Proceedings of
The Radio Club of America, Inc.

Founded 1909

JANUARY, 1947

Volume 24, No. 1

TOP-LOADED ANTENNAS
By Thurlow M. Gordon, Jr.

Summary of:
"Facsimile Communications" by A. H. Stillman
"Measurements on FM Receivers" by Jerry Minter

THE RADIO CLUB OF AMERICA
11 West 42nd Street ★ ★ ★ New York City

The Radio Club of America, Inc.

11 West 42nd Street, New York City — Telephone — Longacre 5-6622

Officers for 1947

MEETINGS

Technical meetings are held on the second Thursday evening each month from September through May at either Havemeyer or Pupin Hall, Columbia University, Broadway and 116th Street, New York. The public is invited.

MEMBERSHIP

Application blanks for membership are obtainable at the Club office. For the Member grade the initiation fee is one dollar and the annual dues are three dollars.

PUBLICATIONS

Editor — Jerry Minter
Assistant Editor — Ernest V. Amy
Assistant Editor — Ralph R. Batcher
Assistant Editor — John L. Callahan
Assistant Editor — Harry W. Houck
Assistant Editor — Lawrence C. F. Horle

Subscription: Four dollars per year, or fifty cents per issue. Back numbers to members, twenty-five cents each.

PROCEEDINGS
of the
RADIO CLUB OF AMERICA

Volume 24 JANUARY, 1947 No. 1

TOP-LOADED ANTENNAS

by

Thurlow M. Gordon, Jr.*

Presented before the Club on June 12, 1941

Resumed amateur operation on the 3.5-4.0 mc. band, the well known "80 meters," makes antenna efficiency for the m-f and h-f regions of special interest. The advantages of top loading for this purpose and practical experience applying the theory are described in this paper.

The editors of the PROCEEDINGS are pleased to publish this paper and regret that the heavy pressure of war work has prevented its earlier appearance.

There has recently been considerable attention given to improving the efficiency of very short antennas for use in the frequency range of 2 to 3 megacycles. It has been shown by several authors, as listed in the bibliography, that very substantial improvement over the short base-loaded antenna may be obtained by placing loading at the end of the antenna. Since with these short antennas it has been desirable to employ vertical polarization, the loading finds itself at the top of the antenna; hence the description "top-loaded" has come into use.

Top loading as applied in practice may lead to results which are far from the ultimate if all the factors involved are not carefully taken into account. It is the purpose of this paper to set forth some of the various pitfalls and to describe a procedure which will aid in avoiding them.

A short antenna may be tuned to resonance by adding the proper reactance either at the base, in the middle, or at the top. The method of feeding power to this antenna will naturally depend on the requirements of the system but, fortunately, considerable latitude in this respect is possible. By proper choice of the value and placement of the added reactance (which resonates the short antenna) the losses of the system may be minimized, thus greatly improving the overall efficiency of the antenna.

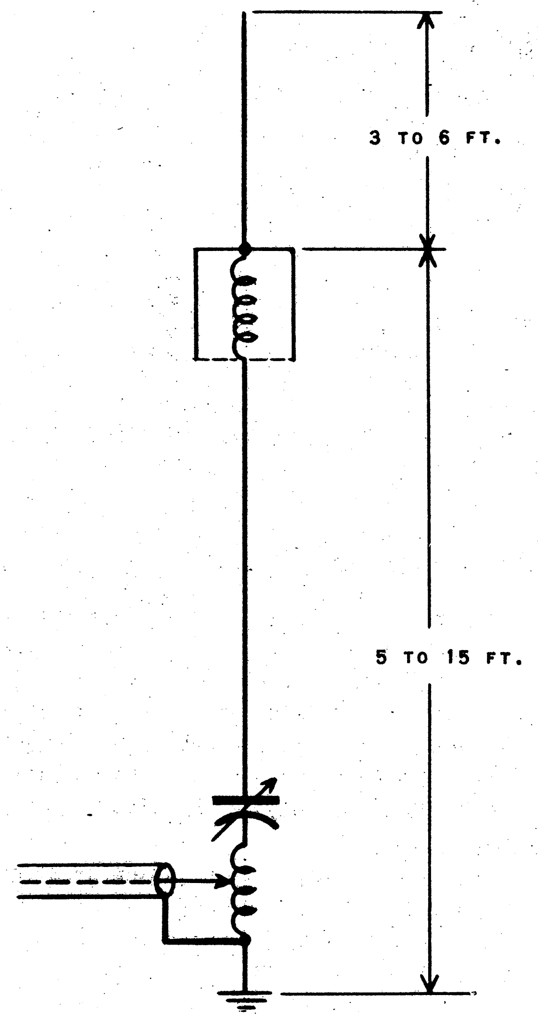
*31 Crawford Street, Bronxville, N.Y.

GENERAL ARRANGEMENT

The top-loaded antenna usually takes the form of a short radiating section of pipe, often only 1/30 of a wavelength long, which is capable of supporting a coil enclosed in a metal protecting shield at the top. Surmounting the shield can, a flexible whip antenna is frequently added.

The bottom end of the coil is connected to the pipe section while the top end of the coil is connected to the closed end of the shield can. The bottom end of the shield can may be left open, but it is usually closed with a bakelite or polystyrene disk. At the top end of the shield can is placed the fitting to attach the whip. Mechanical, physical, and esthetic limitations usually determine how long the pipe or radiating section can be, what size of coil shield can be tolerated, and how long a whip may be used. Electrically, however, several factors should be considered. A large diameter pipe should be used preferably of, or plated with, a good conducting metal which will provide the best conductivity for greatest efficiency. The shield can must not be smaller than 3 inches in diameter to provide space for a high-Q coil. Since the shield can also adds capacitance to the top of the coil, a large can with its greater capacitance will permit the use of a smaller number of turns in the coil and thus lower the resistance. However, there is little need for shield cans greater in diameter than 9 or 10 inches or over a foot in height. A long whip antenna likewise adds capacitance, but this is usually sacrificed for the sake of either economy or general appearance. Three to six feet of whip and five to fifteen feet of pipe are workable dimensions.

For a shield can with a diameter equal to its height, the capacitance to ground in micro-microfarads has been given as twice the diameter in inches. The inductance to give series resonance with this capacitance at the operating frequency is easily computed. When this coil and its shield



Proportioning of Top-Loaded Antenna for Operation at 3 Megacycles

can are assembled with a ten-foot pipe below the coil and a three-foot or four-foot whip is connected at the top of the coil and can, slightly less inductance will resonate the system as a quarter-wave antenna. This coil will therefore be enough to begin with, and should be wound on a form somewhat less in diameter than the shield in order to preserve a high Q.

PRINCIPLES OF TUNING THE ANTENNA

An antenna such as this must be carefully tuned and the field strength observed for the full benefits of the system to be realized. For this purpose it is convenient to provide a series-resonant circuit, consisting of a variable capacitor with a range from 200 to 400 micro-microfarads and a coil with many taps or a slider, in series with the base of the antenna. If the top-loading coil in the can is a little too large or too small this series circuit will tune the system to resonance. This series circuit is also convenient as an impedance-matching network. The slider or taps are used to match a low-impedance feed line or coaxial cable.

It is also convenient to have on hand three radio-frequency ammeters. Lacking these, small lamp bulbs can be used in a pinch. These are for indicating current (1) in the feedline, (2) at the base of the antenna, and (3) at the top of the antenna just under the loading coil.

When the time comes to make field-strength measurements, the best way is not always the simplest way. Measurements should be made at a distance of about half a mile. A suitable field-strength meter can be a communications receiver with an "R" meter, or a milliammeter can be inserted in series with the diode load resistor of any receiver capable of tuning to the transmitted frequency. This meter will read relative field strengths over quite a wide range. Socket-power receivers can cause considerable confusion if line-voltage variations have much effect on the receiver sensitivity. A battery receiver with a meter in the diode load circuit will be quite consistent as long as the batteries are reasonably fresh.

Assume that the loading coil in the shield at the top has been made larger than is necessary to tune the antenna to quarter-wave resonance. Then by peeling off turns of wire, one turn at a time, a point can be observed where the field strength goes through a maximum. As wire is removed from the coil the current indicated at the base of the antenna will increase. The current at the top of the antenna will decrease. A point will be finally reached where the base current goes through a maximum; here the antenna is in quarter-wave resonance.

Each time a turn of wire is removed from the coil, the series-tuned circuit and the top position must be juggled to the adjustment which gives rise to the greatest transmission-line current at a given reference point, and the transmitter loading must be reset to the same value, before comparable field-strength readings can be made.

The juggling of the feeder tap and the tuning capacitor for maximum transmission-line current is a valid means of tuning the antenna to resonance when the top-loading coil is too large or too small and at the same time matching the feeder impedance. Though lengthy and laborious, there is no real shortcut which will produce the same results. A grid-dip meter may be of aid in tuning the antenna system to resonance by adjusting the series-tuned circuit at the base without the feeder connected; then the feeder tap may be juggled for greatest antenna current. However, this adds another piece of equipment. The series-tuned coil can be link-coupled to the transmitter tank coil and the capacitor tuned for a dip in the transmitter amplifier plate meter, the transmitter having been carefully resonated previously without the link. In this case the link may be varied to keep the loading constant.

POWER LOSSES

When the loading inductance at the top of the antenna has been pruned down to that value which produces a maximum current at the base of the antenna, as already stated, quarter-wave resonance has been reached. The losses which are present in the ground connection, the eddy currents which are induced in the ground itself, and the losses in the antenna and the loading coil all reduce the efficiency of the system. It has been proposed to supply sufficient loading to a short antenna to make the base current zero and thus avoid this source of loss. (A parallel tuning circuit at the base of the antenna will be necessary in this case.) Unfortunately, the eddy currents are still induced in the ground. These are not right at the base of the antenna it is true, but they are merely removed a quarter wave-length away.(4) Also, in this condition the currents in the loading coil are high and the losses due to power dissipated in this coil may be greater than the loss was in the ground connection with high current at the base. Obviously there is some point between the condition where the current at the base is greatest and where it is zero that will strike a balance between losses in the ground resistance and in the coil resistance. It is at this point that the maximum field strength will be found.

PRACTICAL TUNING OF ANTENNA

In typical actual installations it has been found that the losses are balanced against one another and maximum efficiency reached when the current at the top of the antenna between the loading coil and the antenna is about 20% greater than the current at the base of the antenna.(3)(4) This is true with a short antenna mounted on an automobile. The greater current at the top of the antenna has also the radiating advantage of a few feet greater effective height. Only about three or four turns of wire more than are required to produce a current maximum at the base will achieve this result. The tuned circuit at the base of the antenna is slightly detuned from resonance to present a slight capacitive reactance and might possibly be replaced by a capacitor of 0.002 microfarad (or some value which is the equivalent of the series circuit), tapped directly on the transmitter tank coil.

PERFORMANCE

A top-loaded antenna will always be capable of providing a greater field strength than a base-tuned antenna of the same vertical height. The difference becomes less marked when the vertical height approaches a quarter-wave, but may still exist when this point is reached. When ground conditions are very poor this would be more evident. It may be convenient to use a top-loaded antenna with the current maximum at the base, since this will allow a single short lead-in to take a few turns around the transmitter tank coil and then be grounded.

Only by setting up and experimenting will a true understanding of a particular installation be achieved. When once this is done, the results will more than make up for the effort expended. No mention has been made of the actual improvement which can be achieved since it is deemed too variable for a definite prediction. Improvements in field strength of 12 decibels have been achieved with short antennas.(3)(4) Longer antennas have shown improvement, but not so much. Certainly the top-loaded short antenna should give improved results with portable transmitters. For fixed stations a top-loaded antenna is an excellent provision for emergency operation. One thing is sure at the present state of the art, - namely, there is no simpler way of getting better results with a short antenna than "top-loading" it!

BIBLIOGRAPHY

(1) "Increased Radiating Efficiency for Short Antennas: A Tuned-Top System for Amateur Frequencies", R.B. Dome, General Electric Company, Schenectady, in QST, September 1934, pages 9-12.

(2) "Control of Radiating Properties of Antennas", C.A. Nickle (W2ETH), R.B. Dome, and W.W. Brown, all of General Electric Company, Schenectady, in Proceedings of Institute of Radio Engineers, December 1934, pages 1362-1373.

(3) "Increasing Radiation at Low Frequencies", Millet G. Morgan, (W6QQJ), Stanford University, in Electronics, July 1940, pages 33-34 and 67-68.

(4) "Raising the Efficiency of Short Vertical Radiators: Recent Developments in the Top-Loaded Antenna", W.C. Hilgedick, U.S. National Park Service, and Millet G. Morgan, (W6QQJ), Stanford University, in QST, December 1940, pages 30-33.

FACSIMILE COMMUNICATIONS

by

A.H. Stillman*

EDITOR'S NOTE: Following is a summary of a Paper presented by Mr. Stillman to the Radio Club of America, New York City in December 1946.

Prefacing the presentation of this Paper, a moving picture demonstrating the application of facsimile to business and industry was shown. The picture, depicting a typical Finch installation in an organization having branches throughout the nation, illustrated the many uses of facsimile communication.

*Senior Facsimile Engineer, Finch Telecommunications, Inc.

The main portion of Mr. Stillman's Paper described in detail a combination Finch facsimile scanner and recorder as is now employed on wire line applications and which is a fundamental part of the broadcasting system.

In conclusion, Mr. Stillman gave a description of a home recorder, AM-FM receiver combination. This combination provides the user with a receiver of excellent design covering the AM-FM standard broadcast frequencies as well as a facsimile recording unit incorporating the latest Finch developments in this field of communications.

MEASUREMENTS ON FM RECEIVERS

by

Jerry Minter*

EDITOR'S NOTE: Following is a summary of a Paper presented by Mr. Minter to the Radio Club of America, New York City, in January 1947.**

Early in 1945, Mr. Lawrence C.F. Horle became concerned over the absence of an R.M.A. Standard Test Procedure for FM Receivers. As a result, a committee on FM receiver testing under the Special Electronic Equipment Section of the R.M.A. Engineering Department met for the first time on June 22, 1945 in New York City. Mr. P.K. McElroy of General Radio acted as chairman.

Mr. Minter outlined the activities of the Committee, of which he became Chairman on November 13, 1945. Concurrently a subcommittee of the R.M.A. Committee on VHF Receivers, under the Chairmanship of Mr. D.E. Foster, had been meeting in Chicago to formulate Standard R.M.A. Receiver Test Methods.

*Vice-President and Chief Engineer, Measurements Corporation, Boonton, N.J.

**Originally presented at a meeting of the Toronto Section of the Institute of Radio Engineers, December 1946.

A coordinated proposal of the recommendations of the two committees were submitted to the New York Committee in June 1946 and the final copy was released to R.M.A. for general distribution on September 26, 1946. (The Data Bureau late in December made available copies of these Standards, entitled "The Measurement of Performance Characteristics of Frequency Modulated Radio Receivers". The publication may be secured by requesting DB-2170-A).

The Data Sheet was described in detail by Mr. Minter and includes the following:

1. Name of manufacturer.
2. Chassis number and model number.
3. Date of beginning production.
4. Wave bands covered.
5. R.F. System (number of selective circuits and method of adjustment).
6. I.F. System (frequencies, number of tuned circuits and method of adjustment).
7. Power supply required.
8. Number, type and function of tubes.
9. Antenna System (built-in or outside and balanced or unbalanced impedance if outside).
10. Automatic tuning (number of buttons).
11. Special features.
12. Sensitivity.
13. Selectivity.
14. Square Wave Testing.
15. Maximum Power Output.
16. Maximum Undistorted Power Output.
17. Electric Fidelity.
18. Input and Output Characteristics.
19. Spurious Response including image ratio and I.F. response.
20. Oscillator Frequency.
21. Underwriters' Approval.
22. Impulse Noise Susceptibility Ratio.
23. Oscillator Radiation Tests.
24. Intermodulation Tests.
25. Random Noise Susceptibility and FM Improvement Factor.

Mr. Minter discussed briefly various design and calibration problems of FM Signal Generators and explained certain characteristics of Measurements' Model 78-FM Standard Signal Generator as applied to the testing of FM receivers.

His observation of local FM stations discloses that the noise and hum levels in their transmitters indicates that, as yet, satisfactory monitoring equipment is not being used.

In conclusion, Mr. Minter credited the New York and Chicago Committee members for the many hours expended in the formulation of the new FM Receiver Test Standards.

AUSTIN C. LESCARBOURA
RECIPIENT OF FRENCH AWARD

Radio Club's publicity chairman, Austin C. Lescarboura of Croton-on-Hudson, New York, has been honored by the Republic of France according to word received from the French Embassy.

In recognition of the technical services rendered to France, he has been awarded the order of "Officier de l'Instruction Publique".

Mr. Lescarboura, publicity and advertising consultant, was formerly editor of various trade and technical journals, including Scientific American and Popular Science Monthly. He is the author of several books as well as a writer of technical papers.

NEW ADVERTISING FEATURE

The Radio Club Board of Directors has sanctioned the inauguration of a column for those wishing to advertise Professional Services.

For complete information and space rates, write to Mr. Paul Ware, c/o Radio Club Proceedings.

F. A. KLINGENSCHMITT

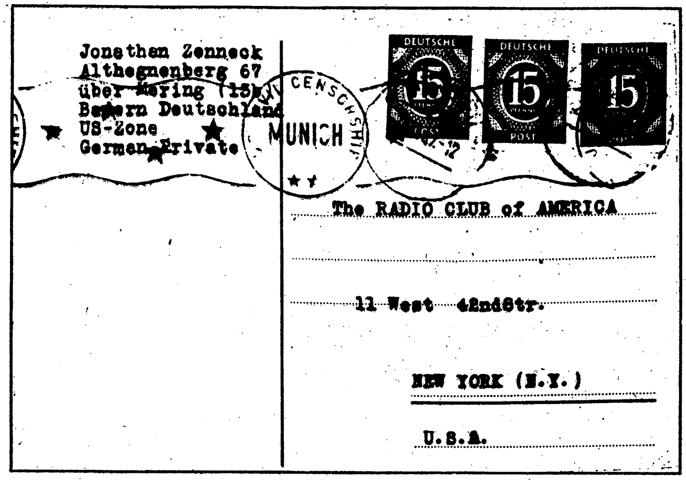
"BRINGS THEM BACK ALIVE"

At a recent Radio Club Board of Directors meeting, Mr. F.A. Klingenschmitt had an interesting story to tell about a "deceased" Club member that came to life.

It seems that Mr. Klingenschmitt was about to leave his office late one afternoon last winter, when the printer arrived with a rush order of Radio Club meeting notices. A bit disgruntled about being detained, yet determined to get the notices in the mail that night, he rolled up his sleeves and tackled the addressograph machine.

Even though the notices should only have been sent to members in and near New York City, he used every plate he could find including a small bunch hidden away in a desk drawer. These particular plates were of foreign members and hadn't been used since the beginning of the war, but into the machine they went and for each a meeting card was started on its merry way. Included in this group was the plate of Dr. Jonathan Zenneck of Germany, deceased, according to the Club records but really very much alive as proven by the card shown at the right.

Mr. Klingenschmitt says the moral of this tale is "Better come to Radio Club meetings or be haunted wherever you are".



Jonathan Zenneck
Althegnenberg 67
über Mering (15b)
Bayern Deutschland
US-Zone
German Private

The RADIO CLUB of AMERICA
11 West 42ndStr.
NEW YORK (N.Y.)
U.S.A.

Jan. 22nd, 1947

Gentlemen,

thank you so much for your kind invitation to your meeting on Dec. 13th, 1946. Unfortunately your card, which arrived yesterday, apparently did not travel with the velocity of light. But even if had received it in time, I would not have been able to attend the meeting. But nevertheless I appreciated your kind invitation very much indeed. I was glad to see from the subject matter of the paper read at this meeting that the Radio Club of America is allways up to date.

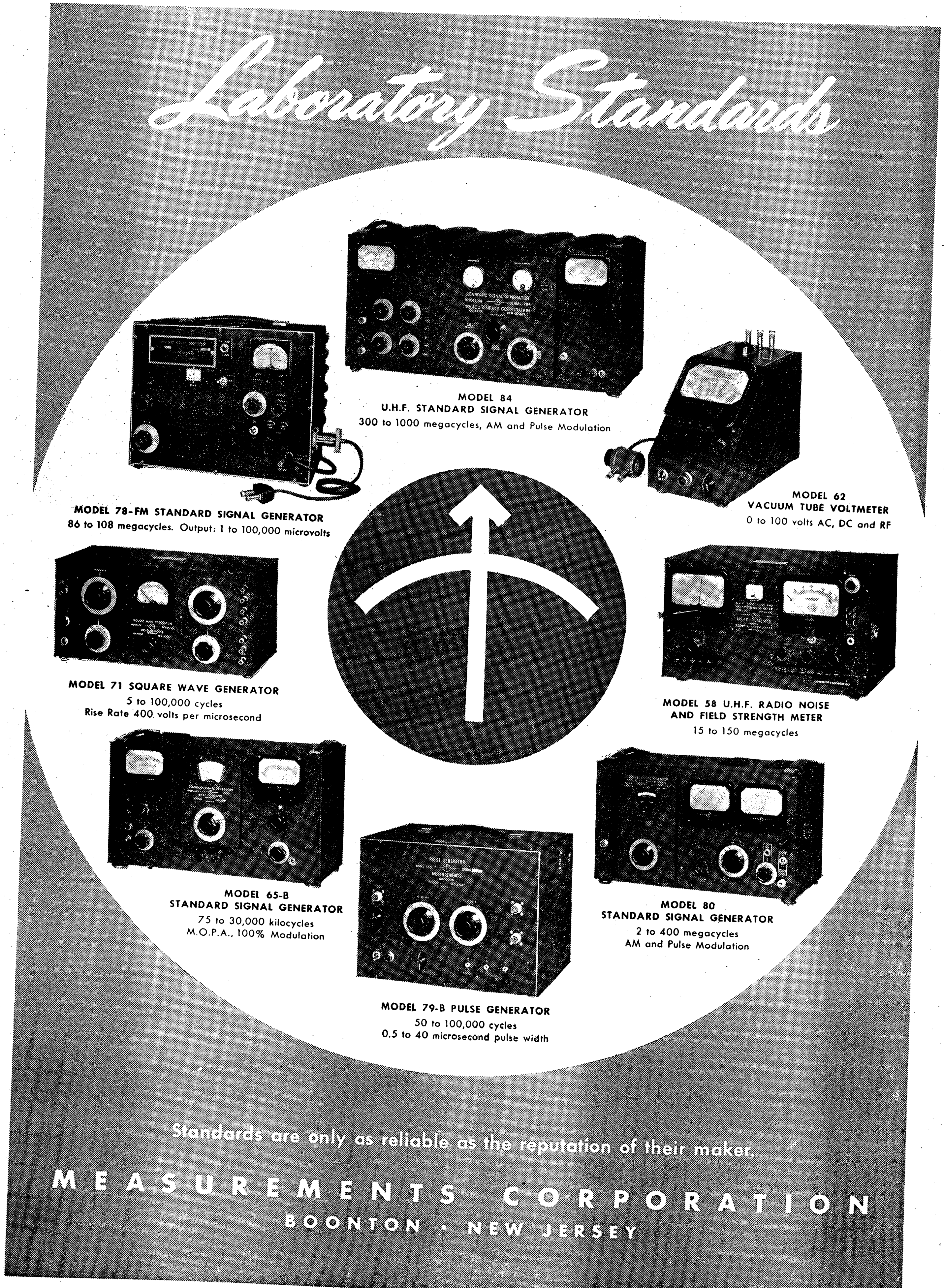
With best wishes for the Radio Club of America

very sincerely yours

J Zenneck

Please give my best regards to Mr. Pacent, if he is still connected with the club.

Next Issue: "Lanac System of Air Navigation and Collision Prevention" by Knox McIlwain, Hazeltine Electronics Corporation.


Laboratory Standards
MODEL 84
U.H.F. STANDARD SIGNAL GENERATOR
300 to 1000 megacycles, AM and Pulse Modulation
MODEL 78-FM STANDARD SIGNAL GENERATOR
86 to 108 megacycles. Output: 1 to 100,000 microvolts
MODEL 62
VACUUM TUBE VOLTMETER
0 to 100 volts AC, DC and RF
MODEL 71 SQUARE WAVE GENERATOR
5 to 100,000 cycles
Rise Rate 400 volts per microsecond
MODEL 58 U.H.F. RADIO NOISE
AND FIELD STRENGTH METER
15 to 150 megacycles
MODEL 65-B
STANDARD SIGNAL GENERATOR
75 to 30,000 kilocycles
M.O.P.A., 100% Modulation
MODEL 80
STANDARD SIGNAL GENERATOR
2 to 400 megacycles
AM and Pulse Modulation
MODEL 79-B PULSE GENERATOR
50 to 100,000 cycles
0.5 to 40 microsecond pulse width
Standards are only as reliable as the reputation of their maker.
MEASUREMENTS CORPORATION
BOONTON · NEW JERSEY

SHERRON offers you an *All-Inclusive* ELECTRONICS SERVICE

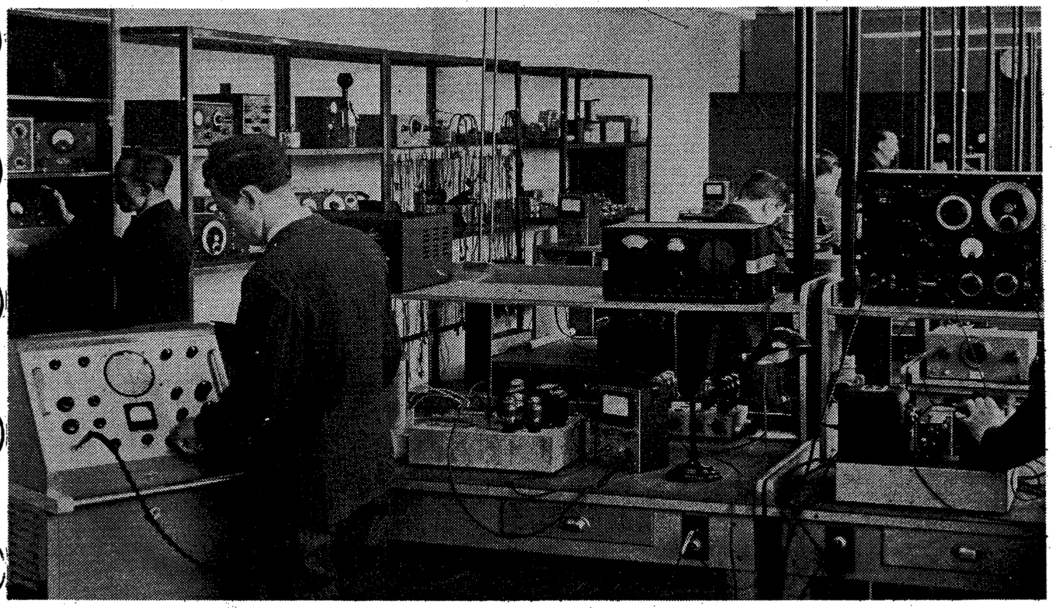
RESEARCH

DESIGN

DEVELOPMENT

ENGINEERING

MANUFACTURING



For Efficient, Economical Production

Are your present manufacturing processes proving too costly? Are outmoded methods exacting a heavy toll in waste time, manpower, materials? You'll find Sherron's all-inclusive electronics service worth looking into.

There's the Sherron laboratory. A full-fledged service in itself, noteworthy for research and development facilities. No mere auxiliary department, but a vital function in the integrated Sherron operation.

A full complement of seasoned electronics engineers and physicists are on hand to initiate your project. Practical, realistic, their job is to explore new ideas, track down new applications to make the tool of electronics do a better job for industry.

Their creative and fact-finding talents, meshed with the skills and resources of Sherron's manufacturing staff, can benefit you in many ways. Why not arrange for a talk with the Sherron management? You will find it worth-while and revealing.

TYPES OF CUSTOM BUILT SHERRON TEST EQUIPMENT

GENERAL TEST EQUIPMENT:

(A) Vacuum Tube Test Equipment — Automatic Production Tube Test Equipment. Electronic Reject circuits provide only positive rejects. Eliminates meters, places quality control in hands of quality control men. (B) Other characteristic test sets for receiving, small transmitting and power tubes, cathode-ray and kinescope tubes. Basic characteristic tests — dynamic and static — and bridge measurements are incorporated. Designed and manufactured to individual needs on custom built basis.

TELEVISION TEST EQUIPMENT:

(A) Television Signal Synthesizer. Includes generating, viewing and transmitting test equipment. Sync generators, monoscopes, shapers, timers, wide band oscilloscopes, air monitors, measuring devices and field survey equipment.

COMPONENT TEST EQUIPMENT:

(A) Focusing and deflection coils. (B) Resistor and condensor testing. (C) Wire and insulation test equipment. (D) Relays, transformers, chokes and other iron components.

All the above available on custom built basis. Designed, developed and manufactured to customers' specs and needs.

INSTRUMENTATION AND MEASURING DEVICES:

(A) A.C. Bridge Measuring: Radio frequency Cathode-ray Null Detector—1 mc operation. Cathode-ray Null Detector — 1000 cycle measurements. (B) D.C. Vacuum Tube Voltmeters and Ammeters: Measurements of minute voltages and currents necessary for laboratory research. (C) Multi-Wave Shape Generator: Source of several wave shapes, including negative and positive pulses and a trigger pulse; used in testing amplifiers at audio and video frequencies. (D) Computers and Calculators: Summing amplifiers — impedance matching networks. (E) Control of Measurements: Flow indicators — sorting, counting, etc. — Measurement of chemical titrations — electronic measurement of surface strains, stresses, films, non-linear surfaces.

All the above designed and manufactured to customers' requirements and specs on custom built basis.

Sherron Electronics W2XDK

SHERRON ELECTRONICS CO.

Division of Sherron Metallic Corporation

1201 FLUSHING AVENUE • BROOKLYN 6, NEW YORK