but does not seem very probable. When metal-to-metal contact first occurs, the shaft wipes the much softer babbitt and imparts to it a surface having the same roughness as the shaft. Subsequent performance and ultimate seizure will be governed by this final roughness rather than the initial one. This effect may possibly be responsible for the fluctuating character of the minimum of the friction coefficient curve I in Fig. 7 of the original paper, although we are more inclined to attribute it to the change produced in the D/C ratio. The suggestion that the broadening of the minimum of the curves for rough surfaces is due to turbulence is an interesting and novel one. A further investigation of this idea should be undertaken.

Mr. Lewis' measurements of the oil-film thickness for a hydrodynamically lubricated plane slider show good agreement with the theoretical curve. From these results, he concludes that the rupture of the oil film, and hence the limit of stable bearing operation, occurs when the thickness of the oil film is of the same order of magnitude as the height of the surface irregularities. This conclusion is most important in substantiating the already postulated mechanism of what occurs when the limiting value of $\mu N/p$ is exceeded, namely, that metal-to-metal contact of the high spots on the two surfaces takes place with resultant failure of the oil film.

In answer to Mr. Tichvinsky's question, it is quite unusual to obtain any sort of waviness from a superfinishing operation, and waviness on a previously ground surface is generally removed. This is due to the small inertia and relatively large cutting area of the superfinishing stones. We agree that it is important to distinguish waviness from roughness, and this difference may be very significant in the region of boundary lubrication.

An Eddy-Current Method of Flaw Detection in Nonmagnetic Metals[1]

S. L. Burgwin.[2] The writer's limited experience in detecting flaws in nonmagnetic materials has indicated some of the possibilities of the eddy-current method of flaw detection, so it is with considerable interest that the present paper has been studied.

When the author claims a type of search unit which is universal, presumably he means universal in the sense that it can be used with almost any conducting material, not in the sense that it can be used for all sizes and shapes of metallic objects. The writer has in mind a particular problem which came up some years ago, wherein it was desired to check small contacts made up of two materials to be sure that they would not split apart. An eddy-current method of test was devised which has since operated very successfully. However, the size and shape of these contacts were such that it would be impractical to use the type of instrument developed by the author.

In other applications his device could be used successfully although, for production applications, practical use would probably require some modification of the design of the test unit for each application. Some years ago the writer developed a search unit of somewhat different design but having approximately the same underlying principle which was used to detect flaws in sheets. The device was successful enough, but scanning large sheets by hand was found to be rather slow and tedious. The successful use of such apparatus on large objects for other than trouble shooting would probably depend upon whether the scanning could be made automatic.

As to the practical use of the unit described in the paper, there are several points of interest which it is believed were not covered in the paper. For instance, if the axis of the search unit is not kept normal to the surface of the test material, as may occur when the surface of the test material is wavy or dirty or when testing objects with rough or uneven surfaces, would a voltage not be generated in the pick-up coil? If so, how serious is this effect? In the paper some mention was made of the rapidity of scanning. Could the author give some concrete idea of how long it would take to scan a sheet of stainless steel 3 ft square and perhaps $^1/_2$ in. thick?

H. J. Roast.[3] A paper such as this, which assists us in the discovery of latent flaws in metal articles, is of considerable value. The writer wishes to inquire whether or not this method will indicate the following: (*a*) Internal dross areas occluded in metal castings; (*b*) Gas holes occluded in metal castings.

The writer is a metallurgist dealing primarily with the manufacture of castings, rather than a physicist whose interest lies in physical phenomena of all kinds. The question from this point of view is whether the lack of continuity of a dross area or gas hole would prevent its reacting to the magnetic field in a manner similar to that of a continuous crack.

We have recently had bronze castings, weighing about $^1/_4$ lb, X-rayed. At the moment, the requirement is for each casting to be X-rayed and the price quoted is $5 each. This is mentioned because it will be obvious that any method which would definitely show up dross areas or gas holes in a more economical way would be highly desirable.

The metal in question is manganese bronze, essentially 60 per cent copper, 40 per cent zinc, with displacement of the zinc of 1 per cent of aluminum, iron, and manganese.

If the method is applicable to the points raised, would it be possible to locate roughly the areas in regard to the various configurations of the casting?

Author's Closure

Many practical matters must be considered in applying the eddy-current method to the location of flaws in a group of identical metallic objects. In general, a jig is employed to hold the exploring head in a suitable and reproducible manner so that the scanning process may proceed regularly and automatically. Full attention can then be directed to reading the indicator if automatic recording is not employed, or if the detection of gross flaws alone is desired. The use of a jig maintains a proper position of the head, and a slightly wavy or dirty surface produces no systematic indication. The scanning rate with apparatus, operating on commercial frequencies, is low, but not so low as to limit its usefulness. The area examined in a given time depends, of course, upon the size of the exploring head, the exciting frequency, and the degree of overlap. It is easily possible to examine 9 sq ft of $^1/_2$-in. stainless steel and make a permanent record of the test in less than 4 min.

Our tests of the method show that it may easily be adapted to the location of voids or dross areas in a casting if these are within $^1/_2$ in. of the surface, and if the casting is not too complicated. By employing properly designed scanning jigs and actual records of the electric currents, it is believed that much could be learned about moderately complicated castings.

Although the basic principles outlined in this paper are still employed, various improvements have been adopted recently which add considerably to the usefulness and convenience of the method.

[1] By Ross Gunn, published in the March, 1941, issue of the Journal of Applied Mechanics, Trans. A.S.M.E., p. A-22.

[2] Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

[3] Vice-President, Canadian Bronze Company, Ltd., Montreal, Canada.