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Optimizing High Frequency Telegraph Transmission

Walter Lyons.

TELE-SIGNAL CORP

THE RADIO CLUB OF AMERICA, INC.

11 West 42nd Street ★ ★ ★ New York City

Edgar Felix EDITOR

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ORGANIZED FOR INTERCHANGE OF KNOWLEDGE OF THE RADIO ART, THE PROMOTION OF GOOD FELLOWSHIP AMONG THE MEMBERS THEREOF, AND THE ADVANCEMENT OF PUBLIC INTEREST IN RADIO



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PROCEEDINGS OF THE RADIO CLUB OF AMERICA

Volume 40, No. 2

OPTIMIZING HIGH FREQUENCY TELEGRAPH TRANSMISSION

WALTER LYONS V.P.

TELE - SIGNAL CORP.

ABSTRACT

High frequency point-to-point communication utilizing recently developed techniques now assure reliability and accuracy rivaling the telephone cable and perhaps the satellite relay for long-distance point-to-point circuits. Adequate power, antenna configuration and frequency division multiplexing applied to independent-sideband systems reduce the hazards that have plagued this medium, so that it can compete in quality and economy.

Multipath delay distortion effects have been reduced to small consequence by the substitution of frequency for time division multiplexing, thus increasing signal pulse duration. In addition, reduction in the modulation index increases correlation between mark and space frequencies, changing delay distortion to a slow change in timing. By increasing the efficiency of bandwidth utilization, by employing a modulation index of 0.8 and by applying the maximum number of channels to a single ISB transmitter reduces interference.

The cost of a teleprinter channel using HF radio compares very favorably with that of a TAT cable. Exclusive of central office expense and investment, the former ranges between approximately half to a quarter the costs of the latter. It is expected, therefore, that the use of HF will increase for record data communications.

INTRODUCTION

Speculation to the contrary, submarine telephone cables certainly, and satellite communications probably, will not replace high frequency communications in record data transmissions. These newer fields, however, provide an incentive to apply techniques to improve reliability and accuracy at HF so that a compatible and integrated communications system may be available. Especially is this required in military logistics and tactics.

In spite of the inherent distortion in the HF mode as compared to the newer forms, technical methods are available to reduce or eliminate their effects. The most troublesome types of distortion are multipath delay, interference, impulse noise and doppler frequency shift.

Reliability of HF is another hazard but it is not unique, since cables are subject to earthquake and trawler breakage, among other causes of long-term outage. Economic considerations are important where a circuit can use several media for communications.

Optimization should therefore take cognizance of the fundamental requirement of HF radio in land areas for antennas, additional terminal gear for sub-channels for diversity reception and the expense of maintaining transmitters and receivers and their operation, which requires signal analysis, propagation prediction and decision to transition frequencies.

On the other hand, cable costs and maintenance are not cheap. Satellites will present problems not unforeseen at this time, which may prejudice their economic feasibility. Other factors besides costs certainly dictate a trial of this exotic means.

FRAMEWORK

Current practice in HF communication tends toward the minimum utilization of spectrum, especially where telegraphic traffic is concerned. It has been proposed⁽¹⁾ and implemented on several long-haul circuits, that FREQUENCY SHIFT KEYING (FSK) sub-carrier utilize fractional modulation indices. The result has been a three-to-one reduction in bandwidth utilization with concomitant power and S/N gain.

The use of automatic error correction means by request for repetition of character transmission based on constant ratio coding (ARC) is widely in use on all major point-to-point circuits having reciprocal paths. This system, first proposed by Dr. H. C. A. Van Duuren, utilizing the Moore code, accounts for significant equivalent power gain due to its error reduction capability. Since several orders of error reduction are available, this is tantamount to a like power gain.^{(2) (3)} Data transmission may require other means for error detection and correction such as redundancy with block encoding or signal element assessment applied to time diversity means to obtain additional orders of accuracy without requiring a circuit return.⁽⁸⁾

In recent years, long strides have been made in the accuracy of prediction of optimum working frequencies from sun spot data and the orientation of planets.⁽⁴⁾ This has resulted in increasing the reliability and accuracy of operation on HF to a degree that rivals all other media. Specifically HF circuits have been known to operate with reliabilities in the upper 90% for periods of a year at economical error rates of one in 10³ to one in 10⁴.

Reasonable cognizance of the reduction of usable spectrum during the low period of the 11 year sun-spot cycle should be made by frequency assignment authority and by the user to effect cooperation in assuring maximum usage by the reduction of interference. Arbitrary rules concerning maximum transmitting power and emission bandwidth should be avoided. Every effort should be made to utilize the most modern equipment and adequate techniques must be employed to reduce the number of transitions (operating frequencies). As an example, ISB transmission and diversity reception together with high-gain antennas should satisfy most circuit requirements.

METHODS

Multipath delay distortion has been observed and its characteristics analyzed over the major long-haul circuits for many years and the consensus of opinion is that 3ms is the maximum distortion with which to cope under consideration of practical high reliability and commercially acceptable error rates. This phenomenon determines that the highest tolerable bit rate be of the order of 100 baud, yielding a bit length of 10 ms.

These effects can be minimized, however, by using very narrow shifts in FSK to maintain a high degree of correlation between mark and space frequencies such that the receiver regeneration sampling will ordinarily be able to follow the changing timing; this type of distortion not being instantaneous but rather building up and decaying at a rate of approx. a quarter of a second, in most instances.

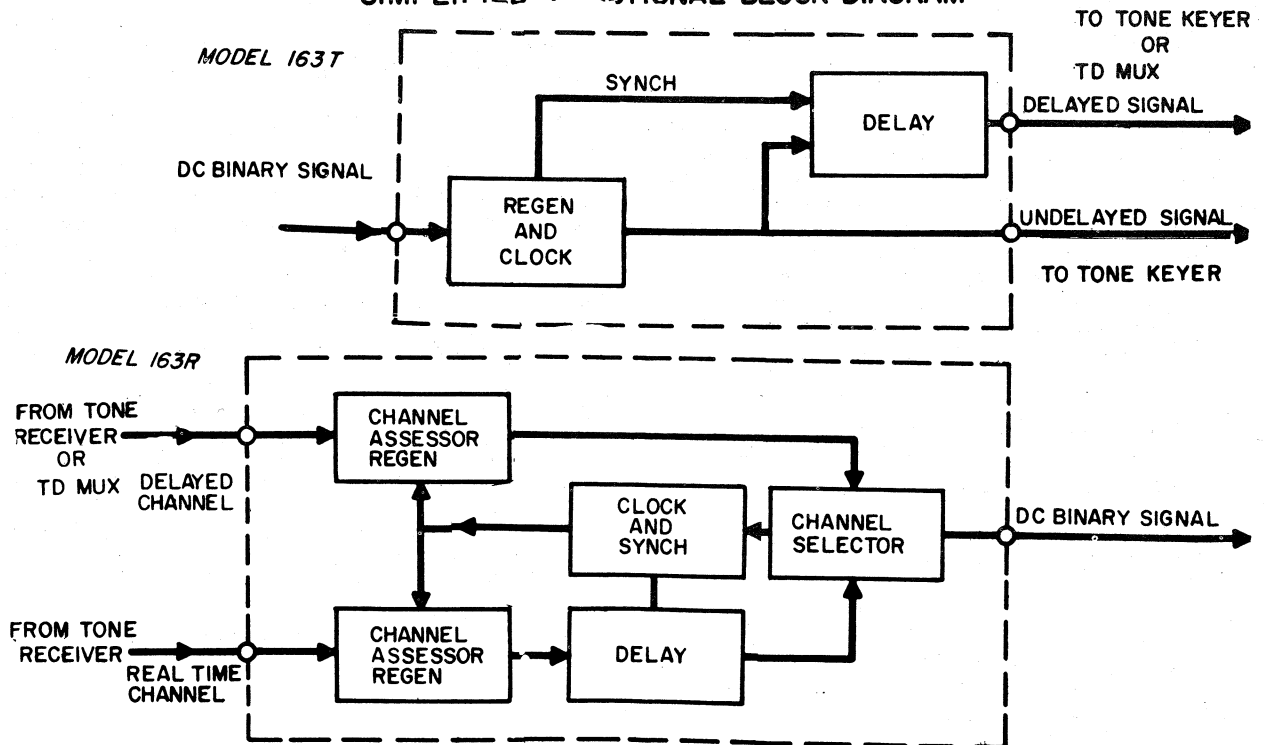
Fortunately, it is rare that high noise will accompany delay distortion so that we are able to use low thresholds to the receiver detector to minimize its effects. This low threshold need only be fixed since modern filter techniques have enabled reductions in noise by reduction of bandwidth to admit only fundamental keying components without significant phase distortion and adequate guardband in frequency multiplexing systems. Because of the peculiar characteristic of impulse noise the reduction of noise-to-signal voltage ratio is significantly more than a linear function.

Operation as close to MUF as is practically consistent with the minimum number of transitions per day is important in the reduction of multipath operation. Intelligent and conscientious operational procedures will assure this. Also, heavily loaded ISB circuits, including forked operation, will reduce the number of required frequency assignments, thus minimizing several problems at one stroke.

Interference is a unique problem of HF as compared to ocean cable or satellite relay for long-haul point-to-point circuits. This most serious handicap is a study of a special study by the IFRB, who recently established a panel of experts, selected by the nations of the world to offer solutions. Recommendations have been made at the first meeting (Geneva 1962) and most certainly more will come.

Even during the present historical low period of sun spot activity and useful band compression, much has been achieved by the implementation of ISB and narrow beam

SIMPLIFIED FUNCTIONAL BLOCK DIAGRAM



antennas and other techniques, by reason of their economic justification. We may, therefore, expect much more from regulations that are formulated by the ITU through auspices of the United Nations and the offices of the IFRB.

Modern techniques for FSK, reducing shift and bandwidth on the order of over 10 / 1, had been proposed (1) on the basis of theoretical studies which determined that 0.8 was an optimum modulation index. This was later confirmed, after practical application, by the engineers of the Kokusai Denshin Denwa in a document for study group III submitted to the Xth Plenary Assembly of the C. C. I. R. in Geneva 1963. When this mode of operation is finally implemented by most carriers, transmission interference should be markedly reduced.

Common to noise bursts, multi-path delay distortion and some types of interference is their sporadic or time variant nature. The application of time-diversity to the circuit has therefore been found to be quite effective in the reduction of errors. In fact, as compared to space or frequency diversity, time-diversity will reduce error rates by about one order more.

When time-diversity is applied to space diversity systems the improvement in error reduction is approximately ten times that by ARQ for high noise burst type error rates, in the order of 1% with no protection. Present practices which utilize dual transmission before transition of operating frequencies can be reduced by more accurate prediction of transition time. Means are available, having recently been developed, which are readily incorporated in synchronous regenerators (5). These means can be set up to assess the circuit by counting the number of distorted keying elements received which suffer a greater distortion level than a preset value. Tests have shown that dependence on such assessment can be relied upon to obviate dualling, after a small amount of experience is gained on the behavior of each particular circuit.

The band width occupancy of facsimile and radio-photo can be held to a minimum of 1 KC rather than 3 KC, (commonly used) if there is a realization by Operations personnel that the transmission detail cannot possibly be improved nor can the speed be increased with adequate detail by using greater bandwidths.

Many tests by operating agencies have shown that multi-path delay distortion precludes the transmission of keying elements shorter than approximately one millisecond duration. From this it may be readily inferred that a further reduction in interference can be obtained for the service.

Interference caused by radio-telephone circuits which cannot be moved to cable can be cut down by doubling the capacity of each ISB voice channel by the application of DATAVOX. (reference 6).

This new equipment will deliver telephone signals of high intelligibility together with good recognition and an equivalent power gain of a significant amount in the presence of impulse noise. Thus a reduction in transmitter power results with concomitant reductions in interference and maintenance costs, operation and capital expenditures.

According to many administrations, the greatest concern with interference to HF record data communications is that caused by national high-powered broadcasting stations, which, of late, have grown very numerous. International agreement and regulation to limit proselytizing within national borders would go a long way to make more telegraph channels available to everyone, including those required by newly developed countries. It might be well to consider the application of compatible single side-band broadcasting to halve the present broadcast spectrum usage and increase power availability (coverage). (7)

RF spectrum bandwidth is a priceless commodity and every effort should be made to utilize it most effectively, relegating highly redundant communications, such as telephone and facsimile, to other media.

The reduction of impulse noise distortion is simpler than is obviously apparent. We are taught that a two-to-one reduction in bandwidth will increase the S/N voltage by the same ratio, but this does not hold for very narrow bandwidths, such as of the order required for fifty cycle/second keying. This is because the crest factor of the noise impulse decreases faster than linearly in this low frequency region.

In reducing bandwidth, crowding channels and keeping cross talk down to practical low levels, filter design becomes critical, especially as regards phase distortion. Little will avail if by avoiding crosstalk we introduce transient impulses of the same or even higher order. A limit of 5% overshoot is a satisfactory criterion. A lower value will cost more without significant improvement.

Spurious signal radiation, in band, from the transmitters operating above design output, poorly adjusted, using unbalanced tubes and incorrectly loaded with high standing-wave ratios on transmission lines, will introduce self-interference, defeating other means for reduction. More than adequate transmitter design, good operation is required to reduce these effects. Many feel that automated (servo) tuning and antenna loading is the answer even though these methods are expensive.

The importance of sufficient power consistent with radiated bandwidth should not be downgraded. Sufficient power to assure an adequate S/N ratio with minimum number of frequency transitions and required reliability is a prerequisite for economical operation and efficient frequency usage. The power does not need to come from the transmitter alone but combined with antenna aperture and

gain. As an example, a single bay rhombic may be used during daylight hours for the high part of this spectrum whereas at night a two-bay end-fire rhombic with the same transmitter would satisfy.

Construction practices in large station installations are an important factor in the reduction of interference, both self and external. At transmitter sites poor practice will create cross-modulation products to be radiated, reducing the number of useful frequencies at the companion receiving site as well as interference to other services. Similarly, at receiving sites care must be exercised to avoid both spurious signal generation and excess noise pickup caused by poor construction practices.

At large transmitter stations high standing wave ratios will cause radiation to adjacent antenna transmission lines, resulting in cross-modulation in any non-linear portion of another working transmitter and hence spurious reradiation. Again, corrosion in tower and guy-joints will act as sources of spurious radiation. Direct radiation of one antenna to the back and side responses of another must be avoided, obviously. The criterion for good practice therefore is to maintain good engineering practices in transmission line matching and siting, as well as careful control of materials used for adequate good construction.

Remembering that good radiators are good receptors the same precautions must be observed at receiving station sites, with the proviso that even more care must be used. As an example, feeders to antennas that are balanced must be matched to avoid a balance-to-unbalance ratio of less than 40 db. For this reason antenna multicouplers should be employed to assure fixed matching impedance in addition to the facility for antenna switching and multiple receiver connection which is provided. Haphazard antenna spacing will result in poor space diversity operation besides the shadowing and coupling that will seriously alter reception patterns.

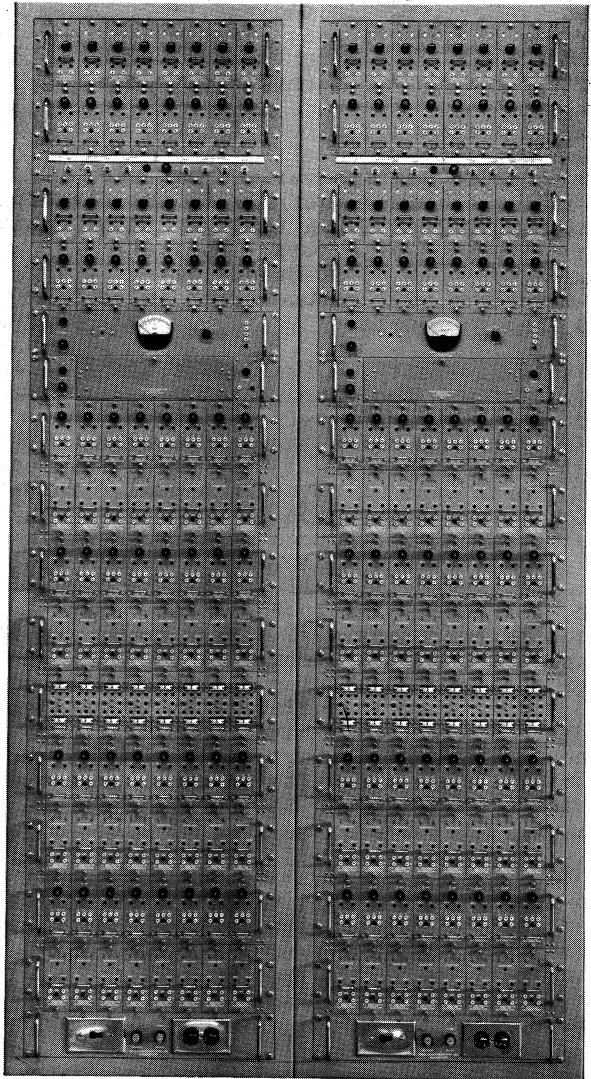
ECONOMICS

Economic considerations reveal that the implementation costs and expense for adequate and reliable HF record data communications is low compared to alternate media. For this reason we should expect that its usage will tend to increase. Since this statement may invoke controversy, an analysis will indicate the following costs:

Capital equipment, buildings, depreciation and Operating (personnel, maintenance and power)

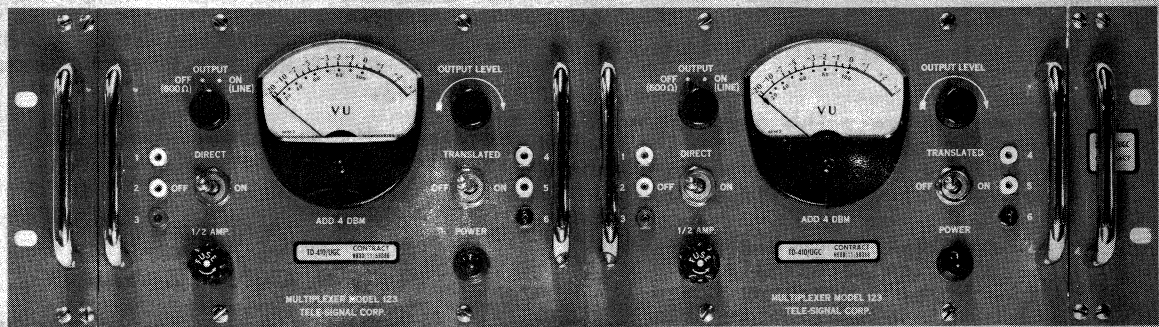
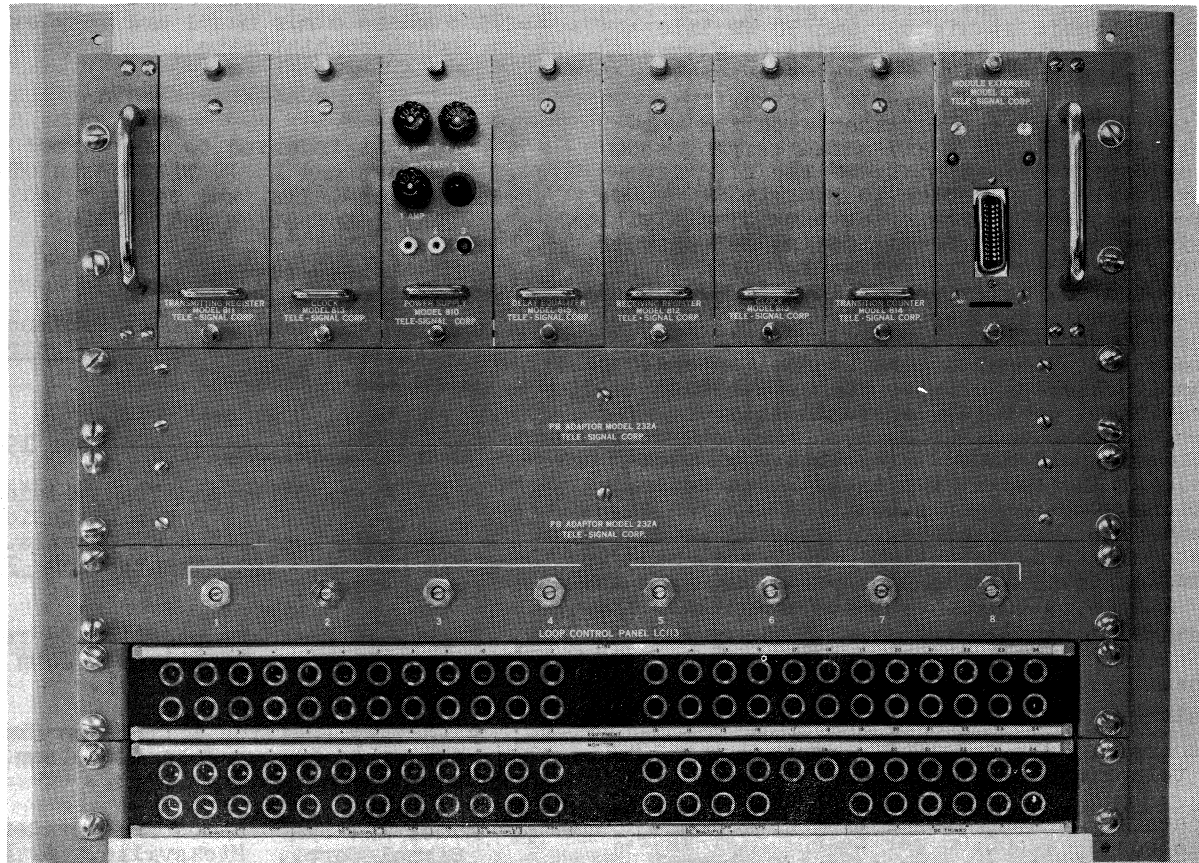
-----cont. page 6

The photograph at right shows the TELE-SIGNAL 5,000 system, which is a dual diversity receiving system and a complete transmitter comprising 32 voice frequency tone channels spaced 96 cps apart, each



capable of handling 75 baud start-stop (100 words per minute) teletype, or 85 baud synchronous data.

On opposite page, at top, the TELE-SIGNAL Model 2100 Serial/Parallel - Parallel/Serial Converter for frequency division Multiplexing for serial data over HF channels. At center: Two TELE-SIGNAL Model 123 Voice Multiplex Transn. units for HF ISB transmission of four voice bands over a 12 kilocycle bandwidth assignment. At bottom: Model 124 TELE-SIGNAL Demultiplex units that separate the four voice channels received at the 12 kilocycle ISB receivers.



Predicted on maximum information rates utilizing ISB with 12 kc sidebands (emission spectrum approx. 10 kc) on a normal New York/Central European circuit, it will be required to employ ARQ (automatic error correction) 100 Kw average power into a two bay rhombic at night, and 50 Kw into a single bay during daylight hours to assure commercial error rates (10^{-3} to 10^{-4}) and circuit availability over 90% of the time. The two transmitters together with the sub-carrier keyers (66) and antennas represent the major investment costs of the high frequency system amounting to roughly \$400,000, including installation. The ARQ time division multiplex equipment, considering teleprinter traffic, is common to any medium and is part of the central telegraph office (CTO) equipment cost not considered here. The 66 sub-carriers spaced 170 cps will require a diplex ARQ for each tone channel in order to transmit 132 teleprinter channels, each operating at 50 baud, approximately.

Considering all direct (exclusive of overhead) cost factors at typically large radio stations with proper allocation for rental, attendants, maintenance, tubes and power together with depreciation (20 years) and including transmission expense to and from the CTO it can be shown, without going into the details) that, per teleprinter per year:

Transmitter expense/channel/year \$ 450
Receiver expense / channel/ year \$ 180

so therefore the total HF costs are \$630 per teleprinter per year.

Comparatively the Trans-atlantic Telephone cable costs \$2800.00 per teleprinter/year. It may be unfair to compare a 132 channel 12 Kc system to a 44 channel 3 Kc cable system. Therefore, "long lines" costs for each media are given below for comparison on an equal channelling basis for 44 teleprinter channels.

Radio expense/channel/year (44 channels - 22 tones) comes to \$1500.00
Trans-Atlantic Telephone Cable expense/channel/year (44 channels - 22 tones) is \$2800.00

Accordingly, exploitation of high frequency radio is at least twice as advantageous when compared to the cable. Moreover there is every reason to believe that costs via HF can be reduced by applying newer methods of operation to save manpower, such as centralized monitoring and remote control of equipment at both receiving and transmitting stations.

By utilizing automatic circuit assessment, as mentioned previously, to warn of upcoming transitions, dualling becomes unnecessary. With centralized control, frequency and antenna changeover can be accomplished easily by one person. Several administrations have already started toward this goal, and in some instances, currently are in such operation. An outstanding example is the transmitter station Rugby 2 of the General Post Office of the United Kingdom.

CONCLUSIONS

Rather than be blinded by new exotic media of communications to the point of neglecting the fullest exploitation of the old long-haul workhorse HF, the communications engineer

should bend some effort in the direction lead by state-of-the-art and economic justification. HF has a unique position in communications on many circuits, as for example, ship-to-shore, and plane-to-ground at long distances and point-to-point circuits operating to remote regions where other means are very expensive even though sophisticated.

ACKNOWLEDGEMENTS

The author is indebted to his former colleagues J. C. Hepburn and E. J. Williamson of RCAC Communications, Inc. who contributed materially in factual information and editing.

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ABOUT THE SPEAKER

Walter Lyons, a Fellow of the Radio Club has been active in the radio engineering field for over 40 years. Before 1933 he was with BTL, Victor Talking Machine Co., Balkeit, Wells-Garner. In 1933 he became Chief Engineer at Emerson Radio, and later went to Hazeltine. In 1938 he joined RCA as the manager (of Station Facilities for RCA Communications, Inc.) where he remained until his retirement in 1962.

He is presently Vice-President of TELE-SIGNAL CORP. at Hicksville, Long Island. He is also Adjunct Professor at the Polytechnic Institute of Brooklyn. He is the Chairman of the EIA Committee TR-6 and a member of study groups of the CCIR. He is a member of PEAC (Panel of Experts Advisory Committee) of the State Department for the IFRB, and a member of many other technical societies.

This paper was received January 19th 1964 and was presented to Club members in Feb.

HAZELTINE

Dr. Louis Alan Hazeltine, neotrodyne inventor, physicist, mathematician and educator, died recently at his home in Maplewood, N. J. A past president of the Institute of Radio Engineers and the Radio Club of America, winner of the Radio Club's Armstrong Medal and its president 1946-1947 joined the Club in 1915 and contributed to its success and growth

Born at Morristown, N. J., August 7, 1886, educated at Stevens Institute of Technology and at Columbia University, Dr. Hazeltine joined the Stevens faculty after graduation in 1906 with a degree in mechanical engineering. He became its Professor of Electrical Engineering in 1918 and Professor of Physical Mathematics in 1933.

In 1944, when a considerable group of radio receiver manufacturers had become licensees under his neotrodyne patents, he resigned from the university and devoted himself to the interests of his licensees and to consulting work. The Hazeltine Corporation was formed to act as the administrator of licensing under Hazeltine and later other inventions. Dr. Hazeltine served the corporation as a director and consultant until his retirement three years ago. The company, in the meanwhile, became a developer and manufacturer of military equipment, principally in the radar and iff fields.

During World War I, Dr. Hazeltine served as a consulting engineer at Washington Navy Yard. He was a member of the Committee on Electrolysis and served as chairman of the American Gas Association's committee on electrolysis in 1920. He was a fellow of the American Institute of Electrical Engineers, the Institute of Radio Engineers and the Radio Club of America.



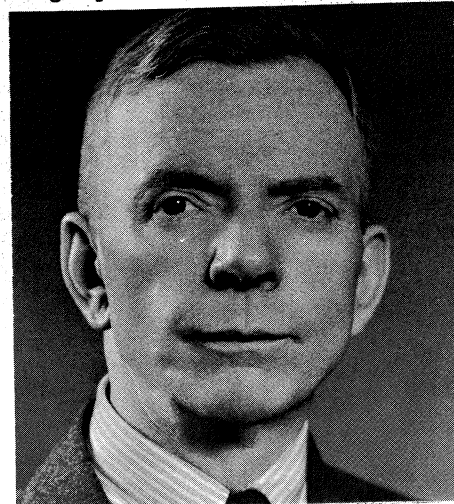
EASTHAM

Melville Eastham, founder and retired president of the General Radio Company, member of the Radio Club of America since 1917 and Fellow since 1932, died in Boston on May 7th. He was a resident of Cambridge, Mass., and of Tigard, Oregon.

Eastham was born in Oregon City, Ore., June 26, 1885, and was educated in Oregon public schools. He moved to Boston in 1909 as cofounder of Clapp-Eastham Company, a manufacturer of radio receiving and transmitting equipment. In 1915, he founded the General Radio Company to manufacture electrical measuring instruments and served as its president until 1944. From 1944 to his retirement in 1950, he held the title of Chief Engineer.

Eastham was responsible for many important electrical standards, components and construction techniques. He was also recognized as a pioneer in employer-employee relations and many employee benefits now widely adopted were initiated and put into practice by him at General Radio. His technical and humanistic guidance enabled General Radio to attain a preeminent position in the electronics industry.

Eastham was a Fellow of the Institute of Electrical and Electronics Engineers and of the American Academy for the Advancement of Science, and a member of the Acoustical Society of America, the American Physical Society and the American Meteorological Society. In 1945, he was awarded the honorary degree of Doctor of Engineering by Oregon State College, the IRE Medal of Honor in 1937 and its Medal of Merit in 1948; the New England Engineering Award in the same year. He was awarded the Radio Club of America's Armstrong Medal in 1956. He was seen at many conferences of IEEE groups and came to many of our banquets.



CLUB AWARDS PRESENTED TO YOUNG SCIENTISTS.

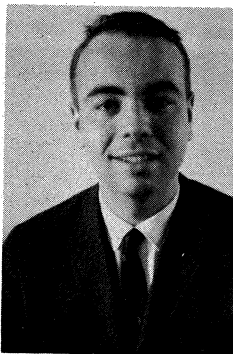
Carrying out its policy of recognizing outstanding achievements by young scientists the Radio Club issued two awards this year. The winners were selected from among the graduates of the SCIENCE HONORS PROGRAM which is sponsored by the Columbia Univ. School of Engineering and Applied Science with support from the National Science Foundation. The selection was based on the ratings of the faculty members associated with this Program, who have guided the activities of some 435 gifted secondary-school students enrolled.

The winners this year were Lawrence H. O'Neill, Jr., and Ralph Linsker. The Awards, cash gifts, were presented to these boys at presentation ceremonies on May 28th at the University's Engineering Building, by the Club's President Ralph R. Batcher. Also in attendance was Dr. Jom Bose, the Club Chairman of its Awards Committee.

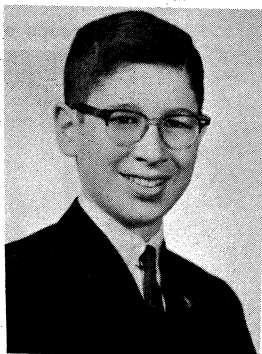
Because of the requirements to qualify for admittance to the Honors Program, which includes passing rigid entrance examinations which are taken by several thousand students who have been nominated by the science staff in each of the several hundred secondary schools located in and around New York City even being permitted to take the courses is an honor. Thus being selected as showing outstanding promise in the field of Science becomes quite an honor.

Our awards, which do not carry designations such as first and second, have been well placed this year, since we talked with both boys at length, and with some of their Professors. Thus (listed alphabetically) we met Ralph Linsker - now only fourteen, who will go this fall directly from the Junior year at Forest Hills High School to the Freshman class at Columbia's School of Engineering. He entered the Honors Program at the age of ten, starting work in the fields of astronomy and astrophysics. He has

O'NEILL



LINSKER



taken courses in solid-state physics, several courses in higher mathematics, group theory and combinatory topology, computer mathematics (in which he then served as assistant instructor at the age of thirteen) relativity physics, plasma physics and biochemistry. (These courses are typical of the work being handled in the Honors Program). His work in both pure and applied mathematics is considered to be of exceptional quality. We found him pleasant and cheerful, and able to converse as an equal with research specialists several times his age.

Larry O'Neill has just turned eighteen, and graduates cum laude this year from Horace Mann School. He also will attend Columbia this fall. A tall, courteous young man with a quiet sense of humor, he is the son of a distinguished electrical engineer. He divides his interest between physics, electronics and literature. During the two years he has been with the Science Honors Program he has studied experimental and solid-state physics, and showed outstanding aptitude and creativity both in experimental work and in theoretical inquiry.

ARRL's 50th Birthday

The American Radio Relay League will celebrate its fiftieth birthday at its 1964 Convention at the New York Hilton, August 21st - 23d, sponsored by the Hudson Radio Council. The East Coast VHF Society will host the International VHF Convention as a special feature.

The program begins with a Friday evening cocktail party following a day full of specially planned programs. In fact the whole three days are filled with contests, special events, panel groups, exhibits of the latest in ham rigs, special YL-XYL events, technical meetings (covering everything from ARKQ to Zener diodes), a military luncheon, ARRL's open forum, SSB sessions, DX session, RTTY, television, Wouff Hong initiation and, of course, the SWOP for the XYL's.

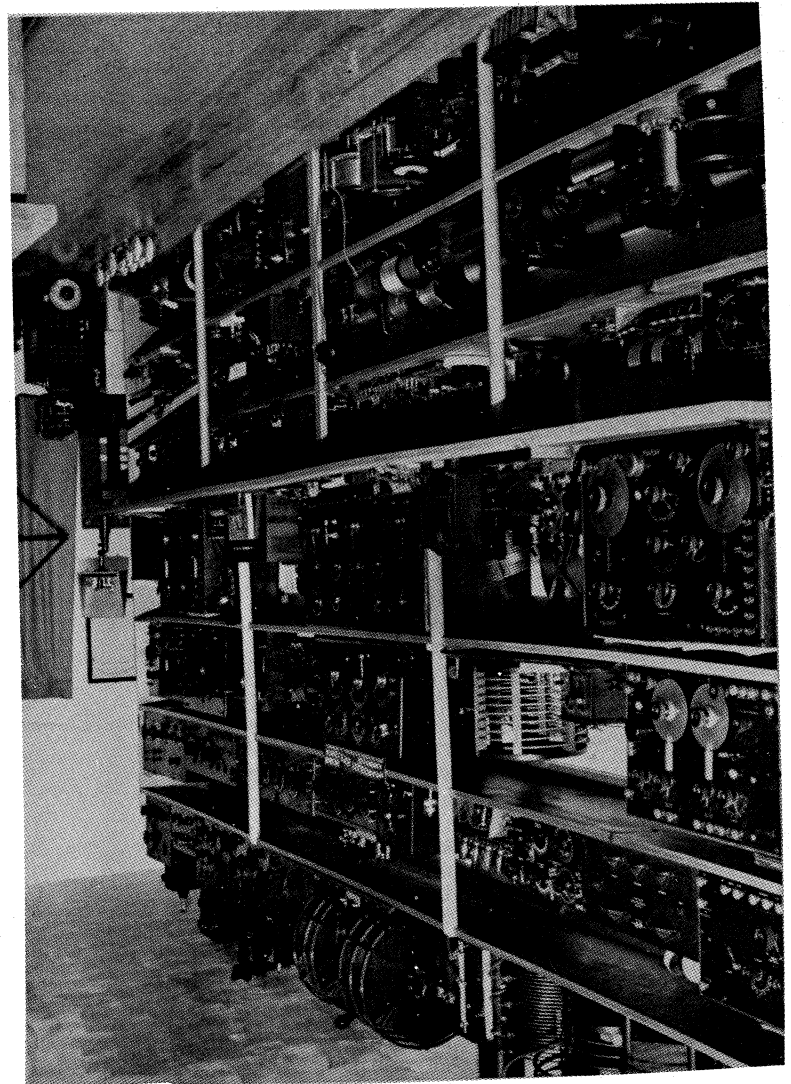
Herbert Hoover, Jr., the ARRL President, will act as Toastmaster and introduce the speaker of the evening, the Hon. Barry Goldwater, (K7UGA - KWIG). The conventioners will make an official visit to the N. Y. World's Fair and while there to K2K2US (in the Coca Cola building, where at all times should visit when at the Fair). A variety of tours and visits have been arranged for the ladies. Pre-convention registration fee (including banquet) \$15.00. Send name, address, call letters with check to HARC Convention, P. O. box 58, Central Islip, L.I., N.Y.



It has become increasingly evident among some members that many items which represent typical examples of early experiments, or methods of operation and tests taking place during the first couple of decades in this century have become irreplaceably lost because of a lack of storage space by relatives of pioneer experimenters after their death, or even by members themselves after their retirement. Whole files of records, photographs, interesting documents, books, magazines and similar items are being thrown out for these reasons. As mentioned in earlier issues of the Proceedings, our ARCHIVES COMMITTEE under the Chairmanship of Harry Houck finds that quite a few of our own members and friends have launched into the establishment of notable displays, collections, and even museums of their own. We are now asking these, and others that we may not be aware of now, to acquaint us with their activities so that we can help in some way. We will devote a page or so in these issues to describing some of the more extensive collections already started.

We take pleasure as a start to mention the collection of Ed Raser, of 19 Blackwood Drive, Trenton, N. J. (zip-08628). The photo here shows only one section of an extensive array of apparatus, much of which has an individual history of its own. How many items can YOU identify? Descriptions of other museums will follow. Already there are hundreds of collectors in this field, as members of the Antique Wireless Association know. ** The Radio Club's ARCHIVES Comm. has a number of plans along these lines to augment these efforts, which will be told later.

** for information about AWA write Bruce Kelly, Holcombe New York.



THE W2ZI HISTORICAL WIRELESS MUSEUM, a private institution and entirely a one man project, is the result of over 30-odd years of collecting and research in the pioneer field of wireless and radio.

The Museum includes over 400 items on display of apparatus and instruments from the 1899 period, when Marconi first came to America, to the end of the Amateur Spark Era which ceased in 1925. There are a few early broadcast sets, but the collection consists mainly of amateur wireless gear from about 1909, naval and marine receivers removed from many ships and vessels, and equipment used by the old time shore stations and the pioneer operating companies back to 1905.

A side collection of some 98 Morse and wireless keys and some

100 significant type vacuum tubes from 1907 to about 1925 are shown. The W2ZI collection also includes a large historical library on the art of wireless and radio, and files of magazines back to 1908 along with many papers and photographs of the early stations, pioneers of wireless and their biographies.

We heartily thank all those amateur radio operators, commercial wireless men and friends who have so willingly contributed to the success of this project.

The Museum is open to the public by appointment only. If you plan to visit the Museum, write or telephone a few days in advance so arrangements may be made. Upon arrival in the Trenton area, telephon 982-4445 - further directions if necessary.

The feature articles appearing in these issues cover most of the technical papers that have been presented at our meetings, and reports from members relating to radio and electronic subjects. We also sometimes include papers by independent contributors who have original and timely material of special interest. We are often asked about the form of written presentations which would expedite publishing. Hence the following Instructions to Authors:

PAPER- a good grade of Bond, white and not too glossy.

TYPING- use black ribbon with freshly cleaned type faces. Type SINGLE-SPACED with narrower-than-usual column widths, as per table below. DOUBLE-SPACE between paragraphs. Pay no attention to the column lengths as we will assemble all material into suitable columns.

COLUMN WIDTHS- a maximum of $4 \frac{3}{8}$ ths inches. The length of each typed line should be this or less, as the word lengths allow, trying to keep as even a right hand margin as possible. This means that with an ELITE style type face set the line length stops to include 43 characters. With PICA style type the lines can have up to 51 characters, (letters and spaces). With other machines, such as Executive styles set to give the $4 \frac{3}{8}$ ths inch length.

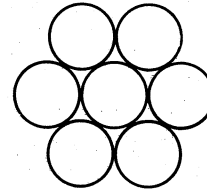
DRAWINGS and PHOTOGRAPHS- Sharp and clear, with captions clipped on separately. Sketches should not be larger than - say- double the size (twice the dimensions) that they are to appear in the article. Black-and-white photos are desired since color shots and slides rarely give good reproductions and are costly to handle. While we can handle black-and-white slides, it is just as well if the original prints are sent. In the case of drawings larger than the above mentioned max. size, the lettering often becomes too small to be read conveniently, but they can be handled if necessary.

LENGTH- the usual presentation is between 2000 and 3000 words. If authors need more space it is well to drop a line to the Editor, who can help determine the best way of handling longer articles.

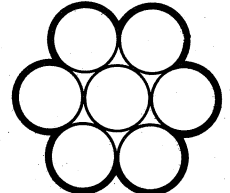
EXTRA COPIES- Fifty copies of issues that contain feature articles are given to authors without charge. Extra copies beyond this number can be ordered at a nominal charge, (of the order of \$ 15 per hundred) if ordered at the time the article is submitted

LITZ WIRE

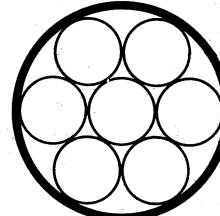
As many as 1000 or more individual strands from 18 thru 48 AWG Effective cross-section equivalents from 10 thru 44 AWG Individual strand insulations including: plain enamel, Formvar, liquid nylon, polyester, polyurethane, DuPont ML polymer Outside fabric servings including: nylon, silk, celanese acetate, cotton or glass Custom engineered and constructed at Hudson's completely integrated wire drawing, enameling and stranding facilities.



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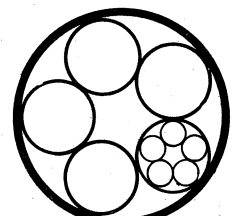


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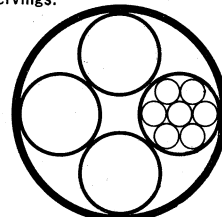
LITZ WIRE - TYPE 1

Film insulated individual wires with one or two outer fabric servings.



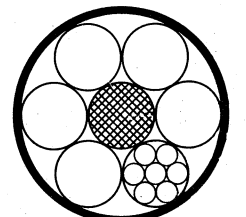
LITZ WIRE - TYPE 2

Sub groupings of individual film insulated wires.



LITZ WIRE - TYPE 3

Similar to Type 2, but with component groups insulated with textile yarn.



LITZ WIRE - TYPE 4

Component groups cabled or spiraled around a cotton core.

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Newsbriefs

The Fifty-fifth Annual Banquet of the Radio Club of America will be held on Friday, Nov. 20th, 1964 at the Appleton Grille of the Seventh Regiment Armory in New York City. This is the scene of the successful affair last fall. Planning and arrangements are well under way and will be announced later.

MARK THIS DATE ON YOUR CALENDAR NOW

FIFTY-FIFTH ANNIVERSARY YEARBOOK

The Club will publish the next Yearbook this fall. Hoping that it will be ready in time for the Banquet on November 20. Letters are going out to some of those who failed to respond to earlier requests for ROSTER changes, and information to update your entry in the FIFTIETH edition. Bill Finch is handling this job this year, and we hope you will make an immediate reply to his letter. If you have responded before you will not be asked again, although if there are any additional changes send them in.

ELMER BUCHER DIES

Members of the Radio Club, recalling his comments published in the earlier issue of the Proceedings this year, were saddened

to hear of his death at his home in Wayne N. J. on June 14th, 1964. Elmer was a selected Guest of Honor at our last banquet but illness prevented his attendance. His letter of regrets, published in part in that issue contained much of interest.

Although he had held many positions of importance during the six decades of radio activities, he will be best remembered as the author of several books that were published at a time they were most needed (during the World War I era) which were musts on the desks of "wireless" experimenters, commercial operators, and the communications operators of the military. He was 78 years old. During the last few years he has been active in collecting and compiling early historical information relating to radio matters.

HARVEY E. SAMPSON DIES

We regret having to note the passing of Harvey E. Sampson, long a Fellow of the Club, and interested in "wireless" since 1923. He was executive for the Harvey Radio Company in mid-town New York City, long a source for communication apparatus and radio components. He lived at

long a source of communication apparatus and radio components. He lived in Massapequa, Long Island. He was 56 years old.

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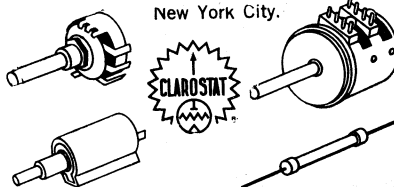
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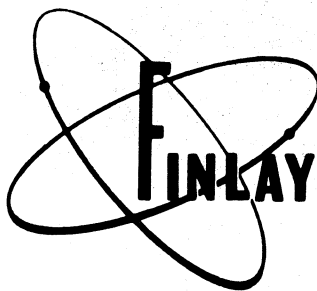
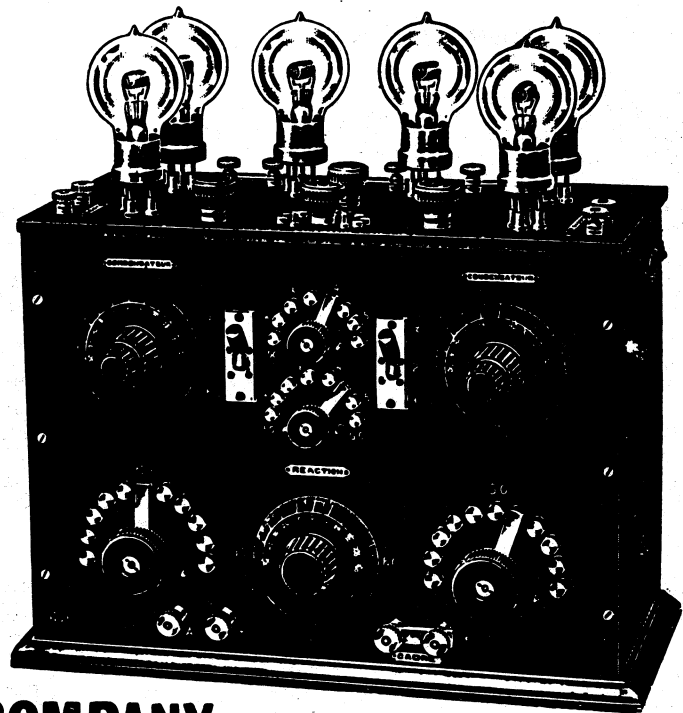
BUSINESS CARD LISTINGS

It has been suggested that many of our members are sometimes hard put when it comes to selecting special equipment items and services to handle unusual problems, and that a listing of some facilities available among other members would be useful. As an experiment we will try devoting a page in

future issues to the display of the "business cards" of some of our members who care to let others know what they are doing. The above are typical cards of some who responded. Space, up to a full page total, will be available to these and others. The cost is nominal (\$35.00 per year, four issues guaranteed) for this size and shape, 1/9 th page.

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