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LONG-DISTANCE RECEIVING MEASUREMENTS OF BROADCAST WAVES ACROSS THE PACIFIC.

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(Received December 17, 1931.)

Summary.—The present paper describes the results of field intensity measurements conducted in Japan with broadcasting stations on the Pacific Coast, particularly with those of the United States. It is stated that KNX has been most strongly heard. Intensity curves showing severe long fadings and seasonal variation of average intensity are presented. Some discussions are given of the correlation of the intensity with solar activity and of the transmission characteristic being deteriorated during the last few years.

Introduction.

It has been vaguely known that the broadcast waves in a frequency band of from 3000 kc to 600 kc, are the worst ones in adoptability to the long-distance communication. Yet the actual propagation data of these medium waves are very little known. Pickard's[1)] observations on WBBM made at Boston may probably be only the reports available. On the other hand, as the band in wave spectrum stands between low and high frequency waves, experimental knowledge of these medium waves is considered to be of extreme importance in the researches of wave propagation.

From this point of view, the receiving measurements of various broadcasting stations at home and abroad have been conducted at this laboratory since the autumn of 1929 and some principal results thus obtained for the long-distance propagation are briefly given.

Measuring Apparatus.

The receiving equipment is composed of a vertical aerial of 60 meters in height, a superheterodyne receiver, a local oscillator for calibration and an attenuator. The main parts of the equipment are as shown in Fig. 1.

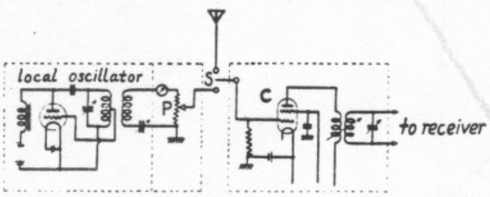

Fig. 1.

The switch S is first connected to the aerial side and the anode current of the second detector is read, and then S is turned to the local oscillator side and the attenuator P is adjusted so that the output of the local oscillator may give an equal magnitude of the detector current as in the previous case. The field strength of incoming waves may thus be measured in μ V/m. The attenuator is of the resistance-wire ladder type, in which BS #40 manganin wire is used. The current flowing into the attenuator is measured by a thermo-junction and a galvanometer, the total e. m. f. impressed between the grid and the filament of the coupler C of the receiver being thus known. The lowest field strength measurable with the equipment is about 1μ V/m.

Results of Measurements.

Long-distance receiving measurements have been conducted on various foreign broadcasting stations, especially on those of the United States, Australia and New Zealand. Among them the following three American stations were observed every day at the time between 1500 and 1800, J. C. S. T.

Station	Frequency	Power	Meterampere
KNX	1050 kc	4900 W	1050
KGO	790	3320	794
KEX	1180	5000	900

(Figures in the table have been reported by the respective station director.)

Though good reception is expected from these medium wave stations in America when night covers the entire path between transmitter and receiver, it is regrettable that the broadcast program comes usually at an end at the beginning of the time of good reception here due to the difference of local times. Most of American stations on the Pacific Coast shut down their transmitters at about 1800, J. C. S. T. (0100, P. S. T.).

Practically, the procedure of the field-strength measurement as described above is somewhat troublesome owing to the small receiving energy of incoming waves accompanied by severe fadings and atmospherics; therefore, we have usually adopted a simple recording scale as explained below:—

R 1......Very weak; arrival of the wave is just recognizable as a beat when the wave is caught.
R 2......Broadcast may be just distinguished from noise.
R 3......Broadcast program may be recognized.
R 4......Broadcast and noise are approximately on an equal level.
R 5......Broadcast is a little stronger than noise.
R 6......Broadcast is moderately strong.
R 7......Broadcast is strong enough to be almost free from noise.
R 8......Broadcast is sufficiently strong and entirely undisturbed by noise.

The field intensity of the American stations observed was generally of an order of 1-10μ V/m (R 2-6) and on days of good reception it reached the highest level of about 20-25μ V/m (R 8). In Figs. 2 and 3 are given examples of the observations made on KNX, receptions under good and bad conditions being respectively shown. Fadings were, as seen in Fig. 4, of a long duration and so severe in nature that, when once the field intensity faded out, the broadcast could not entirely be heard within a few minutes; then the field intensity recovered its original high level, and again the broadcast was able to be heard, this enjoyable state lasting for a few minutes. The trouble caused by fadings was, however, much less on a day when reception was very good.

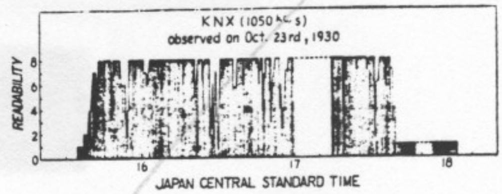

Fig. 2.

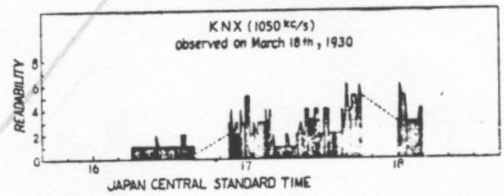

Fig. 3.

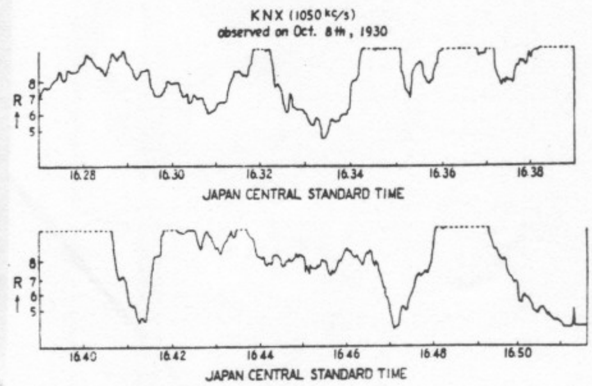

Fig. 4.

On account of such severe fadings, an attempt was made to estimate average readability during an interval of one hour ... in order to know the general condition on reception of the day. From the data thus estimated, an interesting seasonal-variation curve was obtained as shown in Fig. 5. It gives that the reception is worst in summer as is expected, while the best reception is made in autumn, but not in winter.

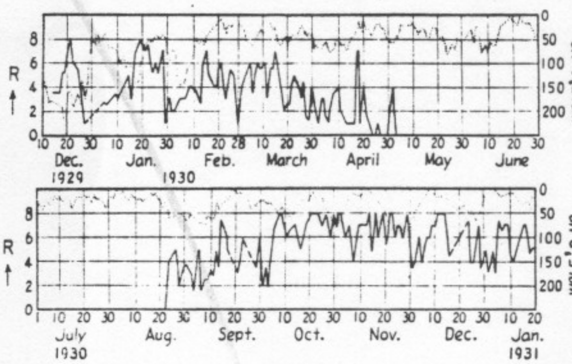

Fig. 5.

The receptions of the other two American stations, KEX and KGO, gave similar characteristics, but the intensities were generally smaller. On comparing, in general, the American broadcasting stations observed, KNX was the strongest, KEX and KGO were the next, and the others were still weaker. The reception of the Australian stations were not so strong as expected, even when tests were made under favourable dark conditions, and though the differences between the local times of Australia, New Zealand and Japan are very small. The field intensity of 20μ V/m was obtained

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with KNX under a condition which was not so good, while 12-15μV/m was obtained at the best condition with 3LO in Melbourne which is a similar 5 kW station.

European stations have generally been heard much weaker in strength at this laboratory, although many high-power stations are reported to exist there. The reason may probably be attributed to bad conductivity of the land intervening over which the transmission takes place.

Some Considerations on the Results.

Although a period of one year, during which the observations were carried out, may be rather too short to give decisive conclusions with respect to the solar relations, some remarks on the results so far obtained will here be given.

It may safely be said that the field intensities of medium waves at long distances have decidedly been weakened during the past few years. The degree of deterioration may be understood from an example described below. We have some data of the receiving measurements made on KGO at about 1400 J.C.S.T., of the summer in 1924, when the broadcast from KGO (λ=312 m, Power=1 kW at that time) was heard every day at a loud speaker intensity.

The receiving condition is, in general, considered to be appreciably bad at such a time of a day in summer, as the absorbing action of the transmission medium is so great. However, the wave intensity was, at the experience mentioned above, so strong that the broadcast could be heard loudly notwithstanding great absorption, and heavy static which always prevails in summer seasons. Unfortunately no data measured in μV/m are available, but it is supposed that the field intensity of 30μV/m might have probably been obtained. It is also regrettable that no data in the autumn and winter seasons are available, as the observations were not continued after the summer of 1924.

On the contrary, the broadcast from KGO and other numerous stations could not entirely been heard throughout the summer of 1930 during which the measurements were carried out. No response was given even at a time when the entire path was almost covered with darkness, as shown in Fig. 5. Accordingly it seems that the transmission was much better in several years ago than in recent few years.

The reason may be attributed to the change of solar conditions. In 1924, the number of sunspots was observed to be small, and accordingly the magnetic disturbances were scarcely experienced, whereas, in 1929 and 1930, numerous magnetic disturbances were recorded. Similar results are given by Pickard[2] and Stetson[3] as to the correlation of broadcast waves with solar activity.

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