the manganese being introduced in the form of the ferrous-oxide to act as a flux, and any residue being due to an overdose of the flux, and such residue should not exceed 2 per cent. Such castings, properly made, can be relied upon to show a tensile strength of 65,000 pounds, a yield point of 35,000, and an elongation of 20 per cent. in 2 inches. Certain manufacturers use vanadium in the place of manganese, and the resulting castings are of the same general character as manganese bronze. Castings of this material where purchased in small quantities are generally somewhat more expensive than those made of the bronzes referred to above, and it is the general experience that founders unused to the casting of manganese bronze experience considerable difficulty in obtaining satisfactory results. Where the quantity, however, to be used on a job is sufficient to appeal to founders experienced in handling the material, most excellent castings can be obtained at a price generally from 10 to 12 per cent. less than corresponding castings of tin bronze.

Forgings, rods and bars of these alloys show very satisfactory non-corrosive properties and physical characteristics considerably greater than the cast material, the exact amount depending on the size and manner of fabrication, and would appear at first glance to be ideal substitutes for similar steel products. Unfortunately, however, the demand for such rods and bars is of such recent origin that the art of fabrication does not seem to have advanced to a point where the product can be guaranteed against failure by disintegration, or by breaking or cracking without apparent cause. These failures in many instances have not manifested themselves until some months after the material has been fabricated and has passed a most rigid inspection, and have been entirely independent of any load thrown on the material. While no satisfactory solution of the causes of, and no remedy for such failures, have as yet been found, it does appear that the same are caused rather by the methods employed in rolling or drawing than by the composition of the material itself. It would, therefore, appear wise to exercise considerable conservatism in the selection of such rods, until the manufacturers have further perfected themselves, and have solved the various problems of temperature and rolling methods, and to use in their stead some of the brasses which have been manufactured for a sufficient length of time so that the engineer can feel comparative security in their use. Among these there appear Muntz metal, an alloy of 60 per cent. copper and 40 per cent. zinc, which in the larger sizes of rods can be depended upon to show a tensile strength of at least 40,000 pounds, and Tobin bronze with a tensile strength of 55,000 pounds, which together with other closely allied alloys are readily available.

Comparatively recently, one of our largest manufacturers of rods has produced an alloy containing about 57½ per cent. copper, 40 per cent. tin, ½ per cent. lead, ½ per cent. iron, and 1½ per cent. nickel, which possesses high non-corrosive properties, together with physical characteristics equal to or slightly superior to Muntz metal. This material is produced in bars and rods.

Tubes made of an alloy of 86 per cent. copper and 14 per cent. tin are extensively used in the navy in condensers, where they come in contact with salt water.

The most prominent copper-nickel alloy to-day appears to be Monel metal, a natural alloy containing about 60 per cent. nickel, 36½ per cent. copper, and 3½ per cent. iron. This material has been very successfully used both in the form of castings and rods for large and small work. Its physical characteristics are at least 65,000 pounds ultimate, 32,000 pounds yield, and 25 per cent. elongation for castings, with the ultimate and yield points at least 10 per cent. higher for rolled rods. Non-corrosive tests indicate that it is not acted upon by either the acids or alkalies as found in construction work. It has been somewhat extensively used for propellers for battleships, both by this country and by foreign countries. It is also used by many valve manufacturers as a seat metal for valves, for use with high pressure and superheated steam. It is also used in the form of forgings for valve stems for high-pressure steam and water valves.

This material has not been in use for a sufficient length of time to determine its non-corrosive qualities under all circumstances, but every indication points to its entire acceptability. It is a comparatively costly material, probably costing in its various forms about 50 per cent. more than the corresponding brass or bronze material, but its greater physical characteristics in many cases make this increase more apparent than real. It appears to require considerable skill on the part of the founder to obtain sound castings of Monel metal, and the unsuccessful attempts of some such have prejudiced many against its use.

The value of nickel-steel alloys for members under tension, as valve stems, has not received sufficient recognition by the waterworks engineer.

While unquestionably not possessing the non-corrosive properties of the brasses or bronzes, a proper steel alloyed with from 20 to 25 per cent. of nickel does possess such properties far in excess of ordinary carbon steels and combines with this property physical characteristics such that it should demand the careful consideration of the engineer.

In 1905 the Department of Water Supply, Gas and Electricity of New York City specified for valve stems a nickel steel to contain not more than 0.05 per cent. phosphorus or sulphur, between 0.21 per cent. and 0.41 per cent. carbon, and between 21 per cent. and 24 per cent. nickel and to have a tensile strength of at least 80,000 pounds, yield point of 40,000 and an elongation of 22 per cent.

One of these stems when examined after five years' service showed no indication of corrosion of that part immersed in water, and only slight pitting of that part exposed to air.

There appears to be very little data available showing the effect of various corrosive substances on alloys. Unquestionably many of the manufacturers of such materials have experimented to a considerable extent on such material, but there appears to have been, in the past at least, a dislike on their part to make public the results which they may have obtained. There are appended to this paper a few results of comparative tests that have come to the attention of the writer and which, while by no means complete or conclusive, may be of some assistance in the selection of non-corrosive alloys.

The Corrosive Effect of Moist Earth on Alloys and Steel.—Six test pieces were embedded in a box of rich earth, which was kept moist with water and occasional additions of ½ per cent. solutions of chlorides of sodium and magnesium. The weighed specimens, consisting of rods 15.2 cm. long by 1.2 cm. diameter, presented about the same area to the corrosive influences in the soil. After having been subjected to the conditions provided for a period of six months, the specimens were taken out, washed, dried and reweighed. The loss in weight represented the amount of corrosion in each case.