not necessary to have either type of heater, as the sand can be heated on an ordinary plate heater set up temporarily anywhere along the line of work. In fact, all the New York work has been done with sand heated in this way, and New York uses nothing but mastic filler for all block pavements.

In adopting the pitch mastic specification given above the American Society of Municipal Improvements

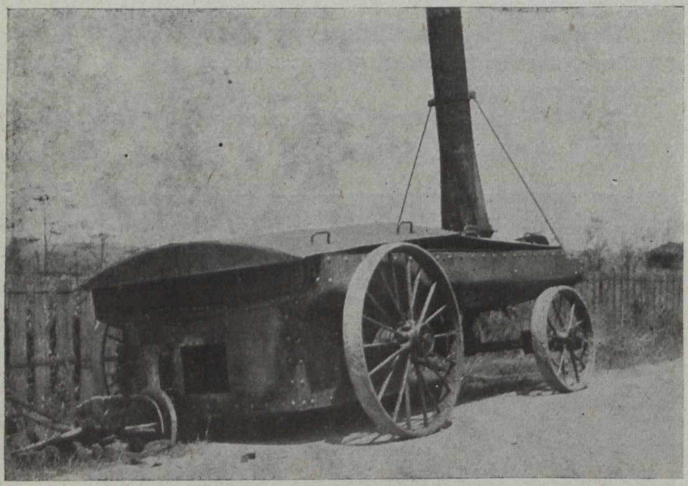

Fig. 3.—Cleveland Type of Sand Heater.

recognized that the addition of hot sand to a bituminous filler is a definite step forward toward the goal of a perfect joint compound. The success that this type of joint filler is enjoying shows that it fills an actual need.

PAINT FOR STEEL AND IRON STRUCTURES.*

THE two most generally accepted theories to account for rusting are that which considers that the iron is attacked by carbonic acid in the water, and the electrolytic theory, which assumes that a flow of electric current dissolves the iron, forming an iron hydroxide, which is then turned into ferric oxide or rust. In either case water must be present, and rust prevention consists of excluding moisture or preventing the results accompanying its presence. The most minute quantities of water suffice to cause rust.

There are four general methods of protection: Covering by inert materials to exclude water, as tin-plating and painting; covering by materials which contain active alkalies, as by concrete; covering with an electrical positive, as in galvanizing; and covering with some substance to render the iron passive, as by chromates. The first system is based solely on an effort to exclude the water; the other systems endeavor to exclude as much water as possible and at the same time to mitigate the action of such moisture as does reach the steel. Usually this mitigation is of a temporary nature and engineers must realize that not much success can be attained in rust prevention when moisture is present.

It has been customary to use paint for the protection of exposed ironwork. Such paints are usually composed of a vehicle and a pigment. They must be free from all elements which are deleterious, as sulphur; they must adhere; they must be permanent; they must be as nearly impervious as possible. Paint pigments used generally are iron oxide, graphite, carbon, the bitumens, zinc oxide and the leads. There are also adulterants, frequently called inert pigments, such as carbonate of lime, chalk, whiting, gypsum, koalin, marl, talc, etc., most of which are valueless.

Zinc oxide is liable to form zinc carbonate, which compound, as it has a volume about twice as great as that of zinc oxide, causes blistering and peeling of paint films.

The lead pigments, particularly the red lead and blue lead, are valuable because they are manufactured under such conditions as to insure a minimum of dangerous ingredients. They are usually, as sold, very fine and react with oils in which they are mixed in such a way as to become practically an integral part of the paint film, while other pigments act more in the manner of stone imbedded in mortar.

As to the inert pigments or, more properly, the adulterants, most of them are valueless. Some are soluble and are leeched from the paint film, rendering it porous. Some contain or absorb water and others hold acids in combination which may attack the paint film or the iron structure. Some of them are not wholly inert and may undergo injurious chemical interactions.

Linseed oil is the principal vehicle used and is the best. Boiled oil has the advantage of containing less water than raw oil. Oil which has been purified by use of sulphuric acid is worse than valueless, as the acid cannot be entirely removed and will act on the iron.

In conclusion, any engineer who uses red lead or blue lead for priming coats and covers this with a high-grade graphite will have the best combination possible, if these pigments are mixed in good, carefully prepared, boiled linseed oil. However, there are conditions where cheaper paints will serve, as for temporary coverings for special purposes, and many of the cheaper pigments are suitable for use in such cases. But for general open-air structural work such as bridges, steel towers, etc., the lead and oil paints are the most reliable.

No matter how good the paint or how carefully prepared, it may be rendered valueless by careless application. It is useless to try to stop rusting by covering up the rust with paint. If paint is to be put on over a film of moisture and a layer of rust, a cheap coat of whiting is as effective as expensive lead and oil. It costs, in some cases, a large sum of money to properly clean a steel structure; but unless it is done, even the most expensive grades of paint will not prevent its rapid destruction. Cleaning by sand blast is the best method.

The use of volatile driers is detrimental to a paint film because their use brings about a condition of drying by subtraction, the film losing in weight. Also, as the film becomes drier, the escaping bubbles of gas make holes which are not closed. Consequently the film is rendered porous and the underlying metal accessible to attack.

Paints are often applied too thick. If a paint film is too thick, it dries on top but remains plastic underneath. In this condition a film is likely to peel or, if subject to abrasion, is easily ruptured. Moreover, two thin coats are better than one thick one, since the second coat will, to a large extent, correct the deficiencies and inequalities of the first coat. The Bureau of Standards has found four coats of paint the minimum that could be depended on to give an impervious film.

While no paint coat can be considered a permanent protection against rusting, much better results will be secured if high-grade ingredients are used than if no care is taken in the selection of the paint materials. As in many other cases, the best is cheapest in the long run and this applies to the application of the paint as well as to the selection of the ingredients.

*Abstract from Quarterly Bulletin.