PROCEEDINGS

of the

RADIO CLUB *of* AMERICA

Vol. I No. 7 November, 1920

R.C.A. SPECIAL NOTICES

In accordance with the recent amendment to the constitution the following men were chosen by the Board to act as additional Directors for the remainder of the year:—

Lester Spangenberg
George Eltz
Lawrence C. Horle
Louis M. Clement
David S. Brown

* * * * * * * *

We take pleasure in formally introducing to the Club the following new members who have been admitted during the past few months:—

W. Aull	J. L. Horning
H. Berman	W. Inman
S. M. Christie	A. L. Kent
G. F. Cronkhite	W. Lindsay
G. J. Corrigan	O. C. Roos
C. Dreher	K. B. Warner
C. H. Handke	H. C. Wheat

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The Club has made arrangements for a private dining room at the Campus Restaurant, Columbus Ave. & 104th St., where the members may dine together before each meeting. Although these facilities for a pleasant social hour have been available for some time the turn-out has not been very large. Why not take this opportunity to really get acquainted before the next meeting by being "on deck" at 6:15 P.M. sharp?

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Office of the Editor—319 W. 94th St., New York City.
Walter S. Lemmon—Editor
Ernest V. Amy
Austin Lescarboura
Lester Spangenberg

The Bureau of Standards—A.R.R.L. Tests of Short Wave Radio Signal Fading

By S. Kruse

Assistant Electrical Engineer, Bureau of Standards

Presented at meeting of the Radio Club of America, Columbia University, September 24, 1920

THE Bureau of Standards—A.R.R.L. tests of short wave radio signal fading were run co-operatively by the Radio Laboratory, Bureau of Standards, and the American Radio Relay League for the purpose of gaining information useful in determining the cause of the swinging or fading of radio signals. The work was divided between the two organizations, the selection of stations and actual performance of the tests falling to the A.R R.L.; while the work of general supervision, preparing the recording forms, correspondence, and the analysis of the results were done by the Bureau of Standards.

Test signals were transmitted by six stations each Tuesday, Thursday and Saturday night, from June 1 to July 17, 1920, inclusive. Five of the transmitting stations were A.R.R.L. stations. The sixth was the station at the Radio Laboratory of the Naval Air Station, Anacostia, D. C.

It is perhaps best to begin a discussion of this kind by defining the term "swinging" or "fading" of signals. This can best be done by example. Supposing that we are listening, at the Radio Laboratory in Washington to station 1HAA at Marion, Mass. 1HAA will call and be received with normal intensity, will begin the preamble of his message still at normal intensity, and then, as he starts to send the text, the signals rapidly become very much louder until within a few seconds they can be heard all over an ordinary room. Then as he proceeds the signals become fainter and may become so weak as to be unreadable or even inaudible for a number of words, and then again begin to become louder, so that by the time the station signs off, the signals are again very loud. It can readily be seen that this kind of thing makes communication very difficult, and on many occasions requires repetition time after time of a message which could otherwise be copied "solid" the first time. In short-wave work swinging is so prevalent that a standard abbreviation has been devised to inform the sending station that his signals are swinging, and at present, in amateur communication this abbreviation, "QSS", is heard quite as often as QRM and QRN, which mean respectively "interference" and "atmospherics," the other two worst difficulties encountered in short wave communication. It is then of interest to attempt to find some explanation as to the cause of swinging, with the possibility in mind that if we know the cause, there may be a remote chance of avoiding the difficulty. Swinging has not been much investigated in the past, for several reasons. It is primarily a long-distance phenomenon, that is to say, long-distance compared to the range of the station which is sending. Most commercial communication is done well within the range of the transmitting station where not much swinging is encountered. In addition to this, commercial communication is done on long wave lengths on which swinging is not very severe nor very rapid. At present, however, the use of short-wave sets is very much on the increase, not only in amateur practice but also by airplanes, in military work, and in low-power ship communication. It seems worth while to attempt to investigate fading at short waves particularly. Naturally, since our ideas as to the cause of fading are rather vague, an investigation depending on a network of stations (rather than one sending and one receiving station) would be the most instructive. The thought that data on the fading of radio signals can be secured by co-operation with a network of amateur radio stations follows at once, as it is here only that one can find a large number of well equipped short-wave stations whose operators are thoroughly familiar with the apparatus and also able to give time and effort to the performance of an investigation. Last spring, therefore, I suggested to Mr. L. E. Whittemore of the Radio Laboratory of the Bureau of Standards that we place before the American Radio Relay League a plan for a system of fading tests in which the A.R R L. stations would do the transmitting and receiving, while the supervisory and clerical work and the analysis of data fell to our laboratory. During the following week such a plan was worked out tentatively by Mr. L. E. Whittemore, Miss H. H. Smith and myself.

Laboratory tests of the method of recording the variations in signal intensity having shown that satisfactory results could be secured without the use of any instruments other than the regular receiving equipment, the Bureau of Standards then officially proposed the plan to the A.R.R.L. The plans were received favorably, especially as they offered an opportunity of finding out with some definiteness what could be done in the way of summer transmission with amateur stations. It has developed since that Mr. H. P. Maxim, and Mr. K. B. Warner, respectively President and Secretary of the A.R.R.L., had discussed a similar plan and were about to write to the Bureau when our letter was received.

The plans for the tests were completed at a conference in the Bureau of Standards Radio Laboratory on April 7 at which there were present: for the American Radio Relay League, Mr. H. P. Maxim, and Mr. K. B. Warner; and for the Bureau of Standards, Dr. J. H. Dellinger, Mr. L. E. Whittemore, and the writer. Commander A. H. Taylor, USNRF, in charge of the Radio Laboratory, Naval Air Station, Anacostia, D. C., as well as Dr. S. J. Mauchley and Mr. A. Sterling of the Department of Terrestrial Magnetism, Carnegie Institution, Washington, were present and offered valuable suggestions. The tentative plans were brought into working shape, and the sending stations agreed upon. Mr. Maxim and Mr. Warner offered the use of their station 1AW at Hartford, Conn., and Commander Taylor the use of station NSF at Anacostia, subject to the approval of the Navy Department. Commander Taylor's offer of NSF was opportune as there was no Washington station capable of good 250-meter transmission which was available for the tests. Both 1AW and NSF did excellent work in the test series, the transmission of the latter station being at times little short of phenomenal.

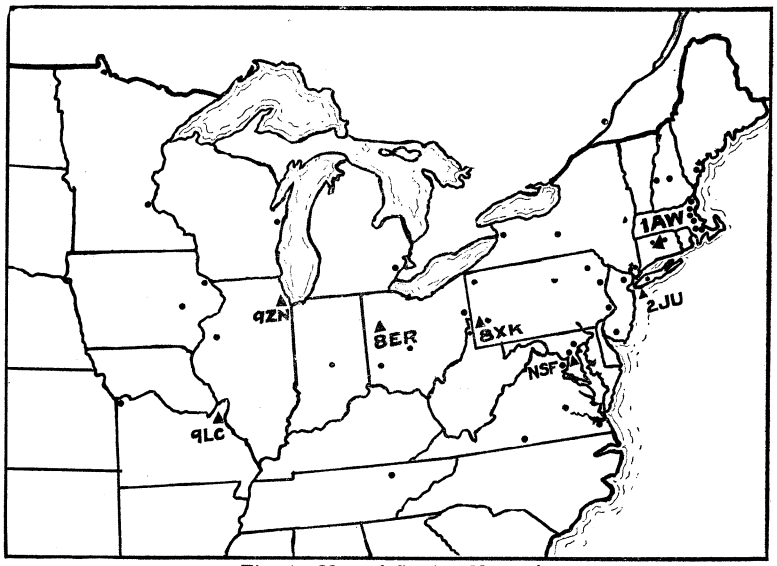

Fig. 1—Map of Station Network.

During the following weeks, Mr. K. B. Warner and the officers of the Traffic Department of the A.R.R.L. did much hard work in selecting recorders properly located, and known to be well enough equipped as to apparatus and experience, who could also find time to take part in the tests.

The Station Network

The station network finally developed is shown in Fig. 1 where the sending stations are indicated by triangles with the call of the station alongside, while the recorders are indicated by circular dots. There were seven sending stations and fifty-one recorders.

Considerable criticism of the lay-out of the fading system was occasioned by the fact that only the northeast quarter of the United States was covered. There were reasons for this. There were almost no stations in the southeast part of the country and not a great many in the southwest. Also such stations as there are, report comparatively little fading. It seemed, then, that not a great deal of information would be obtained from the southern stations. In addition, there is a limit to the number of curves which can be analysed. The amount of work involved in handling the 1260 curves which were received can hardly be appreciated by anyone who has not attempted a job of this kind. The decision to confine the tests to the northeast was a unanimous one in the conference, and the results have shown it to be sufficiently correct. Experimentally the A.R.R.L. has run some nationwide tests, largely to see what transmission conditions were. The reason for the wider spacing of stations west of Pittsburgh is a double one. To begin with, there are fewer stations west of Pittsburgh, and although it might have been possible to secure as many west of Pittsburgh as we did to the east, we did not think this was necessary. The winter range of stations in the Mississippi and Ohio Valleys is enormous compared to that of eastern stations. It did not occur to us that the Mississippi Valley summer conditions are enormously different from the winter conditions, while on the eastern coast ranges do not change particularly with the season. The station arrangement, therefore, which would have been satisfactory for a winter test was not so for the summer test. The western stations, 9ZN at Chicago and 9LC at St. Louis, were working under a considerable handicap, and it became necessary later to add station 8ER at St. Marys, Ohio, in an effort to secure more complete records.

Station Description—Senders.

1AW—Station 1AW at Hartford, Conn., is operated by Mr. H. P. Maxim, President of the A.R.R.L., and Mr. K. B. Warner, Secretary of the same organization. 1AW does not need much advertising. The station location is directly to the east of a large hill toward which the antenna is directive. There are no hills to the north or south and the country is level to the east for about two miles, after which it drops sharply to the Connecticut River. The soil is a heavy clay which is usually very wet in the winter. The station is surrounded by houses at a distance of about 75 feet, and there are trees in all directions except east. The antenna (Fig. 2)[1] is a bent fan of 17 wires spaced three feet apart at the high end and which is elevated 80 feet. All wires are continued through the spreader at the low end (elevation 50 feet) to the anchor gap at the transmitting apparatus which is located in the basement. The ground system consists of a network of buried wires as well as wires to ground rods and to all the metal pipes in the building. The radiating system has a resistance of 5 ohms and a capacity of 0.0011 microfarad. The sending set (Fig. 3)[1] is of the 60-cycle non-synchronous rotary gap type. Either an Acme or Thordarson transformer is used. In either case the input is about 780 watts. A Dubilier mica condenser of 0.01 microfarad capacity is used. The rotary gap is unusual, consisting of a shaft mounted in bronze bearings and carrying 4 metal arms revolving between two fixed electrodes. The rotor diameter is 15 inches and the speed 7000 RPM. It will be seen that while the spark rate is low the peripheral speed of this gap is very much higher than usual. Because of the high speed, or perhaps because of the compressed air traveling before the rotating electrodes, unusually good quenching is obtained so that close coupling with consequent high efficiency may be used. The normal antenna current is 5½ amperes and the decrement quite low.

The second station, **2JU**, operated by Mr. C. J. Goette, is located in Woodhaven, L. I., near Jamaica Bay. There are no large buildings or trees in the neighborhood and the land is very level and slightly marshy.

The antenna is a four-wire L, 50 feet high, 85 feet long, and 10 feet wide. The ground system consists of a lead to the water pipe and an eight-wire fan buried directly under the antenna which is directive eastward.

The sending set (Fig. 4)[2] employs a United Wireless 1-k.w. open-core transformer with a 30,000 volt secondary. This transformer is well known among amateurs under the nickname of "the coffin," which its box resembles. The condenser consists of two Dubilier mica units in series Each unit has a capacity of 0.014 microfarad. The oscillation transformer is the familiar "pancake". The rotary gap is of

1. Omitted. See July 1920 QST, page 35.
2. Omitted. See August 1920 QST, page 35.

the gear type, having eight teeth, and is driven by a synchronous motor. A tone differing noticeably from that of a non-synchronous rotary is obtained.

NSF is the Naval Aircraft Radio Laboratory at the Naval Air Station, Anacostia, D. C. This station is under the direction of Commander A. Hoyt Taylor, USNRF. The transmitting set at NSF employs two electron tubes of the General Electric type P (Navy type CG916) operating in parallel. The filament and plate circuits are fed by the same motor generator set, and the total input to the tubes is about one kilowatt. The plate circuit supply is at 2000 volts direct current, the tone being produced by a motor driven chopper disc, which is placed in series with the key as a shunt to the grid condenser so that the tubes block and cease oscillating whenever either the key or the chopper opens the circuit. The circuit is the familiar one sometimes referred to as the Meissner circuit, both grid and plate circuits being untuned and coupled to the common antenna coil. The antenna is a multiple tuned one 75 feet high and 235 feet long with three down-leads, to the center one of which the sending set is coupled. At 250 meters the current in each down-lead is 2.3 amperes, thus giving a total of 6.9 amperes in the antenna.

For transmitting speech the above described set is used as a power amplifier, the grid being adjusted so that the set does not oscillate. To the grid is coupled the output circuit of a small aircraft radio telephone set. The antenna currents are nearly the same for telephone as when using the set in the ordinary manner.

8XK, the fourth testing station, operated by Mr. F. Conrad of the Westinghouse Electric and Mfg. Co., Pittsburgh, Pa., has become very well known during the past winter as one of the very few short-wave, high-power, ICW stations. The antenna system at 8XK consists of a 6-wire L antenna 120 feet long, suspended 50 feet from the ground over a similar counterpoise elevated 12 feet. A third network buried beneath the counterpoise is used as a ground.

The sending set (Fig. 5)[3] employs two transmitting tubes of a type similar to the General Electric Company's "U" type in the familiar circuit using one coil as a common antenna, plate and grid coil. The plate power is obtained from a ½-kilowatt 110-volt, 900-cycle generator from an airplane transmitter of the type employed on the NC planes. This generator is driven by a direct current motor at such a speed that the frequency is 700 cycles. A transformer steps the 110-volt supply up to 3000 volts which is applied to the plates of the tubes through a high-frequency choke coil. No chopper is necessary to secure an audible tone with this type of transmitter. The antenna current is normally about 5½ amperes. This is measured in the antenna lead.

9ZN—Station 9ZN at Chicago, operated by Mr. R. H. G. Mathews is perhaps the best known station in the network, 9ZN having operated under the present call since several years before the war and during the time doing excellent long-distance work. 9ZN is located in a vacant block on Sheridan Road within 30 feet of the sea wall of Lake Michigan. The aerial (Fig. 6)[4] hung between two steel towers is a vertical fan of 10 wires spaced 15 feet apart at the top and brought together near the station roof; all wires continue through to the antenna switch. The height of the fan is 95 feet. The grounding system consists of 28 wires 30 and 150 feet long buried inshore from the station. In addition, two 100-foot wires in the lake and a considerable number of ground rods near the station are used. The fundamental wave length of the antenna is 300 meters. For miles around 9ZN the country is some of the most level in the United States. The soil is very thin and is underlaid by many feet of sand, which is moist at all times. Two transmitting sets are used at 9ZN, one of which is a 500-cycle Telefunken set, (Fig. 7)[4] no detailed description of which is available. In the 60-cycle non-synchronous rotary gap set the transformer is a United Wireless open-core "coffin" similar to the one used at 2JU. The condenser is of plate glass in oil with about 0.008 microfarad capacity, the rotary gap a seven-point gear type driven at 3600 r.p.m. The antenna current at 9ZN is unusually high, about 8 7 amperes at 250 meters, and somewhat over 9 amperes at 425 meters. This is probably an indication of very low antenna resistance.

8ER—Station 8ER at St. Mary's, Ohio, is operated by Mr. and Mrs. Charles Candler. 8ER under its pre-war call of 8NH established a record, unequalled, I believe, by any other amateur station, of being heard in every state of the Union. The location of 8ER is unusually favorable. The country about St. Mary's is absolutely level. There are no hills for many miles in all directions. Even along the streams the land is very flat. There are no tall buildings near 8ER and only a few large trees to the east. All stations in this portion of Ohio are able to do unusually good work. The antenna is a six-wire L, 55 feet high and 65 feet long. The grounding system consists of a number of 7-foot ground rods also connected to the water

3. Omitted. See September 1920 QST, page 32.

4. Omitted. See January 1920 QST.

pipes and to a cistern. No information is available as to the antenna characteristics. The sending set is of the non-synchronous type with 60-cycle supply, Thordarson transformer, gear type rotary, and glass plate condenser in oil.

9LC—9LC at St. Louis is the only one-half kilowatt station in the system. It is operated by Mr. W. E. Woods, who has become well known in connection with his work at the Otter Cliffs receiving station of the Navy Department and his pre-war work with station 9HS at St. Louis. There are no tall buildings or trees near 9LC. There is a street car line about 200 feet from, and parallel to, the antenna but no interference has been experienced. Not much is known about the topography near 9LC. In general the country about St. Louis is flat. The antenna is a five-wire L, 55 feet high, 65 feet long, and 12 feet wide. The sending set consists of an Acme ½-kilowatt transformer, six Murdock condenser sections, of 0.0017 capacity each, connected in parallel and oil immersed to prevent brushing between leads. Either a quenched gap or a Benwood enclosed rotary is used. The Benwood rotary is a gear type gap enclosed in an air-tight aluminum case which serves not only to muffle the crash of the discharge but also provides a more favorable atmosphere for good quenching. The radiation is 4½ amperes at a decrement of 0.03. 9LC had, during the past winter, a range attained by very few one-kilowatt stations. During these tests, however, the unusually severe summer conditions of the Mississippi Valley did not give this station the opportunity to perform as well as some of the others in the system.

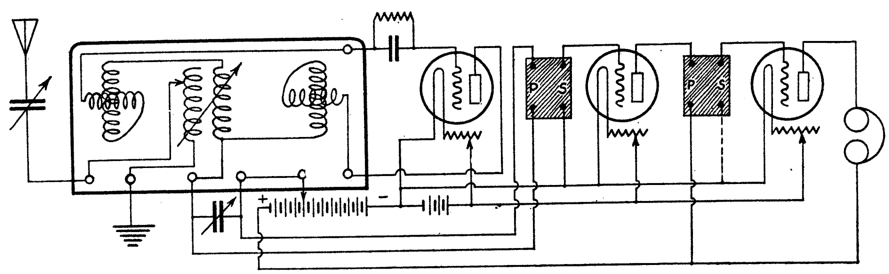

Fig. 8—Paragon receiving set circuit.

Station Description—Recorders.

With a single exception every recording station used a short wave receiving set of the type originally put on the market under the name of the Paragon receiver by the Adams-Morgan Co. The circuit of this set is shown in Fig. 8. The tuning of the primary circuit is accomplished by means of a switch on the inductance and a series condenser in the antenna lead. The secondary circuit is not tuned by means of a shunt condenser but by means of a variable inductor in series with the secondary. A great increase in sensitiveness is secured, as the ratio of inductance to capacity in the circuit is much improved over that obtained when using a shunt condenser. The plate circuit of the tube contains another variable inductor by means of which the degree of regeneration can be controlled. For spark or ICW reception the set is usually operated with the largest degree of regeneration which will not distort the spark tone. Far more regeneration can be used with low spark tones than with high. It is possible that this is the reason why a low spark rate has been found far more effective in amateur practice than the high pitches favored in commercial work. Almost without exception the recorders used a "soft" or gas tube as the detector and "hard" or high vacuum tubes for the amplifier. Minor variations of the circuit occurred, such as the provision of taps on the B battery as a means of varying the plate voltage of the detector tube.

The recorders, with few exceptions, used four or six wire L antennas about 60 feet high and 60 feet long. These were suspended by means of electrose insulators and, in most cases, copper wire, No. 12 or thereabouts, or 7 strand phosphor bronze, was used. The ground connections in most cases were to water pipes; in some cases to buried networks. A few recorders used harp antennas.

All of the transmitting operators except the one actually sending at the time acted as recorders. The stations which served as recorders only are listed below:

Additional Recorders.

1AE S. B. Young, 294 Ashmont St., Dorchester, Mass.
1AK H. C. Bowen, 168 Belmont St., Fall River, Mass.
1BG G. Faxon Shorey, Melrose, Mass.
1CK P. F. Robinson, 149 Hollis Ave., Braintree, Mass.
1CM H. B. McLane, 342 Union Ave., Laconia, N. H.
1DG Stuart Briggs, 94 Walnut Place, Brookline, Mass.

1EK Robert D. Huston, 19 Nevens St., Portland, Maine.
1FB Lawrence C. Cumming, Prout's Neck, Maine.
1HAA Irving Vermilya, Marion, Mass.
1NAQ J. C. Randall, 23 Harrison St., Hartford, Conn.
1SN Wm. E. A. Dodge, Beverly, Mass.
1TS Donald H. Mix, 40 Stearns St., Bristol, Conn.
1YB F. L. Southworth, Sec., Dartmouth College Radio Assn., Hanover, N. H.
2BG A. J. Lorimer, 243 Mackay St., Montreal, Quebec.

A. R. R. L. FADING REPORT

Receiving station call______ Location________________ Date________

Time observations begin_________ General reception this date________

____

______________________________ General character of strays

("static") this date____

____________ Transmitting station call_______ Wave length _____m.

Weather, wind direction, and strength, indicated by check mark below.

Weather:		Wind Direction:		Wind Strength:	
	Clear		N		Calm
	Cloudy		NE		Light
	Rain		E		Medium
	Snow		SE		Strong
	Sleet		S		Storm
	Fog		SW		
	Lightning		W		
			NW		

SIGNAL STRENGTH RECORD. Indicate average strength for each letter by a check mark (✓) in the proper square below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
Very strong 9																											9
Strong 8																											8
Good 7																											7
Fair 6																											6
Rather faint 5																											5
Faint 4																											4
Just readable 3																											3
Very faint, unreadable 2																											2
Just audible 1																											1
Nothing 0																											0
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	

Fig. 9

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Receiving Operator

2BK C. E. Trube, 6 Livingston Ave., Yonkers, N. Y.
2FG F. H. Myers, 45 Albany Trust Bldg., Albany, N. Y.
2JE J. L. Eddy, Jr., 19 Washington St., New Rochelle, N. Y.
2OE S. L. Raynor, College Court, Freeport, N. Y.
2TT A. Rechert, 181 Waverly Place, New York City.
2YM YMCA Radio Club, 153 E. 86th St., New York City.
2ZM L. M. Spangenberg, 25 South Fourth Lake View, N. J.
3BZ W. T. Gravely, Danville, Va.
3EN T. C. White, Jr., 303 Riverview Ave., Norfolk, Va.
3JR H. A. Snow, 1656 Newton St, NW., Washington, D. C.
3NB Marcus Frye, Jr., Box 187, Vineland, N. J.
3SU A. B. Chism, 3729 M St., N.W., Washington, D. C.
3UA E. B. Duvall, 4004 Park Heights Ave., Baltimore, Md.
3ZA C. A. Service, Jr., Bala, Pa.
3ZS C. H. Stewart, St. Davids, Pa.
4AT O. A. Gulledge, Ft. Pierce, Fla.
5DA W. C. Hutcheson, Wind Rock, Tenn.
8AAN A. H. Benzee, Jr., 207 Sumner Pl., Buffalo, N. Y.
8ABI Harrison Daniels, 424 W. First St, Dayton, Ohio.
8BQ H. M. Walleze, 234 Vine St., Milton, Pa.
8CE R. C. Ehrhardt, 117 South Blakely, Dunmore, Pa.
8DA A. J. Manning, 252 McKinley Ave., Salem, Ohio.
8ER Mr. and Mrs. Charles Candler, St. Marys, Ohio.
8IB R. C. Higgy, 50 E. 18th Ave., Columbus, Ohio.
8WY Lord Bros., 531 Beach Ave., Cambridge Springs, Pa.
8XU Sibley College, Cornell University, Ithaca, N. Y.
8ZW J. C. Stroebel, Jr., Wheeling, W. Va.
9DT C. W. Patch, Villa St., Dubuque, Iowa.
9ET W. L. Tomson, 1163 North Broad St., Galesburg, Ill.
9NQ J. H. Burke, Galesburg, Ill.
9ZC J. A. Gjelhaug, P. O. Box 154, Baudette, Minn.
9ZJ F. F. Hamilton, North Alabama St., Indianapolis, Ind.
9ZL H. J. Burhop, Naval Radio Station, Manitowoc, Wisc.
WWV S. Kruse, Radio Laboratory, Bureau of Standards, Washington.
NSF L. C. Young, Radio Laboratory, Naval Air Station, Anacostia, D. C.

Operation

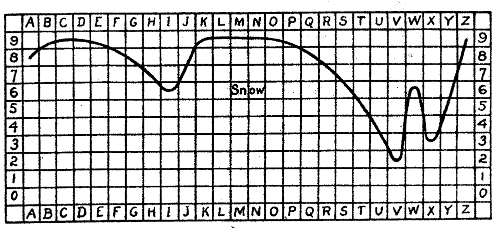
The network performed excellently throughout. After the first two days in which the usual delays occurred, no sending station failed to transmit its test schedule excepting on a very few occasions when the cause of the failure was beyond the control of the operator. The average distance of transmission was 400 miles. When it is considered that no station in the system used an input of over one kilowatt, that communication was at 250 meters where static is usually at its worst, and that the season was the most unfavorable for radio work, it would seem that only very meager results could be expected. Actually, however, an average of 26 recorders stood watch every evening and on no occasion were less than 20 on duty. This performance did not decrease during the period of the tests, the operators having the necessary interest to spend night after night at their instruments struggling with the uproar due to atmospherics. More than half of the schedules listened for were copied in the form of 1260 curves sufficiently good to be used in the final analysis.

The tests were all made at a wave length of 250 meters, under permits issued by the Radio Inspection Service, Department of Commerce. These permits were not necessary for the special amateur stations 9ZN and 8XK nor for the Naval Station NSF. The method of recording the variations of signal intensity is shown in Fig. 9. The test schedule consisted of the alphabet, each letter sent five times at a speed equal to eighteen words per minute, so that the alphabet required about three minutes for transmission. As each letter was received the operator indicated on this chart the intensity at which it was heard, so that when the schedule was complete a curve had been secured showing the swinging during the three-minute period. The intensity scale used may not seem especially satisfactory but its use was unavoidable since an audibility meter cannot be used satisfactorily with a regenerative receiving set, and as a matter of fact, the performance of the method is very good under severe tests. A laboratory test of the method can be seen in Fig. 10. Buzzer transmission of the actual schedule was sent through the primary of an ordinary coupler to the secondary of which two headsets were connected in series. The operators independently recorded the intensity of signals which was varied during transmission by altering the coupling. It will be seen that the curves are alike excepting as to the judgment of the average strength of the signals, so that one curve lies higher on the chart than the other. Many such tests were made, and in no case were the results less satisfactory than those shown on this chart. A test of the method under actual operating conditions is shown in Fig. 11, where Mr. K. B. Warner and H. P. Maxim, at 1AW, Hartford, Conn., recorded the signals from 2JU at Woodhaven, Long Island, simultaneously. The curves do not represent variations in received power since a receiving set operating near the critical point at which it begins to regenerate has something of the characteristics of a generating set and amplifies weak signals more than strong ones.

Method of Testing

The method of running an actual test was as follows: At 10 p.m., eastern standard time, all the sending stations listened for time from Arlington. At 10:10 the first station, 1AW, at Hartford, Conn., (Fig. 1) made a long QST call, saying repeatedly "Bureau of Standards—A.R.R.L. Fading Test." Both the call and the notice were repeated, then the station started to send the test schedule, repeating each letter five times as has been mentioned. All recorders able to hear 1AW tuned in during the QST, and thereafter left all adjustments alone and recorded signal intensity. After the schedule 1AW signed off.

Three tests were made each week, on Tuesday, Thursday and Saturday evenings, the transmission by 1AW coming at 10:10 p.m. eastern standard time, 2JU at 10:20, NSF at 10:30, 8XK at 10:40, 9ZN at 10:50, 9LC at 11:00. After being added to the list of senders, 8ER also transmitted at 11:00. The ranges are sufficiently small in the Mississippi Valley during the summer time so that no interference occurred between 8ER and 9LC.



Laboratory Test of Recording Method

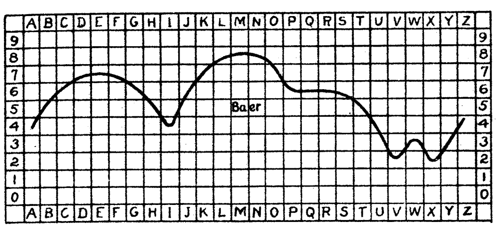
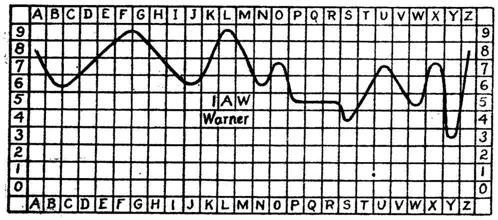


Fig. 10

On every test night each recorder who was on watch filled out one curve sheet (Fig. 9) for each sender that he could hear. At the close of the week he sent in all the sheets made during that week. The original intention to record atmospherics, by means of the various symbols shown, was abandoned as no recorder was able to note signal and static strength simultaneously. Weather conditions are shown roughly by checking the proper words at the lower left corner of the sheet. Recorders were asked to indicate on the lines above the chart, the swinging at various waves, general reception conditions on various waves, and any special conditions. Most of them did this very well and also used this space for indicating general static conditions during the evening. The exact method of recording varied, as it was modified during the tests by reason of improvements suggested by the observers. At first our impression was that the swinging would be very slow, hence the intention was to use a check mark for each group of five letters. This was not adequate as the swinging was often more rapid than could be so shown. Several observers suggested a different observation form in which one column was allowed for each letter, that is to say, five times as many columns as in the present form. This would have been good but clumsy; even the present form is exceedingly unhandy when large numbers must be analyzed. Another suggestion was that a continuous curve be drawn by moving the pencil slowly as the signals come in. This sounds well, but in practice is subject to violent errors when long slow fading takes place, as the temptation to keep the pencil moving in the same direction is irresistible when the curve has continued in the same direction for, say, 20 seconds. The result of this tendency, which appeared both in the field and in laboratory tests, is that slow swings are exaggerated, turns in the curve



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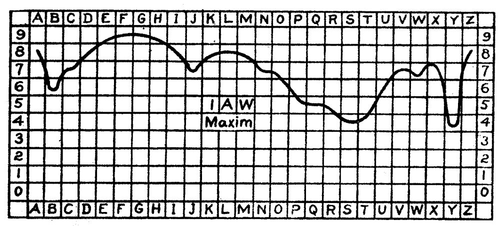

Fig. 11—Two operators receiving at same station.

appear too late, and small variations are omitted. Mr. L. C. Young of NSF suggested the method which proved best in practice, that of using dots for each letter and drawing in the curve later. In this way, attention is paid to each letter, and the tendency for the pencil to acquire a "drift" is checked.

(Part II, to be presented in the December QST, will describe the results of these tests, illustrated with curves of various classes of fading.)