in these proofs. Such changes are always expensive and wasteful, but in technical publications, the addition of new material or changes should be particularly avoided, especially if there is possibility that the article may have important patent significance.

In correcting galley proofs, the more common standard proofreaders' marks, given here, will be found useful. Corrections should be indicated on the edge or border of the galley; they should not be written in the text itself.

He who passes judgment on himself will not be judged by others. If this admonition is observed in the preparation of technical articles, it may be safely assumed that the fate of the manuscript will be a happy one.

Copper-Oxide Rectifiers in Standard Broadcast Transmitters*

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Summary—*Improvements in the processing of copper used in copper-oxide rectifiers make practical the use of this type of rectifier in modern broadcast transmitters. Features are reliability, long life, and ability to withstand surges.*

THE dry-type metal rectifier most commonly known as copper oxide or Rectox is, from an operating standpoint, one of the simplest pieces of apparatus for converting alternating into direct current. It is not only a very simple design, but also easy to operate; usually with outstanding reliability. Many attempts have been made in the past to develop this type of converter into an acceptable form for converting larger blocks of power, and to put the larger types on a more competitive basis with other kinds of converters.

Recently these attempts have been successful, and by giving proper attention to all factors entering into the design of this rectifier, its field has been enlarged to include many applications formerly using hot-cathode vapor tubes. This has been particularly true of recent commercial broadcast transmitters.

Because the construction of the Rectox metal rectifier is so very simple, not many ways have been found to increase its efficiency and output. Each rectifier element consists essentially of a copper disk with a surface layer of cuprous oxide (produced by oxidizing the surface of the disk) and of a second electrode that is in contact with the layer of cuprous oxide. The stack-type rectifier unit as now made consists of a number of such elements which, separated from one another by spacers and special cooling fins, are stacked on bolts and held together by end plates.

The most important material used in the manufacture of this rectifier is the copper. A thorough investigation of the properties of copper and the unavoidable impurities which it contains has revealed that, in general, copper from which certain impurities have been removed as completely as possible to be the most appropriate grade of copper for the manufacture of these rectifiers. Of great influence on the performance of the rectifiers is also the manner in which, beginning in the copper mill and ending in the annealing furnace, the metal is worked and treated.

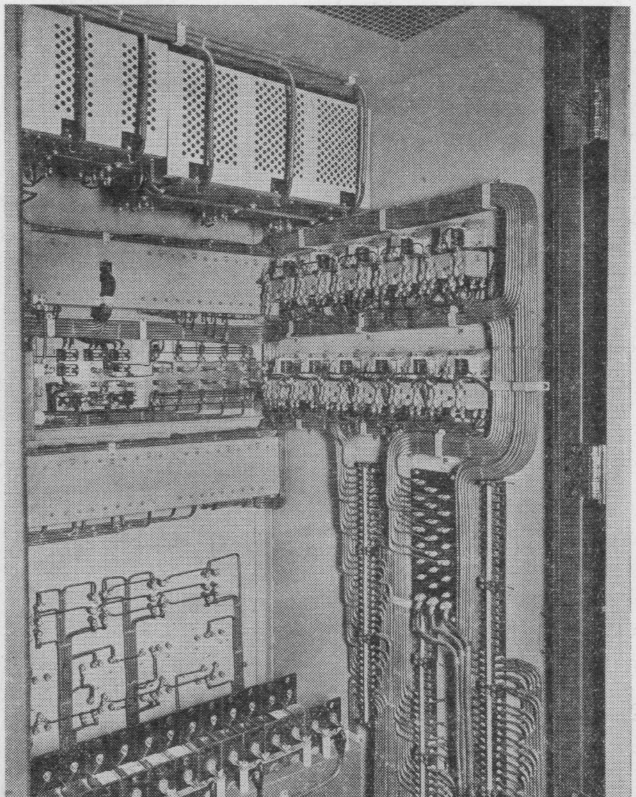

Fig. 1—Rear view of distribution cubicle for 50-kilowatt broadcast transmitter showing at bottom force-draft-cooled 3-phase full-wave 1250-volt, 0.7-ampere and 3-phase full-wave 3000-volt, 1.4-ampere rectifier for plate supplies.

By special annealing treatments, by careful choice of the copper, and by special production tests such rectifiers can be produced with great constancy, long life, and high efficiency. Further improvements in weight and size, as well as cost, have been made by forced-

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draft cooling which in some instances increased the output allowable more than ten times that obtainable with natural cooling.

The new forced-draft Rectox is well suited to application in broadcast transmitting apparatus. Outstanding advantages are its long life and reliability. No maintenance should be required. Even if a failure should occur, the plug-in construction permits replacement about as quickly as a tube. Its operation is instantaneous, that is, it is completely without time lag or any initial transient forming a build-up period. Hence the need for any time-delay device is eliminated, thus simplifying the control circuits.

In a standard line of 5-, 10-, and 50-kilowatt transmitters, all rectifiers except the main plate rectifiers are of this type having ratings from a few hundred volts and a quarter ampere up to 3000 volts and 1.4 amperes. Some of these units have been in operation over 15,000 hours. Nearly all of these units are forced-draft-cooled and are supplied air from the main cooling system used to cool the large radio tubes.

The Half-Wave Voltage-Doubling Rectifier Circuit*

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Summary—*An analysis of the half-wave voltage-doubling rectifier circuit is made with the main assumption that the tube drop is zero while conducting. The performance characteristics of the circuit as predicted by the analysis are presented together with experimental verifications of several of these characteristics. Operating conditions for which polarized electrolytic condensers may be used and the currents to be expected on short circuit are discussed. The performance characteristics calculated from the analysis are presented as curves suitable for use in the prediction of the performance of an assembled circuit, and in the design of this doubler to meet specified operating conditions. A comparison is made of the performance characteristics of the half-wave and full-wave voltage doublers.*

Introduction

THE half-wave voltage doubler is being found useful as a power supply and as a component of high-voltage supplies. This circuit has several advantages over others employing input transformers. It offers economy in cost, size, and weight and hence is used in transformerless receivers. For use in radio-receiver power supplies, it has the important advantage of having a common input and output terminal.

Although no analysis of this half-wave doubler seems to have been made, several references to its operation and applications may be found.[1,2] Greinacher[3] seems to have made the first use of this circuit, employing it as the basic element of his voltage-multiplication circuit.

The results presented in this present paper on the half-wave doubler were obtained by a method of analysis similar to those employed in two previous analyses of the full-wave doubler.[4,5] The purposes of this paper are to present the results of the analysis by means of curves suitable for use in design, to compare some of the theoretical results with experimental results, and to compare the operating characteristics of the half-wave doubler with those of the full-wave doubler.

Analysis

The circuit diagram of the half-wave voltage doubler is shown in Fig. 1, and the current and voltage waveforms are shown in Fig. 2 for a complete cycle of the impressed alternating voltage e. Tube T_1 starts to conduct at $\omega t=\alpha$ and stops at $\omega t=\beta$, where $\omega/2\pi$ is the supply frequency and t is the time in seconds. Tube T_2 starts to conduct at $\omega t=\delta$ and stops at

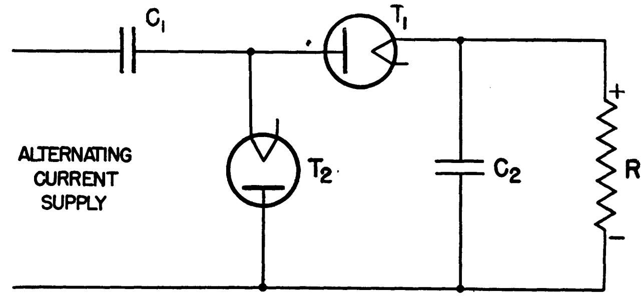

Fig. 1—Circuit diagram of the half-wave voltage-doubling rectifier.

$\omega t=-90$ degrees. Condenser C_1 is charged to approximately the peak value of the alternating voltage while tube T_2 is conducting and is discharged during the rest of the cycle. The voltage of C_1 is e_c and is shown in Fig. 2. The load voltage and also the voltage on C_2 have exactly the same shape as the load current i_L flowing through the load resistance R. The tube currents i_1 and i_2 have been reduced to one fifth of their size for convenience.

To simplify the analysis, the following assumptions are made: (1) the applied alternating voltage is sinusoidal, and the source has no impedance; (2) when conducting the tube drop is zero, and when not conducting the tube resistance is infinite; (3) the condensers have zero power factor and are both the same size;

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