metals is unavoidable, they should be insulated from each other as perfectly as possible.

Cast Iron More Resistive Than Steel.—Under many circumstances cast iron is much superior to either wrought iron or steel, and the closer the grain of the cast metal the more perfectly will it resist corrosive influences.

Action of Pure Iron, Air and Water.—Absolutely pure iron, if it could be obtained, would be unusually resistant to corrosion, unless placed in metallic contact with dissimilar metals. It is interesting to note that the action of pure water and pure air upon pure iron is but slight, and for all practical purposes negligible, but inasmuch as all these commodities are scientific curiosities of the laboratory rather than matters of ordinary experience, the point is not of direct practical importance, except in so far as it indicates the direction in which causes of corrosion may be expected to lie.

Moisture Hastens Corrosion.—Whilst there are many points still the subject of controversy, investigators appear to be agreed that, unless water is present, iron will not rust in air or oxygen. Natural rain-water and mist show great activity in the oxidation of metals, and water, when saturated with air is strongly corrosive to iron and steel. Corrosion proceeds most rapidly when the metal is alternately subjected to wet and dry conditions, such as at the water-line of iron columns, ships, boilers, water tanks, and the like. Deterioration of the metal at the water-line in boilers is a very generally noticeable condition.

Effect of Deeply Immersing and Burying Metals.—Water surfaces in contact with the atmosphere become more or less saturated with oxygen and the corrosive action of the water is consequently increased. Ironwork is much less corroded when immersed to a considerable depth in water than when placed near the surface, where air gains access.

Acids in Soils.—Deeply burying of metal in the soil has also been observed to have a preservative effect, as free oxygen cannot readily reach it. Should the soil, however, contain acids or acid salts these will soon have a destructive effect on the metal, as also will stray electric currents by the setting up of "electrolysis," resulting in rapid corrosion. It has also been observed that exposure to the action of diffused sunlight stimulates the rate of corrosion of iron.

"Busy" Iron.—Railway metals in active service corrode less rapidly than do similar rails laid in sidings which are little used. It may also be taken generally that "busy" iron, and iron subjected to vibration, has been observed to rust much less rapidly than idle metal subjected to similar corrosive influences. A thick scale of rust on the surface of metal retains moisture and hastens further corrosion.

Painting of Metals to Prevent Corrosion.—In regard to the question of painting or "coating" of metals with a view of preventing corrosion much consideration is needed, or more harm than good may result. A form of specification commonly seen requires "all ironwork to receive one (or two) coats of paint before leaving the manufacturer's works." The wisdom of this is very doubtful, inasmuch as the "mill-scale" on the new ironwork is certain to come away sooner or later as oxidation sets in under the paint, and the latter coating will thus be brought away with the scale. In the use of some proprietary "coatings" it is, in fact, recommended that a first coat be applied and allowed to peel away, should it prove disposed to do so, in order that all scale may be removed therewith, and the subsequent coatings will then permanently adhere and protect the metal.

In the galvanizing and other similar trades the mill-scale is removed by dipping the steel and iron goods in hydrochloric acid solution before coating the metal.

Removal of "Mill-scale."—Before painting iron and steel work, as in bridges, etc., the black oxide scale, or "mill-scale," may advantageously be permitted first to turn to red oxide or rust, and the metal then be thoroughly well cleaned with wire brushes or sand blast. This having been well done, the paint will then find its way direct to the metal and form a much more permanent coating. It is often a difficult matter to remove every trace of mill-scale, but the improved results obtained justify this precaution.

Many engineers now frequently allow iron and steel structures to stand for a while and rust, in order that the mill-scale may be loosened and so come away more freely by scraping and wire-brushing, before any coat of paint is applied.

Rust is capable of setting up galvanic activity, but to a less degree than is the case with magnetic or black oxide.

Necessity of Continuous Coatings.—Numerous "coatings" of varying composition have been largely used on all classes of work in which metals are extensively employed. In the case of steel pipe-line in wet soils or situations, the conditions are severe, and no permanently effective coating is at present available. The application of the coating is also of first importance. It should be absolutely uniform and continuous, otherwise, should there be imperfections, such as small holes, galvanic currents leave the metal plates at these points, and the iron or steel work becomes more quickly corroded than would be the case if the same action took place uniformly over the whole surface.

"Coatings" May Prove Detrimental.—Artificial coatings, intended for protection, may thus not infrequently become sources of danger, and, in the case of some paints, the coarser particles of pigment may induce galvanic activity under the paint. It will be advantageous, therefore, to use a pigment which is a bad conductor of electricity, finely ground, and well incorporated with oil.

R. H. Gaine's General Comment.—The whole subject of the corrosion of iron and steel abounds in curious anomalies, and apparently similar materials do not always behave alike under what may be believed to be identical conditions. The general comment on this subject of Mr. R. H. Gaines, the eminent chemist to the New York Board of Water Supply, is of special interest. In a report on the corrosion of a 38-in. diameter steel conduit at Rochester, New York, it is observed that:—

"The corrosive influences of nature can never be precisely imitated, and, moreover, the time during which laboratory experiments extend is relatively so short that they are of little value compared to actual experience. Besides, practical experience on such subjects is always more reliable than mere laboratory experiments. . . . There is a wide divergence of opinion among metallurgists on the corrodibility of the various forms of iron. Experience at Rochester, Portland, and elsewhere, seems to show that cast iron resists corrosion better than any other form of iron, and wrought iron is less easily corroded than mild steel. As between steel and wrought iron, some metallurgists claim that the difference is slight, but their reported experiments have not been carried far enough to base a final opinion."