# MEMORANDUM

October 9, 1962

To: Mr. S. Blake Yates

Re: Antenna Reactance Compensators

Low frequency multi-element antennas tend to resonate very sharply because of rapid change of reactance with frequency. The usual bandwidth of operation is about plus or minus 1 per cent or less.

If some means can be found to slow down the rate of change of reactance with frequency, the useable bandwidth can be increased. This is done by adding a second reactive element to the system. By proportioning and connecting it properly, the net reactance may be held close to zero over an appreciable frequency bandwidth.

The physical structure is shown in Figure 1. The electrical equivalent is in Figure 2. The improvement in reactance is in Figure 3. The improvement in bandwidth is in Figure 4.

The performance of the circuit depends greatly on electrical and physical construction of $L_s$. To achieve large bandwidth, $C_s$ must be as small as possible. Thus $L_s$ must be space wound and open ended. This makes the current go around the coil instead of along the coil. The lineal length of wire in $L_s$ is about one half wavelength at median frequency. $L_s$ is rather like a coiled-up antenna in a box to prevent pickup from outside radiation.

Empirically it has been determined that the potential energy storage of the secondary should be similar to the primary. This means that large-diameter, low-resistance wire will greatly assist in achieving wide bandwidth.

Examination of Figure 1 shows that the primary has an overall length of about 3/2 wavelength. This causes the reactance to change very fast near resonance. A significant increase of bandwidth could probably be achieved by making $L_s$ equal 3/2 wavelengths to provide a commensurately fast rate of change of reactance.

Obviously there is a wide variety of possible alterations in regard to coupling and load, but the simple system above is the heart of the matter.

Grote Reber

GR:sp

K

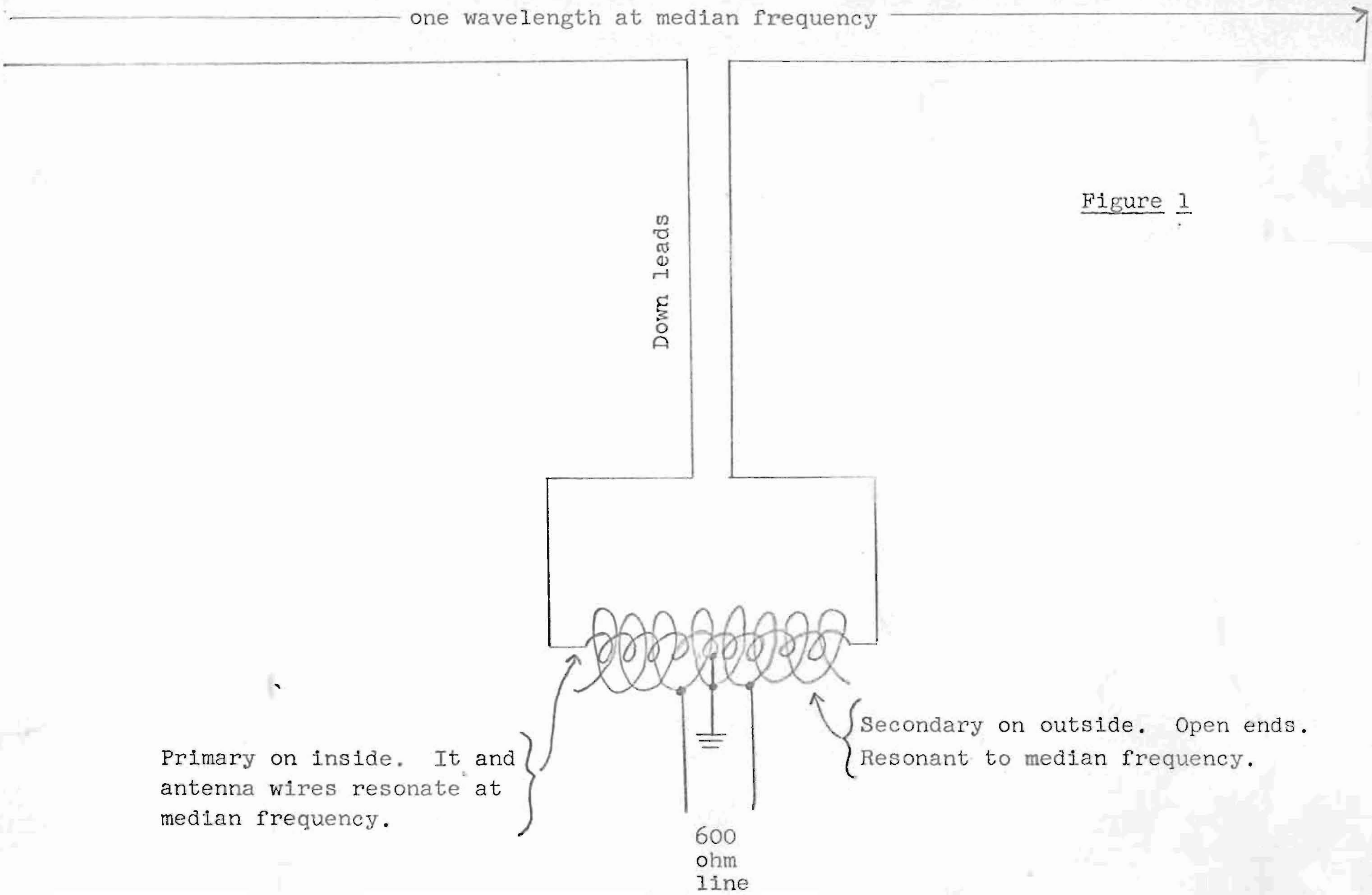

one wavelength at median frequency
Down leads
Primary on inside. It and antenna wires resonate at median frequency.
Secondary on outside. Open ends. Resonant to median frequency.
600 ohm line

Figure 1

One half of a symmetrical system

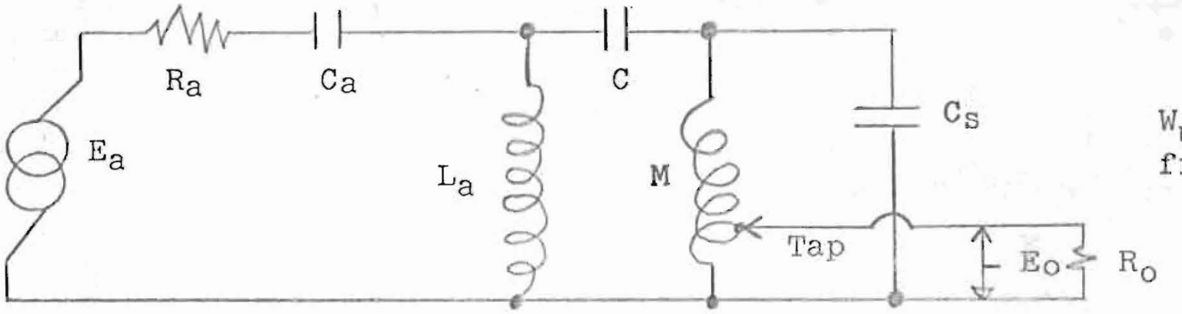



Figure 2

$W_m$ = angular radious at median frequency.

$L_aC_aW_m = L_sC_sW_m$

M = mutual inductance between $L_a$ and $L_s$ phased to aid coupling of C. This means $L_a$ and $L_s$ are wound in opposite directions.

$L_a$ = primary inductance

$L_s$ = secondary inductance

$C_a$ = apparent antenna series capacity

$C_s$ = apparent secondary distributed capacity

C = stray capacity between primary and secondary

Tap point higher up on $L_s$ for higher load resistance

$E_a$ = voltage induced in antenna by signal

$E_o$ = voltage output into load

$R_a$ = antenna radiation resistance

$R_o$ = output or load resistance

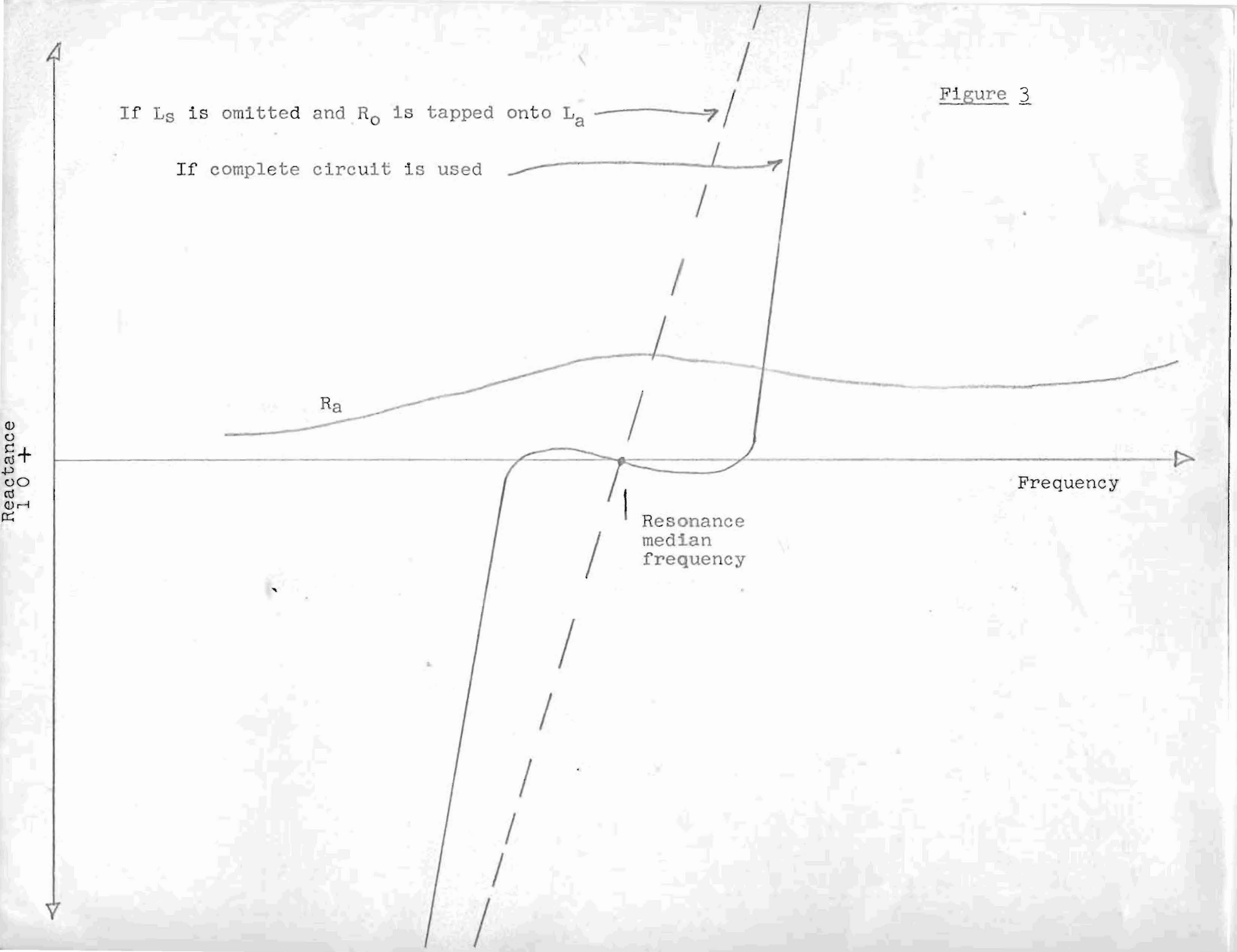
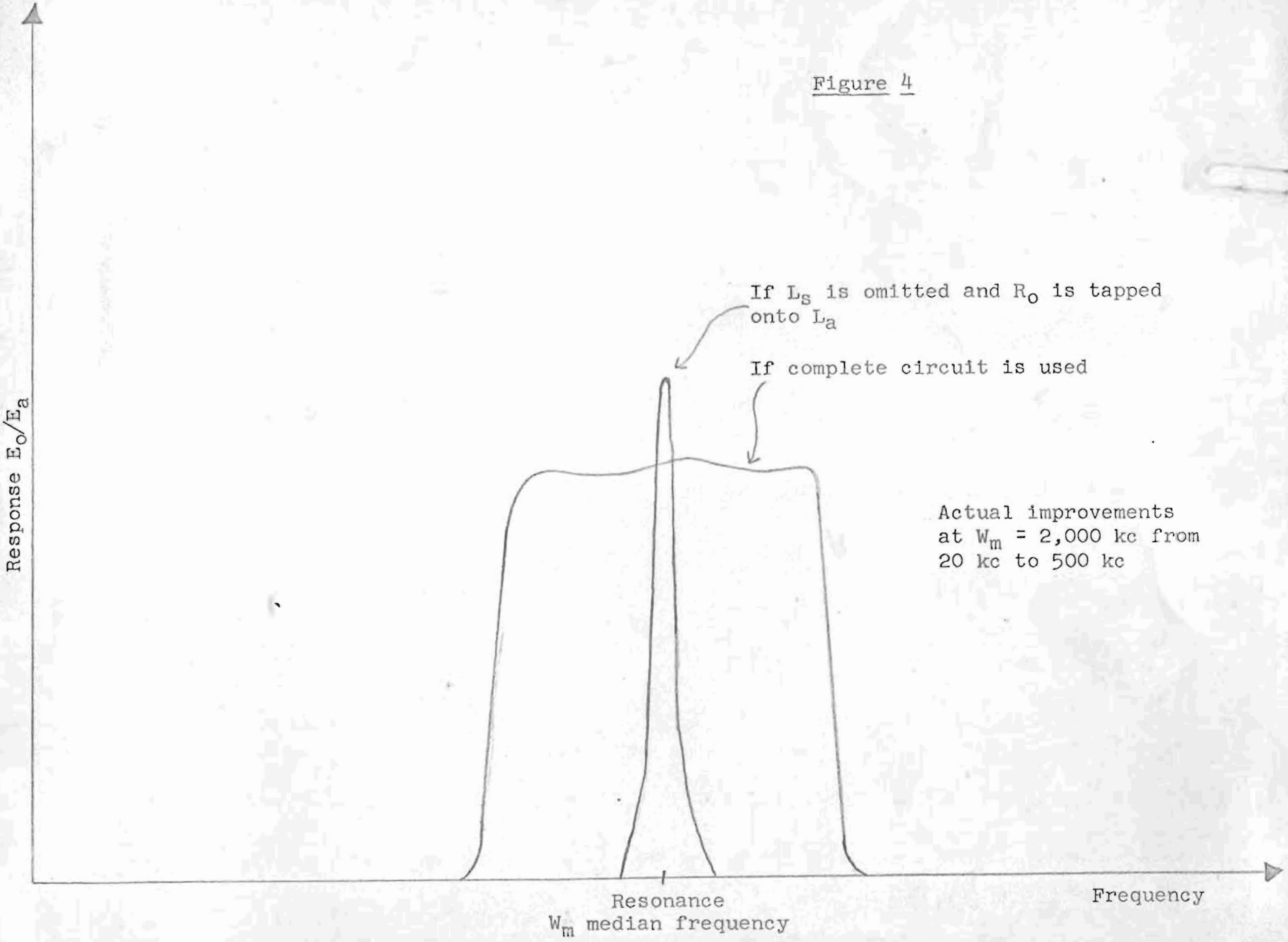

If $L_s$ is omitted and $R_o$ is tapped onto $L_a$
If complete circuit is used
$R_a$
Reactance
− 0 +
Frequency
Resonance
median
frequency

Figure 3

Figure 4


If $L_s$ is omitted and $R_o$ is tapped onto $L_a$
If complete circuit is used
Actual improvements at $W_m$ = 2,000 kc from 20 kc to 500 kc
Response $E_o/E_a$
Resonance
$W_m$ median frequency
Frequency

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ROBERT P. IRWIN
ASSOCIATE
PATENT DEVELOPMENT DIVISION

November 8, 1962

Dr. Grote Reber
Commonwealth Scientific and
Industrial Research Organization
Stowell Avenue
Hobart, Tasmania
Australia

Dear Grote:

Enclosed are three copies of the memorandum you addressed to Blake Yates. We hope that the graphs have been drawn to your satisfaction.

Sincerely yours,

Bob.

Robert P. Irwin

RPI:sp
Enclosures

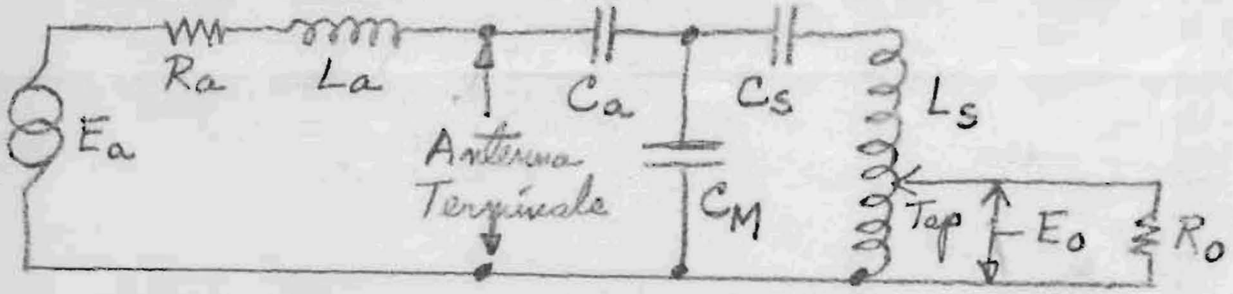
16th November 1962

Dear Bob:

Thank you for your letter and enclosures of the 8th. Please change figure 2 as follows:

Top right; change radious to radians.
Move M to left to be under C.
Add $L_s$ to right of coil
Add dot in top wire just right of $C_a$
Add dot in bottom wire just left of $L_a$ to be under top dot.
Label dots "Antenna Terminals".

The circuit of figure 2 applies only if down leads are cut short so that, looking into antenna terminals, one sees a reactance $C_a$. If down leads are made long; then looking into antenna terminals, one sees a reactance $L_a$. The circuit to be used is shown below.




The coupling is a T network of capacities. $C_s$ must be larger than the distributed capacity of $L_s$. Thus the coil must be space wound. Other variations are possible.

Things are going well down here. I'll keep you advised of anything else which looks interesting.

Best regards,

Grote

Grote Reber

P.S. There is a slight change in the formula for resonance at median frequency. The exact formula can be found in good handbooks on radio engineering. $C_m$ must be included in both primary and secondary parts of the formula.

G.R.

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ROBERT P. IRWIN
ASSOCIATE
PATENT DEVELOPMENT DIVISION

November 19, 1962

Dr. Grote Reber
Commonwealth Scientific and
Industrial Research Organization
Stowell Avenue
Hobart, Tasmania
Australia

Dear Grote:

Thank you for your letter of November 16 pointing out several errors in Figure 2. The errors have been duly corrected on our copy and the new circuit added to it.

There is nothing new regarding this invention. However, we do appreciate your keeping us informed of the advances you are making with it.

You are probably in the height of spring down in Tasmania, and you may be comforted to know that we have had our first snowfall.

Sincerely yours,

Bob

Robert P. Irwin

RPI:sp