

NATURE AND SUBJECT MATTER  
OF THE SUIT

This suit is a consolidation of (1) a suit by The Finney Co. for declaratory judgment that three patents of the Foundation defendant are invalid and not infringed, and wherein the Foundation has counterclaimed that plaintiff has infringed all three patents,\* and (2) an earlier filed suit by the Foundation against The Finney Co. (and another defendant as to whom the earlier suit has been dismissed). Issue has been joined by the pleadings in both suits, and jurisdiction and venue are conceded.

All three patents in suit relate to radio frequency antennas having certain design and performance characteristics in common. From those common characteristics, the antennas of all three of the patents in suit are known as "log periodic antennas."

NATURE OF THE MOTION

Plaintiff's motion attacks the validity of all claims of two of the three patents in suit, namely, Isbell patent No. 3,210,767 (PX-A) and Mayes et al. reissue patent No. Re. 25,740 (PX-B). The motion also attacks the enforceability of the Mayes et al. reissue patent by the Foundation defendant on the ground that this patent is invalid because it was procured by presenting deceptive and misleading evidence to the Patent Office so that the Foundation comes into court with unclean hands.

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\* Other causes of action against defendant JFD are not involved in plaintiff's motion.

### RELATED LITIGATION

The importance of this motion and the urgency of having it considered and decided on its merits are abnormally great in view of three related suits pending in this Court and involving validity and infringement of one or both of the same two patents attacked by the motion.\* In practical effect, the granting of this motion will dispose of all of the issues of patent validity and infringement of two of those related suits, will eliminate one of the two patents involved in the third of those related suits, and will reduce the patent issues in the present suit from a suit on three patents against 17 different antennas charged to infringe to a suit on only one patent against only 8 of the antennas charged to infringe.

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\* The University of Illinois Foundation v. Blonder-Tongue Laboratories, Inc. et al., Doc. 66 C 567 (involving the Isbell patent and the Mayes et al. reissue patent); The University of Illinois Foundation v. Jerrold Electronics Corp., Doc. 66 C 636 (involving the Isbell patent and the Carrel et al. patent); The University of Illinois Foundation v. Channel Master Corporation et al., Doc. 65 C 568 (involving the Isbell patent).

SYNOPSIS OF MOTION

I.

Isbell Patent No. 3,210,767 Invalid  
Because the Application Therefor was Not  
Timely Filed as Required by 35 U.S.C. 102(b)\*

The printed publication PX-4 is a University of Illinois report that admittedly describes the antennas of the invention of this Isbell patent (Stipulation PX-C, par. 5-9).

The Report PX-4 was published April 30, 1959, by virtue of--

- (a) Its availability to the public in the "Local Library," Electrical Engineering Department, University of Illinois (Johnson Affid. PX-D; Lawler dep. PX-E), and
- (b) Extra copies thereof being available to the public, for the asking, at the "Publications Office," Electrical Engineering Department, University of Illinois (Johnson Affid. PX-D; Lawler dep. PX-E).

The "Local Library" as a source of similar technical publications was available to faculty and students of the University of Illinois and to members of the public since prior to April 30, 1959. The

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\* 35 U.S.C. 102:

"A person shall be entitled to a patent unless--

\* \* \*

(b) the invention was \* \* \* described in a printed publication in this or a foreign country \* \* \* more than one year prior to the date of the application for patent in the United States \* \* \*."

"Publications Office" as a source of similar technical publications had been well known to and used by interested members of the public, including persons in industry and faculty and students of the University of Illinois, since prior to April 30, 1959. (Johnson Affid. PX-D;\* Lawler dep. PX-E;\*\* Mayes dep., PX-F).

The application for the Isbell patent (PX-A) was not filed in the Patent Office until May 3, 1960 (PX-A - caption data). By the terms of 35 U.S.C. 102(b), the publication of PX-4 more than one year earlier (on April 30, 1959) renders that patent invalid.

As 35 U.S.C. 102(b) has been interpreted by the courts, without an applicable exception, the availability of PX-4 on April 30, 1959, from either source (a) or source (b), above, constitutes "publication" on that date.

Since a patent exists only by statutory authority, there can be no exception to the express prohibition in the patent

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\* Johnson testified entirely consistently with her affidavit PX-D on direct and cross-examination in related litigation. The pertinent parts of that sworn testimony are submitted herewith as PX-DD and are mentioned further below.

\*\* Lawler testified entirely consistently with his deposition PX-C in related litigation as a witness for the present Foundation defendant. The pertinent parts of that sworn testimony are submitted herewith as PX-EE and are mentioned further below.

statute to the patenting of an invention published more than one year prior to the application for the patent. Isbell patent No. 3,210,767, therefore, must be held invalid because the application therefor was not filed within the time requirement of 35 U.S.C. 102(b).

## II.

A. Mayes et al. Reissue Patent No. Re. 25,740  
Invalid Under 35 U.S.C. 102(f) Because  
Mayes et al. Did Not Themselves Invent the  
Subject Matter Thereof as Required by  
35 U.S.C. 102(f)\*

Mayes and Carrel, when reporting the subject matter of their reissue patent in the form of a "RECORD OF INVENTION" (PX-15), made reference in item 9 thereof to a suggestion they received from a Mr. E. M. Turner of Wright Air Development Center. In his deposition (PX-F, pp. 113-115), Mayes acknowledged his understanding that Turner was referring to moving the arms of the simple dipoles of the Isbell patent into the form of V-dipoles.\*\* This change in the dipoles produced only the results which the prior literature taught Mayes et al. to expect (Mayes dep. PX-F, pp. 116-121); and

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\* 35 U.S.C. 102:

"A person shall be entitled to a patent unless--

\* \* \*

(f) he did not himself invent the subject matter sought to be patented \* \* \*."

\*\* Mayes also admitted that the use and operation of V-dipoles for the purposes described in the Mayes et al. reissue patent had been well known in the art prior to that time (Mayes dep. PX-F, pp. 48-51). How very well known it was is discussed hereinafter.

this is the only change in the earlier developed antennas of the Isbell patent that is disclosed in the specifications and drawings of the Mayes et al. original and reissue patents, as expressly stated in the latter at col. 2, lines 44-49, and confirmed by Mayes (Mayes dep., PX-F, pp. 121-123, 154-156). Thus, the Mayes et al. reissue patent discloses the antennas earlier developed by Isbell when modified only according to the suggestion of Turner.

It follows that, at most, all Mayes and Carrel contributed to the invention disclosed and claimed in their reissue patent was a mere recognition of the expected attributes of what was conceived and suggested to them by Turner. As a matter of established law, what was done by Mayes and Carrel does not constitute the making of an invention; and any invention made was the invention of Turner, not of Mayes and Carrel. The Mayes et al. reissue patent, therefore, must be held invalid under 35 U.S.C. 102(f) because the patentees did not invent the subject matter thereof.

B. Mayes et al. Reissue Patent No. 25,740  
Unenforceable for "Unclean Hands" of the  
Foundation Defendant, Who Furnished the  
Patent Office with Deceptive and Mis-  
leading Evidence in Procuring the Patent

During the prosecution of the application for the Mayes et al. original patent, the Patent Office rejected the claims thereof on a May, 1960, publication (PX-28)\* of an article by

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\* IRE Transactions on Antennas and Propagation, May, 1960, Vol. AP-8, No. 3, pp. 260-267.

Dwight E. Isbell entitled "Log Periodic Dipole Arrays," in view of a previously cited patent to Rowland (file history, PX-29, p. 30).

Mayes et al. responded to that rejection by filing in the Patent Office an affidavit and attorney's argument asserting and documenting completion of their V-dipole development prior to the May, 1960, date of the cited IRE publication and prior to the May 3, 1960, filing date of the application for the Isbell patent covering the log periodic dipole arrays described in the cited IRE publication. That was done for the stated purpose of removing both the IRE publication and the prior Isbell application from consideration by the Patent Office as prior art against Mayes et al. (file history PX-29, pp. 31-43).

That procedure for antedating the description of an invention in a publication is permissible, in view of the grace period provided by 35 U.S.C. 102(b), only if the earliest such publication was not more than a year before the filing date of the application against which the publication is cited (Pat. Off. Rule 131, 35 U.S.C.A., pp. 685-686). However, that Isbell development was described in a printed report by the University of Illinois (PX-4) that was published April 30, 1959,\* and in another printed report by the University of Illinois (PX-17) published at least by September 23,

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\* See Part I of this motion and admitted distribution date of May 5, 1958, in stipulation, PX-C, par. 10.

1959,\* both publication dates being more than one year before the filing of the application for the Mayes et al. original patent. To the extent that any of these facts might not have been known to any particular person in the organizations of the Foundation defendant and its counsel at the time of filing the above-mentioned Mayes affidavit, that information was clearly available and readily ascertainable (discussed and documented in detail hereinafter).

The foregoing facts, known or available to Mayes et al. and to the Foundation defendant and to their counsel, made Isbell's log periodic dipole development prior art having a material bearing on patentability of the Mayes et al. claims in the respects stated in the aforementioned rejection. However, the Mayes affidavit necessarily implied no knowledge by any of them of those facts. Therefore, the filing of the Mayes affidavit was either a deliberate effort to mislead the Patent Office regarding the prior art status of Isbell's work or was done in a reckless and irresponsible disregard of the above-stated facts.

The Patent Office, having thus been misled by the Mayes affidavit, expressly accepted it for the purpose for which it was offered and withdrew the rejection of the Mayes et al. claims on the IRE publication. Concurrently, the Patent Office allowed the first seven claims of the Mayes et al. original patent and, in due

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\* Stipulation, PX-C, par. 11.

course, the remaining claims thereof and the additional claims of their reissue patent, without ever again citing the prior Isbell work as prior art. Had the Patent Office known the foregoing facts, the Mayes affidavit would have been ineffective and would not have been accepted for the purpose for which it was offered. (File histories, PX-29 and PX-30)

The Foundation defendant, having been a party to the foregoing, "is in no position to dispute" the effectiveness of its deception in persuading the Patent Office to grant the Mayes et al. original and reissue patents; and the total effect of this "calls for nothing less than a complete denial of relief \* \* \* for the claimed infringement of the patent thereby procured \* \* \*."

Hazel-Atlas Glass Co. v. Hartford-Empire Co., 322 U.S. 238, 247, 259 (1944) and additional cases cited in the more detailed discussion of the law hereinafter.

## BACKGROUND

### Historical Background

The developments that gave rise to the three patents in suit were made at the University of Illinois in the course of performing research for departments of the United States Government, particularly the Air Force. Specifically, the developments of those three patents were made under an Air Force contract dated August 28, 1958 (PX-1A), which required the University to perform

"antenna research" directed to a variety of antenna problems including, inter alia, continuing work on so-called "broad band antennas" that had been in progress under an earlier contract. The purpose was to devise antennas "for which the patterns and impedance are independent of frequency." Such antennas are commonly termed "frequency independent antennas," and the antennas of both of the patents attacked by this motion fall in that broad category. (Mayes dep. PX-F, pp. 19-30, 52-53; PX-1A) ~~PX-2A~~.

Frequency independent operation is especially important where the radio frequencies being used may fall anywhere within, or vary over, a broad range or band of frequencies and uniform response over such range or band is required by the particular antenna application. Frequency independent antennas find practical application, for example, in specialized military operations termed "electronic countermeasures" (abbreviated "ECM"), as well as in many other operations involving the transmission and reception of widely varying frequencies. (Mayes dep., PX-F, pp. 177-179; Finneburgh affidavit, PX-G). [cite # of PX-G]

The type of frequency independent antennas to which the three patents in suit relate involves certain progressively varying dimensional relationships that render the antennas cyclical or "periodic" in performance as the frequency of operation is varied progressively over the bands of frequencies for which the antennas are designed. The cycles or periods repeat according to a simple proportional relationship that is called "logarithmic" in mathematical terminology. Thus, such antennas are called

"logarithmically periodic antennas" or, using an abbreviated term, "log periodic antennas." (Finneburgh affidavit, PX-G; Mayes article PX-H, p. 3) [cite #]

The two patents in suit attacked by this motion are directed to log periodic antennas which are essentially "unidirectional," i.e., when used as transmitting antennas, they transmit energy as a narrow, unidirectional beam of radiation with only relatively little radiation being emitted in other directions, or conversely, when used as receiving antennas, they receive radiation efficiently from essentially only one direction while being relatively ineffective in receiving radiation from other directions. (Finneburgh affidavit, PX-G; PX-A; PX-B) [cite #]

Development of the particular forms of log periodic antennas to which the three patents in suit relate was based upon earlier work at the University of Illinois by V. H. Rumsey, Raymond H. DuHamel, Dwight E. Isbell, and possibly others. Additional work was done by DuHamel and others at Collins Radio Company of Cedar Rapids, Iowa, after DuHamel left the University about the latter part of 1957. The sequential relationship of the log periodic antenna developments made in the course of all of that work is described in the article (PX-12) entitled "Logarithmically Periodic Antenna Designs" by DuHamel and Ore, published by Collins Radio at least by May 14, 1958. (Mayes dep., PX-F, pp. 18-19, 27-30, 52-54; Mayes article PX-H, pp. 3-4; Stipulation PX-C, par. 14)

The first of that related series of log periodic antenna developments was made by DuHamel (Mayes article PX-H, pp. 1-2) and was patented by the University of Illinois Foundation on an application filed July 9, 1958, which issued as patent No. 2,985,879 (PX-31). It is illustrated in Fig. 1a and described on pp. 1 and 2 of both PX-12 and PX-H.

The second of that related series of log periodic antenna developments was made by Isbell (Mayes article PX-H, pp. 3-5) and was also patented by the University of Illinois Foundation, on an application filed October 20, 1958, which issued as patent No. 3,011,168 (PX-32). That Isbell patent is not here in suit and is to be distinguished from the Isbell patent in suit No. 3,210,767 (PX-A). That development is illustrated in Fig. 1b and described on p. 2 of PX-12 (as well as in PX-H, pp. 3-5).

The next several of that related series of log periodic antenna developments were made at Collins Radio by DuHamel and Ore (Mayes article, PX-H, pp. 4 and 6) and were patented by Collins Radio on a single application filed March 14, 1958, which issued as patent No. 3,079,602 (PX-33). Those developments, their objectives, and their structural and functional relationships are described in PX-12, beginning on p. 2. The resulting antenna forms of particular present interest are shown in Figures 2, 9, and 15 of PX-12 and in Figs. 1-7 and 15 of the patent PX-33.

That related series of prior developments, from the first (by DuHamel) through the last-mentioned group (developed by DuHamel and Ore), illustrates the evolution of log periodic antennas from sheet metal structures through a sequence of rod and wire structures, leading progressively closer to the rod dipole forms of the Isbell patent in suit (PX-A), both in physical structure and in performance characteristics (Mayes article PX-H, pp. 4 and 7). All involved the same kind of mathematical progression of dimensions from one end to the other. All were developed and described in the printed publication PX-12 by May of 1958, prior to the earliest work on any of the developments of the three patents in suit (which were made between the fall of 1958 and January of 1960, as summarized below).

The work of Isbell, Mayes et al., and Carrel et al. that gave rise to their three patents in suit was performed at the University of Illinois under the Air Force contract PX-1A dated August 28, 1958 (Mayes dep. PX-F, pp. 21-23). According to Isbell's report to the University, PX-3, and his Preliminary Statement in a Patent Office interference, PX-I, his earliest conception of the log periodic dipole antennas of his patent in suit was in September, 1958, and such antennas were first built and tested by December, 1958.\*

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\* See colloquy between counsel and stipulation re Isbell's invention dates in Mayes deposition, PX-F, at pp. 35-37.

Thus, as should be understood at the outset, and contrary to what one might gather from the three patents in suit alone, Isbell did not originate the log periodic principle of antenna design. On the contrary, the antennas of the three patents in suit followed a sequence of log periodic antennas developed earlier at the University of Illinois and at Collins Radio Company and separately patented by the University and by Collins Radio in the names of DuHamel, Isbell, and DuHamel and Ore. (Mayes dep. PX-F, pp. 27-30, 52-54; PX-H; PX-I; PX-31; PX-32; PX-33)

The prior art status of the DuHamel patent, PX-31, and the DuHamel and Ore patent, PX-33, are established by their filing dates in the Patent Office (shown on the face of the patents) prior to the earliest alleged conception by Isbell of the subject matter of the Isbell patent in suit. Except as it indicates an intermediate development step between the disclosures of those two patents, the Isbell patent No. 3,011,168, PX-32 (not in suit) is of only historical interest here.

It is primarily in the light of the foregoing prior art background that the subsequent developments of the three patents in suit should be viewed. Although the obviousness of the latter developments has been placed in issue by the pleadings, it should be clearly understood that it is not an issue of this motion. On the other hand, it should also be understood from the foregoing that the antennas of the patents in suit were not the first log

periodic antennas, or the first to provide unidirectional operation with substantially uniform radiation patterns and input impedance over theoretically unlimited frequency bands. The similarities between the prior art log periodic antennas of the DuHamel and Ore patent (PX-33) and the later antennas of the Isbell patent in suit will be further clarified below in explaining the respective structures and performance characteristics of those patents and of the Mayes et al. reissue patent, in accordance with their respective disclosures.

#### Technical Background

The issues raised by this motion are such as to require no special knowledge of technical facts. On the other hand, an understanding of a few uniformly accepted, basic principles of radio frequency wave transmission and reception may be helpful to the Court, and those principles are briefly explained in the Finneburgh affidavit (PX-G) for reference by the Court for that purpose.

#### The Isbell Patent in Suit

The Isbell patent in suit (PX-A) discloses two physically different forms of antennas that are electrically equivalent. As shown in Fig. 1 of the patent and described in the specification, the antennas of the patent may comprise a planar array of dipoles\* 10, 11, 12, etc. of progressively diminishing lengths  $L_1$ ,  $L_2$ ,  $L_3$ , etc., with dipole spacings that similarly diminish in the same

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\* A dipole is an active antenna element. In its simplest form, it is a straight conductor having a center gap, as shown in Fig. 1 of PX-1A. (See Finneburgh affidavit, PX-G.)

direction (col. 1, lines 33-36). As further disclosed in the specification, "the ends of the dipoles fall on a pair of straight lines which intersect and form an angle  $\alpha$ \*" (col. 1, lines 36-40); and the successive lengths and spacings of the dipoles "are related by a constant scale factor  $\tau$ ,"\*\* i.e., a multiplier stated to be "less than 1" (col. 1, line 56). Thus, the length of each successive smaller dipole is equal to the length of the adjacent larger one multiplied by the decimal fraction  $\tau$ , and each successive smaller space between dipoles is equal to the adjacent larger space multiplied by the same decimal fraction  $\tau$ .

As also shown in Fig. 1 and described in the specification of the patent, the several dipoles are "fed" or driven at the "narrow" or small dipole end of the array by an "alternator" or transmitter, shown diagrammatically at 13 as being connected to the antenna by balanced feeder lines (two-wire transmission line) 14 and 16. The feeder lines 14 and 16 continue through the array so as to interconnect the several dipoles with the feeders, and the feeders are "alternated" or transposed between dipoles so as to produce a "phase reversal" between the successive pairs of dipole connections (col. 1, lines 43-49).

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\* Greek letter "alpha."

\*\* Greek letter "tau."

The radiation pattern of such antennas is essentially "unidirectional" to the left (forward direction) as viewed in Fig. 1, typical radiation patterns being shown in the "E plane" (plane of the dipoles) in Fig. 3 and "H plane" (longitudinal of and perpendicular to the plane of the dipoles) in Fig. 4. The scale of these patterns in Figs. 3 and 4 is such that only the radiation in a generally forward direction, or to the left as the antenna is viewed in Fig. 1, is shown (col. 2, lines 3-7 and 45-52). To some degree, one or more much smaller radiation lobes in another or several other directions would appear in Figs. 3 and 4 if they were drawn to a larger scale (or on what is commonly called a logarithmic scale). This is indicated by the reference to a front-to-back ratio of "17db" at col. 2, lines 49-50. (Finneburgh affidavit PX-G)

As shown in Fig. 2 of the patent and described at col. 2, lines 8-45, the physical form of the antenna of Fig. 1 may be modified by substituting closely spaced parallel feeder conductors 17 and 18 of Fig. 2 for the repeatedly transposed feeders 14 and 16 of Fig. 1. By alternating the connections of the dipole halves (e.g., 19 and 19a, 21 and 21a, etc.) to the feeder conductors of Fig. 2, essentially the same alternation in phase between successive dipoles is obtained as with the transposed feeders of Fig. 1 (col. 2, lines 21-23). Although the two halves of each dipole and, hence, the several dipoles of the array of Fig. 2 are not precisely

coplanar, the spacing of the feeder conductors is so small that the effect of the planar arrangement of Fig. 1 is not lost in the structure of Fig. 2, and the previously described operating characteristics are maintained (col. 2, lines 24-28). Thus, for practical purposes, the dipole array of Fig. 2 may be considered to be a substantially planar array and, electrically, essentially the same as the array of Fig. 1.

#### The Prior Art Duhamel and Ore Patents

The DuHamel and Ore patent (PX-33), in Figs. 3, 4, and 5, discloses three forms of log periodic antennas made of straight rods in different configurations that were successively derived from the sheet metal antenna of Figs. 1 and 2 of the patent. All four of those forms include two tapered, planar assemblies that are slightly spaced apart at their apices 28 and that diverge by an angle  $\psi$  (Greek letter psi). All four forms have essentially uniform radiation patterns and input impedance "over a very broad operating (frequency) range, which may be greater than ten-to-one" (col. 1, lines 11-15). As the patent discloses (col. 2, lines 51-53), the angle  $\psi$  may be reduced to  $0^\circ$  so that the center conducting rods 46 and 47 of the two planar assemblies are slightly spaced apart and parallel, as in Fig. 2 of the Isbell patent in suit; and as the angle  $\psi$  approaches  $0^\circ$ , the antennas become more nearly unidirectional (col. 9, line 59-67).

When the angle  $\psi$  is thus reduced to  $0^\circ$  in the antenna of Figs. 1-2 of the DuHamel and Ore patent, its structural similarity to the form of antenna shown in Fig. 2 of the Isbell patent in suit is evident and was acknowledged by Mayes (Mayes dep., PX-F, p. 83).

How the antennas of the Isbell patent are derivable in a simple manner from the antennas of the DuHamel and Ore patent has been pointed out by Mayes (PX-H, p. 4, penultimate par.). As is evident, the antenna of Fig. 2 of the Isbell patent results merely from reducing the tooth widths in Fig. 1 of DuHamel and Ore (PX-33), when the angle  $\psi$  is  $0^\circ$ , as by substituting simple dipole rods for other dipole-like members, with no other change in physical or electrical structure.

The Mayes et al. Original and Reissue Patents

The entire content of the Mayes et al. original patent is given in the Mayes et al. reissue patent now in suit (PX-B). As stated in the latter (col. 1, lines 11-14)--

"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."

The absence of either brackets or parentheses in the specification and first ten claims of the reissue patent shows that the original patent was changed only by addition to the reissue patent of claims 11-17, inclusive.

After briefly describing the subject matter of the previously filed application for the Isbell patent in suit, the Mayes et al. specification continues (col. 1, lines 40-55)--

"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."

As the specification makes clear and as Mayes was forced to admit,\* the Mayes et al. original and reissue patents disclosed the prior Isbell invention as changed only by substituting known V-dipoles for the straight, simple dipoles of Isbell. The result was to give the antenna only the expected and well known operation over a number of additional frequency ranges that are higher harmonics of the range which would be covered by the corresponding straight dipole form of Isbell, sometimes called "multi-mode" operation.\*\* As pointed out in the foregoing Synopsis (Part 1A) and in more detail hereinafter, that single change was admitted by Mayes et al. to have been suggested to them by another person and, therefore, was not their idea in the first place.

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\* See PX-B, lines 44-49, col. 4, lines 19-21; Mayes deposition, PX-F, pp. 113-123, 154-155.

\*\* As explained hereinafter at pp. 49-50 and supported by an antenna handbook published as early as 1943 and by the affidavit of L. H. Finneburgh, Jr. (PX-G, par. 15, 16).

I.

ISBELL PATENT NO. 3,210,767  
INVALID BECAUSE THE APPLICATION THEREFOR WAS NOT  
TIMELY FILED AS REQUIRED BY 35 U.S.C. 102(b)

This ground for invalidity of the Isbell patent in suit (PX-A), summarized in Part I of the foregoing Synopsis, will now be fully presented with detailed reference to the facts, the supporting documents, and the applicable law. The absence of any genuine issue of material fact and invalidity of the patent as a matter of law will clearly appear from this presentation.

The Evidence

The controlling facts upon which this ground of the motion is based are contained in a stipulation of facts, PX-C; an affidavit, PX-D, by Miss Marjorie Johnson, a former employee of the University of Illinois; a deposition, PX-E, of Harold B. Lawler, another employee of the University of Illinois; and a Quarterly Engineering Report, PX-4, printed for the University of Illinois and describing the alleged invention of the Isbell patent. As shown

by the other mentioned documents, the report PX-4 became a "publication" within the meaning of 35 U.S.C. 102(b) on April 30, 1959, more than one year before the May 3, 1960, filing date of the application for the Isbell patent (PX-A).

The Johnson affidavit, PX-D, contains supporting documents from the records of the University of Illinois which need not be considered in view of the stipulation, PX-C, which covers many of the same facts set forth in the Johnson affidavit.

Long after the date of her affidavit, PX-D, Miss Johnson testified as a witness for the defendant in a related suit brought by the University of Illinois Foundation and charging infringement by the Winegard Co. of the same Isbell patent here in suit.\* Her testimony having been given under oath and including cross-examination by counsel for the University of Illinois Foundation, is obviously at least the legal equivalent of an affidavit and, therefore, admissible for the purposes of this motion. A copy of that testimony, PX-~~X~~<sup>DD</sup>, is appended to this motion merely as corroboration of the facts more succinctly stated with complete consistency in the Johnson affidavit PX-D. Accordingly, no further reference need be made herein to that testimony by Johnson in the related suit against Winegard Co.

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\* The University of Illinois Foundation, plaintiff, vs. Winegard Company, defendant, Civil Action No. 3-695-D, United States District Court, Southern District of Iowa, Davenport Division, tried February 13-17, 1967.

The Lawler deposition, PX-E, was taken in the present suit in the form of cross-examination by counsel for the plaintiff with redirect examination by counsel for defendant, The University of Illinois Foundation. The same witness, called on behalf of the University of Illinois Foundation in the aforementioned, related suit against Winegard Company, later testified consistently with his deposition PX-E, with only one immaterial qualification noted hereinafter. Like the Johnson testimony in the related suit mentioned above, the Lawler testimony in that suit is at least the equivalent of an affidavit and, therefore, admissible for the purposes of this motion. A copy of relevant portions thereof, <sup>EE</sup> PX-~~K~~, is appended to this motion merely as corroboration of the facts more fully covered in the Lawler deposition PX-E. Accordingly, with the one minor exception noted, no further reference need be made herein to that testimony by Lawler in the related suit against Winegard Company.

Another University of Illinois report, PX-5, published prior to April 1, 1959, gave advance notice that the work covered in PX-4 would be covered in that report. Therefore, the document PX-5 is also pertinent to the issue raised by this ground of the motion and is supplied as one of the supporting documents.

Agreement by the University of Illinois that the report PX-4 was a "publication" by April 30, 1959, is shown by an

additional document, PX-27, and by a pertinent part of the Mayes deposition, PX-F, also taken in the present suit.

The present defendant, the University of Illinois Foundation, had the opportunity to present evidence rebutting the controlling facts relied upon in this motion when presented with the same issue and most of the same facts in the above-mentioned suit against Winegard Company. Because it produced no material evidence of such character in that suit, and because no additional facts which defendant might now urge could alter the legal effect of those relied upon herein, it is respectfully submitted that only a simple, basic question of law as to the validity of the Isbell patent in suit is presented hereby.

The significance of the controlling facts, so established for the purposes of this motion, will be better appreciated as they are developed below if the specific question of law to be decided is first briefly explained.

#### The Specific Question of Law Presented

As detailed below, the publication PX-4 was made accessible to the public on or before April 30, 1959, in two distinct ways. By that date, copies thereof were available (1) for reference or borrowing at a so-called "Local Library" in the Electrical Engineering Research Laboratory of the University of Illinois, and

(2) for distribution, for the asking, to any responsible, interested person or concern within the University or outside of the University. The intent of such handling of reports like PX-4 was to make their contents available "to the people most genuinely and seriously interested in the subject matter."

(See Mayes dep., PX-F, p. 56, line 13, to p. 57, line 10; Lawler dep., p. 24, lines 20-24, and p. 40, line 1, to p. 41, line 13, and The Hamilton Laboratories, Inc. v. Massengill, cited and quoted, infra, under the heading "The Law on Publication.")

The specific question of law presented is whether or not such accessibility of the publication PX-4 to the public on April 30, 1959, coupled with such intent, constituted "publication" within the meaning of 35 U.S.C. 102(b). That it did constitute such publication is supported by all known authorities dealing with similar or comparable fact situations, as will be pointed out below after a more detailed presentation and documentation of the facts.

#### Uncontested Facts

##### (a) Library Accessibility

The facts enumerated in the succeeding numbered paragraphs and supported as indicated therein establish, beyond dispute, that a printed copy of the publication PX-4 was in the "Local Library" of the Electrical Engineering Research Laboratory of the University of Illinois (sometimes referred to as the "Local

Library EERL") and was available for borrowing and reference by the faculty, other employees, and students of the University and by the general public no later than April 30, 1959.

1. The publication PX-4 was printed and 148 copies thereof were delivered to Miss Marjorie Johnson, the acting Technical Editor of the Publications Office of the Electrical Engineering Department of the University of Illinois, at her office at the University on or before April 30, 1959 (Stipulation, PX-C, par. 4).

2. Miss Johnson in addition to being the acting Technical Editor of the Publications Office, was also the Librarian of the "Local Library EERL" during April, 1959 (Johnson Affidavit, PX-D, par. 20; Lawler dep., PX-E, p. 39, line 17, to p. 40, line 1).

3. In April, 1959, the "Local Library" was located in a "reading room" of the Electrical Engineering Research Laboratory on the same floor of the building as the Publications Office (Johnson Affidavit, PX-D, par. 21). That library and "reading room" were maintained by the Publications Office to assure having at least one copy of every report it produced, as well as copies of publications of other research groups, both at the University and elsewhere in the country (Lawler dep., PX-E, p. 37, line 17, to p. 38, line 5; Johnson affid., PX-E, pars. 21-22).

4. The "Local Library" and the "reading room" in which it was located in April, 1959, were maintained as part of the

operations of the "Publications Office" of the Electrical Engineering Department; and the same employee, Miss Marjorie Johnson, was responsible for all of the operations of the Publications Office, including the printing and distribution of publications by the Electrical Engineering Department and operation of the "Local Library." As Librarian, she had custody of the contents of the "Local Library" and responsibility for the loan and return of such contents. (Johnson Affidavit, PX-D, pars. 2-4, 20, and 22-26; Lawler dep., PX-E, p. 38)

5. The printed material contained in the "Local Library" was available for borrowing and use by many thousands of people at the University of Illinois, including those not directly connected with the Antenna Laboratory, and also by the general public (Lawler dep., PX-e, p. 36, line 3, to p. 37, line 4, and p. 39, lines 10-16; Johnson Affidavit, PX-D, par. 35 (c)).

6. The publications in the "Local Library" were normally kept in one of several locked file cabinets, not to prevent use of such material by the public, but only to maintain control of that material, so that it would not be lost and so that records could be maintained of the names of borrowers and the dates on which material was borrowed (Johnson Affidavit, PX-D, pars. 23, 25, Lawler dep., PX-E, p. 37, line 7, to p. 39, line 9). Those publications were entered on a card index of the contents of the "Local Library," and the report PX-4 is shown thereby to have been a part of those contents (Lawler dep., PX-E, p. 44, lines 9-20).

When anyone wanted to borrow a copy of a publication from the "Local Library," he came to the Publications Office and requested the report from Miss Johnson or one of her assistants, who unlocked and opened the file cabinet and signed-out the requested publication. (Johnson Affidavit, par. 24; Lawler dep., p. 39, lines 10-16).

7. In order to inform people of the availability of publications received by the "Local Library," a magazine-type rack was maintained in a hall of the Electrical Engineering Research Laboratory leading to Miss Johnson's office, copies of publications were placed on display on the rack for that purpose soon after they were received by her, and a notice was maintained on that rack indicating that displayed materials could be borrowed by signing them out with Miss Johnson or one of the other employees of the Publications Office (Johnson Affidavit, PX-D, pars. 27-29; Lawler dep., PX-E, p. 40, line 2, to p. 41, line 13). When publications were received in the Publications Office, they were in the possession of Miss Johnson as Librarian and were immediately available for borrowing by anyone requesting the library copy (Johnson Affidavit, par. 26).

8. Thus, on or before April 30, 1959, the "Local Library" copy of the publication PX-4 was in the possession of Miss Johnson, the librarian of that library, and was available for borrowing or use by the general public (Johnson Affidavit, PX-D, par. 31(a) and (c)). Lawler, as business manager of the Department of Electrical

Engineering of the University of Illinois, when called as a witness for the Foundation in its related suit against Winegard,\* stated that the "reading room" of the Publications Office was an "unofficial reading room used by the department"; and that "it was not a library" in the sense that the department had "tried to obtain library status for it, but couldn't" because "they [the University] said it wasn't large enough" (Lawler testimony, PX-K, pp. 675-676). However, he confirmed on cross-examination that Miss Johnson had charge of that facility, that it was designated by the department as the "Local Library" in the "local distribution list" (PX-35) for reports of the department, and that both students having some laboratory connection at the University and faculty members of the University were aware of the fact that research publications were available there (Lawler testimony, PX-K, pp. 687-689). In addition, in his earlier deposition PX-E, Lawler repeatedly referred to the "Local Library" by that term and expressly confirmed many of the details of its character and functions as related by the references to his testimony in the preceding numbered paragraphs, while contradicting none of them. Thus, his only qualification of his own prior deposition (PX-E) and the affidavit and testimony of Miss Johnson (PX-D and PX-<sup>DD</sup>~~J~~) was that the "Local Library," though publicized and functioning as

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\* See p. 25, supra.

a library for students and faculty of the University and available for use by the public, as well, was not "officially" recognized as having "library status" in the University classification of its facilities.

(b) Copies Available For Sale or at No Charge

The facts enumerated in the next succeeding numbered paragraphs and supported as indicated therein establish, beyond dispute, that "extra" printed copies of the publication PX-4 were available to the public at the Publications Office by April 30, 1959; that the public had knowledge of the availability of such copies for sale or at no charge so long as the supply lasted; that such copies were commonly requested by outsiders and were supplied so far as they were available; and that the prospective availability of a report on the subject of present interest contained in PX-4 had been announced in another, earlier report of a similar character, PX-5, published prior to April 1, 1959.

9. Some of the 148 copies of PX-4 received by Miss Marjorie Johnson (par. 1, supra) had been printed so that the Publications Office would have a supply of extra copies not required for specific distribution and so that such extra copies would be available for internal reference and for distribution to any responsible person requesting a copy until a minimum number of internal reference copies remained on hand (Johnson Affidavit, PX-D, pars. 9-12; Lawler dep., PX-E, p. 23, line 13, to p. 24, line 10).

10. Requests for extra copies of publications, such as PX-4, were regularly received by the Publications Office of the Electrical Engineering Department of the University from people outside the University who were interested in antenna developments, and such requests were normally filled by the Publications Office by supplying such extra copies to the requesting party until only a specified minimum number of copies remained on hand (Johnson Affidavit, PX-D, pars. 9-13; Mayes dep., PX-F, p. 55, line 22, to p. 56, line 5).

11. In some instances, a person requesting one of the "extra copies" was charged for such a copy, but in most instances it was given away without charge (Lawler dep. p. 28, lines 10-17).

12. As soon as copies of reports, such as PX-4, were received in the Publications Office, the extra copies were given to any responsible party requesting a copy, at least in the case of reports prepared pursuant to the contract, PX-1A, under which the reports PX-4 and PX-5 of present interest were rendered

*Combine* { (Johnson Affidavit, PX-D, pars. 16-17; Lawler Dep., PX-E, p. 5, line 18, to p. 6, line 6). (Johnson Affidavit, PX-D, pars. 19; Lawler dep., PX-E, p. 6, line 7, line 17, to p. 10, line 8, and p. 23, line 21, to p. 29, line 12)

13. In April of 1959, many people were aware of the fact that extra copies of publications prepared by the Antenna Laboratory of the University of Illinois could be obtained from the Publications Office of the Electrical Engineering Department of the University. Such people included faculty and students at the University, not connected with the Antenna Laboratory, and members of industry and others who were not connected with the University or with the United States Government. (Johnson Affidavit, pars. 18-19; Lawler dep., PX-E, p. 7, line 17 to p. 10, line 8, p. 23, line 21, to p. 29, line 12; Mayes dep., PX-F, p. 55, line 22, to p. 56, line 5)

14. Copies of the Quarterly Engineering Report No. 1 (PX-5) for the period from September 1 to December 1, 1958 (see title page) were printed and published by the University of Illinois before April 1, 1959 (Stipulation, PX-C, pars. 2-3). That report contained a statement appearing on page 2--

"2.3 Plans for Next Interval

"An investigation of log periodic structures of thin linear elements (zero tooth width) is planned."

The subject matter disclosed in the Isbell patent in suit and described in the report PX-4 for the next "interval" (December 1, 1958, to March 1, 1959 -- see title page) results from reducing

the tooth widths "to zero" in the prior toothed structure of DuHamel and Ore (PX-33, Fig. 1) when the angle  $\psi$  is  $0^\circ$  (pp. 19-21, supra), as explained by Mayes (PX-H, p. 4). Thus, the coming availability of the next report PX-4 on the subject matter of interest was announced in PX-5, which was published and available before April 1, 1959.

(c) PX-4 Described the Invention  
of the Isbell Patent

The additional facts enumerated in the next succeeding numbered paragraphs and supported as indicated therein established, beyond dispute, that the publication PX-4, which was accessible to the public by April 30, 1959, as related above, actually described the alleged invention of the Isbell patent in suit with sufficient clarity to be understood and used by a person having ordinary skill in the relevant art at the time that alleged invention was made.

15. The publication PX-4, on pages 2 and 3, respectively, contains a written description and a schematic illustration of an antenna credited to Dwight E. Isbell, the same Dwight E. Isbell who was named the inventor in the Isbell patent in suit (Stipulation, PX-C, par. 5). That schematic illustration shows an antenna having the same dipole length and spacing relationships as the antenna illustrated in Fig. 1 of the Isbell patent in suit (Stipulation, PX-C, par. 6), and having the cross-over front feed that alternates in phase between successive dipoles as illustrated and described in that patent (Stipulation, PX-C, par. 7).

16. The written description and schematic illustration on pages 2 and 3 of PX-4 illustrate and describe an antenna having the same electrical structure, mode of operation, and performance as the antenna disclosed and claimed in the Isbell patent in suit (Stipulation, PX-C, par. 8), which illustration and description would be sufficient for anyone with antenna design experience to construct a successful antenna having a mode of operation and performance identical to the antenna disclosed in the Isbell patent (Stipulation, PX-C, par. 9).

17. As explained above (pp. 18-19), the structure of the antennas of Fig. 2 of the Isbell patent in suit, as well as the mode of operation thereof, results merely from reducing the teeth to thin-linear elements in the antennas of Figs. 1-4 of the prior art DuHamel and Ore patent PX-33 (or from substituting thin-linear elements for the triangular dipole-like members of Fig. 5 of that prior art patent) when the angle  $\psi$  is reduced to  $0^\circ$  as disclosed therein (each of those prior art forms having also been disclosed by May, 1958, in the prior art publication PX-12). PX-4, itself, calls attention to the "solid sheet, broad tooth, log periodic antennas" that were earlier shown in Figs. 1-2 of PX-33 and Fig. 2 of PX-12, and to the indicated "comparable" performance of the simple dipole form disclosed in PX-4. Therefore, while PX-4 "schematically" shows and describes only the form of antenna having the "cross-over" front feed of

Fig. 1 of the Isbell patent in suit, it is evident that the parallel feeder structure of Fig. 2 of that patent was old in the prior art developments of DuHamel and Ore and was merely carried over by Isbell into his patent in suit, so that any contribution over the prior art that is disclosed by the Isbell patent in suit was, in fact, disclosed by the publication PX-4 by April 30, 1959.

18. The coming availability of the report PX-4 on the particular subject of present interest was announced to the public in advance of its preparation in the earlier report PX-5, published prior to April 1, 1959, as detailed in paragraph 14, supra.

(d) Summary of Controlling Facts

Beyond dispute, the printed publication PX-4 described the alleged invention of the Isbell patent in suit and, for the purpose of making the fruits of the described research generally available, that report was made accessible to the public in two ways (for reference or borrowing at the "Local Library" and by gift or sale from the Publications Office) more than a year before the application for the Isbell patent in suit. Accordingly, there remains only the legal question of whether such availability, coupled with such intent, constituted "publication" within the meaning of 35 U.S.C. 102(b) so as to render the Isbell patent in suit invalid.

### The Law on "Publication"

While a considerable number of court decisions have considered what constitutes a "printed publication" under 35 U.S.C. 102(b), many of those decisions deal only with what constitutes "printed" within the meaning of that section of the statute, rather than what constitutes "publication." Since it is evident on inspection that the document PX-4 was "printed," such decisions are not pertinent. The only question here is whether the availability of that document more than one year before the application for the Isbell patent in suit on May 3, 1960, constituted "publication" under the law.

The early decision in Cottier v. Stimson, 20 Fed. 906 (Cir. Ct., D. Ore., 1884) set forth the general requirements for a "publication." In that decision (p. 910), the Court said:

"In Walk. Pat. 56, it is said that a 'printed publication is anything which is printed, and, without any injunction of secrecy, is distributed to any part of the public in any country. Indeed, it seems reasonable that no actual distribution need occur, but that exposure of printed matter for sale is enough to constitute a printed publication.'

"But something besides printing is required. The statute goes upon the theory that the work has been made accessible to the public, and that the invention has thereby been given to the public, and is no longer patentable by any one. Publication means put into general circulation or on sale, where the work is accessible to the public. See Reeves v. Keystone Bridge Co. 5 Fisher, 467."  
(Emphasis added)

In substance that decision held that a printed work is a "publication" when it is accessible to the public. This accessibility to the public can occur in a number of different ways, many of which have been specifically considered by the courts.

(a) Deposit in a Library

One of the common ways in which a printed work is made accessible to the public is by placing a copy in a library where it is accessible to members of the public. In an early decision in John Crossley & Sons v. Hogg, 83 Fed. 488 (Cir. Ct., D. Mass., 1897), it was held that publication had been established by proof that a single copy of a book was received in a library and that such publication was sufficient to bar the grant of a valid patent.

There is no requirement that members of the public actually used the printed copy contained within a library. It is merely necessary to establish that a copy of the publication was received by the library. Thus, the Patent Office Board of Appeals held in Gulliksen v. Halberg v. Edgerton v. Scott, 75 USPQ 252 (1937) that "publication" of a thesis was established when it was proved that a copy of the thesis had been received by a college library. The Board said at page 257:

"Since both affidavits referred to above clearly show that the thesis was received September 25, 1929, it is held that the dates when the same was bound or indexed is of no importance for the thesis became available to the public as soon as received in the library." (Emphasis added)

Subsequently, the Sixth Circuit Court of Appeals held in The Hamilton Laboratories, Inc. v. Massengill, 111 F.2d 584, 585, 45 USPQ 594, 595 (1940);

"\*\*\*the Weed thesis is in the prior art and marks a step in its development since it was put on file in the library of the college, available to students there and to other libraries having exchange arrangements with Iowa State. John Crossley and Sons v. Hogg, C. C., 83 Fed. 488, 490; Britton v. White Mfg. Co., C.C., 61 Fed. 93, 95. We think intent that the fruits of research be available to the public is determinative of publication under the statute\*\*\*." (Emphasis added)

More recent decisions have followed and further clarified the foregoing statements of the law. For example, the sufficiency of the deposit in a library of a single copy of printed matter and the immateriality of the obscurity of the library were commented on by the Court of Customs and Patent Appeals in the case of In re Tenney, Frank and Knox, 254 F.2d 619, 627, 117 USP2 348, 354 (1958). In that case, the Court observed--

"It is no doubt true that our present law is anomalous, as evidenced by our conclusion that a microfilm is not 'printed.' A foreign patent file, laid open for public inspection, is not a printed publication because typewritten, while a printed publication available to the public only in a Southern Rhodesian library would be."

Still more recently, the District Court for the Southern District of California held that the filing of a copy of a thesis in a college library on October 9, 1950, barred a patent applied for October 30, 1951 (21 days over the permissible

one year). Indiana General Corp. v. Lockheed Aircraft Corp., 249 F. Supp. 809, 815, 816 (1966). In that decision, the Court cited the Hamilton Laboratories v. Massengill case, supra, as an authority "squarely in point."

About the same time, the District Court for the Southern District of New York (while denying a motion for summary judgment because of unresolved questions of fact in the particular case) reviewed the same and related questions of law in some detail and concluded that a "'printed publication' as contemplated by Congress in 35 U.S.C. 102"--

"can include a document printed, reproduced or duplicated by modern day methods, including microfilming, upon a satisfactory showing that such document has been disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it and recognize and comprehend therefrom the essentials of the claimed invention without need of further research or experimentation." (Emphasis added)

I.C.E. Corporation v. Armco Steel Corporation, 250 F. Supp. 738, 743 (1966).

(b) Availability to the Public  
by Sale or Without Charge

The "publication" of a printed work also occurs when copies of the work are first accessible to the public, by purchase or without cost. In the above-cited case of In re Tenney, Frank & Knox, 254 F.2d 619, 628, 117 USPQ 348, 355 (C.C.P.A., 1958), in a concurring opinion, Judge Rich stated his view of the law to be that--

"When a book has been printed and copies are available for delivery, an advertisement offering it for sale would bring about its 'publication' even before any copies are actually sold."

In its majority opinion in that case (at 254 F.2d 624), the Court stated--

"The essence of all we have quoted is that, in consideration for the patent grant, something must be given to the public which it did not have before (Albeit that the enjoyment of this 'something' may be postponed for seventeen years). If the public is already possessed of that 'something', or if it is accessible to the public, there is a failure of consideration and no patent may be granted."

Explaining what "accessible to the public" means, the Court stated further (at 254 F.2d 626-627)--

"But though the law has in mind the probability of public knowledge of the contents of the publication, the law does not go further and require that the probability must have become an actuality. In other words, once it has been established that the item has been both printed and published, it is not necessary to further show that any given number of people actually saw it or that any specific number of copies have been circulated. The law sets up a conclusive presumption to the effect that the public has knowledge of the publication when a single printed copy is proved to have been so published. See Evans v. Eaton, 1818, 3 Wheat. 454, 514, 4 L.Ed. 433; Curtis, Law of Patents, pp. 500-03 (4th ed. 1873)." (Emphasis added)

The Tenney case, supra, is consistent with the law as previously stated by other courts and text writers over the years. Thus, as far back as 1884, when the substance of the present statute on this point was also in force, the Court specifically stated in

Cottier v. Stimson (cited and quoted at p. 37, supra) that--

"exposure of printed matter for sale is enough to constitute a printed publication," [Quoted from Walk. Pat. 56]

and that, in the Court's own words--

"Publication means put into circulation or on sale\*\*\*." (Emphasis added)

No contrary decision throughout the history of the United States Patent System has been found.

Clearly, if it is enough that copies of printed material be "on sale" or exposed "for sale", availability to the public is still greater where, as here, such printed matter was known to be available without charge and had frequently been so supplied on request.

#### Summary

Summarizing the facts and the law affecting the Isbell patent in suit, as presented above, each of two independent, but simultaneous occurrences constituted legal "publication" of PX-4 by April 30, 1959. Those occurrences were: (1) the "Local Library" copy was available to the public in a repository for technical publications that was both used as a "library" and called a "library", and that was clearly established and operated to perform the function of a "library," and (2) "extra copies" of the publication were available for sale or free distribution, with public knowledge

of this availability. That publication, and others of similar character were made accessible to the public in both of those ways with the clear intent to make the fruits of the University research available to all.

While both of those two occurrences independently constituted legal "publication" by April 30, 1959, it is also evident that the same physical organization under the supervision of the same individual, Miss Marjorie Johnson, made the publication PX-4 available both through its library reference and loan facility and through the Publications Office facility for furnishing copies of the publication for sale or at no charge. Thus, that same physical organization actually performed more than the normal functions of a library in making possible and facilitating both modes of making the publication accessible to the public.

By all of the standards derivable from pertinent court decisions and other recognized authorities, the publication PX-4 was legally "published" on or before April 30, 1959. Since it clearly described the alleged invention of the Isbell patent in suit, and did so more than a year prior to the application for the patent, that patent must be held invalid under the provisions of 35 U.S.C. 102(b).

## II.A.

MAYES ET AL. REISSUE PATENT NO. 25,740  
INVALID UNDER 35 U.S.C. 102(f) BECAUSE  
MAYES ET AL. DID NOT THEMSELVES INVENT  
THE SUBJECT MATTER THEREOF AS REQUIRED  
BY 35 U.S.C. 102(f)

This ground for invalidity of the Mayes et al. reissue patent in suit (PX-B), summarized in Part II.A. of the foregoing Synopsis, will now be fully presented with detailed reference to the facts, the supporting documents, and the applicable law. The absence of any genuine issue of material fact and invalidity of the patent as a matter of law will clearly appear from this presentation.

### The Evidence

The controlling facts upon which this ground of the motion is based are contained in the deposition (PX-F) of Paul E. Mayes and the "RECORD OF INVENTION" (PX-15) signed by both Paul E. Mayes and Robert L. Carrel and identified by Mayes in his deposition.

The University of Illinois report, PX-4, on which Part I of this motion was primarily based and another report, PX-17, are also relied upon to confirm the priority of the work of Isbell over that of Mayes et al.; and portions (PX-34) of a 1943 radio handbook are relied upon merely to demonstrate what had long been known in the art about the design and operation of V-dipoles.

The significance of the controlling facts, so established for the purposes of this motion, and the immateriality of any additional facts that defendants might conceivably assert in response thereto, will be better appreciated as they are developed below if the specific question of law to be decided is first briefly explained.

#### The Specific Question of Law Presented

As summarized in the background discussion above (pp. 20-21) and as documented in more detail in the ensuing development of the uncontested facts, the only departure from the prior invention covered by the Isbell patent in suit (PX-A) that is disclosed in the Mayes et al. original and reissue patents is the mere substitution of known V-dipoles for the straight, simple dipoles of Isbell; such substitution of V-dipoles was suggested to Mayes and Carrel by Mr. E. M. Turner of Wright Air Development Center; and such substitution of V-dipoles gave to the antenna only the expected and well known operation over a number of additional, higher, harmonic, frequency ranges. Thus, the only departure from the prior Isbell invention was the substitution suggested by Turner; the inherent results of such substitution were well known, and expected; and nothing was left as a possible contribution by Mayes and Carrel but a recognition of those well known and expected results.

The specific question of law presented is whether or not Mayes and Carrel made an invention entitling them to patent the identical structure suggested by Turner merely because they recognized and verified the inherent, well known, and expected results obtainable with that structure. That they were not entitled to do so is supported by all known authorities dealing with similar or comparable fact situations, as will be pointed out below following a more detailed presentation and documentation of the facts.

#### Uncontested Facts

The alleged invention of the Isbell patent in suit was described in a printed report by the University of Illinois (PX-4) that was dated "31 March 1959" on the title page and signed thereon by Mayes, himself, and that was published April 30, 1959, as established in Part I of this motion and, in any event, by the admitted mailing of that report by May 5, 1958, to the entire distribution list filling the last five and one-half pages of the report (Stipulation, PX-C, par. 10). That alleged invention was necessarily made sometime prior to the description thereof in the "31 March 1959" report, PX-4.

The later dates and the place of making the alleged V-dipole invention of the Mayes et al. reissue patent in suit are detailed in a "RECORD OF INVENTION" (PX-15), over the signature of both Mayes and Carrel.\* That document, in the items numbered 9-11,

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\* Produced by the Foundation defendant and identified by Mayes (Mayes dep., PX-F, p. 113, line 2, to p. 114, line 5).

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✓  
13, and 15 on the first page thereof, fixes the date and place of making the invention between June 11 and June 23, 1959, at the Antenna Laboratory of the University of Illinois. By specific reference thereto in items 19 and 20 on page 2 thereof, that document also refers to the related, prior, invention of the Isbell patent in suit and to its description in the University of Illinois Antenna Laboratory Technical Report No. 39 (PX-17) of "1 June 1959" (title page) or "10 June 1959" (front cover). On its face, PX-17 includes every detail of the Isbell patent disclosure. It became a "publication" at least by September <sup>21</sup>23, 1959 (Stipulation, PX-C, par. // )

Mayes admitted in his deposition (p. 7, line 19, to p. 8, line 5), that he was familiar with the work on which the Isbell patent in suit was based at the time that work was going on and with the records of that work as they were prepared.

As shown by item 9 on page 1 of the "RECORD OF INVENTION" (PX-15), the first occurrence leading to the alleged invention of the Mayes et al. patent in suit was a question, asked by Mr. E. M. Turner of Wright Air Development Center, "if the angle of dipoles on a log-periodic dipole array had been used as a design parameter." Mayes stated his understanding that, in asking that question, Mr. Turner "was referring to moving the dipole arms of the simple dipoles in antennas of the type disclosed in the Isbell 767 patent (PX-A), forwardly so that they would be in effect a V-dipole" (Mayes dep., PX-F, p. 114, line 6, to p. 115, line 20). Mayes further testified that he understood that Mr. Turner's suggestion

had reference only to operation of the antenna on the fundamental one-half wave mode; that it would have been apparent prior to that time to anyone familiar with V-dipoles and their operation that this would not improve the gain and would detract from the directivity on the one-half wave mode operation; but that, nevertheless, Mayes and Carrel tested an antenna of the Isbell type after V'ing the elements forwardly and verified that there was no significant difference in operation on the one-half wave mode of operation (Mayes dep. PX-F, p. 116, line 7, to p. 117, line 15). Mayes then testified further that they took a similar antenna and tested it on higher modes of operation; that the gain was increased and the directivity was sharper than when using the Isbell antenna on the half-wave mode; that, as was well known prior to June 1959, the same improvement was obtained with V-dipoles generally; and that such improvement from substituting V-dipoles in the Isbell antenna resulted "as expected" (Mayes dep. PX-F, p. 117, line 16, to p. 120, line 24).

Finally, Mayes testified (consistently with the clear disclosure of the Mayes et al. patent in suit\*), that the prior antennas of the Isbell patent and the V-dipole antennas of Mayes et al. reissue patent "are identical" other than for the smaller

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\* PX-B, col. 1, lines 40-55; col. 2, lines 44-49; and col. 4, lines 9-21, the first of these citations being quoted in full at p. 20, supra.

included angle between the two elements of each dipole in the V-dipole antennas of the Mayes et al. patent.

The suggestion of using V-dipoles necessarily required some determination of the proper included angle to be used between the diverging arms or elements of each V-dipole. How to determine this parameter of the design of the V-dipole form of the antenna appears at column 3, lines 19-34 with the general suggestion that it range from "about 114° for the [three] half-wavelength mode to about 62° for the 9/2 wavelengths mode."\* However, essentially that same range of V-angles would have been implicit to one skilled in the art from the mere suggestion of using V-dipoles and is clearly the only parameter data for such an antenna that Mayes could have compared with "some of the references of previous literature," as he stated in his deposition (PX-F, p. 117, line 22, to p. 118, line 7).

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\* Omission from the patent of the word "three" enclosed in brackets in this quotation is an obvious typographical error in the patent. As Mayes testified (Mayes dep., PX-F, pp. 50, 116-117), any Veeing of the dipole arms is disadvantageous for operation in the half-wavelength mode, for which one would use the straight dipoles of the Isbell patent in suit, but that the improvement in operation occurs when the V-dipoles are "1.5 times the wavelength, i.e., three half-wavelengths). See Finneburgh affidavit, PX-G, par. 16 .

At least as early as 1943, handbook information gave essentially the same V-angle information, as is evidenced by the "Radio Engineers' Handbook" by Frederick Emmons Terman (1943) pp. 788 and 807-808 (PX-34). As explained in the Finneburgh affidavit, PX-G, use of that handbook information to determine the included angles for the diverging arms of V-dipoles for  $3/2$  wavelengths mode operation and for  $9/2$  wavelengths mode operation would result in selecting, respectively, a little less than  $120^\circ$  (corresponding closely to the  $114^\circ$  in the Mayes et al. patent) and a little less than  $70^\circ$  (corresponding closely to the  $62^\circ$  in the Mayes et al. patent). Thus, selection of the appropriate V-angle in accordance with the disclosure of the Mayes et al. patent in suit involved only normal, well known, engineering practice that would have been employed by anyone skilled in the art in following Turner's suggestion of using V-dipoles.

Summarizing the controlling facts, it is clear beyond dispute that Turner suggested the use of V-dipoles in place of the straight dipoles of the Isbell patent in suit, although he may have had in mind only half-wave mode operation. Mayes and Carrel merely tested the resulting V-dipole antenna on higher modes and verified that the previously well known and characteristic operation of V-dipoles resulted as one skilled in the art at that time would have expected; and the V-angles disclosed by Mayes et al. for use for that purpose were only those that had been customarily employed in the prior art for the same purpose.

Thus, the particular antenna structures that are claimed in the Mayes et al. reissue patent in suit are only what were suggested by Turner; the design parameters employed were only those earlier taught by Isbell plus what was common practice in the prior art when using V-dipoles; and the mode of operation was only what was expected from the then well known operation of the Isbell antennas and of the prior art V-dipoles. Accordingly, there remains only the legal question of whether Mayes and Carrel themselves made an invention, if any is disclosed in their patent in suit, or merely derived the idea from another and added nothing patentable to it, so as to be barred from the right to a patent by 35 U.S.C. 102(f).\*

The Law on Derivation of the  
Patented Invention from "Another"

An application of the law on patentability of inventions to the particular fact situation existing in this case may best be taken in two steps. It is first necessary to recognize what should be an obvious principle of law, i.e., what Turner admittedly suggested to Mayes et al. could not have been the invention of Mayes et al. That principle of law may have been first stated by the courts in the historic case of Stearns v. Davis, 22 Fed. Cases

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\* Quoted in first footnote, p. 5, supra.

1182, Fed. Case No. 13,338 (C.C., Dist. of Col., 1859). The principle has never been better stated than in the headnote of the report of that case (fully supported by the opinion), which reads:

"One who receives a 'suggestion' of a machine from another, and promptly reduces it to practical use, is not an inventor, and will acquire no right by reason of any laches of the original inventor in perfecting his invention. If the latter forfeits his rights, the forfeiture will be to the public."

The foregoing was, perhaps, the first authoritative statement of the law of "originality" or "derivation" that necessarily follows from the Constitutional provision for granting patents only to "Inventors," not to those who derived their ideas from others. Some 16 years later, the same thing was stated, in substance, by the Supreme Court in the noted case of Smith v. Nichols, 88 U.S. 112, 22 L.Ed. 566, \_\_\_\_ (1875). In the words of the Supreme Court--

"A patentable invention is a mental result. It must be new and shown to be of practical utility. Everything within the domain of the conception belongs to him who conceived it. The machine, process or product is but its material reflex and embodiment. A new idea may be ingrafted upon an old invention, be distinct from the conception which preceded it, and be an improvement. In such case it is patentable.\*\*\* These rules apply alike, whether what preceded was covered by a patent or rested only in public knowledge and use. In neither case can there be an invasion of such domain and an appropriation of anything found there. In one case everything belongs to the prior patentee; in the other to the public at large."

The same principle was applied a few years later by the Supreme Court in the equally well known case of Atlantic Works v. Brady, 107 U.S. 192, 27 L.Ed. 438 (1882). The exposure of Brady's derivation of the idea of his patent and the holding of the patent void is detailed at 27 L.Ed. 442.

Such "derivation" or "originality" questions most frequently arise in patent interferences between rival inventors in the Patent Office. Where, as here, the basic idea was derived by the appellant from the appellee, and the particular detail of construction employed could have been worked out by one skilled in the art (for example, the included angle of the V-dipole arms, which is not even mentioned in most of the claims here in suit), the Court of Customs and Patent Appeals held the appellee to be the inventor, not the appellant who had merely used the skill of the art in producing an operable structure. Barba v. Brizzolara, 104 F.2d 198, 202-203, 41 USPQ 749, 754-753 (C.C.P.A., 1939). See, also, Finch v. Dillenback, Jr., 121 F.2d 459, 466, 49 USPQ 731, 738 (C.C.P.A., 1941).

As the Court of Customs and Patent Appeals explained more fully in Applegate et al. v. Scherer et al., 332 F.2d 571, 141 USPQ 796, 798-799 (1964)--

"An originality or derivation case, which this is, is quite unlike a case involving independent inventors, between whom true 'priority' must be decided.

"Appellants seem to propose that there cannot be a conception of an invention of the type here involved in the absence of knowledge that the invention will work. Such knowledge, necessarily, can rest only on an actual reduction to practice. To adopt this proposition would mean, as a practical matter, that one could never communicate an invention thought up by him to another who is to try it out, for, when the tester succeeds, the one who does no more than exercise ordinary skill would be rewarded and the innovator would not be. Such cannot be the law. A contrary intent is implicit in the statutes and in a multitude of precedents."

Clearly, on the authority and reasoning of the above cases, Mayes et al. did not themselves invent the structure claimed in their patent, which was suggested to them by Turner. In that connection, the facts of those cases and of the present case must be distinguished from the many cases reaching the opposite result because the one making the suggestion did not suggest enough for one having ordinary skill in the art to make a complete and operative device. In the present case, Turner suggested precisely what Mayes et al. disclosed, namely, the prior Isbell antenna modified only by substituting V-dipoles for straight dipoles. What V-angle to use for any higher harmonic mode operation above the half-wave mode for which the Isbell antennas had been designed, being handbook information at least since 1943, was clearly implicit in the mere suggestion of the use of the well known V-dipoles.

The next step is to deal with what Turner did not suggest to Mayes et al., namely the use of the proposed V-dipole forms of the Isbell antennas on the 3/2 wavelengths and higher harmonic modes, which produced higher gain and sharper directivity (something which Turner may not have appreciated). The authorities are uniform in holding that when one merely makes a new or extended use of an old device, he is not entitled to a patent on the device itself, which he did not invent.

The last cited principle may have had its first clear statement in Roberts v. Ryer, 91 U.S. 150, 157, 23 L.Ed. 267, 270 (1875), in which the Supreme Court more specifically stated--

"It is no new invention to use an old machine for a new purpose. The inventor of a machine is entitled to the benefit of all the uses to which it can be put, no matter whether he had conceived the idea of the use or not." (Emphasis added)

In that case, comparing the claimed machine of the Sanford patent in suit with the prior Lyman machine, the court continued--

"There was no change in the machine: It was only put to a new use. If there was any change of construction suggested, it was only to increase its capacity for usefulness\*\*\*Clearly, we think, therefore; the invention of Sanford was anticipated by Lyman and his patent is, on that account, void."

The logic of the decision in Roberts v. Ryer is clear and has constituted the cornerstone of a host of subsequent decisions involving countless variations of the particular facts involved in that case. However, a comment seems warranted on a related principle of patent law codified in the 1953 Patent Act,

namely, that "a new use of a known\*\*\*machine" is embraced by the term "process" [35 U.S.C. 100(b)], and that "Whoever invents or discovers any new and useful process\*\*\*may obtain a patent therefore, subject to the conditions and requirements of this title." [35 U.S.C. 101]. The distinction between the principle of Roberts v. Ryer and the quoted portions of 35 U.S.C. 100(b) and 101 is simply this: One who merely puts an old machine to a new use, or uses it in a different way, or for a new purpose, if his conception is inventive in character ("unobvious"), is entitled to patent his conception as a "new and useful process" by the terms of 35 U.S.C. 100(b) and 101. However, where there is no change in the construction of the machine, or any change made in the machine is not inventive, neither the machine nor its inherent functions is new and one who conceives only the new use for the machine is not entitled to claim the machine itself, as his invention, or to patent it, though he may be entitled to patent, in terms of a "process," the particular new steps or operations involved in the new use.

Thus, here, the claims of the Mayes et al. patent in suit improperly cover precisely the device that Turner suggested to Mayes et al., namely, the dipole antennas of Isbell modified only by substituting for Isbell's straight dipoles the well known V-dipoles of the prior art (even including the same V-angles for particular

higher modes of operation that were handbook standards in the prior art use of such V-dipoles).

The principle that discovering a new use for an old device does not entitle one to a patent on the old device, whether or not the new use was previously known, was re-emphasized again in 1892 in another historic case, Ansonia Brass & Copper Co. v. Electrical Supply Co., 144 U.S. 11, 36 L.Ed. 327, 329, citing and repeating the above-quoted language from Roberts v. Ryer.

This has been the law ever since. Thus, in General Electric Co. v. Jewel Incandescent Lamp Co., 326 U.S. 242 (1945), the Supreme Court said (at p. 249)--

"Where there has been use of an article or the method of its manufacture has been known, more than a new advantage of the product must be discovered in order to claim invention. See DeForest Radio Co. v. General Electric Co., 283 US 664, 682, 75 L ed 1339, 1347, 51 S.Ct 563. It is not invention to perceive that the product which others had discovered had qualities they failed to detect. See Corona Cord Tire Co. v. Dovan Chemical Corp. 276 US 358, 369, 72 L ed 610, 614, 48 S Ct 380."

This Court, in 1959, restated the principle and quoted and cited the first part of the above quotation from General Electric v. Jewell. Armour Research Foundation of Illinois Institute of Technology et al. v. C. K. Williams & Co., Inc., 170 F. Supp. 871, 884, 121 USPQ 3, 13 (1959); affirmed, 280 F.2d 499.

The same principle has been applied by the Court of Appeals of the Seventh Circuit in the type of situations involved in the Ansonia case, supra. B.&M. Corp. v. Koolvent Aluminum Awning Corp. of Indiana, 257 F.2d 264, 267, 118 USPQ 191, 194 (1958). Armour & Co. v. Wilson & Co., 274 F.2d 143, 150, 124 USPQ 115, 120-121 (1960), citing 35 U.S.C. 102(f) on which this part of this motion is based.

#### Summary

In claiming only the V-dipole form of Isbell's log periodic antennas and the inherent functions or properties thereof when operating at higher harmonic frequencies, the Mayes et al. patent covers the precise antenna structure suggested to them by Turner. By the first principle of law discussed above, it is clear that such structure, per se could not be the invention of Mayes et al.; and by the second principle of law discussed above, it is equally clear that such structure was not rendered patentable to Mayes et al. by their concept of using it at higher frequencies, whether or not Turner knew that it could be so used or appreciated the advantages of doing so.

The factual premises upon which these legal conclusions are based, being admitted by Mayes in his testimony and by Mayes and Carrel in their Invention Record (PX-15), their patent is necessarily invalid as a matter of law, and no other facts which defendants might conceivably allege could alter this final legal conclusion.

## II.B.

### MAYES ET AL. REISSUE PATENT NO. 25,740 UNENFORCEABLE FOR "UNCLEAN HANDS" OF THE FOUNDATION DEFENDANT, WHO FURNISHED THE PATENT OFFICE WITH DECEPTIVE AND MIS- LEADING EVIDENCE IN PROCURING THE PATENT

This ground for unenforceability of the Mayes et al. reissue patent in suit (PX-B), summarized in Part II.B. of the foregoing Synopsis, will now be fully presented with detailed reference to the facts, the supporting documents, and the applicable law. The absence of any genuine issue of material fact and the unenforceability of the patent as a matter of law will clearly appear from this presentation.

#### The Evidence

The controlling facts upon which this ground of the motion is based are contained in the file history (PX-29) of the Mayes et al. original patent and the file history (PX-30) of the Mayes et al. reissue patent in suit; the University of Illinois reports PX-4 and PX-17, which disclose the Isbell invention; the Stipulation PX-C as it refers to those two reports; the deposition (PX-F) of Paul E. Mayes; and the "RECORD OF INVENTION" (PX-15) signed by both Paul E. Mayes and Robert L. Carrel and identified by Mayes in his deposition.

The significance of the controlling facts, so established for the purposes of this motion, and the immateriality of any additional facts that defendants might conceivably assert in response thereto, will be better appreciated as the controlling

facts are developed in detail below if the specific question of law to be decided is first briefly explained.

The Specific Question of Law Presented

As explained and documented in Parts I and II.A. of this memorandum (pp. 34 to 36, and 46 to 47, supra), the log periodic dipole antennas of the Isbell patent in suit (PX-A) were described in the reports PX-4 and PX-17 prior to any conception of the subject matter of the Mayes et al. reissue patent in suit, and those reports were both published more than one year prior to the first application of Mayes et al. for a patent on that subject matter. It is evident that, if this was not known to the Foundation defendant, it should have been so known and could have been readily ascertained by it.

Despite those facts, when the Patent Office cited another article describing the prior Isbell antennas and published prior to the first Mayes et al. application, but less than a year prior, the applicants filed an affidavit by Mayes to eliminate that publication from consideration as a reference against them. Admittedly, that affidavit was filed to establish that Mayes et al. made their alleged invention prior to the publication date of that particular cited article, so as to eliminate the article from consideration as prior art, but said nothing about the fact that the same information had been earlier published in PX-4 and PX-17. Yet, those two earlier publications, if known, could not have been eliminated from consideration because they had both been published more than one year prior to the first application for the Mayes et al. patent.

Based on those facts, the specific question of law presented is the right of the Foundation defendant to enforce the patent (or the reissue patent in suit that replaced it) which they procured by misleading the Patent Office in that manner, inducing it to withdraw a rejection of the Mayes et al. claims based on the prior work of Isbell, and securing the Mayes et al. patent and subsequent reissue thereof without the prior art work of Isbell ever again being considered by the Patent Office. That the Foundation defendant is not entitled to enforce the Mayes et al. reissue patent in suit after having been a party to such deception, is supported by the most fundamental principles of equity and by a series of Supreme Court decisions rendered over the last 23 years.

#### Uncontested Facts

The Mayes et al. original and reissue patents, by their express terms and as confirmed by Mayes (Part II.A., pp. 48-49, supra), are directed to log periodic dipole antennas of the type described in a patent application of Dwight E. Isbell, Serial No. 26,589, filed May 3, 1960,\* and differing only in the use by Mayes et al. of "V-shaped elements" instead of the straight dipoles disclosed in that Isbell application. However, the Mayes et al. original and reissue patents and the applications on which they were based did not state that the work of Isbell was completed or known to Mayes et al. before they made their alleged V-dipole invention (see Mayes et al. reissue patent, PX-B).

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\* See application Serial No. and filing date given in the heading of the Isbell patent in suit, PX-A.

The application for the Mayes et al. original patent was filed September 30, 1960 (see heading of that patent, PX-B). During the prosecution of that application, the Patent Office rejected the claims thereof on a May, 1960, publication\* of an article by Isbell entitled "Log Periodic Dipole Arrays," in view of a previously cited patent to Rowland (file history, PX-29, p. 30).

Prior to the conception by Mayes et al. of their V-dipole modification of the Isbell antennas, the development work by Isbell had been completed and described in the reports PX-4 and PX-17, and those reports were published more than one year prior to the application for the Mayes et al. original patent (Part II.A., pp.46-47 supra). Moreover, Mayes was familiar with the work of Isbell at the time it was going on and with the records of that work as they were prepared (Part II.A., p. 47, supra).

Mayes, himself, was familiar with the requirement that an application must be made within one year of the date of publication of the invention thereof (Mayes dep., p. 173). As Associate Director of the Antenna Laboratory of the University of Illinois, it is inconceivable that Mayes did not have knowledge of the fact of the early publication of PX-4 and PX-17 at the time he executed his affidavit, as counsel for the Foundation defendant conceded (Mayes dep., p. 177, lines 5-9).

\*\* IRE Transactions on Antennas and Propagation, May, 1960, vol. AP-8, No. 3, pp. 260-267.

Yet, Mayes et al. responded to the above-mentioned rejection of their application by filing in the Patent Office an affidavit by Mayes and an attorney's argument asserting and documenting completion of their V-dipole development prior to the May, 1960, date of the cited IRE publication and prior to the May 3, 1960, filing date of the Isbell log periodic dipole application. That was done without disclosing or suggesting the much earlier publication of the reports PX-4 and PX-17 or the priority of the work of Isbell. Counsel's own argument to the Patent Office stated that Mayes was "fully and completely familiar with\*\*\*Mr. Isbell's work," and the same counsel had previously filed the Isbell application. Nevertheless, as stated in their argument accompanying the Mayes affidavit, it was filed for the purpose of removing both the IRE publication and the Isbell application from consideration as prior art against Mayes et al. (file history, PX-29, pp. 31-43) The necessary (but untrue) implication of the affidavit and argument was that Mayes et al. knew of no other facts making Isbell's work prior art against them.

The fact that the Isbell work had been published much earlier in PX-4 and PX-17 and more than a year before the original application of Mayes et al. should have prevented any such removal of Isbell's prior work from consideration as prior art against

Mayes et al., by the express terms of the Patent Office Rule\* under which the Mayes affidavit was filed.

The contents and prior publication of PX-4 and PX-17 by the University of Illinois must have been known to Mayes. Admittedly (see PX-15), he knew all about the priority of the work of Isbell, in any event. And all of that knowledge by Mayes was, at least readily available to the Foundation defendant and its counsel.

Thus, either the filing of the Mayes affidavit was a deliberate effort to deceive the Patent Office as to the proper status of the Isbell work as prior art, or that affidavit was filed with a reckless and irresponsible disregard of the fact that the prior work of Isbell was a part of the prior art. That such prior art was material to the issue of patentability of the claims of the Mayes et al. application is evident from the Examiner's reliance upon that prior art in rejecting those claims. It is also evident from the fact that Mayes et al. took steps to remove that prior art from consideration by the Patent Office, rather than rely on an argument that it was not material.

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\* Section 1.131 [Rule 131(a)] of the "RULES OF PRACTICE IN PATENT CASES AS AMENDED TO AUGUST 23, 1954 [35 U.S.C.A., pp. 685-6] provides for the filing of affidavits to overcome cited publications "unless the date of such\*\*\*printed publication be more than one year prior to the date on which the application was filed in this country." Having filed the Mayes affidavit under the provisions of this rule, counsel for Mayes et al. must have known of its limitation as herein quoted.

The Patent Office, having thus been misled by the Mayes affidavit, expressly accepted it for the purpose for which it was offered, withdrew the rejection of the Mayes et al. claims on the cited IRE publication, and concurrently allowed the first seven claims of the application, which became the first seven claims of the Mayes et al. original and reissue patents (file history PX-29, pp. 44-45). In due course, the remaining claims thereof and the additional claims of the Mayes et al. reissue patent were allowed by the Patent Office without ever again citing the prior Isbell work as pertinent prior art. (File history, PX-29, page 46 to the end; reissue file history, PX-30, in its entirety).

#### The Applicable Law

In Hazel-Atlas Glass Company v. Hartford-Empire Company, 322 U.S. 238 (1944), the Supreme Court clearly established the principle of law that "fraud" in obtaining a patent for an invention requires a complete denial of relief to the patentee against a claimed infringement. As the court stated (at p. 246)--

"This matter does not concern only private parties. There are issues of great moment to the public in a patent suit. [citing prior decisions]. Furthermore, tampering with the administration of justice in the manner indisputably shown here involves far more than an injury to a single litigant. It is a wrong against the institutions set up to protect and safeguard the public, institutions in which fraud cannot complacently be tolerated consistently with the good order of society."

As regards the extent, if any, to which the wrongful acts committed in procuring the patent actually influenced the granting thereof, the court stated (at p. 247)--

"Doubtless it is wholly impossible accurately to appraise the influence that the article exerted on the judges. But we do not think the circumstances call for such an attempted appraisal. Hartford's officials and lawyers thought the article material. They conceived it in an effort to persuade a hostile Patent Office to grant their patent application\*\*\*. They are in no position now to dispute its effectiveness."

As to the particular relief to which a defendant is entitled when sued on a patent so procured, the court had this to say (at p. 250)--

"Had the District Court learned of the fraud on the Patent Office at the original infringement trial, it would have been warranted in dismissing Hartford's case. In a patent case where the fraud certainly was not more flagrant than here, this court said: 'Had the corruption of Clutter been disclosed at the trial\*\*\*, the court undoubtedly would have been warranted in holding it sufficient to require dismissal of the cause of action there alleged for the infringement of the Downie patent.' [citing cases] The total effect of all this fraud, practiced both on the Patent Office and the courts, calls for nothing less than a complete denial of relief to Hartford for the claimed infringement of the patent thereby procured and enforced."

Shortly after its decision in the Hazel-Atlas case, in Precision Instrument Manufacturing Co. v. Automotive Maintenance Machinery Co., 324 U.S. 806 (1945), the Supreme Court clarified the kinds of misconduct that fall within the rule of Hazel-Atlas. In the later case, the court explained that it is the "unclean hands" maxim of equity that constitutes the guiding doctrine, and

that anyone "tainted with inequitableness or bad faith relative to the matter in which he seeks relief" must be denied that relief. More specifically, in that regard, the court stated (at p. 815)--

"Accordingly one's misconduct need not necessarily have been of such a nature as to be punishable as a crime or as to justify legal proceedings of any character. Any willful act concerning the cause of action which rightfully can be said to transgress equitable standards of conduct is sufficient cause for the invocation of the maxim by the chancellor."

What is required "to transgress equitable standards of conduct" and call for the denial of relief was further explained by the court (at p. 818) as follows:

"We need not speculate as to whether there was sufficient proof to present the matter to the District Attorney. But it is clear that Automotive knew and suppressed facts that, at the very least, should have been brought in some way to the attention of the Patent Office\*\*\*. Those who have applications pending with the Patent Office or who are parties to Patent Office proceedings have an uncompromising duty to report to it all facts concerning possible fraud or inequitableness underlying the applications in issue. [Case citation] This duty is not excused by reasonable doubts as to the sufficiency of the proof of the inequitable conduct nor by resort to independent legal advice. Public interest demands that all facts relevant to such matters be submitted formally or informally to the Patent Office, which can then pass upon the sufficiency of the evidence. Only in this way can that agency act to safeguard the public in the first instance against fraudulent patent monopolies. Only in that way can the Patent Office and the public escape from being classed among the 'mute and helpless victims of deception and fraud.'"

In the most recent Supreme Court decision on this subject, on writ of certiorari to the Court of Appeals of the Seventh Circuit in Walker Process Equipment Inc. v. Food Machinery and Chemical Corp., 322 U.S. 172 (1965), the court cited its prior decisions in the Hazel-Atlas and Precision Instrument cases for the proposition that a person sued for infringement may challenge the validity of the patent on various grounds, including fraudulent procurement. Clarifying the breadth of that rule, the court further stated (at p. 176)--

"In fact, one need not await the filing of a threatened suit by the patentee; the validity of the patent may be tested under the Declaratory Judgment Act, 28 U.S.C. §2201 (1964 Ed.)."

Thus, the defense asserted here against the Mayes et al. reissue patent in suit applies equally well to plaintiff's declaratory judgment suit and to the earlier suit by the Foundation with which the declaratory judgment suit has been consolidated.

Summarizing and applying the principles of the three Supreme Court cases reviewed above to the facts of the present case, there can be no doubt that--

1. The Mayes affidavit was filed in the application for the original Mayes et al. patent at a time when all parties concerned knew that the prior work of Isbell preceded the work of Mayes et al. and was known to Mayes et al. before they conceived the subject matter of their own patent application.
2. Mayes and Carrel both knew of the prior report PX-17 which most fully described the Isbell work and to which they referred in their invention record, PX-15.

3. As counsel for the Foundation defendant acknowledged, Mayes undoubtedly had knowledge of the fact that both of those reports PX-2 and PX-17 had been published more than one year before the Mayes et al. application.
4. Mayes, admitted his own knowledge that publication of the subject matter of a patent application more than a year before filing it bars the grant of a valid patent.

Thus, whether or not any particular individual involved in the procurement of the Mayes et al. original and reissue patents knew all of the foregoing facts, it is evident that all of those facts could readily have been ascertained and that the Mayes affidavit was filed either with knowledge of those facts or in a reckless and irresponsible disregard for those facts. Clearly, such conduct does not meet the standard required of parties engaged in the procurement of patents from the Patent Office, as so clearly prescribed by the Supreme Court in the Precision Instrument case (p. 66, supra). That conduct was obviously "willful" and, since it transgressed the equitable standards so prescribed, it "is sufficient cause for invocation of the "maxim" by the chancellor and a declaration, on this motion for summary judgment, that the Mayes et al. reissue patent in suit is unenforceable and invalid.

#### CONCLUSIONS

1. The Isbell patent, No. 3,210,767 (PX-A), is invalid because the subject matter thereof was described in a printed publication (PX-4) by April 30, 1959, more than one year prior to the May, 1960, date of application for the patent [35 U.S.C. 102(b)].

2. The Mayes et al. reissue patent, No. Re. 25,740, is invalid because Mayes et al. did not themselves invent the subject matter thereof [35 U.S.C. 102(f)].

3. The Mayes et al. reissue patent, No. Re. 25,740 is unenforceable because it and the original patent upon which it was based were procured by presenting the Patent Office with deceptive and misleading evidence to the effect that the earlier work of Dwight E. Isbell was not a part of the prior art, whereas it was in fact a part of the prior art, was known to the applicants before they made their alleged invention, and had been described in printed publications (that were not before the Patent Office) more than one year prior to the date of the application for the Mayes et al. original patent. Hazel-Atlas Glass Co. v. Hartford-Empire Co. 322 U.S. 238 (1944); Precision Instrument Manufacturing Co. v. Automotive Maintenance Machinery Co., 324 U.S. 806 (1945); Walker Process Equipment, Inc. v. Food Machinery and Chemical Corp., 322 U. S. 172 (1965).

Respectfully submitted,

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

THE FINNEY COMPANY,  
a partnership,

Plaintiff

v.

JFD ELECTRONICS CORPORATION,  
a corporation,

and

THE UNIVERSITY OF ILLINOIS FOUNDATION,  
a non-profit corporation,

Defendants.

CIVIL ACTION NOS.

65 C 220

and

65 C 671

(Consl.)

STIPULATION OF FACTS

IT IS HEREBY STIPULATED AND AGREED by and between the parties to this cause, by their undersigned counsel, that:

1. The contract between the University of Illinois and the Air Force, No. AF33(616)-6079 required the University of Illinois to distribute copies of Quarterly Reports and Technical Reports prepared under such contract to designated groups and individuals listed in a "Distribution List" established by the Air Force.

2. Copies of Quarterly Engineering Report No. 1, prepared by the University of Illinois under its said Air Force contract, were printed and distributed to the said Distribution List before April 1, 1959.

3. The said Quarterly Engineering Report No. 1 includes the following statement appearing on page 2:

"2.3 Plans for Next Interval

An investigation of log periodic structures of thin linear elements (zero tooth width) is planned."

4. Quarterly Engineering Report No. 2, prepared by the University of Illinois under its said contract with the Air Force, was printed and 148 copies thereof were delivered by the printer to Miss Marjorie Johnson, the acting Technical Editor of the Publications Office of the Electrical Engineering Department of the University of Illinois. Printing and binding of said copies was completed April 29, 1959, and said copies were at the office of Miss Marjorie Johnson at the University on April 30, 1959.

5. The said Quarterly Report No. 2 contains on pages 2 and 3, respectively, a written description and a schematic illustration of an antenna credited to Dwight E. Isbell, the same Dwight E. Isbell who was named the inventor in the patent in suit No. 3,210,767 granted on an application filed in the United States Patent Office on May 3, 1960 and assigned Serial No. 26,589.

6. The said schematic illustration illustrates an antenna having the same dipole length and spacing relationships as the antenna illustrated in Figure 1 of the said application and described in the related portions of the specification thereof.

7. The said schematic illustration illustrates the same crossover front feed that alternates in phase between successive dipoles as is illustrated and described in the said application.

8. The said written description and schematic illustration illustrate and describe an antenna having the same electrical structure, mode of operation, and performance as the antenna disclosed and claimed in the said application.

9. The said written description and schematic illustration provide a description which would be sufficient for anyone with antenna design experience to construct a successful antenna having a mode of operation and performance identical to the antenna disclosed in the said application.

10. The earliest distribution of any of the printed copies of the said Quarterly Report No. 2 to the groups and individuals on the said Distribution List occurred on May 5, 1959, when the addressed copies were deposited in a United States Post Office at Champaign, Illinois.

11. A printed copy of Technical Report No. 39, prepared by the said Dwight E. Isbell of the University of Illinois under the said Air Force contract was received by the Library of Congress on September 21, 1959, and was a "printed publication" as defined in Title 35, U.S.C., Section 102(b), as of that date.

12. Technical Report No. 52, prepared by Robert L. Carrel, of the University of Illinois, was received by the Defense Documentation Center for Scientific and Technical Information of the Department of Defense on October 18, 1961 and was a "printed publication" as defined in Title 35, U.S.C., Section 102(b) as of that date.

13. The Robert L. Carrel who authored the said Technical Report No. 52 is the same Robert L. Carrel who was named one of the joint inventors in the patents in suit Nos. Re. 25,740 and 3,150,367.

14. The printed publication CTR-198 of the Research and Development Division of Collins Radio Company, heretofore identified in this suit as Plaintiff's Exhibit 12 (PX-12), was a printed publication at least by May 14, 1958, when copies thereof were filed in the Copyright Office, Library of Congress with an application for registration of the copyright thereon.

15. A paper entitled "Some Recent Results in Frequency Independent Antenna Research," as printed by The 20th National Electronics Conference Seminar in a brochure entitled "Topics in Modern Antenna Theory," and bearing the date of October 19, 1964, was delivered by Paul E. Mayes, Associate Director of the Antenna Laboratory, Electrical Engineering Department, University of Illinois, shortly prior to that date. Said Paul E. Mayes is one of the patentees of each of U. S. patents 3,150,376 and Re. 25,740 here in suit.

16. The book "Radio Engineers' Handbook," by Frederick Emmons Terman, First Edition, McGraw Hill Book Company, Inc., was published during the year 1943 as stated therein, and copies of selected portions thereof may be introduced by any of the parties and received in evidence subject to objection by any adverse party on any ground other than authenticity.

Respectfully submitted,

McNENNY, FARRINGTON, PEARNE & GORDON

By

One of the Attorneys for Plaintiff  
920 Midland Building  
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623-1040

MERRIAM, MARSHALL, SHAPIRO & KLOSE

By

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The University of Illinois Foundation  
30 West Monroe Street  
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OSTROLENK, FABER, GERB & SOFFEN

By

One of the Attorneys for Defendant  
JFD Electronics Corporation  
10 East 40th Street  
New York, New York 10016  
Murray Hill 5-8470

STATE OF ILLINOIS )  
 ) SS:  
COUNTY OF COOK )

AFFIDAVIT

Marjorie A. Johnson, being duly sworn, deposes and says that:

1. Her home address is 400 East Randolph Street, apartment 818, Chicago, Illinois.
2. She was continuously employed in Urbana, Illinois, between June, 1958 and March, 1962 by the University of Illinois as the Technical Editor of the Publications Office of the Electrical Engineering Department.
3. In her capacity as such Technical Editor of the Publications Office, it was her responsibility directly to supervise all of the work done by the personnel of such Publications Office and to be directly responsible for all of the work performed by such Publications Office.
4. During her said employment, she was responsible for the printing and distribution of publications published by the Electrical Engineering Department of the University of Illinois, including the printing and distribution of Technical Reports and Quarterly Engineering Reports published by the Antenna Laboratory of such Electrical Engineering Department.
5. During the early part of 1959, including the month of April, 1959, it was generally the practice of the Publications Office to have such reports printed by the Champaign Letter Shop (also known as Stipes Publishing Company), and such printing was handled in the following manner:

(a) Drafts of reports were received by the Publications Office from the personnel of the Antenna Laboratory.

(b) These drafts were edited by her and, when approved, were typed on multilith masters by personnel of the Publications Office.

(c) The multilith masters were then supplied to the Champaign Letter Shop, and the reports were printed.

6. Business records generated in connection with the printing of such reports and formalities relating thereto normally included the following:

(a) A "Requisition" for printing a report, issued to the U of I (University of Illinois) print shop, was usually first issued to determine if the U of I print shop could print the report within the required time.

(b) In the event the U of I print shop was unable to print the report within the required time, a "Purchase Order" was issued to the Champaign Letter Shop requesting it to perform the printing and binding.

(c) After a report was printed and bound by the Champaign Letter Shop a "Delivery Invoice-Voucher" was issued by the University so that the Champaign Letter Shop could be paid for its work.

7. It was the practice of the Champaign Letter Shop to deliver printed and bound reports to the Publications Office the same day the printing and binding was completed, or if the reports were completed late in the day to deliver the reports early the following morning.
8. It was her regular practice to request the issuance of the "Delivery Invoice-Voucher" for a given report soon after the completed, printed, and bound copies of that report were received at the Publications Office from the Champaign Letter Shop.
9. It was the practice of the Publications Office in April of 1959 to order a sufficient number of copies of reports under Air Force Contracts with the University to cover the distribution list normally set forth in such Air Force Contracts and, in addition, the requirement for distribution within the University of Illinois in accordance with a "local list". The cost of such printing was treated as a cost under the contract.
10. It was the practice of the Publications Office in April of 1959 to order extra copies at the same time as those ordered under the contract and to charge the cost of such extra copies to EEIC ("Electrical Engineering Indirect Costs").
11. Such extra copies were ordered, printed, bound, and delivered at the same time as the copies ordered under the contract.
12. Such extra copies were printed so that copies would be available both for internal reference and for distribution to any responsible person requesting a copy until a minimum number of internal reference copies remained on hand.

13. Requests for "extra copies" of such reports were regularly received from people outside the University of Illinois who were interested in antenna developments, and such requests were normally filled by giving such "extra copies" to the requesting party until only the above-mentioned minimum number remained on hand.

14. If a printed and bound report were received by the Publications Office from the Champaign Letter Shop by early afternoon of a given day, copies of such report were generally distributed within the University in accordance with the "local list" on the same day they were received from the Champaign Letter Shop, and if such a report were received in the late afternoon it was generally distributed in accordance with the "local list" no later than the following morning.

15. Local distribution under the "local list" was made in the following manner:

(a) Any copies for individuals or groups located in the building in which the Publications Office was located were either delivered directly to the individual or group, or were placed in the appropriate mailbox within such building assigned to the individual or group.

(b) Any copies for individuals or groups in the E.E. (Electrical Engineering) Building were held until a group of items was accumulated and then, at least once a day,

such copies and the accumulated items were taken by an employee of the University to the E.E. Building where they were placed in the appropriate mailbox in that building assigned to such individual or group.

(c) Any copies for individuals or groups in buildings other than the E.E. Building or the building in which the Publications Office was located were generally placed in the University mail.

16. As soon as copies of such reports were received in the Publications Office, the extra copies were freely given to any responsible party requesting a copy (unless the report was restricted, as by being printed under a classified contract, for example).

17. It is her understanding and belief that contract AF 33(616)6079 was not a classified contract.

18. It was known by many employees of the University of Illinois other than personnel of the Antenna Laboratory, by members of the student body, and by many other people not connected with the University of Illinois or the United States Government that copies of such reports could be freely obtained from the Publications Office of the Electrical Engineering Department of the University.

19. It was common for University employees who were not directly involved in the work of the Antenna Laboratory to request and receive extra copies of reports published by the Antenna Laboratory.

20. During the month of April, 1959, while acting as Technical Editor of the Publications Office of the Electrical Engineering Research Laboratory she was also in charge of the Local Library of the Electrical Engineering Research Laboratory and acted as its Librarian.

21. In April, 1959, the Local Library of the Electrical Engineering Research Laboratory was located in a reading room in the same building as the said Publications Office.

22. The said Local Library received copies of reports published by the various research groups of the University of Illinois, including the Antenna Laboratory and also received reports from research groups elsewhere in the country.

23. The publications and reports of the Local Library of the Electrical Engineering Research Laboratory were normally kept in one of several locked file cabinets in such Local Library.

24. When anyone wanted to borrow a copy of a report from the said Local Library he came to the Publications Office and requested the report. She or one of her assistants then took the keys to the file cabinet, opened the file and signed-out the requested report.

25. The said file cabinets were not locked to prevent use of the material contained therein by the public, but only to maintain control of the material, so that it would not be lost and so that records could be maintained of the name of the borrower and date the material was borrowed.

26. When copies of such reports were received in the Publications Office from the Champaign Letter Shop the library copy of the said Local Library of the Electrical Engineering Research Laboratory was immediately in her possession as Librarian and was immediately available for borrowing by members of the public requesting the library copy.
27. In order to inform people of the availability of reports received by the Local Library of the Electrical Engineering Research Laboratory, a magazine type rack was maintained in a hall of the building leading to her office.
28. Soon after reports were received by her, copies thereof were placed on display on said rack to publicize their availability.
29. A notice was also maintained on said rack that the displayed reports could be borrowed provided the borrower signed-out the reports with her or one of the other employees of the Publications Office.
30. Attached hereto is a paper bearing an identification number 5338 which she believes is a copy of a "local list" for distribution within the University of such reports published under the Air Force Contract AF 33(616)6079; and she believes that this "local list" applied to all Quarterly Engineering Reports and Technical Reports published by the Antenna Laboratory under the Air Force Contract AF 33(616)6079, as indicated thereon, and was in effect before, during, and after the month of April, 1959.
31. Attached hereto are photocopies of a "Requisition" bearing an identification number 5341, a photocopy of a related "Purchase Order" bearing an identification number 5339, and a photocopy of a related "Delivery Invoice-Voucher" bearing an identification number 5340.

32. She believes the attached documents bearing the identification numbers 5341, 5339 and 5340 are photocopies of the "Requisition", "Purchase Order" and "Delivery Invoice-Voucher" relating to the printing of the front and back covers for Quarterly Engineering Report No. 2 under Contract AF 33(616)6079, as indicated thereon.

33. Attached hereto are photocopies of a "Requisition" bearing an identification number 5344, a photocopy of a related "Purchase Order" bearing an identification number 5342, and a photocopy of a related "Delivery Invoice-Voucher" bearing an identification number 5343.

34. She believes that the attached documents bearing the identification numbers 5344, 5342 and 5343 are photocopies of the "Requisition", "Purchase Order" and "Delivery Invoice-Voucher" under which remaining portions of the printing of the Quarterly Engineering Report No. 2 under Contract AF 33(616)6079 were printed and under which the copies of such report were gathered and bound, as indicated thereon.

35. Based upon her knowledge of the regular procedures followed by the Publications Office during April of 1959 and based on her review of the attached documents bearing the identification numbers 5338 and 5344:

(a) The printing, gathering and binding of Quarterly Engineering Report No. 2 under Contract AF 33(616)6079 was completed by April 29, 1959 and the completed printed copies, including the extra copies ordered

under EEIC, were delivered to the Publications Office no later than April 30, 1959.

(b) The distribution of said Quarterly Engineering Report No. 2 to the "local list" (document No. 5338) was completed no later than April 30, 1959.

(c) The said "Local Library Copy" of the said Quarterly Engineering Report No. 2 was available for borrowing by the general public no later than April 30, 1959.

(d) The extra copies of the said Quarterly Engineering Report No. 2 were available to be given to any member of the public requesting same no later than April 30, 1959.

Marjorie A. Johnson  
Marjorie A. Johnson

Before me personally appeared Marjorie A. Johnson, to me known to be the person described in the above affidavit, who signed the foregoing instrument in my presence and made oath before me to the allegations set forth therein on the 22nd day of July, 1966.

Melaine Paszek  
Notary Public

My Commission expires:  
Nov. 17, 1967

AF 33(616)-6079

Distribution Total

1327

LOCAL LIST

5338

	<u>Technical</u>	<u>Progress</u>
P. Mayes	9	9
Dr. E. C. Jordan, E. E. Bldg.	1	1
<del>Dean Wendell Miller, 145 E. E. Bldg.</del>	<del>1</del>	<del>1</del>
Engineering Library, 106 Civil Eng. Hall	2	2
Local Library, E.E.R.L.	1	1
C. H. Tang (box)	1	1
Raj Mittra, E.E. College box	1	1



THIS COPY FOR  
DEPARTMENT

# UNIVERSITY OF ILLINOIS DELIVERY INVOICE - VOUCHER

UNIVERSITY OF ILLINOIS  
PURCHASING DIVISION  
200 ADMINISTRATION BLDG. (EAST)  
URBANA, ILLINOIS

UNIVERSITY ORDER NO.

448995

MUST BE GIVEN

PLEASE RENDER INVOICE IN QUADRUPPLICATE ON  
THIS FORM AND MAIL ALL COPIES TO THE ABOVE ADDRESS.

PAY TO:

FIRM NAME	Champion Letter Shop CO., INC.
STREET AND NUMBER	10 Chester Street
CITY AND STATE	Urbana, Illinois

5340

DATE April 27, 1957

FIRM INVOICE NO.

TERMS: D/C

2% 10th OF MONTH FOLLOWING  
UNLESS OTHERWISE STATED.

QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
117	Small and large envelopes (to be printed in accordance with copy supplied) books plain. Print on white stock - (22 ct. envelopes (1079))		\$ 2.17
PAYEE SHOULD NOT WRITE BELOW THIS LINE			

032838

UNIVERSITY OF ILLINOIS  
BUSINESS OFFICE  
URBANA

# REQUISITION

DUPLICATE  
FOR DEPARTMENT  
REQUISITIONING

1618-P  
5341

Department Requisitioning Electrical Engineering Office Address No. 5341  
DATE 4-16-59

TO THE DIRECTOR OF PURCHASES:  
Please Deliver the Following to: 100 Electrical Engineering Research Lab  
Room Number 5341 Building

Not Later Than \_\_\_\_\_ Call R. Ripper Name Ext. 2621 For additional information

QUANTITY	CATALOG NUMBER	ITEM (Give Complete Specifications)	Estimated Cost (If Available)	Suggested Vendor (If Available)	P. O. Number
117		front and back covers; fronts to be printed in accordance with copy supplied, backs plain. Print on blue stock. (QER #2, contract 6079)	Cost	U. of I. Print Shop  ✓ 4/20/59	
		Johnson			

APPROPRIATION 46 22 75 345  
AF 53(616)6079

I hereby certify that there is an unobligated balance available for the above expenditures in the appropriation indicated.

Approved: \_\_\_\_\_

CLASSIFICATION	
5. Equipment	
7. Improvements	
4. Other Expense	

REQ. NO.	APPROPRIATION	ENC. NO.	DEPARTMENT NAME
1-12-R	40 22 25 314 AF 33 (616) 1079 (4)	175.00 to	Elec. Eng. 100 Elec. Eng. Res. Lab. 6304

DEPARTMENT REQUISITIONING

DELIVER TO

# UNIVERSITY OF ILLINOIS

## PURCHASE ORDER

BUSINESS OFFICE—PURCHASING DIVISION  
200 ADMINISTRATION BUILDING (E)  
URBANA, ILLINOIS

NO. 61827-  
THIS NUMBER MUST APPEAR  
ON ALL CORRESPONDENCE AND  
SHIPMENTS.

DATE

TO  
• Champaign Letter Shop  
• 18-12 Shelter Street  
• Champaign, Illinois

SHIP  
TO

UNIVERSITY OF ILLINOIS

100 Elec. Engineering Research Lab.

URBANA, ILLINOIS

DELIVERY DESIRED BY

SHIP VIA:

(SHIP CHEAPEST WAY UNLESS OTHERWISE SPECIFIED)

QUANTITY	DESCRIPTION	PRICE	AMOUNT
117	copies of Quarterly Engineering Report No. 2, Contract AF 3079 Research Studies on Problems Related to E.C.M. Antennas <sup>2</sup> please print on both sides of the paper		
	25 mats, including six page distribution list and three page Reports Memoranda. Crocks and backs as marked at the top of each mat.		
117	copies of the above - gather and bind.		
2	complete vellum copies of the above. Print on one side of the paper only.		
117	Transmittal letters printed on letterhead paper		
117	transmittal letters printed on buff		
Prices to be in accordance with attached schedule			

175.00  
77.26  
97.74

adj - 97.74

E

2% 10TH OF MONTH FOLLOWING UNLESS OTHERWISE STATED

PRICE

TERMS

AS PER

INVOICE		TERMS		TRANSPORTATION CHARGES		AS PER	
PASSED	AMOUNT	PASSED	AMOUNT	DATE	CRS. NO.	Carrier	Pro. No.
				/			
				/			
				/			
				/			

THIS COPY FOR  
DEPARTMENT

UNIVERSITY OF ILLINOIS  
**DELIVERY INVOICE - VOUCHER**

UNIVERSITY OF ILLINOIS  
PURCHASING DIVISION  
200 ADMINISTRATION BLDG. (EAST)  
URBANA, ILLINOIS

UNIVERSITY ORDER NO.  
**44827-5**

MUST BE GIVEN

PLEASE RENDER INVOICE IN QUADRUPPLICATE ON  
THIS FORM AND MAIL ALL COPIES TO THE ABOVE ADDRESS.

5345

**PAY TO:**

FIRM NAME	Charvelon Letter Shop 00506
STREET AND NUMBER	18 Market Street
CITY AND STATE	Urbana, Illinois

DATE **APRIL 22, 1950**

FIRM INVOICE NO.

TERMS: **net**

2% 10th OF MONTH FOLLOWING,  
UNLESS OTHERWISE STATED.

QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
117	Copies of Quarterly Engineering Report No. 1, Volume 13 1949 "Technical Studies on Problems Related to Public Airborne" - please print on both sides of the paper		
	25 sets, including air page distribution list and three page Reports Memoranda. Fronts and backs as marked at the top of each set. @ 1.50		37.50
117	copies of the above - gather and bind. @ .23		26.76
2	Complete volume copies of the above. Printed on one side of the paper only. @ 1.00		2.00
117	Transmittal letters printed on 100lb. paper		1.20
117	Transmittal letters printed on buff		1.20
			77.86
PAYEE SHOULD NOT WRITE BELOW THIS LINE			

022574

UNIVERSITY OF ILLINOIS  
BUSINESS OFFICE  
URBANA

# REQUISITION

DUPLICATE  
FOR DEPARTMENT  
REQUISITIONING

Department Requisitioning Electrical Engineering No. 1612-77  
Office Address DATE April 16, 59

TO THE DIRECTOR OF PURCHASES:  
Please Deliver the Following to 100 Electrical Engineering Research Lab Room Number Building 5346  
Not Later Than \_\_\_\_\_ Call R. Ripper Name Ext. 2621 For additional information

QUANTITY	CATALOG NUMBER	ITEM (Give Complete Specifications)	Estimated Cost (If Available)	Suggested Vendor (If Available)	P. O. Number
117		copies of Quarterly Engineering Report No. 2, Contract AF 6079 "Research Studies on Problems Related to E. C. M. Antennas" please print on both sides of the paper. 25 mats, including six page distribution list and three page Reports Memoranda. Fronts and backs as marked at the top of each mat.	Cost	U. of I. Print Shop	
117		copies of the above - gather and bind.			
2		complete vellum copies of the above. Print on one side of the paper only.			
117		transmittal letters printed on letterhead paper.			
117		transmittal letters printed on buff.	Cost		

*Completed 4/30/59*

APPROPRIATION 46 22 25 314 CLASSIFICATION

I hereby certify that there is an unobligated balance available for the above expenditures in the appropriation indicated.

Approved \_\_\_\_\_

AF 33(616)0070

5. Equipment	
7. Improvements	
4. Other Expense	<u>4</u>



3. For about 10 years prior to 1950, except for a period of about four years during World War II, he was Chief Engineer of Ward Products Corporation, a manufacturer of antennas, and for the Ward Products Division of Gabriel Corporation after acquisition of the former by the latter about 1949;

4. During about four years of the period of World War II, he was the Chief Electronics Engineer of Winters & Crampton which, during that period, was heavily engaged in the manufacture for the war effort of antennas, oscillators, frequency multipliers, radio frequency power amplifiers, and variable air capacitors;

5. After completing his academic training about 1936, and up to the time he entered the employ of Ward Products Corporation about 1939, he was engaged in electronic and electrical development and research for Clark Controller Company, a manufacturer of electronic and electrical control equipment;

6. His academic training was both in the fields of mechanical engineering and electrical engineering, and he received bachelors degrees in both and a masters degree in electrical engineering from Massachusetts Institute of Technology; and

7. For over thirty years, his work has been entirely in the field of electrical and electronic equipment sales and development engineering and manufacturing, with the great bulk of that work for at least twenty-three of those years being in the field of radio and television antennas. Fifteen patents on antennas have been granted in his name as a sole or a joint inventor.

The following facts believed by him to be of interest and, possibly, helpful to the Court in connection with the above-entitled suit are known to him as a result of his training and experience in the electrical and electronics industry and, particularly, in the radio and television antenna industry:

8. For many years, and particularly since the advent of commercial television, much development work has been done in an effort to provide radio frequency antennas for a variety of radio and television purposes that are capable of operating effectively over more than a limited range of frequencies. Such antennas have been commonly referred to as "broad band antennas," the term being loosely used and commonly applied where the band of frequencies to be covered by a single antenna involved maximum to minimum frequencies ratios up to about two-to-one.

9. Particularly since the advent of commercial television, a great deal of work has also been done to provide antennas that would be effective over each of two or more moderate frequency ranges which are separated in the frequency spectrum by intermediate frequencies over which reception is not desired. An example would be an antenna designed to operate over the low VHF television band (54-88 megacycles -- generally abbreviated mc) of Channels 2 to 6 and the high VHF television band (174 to 216 mc) of Channels 7 to 13.

10. At least since shortly after the advent of commercial television and long prior to 1959, antennas comprising one or more V-dipoles have been extensively used to cover a plurality of spaced frequency bands such as the low VHF and high VHF television bands. For such purposes, the V-dipoles were dimensioned to be approximately a half wavelength long from tip to tip, measured along the arms of the V-shaped dipoles, for a frequency near the middle of the low VHF frequency range. When so dimensioned, the same V-shaped dipoles were approximately  $3/2$  wavelengths long at a frequency near the middle of the high VHF frequency range. In the low VHF frequency range, such V-dipoles operated approximately the same as simple, straight dipoles, so as to effectively receive over that range, although with diminishing effectiveness above and below the frequency for which the dipoles were approximately one-half wavelength long. Such operation was commonly termed "operation in the one-half wavelength mode." In the high VHF frequency range, the same V-dipoles, by virtue of their V-shaped configurations, operated effectively over that range with diminishing effectiveness above and below the frequency at which the V-dipoles were approximately  $3/2$  wavelengths long. Such operation in the high VHF range was commonly termed "operation in the  $3/2$  wavelengths mode." Such V-dipoles were well known to operate similarly over still higher frequency ranges at which the V-dipoles were approximately  $5/2$ ,  $7/2$ ,  $9/2$ , etc. wavelengths long, and such operation at higher frequencies was commonly termed operation in the  $5/2$  wavelengths mode,  $7/2$

wavelengths mode,  $9/2$  wavelengths mode," etc.

11. For various communication purposes and other specialized radio frequency operations, it became important to provide antennas whose operation would be essentially uniform over very broad frequency bands involving frequency ratios far in excess of two-to-one. The principal characteristics of an antenna having uniform response over any given frequency range were uniform "radiation patterns" and uniform "impedance" or "input impedance" over that range. Antennas having such uniform characteristics were generally referred to as being "frequency independent" over that range, and the problem of designing frequency independent antennas increased in difficulty and complexity as the frequency range to be covered for various purposes increased.

12. Frequency independent operation of antennas is especially important where the radio frequencies being used may fall anywhere within, or vary over, a broad range or band of frequencies and uniform response over such range or band is required by the particular antenna application. Frequency independent antennas find practical application, for example, in specialized military operations termed "electronic countermeasures", abbreviated "ECM", as well as in many other operations involving the transmission and reception of widely varying frequencies.

13. The type of frequency independent antennas to which the three patents in suit relate involves certainly progressively varying dimensional relationships that render the antennas cyclical or "periodic" in performance as the frequency of operation is varied progressively over the bands of frequencies for which the antennas are designed. The cycles or periods repeat according to a simple proportional relationship that is called "logarithmic" in mathematical terminology. Thus, such antennas are called "logarithmically periodic antennas" or, using an abbreviated term, "log periodic antennas." Isbell U. S. patent No. 3,210,767, and Mayes et al. patent No. Re. 25,740 involved in the above-entitled suit are directed to log periodic antennas which are essentially "unidirectional," i.e., when used as transmitting antennas, they transmit energy as a narrow, unidirectional beam of radiation with only relatively little radiation being emitted in other directions, or, conversely, when used as receiving antennas, they receive radiation efficiently from essentially only one direction while being relatively ineffective in receiving radiation from other directions.

14. The above-mentioned Isbell patent makes use of a series of simple, straight dipoles 10, 11, 12, etc. of progressively diminishing lengths  $L_1$ ,  $L_2$ ,  $L_3$ , etc., with dipoles spacings that similarly diminish in the same direction. The dipole lengths and spacings are related by a constant scale factor or multiplier stated

in both patents to be "less than 1". Thus, the length of each successive smaller dipole is equal to the length of the adjacent larger one multiplied by the decimal fraction constituting the common scale factor, and each successive smaller space between dipoles is equal to the adjacent larger space multiplied by the same decimal fraction.

15. The above-mentioned Mayes et al. reissue patent is directed to antennas differing from the antennas of the Isbell patent only by substituting V-dipoles for the simple, straight dipoles of the antennas of the Isbell patent, for the purpose of rendering the antenna effective over higher frequency ranges than the one-half wavelengths mode, such as the  $3/2$  wavelengths mode,  $5/2$  wavelengths mode,  $7/2$  wavelengths mode,  $9/2$  wavelengths mode, etc. Whenever V-dipoles were used prior to 1959 as described in paragraph 10 above, herein, the included angle between the diverging arms or elements of each V-dipole was customarily determined by the particular mode of operation desired according to data that had long been available in standard handbooks for radio engineers, one of these handbooks being "Radio Engineers' Handbook" by Frederick Emmons Terman, 1943 (stipulation, PX-C), pp. 806-807 and the graph referred to therein and appearing at p. 788).

16. Referring particularly to page 807 of the Terman handbook cited in the preceding paragraph, the mode of operation of a V-dipole on higher modes than the half wavelength mode is

described so as to explain the need for selecting the proper V-angle according to the higher mode of operation desired. How to calculate the V-angle for a particular mode of operation is disclosed with reference to Fig. 19 of the handbook, appearing at p. 788 in the form of a graph of angles relative to the lengths of the dipole arms in terms of wavelengths (which lengths determine which of the higher modes of operation is to be used). Following the instructions so given by Terman and using the graph in Fig. 19 as directed, one would arrive at an included angle between the arms of a V-dipole of approximately  $120^\circ$  for  $3/2$  wavelengths mode operation and approximately  $70^\circ$  for  $9/2$  wavelengths mode operation. As explained in footnote 2 on p. 807, other practical considerations require some reduction of the included angle in practice, so that the calculated values of  $120^\circ$  and  $70^\circ$ , above, would be reduced and closely approximate the corresponding figures of  $114^\circ$  and  $62^\circ$  given in the Mayes et al. reissue patent, col. 3, lines 24-27. Thus, as early as 1943, any competent antenna engineer considering the use of a V-dipole for operation above the half wave mode would have understood that the included angle between the arms of the V-dipole would be determined by the desired higher mode of operation and would range from an angle of close to  $114^\circ$  for  $3/2$  wavelengths mode operation to an angle close to  $62^\circ$  for  $9/2$  wavelengths mode operation.

17. The radiation patterns of antennas of the type to which the above-mentioned Isbell and Mayes et al. patents are directed are essentially "unidirectional" to the left ("forward

direction") as viewed in Fig. 1 of both of those patents, typical radiation patterns for the antennas of the Isbell patent, for example, being shown in Fig. 3 and Fig. 4 thereof. The scale of those patterns shown in Fig. 3 and Fig. 4 of the Isbell patent is such that only the radiation in a generally forward direction is shown. To some degree, one or more much smaller radiation lobes in another direction or in several other directions would appear in Fig. 3 and Fig. 4 if drawn to a larger scale or, for example, if drawn on a variable scale commonly called a "logarithmic scale." This is indicated by the reference at col. 2, lines 49-50 of the Isbell patent by the reference to a "front-to-back ratio" of "17db," which is an expression used to indicate the relative intensity of radiation in the forward direction compared to the backward direction.

Further affiant saith not.

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Lewis H. Finneburgh, Jr.

Subscribed and sworn to before me this \_\_\_\_\_ day of  
April, 1967.

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Notary Public

OFFICE OF NAVAL RESEARCH

5278

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COGNIZANT BUREAU \_\_\_\_\_ RECOMMENDED SECURITY CLASSIFICATION \_\_\_\_\_ REC. OF INV. NO. \_\_\_\_\_

1. NAME OF INVENTOR Paul E. Hayes RANK, RATING, TITLE OR POSITION Research Associate Professor

2. EMPLOYER'S NAME AND ADDRESS University of Illinois, Urbana, Illinois

3. DATES OF EMPLOYMENT OR MILITARY SERVICE September 13, 1954 to present

4. PRESENT ADDRESS (No. Street, City, County, State) 1902 Broadmore Dr., Champaign, Illinois TELEPHONE CH 6-1165 PERMANENT OR UTIL Permanent

5. PERMANENT ADDRESS (No. Street, City, County, State) 1922 Broadmore Dr., Champaign, Illinois TELEPHONE

6. NAME(S) AND ADDRESS(ES) OF CO-INVENTORS (If any) Robert L. Carroll 1017 S. Anderson, Urbana, Illinois

7. DESCRIPTIVE TITLE OF INVENTION Log-Periodic Resonant-V Array

8. LIST DRAWINGS, SKETCHES, PHOTOS, REPORTS, DESCRIPTIONS, NOTEBOOK ENTRIES, ETC. WHICH SHOW OR DESCRIBE INVENTION See attached drawings.

9. EARLIEST DATE AND PLACE INVENTION WAS CONCEIVED (Brief outline of circumstances) On June 11, 1959 Mr. E. M. Turner of Wright Air Development Center asked if the angle of dipoles on a log-periodic dipole array had been used as a design parameter. This was tried with no significant change in performance. The idea of operating at higher frequencies so that a change would be obtained then lead to the present invention.

10. DATE AND PLACE OF FIRST SKETCH, DRAWING OR PHOTO August 18, 1959, Antenna Lab.

11. DATE AND PLACE OF FIRST WRITTEN DESCRIPTION August 18, 1959, Antenna Lab.

12. DISCLOSURE OF INVENTION TO OTHERS

NAME, TITLE AND ADDRESS	FORM OF DISCLOSURE	DATE AND PLACE OF DISCLOSURE	WAS SIGNATURE OBTAINED (YES OR NO)
F.L. Woole, Professor New Mexico State Univ. Los Cruces, New Mexico	Written Copy and Photo	August 18, 1959 Antenna Lab.	Yes
I.A. Shubert, Res. Ass't University of Illinois	"	"	"
F.R. Allen, Research Ass't University of Ill.	"	"	"

13. DATE AND PLACE OF COMPLETION OF FIRST OPERATING MODEL OR FULL SIZE DEVICE June 23, 1959

14. PRESENT LOCATION OF MODEL Antenna Lab.

15. DATE, PLACE, DESCRIPTION AND RESULTS OF FIRST TEST OR OPERATION June 23, 1959, Antenna Lab., radiation patterns were first measured for V-elements in

Bottoms chopped of copies by mistake PX-15

16. LOCATION OF TESTS: Santa Ana, California

17. DATE, PLACE, DESCRIPTION AND RESULTS OF LATEST TESTS (See 16) at present writing have achieved improved performance.

Jon Erickson, 814 W. Williams, Champaign (witness)

John Keenan, 27 Redtree Drive, Colonial Mobile Park, Champaign, Ill.

18. IDENTIFY RECORDS OF TESTS AND GIVE PRESENT LOCATION OF RECORDS, LFV-1, LFV-2, LFV-4 and input impedance charts in notebook entitled "LFV Impedance Data", Antenna Laboratory

19. REFERENCES TO OTHER PUBLICATIONS: Log-Periodic Dipole Array invented by D.E. Isbell and reported in Antenna Lab Technical Report No. 39, June 1, 1959.

20. OTHER KNOWN CLOSELY RELATED PATENTS, PATENT APPLICATIONS AND PUBLICATIONS

PATENT OR APPLICATION NO.	DATE	TITLE OF INVENTION OR PUBLISHED ARTICLE	NAME OF PUBLICATION
760297	20 May 1959	Log-Periodic Dipole Array	University of Illinois Antenna Lab, Rep. No. 39

21. EXTENT OF USE: Past, Present and Contemplated (of any type of experimental or other use) - Should be useful as receiving antenna for television and other communication applications.

22. DETAILS OF INVENTION HAVE BEEN RELEASED TO THE FOLLOWING COMPANIES OR ACTIVITIES

NAME AND ADDRESS	INDIVIDUAL OR REPRESENTATIVE	CONTRACT NO.	DATE
Collins Radio Company Cedar Rapids, Iowa	R. H. Duffanel	*****	5/11/59 (approx)
Boeing Airplane Company Seattle, Washington	D.E. Isbell	*****	6/15/59

# RADIO ENGINEERS' HANDBOOK

BY

FREDERICK EMMONS TERMAN, Sc.D.

*Professor of Electrical Engineering and Executive Head, Electrical  
Engineering Department, Stanford University (absent on  
leave); Director, Radio Research Laboratory,  
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FIRST EDITION

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1943

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$I$  = current, amp., at a current loop.

$L$  = length of antenna, meters.

$\lambda$  = wave length, meters.

$\theta$  = angle of elevation measured with respect to wire axis.

The field distribution is a figure of revolution about an axis coinciding with the antenna wire, is symmetrical about a plane perpendicular to the center of the wire, and has the character illustrated in Fig. 19. The relative magnitude and position of the various lobes in the directional pattern can be quickly obtained with the aid of Figs. 19 and 20.

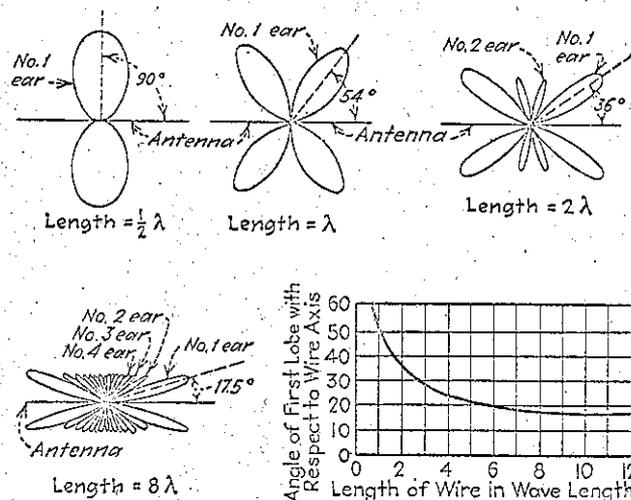


FIG. 19.—Polar diagram showing strength of field radiated in various directions from an antenna consisting of a wire remote from the ground. These diagrams can be considered as cross sections of a figure of revolution in which the axis is the antenna.

**Radiation Resistance and Gain.**—The radiation resistance of an isolated wire is

$$\text{Radiation resistance} \left\{ = 30 \left[ 0.5772 + \log_e \left( 4\pi \frac{l}{\lambda} \right) - Ci \left( 4\pi \frac{l}{\lambda} \right) \right] \right. \quad (14)$$

where the resistance is in ohms,  $l/\lambda$  is the antenna length in wave lengths, and  $Ci(x)$

$$Ci(x) = \int_{\infty}^x \frac{\cos x}{x} dx \quad (15)$$

Values of  $Ci(x)$  can be obtained from the tabulated values of  $Si(x)$  given in Table 13 Sec. 1. When  $\frac{l}{\lambda} > 1$ , the radiation resistance is approximately

$$\text{Radiation resistance} \left\{ = 17.32 + 30 \log_e \left( 4\pi \frac{l}{\lambda} \right) \right. \quad (16)$$

The relation between radiation resistance and length is given in Fig. 21, which also gives the gain of an isolated long-wire antenna as compared with an antenna a half wave length long. The power gain of the latter as compared with a doublet is 1.63.

**Effect of a Perfect Ground on Characteristics of a Resonant Wire.**—The effect of a perfect earth on the directional characteristics of a resonant wire antenna is determined by the method of images discussed in Par. 4. For horizontal antennas, and also

The power gain of a rhombic antenna array depends upon the length of the leg, measured in wave lengths, and upon the other proportions of antenna. With leg lengths ranging from two to four wave lengths, the power gain is commonly of the order of 20 to 40 in typical cases. The higher gains tend to go with the longer lengths, since then the concentration of energy in the desired direction is greater, and furthermore the amount of energy radiated is greater in proportion to that dissipated in the terminating resistance.

The radiation resistance of a rhombic can be defined as that quantity which when multiplied by the square of the average current in the wire will equal the radiated power. When the length and breadth are both considerably greater than  $\lambda$ , this resistance  $R$  in ohms is<sup>1</sup>

$$R = 240 \left[ \log_e \left( 4\pi \frac{l}{\lambda} \cos^2 \phi \right) + 0.577 \right] \quad (35)$$

In considering its effect on current distribution, this resistance can be considered as being uniformly distributed along the wire.

The terminating resistance of a rhombic antenna must dissipate a considerable amount of power when the antenna is used for transmitting. This may in typical

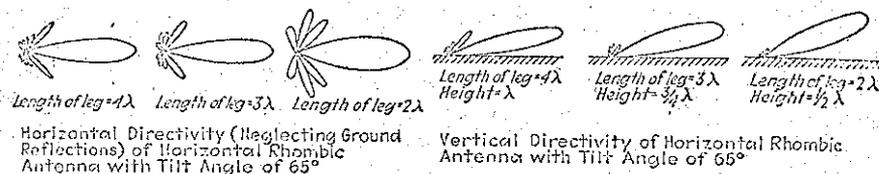


FIG. 41.—Polar diagram showing directional characteristics of the same horizontal rhombic antenna for three different frequencies.

cases be of the order of a quarter to a half of the total power supplied to the antenna, with the exact value depending upon the antenna design. When high-powered transmitters are involved, a convenient way of obtaining a terminating resistance of the required power-handling capacity is to use a two-wire transmission line having a characteristic impedance equal to the desired terminating resistance and employing iron wire to give high loss. This transmission line can be run back from the terminating apex toward the input apex, and after being made sufficiently long to dissipate all except a negligible proportion of the power, can be terminated in a low-wattage resistance, or even left unterminated.

It is possible to modify the minor lobes in the rear of the directional pattern, and in particular to obtain a null in any desired backward direction; merely by modifying the magnitude or phase angle, or both, of the terminating resistance.

There is an advantage in making each conductor of a rhombic antenna consist of two or more spaced wires connected in parallel. This lowers the characteristic impedance of the rhombic antenna, thereby making the terminating impedance less critical and also causing a greater proportion of the total energy supplied to the rhombic to be radiated. There is a further advantage to be gained by arranging such a spaced-wire conductor so that the effective conductor diameter is greater at the two corners of the rhombic than are between the apexes than at the corners of the apexes. It is possible in this way to compensate for the fact that the varying spacing between the sides of the rhombic tends to cause the characteristic impedance of the antenna to be different at different places.

<sup>1</sup>Lewis, *loc. cit.*, or Rhombic Transmitting Aerial Efficiency, *Wireless Eng.*, Vol. 18, p. 150, May, 1941. This latter article also contains additional useful information on the performance of rhombic antennas.

15. The Resonant V Antenna.—This antenna consists of two long resonant wires arranged to form a V and excited so as to carry equal currents that are in phase opposition. The apex angle of the V is made twice the angle that the first lobe in the field pattern of a long resonant wire makes with the wire (see Fig. 19).<sup>2</sup> This gives a strong concentration of radiation in the plane of the V, with the major lobe of the directional pattern in the direction of the line bisecting the V as shown in Fig. 42.

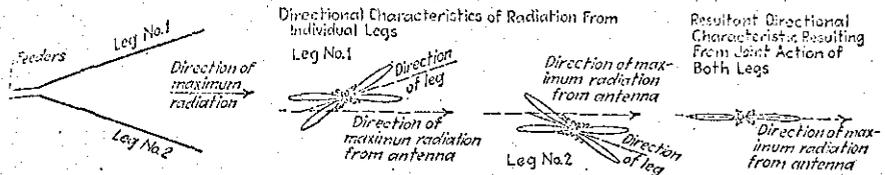


Fig. 42.—V antenna, showing how the radiation from the two legs combine to give a well-defined beam.

The radiation pattern from a V antenna, if it is assumed that the antenna is remote from earth and that each leg is an even multiple of a half wave length long, is<sup>3</sup>

$$\text{Field strength in plane of V} = \sqrt{E_a^2 + E_b^2 - 2E_aE_b \cos \left( 2\pi \frac{l}{\lambda} \sin \alpha \sin \phi \right)} \quad (36a)$$

Radiation in vertical plane passing through bisector of apex angle

$$\epsilon = \frac{120I}{d} \left[ \frac{\sin \left( \frac{n\pi}{2} \cos \alpha \cos \theta \right) \sin \alpha}{1 - \cos^2 \theta \cos^2 \alpha} \right] \quad (36b)$$

where  $E_a$  and  $E_b$  = radiation in desired direction from individual legs of antenna as given by Eq. (13).

$l$  = length of leg.

$\lambda$  = length corresponding to one wave length.

$\alpha$  = half of angle at apex.

$\phi$  = bearing angle with respect to bisector of apex.

$\epsilon$  = field strength, volts per meter.

$n$  = number of half wave lengths in each leg of antenna.

$\theta$  = angle of elevation with respect to plane of antenna.

$I$  = current at current loop.

$d$  = distance to antenna, meters.

Increased directivity can be obtained by means of an array, each element of which is a V antenna. Thus the directivity in a vertical plane can be improved by stacking two or more V's one above the other, as illustrated in Fig. 43a. Similarly, a uni-directional pattern can be developed by the use of a second system of V antennas spaced an odd number of quarter wave lengths behind the original system and excited

<sup>1</sup> For further information see P. S. Carter, C. W. Hansell, and N. E. Lindenblad, Development of Directive Transmitting Antennas by RCA Communications, Inc., *Proc. I.R.E.*, Vol. 19, p. 1773, October, 1931; P. S. Carter, Circuit Relations in Radiating Systems, *Proc. I.R.E.*, Vol. 20, p. 1004, June, 1932.

<sup>2</sup> When the sides of the V are short, for example, one wave length or less, the apex angle at which the power gain of the antenna is maximum is less. Thus, for legs one wave length long, maximum gain is obtained with an apex angle of 90° rather than the 105° corresponding to exact superposition of the major lobes. When the antenna is near the earth, the optimum angle is also slightly less than when the V is isolated.

<sup>3</sup> See Carter, Hansell, and Lindenblad, *loc. cit.*

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