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B Progress Report on the Design and Construction of Side  
Tone Delay Apparatus on Subcontract under Contract

The first apparatus built was designed on the principle of a constant tape speed of about 40" per second with a variable distance between the recording and playback heads. The recording head was fixed in position and the playback head was movable on a track which was designed to preserve the alignment. The tape in the form of an endless loop was carried over two light low inertia pulleys, one of which was fixed and the other having a spring mounting which maintained a constant tension on the tape. The sound quality was fair. The loop of tape of overall length about 2 feet appeared to give adequate results for periods up to one-half hour. The overall quality, however, was not by any means equal to the Magnecord equipment. Although lower quality amplifiers (Pentron) were used in this work, the main difference in quality was noise inherent in the tape and head system used.

Consequently, a variable speed constant head separation device was designed and built. The heads were fixed in position at the minimum distance (1"). The endless loop of tape was driven by a variable speed DC motor, using a 6 volt storage battery. Since an overall speed range of at least 10-1 was desired with good torque over the range, the use of a resistance in the field was found to be inadequate. The desired conditions were made by varying the armature resistance and the field resistance simultaneously, but in opposite directions. This was accomplished by a modified potentiometer, fixed resistance combination between the field and the armature. In this way, a 25-1 speed range was obtained with good torque.

The range of delay with this equipment was from about 0.02 to 0.4 seconds. The noise level of the machine was fairly high, apparently due to inadequate alignment and tracking of the tape.

It became apparent that construction of a higher order of accuracy was necessary. It was decided to modify the Magnecord recording unit by keeping a fixed relationship between the heads and a constant tape speed by including means for varying the length of tape between the fixed record and playback heads. This can be done by an arrangement of small pulleys, the middle one of which can be varied in distance from the heads. In using this method, the amount of tape between the heads is twice the separation of the middle roller from the heads. When this apparatus was constructed and tested, it was found that the introduction of the auxiliary equipment

in the neighborhood of the heads upset the shielding system and resulted in the introduction of a fair amount of noise. Consequently the position of the heads was modified to the extent that they were turned at 180° so that the gaps faced each other and were about 1/4" apart. A shield was inserted between the heads and a small pulley mounted on a shaft running in micro ball bearings was used to position the tape. The separation of this pulley from the heads was controlled by a dial operating a carriage. The dial was calibrated directly in delay in seconds. This device was extensively tested in the laboratory and found to give, with 15" per second tape speed, delay which could be varied between 0.07 seconds and 0.5 seconds with overall sound quality approximately equal to that of the original Magnecord unit. The apparatus was tested by means of a steady thousand cycle input from an audio frequency oscillator. The sound from the playback head was examined and found to be of adequate quality from the standpoint of wow, flutter and noise.

**B** This machine was installed in the laboratories of \_\_\_\_\_ and tested extensively with actual subjects. The quality of reproduction steadily and rapidly deteriorated and after several days use became completely inadequate. Examination disclosed the fact that the mechanical ruggedness of the equipment was inadequate for the conditions of use.

A small drive pulley was constructed for use to the standard Magnecord equipment which would permit a delay of 0.3 seconds with the 7-1/2" per second tape speed for use with the subjects while a new apparatus was constructed.

It was decided that the difficulties encountered in previous designs could best be avoided by using a variable tape speed with the standard erase, record and playback head assembly of the Magnecord unit. The standard Magnecord motor which is synchronous will be used to drive a disc at variable distances from the axis. Thus a drive free from wow should be realizable and with a 1-10 speed range a tape speed of 3" to 30" per second will be obtainable which will give a side tone delay from 0.05 to 0.5 seconds.

The Magnecord recording unit has been completely dismantled and is being rebuilt with these modifications. The standard Magnecord endless loop tape device will be used. It holds up to 600 feet of tape which means that the tape will have a long life. This design, of course, suffers from the disadvantage that a permanent record of the test of the subject is not obtained, but it is felt that the advantages will compensate for the necessity of using auxiliary recording equipment. The motor drive is presently being assembled. Difficulties have been encountered because of the necessity that the driven disc be free floating. Completion of the unit within two weeks is contemplated.