results obtained by the writer from some hundreds of experiments on Composition 1 are as follows:

	Maximum Stress. Tons per square inch.	Elongation per cent. on two inches.
Highest	20.0	16.0
Lowest	6.5	3.7

in every case composition being identical; i.e., copper, 88 per cent.; tin, 10 per cent., and zinc, 2 per cent. This wide range of variation emphasizes the care required in making up the alloys.

Typical compositions of ordinary commercial gun metals are included in the following table, Nos. 1 and 2 representing the usual run of alloys for valve bodies, engine and boiler fittings, but not for fittings in conjunction with high-pressure boilers or high-speed engines. Nos. 3 and 4 represent cheaper types of gun metal in which outside scrap enters largely into the composition:

	1	2	3	4
Copper, per cent.	80	80	70	55
Tin, per cent.	4	6	4	5
Zinc, per cent.	10	8	4	..
Lead, per cent.	6	6	4	..
Merchant scrap, per cent.	..	..	18	40

As in the brasses, the addition of lead to a gun metal facilitates free turning. Scrap is, of course, a variable factor, and should as far as possible be sorted into uniform grades.

Bearing Brasses.

Solid bearings are being largely replaced by shells lined with anti-friction metal. When a copper-tin alloy is used as a bearing brass its composition will vary between the following limits:

Copper, from	88 to 82 %
Tin, from	10 to 14 %
Zinc, from	2 to 4 %

An intermediate alloy, copper, 84 per cent.; tin, 12 per cent., and zinc, 4 per cent., represents a composition which has successfully met severe service conditions. A cheap and hard bearing may be made from copper, 52 per cent.; tin, 8 per cent., and merchant scrap, 40 per cent. However, on the whole, bearing brasses of phosphor bronze yield better results than are obtained from copper-tin alloys.

It may be well to note here that the increase in hardness, followed by the increase in content of tin, is also associated with a sharp increase in brittleness. Only in the case of bearing brasses is it advisable to exceed a content of 10 per cent. tin, a feature illustrated in the following table, which represents the mean of six tests:

Analysis.			Maximum Stress. Tons per	Elongation per cent. on two
Copper.	Tin.	Zinc.	sq. inch.	inches.
85	13	2	11.9	1.5

These results are of importance in view of the fact that gun metal is often stated as containing 16 per cent tin. Such a composition would be far too brittle for the purpose to which gun metal is usually applied; it is, in fact, a bell metal.

Bronzes.

Manganese bronze has been dealt with under the heading of manganese brass. With this and phosphor bronze types of alloy the special constituent is chiefly noticeable by the low amount present. The latter is essentially a copper-tin alloy, containing from traces up to 1 per cent. phosphorus. Analyses of two typical varieties are given in the following table:

Phosphor Bronze.

	Ordinary or "Mild."	"Hard."
Copper	89.31	88.63
Tin	10.16	10.32
Arsenic	0.01	0.01
Antimony	0.05	0.06
Phosphorus	0.47	0.98

The "hard" type is, in foundry practice, used for casting pinions, spur and bevel wheels, slide valves and bearing brasses. The "mild" type is extensively used for various machine and engine details, and also for heavy castings, such as the ram and stern fittings of a modern cruiser. Typical tensile tests of bars from commercial castings are shown in the following table, the bronze in each case being that of the "mild" type:

	Maximum Stress. Tons per sq. inch.	Elongation per cent. on six inches.
1	19.0	18.8
2	20.7	24.5
3	21.5	33.0
4	22.4	27.0
5	26.2	51.0

The usual specification for casting of this type is a maximum stress of 17 tons per square inch and an elongation of 15 per cent. on six inches. No. 5 represents the highest value the writer has obtained from this type of bronze. The lowest value from bronze of precisely the same composition is as follows:

Maximum Stress. Tons per sq. inch.	Elongation per cent. on 6 inches.
12.5	5.0

A comparison of the two elongations, viz., 5 per cent. and 51 per cent., is of much interest as showing the range of properties in an alloy of constant chemical composition.

As the amount of phosphorus increases beyond 0.5 per cent. ductility decreases, whilst hardness and brittleness increase. For a hard type of bronze that is a good bearing metal, 1 per cent. phosphorus is a suitable limit, but where extreme hardness is required 1½ or 2 per cent. may be added. A higher content of phosphorus than 2 per cent. is useless for castings. It will be noted that British phosphorus bronzes approximate 90 per cent. copper and 10 per cent. tin, whilst certain American types contain lead. Thus a typical "car brass" is as follows:

Copper	79.7 %
Tin	10.0 %
Lead	9.5 %
Phosphorus	0.8 %

Aluminium Bronze.

The most general composition is. copper, 90 per cent., and aluminium, 10 per cent. For some reason these bronzes have not yet met with a very wide industrial application, probably owing to the fact that their properties have not been systematically investigated. From the foregoing composition the writer has obtained results varying between the following limits:

Maximum Stress. Tons per sq. inch.	Elongation per cent. on 2 inches.
18 to 26	2 to 16

It is hoped to shortly supplement these results by others obtained from a more exhaustive investigation.