ing in all about 36 tons. The normal discharge current is 179 amperes whilst the maximum energy load is 800 amperes. The batteries will be capable of storing sufficient energy to operate for a whole working day without recharging.

At each end of the locomotive there is a driver's cab fitted with a British Thomson-Houston master controller

divisions, separated by a lattice girder frame passing longitudinally down the car from cab to cab, and its top supporting a series of sloping doors which cover and protect the secondary batteries. The height of locomotive from rail level to top of cabs is 9 ft. 6 in., the distance from rail level to top of battery tank being 6 ft. 8 in.

Storage Battery Electric Locomotive.

one of which (10 ft. 10 in. in length) is extended so as to accommodate the controlling apparatus, the air-compressor, and the air-receiver. The cabs are constructed entirely of steel, and are so arranged that they join the portion carrying the battery, the latter being on the Jarrah wood floor in two

The locomotives weigh 65 tons each, and their free running speed on the level, when hauling a load of about 60 tons, is from 7 to 10 miles per hour. They are each fitted with the automatic centre coupler buffers, and, also with the Westinghouse air-brake.

"ALLOYS."

BY PERCY LONGMUIR, OF LONDON, ENGLAND.

Carnegie Research Medallist.

(Continued.)

Copper-Tin Alloys.

Notwithstanding the literature on these alloys, their application is exceedingly limited, the only general one being found in phosphor bronzes, which are essentially copper-tin alloys deoxidized by phosphorus, some portion of the latter element remaining in the final alloy.

In practice the only copper-tin alloys used are found in bell metals, in which the chief requirement is that of "tone," and strength is of secondary moment only. The Admiralty requirements for ships' bells are five of copper to one of tin, or—

Copper	83.3 %
Tin	16.7 %

This alloy gives a good tone, casts fairly well, and presents a good appearance when turned up. A trace of phosphorus is added just before casting, or sometimes the alloy is made up as follows:

Copper	82.0 %
Tin	17.0 %
Yellow brass	1.0 %

where to some extent the zinc of the yellow brass acts as a deoxidizer. Gong metal approximates 80 copper and 20 tin, a composition which represents the highest content in tin of the bell metal series. Speculum metal is white in color, brittle in properties, and admits of a very high polish. Its application is, however, exceedingly limited, and for the greater part these alloys have been replaced by glass. A general composition is 67 of copper and 33 of tin. Ross's alloy contained 68.27 per cent. of copper and 31.79 per cent. of tin.

Copper-Tin-Zinc Alloys.

Under this heading are grouped alloys known as machine brasses or gun metals. The origin of the term gun metal is familiar, but the copper alloys have long been superseded by steel for ordnance, and the only guns now made are small ornamental cannon. All modern gun metals contain zinc in amounts varying from 1½ per cent. up to appreciable quantities. The addition of zinc to a copper-tin alloy gives sharpness or "life" to the fluid alloys, and leads to the production of sounder castings. Three types of high quality gun metals are shown in the following table:

	1	2	3
Copper	88	86	87
Tin	10	10	8
Zinc	2	4	5

No. 1 is the Admiralty specification for gun metal castings. These alloys are used for high-pressure steam fittings, air and water pumps, engine and machine details, boiler mountings and the like. Typical tests of numbers 1, 2 and 3 obtained by the writer are as follows:

	1	2	3
Maximum stress—tons per square inch	18.0	17.0	16.5
Elongation, per cent. on 2 inches	11.0	10.5	9.0

Evidently, then, with care in casting, the three can be made to give very similar tension results, a remark also applicable to their behavior under steam or hydraulic tests. No. 3 is the least costly of the series, and is decidedly easier to treat in machine and finishing shops than the comparatively hard alloy, No. 1, a feature of some moment in estimating total costs. The highest and lowest tensile