Amateur Radio Resources that Save Space

Updated

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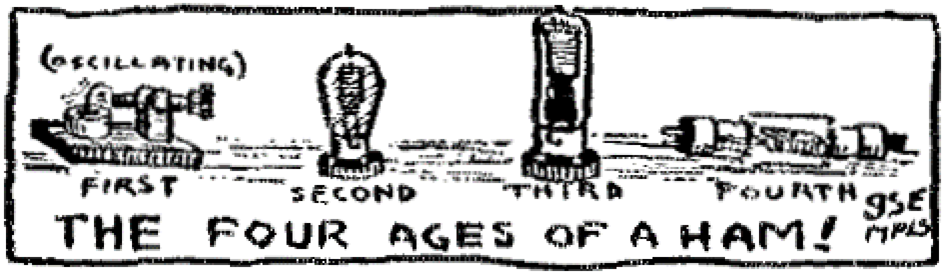
Summary

If you buy too much ham stuff, your house will overflow with Amateur Radio equipment. Steve, K6OIK will show how to continue collecting ham stuff even if your house is overflowing. The secret is to collect stuff that occupies no space. Radio information, in the form of articles, papers, books, or other publications, is available online. Whether it is an article from Popular Electronics, a home-study course from National Radio Institute, a book on antennas, an NAB Engineering Handbook, or papers from the IEEE or Bell System Technical Journal, it is available online if you know where and how to look. Steve will show the sources of information (software, archival articles, papers, and books) that Google often fails to find and yet is free and will occupy no space other than on your hard drive.

The Four Ages of a Ham



Tactical Error: Opening a Go Kit First Thing…

Journal of the California Historical Radio Society, Spring/Summer 2020

… Leads to the Fifth Age

THE FIFTH AGE!

Sources of Information that Takes No Space

- **FARS web site "Radio Links"**
- **Sherwood Engineering**
- **ARRL magazines**
- **Other Amateur Radio magazines**
- **Online repositories**
- **IEEE Xplore**
- **Internet Archive**
- ***Bell System Technical Journal***
- **MIT Rad Lab series**
- **Royal Society**
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- **Listen to the Golden Age of radio**

FARS Web "Radio Links" – Software & Presentations
https://www.fars.k6ya.org/others

- General circuit analysis and design (5)
- Filter design (1)
- Inductors and inductance (1)
- Transmission lines (3)
- Smith charts, match networks, and tuners (11)
- Miscellaneous RF routines (1)
- Antenna modeling (10)
- HF propagation prediction (7)
- VHF/UHF propagation prediction (2)
- Morse code practice and apps (20)

Sherwood Engineering Receiver Test Data

http://www.sherweng.com/table.html

Sort column

Device Under Test	Noise Floor (dBm)	AGC Thrshld (uV)	dB	100kHz Blocking (dB)	Sensitivity (uV)	LO Noise (dBc/Hz)	Spacing kHz	Front End Selectivity	Filter Ultimate (dB)	Dynamic Range Wide Spaced (dB)	kHz	Dynamic Range Narrow Spaced (dB)	kHz
LO Noise Corrected 05/10/19 Yaesu FTdx-101D	-127 -136[b] -141[6]	4.5 1.6[b] 0.58[b1]	3	>147	0.60 0.20[b] 0.12[b1]	154 155	10 50	A Trk Presel	>115	110	20	110	2
Added 9/29/14 FlexRadio Systems 6700 Hardware Updated	-118 -135[b2]	3.0 1.0[b2]	Var	130 preamp Off	2.0 0.25[b2]	145 155	10 50	B Band Pass	115	99	20&2	108[y]	20&2
Added 12/30/20 Yaesu FTdx10	-126 -135[b] -140[6]	4.2 1.46[b] 0.54[b1]	3	141	0.63 0.21[b] 0.15[b1]	152 153	10 50	B Half Octave	105	107	20	107	2
Added 02/11/18 Icom IC-R8600 Second sample S/N 02001177	-131 -142[b] -130[ab]	2.40 0.67[b]	3	125	0.40 0.12[b] 0.49[ab]	144 148	10 50	B Half Octave	>100	109[ab] 88[ac]	20	107[ab] 88[ac]	2
Added 11/10/15 Elecraft K3S	-135 -138[b] -145[10]	1.5 0.45[b]	3	150	0.27 0.20[b] 0.08[10]	144 146	10 50	B Band Pass	110	107[q]	20	106[p] 106[q]	2
Added 3/17/17 Elecraft K3S 2nd Sample 10 meter data	-135 -138[b] -145[10]	1.5 0.45[b]	3	150	0.27 0.20[b] 0.08[10]	144 146	10 50	B Band Pass	110	106[ah]	20	105[ah]	2
Added 02/23/15 Elecraft K3 (RX Gain Recal) New Synthesizer	-136 -139[bq]	1.0 0.3[b]	3	141	0.27 0.20[b]	145 147	10 50	B Band Pass	108	105[q]	20	107[p] 104[q]	2
Added 04/25/16 Icom IC-7851	-123 -135[b] -141[b1]	8.5 1.85[b] 1.16[b1]	3	149	0.65 0.16[b] 0.11[b1]	148 153	10 50	A Trk Presel	100	110[aa]	20	105[aa]	2
Added 10/15/18 Kenwood TS-890S	-131 -140[b] -141[6]	2.1 0.53[b] 0.14[b1]	3	>151	0.39 0.13[b] 0.10[b1]	155 156	10 50	B Half Octave	>118	106	20	105	2
Added 10/02/12 Hilberling PT-8000A Hardware Rev 2.00	-128 -141[b]	5.4 1.0[b]	3	142	0.45 0.11[b]	144 149	10 50	A Trk Presel	100	105	20	105[w]	2
Added 08/10/12 Elecraft KX3	-123 -138[b2]	12 1.3[b2]	3	138	0.9 0.09[b2]	144	10	B Band Pass	110	105	20	104[t] 96[u] 65[v]	2

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- ***QST* Product Reviews and Extended Test Reports**
  - http://www.arrl.org/product-review

Amateur Radio Magazine Archives

- ***CQ* magazine**
  - Index list 1980 – 2011
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Non-Foster Circuits and Stability Theory

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***Abstract*—Antenna engineers have realized that non-Foster circuits offer new approaches to antenna loading, broadband impedance matching, and making single- and double-negative metamaterials (SNG, DNG) having considerable bandwidth. Non-Foster circuits are examined from the perspective of active linear network theory. A definition of a non-Foster network is given. Realizability and synthesis of such networks is discussed followed by a discussion of stability assessment for linear circuits generally and non-Foster circuits in particular. An example of a non-Foster impedance matching network designed and built to match an electrically small monopole is described. The impedance match bandwidth of the non-Foster circuit was found to exceed the infinite-complexity Fano limit by a substantial margin.**

I. Introduction

Nearly ninety years ago, O.J. Zobel and R.M. Foster determined necessary and sufficient conditions for a 2-terminal immittance function to be passive and lossless [1, 2]. A non-Foster network can be defined as a network (i.e. a topology or linear graph for connecting together circuit elements having known (mathematically exact) terminal behaviors) which must contain one or more non-Foster parts. A non-Foster part is an element or a 2-terminal subnetwork whose immittance is imaginary at all real frequencies and the derivative of whose reactance or susceptance function is zero or negative at one or more real frequencies. It is worth noting that a non-Foster network need not contain negative capacitors or inductors. In view of Carlin and Youla, any rational driving-point immittance function whatsoever can be realized using a restricted class of elements that includes exactly one negative and one positive resistor [3, 4]. Hence, while networks containing negative capacitors or inductors are categorically non-Foster, so too are networks that contain neither of these elements. A non-Foster network need not show non-Foster behavior at its terminals. A perfect impedance matching network will have a constant resistance as its input impedance. Hence, neither an external test of terminal behavior nor internal inspection of element types necessarily reveals that a given network is non-Foster. Only by examining all possible 2-terminal subnetworks that can be topologically separated from the network can one establish whether the network is non-Foster.

II. Antenna Impedance Matching

Passive impedance matching of antennas is subject to two theoretical restrictions on achievable match bandwidth. Fano bounded the return loss-bandwidth product, and Carlin-La Rosa bounded the insertion gain-bandwidth product. The former addressed reflection from match network input, and the latter addressed power transmission through the network to a complex load. The Fano bound applies to match networks that are passive and lossless. The Carlin-La Rosa bound applies to match networks that are passive and reflectionless. Neither bound applies to networks that are not passive. Non-Foster networks are active and therefore not subject to either bound. Indeed, one can show that unlimited match bandwidths are possible in principle. The demonstration relies on the fact that an antenna impedance function can be approximated over any desired band of frequencies by a positive-real rational function of finite order. An antenna impedance function may be transcendental. If poles and zeros are the only singularities and are isolated and denumerable, a sequence of rational functions of increasing order may be defined that converges to the antenna impedance. Each rational approximant in this sequence has a Darlington representation as a finite-order lossless reactance 2-port terminated by a resistor. For every such reactance 2-port, one may construct an inverse 2-port by formal inversion. Thus a sequence of matching networks is defined that matches the antenna over arbitrarily great bandwidth.

Four canonical realizations of a formal inverse matching network are presented. A formal inverse of any 2-port can be expressed as a cascade of three 2-ports – a NIC, a copy of the 2-port to be inverted with its ports reversed, and a second NIC. The inversion is straightforward to prove using transmission matrices, i.e. ABCD chain matrix parameters. Suppose the 2-port to be inverted has the transmission matrix

$$T_{network}=\begin{bmatrix}A(s) & B(s)\\ C(s) & D(s)\end{bmatrix} \text{ and } T_{reversed}=\frac{1}{AD-BC}\begin{bmatrix}D(s) & B(s)\\ C(s) & A(s)\end{bmatrix} \quad (1)$$

and let the NIC have general transmission matrix

$$T_{NIC}=\begin{bmatrix}\gamma(s) & 0\\ 0 & -\gamma(s)\end{bmatrix} \quad (2)$$

then the "NIC–reversed-network–NIC" cascade has a transmission matrix given by the matrix product

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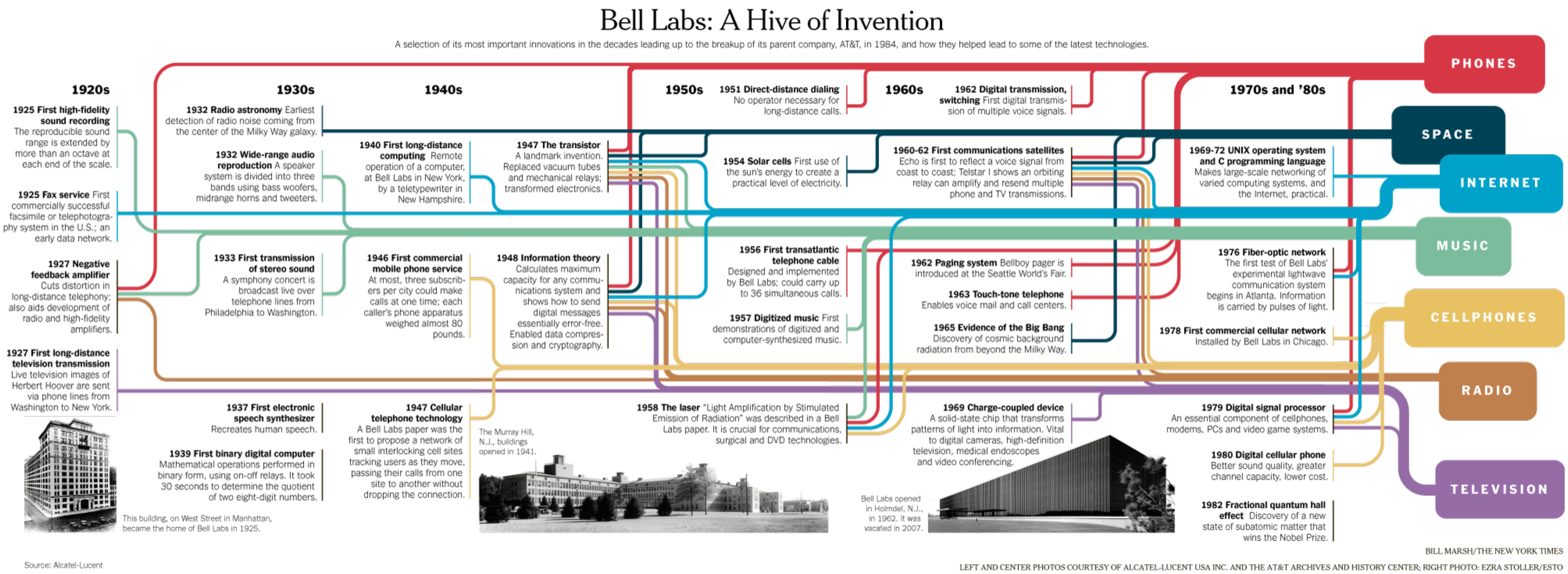

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Kelly JL, “A new interpretation of information rate,” 1956
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Trumbore FA, “Solid solubilities of impurity elements in germanium and silicon,” 1960
Sze SM, Shockley W, “Unit-cube expression for space-charge resistance,” 1967
Nicollian EH, Goetzberger A, “The Si-SiO, interface: electrical properties as determined by the metal-insulator-silicon conductance,” 1967
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Optics

Fox, AG, Li T, “Resonant modes in a maser interferometer,” 1961
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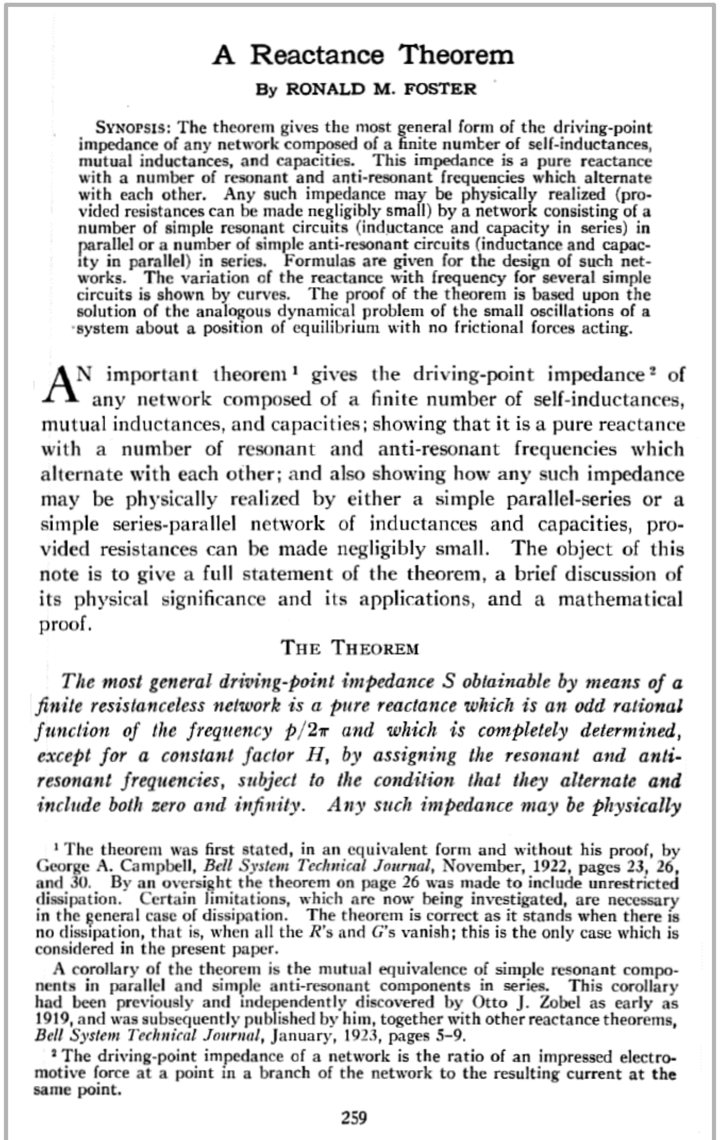

A Reactance Theorem

By RONALD M. FOSTER

SYNOPSIS: The theorem gives the most general form of the driving-point impedance of any network composed of a finite number of self-inductances, mutual inductances, and capacities. This impedance is a pure reactance with a number of resonant and anti-resonant frequencies which alternate with each other. Any such impedance may be physically realized (provided resistances can be made negligibly small) by a network consisting of a number of simple resonant circuits (inductance and capacity in series) in parallel or a number of simple anti-resonant circuits (inductance and capacity in parallel) in series. Formulas are given for the design of such networks. The variation of the reactance with frequency for several simple circuits is shown by curves. The proof of the theorem is based upon the solution of the analogous dynamical problem of the small oscillations of a system about a position of equilibrium with no frictional forces acting.

AN important theorem[1] gives the driving-point impedance[2] of any network composed of a finite number of self-inductances, mutual inductances, and capacities; showing that it is a pure reactance with a number of resonant and anti-resonant frequencies which alternate with each other; and also showing how any such impedance may be physically realized by either a simple parallel-series or a simple series-parallel network of inductances and capacities, provided resistances can be made negligibly small. The object of this note is to give a full statement of the theorem, a brief discussion of its physical significance and its applications, and a mathematical proof.

THE THEOREM

The most general driving-point impedance S obtainable by means of a finite resistanceless network is a pure reactance which is an odd rational function of the frequency $p/2\pi$ and which is completely determined, except for a constant factor H, by assigning the resonant and anti-resonant frequencies, subject to the condition that they alternate and include both zero and infinity. Any such impedance may be physically

[1] The theorem was first stated, in an equivalent form and without his proof, by George A. Campbell, *Bell System Technical Journal*, November, 1922, pages 23, 26, and 30. By an oversight the theorem on page 26 was made to include unrestricted dissipation. Certain limitations, which are now being investigated, are necessary in the general case of dissipation. The theorem is correct as it stands when there is no dissipation, that is, when all the *R*'s and *G*'s vanish; this is the only case which is considered in the present paper.

A corollary of the theorem is the mutual equivalence of simple resonant components in parallel and simple anti-resonant components in series. This corollary had been previously and independently discovered by Otto J. Zobel as early as 1919, and was subsequently published by him, together with other reactance theorems, *Bell System Technical Journal*, January, 1923, pages 5–9.

[2] The driving-point impedance of a network is the ratio of an impressed electromotive force at a point in a branch of the network to the resulting current at the same point.

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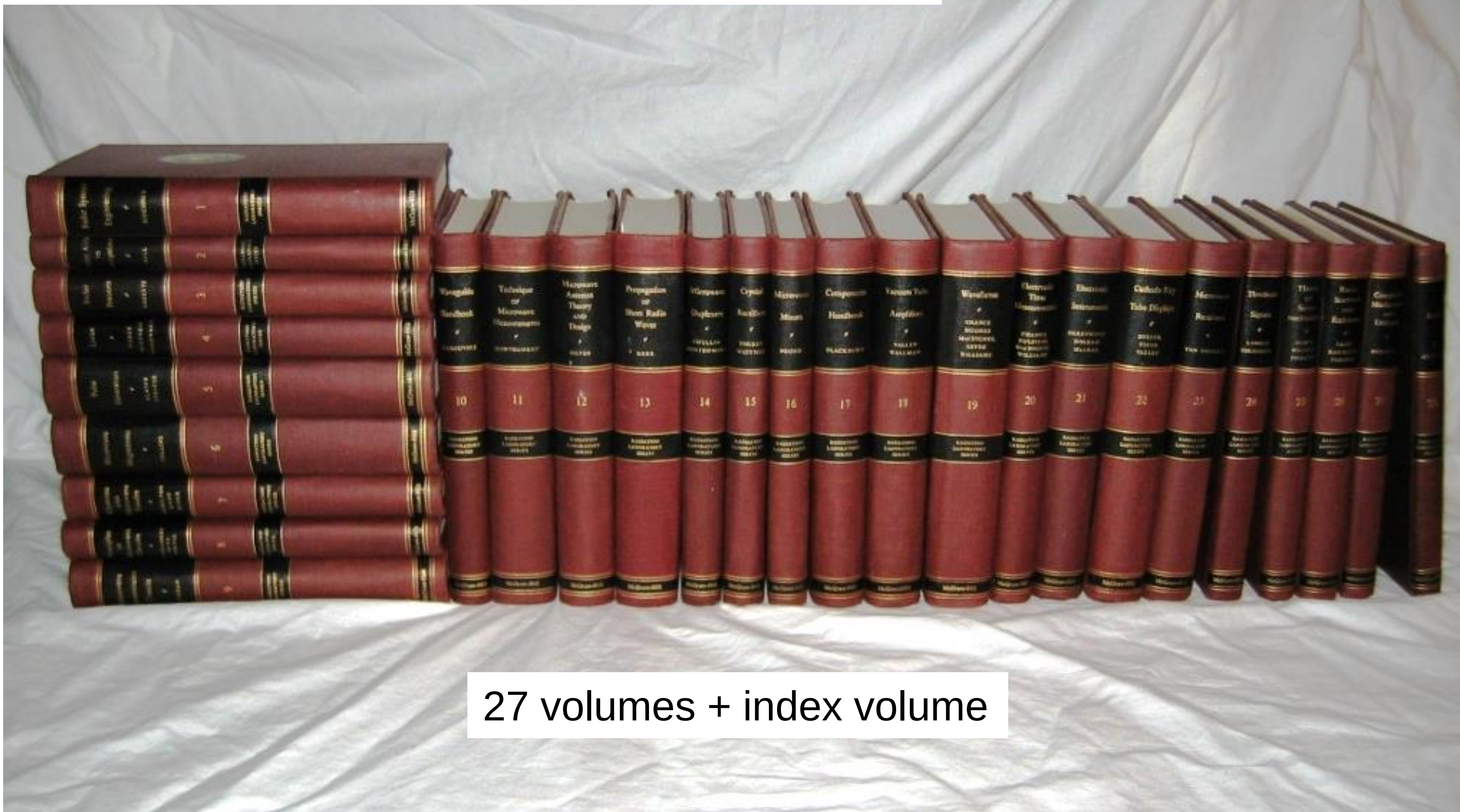

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VIII. *A Dynamical Theory of the Electromagnetic Field.* By J. Clerk Maxwell, *F.R.S.*

Received October 27,—Read December 8, 1864.

PART I.—INTRODUCTORY.

(1) The most obvious mechanical phenomenon in electrical and magnetical experiments is the mutual action by which bodies in certain states set each other in motion while still at a sensible distance from each other. The first step, therefore, in reducing these phenomena into scientific form, is to ascertain the magnitude and direction of the force acting between the bodies, and when it is found that this force depends in a certain way upon the relative position of the bodies and on their electric or magnetic condition, it seems at first sight natural to explain the facts by assuming the existence of something either at rest or in motion in each body, constituting its electric or magnetic state, and capable of acting at a distance according to mathematical laws.

In this way mathematical theories of statical electricity, of magnetism, of the mechanical action between conductors carrying currents, and of the induction of currents have been formed. In these theories the force acting between the two bodies is treated with reference only to the condition of the bodies and their relative position, and without any express consideration of the surrounding medium.

These theories assume, more or less explicitly, the existence of substances the particles of which have the property of acting on one another at a distance by attraction or repulsion. The most complete development of a theory of this kind is that of M. W. Weber*, who has made the same theory include electrostatic and electromagnetic phenomena.

In doing so, however, he has found it necessary to assume that the force between two electric particles depends on their relative velocity, as well as on their distance.

This theory, as developed by MM. W. Weber and C. Neumann†, is exceedingly ingenious, and wonderfully comprehensive in its application to the phenomena of statical electricity, electromagnetic attractions, induction of currents and diamagnetic phenomena; and it comes to us with the more authority, as it has served to guide the speculations of one who has made so great an advance in the practical part of electric science, both by introducing a consistent system of units in electrical measurement, and by actually determining electrical quantities with an accuracy hitherto unknown.

* Electrodynamische Maassbestimmungen. Leipzic Trans. vol. i. 1849, and Taylor's Scientific Memoirs, vol. v. art. xiv.

† "Explicare tentatur quomodo fiat ut lucis planum polarizationis per vires electricas vel magneticas declinetur."—Halis Saxonum, 1858.

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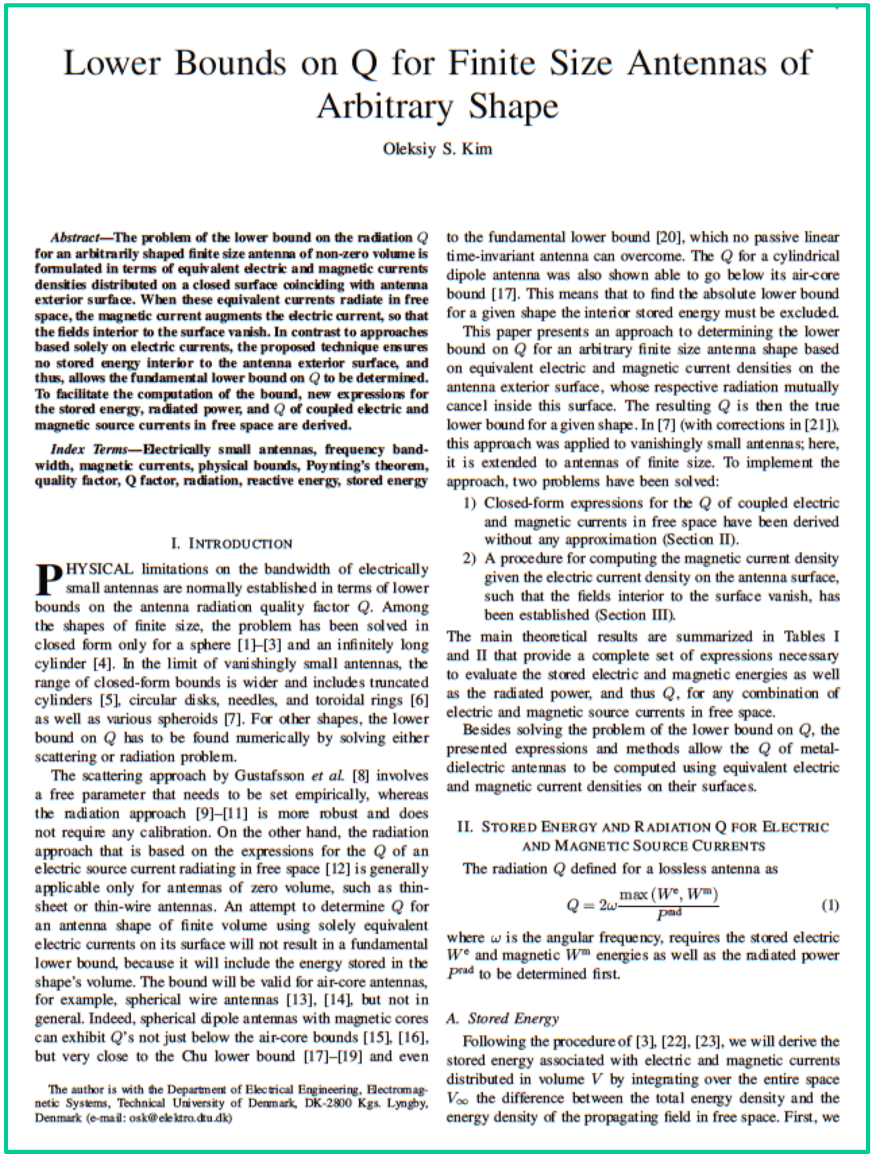

Lower Bounds on Q for Finite Size Antennas of Arbitrary Shape

Oleksiy S. Kim

***Abstract*—The problem of the lower bound on the radiation Q for an arbitrarily shaped finite size antenna of non-zero volume is formulated in terms of equivalent electric and magnetic currents densities distributed on a closed surface coinciding with antenna exterior surface. When these equivalent currents radiate in free space, the magnetic current augments the electric current, so that the fields interior to the surface vanish. In contrast to approaches based solely on electric currents, the proposed technique ensures no stored energy interior to the antenna exterior surface, and thus, allows the fundamental lower bound on Q to be determined. To facilitate the computation of the bound, new expressions for the stored energy, radiated power, and Q of coupled electric and magnetic source currents in free space are derived.**

***Index Terms*—Electrically small antennas, frequency bandwidth, magnetic currents, physical bounds, Poynting's theorem, quality factor, Q factor, radiation, reactive energy, stored energy**

I. Introduction

PHYSICAL limitations on the bandwidth of electrically small antennas are normally established in terms of lower bounds on the antenna radiation quality factor Q. Among the shapes of finite size, the problem has been solved in closed form only for a sphere [1]–[3] and an infinitely long cylinder [4]. In the limit of vanishingly small antennas, the range of closed-form bounds is wider and includes truncated cylinders [5], circular disks, needles, and toroidal rings [6] as well as various spheroids [7]. For other shapes, the lower bound on Q has to be found numerically by solving either scattering or radiation problem.

The scattering approach by Gustafsson *et al.* [8] involves a free parameter that needs to be set empirically, whereas the radiation approach [9]–[11] is more robust and does not require any calibration. On the other hand, the radiation approach that is based on the expressions for the Q of an electric source current radiating in free space [12] is generally applicable only for antennas of zero volume, such as thin-sheet or thin-wire antennas. An attempt to determine Q for an antenna shape of finite volume using solely equivalent electric currents on its surface will not result in a fundamental lower bound, because it will include the energy stored in the shape's volume. The bound will be valid for air-core antennas, for example, spherical wire antennas [13], [14], but not in general. Indeed, spherical dipole antennas with magnetic cores can exhibit Q's not just below the air-core bounds [15], [16], but very close to the Chu lower bound [17]–[19] and even to the fundamental lower bound [20], which no passive linear time-invariant antenna can overcome. The Q for a cylindrical dipole antenna was also shown able to go below its air-core bound [17]. This means that to find the absolute lower bound for a given shape the interior stored energy must be excluded.

This paper presents an approach to determining the lower bound on Q for an arbitrary finite size antenna shape based on equivalent electric and magnetic current densities on the antenna exterior surface, whose respective radiation mutually cancel inside this surface. The resulting Q is then the true lower bound for a given shape. In [7] (with corrections in [21]), this approach was applied to vanishingly small antennas; here, it is extended to antennas of finite size. To implement the approach, two problems have been solved:

1) Closed-form expressions for the Q of coupled electric and magnetic currents in free space have been derived without any approximation (Section II).
2) A procedure for computing the magnetic current density given the electric current density on the antenna surface, such that the fields interior to the surface vanish, has been established (Section III).

The main theoretical results are summarized in Tables I and II that provide a complete set of expressions necessary to evaluate the stored electric and magnetic energies as well as the radiated power, and thus Q, for any combination of electric and magnetic source currents in free space.

Besides solving the problem of the lower bound on Q, the presented expressions and methods allow the Q of metal-dielectric antennas to be computed using equivalent electric and magnetic current densities on their surfaces.

II. Stored Energy and Radiation Q for Electric and Magnetic Source Currents

The radiation Q defined for a lossless antenna as

$$Q = 2\omega \frac{\max\left(W^{\mathrm{e}}, W^{\mathrm{m}}\right)}{P^{\mathrm{rad}}} \quad (1)$$

where ω is the angular frequency, requires the stored electric W^{e} and magnetic W^{m} energies as well as the radiated power P^{rad} to be determined first.

A. Stored Energy

Following the procedure of [3], [22], [23], we will derive the stored energy associated with electric and magnetic currents distributed in volume V by integrating over the entire space V_{∞} the difference between the total energy density and the energy density of the propagating field in free space. First, we

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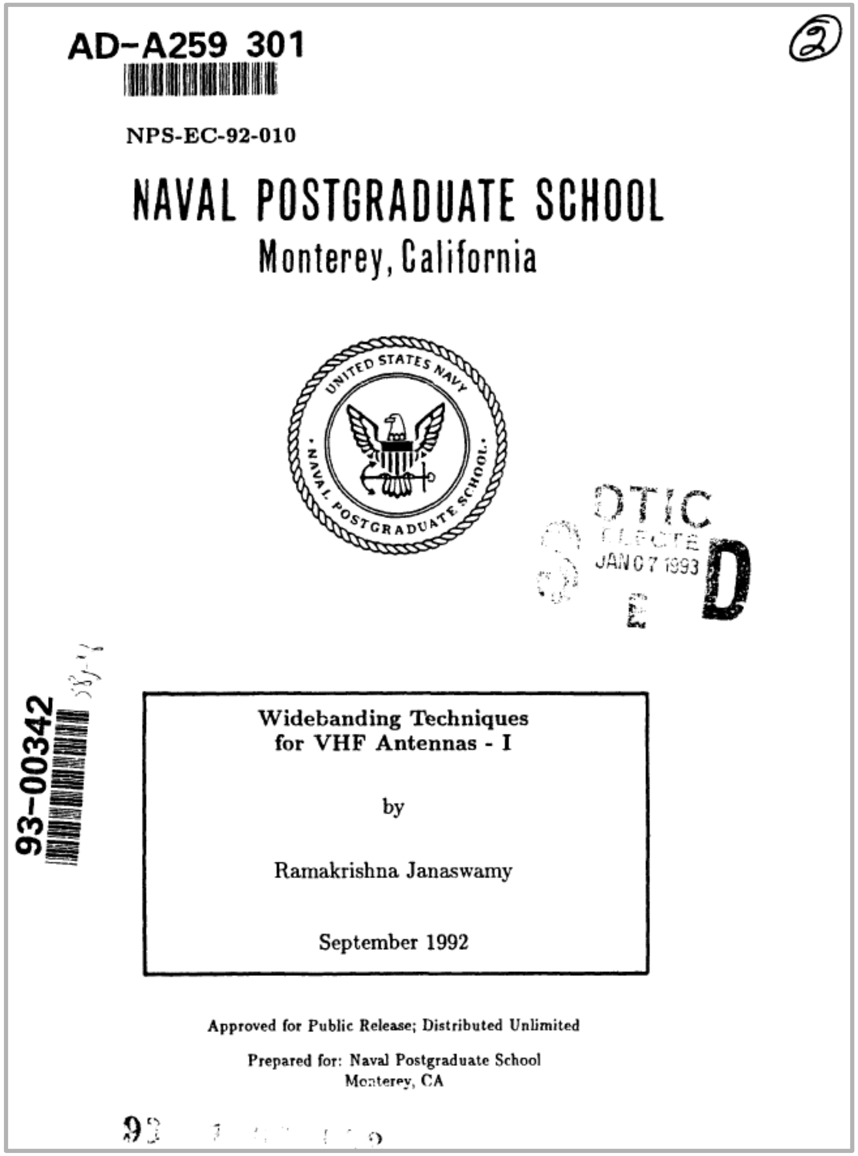

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Wideband Techniques
for VHF Antennas - I

by

Ramakrishna Janaswamy

September 1992

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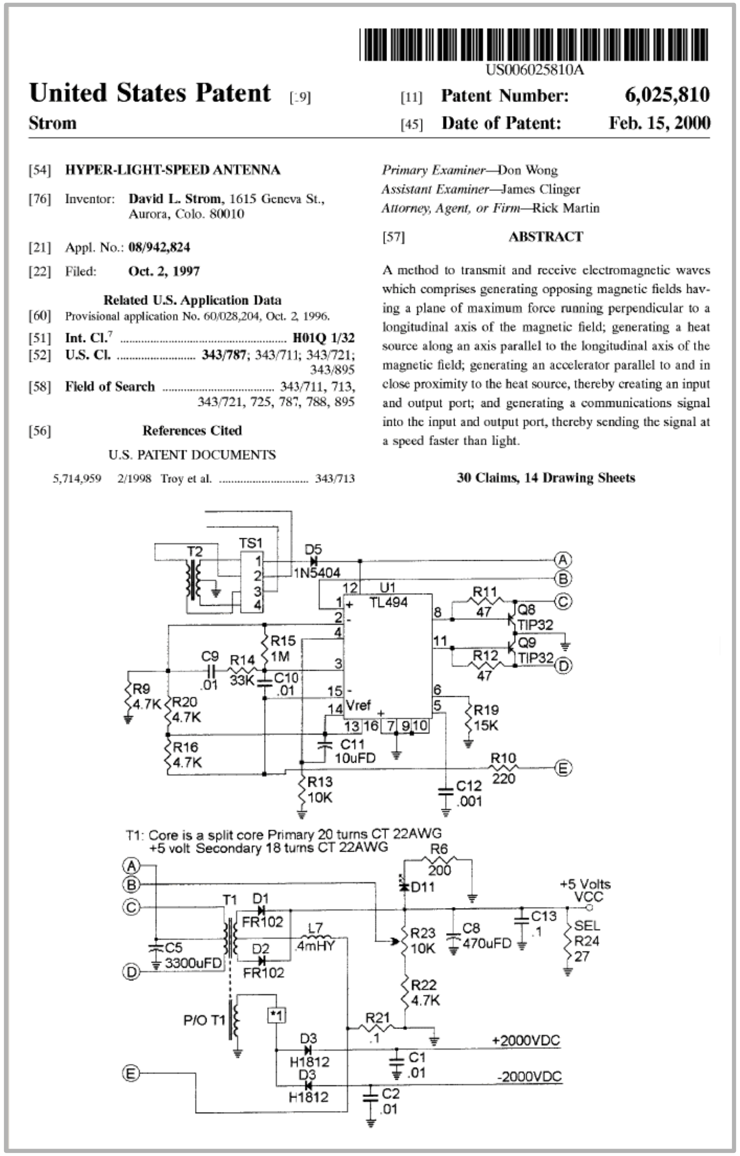

US006025810A

United States Patent [19] **Strom**

[11] **Patent Number:** **6,025,810**
[45] **Date of Patent:** **Feb. 15, 2000**

[54] **HYPER-LIGHT-SPEED ANTENNA**

[76] Inventor: **David L. Strom**, 1615 Geneva St., Aurora, Colo. 80010

[21] Appl. No.: **08/942,824**

[22] Filed: **Oct. 2, 1997**

Related U.S. Application Data

[60] Provisional application No. 60/028,204, Oct. 2, 1996.

[51] **Int. Cl.**[7] **H01Q 1/32**
[52] **U.S. Cl.** **343/787**; 343/711; 343/721; 343/895
[58] **Field of Search** 343/711, 713, 343/721, 725, 787, 788, 895

[56] **References Cited**

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Primary Examiner—Don Wong
Assistant Examiner—James Clinger
Attorney, Agent, or Firm—Rick Martin

[57] **ABSTRACT**

A method to transmit and receive electromagnetic waves which comprises generating opposing magnetic fields having a plane of maximum force running perpendicular to a longitudinal axis of the magnetic field; generating a heat source along an axis parallel to the longitudinal axis of the magnetic field; generating an accelerator parallel to and in close proximity to the heat source, thereby creating an input and output port; and generating a communications signal into the input and output port, thereby sending the signal at a speed faster than light.

30 Claims, 14 Drawing Sheets

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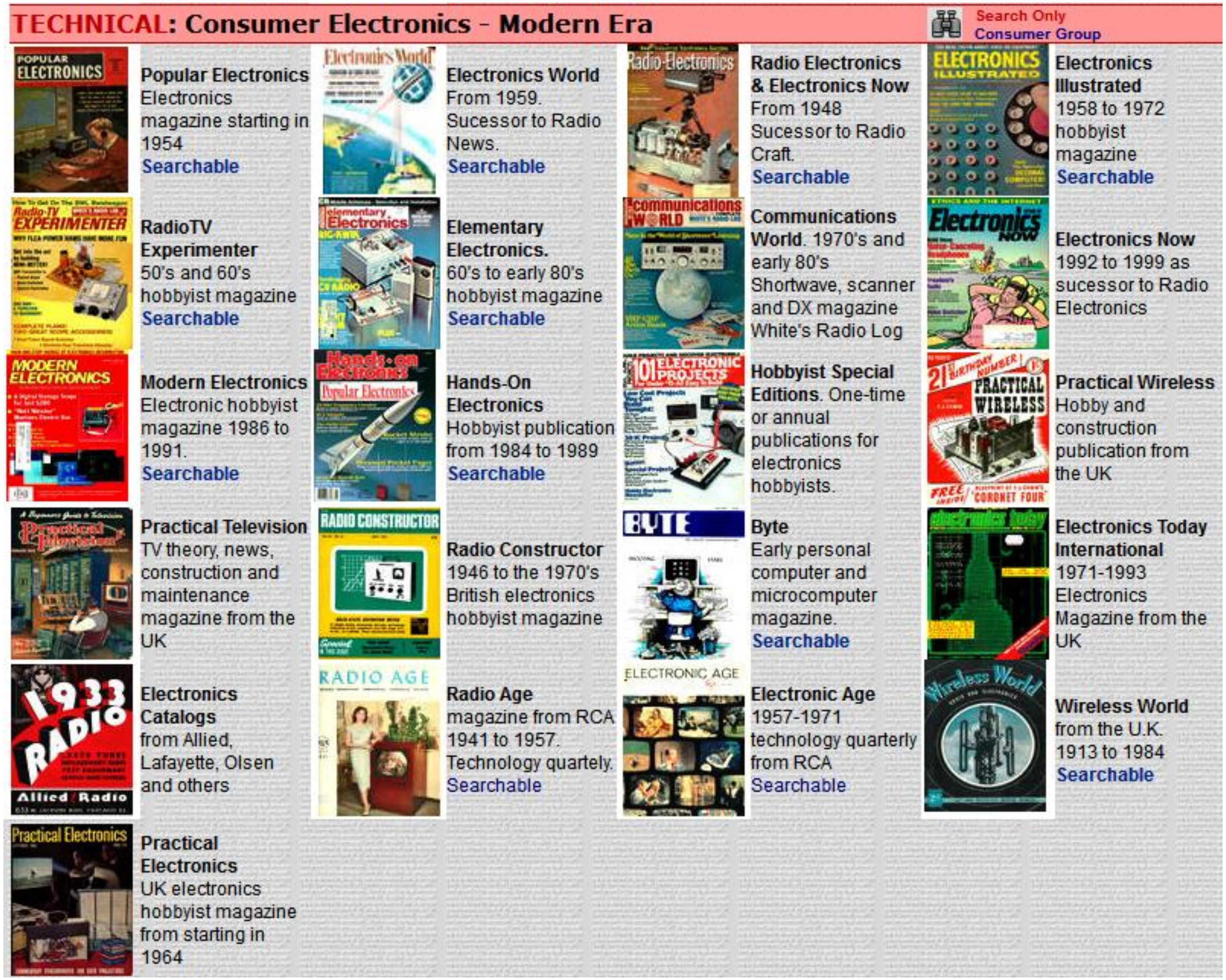

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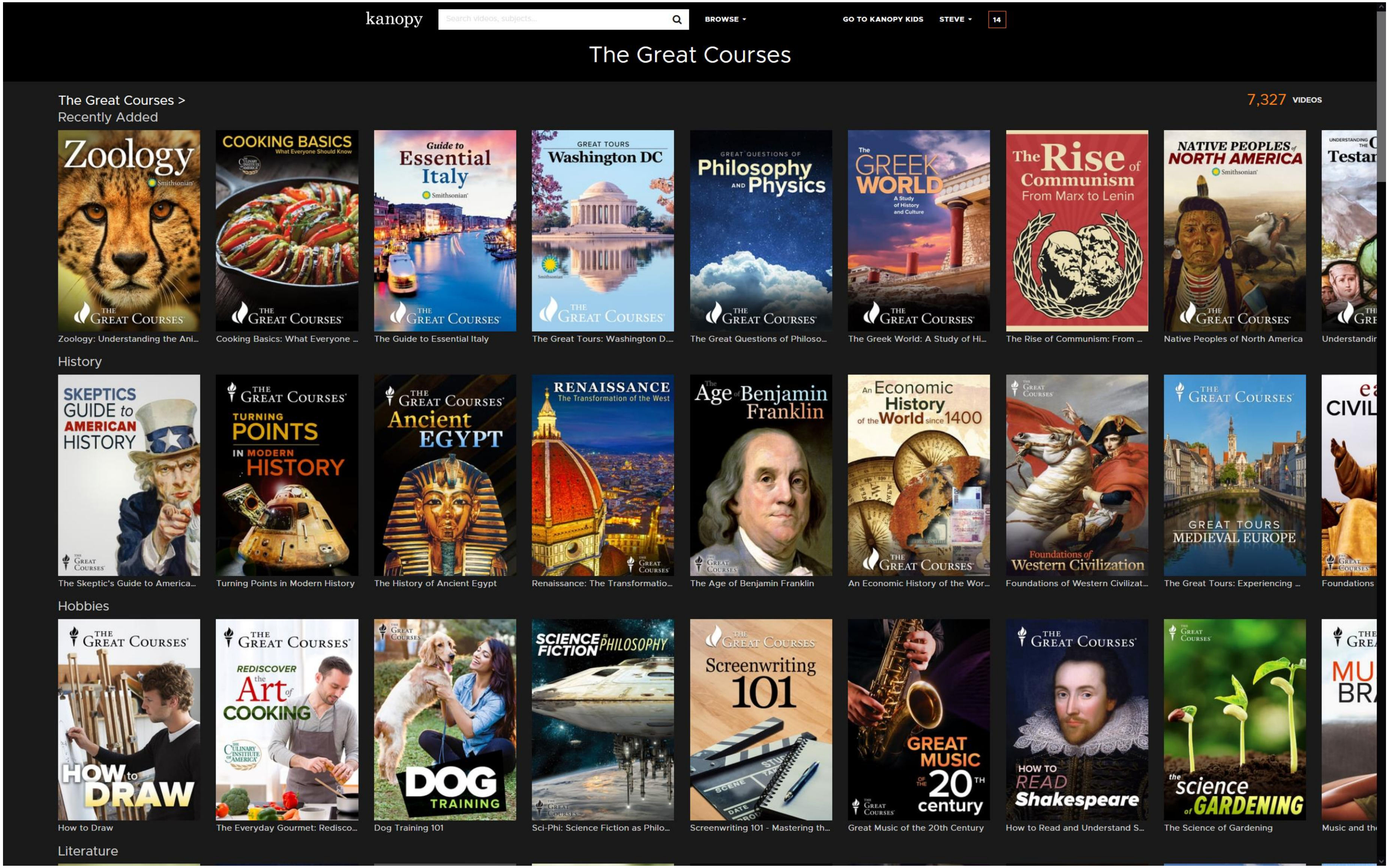

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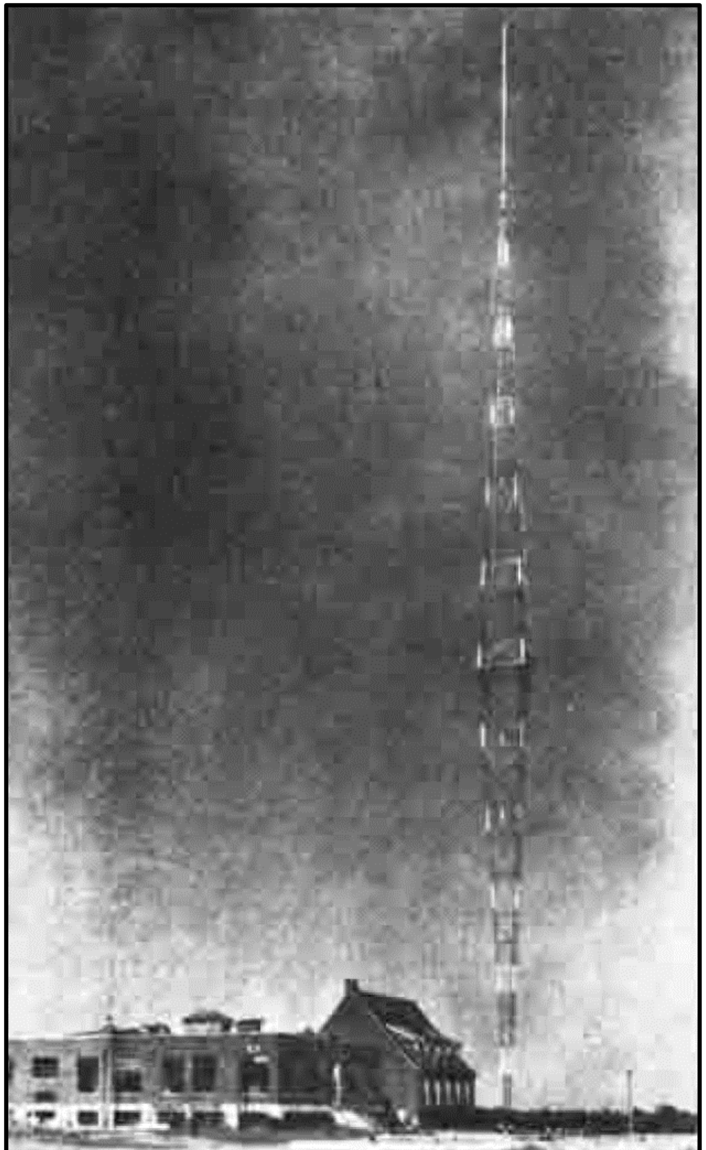

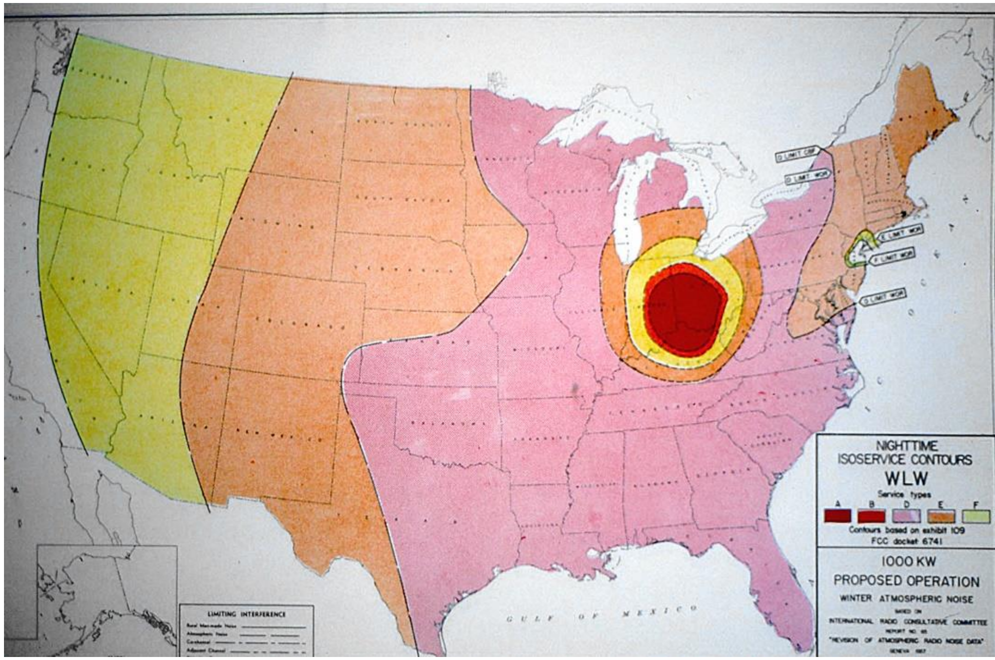

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