odd number of half wave lengths apart, l being the length of each wire and λ being the operating wave length in like units.

18. An antenna comprising pairs of relatively long conductors the conductors of each pair being disposed with respect to each other at an angle substantially equal to twice

$$50.9\left(\frac{l}{\lambda}\right)^{-0.513}$$

degrees the apices of each pair being separated along the direction of the bisector of the angle formed by the conductors by an odd number of quarter wave lengths; and, similar pairs of conductors in a substantially parallel plane spaced apart from said first pairs, l being the length of each wire and λ being the operating wave length in like units.

19. An antenna arrangement comprising a pair of diverging linear conductors angularly disposed with respect to each other, another pair of angularly disposed diverging conductors similar to said first mentioned pair and spaced apart from said first pair in a direction along the bisector of the angle of the conductors, both said pairs of angularly disposed conductors being arranged to form opposite angles of a four sided plane figure, the conductors of each pair being excited in phase opposition whereby radiant action occurs principally in the plane of said conductors and along the direction of said bisector.

20. A diamond-shaped antenna arrangement comprising a pair of V-shaped antennæ arranged to form a parallelogram, and means for connecting the apex of each V antenna to high frequency apparatus whereby the legs of each V which lie alongside each other are excited in phase opposition so that radiant action occurs principally in the plane of the V-shaped antennæ and principally in a direction along a line joining the apices of said V-shaped antennæ.

21. An antenna system comprising a pair of linear conductors angularly disposed with respect to each other, each of a length including substantially a plurality of one-half wave lengths and being open-ended, another similar pair of angularly disposed linear conductors also of a length including a plurality of one-half wave lengths and being open-ended, both of said pairs being so arranged that the open ends of one pair point in a substantially opposite direction with respect to the open ends of the other pair and the acute angles formed by said pairs face one another, and means for exciting the radiators of each pair in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the radiators.

22. A directional transmitting antenna arrangement comprising a pair of V-shaped antennæ arranged to form a parallelogram, and means for exciting the radiators of each pair in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the radiators whereby radiant action occurs principally in the plane of said radiators and principally along a line joining the apices of said V-shaped antennæ.

23. A directional antenna arrangement comprising a pair of open-ended V-shaped antennæ arranged in a horizontal plane such that the open ends of each pair point in opposite directions with respect to the other pair, and means for connecting the apex of each V antenna to high frequency apparatus whereby radiant action occurs principally in the plane of the V-shaped antennæ and principally in a direction corresponding to the line joining the apices of said V-shaped antennæ.

24. A directional antenna arrangement comprising a pair of open-ended V-shaped antennæ arranged such that the acute angle formed by the individual conductors of each pair of antennæ face each other and the open ends of each pair point in different directions, and means for connecting the apex of each V antenna to high frequency apparatus whereby radiant action occurs principally in the plane of the V-shaped antennæ and principally in a direction corresponding to a line joining the apices of said V-shaped antennæ.

25. A directional antenna arrangement comprising a pair of V-shaped antennæ arranged in such manner that the acute angle formed by the individual conductors of each pair face each other, and means for connecting the apex of each V antenna to high frequency apparatus whereby radiant action occurs principally in the plane of the radiators and principally in a direction corresponding to a line joining the apices of said V-shaped antennæ.

26. A directional antenna comprising a pair of linear conductors angularly disposed with respect to each other and placed in a plane at an angle to the horizontal, said plane extending in the desired direction of transmission, each conductor being of a length including substantially a plurality of one-half wave lengths, means for producing standing waves thereon whereby radiant action of the antenna is predominantly along the direction of the bisector of the angle formed by the conductors, and another pair of conductors similar and parallel to said first mentioned pair of conductors and spaced therefrom in a direction along the bisector of the angle of the conductors by an odd number of one-quarter wave lengths.

27. A directional transmitting antenna comprising a pair of linear conductors angularly disposed with respect to each other, each of a length including substantially a plurality of one-half wave lengths and being open-ended, and disposed in a plane at an angle from the horizontal, said plane extending in the desired direction of transmission, means for exciting the radiators in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the radiators, and another pair of conductors similar and parallel to said first mentioned pair of conductors and spaced therefrom in a direction along the bisector of the angle of the conductors by an odd number of one-quarter wave lengths.

28. A directional transmitting antenna comprising a plurality of pairs of linear conductors, the conductors of each pair being angularly disposed with respect to each other, each conductor being of a length including substantially a plurality of one-half wave lengths and being open-ended, said plurality of pairs being disposed in a horizontal plane along the bisector of the angle of the conductors, means for exciting the two radiators of each pair in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the radiators of each pair, and means for feeding the successive pairs of radiators so that the currents in the successive radiators of each pair differ in phase by an angle $2\pi S/\lambda$ where S is the spacing along the bisector and λ the wave length.

29. A directional transmitting antenna comprising a plurality of pairs of linear conductors, the conductors of each pair being angularly disposed with respect to each other, each conductor being of a length including substantially a plurality of one-half wave lengths and being open-ended, said plurality of pairs being disposed in a plane at an angle from the horizontal, said plane extending in the desired direction of transmission, means for exciting the two radiators of each pair in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the radiators of each pair, and means for feeding the successive pairs of radiators so that the currents in the successive radiators of each pair differ in phase by an angle $2\pi S/\lambda$ where S is the spacing and λ the wave length.

30. A broadside directional antenna comprising a pair of linear conductors angularly disposed with respect to each other, another pair of angu-

larly disposed linear conductors arranged adjacent and in the same plane with said first pair so that said two pairs are side by side and have their acute angles opening in the same direction, and means for producing standing waves thereon whereby radiant action of the antenna is predominantly along the direction of the bisectors of the angles formed by the conductors of each pair for effecting beam concentration.

31. A broadside directional antenna comprising a pair of linear conductors angularly disposed with respect to each other in a horizontal plane, another pair of angularly disposed linear conductors arranged adjacent and in the same plane with said pair so that said two pairs are side by side and have their acute angles opening in the same direction, said pairs being arranged to be excited in phase opposition whereby standing waves of opposite instantaneous polarity are formed thereon.

32. A directional transmitting antenna comprising a pair of linear conductors angularly disposed with respect to each other, each of a length including substantially a plurality of half wave lengths and being open-ended, a transmission line, a pair of vertical connections extending from said pair of conductors to said transmission line, and means in circuit with said transmission line for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors, another pair of conductors substantially similar and parallel to said first mentioned pair and spaced therefrom in a direction along the bisector of the angle of the conductors, and a pair of vertical connections in circuit with said last pair of conductors, and joining said last pair with said transmission line.

33. A directional transmitting antenna comprising a pair of linear conductors angularly disposed with respect to each other, each of a length including substantially a plurality of half wave lengths and being open-ended, a transmission line, a pair of vertical connections extending from said pair of conductors to said transmission line, and means in circuit with said transmission line for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors, another pair of conductors substantially similar and parallel to said first mentioned pair and spaced therefrom in a direction along the bisector of the angle of the conductors, and a pair of vertical connections in circuit with said last pair of conductors, said two pairs of vertical connections being joined together by a pair of horizontal conductors.

34. An antenna arrangement comprising a pair of conductors each of a length including several half wave lengths at the operating frequency, said conductors being angularly disposed at an acute angle with respect to each other, each conductor making the same angle with, but lying on opposite sides of a line representing the desired direction of radiant action, and a U-shaped metallic circuit having legs substantially parallel to each other connected between substantially opposite points on said angularly disposed conductors, which points are relatively close together.

35. An antenna arrangement comprising a pair of conductors each of a length including several half wave lengths at the operating frequency, said conductors being angularly disposed with respect to each other, each conductor making the same angle with, but lying on opposite sides of a line representing the desired direction of radiant action, and a circuit having conductors substantially parallel to each other connected between substantially opposite points on said angularly disposed conductors, which points are relatively close together, and means for effectively connecting together for high frequency currents, similarly located points on each of said parallel conductors.

36. An antenna arrangement comprising a pair of conductors each of a length including several half wave lengths at the operating frequency, said conductors being angularly disposed with respect to each other, each conductor making the same angle with, but lying on opposite sides of, a line representing the desired direction of radiant action, a U-shaped circuit having legs substantially parallel to each other connected between substantially opposite points on said angularly disposed conductors, which points are relatively close together, and a transmission line connected to the legs of said U-shaped circuit and to said angularly disposed conductors for energizing said conductors in phase opposition.

37. A directional antenna comprising a pair of angularly disposed substantially straight conductors, said conductors being angularly disposed with respect to each other, each conductor being of a length including a plurality of half wave lengths at a desired operating frequency, means for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed thereon whereby radiant action of the system formed by said angularly disposed linear conductors is predominantly along the direction of the bisector of the angle formed by the conductors, another pair of conductors parallel and similar to said first mentioned pair of conductors, and a substantially radiationless transmission line, not less than a quarter wave length long at the desired operating frequency, joining substantially opposite points on said pairs of conductors, the points on each pair being relatively close together.

38. A directional antenna comprising a pair of straight conductors angularly disposed with respect to each other, each conductor being of a length including a plurality of wave lengths at the operating frequency and being electrically open-ended at their most widely separated ends, means for exciting said conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed thereon, and another pair of open-ended conductors similar and parallel to said first mentioned pair of conductors and being spaced therefrom in a direction along the bisector of the angle of the conductors such that radiant action of said pairs of conductors is substantially unidirectional.

39. A directional antenna comprising a pair of straight conductors angularly disposed with respect to each other, each conductor being of a length including a plurality of half wave lengths at the operating frequency, said conductors being electrically open-ended at their most widely separated ends, another pair of open-ended conductors similar and parallel to said first mentioned pair of conductors and spaced therefrom in a direction along the bisector of the angle of the conductors, and a substantially radiationless transmission line connected between points on said pairs of conductors, the points chosen on each pair being relatively close together, said transmission line being not less than a quarter

wave length long at the desired operating frequency.

40. A directional antenna comprising two pairs of conductors, the conductors of each pair being substantially straight and being arranged so as to form substantially a V, each conductor of each of said pairs of conductors being of a length including a plurality of wave lengths at the desired operating frequency, the most remote ends of the conductors of each pair being electrically open-ended, both pairs of conductors lying in the same plane and symmetrically about a line representing a desired direction of radiant action.

41. A directional antenna comprising two pairs of conductors, the conductors of each pair being substantially straight and being arranged so as to form substantially a V, each conductor of each of said pairs of conductors being of a length including a plurality of wave lengths at the desired operating frequency, the most remote ends of the conductors of each pair being electrically open-ended, both pairs of conductors lying in the same plane and symmetrically about a line representing a desired direction of radiant action, and a substantially radiationless transmission line not less than a quarter wave length long connected between similar points on said pairs of conductors, the points taken on each pair of conductors being close together relative to the electrical open ends of said conductors.

PHILIP STAATS CARTER.

Referring to 2 page Research Progress Report

A Yes.

Q And others that have worked on research and development under government contracts that give rise to patents?

A Yes.

Q I would like to have the reporter identify as Plaintiff's Exhibit 27 a copy of a report dated June 12, 1959, in the electrical engineering department of the University of Illinois, apparently made by Georges Deschamps, the copy having been stamped by counsel as document #s 5336 and 5337, it being a two page document.

(Plaintiff's Exhibit 27 marked for identification as of January 19, 1967.)

Dr. Mayes, can you identify the report which is Plaintiff's Exhibit 27 and tell why a report of this type was prepared and for what purpose?

A This report was prepared to summarize the activities under a given research contract to assist the engineering publications department in preparation of the research summary which is issued annually.

Q Do you know whether Dr. Deschamps or someone else in the antenna laboratory or associated with the antenna laboratory might have compiled the bibliography that follows the fourth paragraph of the body of the report?

A I can't be sure, but I suspect I probably compiled it.

Referring to 2 pg. Research Progress Report

Q I call your attention to the last item in the bibliography identifying an article entitled "Research Studies on Problems Related to Antennas," and identified as Quarterly Engineering Report #1, January, 1959; #2, April, 1959; Contract # AF 33 (616)-6079. Could you tell me if that appears to be a proper identification of that item?

A Proper in what way?

Q As to the contract under which the report was written, for example.

A I am sure that Quarterly Engineering Reports were prepared under this contract. I could not establish, without reference to the reports, whether or not these dates are correct.

Q Is that report the one previously identified as plaintiff's Exhibit 8? ← *Blonder Tongue's Exh. No.*

A Yes.

Go to next pg.

Q I call your attention to the fact that on the title page of that report, it carries date 31-3-59; can you tell me the significance of that date, what that date would refer to, the writing of the report?

A Not necessarily.

Q To what did it refer?

A It's the approximate date of issue of the report as stipulated in the contract.

Q So that 31-3-59 date would not necessarily be the day of the writing of the report?

A No.

Q Or the day the report was printed?

A No.

Q Or the day the report was published?

A No.

Q Is there anything in that report that you know of that includes the date April, 1959?

A I don't know; I would have to look through it to see.

Q Well then, what would be the significance of the date April, 1959 in the bibliography at the end of Plaintiff's Exhibit 27?

A I am not sure.

Q If you had compiled the report as you indicated you might have, what would you consider that date to be?

A Ordinarily I would think that the date should be 31-3-59.

Q What would you consider the April, 1959 to signify?

A I don't know.

Q Is it not normal in bibliographies in technical publications to cite publications by their publication date?

A Yes.

Q And wouldn't one normally interpret that April, 1959 date to be a publication date?

A Yes.

Q Going back to the Carrel publication, Technical Report #53, Plaintiff's Exhibit 24, I would like to call your attention to the paragraph beginning in line 5 on page 163, which I will read: "There also exists the possibility of tailoring the directivity characteristic such that the patterns are frequency dependent in a special way. This would require that T and σ or both be a function of position. In this case σ' should be held constant to achieve a frequency independent input impedance. The above idea was applied to one model in which α was fixed at 25°. The spacing between all elements was a constant, one-half inch. σ varied along the antenna from 0.022 to 0.088. The measured directivity increased with frequency from 5 to 8.5 db, then decreased to 7.5 db."

Dr. Mayes, does not that paragraph purport to describe an antenna design and model and test results of what Mr. Carrel characterized as a frequency dependent antenna?

A Yes.

Q And what was the principal characteristic of that an-

Boom spacing is not critical

Broad range without much change

Must be very close together for [illegible]

L - P pattern — substantially coplanar

(A) All in same plane or as near as possible - elements

So an antenna can be log periodic over a band & non log periodic over another band

Besides

Fact that

log per antennas

~~...~~ sometimes

have additional

non-periodic elements

added to them

to improve or change

circuit characteristics

~~you know~~ to Meyer ~~that~~

if you ~~brought~~ reduced the spacing between the ~~2~~ upper & lower planes of dipole elements of the BT Dave-PEX10? arrays to a very small value where the arrays lay in the same or nearly the same plane, ~~those~~ the antenna two tiers would ~~not~~ would do produce ~~satisfactory~~ useful directivity & reception ~~[illegible]~~. Same with Colon Rash

LOG PERIODIC BACKWARD WAVE ANTENNA ARRAY

Original Filed Sept. 30, 1960 2 Sheets-Sheet 1

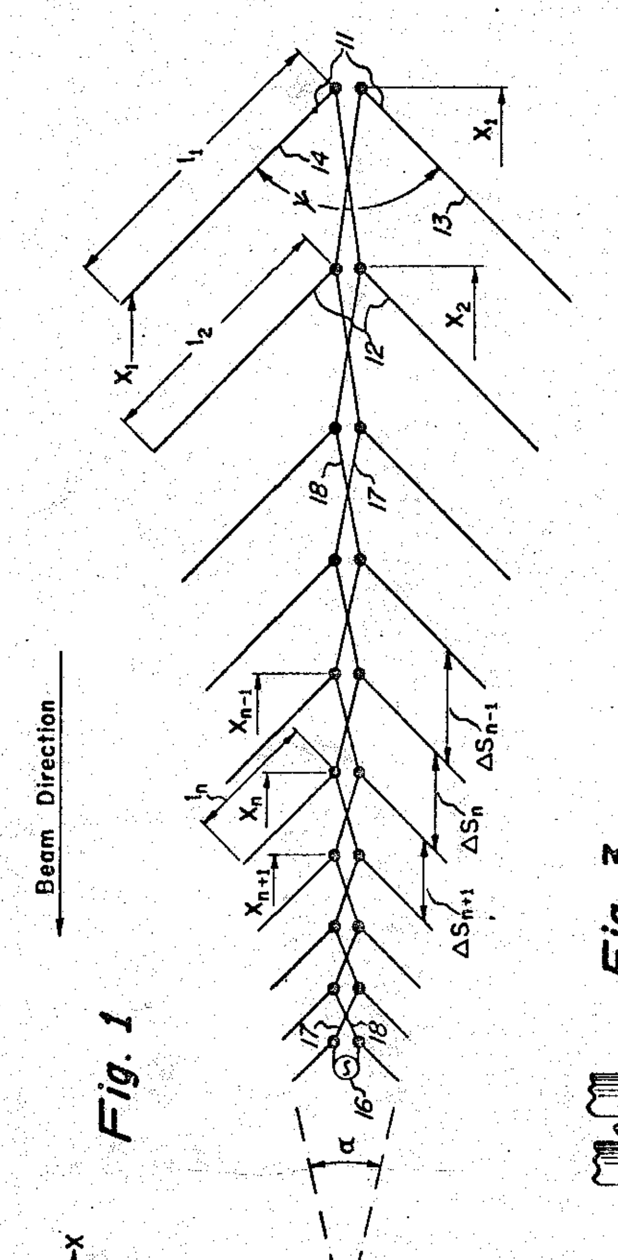


Fig. 1

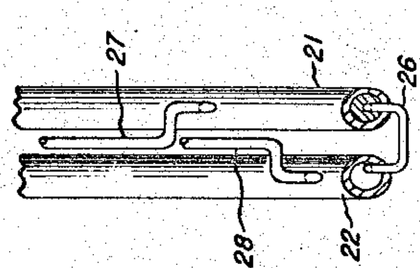


Fig. 3

INVENTORS:
Paul E. Mayes
Robert L. Carrel

BY Merriam, Smith & Marshall
ATTORNEYS

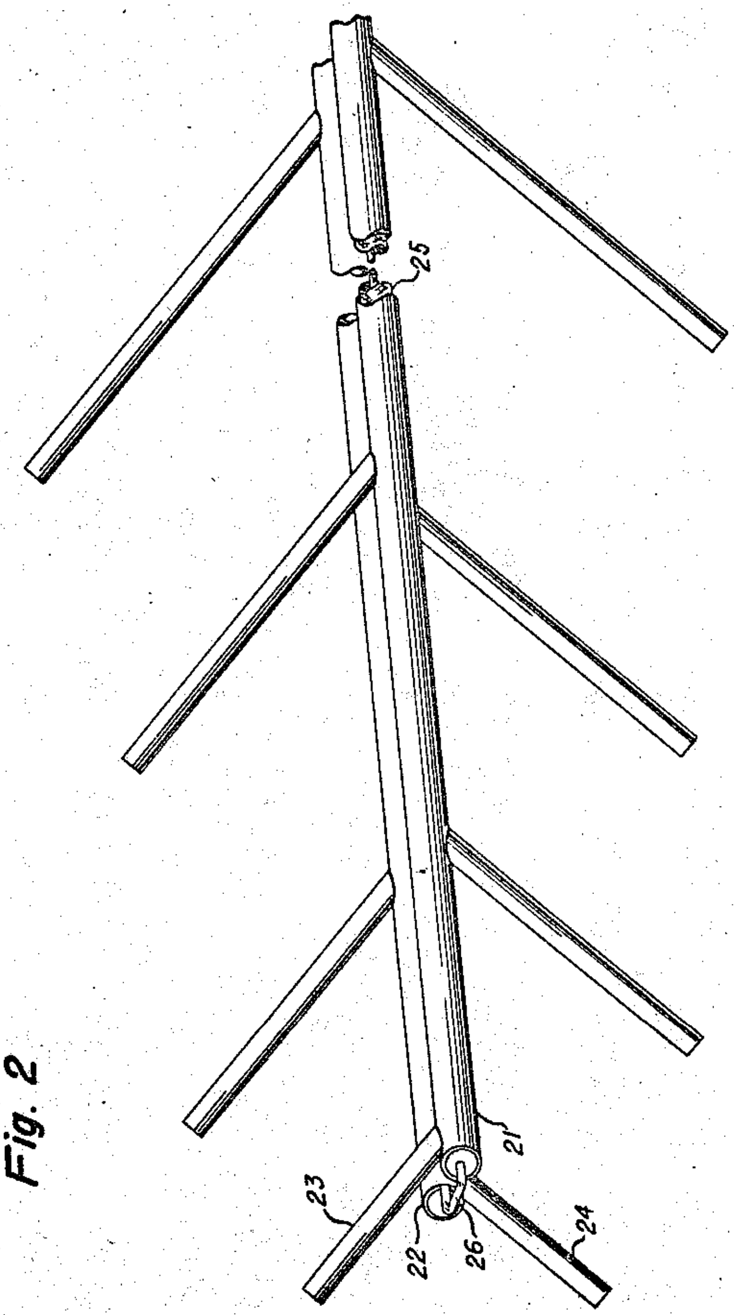


Fig. 2

INVENTORS:
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Robert L. Carrel
BY
Merriam, Smith & Marshall
ATTORNEYS

25,740

LOG PERIODIC BACKWARD WAVE ANTENNA ARRAY

Paul E. Mayes, Champaign, Ill., and Robert L. Carrel, Richardson, Tex., assignors to The University of Illinois Foundation, a non-profit organization of Illinois

Original No. 3,108,280, dated Oct. 22, 1963, Ser. No. 59,671, Sept. 30, 1960. Application for reissue Mar. 5, 1964, Ser. No. 363,315
17 Claims. (Cl. 343—792.5)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to antennas and more particularly it relates to antennas having unidirectional radiation patterns that are essentially independent of frequency over wide bandwidths.

In the copending application of Dwight E. Isbell, Ser. No. 26,589, filed May 3, 1960, there are described certain antennas comprising coplanar dipole arrays which have an unusually wide bandwidth over which the performance of the antennas is essentially frequency independent and the input impedance nearly constant, the antennas also having a unidirectional pattern with a directivity comparable to a Yagi array. As described in the aforementioned application, these arrays comprise a number of dipoles arranged in side-by-side relationship in a plane, the length of the dipoles and the spacing between adjacent dipoles varying according to a definite mathematical formula, with each of the dipoles being fed at its midpoint by a common feeder which introduces an added phase shift of 180° between connections to successive dipoles. The dipoles which are used to make up the array vary progressively in length, the longest dipole element being about ½ wavelength long at the low frequency limit of a given antenna's effective range and the shortest element being about ⅜ wavelength long at the upper frequency limit.

In accordance with the present invention, it has been found that the directivity of an antenna of the type described in the aforementioned application may be increased and the effective frequency range of an antenna of fixed size may be extended by inclining the dipoles of Isbell to form V-elements, each of which consists of two straight arms of equal length defining an apex which points away from the direction of radiation of the antenna which is also the direction in which the element size decreases. The modification of the straight dipoles of Isbell to V-shaped elements permits the antenna to be operated over bands of frequencies higher than those established, as described above, by the length of the shortest dipole in the antenna, with increased directivity, thus obviously increasing the effective frequency range of a given antenna.

The invention will be better understood from the following detailed description thereof taken in conjunction with the accompanying drawings, in which the same numbers are used to denote corresponding elements in the several views and in which:

FIGURE 1 is a schematic plan view of an antenna made in accordance with the principles of the invention;

FIG. 2 is a perspective view of a practical antenna embodying the invention; and

FIGURE 3 is a fragmentary view of an improved and preferred form of an antenna similar to that shown in FIGURE 2, as seen from a point directly in front of and above the narrow end of the antenna.

Referring to FIGURE 1, it will be seen that the antennas of the invention are composed of a plurality of V-elements, e.g., **11** and **12**, each of which consists of a pair of arms, e.g., **13** and **14**, defining an apex in the middle of the V-elements, said V-elements being arranged in a herringbonelike pattern. The arms of a given V-element are equal in length and corresponding arms of the several V-elements, i.e., the arms on the same side of a line passing through the apexes of the V-elements, are substantially parallel to each other. It will be noted that the lengths of the arms of successive V-elements and the spacing between the apexes of the elements are such that the extremities of the elements fall on a pair of straight lines which intersect to form an angle α. In the preferred embodiment of the invention the antenna is symmetrical about a line passing through the apexes of the V-elements, as shown.

The antenna is fed at its narrow end from a conventional source of energy, depicted in FIGURE 1 by alternator **16**, by means of a balanced feeder line consisting of conductors **17** and **18**. It will be seen that the feeder lines **17** and **18** are alternated between connections to consecutive V-elements, thereby producing a phase reversal between such connections.

The length of the arms in the antenna, and the spacing between the V-elements, are related by a constant scale factor τ defined by the following equations:

$$\tau = \frac{l_{(n+1)}}{l_n} = \frac{\Delta S_{(n+1)}}{\Delta S_n}$$

where τ is a constant having a value less than 1, l_n is the length of an arm in any intermediate V-element in the array, $l_{(n+1)}$ is the length of an arm in the adjacent smaller V-element, the subscript n designating the nth arm running in an order from larger to smaller, ΔS_n is the spacing between the apex of the V-element having the arm length l_n and the apex of the adjacent larger V-element, and $\Delta S_{(n+1)}$ is the spacing between the apex of the V-element having the arm length l_n and the apex of the adjacent smaller V-element.

The arms of the individual V-elements forming the antenna array are inclined to point in the direction of decreasing V-element size so that the apex of each of the elements points in a direction away from the angle α formed by the lines passing through the extremities of the individual V-elements.

The angle formed by the arms of a V-element is designated as ψ. It will be seen that when the angle ψ is equal to 180°, the antennas of the invention are identical with those described by Isbell in the application mentioned above. In the instant invention, however, the angle ψ preferably has a value between about 50° and 150°.

It will be seen from the geometry of the invention as given above that the distances from the base line O at the vertex of the angle α to the apexes of the V-elements forming the array are defined by the equation:

$$\tau = \frac{X_{(n+1)}}{X_n}$$

where X_n is the distance from the base line O to the apex of the V-element having the arm length l_n, $X_{(n+1)}$ is the corresponding distance from the base line to the apex of the adjacent smaller V-element, the τ has the significance previously given.

The radiation pattern of the antennas of the invention having the geometrical relationship among the several parts, as defined above, is unidirectional in the negative X direction, i.e., extending to the left from the narrow end of the antenna of FIGURE 1.

The use of V-elements in the antennas of the invention, rather than dipoles, increases the directivity of the invention and also permits more effective utilization of a given antenna since the same structure can be used in several frequency modes to achieve coverage of different frequency bands. In the special case of an antenna having straight dipoles rather than V-elements (i.e., when $\psi=180°$), the effective frequency range is that in which the low limit corresponds to that frequency in which the largest dipole in the antenna is about ½ wavelength long and the upper frequency limit to that frequency in which the smallest dipole in the antenna is about ⅜ wavelength long. In general, therefore, it may be said that the frequency range of the straight dipole array corresponds to the mode of operation in which the lengths of the dipoles in the array are about ½ wavelength long. As the frequency is raised above the upper limit of the ½ wavelength mode in the dipole array, the antenna will also be found to radiate effectively at frequencies in which the dipoles are about 3/2 wavelengths long (the 3/2 wavelengths mode), 5/2 wavelengths long (the 5/2 wavelengths mode) and so on. At frequencies above the half-wavelength mode, however, the radiation pattern of the dipole array becomes multilobed and is, therefore, of limited usefulness. By inclining the arms of the dipole to form the V-elements of the instant invention, it has been found that a single lobe of improved directivity may be obtained as the frequency is raised from the half-wavelength mode through the intervening ranges to the 9/2 wavelengths mode and beyond. For each mode of operation there exists an optimum value for the angle ψ, ranging from about 114° for the half-wavelength mode to about 62° for the 9/2 wavelengths mode. By using a compromise value for ψ within this range, however, a practical antenna can be made to achieve acceptable performance over several modes of operation, thereby increasing its effective range without increasing the number of elements therein. This result is possible since many of the elements forming the antenna array are used at more than one frequency.

The construction of an actual antenna made in accordance with the invention is shown in FIGURE 2. In this antenna the balanced line consists of two closely-spaced and parallel electrically conducting small diameter tubes **21** and **22** which also act as a mechanical support for the dipole elements and to which are attached the arms which form the V-elements of the invention. It will be noted that each of the two arms, e.g., **23** and **24**, making up one V-element is connected to a different one of said conductors **21** and **22**. Moreover, considering either one of the conductors **21** and **22**, consecutive arms along the length thereof extend in opposite directions. It will be seen that this construction has the effect of alternating the phase of the connections between successive V-elements, as depicted schematically in FIGURE 1. Although the V-elements of FIGURE 2 are not precisely coplanar, differing therefrom by the distance between the parallel conductors **21** and **22**, in practice this distance is usually small so that the arms of the V-elements are substantially coplanar and the advantages of the invention are maintained. In some instances, however, it may be advantageous to bend the individual arms, e.g., **27** and **28**, close to the point of attachment to the feeder line, as shown in FIGURE 3, so as to position all the arms in the same plane. The antennas of FIGURES 2 and 3 may be conveniently fed by means of a coaxial cable **25** positioned within conductor **21**, the outer conductor of the cable making electrical contact with conductor **21** and the central conductor **26** of the cable extending to and making electrical connection with conductor **22**, as shown.

The antennas of the invention may also be fed by a balanced two wire line which is twisted between elements to achieve the desired phase reversal. Other methods of achieving the desired phasing may be employed, e.g., transmission line loops or stubs.

As an example of the invention, an antenna of the type shown in FIGURE 3 was constructed using 0.125" diameter tubing for the balanced line and 0.050" diameter wire for the arms of the V-elements. The arms were soldered to the feeder line and the array was fed by a miniature coaxial cable inserted into one of the conductors of the balanced line. The antenna had 25 arms, the largest of which was 1 ft. long with the shortest being about 3½" long. The antenna was further defined by the parameters $\tau=0.95$ and $\psi=70°$. This antenna exhibited typical directivity gains ranging from 12 db over isotropic in the 3/2 wavelengths mode to 17 db in the 7/2 wavelengths mode, with essentially constant input impedance within each mode.

Except with respect to the angle of inclination of the arms of the V-elements, the parameters which define the antennas of the invention are essentially similar to those of the corresponding straight dipole arrays in which the arms extend at right angles from the feeder lines. Thus, the parameter τ preferably has a value between about 0.8 and 0.95 and the angle α suitably ranges between 20° and 100°. Moreover, the upper and lower limits of the bandwidth for the ½ wavelength mode of operation can be adjusted as desired by making the longest V-element correspond in length to about ½ wavelength at the lower limit and the shortest V-element to about ⅜ wavelength at the upper frequency limit.

In addition to its use as a direct radiator or receiver, the resonant-V array of the invention has several advantages over other antennas currently used as primary feeds for parabolic and other reflectors. Its independence of frequency in any single mode assures constant illumination of the reflector. Moreover, the input impedance remains essentially independent of frequency so that no tuning is required as the frequency is varied.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. A broadband unidirectional antenna comprising an array of a plurality of V-elements in a planar herringbonelike ararngement, each of said elements having a pair of equal arms defining an apex, the apexes of said V-elements lying on a straight line, the corresponding arms of said elements progressively increasing in length and spacing, the extremities of the arms of said V-elements substantially falling on a V-shaped line forming an angle α at its vertex, the apexes of said V-elements pointing in a direction away from the vertex of said angle α, the ratio of the arm lengths of any pair of adjacent V-elements being given by the formula

$$\frac{l_{(n+1)}}{l_n}=\tau$$

where l_n is the length of an arm in the larger of said pair of V-elements, $l_{(n+1)}$ is the length of an arm in the adjacent smaller V-element of said pair, the subscript n designating the nth arm running in an order from larger to smaller, and τ is a constant having a value less than 1, the spacing between the apexes of said V-elements being given by the formula

$$\frac{\Delta S_{(n+1)}}{\Delta S_n}=\tau$$

where ΔS_n is the spacing between the V-element having the arm length l_n and the adjacent larger V-element, $\Delta S_{(n+1)}$ is the spacing between the V-element having the arm length l_n and the adjacent smaller V-element, and τ has the significance previously assigned, said V-elements being adapted to be fed as a group from the small end of the individual V-elements fed at the apexes thereof by a common feeder which introduces an additional 180° phase shift between successive V-elements.

2. The antenna of claim 1 wherein the angle formed by the arms of any V-element at the apex thereof has a value within the range from about 50° to about 150°.

3. The antenna of claim 1 which is symmetrical about a line passing through the apex of each V-element therein, and in which the corresponding arms of the V-elements are parallel.

4. The antenna of claim 1 in which the angle α has a value between about 20° and 100° and the constant τ has a value between about 0.8 and 0.95.

5. A broadband unidirectional antenna comprising a balanced feeder line consisting of two closely spaced, straight and parallel conductors, a plurality of substantially coplanar V-elements, each V-element comprising a pair of arms of equal length defining an apex, one of said arms of each V-element being connected at the apex of said V-element to one of said conductors, the other of said arms being connected directly opposite the first to the other of said conductors, the arms of any V-element extending in opposite directions at an acute angle to the plane determined by said conductors, consecutive arms on each of said conductors extending on opposite sides of said plane, the ratio of the lengths of the arms in adjacent V-elements being given by the formula

$$\frac{l_{(n+1)}}{l_n}=\tau$$

where l_n is the length of an arm of a V-element, $l_{(n+1)}$ is the length of an arm in the adjacent smaller V-element, the subscript n designating the nth arm running in an order from larger to smaller, and τ is a constant having a value less than 1, the spacing of the apexes of the V-elements along said feeder line being given by the formula

$$\frac{\Delta S_{(n+1)}}{\Delta S_n}=\tau$$

where ΔS_n is the spacing between the V-element having the arm length l_n and the adjacent larger V-element, $\Delta S_{(n+1)}$ is the spacing between the V-element having the arm length l_n and the adjacent smaller V-element, and τ has the significance previously assigned.

6. The antenna of claim 5 in which the angle formed by said arms with the plane determined by said feeder line, measured in a plane perpendicular to said plane, has a value between about 25° and about 75°.

7. The antenna of claim 5 in which τ has a value of about 0.8 to 0.95.

8. An aerial system for wide-band use comprising a plurality of herringbone-like conducting V-elements planarly arranged, a two-conductor balanced feeder connected to each of said elements at substantially the inner end thereof, each two opposite V-elements forming a pair constituting dipole halves, the connection from each adjacent dipole section being to a different feeder, said V-elements being selectively spaced from each other, each V-element of each pair having arms of substantially equal length substantially defining an apex with the apexes of the plurality of V-elements all lying in substantially a straight line and terminating at the feeder, the said dipoles of each pair being of different electrical lengths with successive dipoles differing in electrical length with respect to each other by substantially the same scale factor, each dipole and the feeder between successive dipoles constituting a cell, and the selective spacings between adjacent dipoles decreasing from one end to the other with the greater spacing being between the longest dipoles and being such that the combination of dipole lengths and spacings provides a substantially uniform wide-band response over a plurality of frequency bands bearing substantially harmonic frequency relationships to each other, the connection between the dipoles and the feeder being made in such a manner that the directive gain of the antenna increases as operation shifts from one band to an adjacent band of higher frequencies, and means to connect the feeder to an external circuit at a location substantially removed from the longest of the V-elements and in the direction of the smallest of the V-elements.

9. An aerial system for wide-band use including a two-conductor balanced feeder extending in a selected plane, a plurality of herringbone-like conducting V-elements planarly arranged and spaced along the feeder, each of

the elements having a pair of arms of substantially equal length defining substantially an apex with the apexes of the plurality of V-elements all lying in substantially a straight line and all terminating at the feeder, a connection between each of the V-elements and one of the feeders at the inner end of the elements, the two V-elements forming each pair constituting dipole halves, adjacent dipole sections being connected to different feeders, each of the pairs of dipoles being of different electrical lengths with successive dipoles differing in electrical length with respect to each other by substantially a common scale factor, each dipole and the feeder connected thereto in the region between one dipole pair and the next adjacent dipole pair constituting a cell, the spacings between the dipoles as connected to the feeders differing from each other also by substantially the same common scale factor, the scale factor being so chosen that the combination of dipole lengths and spacings providing the several cells have a substantially uniform wide-band response over several frequency bands bearing substantially harmonic frequency relationships to each other, the connection between the feeder and the dipoles being made in such a manner that the directive gain of the antenna increases with operational shift from one band to another band of higher frequency, and means to connect the feeder to an external circuit at a location substantially removed from the longest of the V-elements in the direction of the smallest of the V-ealements.

10. An aerial system for wide-band use including an elongated two-conductor balanced feeder, a plurality of herringbone-like conducting V-elements planarly arranged and spaced along said feeder, each of the elements having a pair of arms of equal length defining substantially an apex with the apexes of the plurality of V-elements all lying in a substantially straight line, a connection between each of the V-elements and the feeder to terminate the elements substantially at the feeder, the two V-elements forming each pair constituting dipole halves, adjacent dipole sections of the plurality being connected to different feeders and the dipoles being relativtely spaced so that the spacings between successive dipoles differ from each other by substantially a common scale factor, adjacent dipole sections having different electrical lengths, each dipole and the feeder connected between it and the adjacent dipole constituting a cell, the lengths of the dipoles increasing from end of array where spacings between adjacent dipoles is less to end of the array where adjacent dipoles are spaced the greatest distance, the spacings by the scale factor variation between adjacent dipoles being such that a combination of the various dipole lengths and spacings provides a substantially uniform wide-band response over several frequency bands bearing substantially harmonic frequency relationships to each other, the connection being made in such a manner that the directive gain of the antenna increases as the operation shifts from one band to another band of higher frequency, and means to connect the feeder to an external circuit at a location substantially removed from the longest of the V-elements in the direction of the smallest of the V-elements.

11. An antenna system for wide-band use comprising a plurality of at least three linear dipole elements, each dipole composed of two conducting elements planarly arranged in V-formation with the smaller angle between the axes of the elements being in the range from about 62° to 114°, all dipoles lying substantially in a common plane to form a herringbone-like pattern, a two-conductor balanced feeder connected to said elements at substantially the inner ends thereof, said ends being at substantially the apex of each V-formation dipole, the connection from each adjacent dipole section being to a different feeder and the V-formation dipoles being spaced from each other in a gradually decreasing manner from the longest to the shortest, the two elements of each V-formation dipole being of equal length and successive elements being of electrical lengths which differ from one dipole to the *next by a substantially constant scale factor, the apexes of all elements lying in substantially a straight line and all apexes being approximately on the axis of the feeder, and means to connect the feeder elements to an external circuit at a location which is substantially removed from the longest of the dipole elements in the direction of the smallest dipole elements.*

12. An antenna adapted for use over a wide frequency spectrum comprising a multiplicity of substantially coplanarly positioned conducting elements, each element forming half of a dipole with corresponding dipole halves positioned substantially parallel to one another and the two elements of each dipole being of substantially the same length, the electrical lengths of the dipole elements of adjacent dipoles differing by a factor which is substantially the same throughout the antenna so that a progressive length change occurs between the longest and shortest elements, the electrical length of each dipole being approximately an odd multiple of a half wavelength at a frequency within the operating spectrum over which the antenna is to provide a maximum response, the dipole elements of each dipole pair being arranged in V-formation and the elements forming an angle between each other in the region of the open portion of the V-formation which is in the range between about 62° and 114°, a pair of feeder conductors for feeding each pair of dipole elements, one dipole element of each pair being connected to one feeder conductor and the other dipole element of each dipole pair being connected to the opposite feeder conductor, adjacent dipole elements of different dipole pairs being connected to opposite feeder conductors and spaced along the feeders to provide a gradual spacing variance from one end to the other whereby the directive gain of the antenna increases as its operation shifts from one frequency range where the element lengths are approximately an odd integral number of half wavelengths to the next higher frequency range where the element lengths are once more approximately an odd integral number of half wavelengths, and means to connect the feeder elements to an external circuit at a location which is substantially removed from the longest dipole elements in the direction of the shortest dipole elements.

13. An antenna adapted for operating over a wide frequency spectrum comprising a plurality of pairs of conducting linear elements forming dipoles and being so positioned that the elements of each pair are arranged in substantially V-formation and so that all pairs are substantially coplanar and all elements which form each half of the several dipoles are substantially parallel to each other, a pair of feeder conductors for establishing electrical connection between the dipole elements and an external circuit, the individual dipole elements of each pair being so connected to the feeder conductors that one dipole element connects with one conductor and the other dipole element connects with the other conductor, the connections of adjacent dipole elements of each pair being reversed so that the adjacent dipole elements are connected to opposite conductors of the feeder pair, the dipole elements of the several pairs being arranged so that the inner ends of each dipole terminate at substantially the feeder conductors and the angular separation between each dipole element in the region of the open V-formation is in the range from about 62° to about 114°, the dipole elements of each of the several pairs of V-formation dipole elements differing in electrical length progressively and uniformly from each other according to a substantially constant scale factor, the longest dipole elements connecting substantially to one end of the feeder conductors and the smallest of the dipole elements connecting substantially to the opposite end of the feeder conductors, the dipole lengths all being approximately odd multiples of a half wavelength at a frequency within the operating spectrum over which maximum response is achieved and the lengths of the progressively and uniformly changing dipole elements relative to each other being such that in the direction from the longest dipole element to the shortest dipole element the lengths change substantially in accordance with a scale factor lying within the range between 0.80 and 0.95 and the particular frequency at which the individual dipoles provide maximum response progressively changes from the lowest in the operating spectrum near the longest dipole to the highest in the spectrum near the shortest dipole, the parallelly positioned pairs of adjacent dipoles being spaced relative to each other along the feeder substantially according to a selected scale factor determined by the spacing between any two adjacent pairs of dipoles so that the assembly provides substantially log-periodic antenna properties, and means to connect an external circuit to the pair of feeder elements at a location along the feeder conductors substantially removed from the longest of the dipole elements in the direction of the shortest of the dipole elements.

14. An antenna system for wide-band use comprising a minimum of three pairs of conducting V-positioned linear elements substantially coplanarly arranged, a two-conductor balanced feeder connected to said elements at substantially the inner ends thereof, one element of each pair of linear elements being located on the opposite side of the feeder from the other element of the pair with the said elements forming a pair constituting the two halves of a dipole, adjacent elements of the dipoles being parallelly positioned and connected to a different conductor of the balanced feeder, said V-positioned elements all being selectively spaced from each other, the V-positioned elements of each dipole having substantially the same length and each V-positioned dipole substantially defining an apex with the apexes of all of the plurality of V-positioned elements lying substantially in a straight line along the balanced feeder, the smaller angle between the axes of the linear dipole elements being in the range between about 62° and 114°, the electrical length of the linear dipole elements decreasing from one end of the feeder to the other, each dipole and the feeder between adjacent dipoles constituting a cell, the dimension of the several cells measured from the point of connection of one dipole and the feeder to the outer end of the next electrically smaller adjacent dipole also decreasing from one cell to the next in the direction of decreasing dipole length according to a scale factor which is substantially the same for all pairs of adjacent cells along the feeder so that the combination of cells provides a substantially uniform wide-band response over a plurality of frequency bands, the maximum spacing between adjacent dipoles being selected so that the directive gain of the antenna increases as operation shifts from one frequency band to at least one other band of a higher frequency, and means to connect the feeder elements to an external circuit at a location which is substantially removed from the longest of the V-positioned dipole elements in the direction of the shortest of the dipole elements.

15. An antenna system for wide-band use comprising a plurality of spaced linear conducting elements all located substantially coplanarly, the conducting elements being positioned to provide a plurality of V-formation arrangements with each V-formation arrangement including two elements and the plurality providing at least three V-formations, a two-conductor balanced feeder having one conductor connected substantially to the inner end of one element of each V-formation at a point approximately at the V-apex and the other conductor connected substantially to the inner end of the second element of each V-formation also approximately at the V-apex, the elements on each side of the feeder being substantially parallelly positioned, adjacent elements on the same side of the feeder being connected to different conductors of the feeder, the elements of each V-formation dipole having substantially the same length with all V-apexes lying substantially in a straight line, the V-formation elements being spaced from each other along the balanced feeder with each *dipole and the feeder between successive dipoles constituting a cell, the electrical length of each of the adjacent dipoles decreasing from the dipoles connected to the one end of the feeder to those connected to the other end of the feeder, the cell dimension measured from the point of connection of one dipole and the feeder to the outer end of the next electrically smaller adjacent dipole also decreasing from one end of the feeder to the other in the same direction substantially according to a common scale factor, such combination of cells providing a substantially uniform wide-band response over a plurality of frequency bands, the maximum spacing between adjacent dipoles being selected so that the directive gain of the antenna increases as operation shifts from one frequency band to at least one other band of higher frequency, and means to connect the feeder elements at a region substantially removed from the longest dipole elements and in the direction of the smallest dipole elements to an external circuit.*

16. An antenna system for wide-band use comprising a minimum of three pairs of linear conducting elements arranged substantially coplanarly and in V-formation with the apexes of all V-formations being in substantially a straight line, each pair of elements comprising each V-formation providing the halves of a dipole, a two-conductor feeder extending substantially along the line of the apexes of the V-formation conducting elements, the elements which provide the sides of each V-formation dipole half all being substantially parallel and there being a connection from such linear elements to the feeder from substantially the end of the element at the V-formation apex, adjacent parallel linear conducting elements being connected to different conductors of the feeder so that the halves of the dipoles connect to different conductors of the feeder and adjacent dipoles are reversely connected, the halves of the V-formation elements of each dipole being substantially the same length, adjacent dipole elements being spaced from each other along the feeder, the electrical length of the linear conducting elements providing the V-formation dipoles decreasing from one end of the feeder to the other in accordance with a selected common scale factor representing the ratio of lengths between any two adjacent dipoles, each dipole and the feeder between it and the adjacent dipole constituting a cell, the dimension of the several cells measured from the point of connection of one dipole and the feeder to the outer end of the next electrically smaller adjacent dipole also decreasing from one cell to the next in the direction of decreasing dipole length according to a scale factor which is substantially the same for all pairs of adjacent cells along the feeder so that the combination of cells provides a substantially uniform wide-band response over a plurality of selected frequency bands, and means to connect an external circuit to the feeder elements at a location which is substantially removed from the longest of the V-formation dipole elements in the direction of the shortest of the V-formation dipole elements.

17. An antenna system for wide-band use comprising a minimum of three pairs of linear conducting elements arranged substantially coplanarly and in V-formation with the apexes of all V-formation linear conducting elements being in substantially a straight line, each pair of elements comprising each V-formation providing the halves of a dipole, a two-conductor feeder extending substantially along the line of the apexes of the V-formation conducting elements, the elements which provide the sides of each V-formation dipole half all being substantially parallel and there being a connection from such linear elements to the feeder from substantially the end of the element at the V-formation apex, adjacent parallel linear conducting elements being connected to different conductors of the feeder so that the halves of the dipoles connect to different conductors of the feeder and adjacent dipoles are reversely connected, the halves of the V-formation elements of each dipole being substantially the same length, adjacent dipole elements being spaced from each other along the feeder, the electrical length of the linear conducting elements providing the V-formation dipoles decreasing from one end of the feeder to the other substantially in accordance with a selected common scale factor representing the ratio of lengths between any two adjacent dipoles, each dipole and the feeder between it and the adjacent dipole constituting a cell, the cell dimension from the inner end of one dipole to the outer end of the next electrically smaller adjacent dipole also decreasing from one cell to the next in the direction from the longer to the shorter dipoles so that the combination of cells provides a substantially uniform wide-band response over a plurality of selected frequency bands, and means to connect an external circuit to the feeder elements at a location which is substantially removed from the longest of the V-formation dipole elements in the direction of the shortest of the V-formation dipole elements.

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HERMAN KARL SAALBACH, *Primary Examiner.*

ELI LIEBERMAN, *Examiner.*

PX 57

Sept. 1, 1931. H. O. PETERSON 1,821,402

ANTENNA

Filed Nov. 8, 1927 2 Sheets-Sheet 1

Fig.1

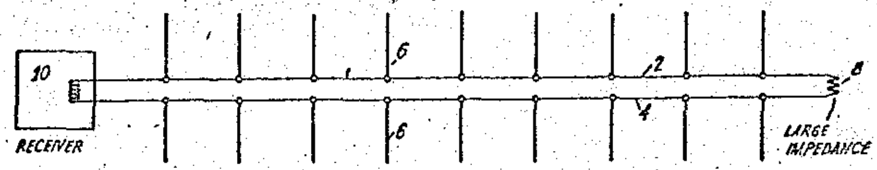
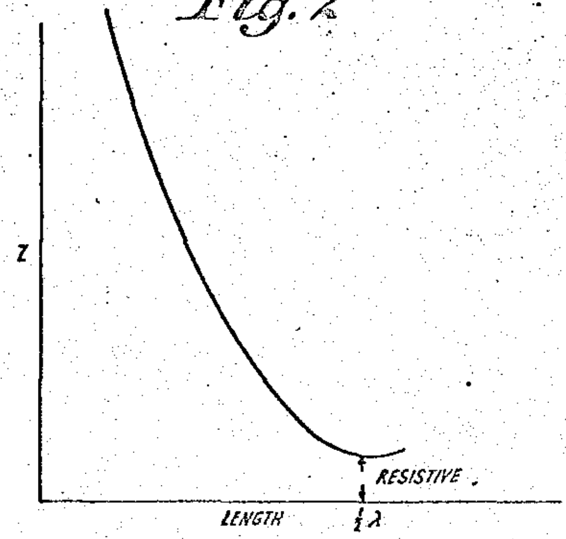


Fig.2



UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN

PLAINTIFF EX. NO. 57

DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

Fig.3

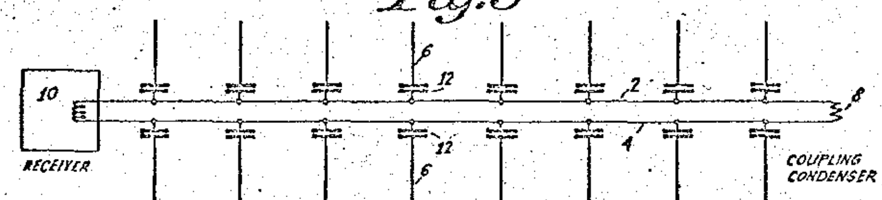


Fig.4

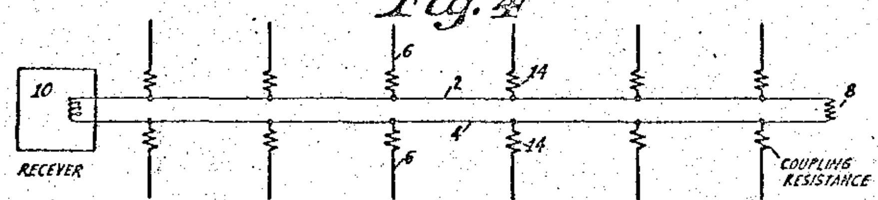


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Fig. 5

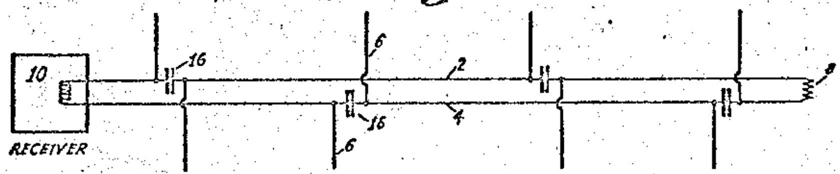


Fig. 6

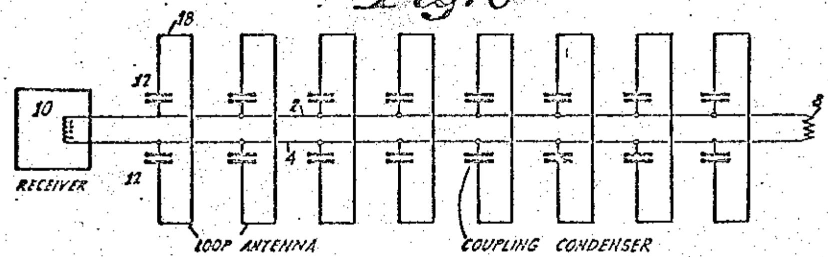


Fig. 7

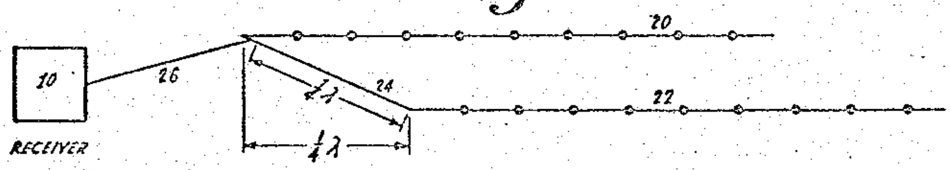
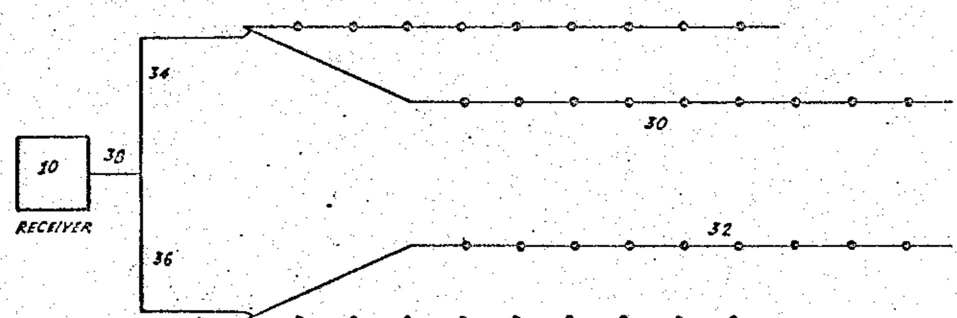


Fig. 8



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Patented Sept. 1, 1931 1,821,402

UNITED STATES PATENT OFFICE

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ANTENNA

Application filed November 8, 1927. Serial No. 231,804.

This invention relates to antennæ for the reception of radiant energy, and more particularly to directive antennæ for the reception of signals transmitted on very short waves.

A favored type of directive receiving antenna is the wave antenna invented by H. H. Beverage, but the ordinary wave antenna is not suitable for the reception of short wave energy. The difficulty seems to be that the great reduction in the horizontal length of the antenna at short wave lengths, makes the horizontal length become comparable with the vertical height above ground, as a result of which the ordinary nondirectional antenna effect becomes comparable with the directive or cumulative antenna effect, and thereby greatly distorts the directive characteristics of the antenna.

To overcome this difficulty Clarence W. Hansell, in a copending application Serial Number 161,171, filed Jan. 18, 1927, suggested the use of a special form of wave antenna comprising two wires a plurality of waves long, spaced about a half wave apart, and extending in the direction of desired reception, with a large number of doublets or half wave antennæ coupled transversely between the longitudinal wires or feeder members. I have found that by a simple change in construction I can greatly improve the operation of such an antenna, and to so do is one object of my invention.

The energy in the transverse pickup units is applied to the feeder members at phase displacements approximating those of the wave travelling in space, and therefore in order that the energy shall add cumulatively in proper phase, it is necessary that the velocity on the feeder members be substantially equal to that of the wave in space. An ordinary transmission line will transfer energy at a velocity very closely approximating that of a wave in space, but the addition of distributed transverse impedance to such a line will cause it to have a lower velocity. The transverse pickup units, if tuned, load the line as resistances of relatively small value, and therefore greatly lower the velocity on the loaded line relative to that of light.

In the application of Clarence W. Hansell already referred to, it was suggested to overcome this difficulty by suitably tuning the line for increased velocity. I find that a much simpler way to accomplish the same result is to use pickup units of high impedance, or to loosely couple the units to the feeder members through high impedances, and to employ relatively closely spaced feeder members. The impedance of the pickup wires may be increased by making them shorter than a half wave in length, so that they are not tuned, and they are coupled externally of the feeder members, rather than between them. With this arrangement an antenna only a wave in length is markedly directive, though antennæ two or three waves in length may be used conveniently, and give even better directivity and pickup.

The facts that the feeder members, being closely spaced, do not themselves pick up received energy, that the surge impedance later referred to is in the form of an ohmic resistance, and that the transverse pickup means are untuned, being different in length from a true half wave, result in that the antenna may efficiently receive an appreciable band of frequencies, that is, the antenna is not critically tuned. This result is desirable, and to make possible the reception of an even greater band of wave lengths is another object of my invention. For this purpose I find it desirable to limit the loading which the transverse pickup means apply to the feeder members by means other than the reduction in length of the transverse doublets, for the proportional reduction in length for a given transversal varies rapidly relative to a change in wave length. I therefore couple the pickup means to the feeder members through limiting impedances, which may preferably take the form of small series condensers. By loosely coupling the pickup wires to the feeder members in this manner they have less effect upon the line velocity, and their effect remains small in spite of appreciably large variations in the length of the received wave.

It is also an object of this invention to make the antenna unilateral in directivity, which I do by closing the end of the feed line nearest the desired transmission station with a resistance equal to the surge impedance of the line, which absorbs energy approaching from the opposite direction, and thereby prevents its reflection back to the receiver coupled to the other end of the feed line. The damping impedance is equal to the surge impedance of the transmission line as loaded by the pickup devices.

The surge resistance at the end of the feeder members fairly effectively prevents pickup of signals coming from a direction opposite to that desired, but back end residuals will nevertheless occur, just as in the case of a long wave antenna. To obviate these I use a plurality of antennæ located in broadside and displaced an odd number of quarter wave lengths, relative to the wave front of the approaching wave, so that the resulting phase opposition caused by unsymmetrical coupling neutralizes the undesired signals, as will be explained in more detail later.

A still further object of my invention is to increase the sharpness of directivity of such an antenna system, which I do by employing a plurality of end-on antennæ, or of staggered pairs of antennæ, such as have already been described, positioned relatively in broadside, and coupled together by symmetrically branched transmission lines.

The invention is more completely described in the following specification, accompanied by drawings in which

Figure 1 represents an antenna embodying my invention in a simple form;

Figure 2 is a curve showing the effect of the length of a transversal on its impedance;

Figure 3 illustrates the use of coupling condensers;

Figure 4 illustrates the use of coupling resistances;

Figure 5 is a modification in which the pickup means are connected in series, rather than in parallel;

Figure 6 shows loop antennæ instead of simple transverse wires for the pickup means.

Figure 7 shows a staggered pair of antennæ; and

Figure 8 shows a broadside combination of staggered pairs of antennæ.

Referring to Figure 1 it will be seen that there is a pair of linear feeder members 2 and 4, to which there are coupled transverse pickup wires 6. The feeder members alone would transfer energy at a velocity almost equal to that of light. However, with transverse impedances connected across the line the velocity is reduced.

In Figure 2 the impedance of a transversal is shown as a function of its length. It is seen that at a half wave length the impedance is low and is resistive, the transversal being tuned. This is a condition in which the transversals most greatly reduce the desired high feed line velocity. By shortening the doublets their impedance is greatly increased, and their effect on the line velocity may be brought within allowable limits. Hence in Figure 1 the length of each transverse wire is substantially less than a half wave length.

The feeder members need be only approximately a wave in length and a good directive pattern will be obtained. But a length of two or three waves adds to the directivity and the pickup, and therefore is preferable. However, this leads to the necessity for higher line velocities, for while a velocity of about 80 percent, relative to light, is sufficient when the feeder members are only one wave long, velocities of about 90 to 95 percent are respectively needed for antennæ, three to six waves long, if the energies of the pickup wires at the remote end of the antenna are to add, rather than oppose, the line energy.

The end towards the transmitter is closed by a resistance 8, equal to the surge impedance of the feeder members, considered as a loaded transmission line, while the end remote from the transmitter is coupled to a suitable receiver 10.

In Figure 3 the arrangement is similar to that shown in Figure 1 except that the transverse pickup wires 6 have been coupled to the feeder members 2 and 4 by small series coupling condensers 12. By their use the transversals are loosely coupled to the feeder members, so that the effective loading is reduced. For this reason the transversals need not be shortened so much, or from another and more practical view point, for a given length of transversal the antenna is suitable for a greater band of applied frequencies.

Figure 4 is similar to Figure 3 except that in place of the coupling condensers 12 there have been used coupling resistances 14.

In Figure 5 I have shown a modification designed to add the potential pickup of the various transversals in series, rather than in parallel, and for this purpose the two halves of the transversal are connected on either side of a series condenser 16 to one or the other of the feeder members. By this arrangement the coupling condensers are in series with the line, and tend to increase its velocity.

So far I have assumed that the pickup means are simple transverse wires, but the same principle, namely, the limiting or reduction of the effect of the individual pickup means on the velocity characteristics of the feeder members, may equally well be applied to other types of pickup means, exemplified by the loop antennæ 18 in Figure 5. These are loosely coupled to the feeder members 2 and 4 through small coupling condensers 12.

It has already been pointed out that in spite of the surge resistance 8 some residual back end pickup may be noted at the receiver. To completely obviate this I may resort to the arrangement shown in Figure 7 in which the pair of antennæ 20 and 22, arranged relatively in broadside but only about a tenth of a wave apart, are displaced a quarter wave length relative to the wave front of the approaching wave. The feeder members have negligible pickup, because of their close juxtaposition, and similarly the collecting transmission line 24 has negligible pickup, but there is a phase displacement in quadrature taking place across a quarter wave of its length, and therefore signals approaching from the desired direction combine in phase at the transmission line 26, for it is connected to the mid point of the remaining portion of the line 24, and the sum of the signals is applied to the receiver 10. However, energy travelling in the opposite direction reaches corresponding portions of the antennæ at a quarter wave apart in phase, and the energy from the antenna 22 experiences another quarter wave displacement in traversing the extra quarter wave length of the transmission line 24, hence the energies combine at a phase displacement of 180°, and neutralize one another. While the neutralization of residuals is perfect at only one wave length, the staggered pair of antennæ is equally good for desired signals over a full band of wave lengths, inasmuch as the signals are always combined in phase.

Figure 8 is a broadside array of staggered pairs of antennæ. The pair 30 and the pair 32 are each arranged as was the staggered pair in Figure 7, and their outputs are combined in phase by a symmetrically branched system of transmission lines comprising the lines 34, 36 and 38, the latter of which leads to a receiver 10.

I claim:

1. A directive receiving antenna for short waves comprising a pair of feeder members and a plurality of transverse pickup wires coupled to the feeder members, said pickup wires being substantially smaller than a half wave in length in order to detune them and to limit their effect on the velocity of energy transfer on the feeder members.

2. A directive receiving antenna for short waves comprising a pair of relatively closely spaced feeder members and a plurality of transverse pickup wires externally coupled to the feeder members, said pickup wires being substantially smaller than a half wave in length in order to detune them and to limit their effect on the velocity of energy transfer on the feeder members.

3. A directive receiving antenna for short waves comprising a pair of relatively closely spaced feeder members extending in the direction of desired reception and a plurality of transverse pickup wires externally coupled to the feeder members, said pickup wires being substantially smaller than a half wave in length in order to detune them and to limit their effect on the velocity of energy transfer on the feeder members.

4. A directive receiving antenna for short waves comprising a pair of relatively closely spaced feeder members extending in the direction of desired reception, a plurality of transverse pickup means arranged externally of the feeder members, and relatively high impedances loosely coupling the pickup wires to the feeder members in order to limit the effect of the impedance of the pickup means on the velocity of energy transfer on the feeder members.

5. A directive receiving antenna for short waves comprising a pair of relatively closely spaced feeder members extending in the direction of desired reception, a plurality of transverse pickup means arranged externally of the feeder members, and small condensers coupling the pickup means to the feeder members in order to limit the effect of the impedance of the pickup means on the velocity of energy transfer on the feeder members.

6. A directive receiving antenna for short waves comprising a pair of relatively closely spaced feeder members extending in the direction of desired reception, a plurality of transverse pickup means externally coupled to the feeder members, and a resistance equal to the surge impedance of the system connected across the end of the feeder members nearer the desired transmission station.

7. A directive receiving antenna for short waves comprising a pair of relatively closely spaced feeder members extending in the direction of desired reception, a plurality of pickup wires transversely and externally positioned relative to the feeder members, a plurality of impedances loosely coupling the pickup wires to the feeder members, and a resistance equal to the surge impedance of the system connected across the feeder members at the end nearer the desired transmission station.

8. A directive receiving antenna for short waves comprising a plurality of pairs of relatively closely spaced feeder members each extending in the direction of desired reception and located relatively in broadside, a plurality of transverse pickup means externally coupled to the feeder members, said pickup means being detuned to limit their effect on the velocity of energy transfer on the feeder members and a transmission line system interconnecting the feeder members in proper relation to combine their energies cophasially.

9. A unilaterally directive receiving antenna for the reception of short waves comprising a pair of relatively closely spaced feeder members each extending in the direction of desired reception and located relatively cosely in broadside but staggered an odd number of quarter wave lengths relative

to the wave front of an approaching wave, a plurality of transverse pickup means externally coupled to the feeder members, and means for combining the energies of the feeder members cophasially with respect to energy approaching from the desired direction, whereby reflected energy pickup from energy travelling in the opposite direction is combined in phase opposition.

10. A unilaterally directive receiving antenna for the reception of short waves comprising a pair of relatively closely spaced feeder members each extending in the direction of desired reception and located relatively in broadside but staggered a quarter wave length relative to the wave front of an approaching wave, a plurality of transverse pickup means externally coupled to the feeder members, a collecting transmission line connecting the ends of the feeder members remote from the desired transmission station, a receiver, and a transmission line unsymmetrically coupling the receiver to the collecting transmission line in order to introduce a quarter wave change in phase.

11. A unilaterally directive receiving antenna for the reception of short waves comprising a plurality of staggered pairs of antennæ located in broadside, each pair of antennæ comprising a plurality of pairs of relatively closely spaced feeder members extending in the direction of desired reception, and located relatively in broadside but staggered an odd number of quarter wave lengths relative to the wave front of an approaching wave, a plurality of transverse pickup means externally coupled to the feeder members, means for combining the energies of the feeder members in each pair of antennæ cophasially with respect to energy coming from the desired direction, whereby reflected energy pickup from energy travelling in the opposite direction is neutralized, and means for combining the energies from all of the pairs of antennæ in proper phase for utilization in a receiver.

12. An extensive antenna system for receiving electromagnetic waves comprising closely spaced, substantially linear feeder members and transverse pick-up conductors symmetrically coupled thereto through series resistances.

13. An extensive antenna system for receiving electromagnetic waves comprising closely spaced, substantially linear feeder members and a plurality of pick-up conductors transversely, externally and symmetrically coupled thereto through series resistances.

14. An extensive antenna receiving system comprising feeder members and a plurality of conductive pick-up elements transversely and externally coupled thereto through series limiting impedances.

15. A directive antenna system for receiving electromagnetic waves comprising a two conductor transmission line linear throughout its length, a plurality of linear pick-up elements parallel to each other arranged in one plane, a limiting impedance for connecting each of said elements externally to one of said conductors, another plurality of pick-up elements parallel to each other and arranged in the same plane as the plane of said first mentioned plurality of elements, and, an impedance, in series with each of said elements of said second mentioned plurality for connecting each of said elements to the other conductor of said line.

16. A directive receiving antenna for short waves comprising a pair of relatively closely spaced conductors linear and continuously conductive throughout their length forming a transmission line extending in the direction of desired reception, a plurality of linear pick-up elements externally coupled to one of said conductors, all of the said pick-up elements being parallel and lying in one plane, another plurality of linear pick-up elements parallel to each other lying in the same plane as said first mentioned plurality of elements, coupled to the other conductor of said line, and, an impedance, equal to the surge impedance of the system connected across the end of the transmission line nearer the desired transmission station.

17. A receiving system as defined in claim 16 characterized by the additional feature that each of the pick-up elements is coupled to its linear conductor through a series impedance.

HAROLD O. PETERSON.

J-1 R+R

July 5, 1966 I. S. BLONDER ETAL **3,259,904**

ANTENNA HAVING COMBINED SUPPORT AND LEAD-IN

Filed Nov. 21, 1963

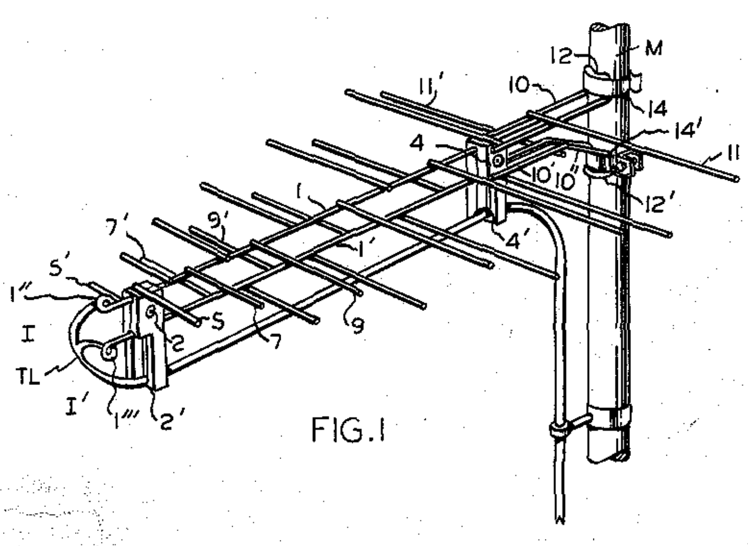

FIG. 1

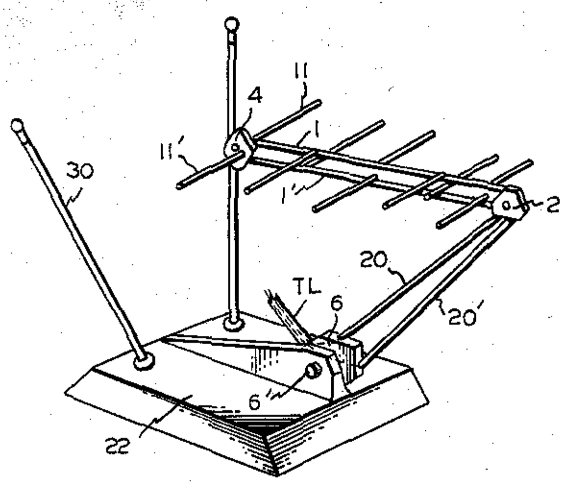

FIG. 2

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BY Rines and Rines

ATTORNEYS

United States Patent Office 3,259,904
Patented July 5, 1966

1

3,259,904

ANTENNA HAVING COMBINED SUPPORT AND LEAD-IN

Isaac S. Blonder, West Orange, N.J., and Abraham Schenfeld, New York, N.Y., assignors to Blonder-Tongue Electronics, Newark, N.J., a corporation of New Jersey

Filed Nov. 21, 1963, Ser. No. 325,511
6 Claims. (Cl. 343—792.5)

The present invention relates to directive antennas and, more specifically, to antennas adapted for receiving very high frequencies, such as the ultra-high-frequency television band.

Numerous types of antennas have been evolved for broad-band directive radio and television reception including driven arrays, Yagi-type arrays, log periodic linear and V-type antennas, helical antennas and other configurations. The problems of mounting such antennas upon masts for outdoor operation or upon portable structures adapted for directional adjustment in connection with indoor reception have, however, long plagued the art; the mounting and adjusting structures introducing "ghosts" and other deleterious electrical field-pattern aberrations over the band. It is to the improvement of such mounting structures and the minimizing of electrical interfering effects over a wide band of frequencies, including stabilizing of outdoor performance and providing for ready adjustability in indoor performance, that the present invention is primarily directed.

A further object of the invention is to provide a new and improved antenna particularly adapted for ultra-high-frequency television reception.

Still another object is to provide a novel antenna of improved performance for more general use, also.

Other objects will be made more evident hereinafter and will be particularly pointed out in the appended claims. In summary, however, the invention contemplates a pair of rigid conductors held spaced a predetermined vertical distance apart in a vertical plane, first and second pluralities of horizontal dipole elements lying in corresponding first and second vertically spaced horizontal planes containing the respective conductors, the dipole elements extending from opposite sides of each conductor at successive points therealong with dipole elements connected to one conductor extending in opposite horizontal directions to the corresponding dipole elements of the other conductor, the length of the dipole elements successively increasing from one end of the conductors towards the other end thereof, means for feeding the energy received by the antenna at the said one end of the conductors, and means for mounting the antenna comprising a further pair of rigid, preferably diverging, conductive extensions of the said conductors mechanically secured in rigid spaced-apart relation at the end thereof. Further preferred details are hereinafter set forth.

The invention will now be described in connection with the accompanying drawing, FIG. 1 of which is an isometric view of an outdoor preferred embodiment thereof; and

FIG. 2 is a similar view of a modified indoor version.

Referring to FIG. 1, the antenna comprises a pair of rigid conductors **1, 1'** held spaced apart a predetermined vertical distance in a vertical plane by forward and rearward insulating clamps **2** and **4**. While the terms "vertical" and "horizontal" as herein employed describe the preferred orientation for ultra-high-frequency television reception, they are intended more generically to be illustrative of relative orientations without being confined to actual direction. Similarly, though the invention is decribed in connection with radio-wave reception, the antenna may also be used for transmission, if desired, as is well known.

2

Unlike prior-art arrays, including Yagi arrays, conventional log-periodic structure and the like, first and second pluralities of horizontal dipole elements **5, 7, 9 . . . 11** and **5', 7', 9' . . . 11'** are provided, lying in corresponding first and second vertically spaced horizontal planes I and I' containing the respective longitudinal conductors **1** and **1'**. The dipole elements are shown angularly extending transversely from opposite sides of each conductor at successive points therealong. The dipole elements connected to one conductor, moreover, extend in opposite horizontal directions to the corresponding dipole elements of the other conductor (such as **5** to the right **5'** to the left; **7** to the right, **7'** to the left; and so on). The length of the dipole elements preferably successively increases from one end (**5, 5'** being shortest) towards the other end (**11, 11'** being longest), as is well known, to provide directivity. A parallel-wire transmission line TL is connected at looped terminal portions **1''** and **1'''** beyond the clamp **2** that secures the connecting portions **1''** and **1'''** in spaced-apart relation, extending outside or to the left of the smallest dipole elements **5, 5'**. The line TL may be supported below the antenna by depending guides **2'** and **4'** in the respective clamps **2** and **4**, the latter being shown positioned near the largest dipole elements **11, 11'**.

The antenna of FIG. 1 is mounted upon a mast M through the use of pairs of horizontally spaced conductor-loop extensions **10** and **10'**, shown extending to the right beyond the longest dipole elements **11, 11'**. The extensions **10, 10'**, respectively, terminate in upwardly and downwardly extending vertical loops **12** and **12'** that may be transversely curved to fit the mast M, as shown, and are securely mechanically strapped at **14** and **14'** to the mast to hold the system **1–1'** in rigid spaced-apart relation at the mast end. Further to aid in mechanical stability, the extension **10'**, while in part initially extending in the lower horizontal plane I', diverges downwardly at **10''**. Fortuitously, this mechanical stability-providing diverging construction has been found minimally to affect the electrical field pattern, particularly if the length of the extension between the longest elements **11, 11'** and the mast M is made comparable to the separation along conductors **1** and **1'** of the last dipole elements **11** from the next-to-the-last element, to its left in FIG. 1. Minimal field abberations and "ghost" reflections over the complete ultra-high-frequency band, for example, has been thus attained with the above construction, together with satisfactory broad-band impedance matching, provided further that the vertical separation distance of the rigid conductors **1, 1'** is kept less than the average distance between successive dipole elements (preferably the order of an inch for UHF band operation), and which, in turn, is kept much less than the wavelengths involved, as is well known. At the UHF channel 47 frequency, for example (671 megacycles), a 20 decibel front-to-back ratio has been obtained with this construction, providing about a 36-degree half-power horizontal beam width and no detectable forward secondary lobes.

This same general type of construction has also been found admirably suited for indoor direction adjustable antennas, as shown in FIG. 2. In this embodiment, however, the small-dipole end of the antenna is used not only for the connection to the transmission line, but also for the support-providing extensions. These extensions are illustrated as rigid conductors **20** and **20'** depending at preferably an acute angle below the antenna at the insulating clamp **2** and slightly diverging for mechanical and impedance-matching purposes, being clamped at their bottom or free ends by a further insulating clamp **6**. The transmission line TL is thus connected to the conductors **1** and **1'** by these combined extension-supporting and transmission-line feed members **20, 20'**. The clamp **6** is pivoted at **6'** to a bracket carried by a base **22** so that the members **1–1′**, **20–20′** may be adjusted as a unit for both electrical impedance-matching purposes and appropriate pivoting action for reception-direction adjustment, the length of the preferably diverging extension lines **20**, **20′** is made substantially equal to the length of the rigid antenna-supporting conductors **1**, **1′**.

If VHF reception is also to be provided, it has been found that minimal interference is caused by the antenna of the present invention if V-type VHF dipoles **30** are mounted on the base forward of the pivoted clamp **6** and with a sufficient included angle in the V to contain the array of the invention.

Further modifications will occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. An antenna for ultra-high-frequency operation and the like, having, in combination, a pair of rigid conductors held spaced a predetermined vertical distance apart in a vertical plane, first and second pluralities of horizontal dipole elements lying in corresponding first and second vertically spaced horizontal planes containing the respective conductors, the dipole elements extending from opposite sides of each conductor at successive points therealong with dipole elements connected to one conductor extending in opposite horizontal directions to the corresponding dipole elements of the other conductor, the length of the dipole elements successively increasing from one end of the conductors towards the other end thereof, means for connecting a parallel-wire transmission line to the said one end of the conductors and means for mounting the antenna comprising a further pair of rigid diverging conductive extensions of said conductors mechanically secured in rigid spaced-apart relation at an end thereof, the said diverging conductive extensions being provided at the said other end of the pair of rigid conductors and each comprising a pair of horizontally spaced conductors terminally provided with a vertical loop, and the said mechanical securing means comprising mast-strapping means for strapping the said vertical loops, and the distance of the said mast-strapping loops from the said other end being comparable to the distance between the longest and next-to-longest pairs of dipole elements of the antenna.

2. An antenna for ultra-high-frequency operation and the like, having, in combination, a pair of rigid conductors held spaced a predetermined vertical distance apart in a vertical plane, first and second pluralities of horizontal dipole elements lying in corresponding first and second vertically spaced horizontal planes containing the respective conductors, the dipole elements extending from opposite sides of each conductor at successive points therealong with dipole elements connected to one conductor extending in opposite horizontal directions to the corresponding dipole elements of the other conductor, the length of the dipole elements successively increasing from one end of the conductors towards the other end thereof, means for connecting a parallel-wire transmission line to the said one end of the conductors and means for mounting the antenna comprising a further pair of rigid diverging conductive extensions of said conductors mechanically secured in rigid spaced-apart relation at an end thereof, the transmission-line connecting means and the diverging conductive extensions being combined and extending downward from the said one end to include an acute angle between the dipole carrying conductors and their extensions.

3. An antenna as claimed in claim **2** and in which the conductive extensions are clamped at their free ends against relative movement with the clamp being pivotally mounted upon a base to permit adjustment, as a unit, of the dipole-carrying conductors and their extensions.

4. An antenna as claimed in claim **3** and in which a pair of V-type dipole elements for different frequency reception, are mounted on the said base forward of the pivotal clamp, with the said horizontal dipole elements contained within the V.

5. An antenna for operation over a predetermined frequency band, having, in combination, a pair of rigid longitudinal conductors held spaced a predetermined vertical distance apart in a vertical plane, first and second pluralities of dipole elements lying in corresponding first and second vertically spaced horizontal planes containing the respective conductors, the dipole elements extending from opposite sides of and transversely at an angle to each conductor at successive points therealong with dipole elements connected to one conductor extending in opposite direction to the corresponding dipole elements of the other conductor, the length of the dipole elements successively increasing from one end of the conductors towards the other end thereof, means for connecting a parallel-wire transmission line to the said one end of the conductors, rigid insulating means securing the said connecting means mechanically in spaced-apart relation and connected with means for supporting the transmission line near the said one end, and means for mounting the antenna at a region of the said conductors remote from the said one end, further rigid insulating means being provided for securing the said longitudinal conductors mechanically in rigid spaced-apart relation near the said region, the said vertical distance being less than the distances between the said successive points and less than the wavelengths of the said band.

6. An antenna as claimed in claim **2** and in which the lengths of the said conductors and of their extensions are substantially equal.

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3,212,094	10/1965	Berry	343—792.5

HERMAN KARL SAALBACH, *Primary Examiner.*

C. BARAFF, E. LIEBERMAN, *Assistant Examiners.*

Mapp – rebuttal

ejuagular – Runny inventor?

(✗) (✗) Sheet metal antennas couldn't be used in TV commercial means?
(JFD UHF?) VU VISTA UHF [illegible]

Isbell found that if angle too small
P.Ex.47 couldn't get impedance to operation frequency [illegible]

only B' goes to 0 – impedance goes – not [illegible]
[illegible] capable of practical use.

P.Ex.46 – [illegible] by geometry – ratio of dimensions/lengths of teeth have same ratio

Spacing?

(✗) No way of predicting by pres. structure whether cells will have freq independ
[See DEx 7]

Few guide lines then.

(2)

(+) 10 8 attempts / -- 1 in attempts
to achieve ~~Tibbett's~~ claim of PX 1,

PX-30 — wave ~~good~~ guide in function
~~to~~ through ~~none~~ or coax
(Spiral

improved
Don't your known structures, P Ex 31, 32.
(+) (+) have been made & known as
ground hard chrome
~~type wedge antenna~~ — Godley 2083,260
P. Ex 16

(+) Ex. 31 + 32 + 37, 38 — all ground plane antennas —
~~to~~ ~~[illegible]~~ art of Tibbett pat
as ~~[illegible]~~ a ground plane antenna? P Ex 1?

your Myrick Cane pat — P Ex 20

{ When Dipole of P Ex 36 made?
{ at ~~that~~ time were transmitted feeds known in dipole arrays

note for us

(3)

It may be that existence structure & some shapes of lip per are not [illegible] predurally, [illegible] most relevant to [illegible] patent, or longer + [illegible] an [illegible] of the same, — or ~~[illegible]~~ [illegible] [illegible] [illegible]?

Jack — quote.

~~extreme [illegible] dapened extreme [illegible] effect on [illegible]?~~

(sd[illegible] plane — [illegible].) ~~among dipoles~~

(an reference [illegible] longer [illegible] + alt [illegible]?

no prior lip per - ~~[illegible]~~ dipoles beyond [illegible]

[illegible] channel?

(4)

Uniform ~~gain~~ channel bandwidth of 6 Mc — merging these depths any ... Tubbed that had convenant or uniform gain of ~~the 6~~ an same bandwidth.

~~Rebuttal~~

[Defense evidence]

(1)

Mr Hamel

~~until '51~~

now with Hughes — 7 yrs.

~~P. Ex 50~~ —

P Ex 51 — 4 - known as has been made to more articles in Electronic Design.

What do you mean it did not make

(*) none of these did not function as LP antennas wires + tubes — LP

What's the nature of arrangement - your drawing - based on under which you receive royalties from licensed LP patents. any functional return from LP antennas licensed under Foundation ~~Patent~~ patents

Do you know if Hughes gets any income [15% net and for all inventions and you receive on sale of all items]

Did not continue any antennas similar,

P. did you continue —

Simpler approach

Hammel

(2) Design principles did not make the cell... any later computer — by permuting complementary condition

(Planning, ... elimination — repeat cells — 2 different size)

planned not necessary in later ones

planar patterns — sheet metal

complementary — replace metal by air.

after thinking have

(t) Not simplified — as that ... — clear principles.

(3)

P Ex 55 - Jarek --

p 18 - 13 -

D Ex 14 - der Hamel patent

X-examination - correctness of col. 2 - lines 52 - 54)

Beg paused for appear here

What about other the Fig. 4 - bad for < 7?

(3) cross feeds

(P) 215 - 2[illegible]

(1) ratio length of two-dim elements same & comp. defined

(2) elec. spacing

(4) When I get zig-zag at 0 -- arrays?

all the upper & lower arrays & planes

[illegible] the upper & lower antenna elements in expand towards vertical planes?

(4) New antenna :-

~~2-3 B incorporate~~

~~Offset design~~

---

(5)

Mayer (cont) – apt. Trans.

~~shape for thin layer – circular cylinder~~

3/4" – what fraction of λ at high end of VHF band

(7A) 1/12–1/10 λ at high end VHF

1" – (8A) 1/2" at VHF ~~then fraction of λ~~

checked → 1 1/32

ONLY λ DISTANCE support/radiation–transmit separation, width, depend on Dipole

compare?

my own knowledge of resonance, layers – 1/12 or 1/20 of λ

Agree with Harris – separation at high end –1/100 λ at high end ~~what~~ ~~asked~~ ~~a~~ ~~NOT~~ ~~change of~~ ~~spacing~~ ~~affects~~ ~~Fraction of~~

POINT OF SEPARATION – where they are closer – gets poor – *

When was first time

~~Had~~ you known of

your theory of this order of a magnitude – they also know that by pencil

never could till by dimensionally spread places when 12T

cross of T shell (or [illegible] element)

antenna

first with

spaced planes

with 11-mm line.

Standard cross to turn [illegible]

~~that~~ when J.T.D. mentioned spacing
minimum antenna
~~[illegible]~~ after — drawings from planes —

[illegible] [illegible] ?
[illegible] cross

DX14 ~~under~~
Mulhauser

Do you disagree with Mulhauser
Spratum that tooth inventor
in Fig 5 reduced from ~~that~~ of Fig 4

?

That end col. 10 — line 14.—

Katzin – teaches

Quote Stevens

No. 3.

Capacitive ~~direct~~ connections both well known at time & Galvanic

Katzin apples (?) 6 line in

pass current ~~do same thing~~ from antenna same way – same reasons

p. 2. col. 1

c18-57

Direct current involved in Katzin antenna – radio circuits all a.c.

capac. & direct connections both present

P. Ex 5 ~~[illegible]~~

Ex. 0 [illegible] Pi Stevens patent 1,821,402

Fig. 5 – shows X connection

P. Ex 3
Patterson [illegible] in
Fig 3 C & log remainder
(tertiary structure;
Schwartz that all the residues — Anemone devices)

(PX57)
(*) Patterson P. Ex 40 [illegible] mentioned in Patterson (D Ex 3) - [illegible]
Fig 5 shows transposed [illegible] between [illegible]

any
PR [illegible], [illegible] of first line.
Knows manifest effect of temperature prior to 1958.

See Patterson P. Ex. 17

D. Ex. 19
Schwartz

col 11. line 52-65
counter [illegible]
drawing lines 62-67 [illegible]

log remainder [illegible]

Fact that only structural change between Fig 19 of Mr. [illegible] & third leg & still is bend, applies to V shape!

Purpose of V-shape in Fig. 8

Carter

1. 9X15

Drawn graphs Fig 12
cover also 1/2 dipole elements

cover total included V angle of
for 3/4 dipole (3/4 dia)

57°

x2 → ≈ 114°

~~3/4 dipole~~

1/2 dipole

1/4 dipoles

$2\,1/4\times$ ≈ 31° total ≈ 62°

Back in 1930!

Compare 62° & 114° — p. 9 Myers Claims per PEx20
Same 62° & 114°?

Kolster - PEX18

Sand - Large ratio of diameter to length in conical dipole 12,1% -

~~Has~~

If we call dipole elements teeth - - is a larger tooth width than a ~~[illegible]~~ wire dipole? - The smaller the dipole ~~[illegible]~~ wire, the nearer zero becomes the tooth width?

(col. 3, line 46)

During [illegible] dipole also well known in line of [illegible] pattern to decrease [illegible] bandwidth of dipole

7 ~~flat strips~~ ~~has~~

Triangular or conical shaped elements called dipoles (col. 2, line 41) - through 8 inches ~~[illegible]~~ across ~~[illegible]~~ dipole (or teeth)

Flat strips also called dipoles (28, FO. 1

(col. 4 line 17) Recognized that thickening dipole measurements broadened bandresponse

D Ex 16

~~Scott; Figs 19, 20, 21~~ – – For that antenna – strip line, zig zag, – trapezoidal arrays all equalize.

~~nothing coverlands & Vanceplants;~~
~~[illegible]~~

D Ex 17 – Peterson

~~Not Lys permits arrange only 2 elements – [illegible] many elements~~

~~Depends~~

~~Patented shows only 2 elements – so wouldn't help render~~

~~Doesn't the patent not say can have more than 2 elements – p. 2, col. 1, line 63 – –~~

~~omitted to mention~~

Isn't crossed ~~or transposed~~ feeder R of Fig. 6 same as used in Isbell?

Fig 6 – strap – dipoles

Fig 7 – here not v/x 3 same crossed or transposed feeder Run 1957?

(as in Myers & Carrel patent answer?)

Agree ~~is~~ the invention of Tibbell patent P Ex 1 completed before your & Carrel made the invention of your patent ~~P Ex~~ P Ex 20, in issue?

~~Grays [illegible]~~
~~Agree Tibbell invention published or written~~
a ~~[illegible] Sept 30, 1960~~ ~~{ before Sept 30, 1959 }~~.

Structural diff between Myers & Carrel antenna patent & that of Tibbell patent P Ex 1 is bends of stepped dipoles into V's?

Warner BT dept P Ex 10's th
~~When~~ was 1st ~~[illegible]~~ two- ~~parallel~~ -plane ~~[illegible]~~ log periodic between feeding dipole antenna with 300 ohm feed on the [illegible] of your (VBI)

JFD follow?
JFD increase spacing between planes at anytime? when?

ROBERT HESLIN WA2IQC/7
FAIRCHILD STRATOS CORPORATION
YUMA TEST STATION
YUMA, ARIZONA

November 13, 1961

ONE ANTENNA FOR 2, 1-1/4" & 3/4" METERS

One ~~of the biggest~~ problems confronting the amateur who works ~~many~~ different bands is that of finding room for all the necessary antennas. Here ~~is one antenna which~~ is simple to construct, inexpensive, and covers three bands. In addition, it will give ~~6.5 db of~~ gain over a dipole, with constant impedance and radiation pattern characteristics versus frequency. The ~~antenna about to be~~ described is not new by any means. It is being used both commercially and by the Military in many different forms.

~~The results show an antenna of moderate size, constant gain, impedance and radiation patterns over the entire three bands of interest.~~ The structure can be fed by either 52 or 75 ohm coax and will produce a standing wave ratio of under 2.4:1 over the entire frequency range. Provisions ~~are also included~~ to feed it with open wire line. ~~The method of feeding makes it simple to rotate.~~

The correct name of the antenna is a transposed log-periodic dipole array (1).

The term "log-periodic" simply means an antenna whose electrical characteristics vary periodically with the logarithm of the

- - - - - - - - - - - - - - - - - -

(1) D. E. Isbell May 1960 P.G.A.P. IRE Transactions

frequency. In simple terms, it is an antenna whose resonance transfers smoothly from one element to the next as the frequency is varied.

At the end of this article will appear radiation patterns, impedance data and gain figures. The radiation patterns are field plots for the two principle planes of the antenna and demonstrate the constant beamwidth feature of the array. They are measured curves of the full scale antenna taken outdoors on top of a 50 foot high rotatable tower.

Several methods of construction were tried before the ~~following~~ configuration was ~~arrived at~~ obtained. The method described ~~is far from~~ may not be the best, but in the interest of cost, time and tool requirements, it was felt that this was an antenna that could be built ~~by the average amateur in his own back yard~~ with a minimum of cost and effort. The only nonstandard tool required ~~that is not standard household equipment~~ is a 1/4 - 20 die.

CONSTRUCTION

"A" copy

The first step in construction is to modify the 32 TV element straps. Refer to the sketch in Figure I ~~which is a sketch of the clamp~~ for the ~~before and after the~~ modification. The small threaded insert in the standoff is spotwelded in three places, ~~and~~ If ~~it~~ this is tightened in a vise and given a sharp rap with a hammer, ~~it~~ the insert will fall out without damaging the clamp.

Next, the two 10 foot lengths of aluminum conduit are cut to obtain two seven foot sections. The two 12 foot and one 43 inch pieces of 1/4" aluminum rod are cut to size according to Table I. Each piece of aluminum rod is then threaded a distance of one (1) inch on one end of the rod. ~~You will now have~~ This gives two 7 foot lengths of tubing, 32 modified clamps and 32 half elements. ~~The antenna is constructed~~

~~from two identical sections~~. Figure II shows the method of attaching elements and clamp to the boom, and Figure III shows the complete layout of one section giving element lengths and spacings. After assembly of the two identical sections, they are ~~laid~~ on top of ~~one~~ another, ~~so that the array appears as in Figure IV~~. Figure IV also shows how the coax cable is attached ~~after feeding it through the inside of either of the two 7 foot booms~~. The shield of the coax is folded back and tightened under ~~the~~ clamp which holds the first element. The center conductor is then run over to the other boom and it, too, is tightened under the first element clamp. The method of feeding provides an "infinite balun" and presents a good match to either a 50 or 75 ohm coaxial line.

The spacing between the two 7 foot booms ~~was not found to be critical, but it is suggested that the spacing~~ shown be adhered to as closely as possible. Any convenient method of clamping the sections together ~~is all right~~ as long as they ~~remain separated and do not touch one another~~. The antenna ~~described~~ here was held with three wooden blocks, as shown in Figure V. Two identical blocks were constructed of 4 inch pieces of 2x4. Two 3/4" holes are bored through the blocks and the blocks are then sawed down the center of the two holes as shown. These two blocks are placed near ~~either~~ end of the antenna, ~~as shown in the photograph,~~ and clamped together with long bolts or wood screws. The third block is ~~made~~ identical to the first two except that 4x4 lumber is used. This permits the use of a mast which ~~could~~ be screwed into a suitable coupling that is mounted on the 4x4 center block. These blocks should receive several good coats of paint to prevent warping and water absorption.

~~which could upset the impedance of the antenna~~.

Upon completion of the antenna it is only necessary to raise it to a suitable height and use it. There is absolutely no tuning necessary since the antenna is already optimized. The array has a considerable advantage over other tri-band arrays, in that it does not utilize traps or other frequency division devices which only tend to lower the efficiency. It is evident from the voltage standing wave chart, Figure VI, that this antenna is not only good over the three ham bands, but over the entire frequency range from 140-450 Mc. It is interesting to note that this takes in the upper TV channels and would thereby serve as a highly efficient UHF TV antenna.

The assistance of MR. R. LOGAN, SECTION HEAD MICROWAVE & ANTENNA LAB. FAIRCHILD ELECTRONIC SYSTEMS DIVISION, WYANDANCH, N.Y., IN THE PREPERATION OF THIS ARTICLE IS HIGHLY APPREACIATED

TABLE I

PARTS LIST

2 - Standard 10 foot lengths 1/2" rigid aluminum conduit

32 - Stainless steel T.V. mast standoff clamps. Channel Master #9662

2 - Lengths 12' long by 1/4" diameter aluminum rod

1 - Length 43 " by 1/4" diameter aluminum rod

32 - 1/4 - 20 Aluminum or cad plated hex nuts

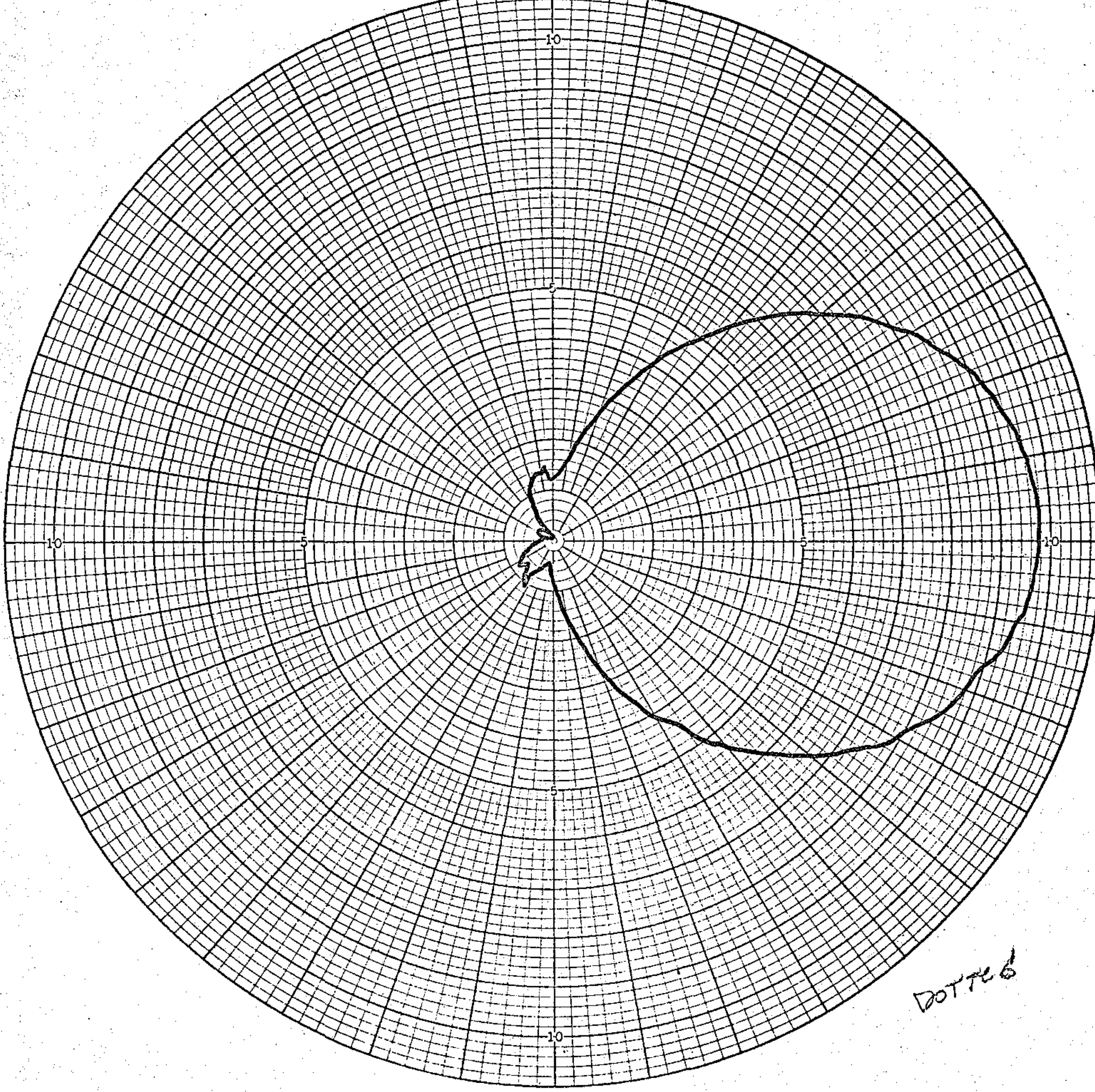
Place both 12 foot sections of 1/4" aluminum rod together and cut in accordance with the following list to obtain two (2) pieces of each length:

(19-1/2", 17-1/2", 15", 13", 11-3/4", 10-3/4", 9-3/4", 8-3/4", 8", 7-1/4", 6-1/2", 6", 5-3/4", 4-1/2")

There will now be 28 elements. The remaining two 43 inch pieces are cut to obtain two 16-1/2" and two 4-3/4" pieces for a total of 32 pieces.

FAIRCHILD ASTRIONICS DIVISION

Antenna Type | Antenna Location | File No.



Date ______ Sheet ___ of ___

Observer ______

Gain: Setting ______

Detector ______

Pattern: Θ = ______ Ψ = ______ ϕ = ______

Polarization: E_ϕ ______ E_Θ ______ Other ______

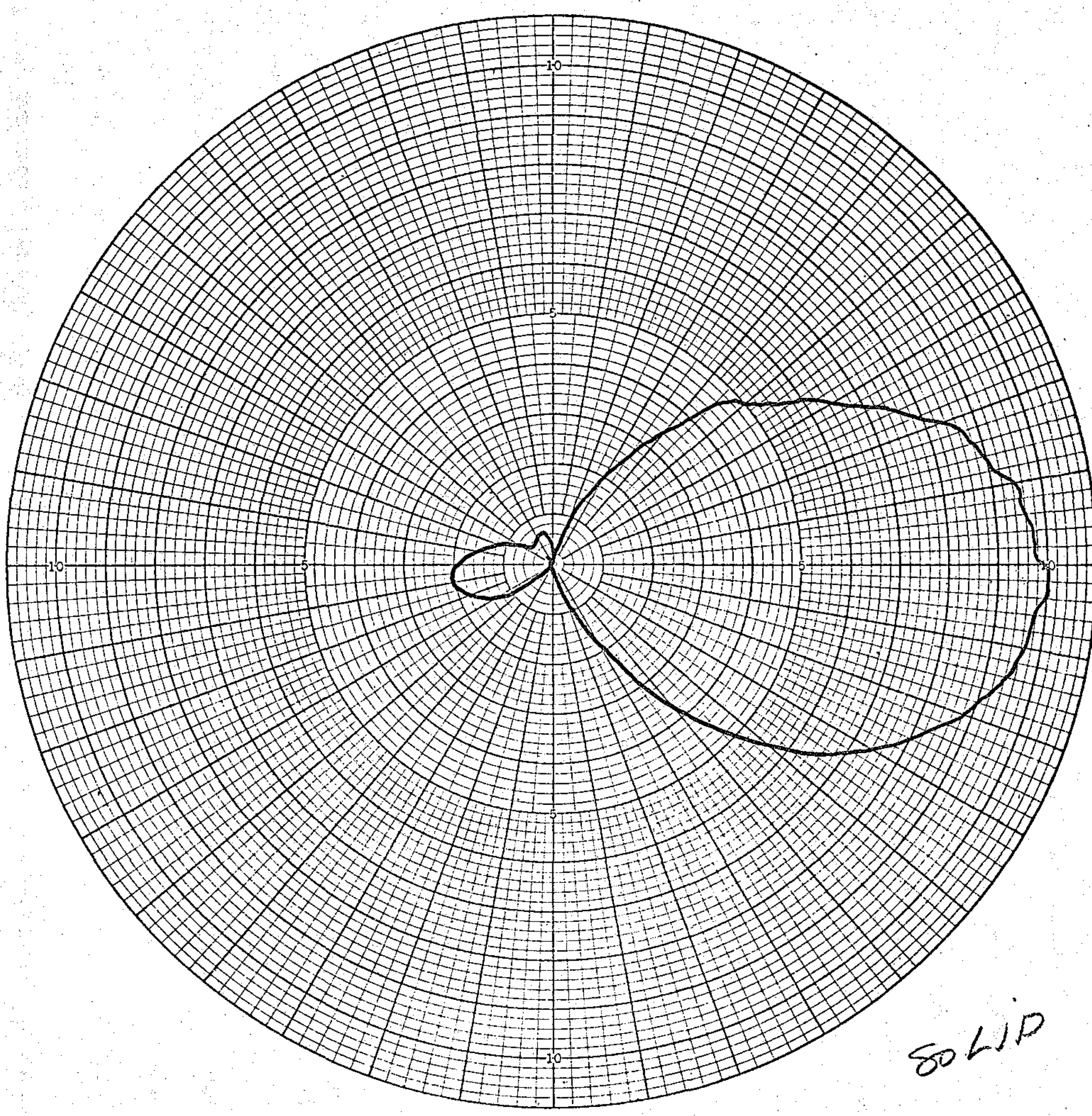
Curve Plotted in: Voltage X Power ___ DB ___

Measured Frequency 140 MC

Remarks: H or vertical plane field patterns 3db BW = 80°

FAIRCHILD ASTRIONICS DIVISION

Antenna Type | Antenna Location | File No.



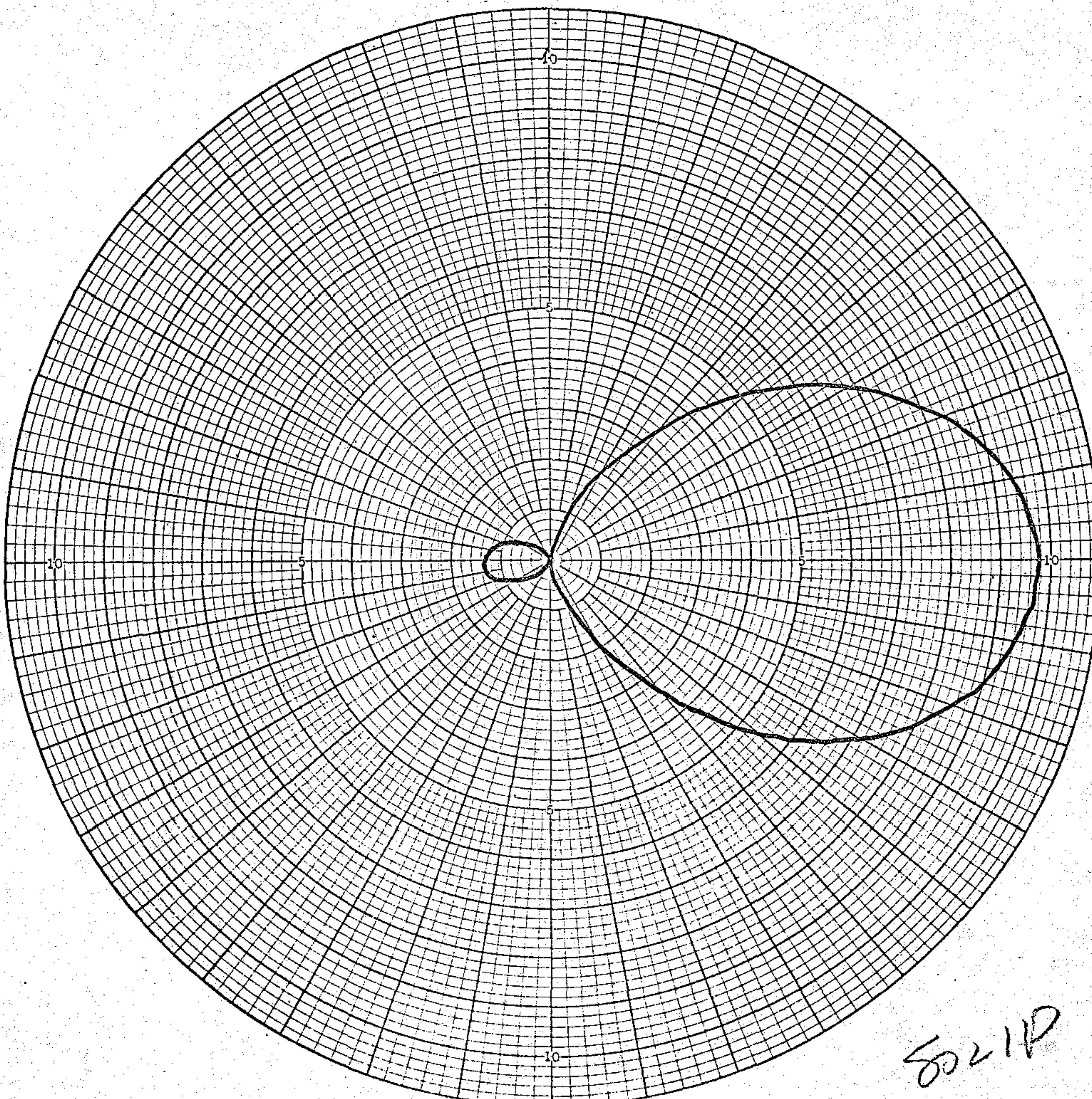
SOLID

Date ______ Sheet ___ of ___	Pattern: Θ = ______ Ψ = ______ ϕ = ______
Observer ______	Polarization: E_ϕ ______ E_θ ______ Other ______
Gain: Setting ______	Curve Plotted in: Voltage X Power ___ DB ___
Detector ______	Measured Frequency 140 MC

Remarks: E or horizontal plane field patterns 3 db BW = 59°

FAIRCHILD ASTRIONICS DIVISION

Antenna Type | Antenna Location | File No.



8021P

Date ________ Sheet ___ of ___

Observer ________

Gain: Setting ________

Detector ________

Pattern: Θ = ____ Ψ = ____ φ = ____

Polarization: E_ϕ ____ E_Θ ____ Other ____

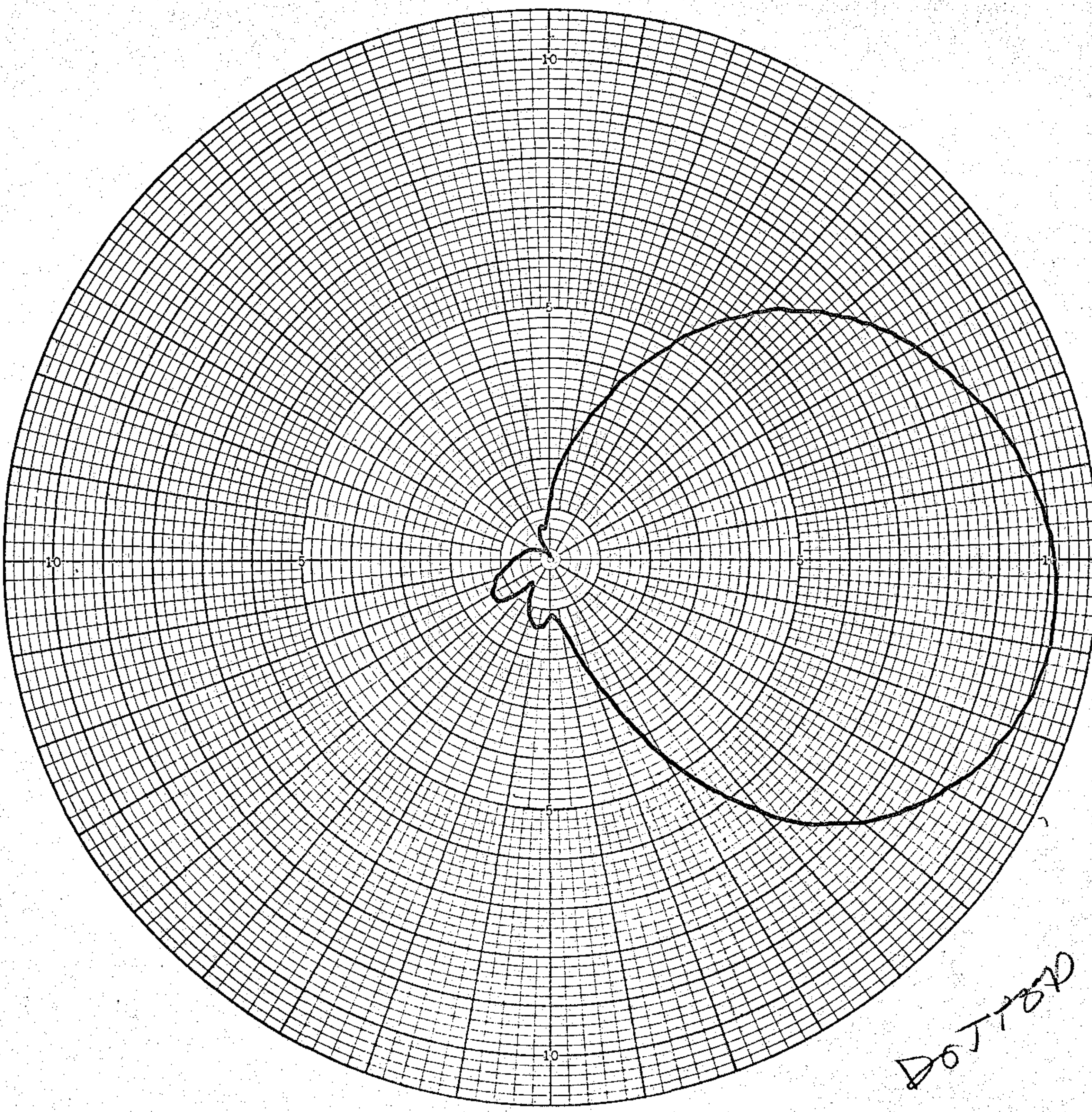
Curve Plotted in: Voltage X Power ____ DB ____

Measured Frequency 250 MC

Remarks: E or horizontal plane field patterns 3db BW = 62°

FAIRCHILD ASTRIONICS DIVISION

Antenna Type | Antenna Location | File No.



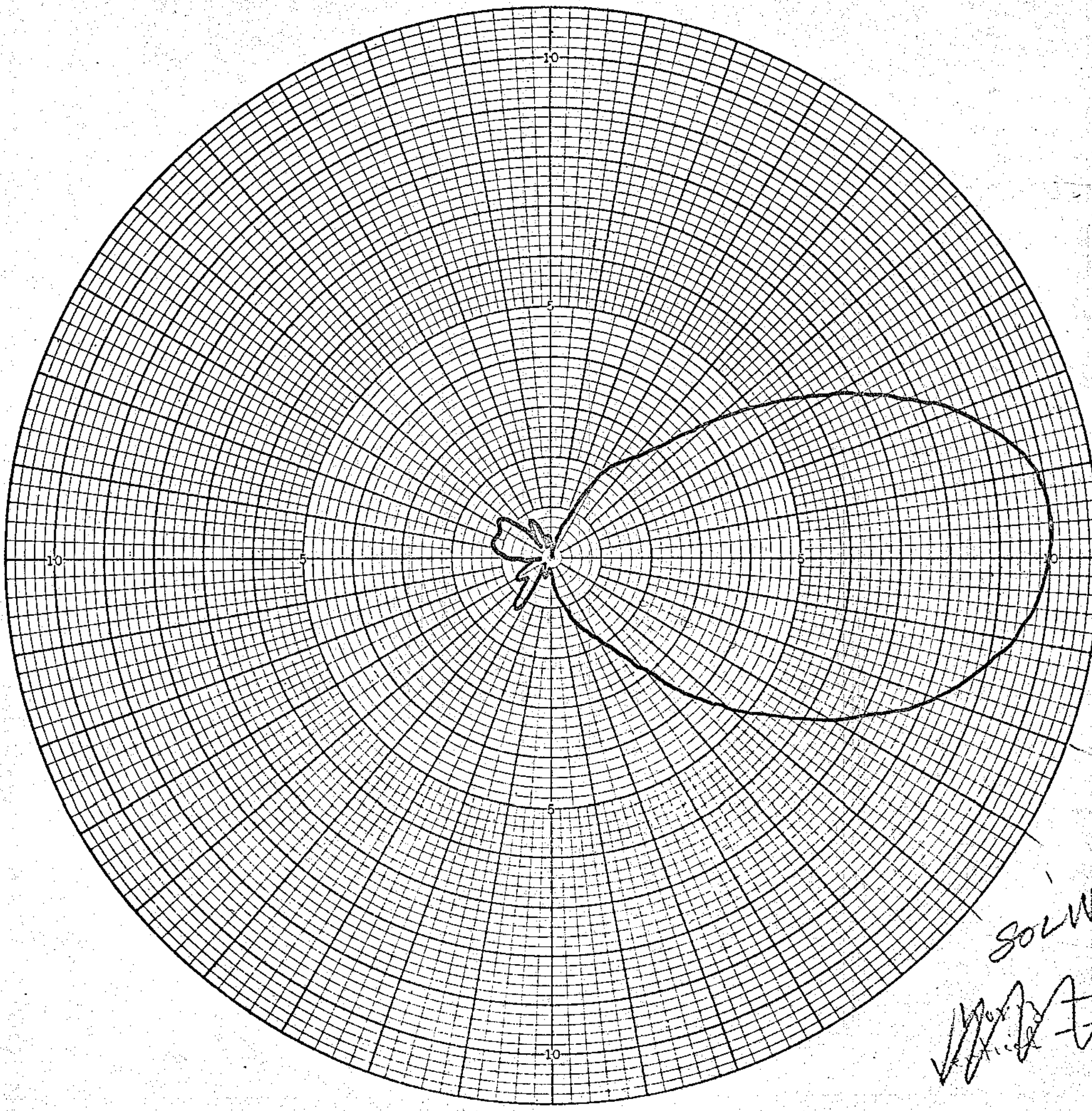
Date ____ Sheet ___ of ___	Pattern: Θ = ____ Ψ = ____ φ = ____
Observer ____	Polarization: E_ϕ ____ E_Θ ____ Other ____
Gain: Setting ____	Curve Plotted in: Voltage X Power ___ DB ___
Detector ____	Measured Frequency 250 MC

Remarks: H or vertical plane field patterns 3 db BW = 90°

ENG. 199

FAIRCHILD ASTRIONICS DIVISION

Antenna Type | Antenna Location | File No.

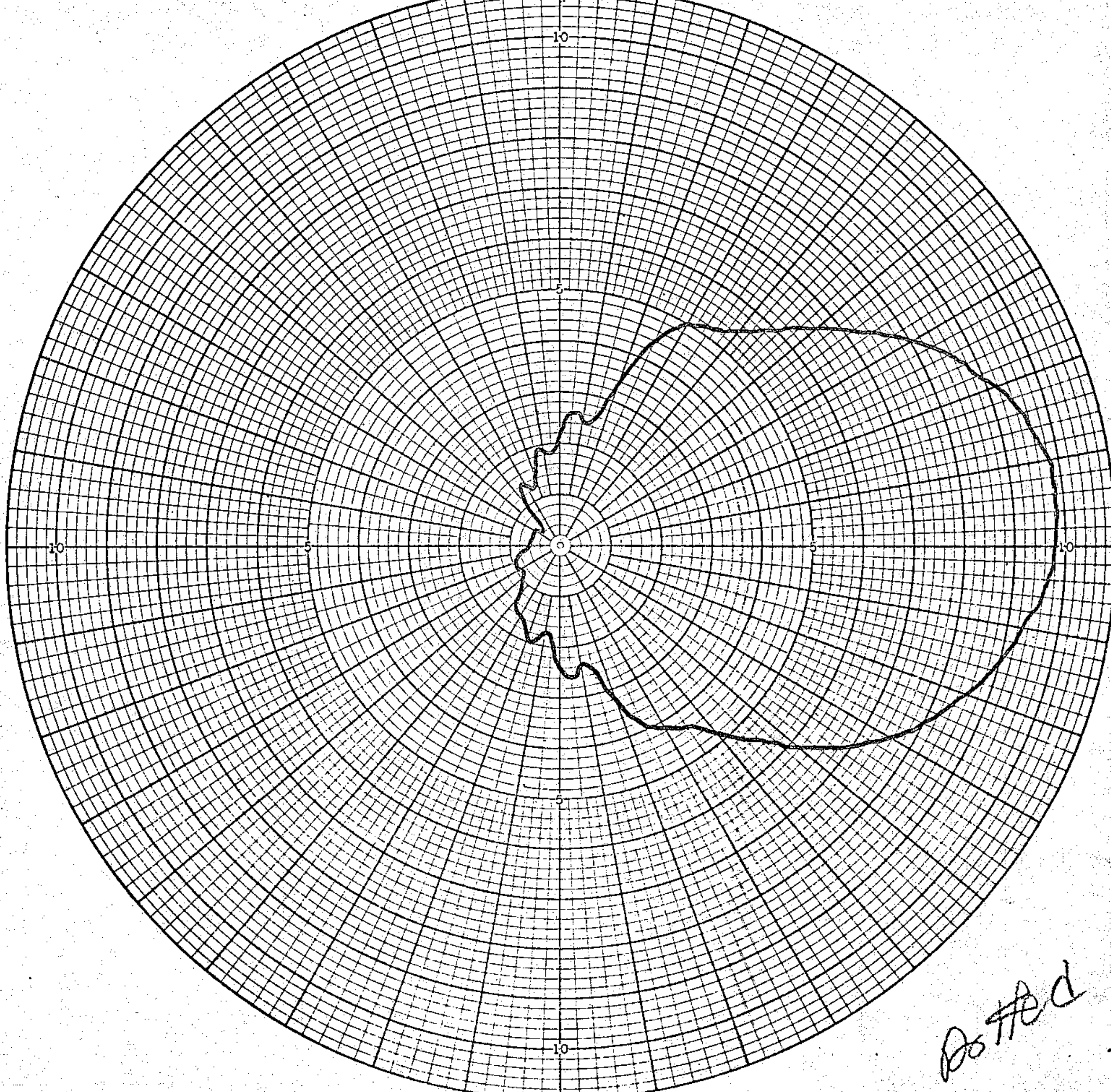


Date ______ Sheet ___ of ___	Pattern: Θ = ______ Ψ = ______ φ = ______
Observer ______	Polarization: E_ϕ ______ E_Θ ______ Other ______
Gain: Setting ______	Curve Plotted in: Voltage X Power ___ DB ___
Detector ______	Measured Frequency 450 MC

Remarks: E or horizontal plane field patterns 3db BW = 54°

FAIRCHILD ASTRIONICS DIVISION

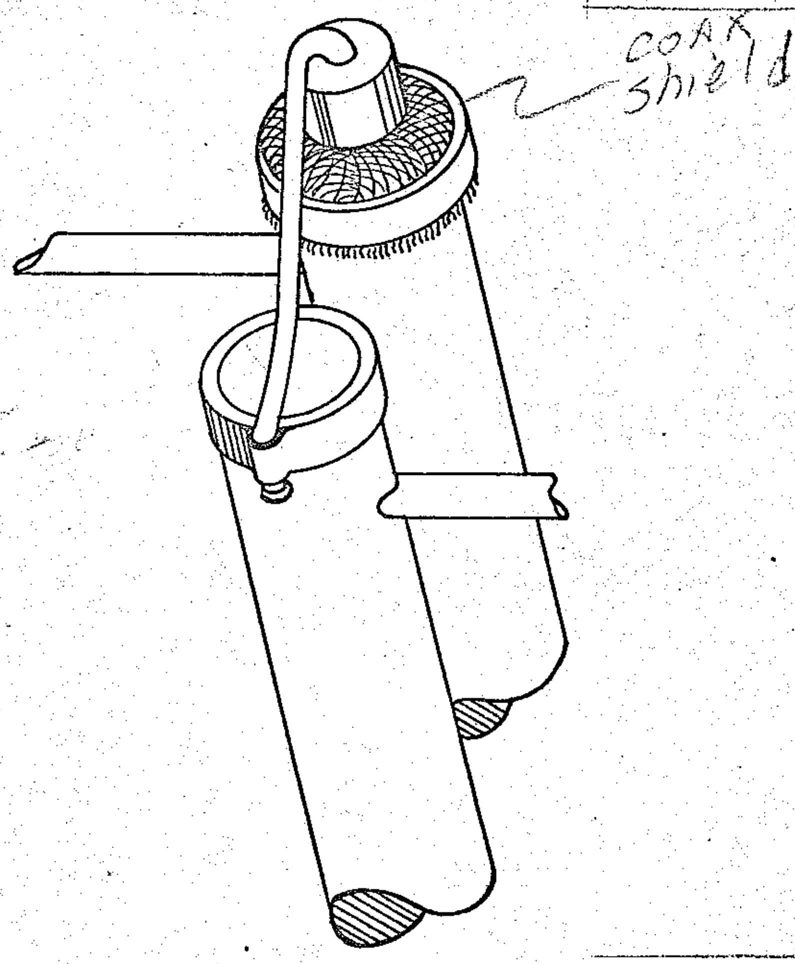
Antenna Type | Antenna Location | File No.



Date ______ Sheet ___ of ___	Pattern: Θ = ______ Ψ = ______ φ = ______
Observer ______	Polarization: E_ϕ ______ E_Θ ______ Other ______
Gain: Setting ______	Curve Plotted in: Voltage X Power ___ DB ___
Detector ______	Measured Frequency 450 MC

Remarks: H or vertical plane field patterns 3db BW = 70°

TOP



5.5

Fig 5

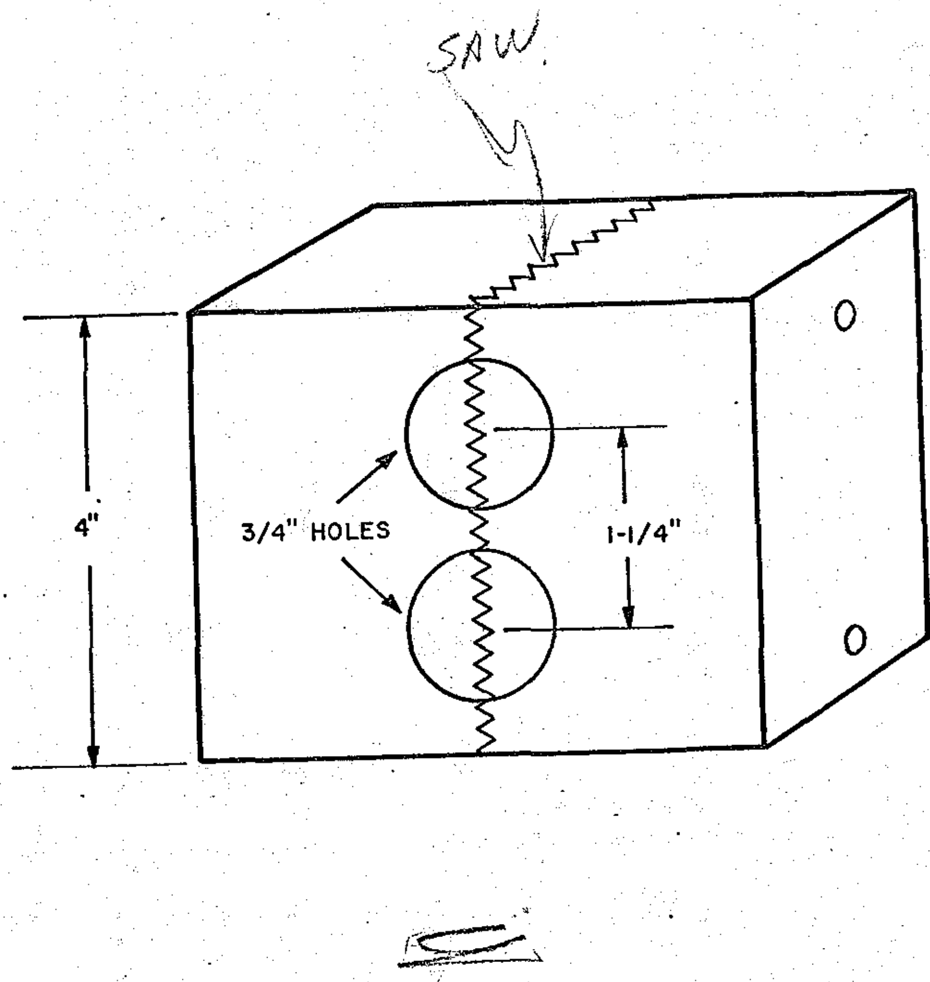


FIG 4

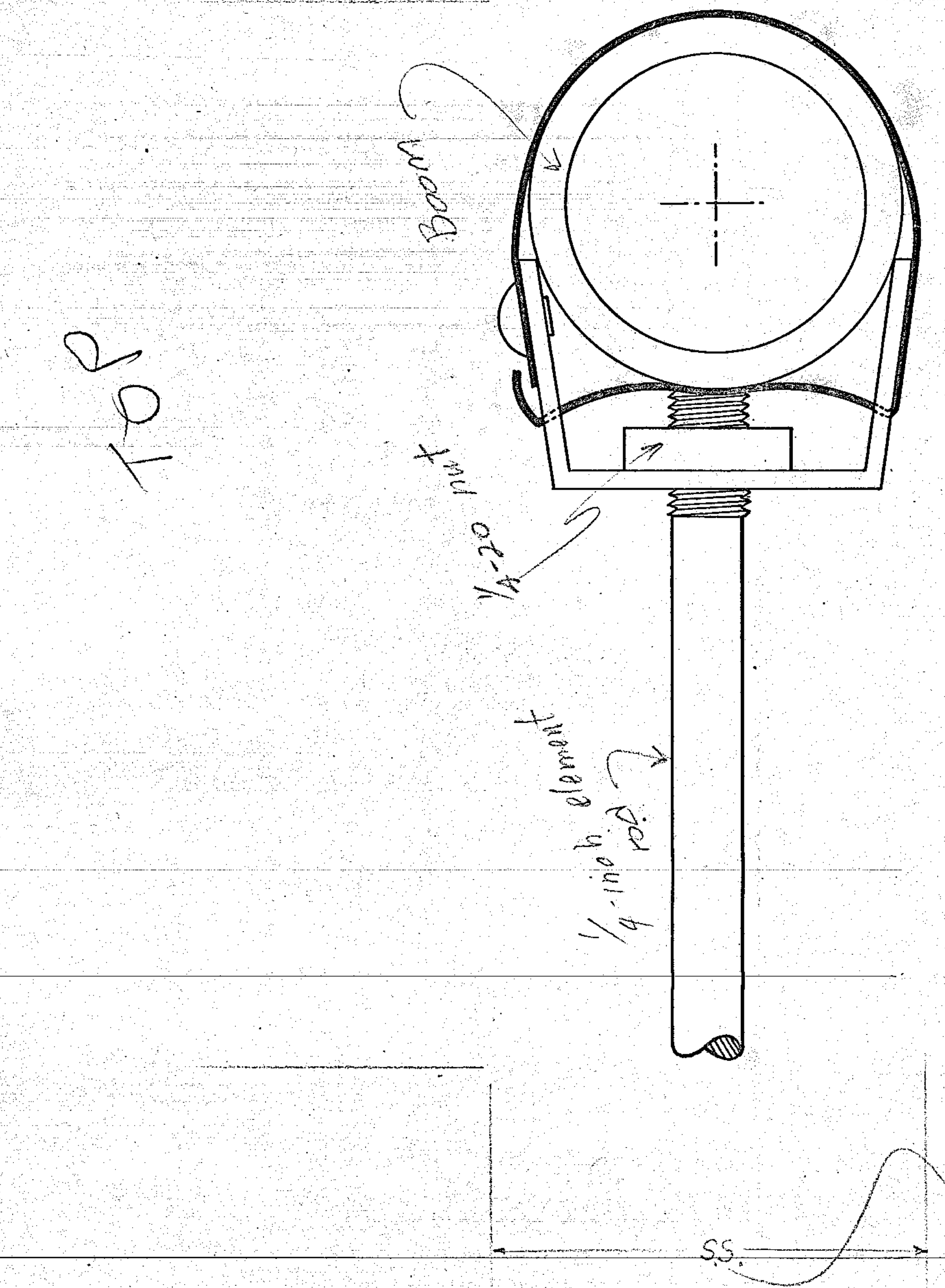


FIG. II METHOD OF ATTACHING ALL ELEMENTS TO BOOM

FIG 2
Ideslin

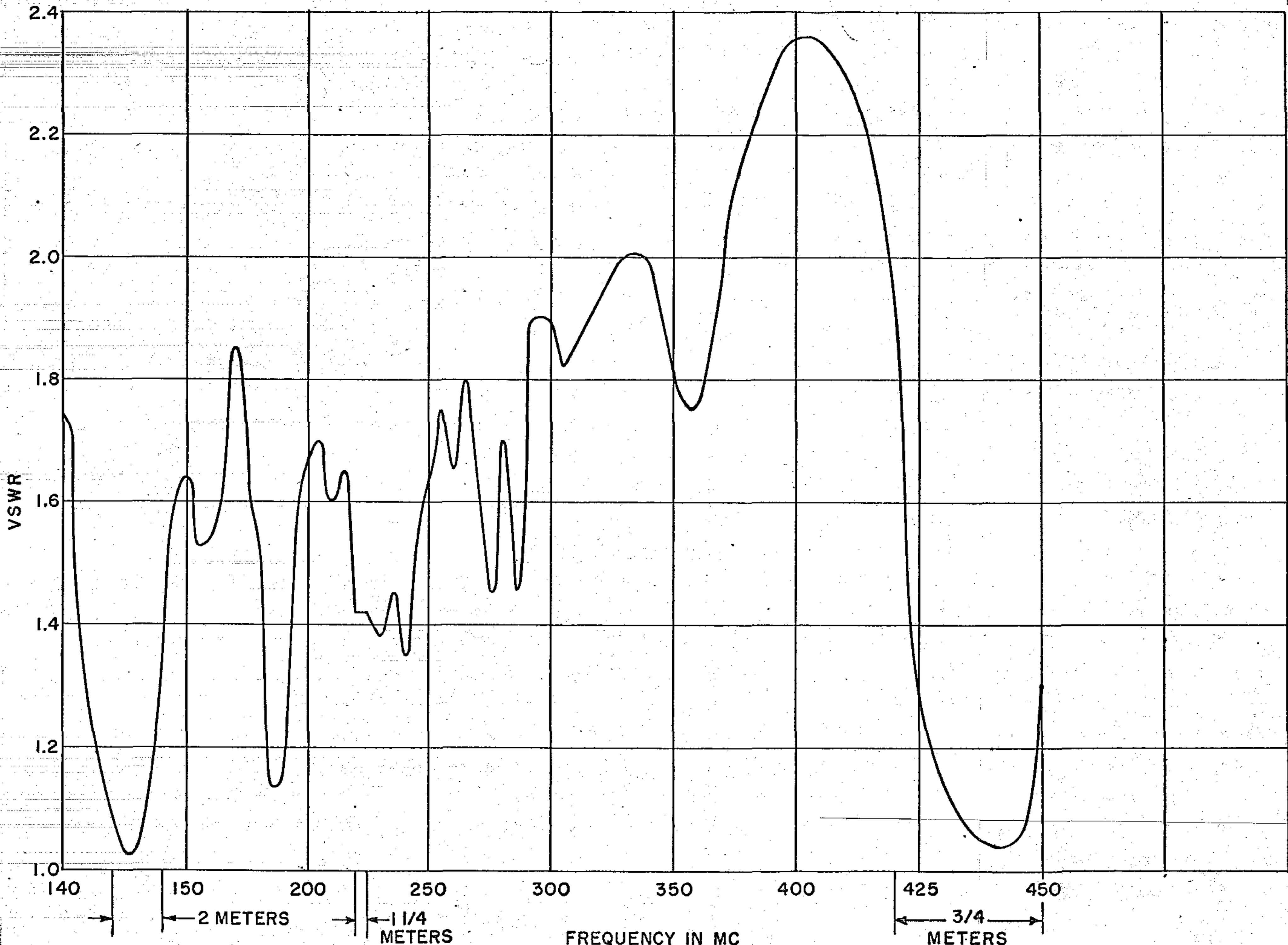


FIG 6

FIG VI -
VOLTAGE STANDING
WAVE RATIO ON
50 OHM LINE

8 1/2" (81% REDUCTION)

1127/4A

dimension lines are to be drawn to cen of elements

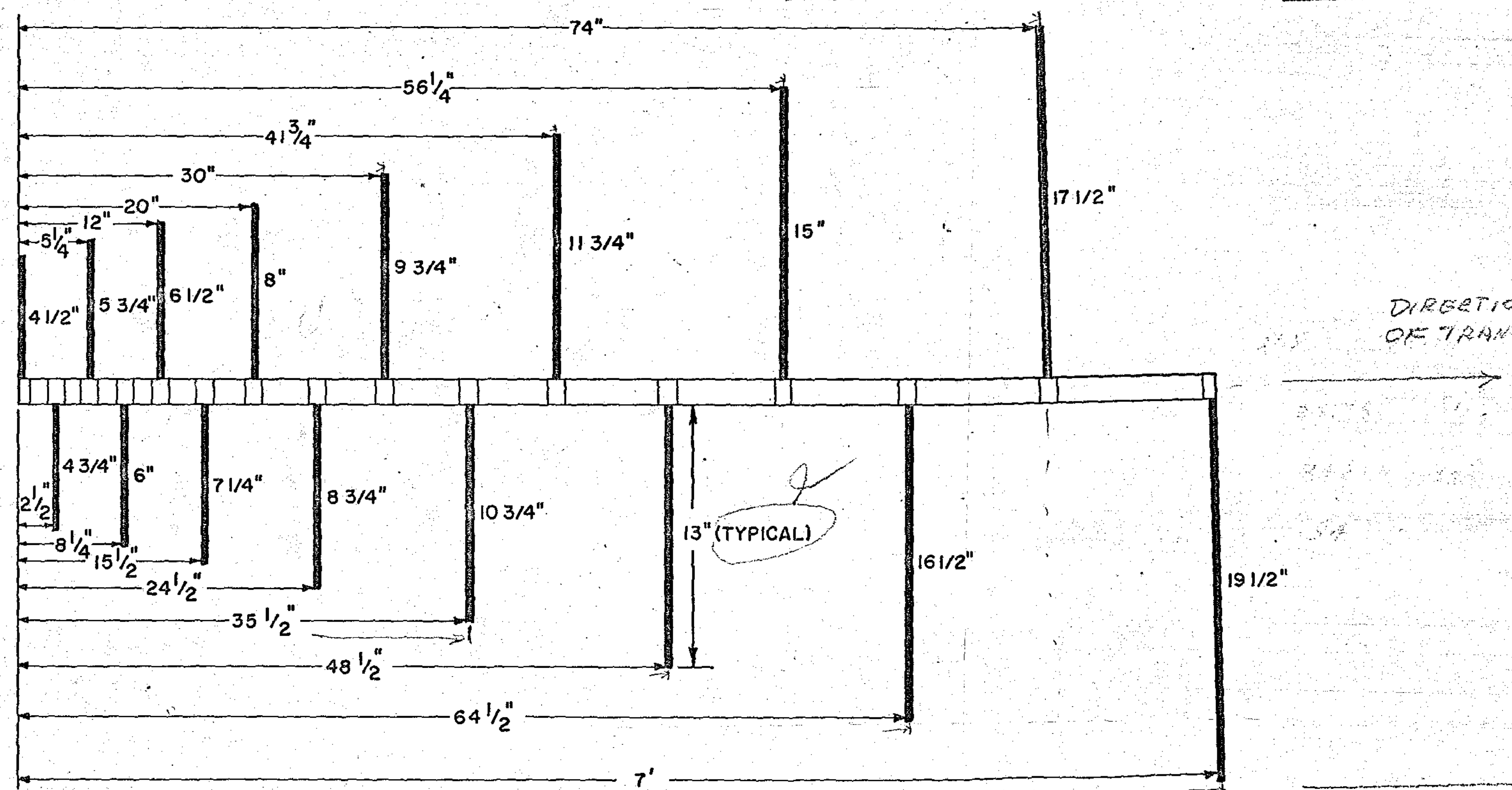


FIG. III - ALL DIMENSIONS ARE TO THE ELEMENT CENTERS.

8 1/2" (85% REDUCTION)

FIG 3

TSP

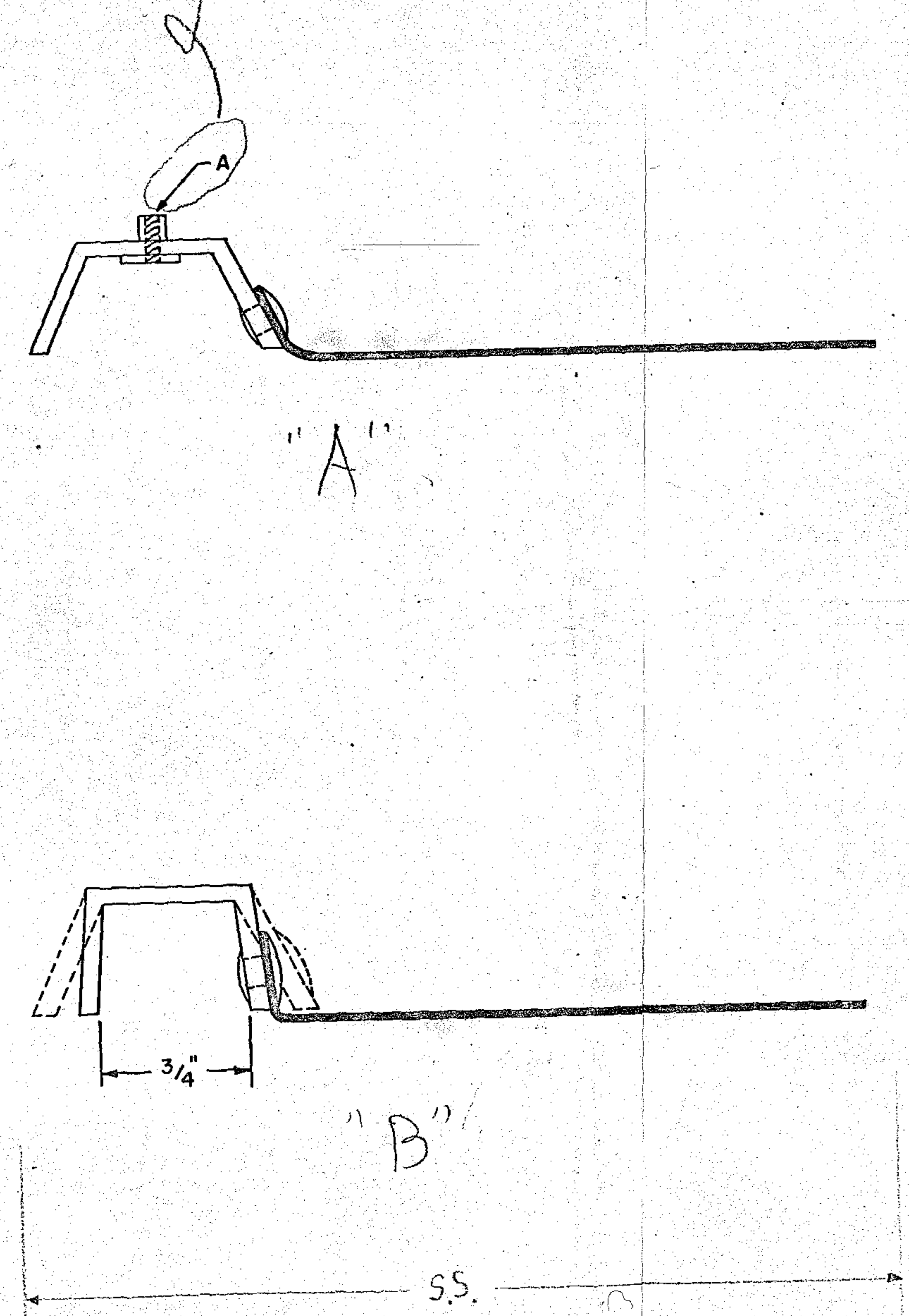


Fig 1
Heslin