action is so marked that in the course of a few years the house which has been covered with an excellent quality of white lead paint may be but poorly protected, especially if it is exposed to salt sea air.

Figure 1 shows the general appearance of this condition when examined with a magnifying glass, while Figure 2 shows the condition in contrast of a better proportioned paint subjected to exactly the same exposure and use.

Zinc oxide pigment is another which is well and favorably known. Owing to its non-poisonous properties, it is more desirable than white lead for interior work. This pigment used alone is also unsatisfactory as it produces a brittle coating that is likely to crack.

Other pigments commonly used are red oxide of iron, ochre, sienna, ultramarine, Prussian blue, chrome yellow, lamp black, and many besides, too numerous to mention.

Co-operation is as effective in promoting efficiency with pigments as with people, and by far the best results have been obtained with paints in which suitable pigments have been properly combined.

Little was known about the reactions between pigments and vehicles, or the reasons for good or bad service of paints made from given materials, until comparatively recent times. Certain bad combinations were shunned from sad experience. It was learned, for instance, that white lead paint mixed with ultramarine blue, will darken owing to the formation of black sulphide of lead, and that a sign coated with white lead paint will sometimes change from white to yellow within an hour if exposed to the sulphur fumes from a locomotive.

The study of paints was given great impetus about the year 1890, through the published investigations of Dr.

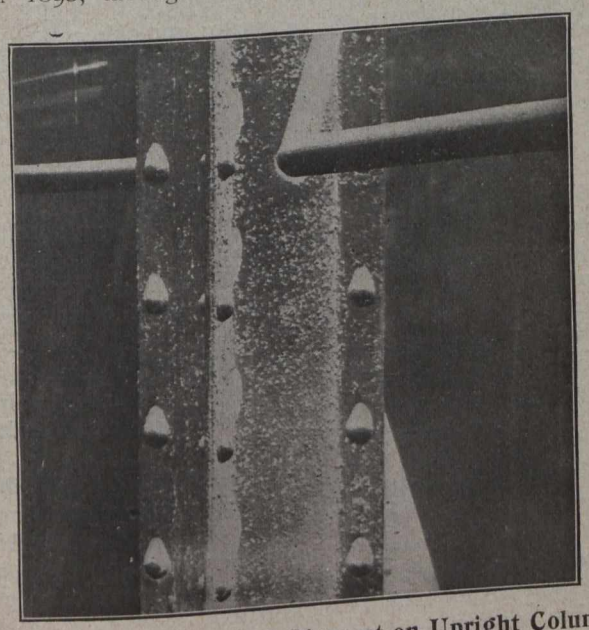

Fig. 5—Coarse-Particled Pigment on Upright Column, Fine-Particled on Horizontal Railing

Charles B. Dudley, for many years the able, widely known and respected chemist of the Pennsylvania Railroad. In his studies, among other things, the properties of paint materials were systematically investigated, and what was learned brought about radical changes in the composition and manufacture of paints.

The Pennsylvania Railroad gained much valuable information as the result of Dr. Dudley's work. It was clearly realized, for example, that the effectiveness of a paint did not by any means depend upon its cost per gallon or pound. As a matter of fact, it was proven that some of the most durable paints could be had at a minimum cost.

Other railroads were not slow to follow the lead of the Pennsylvania, one of the first to start on this work being the Philadelphia and Reading, now known as the Reading Railway. The results of some of these investigations were presented by the writer before the Franklin Institute, and elsewhere.

The size and form of the particles of the pigment were shown to have a great influence upon the life of a paint

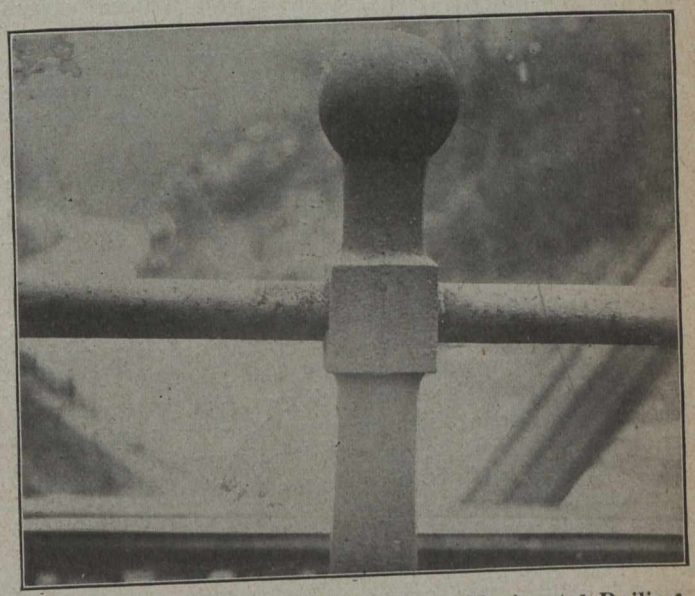

Fig. 6—Coarse-Particled Pigment on Horizontal Railing, Fine-Particled on Upright Post

coating, though this subject had not previously received any attention. A brief description of a case that clearly illustrates this point may be of interest:

Two bridge paints had been used upon the lines of the Reading for a period of about ten years. These paints were made by the same manufacturer, and contained almost the same proportions of the same materials. Though they were exposed side by side and under like conditions all along the road, one of them became known for its good service, and the other for very poor service. The life of one was twice that of the other.

The difference between the service rendered by these paints was so marked that we determined to get at the real causes, so as to bring the quality of all our paint deliveries to the same high standard of durability represented by the better paint.

The discovery that the main difference between the two paints was in the relative size of the particles of the pigments resulted from this investigation. In the long-lived paint, these particles ranged from two to ten ten-thousandths of an inch in diameter, with comparatively few of the maximum sizes; while in the short-lived paint the diameters ranged from two to one-hundred-and-eighty ten-thousandths of an inch.

The average diameter, as nearly as we could estimate, of the particles of the pigment of the satisfactory paint was four ten-thousandths of an inch, against eighty ten-thousandths of an inch for the unsatisfactory paint; and, as the volumes of spheres are to one another as the cubes of their diameters, it follows that the average particle of the pigment of the good paint was eight thousand times smaller in volume than that of the bad.

The composition of these two paints was about 25 per cent. oxide of iron combined with inert matter, such as clay and gypsum, as a filler, ground in pure linseed oil,