High-fidelity broadcast transmitter performance

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In connection with the present interest in high-fidelity, it is worth while to review what is now possible from the standpoint of transmitters, not implying that the majority, or even a small per cent, of stations on the air are capable of such performance.

Mr. Laporte is an engineer with wide experience in the design and construction of broadcast transmitters. He installed the Milan, Italy, station, and one of the best known high-quality transmitters in New Jersey was erected under his supervision.

AUDIO RESPONSE—The first matter of interest in high-fidelity transmission is audio response. In modern designs, practically uniform response between 30 and 10,000 cycles has actually been achieved. Three sample audio response curves are shown in Fig. 1 made on stations in daily operation which were installed and tested by the author. The curves shown are for the station characteristic, that is, from the input of the line-terminating equipment to the antenna.

Latest designs of studio speech input apparatus are usually like the lower curve of Fig. 1. Latest designs of microphones have characteristics about like this also.

AUDIO DISTORTION—Waveform distortion in the transmitting equipment is being constantly reduced. Specifications of the FRC call for less than 10 per cent combined audio harmonics. Some of the most advanced designs of transmitting apparatus have much less than this figure. One of the most recent highpower transmitters gave the characteristic shown in Fig. 2. At the very low and the very high modulation frequencies, distortion is usually much greater than for the middle audio range. While distortion of the higher

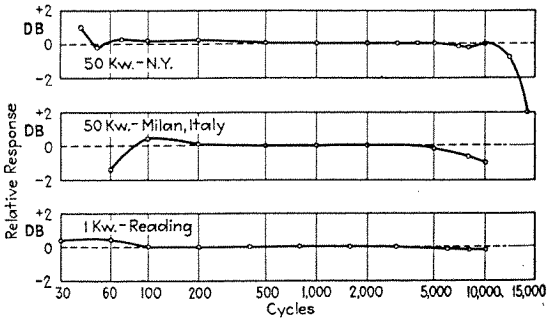

Fig. 1—Over-all characteristics of modern transmitters

frequencies is of small importance aurally, it becomes very important from the standpoint of cross-talk, and also interchannel interference.

PERCENTAGE MODULATION—Full 100 per cent modulation has been an everyday reality now for three or four years, though much of the apparatus claiming this feature produces considerable distortion at high modulation percentage. Recent important advancements have been made in maximum modulation without excessive distortion, as Fig. 2 shows. The most important improvements lately accomplished in low distortion high-percentage modulation has been at the low frequency end. Plate modulation using Class B modulators seems to be superior to Class B radio frequency systems in low-distortion, high-frequency modulation, especially at the lower frequencies.

SYLLABIC MODULATION—Until recently very little attention has been paid to the syllabic modulation characteristics of transmitting apparatus. Transmitter performance has always been demonstrated

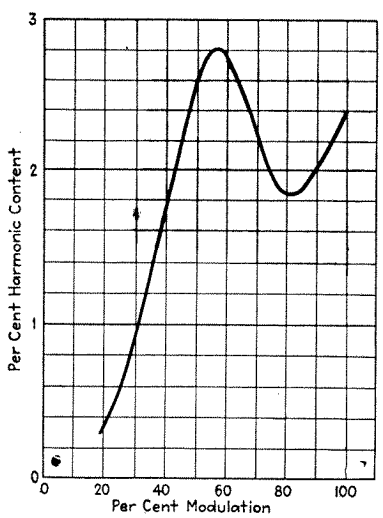

Fig. 2—Arithmetic sum of all harmonics (2nd to 12th) at 200 cycles

under steady-state modulation conditions. Telephonic modulation, however, is not in any sense a steady-state phenomenon, in that it is introduced in "chunks" or syllables, the components of which are continuously changing in frequency, amplitude and waveform. For

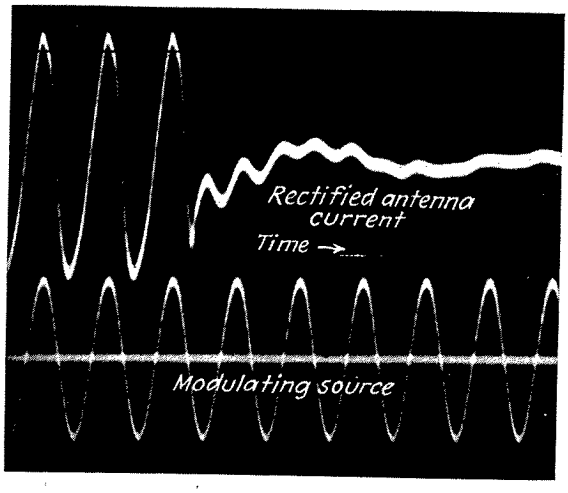

Fig. 3a—Transient occurring with sudden removal of modulation

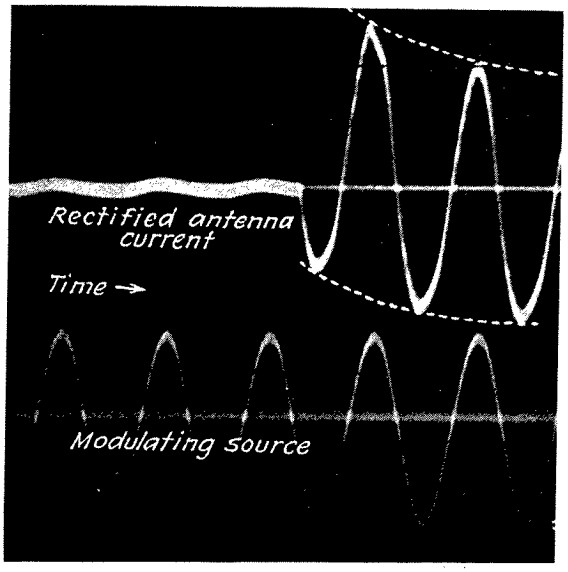

Fig. 3b—Transient on start of modulation

high-fidelity transmission it is necessary to have a transmitter characteristic such that it is essentially free from transients resulting from the sudden introduction or removal of modulation, or from transients which result from sudden changes in amplitude or frequency. The presence of transients, especially oscillatory transients, under these conditions produces serious distortion. Figure 3-a and 3-b show the presence of such transients at the removal and the introduction of modulation, respectively. Those shown resulted from switching the modulation source, a tone oscillator, and are not very bad as transmitters go. Figure 4 shows the result of improvements in the same transmitter, where the starting transient is nearly eliminated.

Syllabic modulation transients are due to low power factor in various parts of the audio amplifier chain. The presence of large amounts of leakage reactance, especially in interstage couplings, is detrimental to good modulation in this respect. Elimination of these transients is obtained when all power-transfer elements are made to have pure-resistance characteristics.

A form of syllabic modulation transient is introduced when a transmitter is operated in such a manner as to cause to varying power demand upon the plate supply. With such variation, filter transients result unless special attention is directed to a highly stable design of filter. Grid bias circuit regulation also plays an important part in connection with syllabic modulation.

STABILITY—This factor usually refers to the complete absence of parasitic oscillations in a piece of equipment. Instability in audio amplifiers produces howling or motor-boating. Instability in a transmitter may produce many interesting but troublesome effects. Parasitics may be of very high frequency, of a frequency nearly that of normal operation, or be of very low (sometimes audio) frequency. Many a transmitter is stable on carrier but unstable during various portions of a modulation cycle. If a power-amplifier breaks into a 50-kc. parasitic oscillation on peaks of modulation (not an uncommon occurrence), the 50-kc. sidebands thus generated are splashed over the five adjacent channels on each side of the assigned channel and produce a serious form of interchannel interference.

Factory-made transmitters today are completely stable before they are turned over to service by responsible factory engineers. Probably as much study and experience has been required to attain transmitter stability as any other transmitter characteristic. Complete stability is essential to high-fidelity transmission, both from the standpoint of the station's own transmissions, and its interference with the transmissions of other stations on adjacent or other channels.

RIPPLE—Commercial transmitting equipment now is generally capable of holding carrier ripple at least 50 db below 100 per cent modulation level. On a recent ultra-high power station it is rumored in engineering circles that ripple is 70 db down. Such a low level of transmitter noise theoretically permits a useful program range of at least 50 db, which should allow better symphonic rendering by reducing program compression.

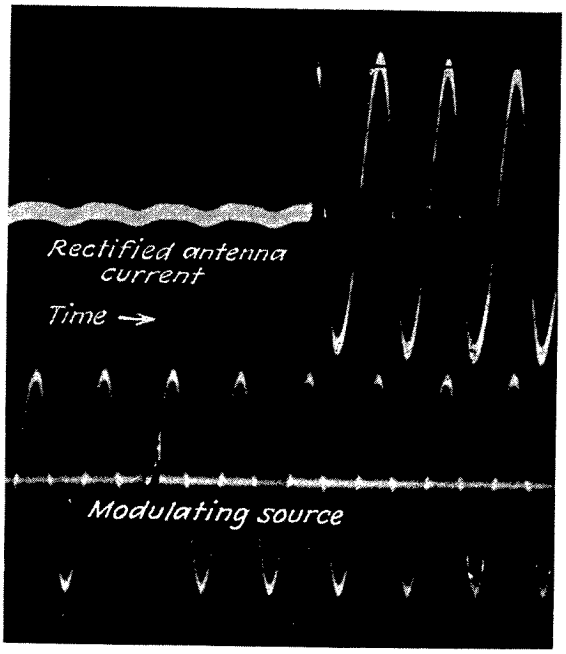

Fig. 4—Result of improving transmitter to eliminate transients