In the case of a ravelled road, having first determined that the road was well built, we must decide whether the traffic is too great for the type of surface, or whether the failure was due to neglect. If the former, we must resurface with some better type. If the latter, we can repair the old surface.

Resurfacing should always be preceded by scarifying and by bringing the road up to the necessary depth of stone. For water-bound macadam needing greater surface strength, several classes of chemical binder may be used, of which I shall discuss two, bitumen and lignin.

The bitumen may be applied either by penetration or mixing methods. The former is the cheaper, the latter the more trustworthy. Which method is to be used will, after consideration of the care the road will receive, depend on the estimate of the overload, as will also the depth of the bituminous sheet. My own observation leads me to question the wisdom of attempting to get any thickness exceeding one-half inch by penetration methods. It also leads me for this class of work to prefer tar to asphalt. The former material appears less sensitive to injury by dirt and to yield better results in repair work.

The lignin binders are derived from the waste products of wood pulp or tannin manufacture. They are cements, being also used to bind core sand in foundry work and impart a tensile strength to the binding materials. They will not act on materials soaked in the so-called road oils. The action of some of these materials on slag and red shale is quite remarkable. They are slightly soluble in water, and will, therefore, need renewal. Their application, however, is easy and inexpensive, and the effect of successive applications seems cumulative, increasing not only the depth of penetration, but the strength of the bond. The waterproofing of lignin-bound roads with bituminous tops has been carried out in Connecticut, but I am unable to give any facts as to the results.

For water-bound macadam roads that have failed through neglect a thin coat of gravel carrying some earthy matter, or of screenings or coarse sand mixed with earth, will usually cure cases that have not gone too far. In some of the counties of New Jersey it is usual to fill all ruts, depressions, etc., with fine stone, and to give the middle of the road a coat of the same mixed with a little clay. Much of this material is wasted by being thrown off the road by the traffic, and the old ruts almost invariably reappear. This method, however, is very successful in preventing ravelling. It seems a false economy to omit rolling, and wet rolling at that. The same is true of patching holes with anything but macadam-size stone. The roads treated with small stone are yearly losing depth. The moisture for wet rolling is usually bountifully supplied by nature, in the early spring. It can also be had by the use of hygroscopic salts where water is hard to get. Traffic will usually throw off from the road surface enough stone to pay for rolling.

A treatment of clay, without rolling, will often give astonishing results. Such treatment, however, seems only a palliative, not a cure. Roads thus treated become dusty or muddy according to the weather, show a tendency to ravel again, and are hard to properly treat with bitumens. They will, however, take the lignin binders with good results, if the dose of clay has not been excessive, or if the excess is swept off before treatment.

In closing, a word of warning as to the use of the so-called cold oils may not be out of place. Those of the so-called non-asphaltic class, to a greater extent than the so-called light asphaltic oils, seem to act as lubricant on road materials and to foster pot-holes, ravelling, and other failures. It may be possible to properly apply these materials, but if so it is rarely done. It is certain that even slight depressions will cause a deep penetration of the road. The dust-laying qualities of the material thus absorbed are lost, and its lubricating effect given the best possible conditions to get in its pernicious work. Local authorities, and even private individuals, seem to select roads with uneven surfaces as those on which to use these oils.

ELECTRIC WELDING FOR TRACK REPAIRS.

There are many methods by which electric welding can be carried out, one of the most interesting being, perhaps, that of Zerener, which consists of a combination of an electric arc and an electro-magnetic device whereby the arc can be controlled. Two heavy carbon electrodes are used, and the arc which is struck between them is blown to the position in which it is required by means of the magnet. The most simple is the Bernardos process, which consists of drawing an arc directly between a carbon electrode and the metal which is to be treated. The outfit consists merely of a rheostat for controlling the current, a carbon electrode which consists of a hard, solid carbon rod about 4½ ins. in circumference and some 8 ins. or 10 ins. long, fitted with a clamp to take the conductor, and with an insulated handle and shield to protect the operator. There is also the Lorain system, which requires a comparatively costly plant, with generator and hydraulic grips, used principally for making rail joints by welding on splice bars.

An interesting method of building up new metal in the worn parts of tram and other rails by electric welding is now being used, the special feature of the process being that it requires no carbon electrode. The electrode is a rod of specially treated steel, and the arc between it and the rail, according to information made public by the engineer of the firm using it, fuses the electrode and welds it to the steel, building up new metal in the worn or defective places. Current is taken from the trolley wire, and the equipment consists of a light car provided with rheostats for controlling the current and the necessary switch gear. An insulated handle is provided for holding the metal electrode, which is, of course, the positive terminal, the negative being the rail on which the repair is to be carried out. The electrode is placed in momentary contact with the defective portion and withdrawn, an arc being thus formed which carries metal from the positive bar of steel into the faulty place. The action continues as long as the electrode is held in position, and can be stopped at any moment, either by opening a switch or moving the electrode away, so that the arc is broken.

With a galvanometer receiver reflecting a beam of light on a moving photographic strip, H. Abraham, of the Paris Observatory, makes accurate photographic time records of Hertzian waves. With a clock making second marks on the strip, he claims to make measurements to 1-1,000 second, and to estimate 1-40,000 second on the wave charts.

Clay Products Industry in United States.—The magnitude of the clay-working industry of the United States is shown in a chart just issued, compiled by Jefferson Middleton of the United States Geological Survey. This chart shows a total value for 1912 of $172,811,275, which is an increase of $10,575,094 over the figures for 1911. These products include the several varieties of brick, drain, and other tile, and of sewer pipe, terra cotta, pottery, fire brick, and other clay products, the various building bricks representing the greatest value, with a total of $73,425,819. The number of building bricks manufactured was 10,281,114,000.