Letters to the Editor.

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Hardness of Alloys.

IN continuation of my note on the hardness of metals in NATURE of Feb. 19, I now subjoin diagrams showing the variation of hardness which occur in certain alloys of copper with the percentage of the alloying metal (Fig. 1).

The alloys were prepared by melting, in a quartz test-tube and in an atmosphere of hydrogen or coal gas, the proper proportions of the constituent. When melted these were stirred by shaking the tube, which was then allowed to cool. This left the alloy in the form of a 'button,' from which the test-pieces were cut. No hammering or any kind of work other than that required to file or grind them to a conical shape was used in their preparation; all the hardnesses indicated in the diagrams therefore refer to cast metal.

In these diagrams the ordinates give the hardness in tons per square inch, the abscissæ being the volume percentage of the alloying metal, that is, so much per cent. of the volume consists of the alloying metal and the rest of copper.

In every case, except that of bismuth, there is a certain amount of hardening as the percentage of alloying metal increases to something like 30 per cent., and in general the alloy becomes brittle near the point of maximum hardness.

To determine the ordinates of the 'hardness' curves, eight alloys were prepared for each of the metals used (or ten if pure metal at each end of the percentage scale is included), and though the brittle specimens were difficult to deal with, I believe that the result gives a fair representation of the facts.

Some of the alloys, notably those containing tin and antimony, though not hard, could not be cut with a saw, the saw refusing to bite when applied with a light pressure, and splintering the metal when the pressure was increased.

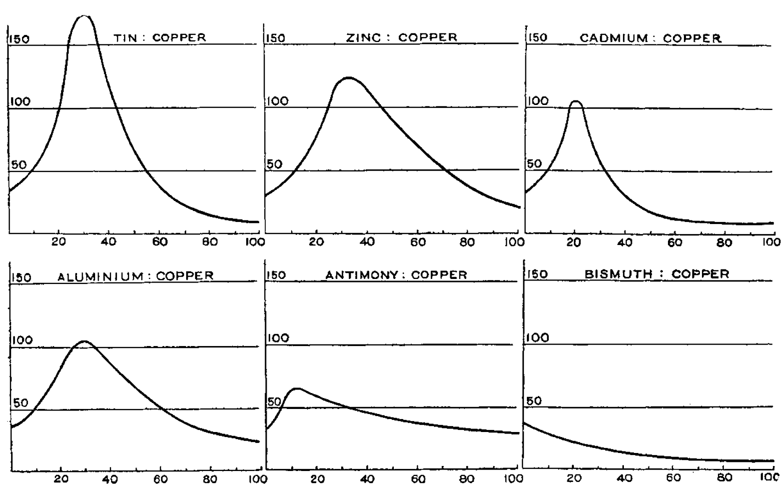

FIG. 1.—Hardness of alloys of copper. Ordinates give hardness in tons per sq. in.; abscissæ give volume percentage of alloying metal.

It seemed worth while, therefore, to measure the coefficient of friction of the alloys under such high pressures as exist at the cutting edges of the saw teeth and at the point of the conical test-pieces.

The measures were made by the apparatus sketched in Fig. 2. A platform mounted on rollers carries a

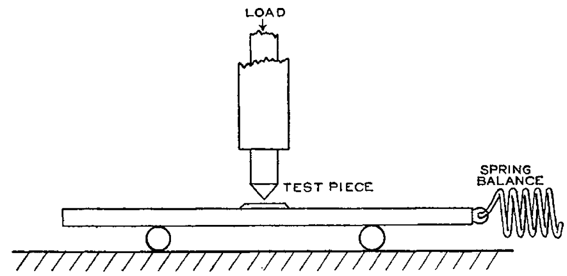

FIG. 2.

polished plate of some hard material, on which the loaded test-piece presses. A lateral force is

COEFFICIENTS OF FRICTION UNDER HIGH PRESSURE.

		Coefficients of Friction.	Pressure. Tons per square inch.
Steel on Glass	dry	0·12	111·0
,, ,,	in water	0·125	110·0
,, ,,	in oil	0·12	110·0
,, on Sapphire	dry	0·1	117·0
,, ,,	in water	0·101	117·0
,, ,,	in oil	0·114	117·0
Pure Copper on Sapphire	dry	0·100	20·0
Pure Cadmium on Sapphire	dry	0·1	2·3
Pure Tin on Sapphire	dry	0·124	0·22
Copper Alloy 20 % Zinc on Sapphire	dry	0·100	32·0
,, ,, 28 % Tin on Sapphire	dry	0·084	68·0
,, ,, 40 % Tin on Sapphire	dry	0·085	16
,, ,, 40 % Tin on Steel	dry	0·090	16
,, ,, 15 % Bismuth on Steel	dry	0·092	5·8
,, ,, 15 % Bismuth on Sapphire	dry	0·092	3·7
,, ,, 20 % Antimony on Sapphire	dry	0·094	5·2

applied to the platform by a spring balance, and the reading of this balance when the force is just sufficient to cause the hard surface to slip under the point is noted.

The Table above gives samples of the result obtained. When the plates were well polished the balance readings were very consistent, and the force required to cause 'slip' was closely proportional to the load on the test-piece.

It appears that with these high pressures, lubrication has no practical effect, the lubricant, I suppose, being completely squeezed out.

It appears also that for pressures of the order employed, the pressure itself is a matter of indifference, the important factors being the nature of the materials and the product of the area of contact and the pressure, *i.e.* the load. It would occupy too much space to give the details of these experiments, which I hope to repeat with a more convenient form of apparatus.

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