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## THE REPRODUCTION OF CYLINDER RECORDINGS AT THE LIBRARY OF CONGRESS

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The reproduction of cylinder recordings has been a continuing challenge to the Library of Congress since the Recording Laboratory was first installed in 1941 through a grant from the Carnegie Corporation of New York. In that year 200 cylinders collected by Percy Grainger, containing valuable examples of Maori, Raratongan, English, and Danish folk music, originally recorded between 1904 and 1927, were transferred to instantaneous discs. Instantaneous discs, usually made of nitro-cellulose, are those that can be played back immediately after manufacture, in contrast to metal masters, which require processing and the production of shellac or plastic copies before playback is possible. Since 1941 the Laboratory has duplicated about 5000 cylinders onto disc or tape. Outstanding among these have been the Frances Densmore North American Indian collection of some 2500 cylinders, transferred to the Archive of Folk Song from the Smithsonian Institution in 1948, and the somewhat smaller but equally important collections from such sources as the Royal Library at Copenhagen and the Erich von Hornbostel collection at the University of Berlin.

Since its inception, the Recording Laboratory has been equipped with the standard recording instruments of the day. During World War II the record lathe, the wire recorder, and the film recorder were the principal instruments. In 1950 the tape recorder became the workhorse of the industry, primarily because of the ease in editing and assembly. At present the Recording Laboratory is equipped with two Ampex 300 tape recorders, two Sculley record lathes, two professional turntables, one variable speed turntable, one cylinder reproducer, and four relay-racks of associated equipment.

When cylinders are selected for transcription,

they are in various degrees of degradation of deterioration, ranging from simple grit and dirt to actual breakage. They are carefully inspected, and all foreign matter is separated from the surface through a series of baths, and brushing with three-inch camel's hair brushes cut to a length of one inch. Cutting the brushes gives the camel's hair an increased stiffness, but not enough to impair the cylinders' vertical modulation; that is, the brush is not so stiff as to disturb the cut grooves in any manner which would impair the quality of reproduction. We also use film-cleaning felt for hard-to-remove stains or other adhering matter. By far the most troublesome to remove is mold that has actually grown on the surface of the cylinder. We can remove the visible effects, but permanent scars are left in the surface. These increase surface noise of the cylinder and degrade the whole performance. On particularly important wax cylinders we have repaired broken pieces successfully by cementing them, then sealing the crack by heat applied to jewelers' tools, and carefully reconstructing a path for the stylus. All of this is done under a microscope. The heat is slight and the work tedious, but the results are surprising.

The baths we use are equally simple: one-quarter cup of a liquid household detergent to one gallon of tepid, distilled water. If the cylinders had previously been packed in newspaper or the like, a few minutes' soaking will remove pieces adhering to the surface. If cotton has been used and has hardened, a longer soaking is required. Grease can be removed with carbon tetrachloride, but this agent should be tried first on an ungrooved end to make sure it will not affect the base material. Alcohol in its denatured form has been used on some plastic

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## REPRODUCTION OF CYLINDERS (cont.)

cylinders with good results. This should also be tested before wholesale cleaning. It must be remembered that even in the early 1900's manufacturers were changing the wax base material and later the plastic formulations.

The cylinder reproducer itself has undergone many transformations, both in pick-up and in drive units. The first pick-up was developed for us by a commercial concern and used the photo-electric principle. This worked for a time with the coarse-grooved cylinders, but it had a very fine azimuth adjustment, which was too critical and unreliable: it was extremely difficult to adjust the light reflected upon the photo cell so that its maximum, median, or minimum intensity corresponded with similar modulations of the hill and dale cut grooves found on the cylinder. Next was an electromagnetic pick-up with an extremely low output. Since we lacked the high gain, low noise amplifiers of today, it was virtually impossible to separate noise from signal except on heavily modulated cylinders, that is, those cylinders with deeply cut grooves. (The results from this cartridge were sufficiently gratifying that we are now trying to obtain a similar type for future work on cylinders.) Since the bandwidth of information on cylinders is limited to roughly 200 cycles to 4500 cycles, we decided on the use of a crystal pick-up. We obtained one from the Dictaphone Corporation and then remodeled it to fit our particular need. This model had the largest output for a given modulation, that is, it provided the greatest volume of sound for any given depth of groove, and was as good as we could find.

We found that we could diminish surface noise by fitting the styli tips as exactly to the grooves as possible, using tips with radii varying from .008 to .004 inch. Since the stylus in the cartridge secured from the Dictaphone Corporation was not readily removable, it was necessary to secure several cartridges, each supplied with a stylus with a tip of a different radius. In all, four cartridges were in use.

The drive unit has undergone many changes; we finally settled upon independent drives for the mandrel, the drum upon which the cylinder is rotated, and for the feed bar, which carries the head across the grooves of the cylinder. Since the Library of

Congress operated on direct current, we decided to take advantage of the operating characteristics of the direct current shunt motor, which although less powerful, is more sensitive to control than the series wound motor. We found it ideal for speed control through the use of power-stats, devices for varying the voltage accepted by a motor. Approximately 5000 cylinders have now been transferred in the Laboratory, and we believe we have covered the complete range of speeds used. The mandrel speeds vary from approximately 50 rpm to 250 rpm, and the pitches range from 90 lines per inch to over 200 lines per inch.

Instead of using different lead screws for reproducing cylinders with differing pitches, for example, 100, 150, 160, or 200 lines per inch, we can simulate any speed by altering the speed of the independent drive. Thus only one lead screw of an intermediate ratio need be used as permanent equipment. Odd pitch ratios, such as 90 lines per inch, can then be easily handled by this means. The speed of the independent drive of the mandrel can be varied easily when it is necessary to compensate in cases where the mandrel speed slowed down or increased during the original recording.

However, it must be remembered that although the rpm may vary, the pitch remains constant. When it is necessary to speed up or slow down the mandrel to handle cylinders which were recorded at an inconstant speed, the speeds at which the mandrel is rotated and that at which the head is carried across the cylinder by the lead screw must be kept in proper ratio; that is, there must be a like change in both. This can be accomplished either by tandem linear potentiometers or by some other mechanical arrangement.

At the present time, the cylinder unit of the Laboratory is both unattractive and bulky, occupying an unnecessarily large area. We are currently in the process of redesigning the whole assembly around smaller drives and a magnetic cartridge with removable styli. Unfortunately, we have not been able to find a manufacturer who will make a cartridge to our own specifications.

The Recording Laboratory is always interested in hearing from any person on the subject of cylinders and their reproduction, for the experience of others is always a help to us.



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