engine; the total weight of iron and timber in the traveler, the engine, the cross-ties and about 10,000 ft. of ropes, including blocks attached to the traveler, amounted to 57 tons.

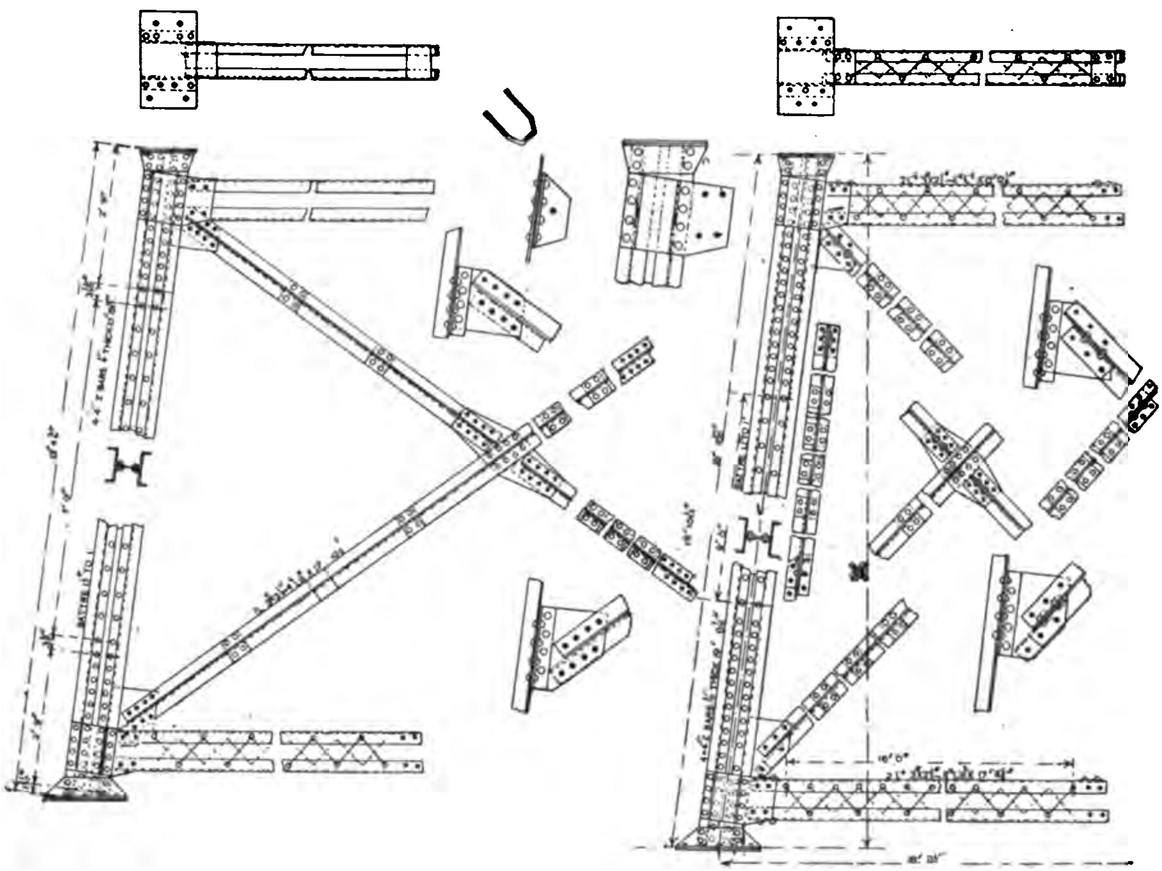
For the purpose of getting a massive roadway floor, 6-in. arches of sharp burned hollow brick are to be built between the stringers; they are to be covered with concrete and with a top layer of asphaltum the height of the track rails. Temporarily a wooden floor has been laid.

The sidewalk will be planked.

The total amount of first-class masonry in abutments and piers is about 400 cub. yds., and of steel structure, 375 tons. The total cost will be $60,000.

The work was done by the Schultz Bridge & Iron Company of Pittsburg, Pa.

liquid on an asbestos filter in a platinum boat, taking pains at the last to pour out all the liquid, and at the same time leave as much of the separated carbon in the beaker or dissolving jar as possible. Now add about 10 c.c. of dilute hydrochloric acid [sp. gr. 1.1] to the beaker or jar, and so manipulate that this acid shall touch all parts of the beaker or jar which has been in contact with the solvent liquid. Pour this acid on the filter, and wash the carbon out of the beaker or jar by means of a wash bottle containing the same strength acid. Continue the washing with the acid until all color has disappeared from the washings, and then wash with water until the washings no longer react for hydrochloric acid. After the washing is complete the filtrate should be poured into a large beaker and diluted with clean water, and acid added, if necessary, to hold



CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

I.—METHOD OF DETERMINING CARBON IN IRON AND STEEL.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 252, Volume LXVII.*)

OPERATION.

Put 3 grams of fine borings of the iron or steel in a 16-oz. beaker or pint dissolving jar, and add 200 c.c. of an acid solution of the double chloride of copper and potassium which is at a temperature not above 100° F. Allow to dissolve, taking pains to agitate the liquid during solution. As soon as the separated copper has all disappeared, allow to stand a little while to settle if necessary, and then pour the supernatant the sub-chloride of copper in solution, until it is possible to see whether any carbon has escaped the filter. If any is found, of course the liquid must be passed through the filter again, or the material all thrown away, and a fresh start made. Dry the carbon at a temperature not above 212° F., and then place the boat with the dried material in it in the combustion furnace. While the drying is going on, weigh the absorption potash bulb and prolong, which have been previously prepared as described below, and place them in their proper position, in connection with the combustion train, which has likewise been previously prepared as described, and in which the preheating furnace has been lighted long enough, so that its porcelain tube is fairly red, for at least 5 or 6 in. of its length. Start the combustion by turning on enough burners at the front end of the combustion tube to embrace about 3 in. of it with flame, and at the same time see that the connection to the air gas holder is closed, and then open the connection between the oxygen gas holder and the combustion tube, and then adjust at the aspirator so as to allow about three bubbles a second to show in the absorption potash bulb. As soon as the combustion tube above the burners already lighted becomes perceptibly red, turn on enough more burners to embrace a couple of inches more of the tube, and allow this portion likewise to become perceptibly red. From this point turn on one or two burners at a time, allowing the tube above them to get red before turning on more, until enough have been turned on to heat the tube red a couple of inches toward the rear end from where the boat lays inside. Continue the combustion after the last burner is lighted, about 15 minutes for steel and not less than 30 minutes for pig or cast iron, taking care to keep the flow of oxygen to the combustion tube sufficient to maintain a slight pressure in this tube, and at the same time not allow over about three bubbles per second to pass the absorption potash bulb. After the burning is completed, turn down the gas supply to the burners by means of a cock one-half, or turn out every other burner so as to allow the combustion tube to cool down slowly, and then shut off the oxygen supply and turn on the air supply for aspiration. Allow not less than a liter of air to pass through the absorption potash bulb, at a rate of not over three bubbles a second. While the aspiration is going on, diminish the gas supply to the burners by means

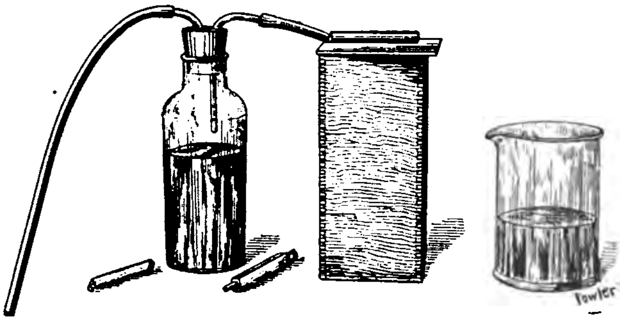


Fig. 1.

of the cock, or turn out additional ones as fast as the tube will stand it. When the aspiration is complete, detach the potash bulb and prolong from the furnace, close the ends with rubber caps, and place in the balance case. Allow to stand 15 minutes, and then weigh.

APPARATUS AND REAGENTS.

We prefer to use, in dissolving the iron or steel, a jar of thick, heavy glass, rather than a beaker. The jars we have found useful hold about a pint, and have a nose for pouring. One is shown in fig. 1.

about 40 in. long. The two horizontal parts at the top of the frame are perforated with ⅜-in. holes 5 in. apart each way, which holes, without any bushing, serve as bearings for the hollow tubular shafts. The top of each shaft carries a wooden pulley 4 in. in diameter, which has a brass bushing and set screw by means of which it is fastened to the shaft. Brass washers between the pulleys and the top of the frame carry the weight of the revolving parts and diminish the friction. A little tallow and graphite on the rubbing surfaces is also valuable for the same purpose. We use an electric motor for power, and the glass stirring rods revolve about 400 revolutions per minute. By taking care to wash the stirring rods both before and after using they may be adjusted once for all and left in position. The beakers or dissolving jars are supported on wooden blocks of the proper height, which blocks are movable, so as to allow the beakers or dissolving jars to be put in position or removed from the same without difficulty. With this stirring apparatus and the amounts of material previously prescribed, complete solution takes place in from 7 to 45 minutes, depending on the size of the borings and the nature of the steel or iron.

As will be seen by the cut, fig. 1, the devices for filtration consist of a receptacle to receive the filtrate, which is connected at the outlet with the exhaust pump or suction, and at the inlet with the platinum boat. The platinum boat is about 3 in. long, ½ in. wide at top, $\frac{7}{16}$ in. wide at bottom, and about ⅜ in. high. It is fitted with a perforated false bottom, which leaves a clear space underneath it of about ⅛ in. The boat is also fitted with a tubular opening at one end, which serves both as a means of connection to the inlet of the filtrate receptacle, and also as a passage-way from the boat for the filtrate. The boat rests on a clean glass plate, supported on a block, which glass plate serves to catch anything that may escape from the boat during filtrations, with a chance to recover the same if desired. This form of boat is as efficient as any we have ever seen, and seems to give less difficulty about keeping tight joints than those with perforated bottom. They may be obtained by special order from any dealer in chemical platinum.

The asbestos which we have found to give best results is the mineral known as "actinolite." We consider it essential to ignite the material as received after it has been picked up and

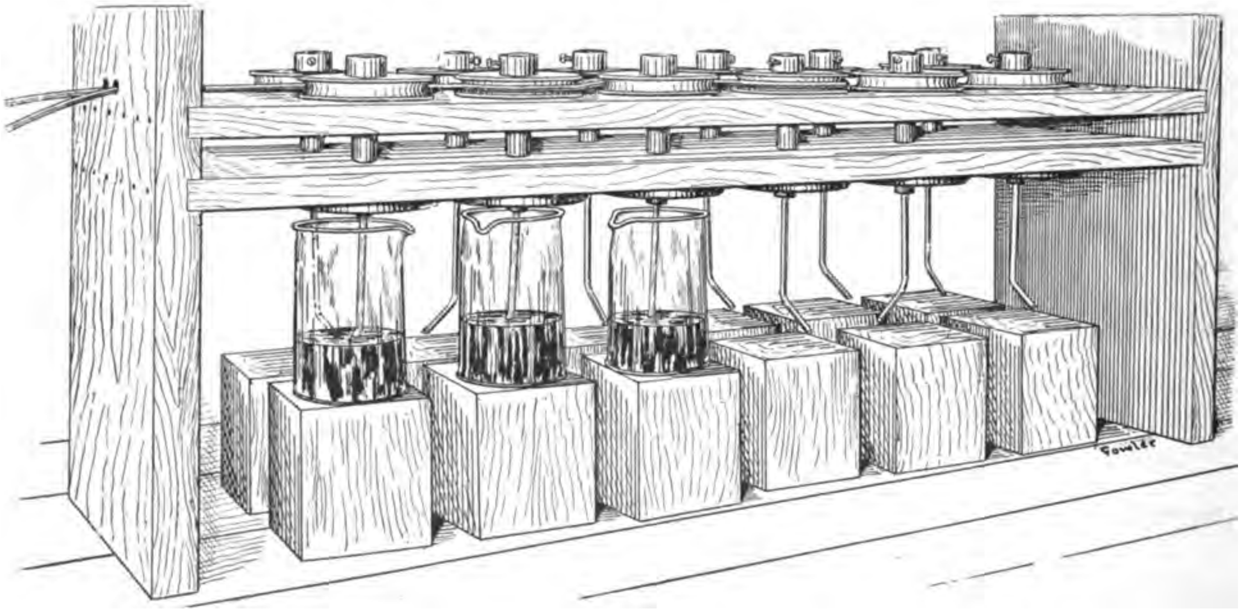


Fig. 2.

The agitating apparatus shown in fig. 2 consists, as will be seen, of a slight modification of the well-known stirring machine shown in the Chemical Analysis of Iron, by A. A. Blair, arranged to stir 12 beakers at once. The shaft carrying the stirring rod consists of a ⅜-in. diameter brass tube, carrying at the bottom a disk which revolves with it. This disk, which is 4½ in. in diameter and slightly turned up at the edges, serves very satisfactorily as a cover to the beakers in place of the perforated glass plate. The disk should revolve within about ½ in. of the top of the beakers. The hole in the brass tube used as a shaft serves to receive the cork carrying the glass rod, which, as is observed, is bent at the lower end so that it will just nicely revolve in the beakers or dissolving jars. The frame of the apparatus is made of wood about 11½ in. wide and

cut with shears into short lengths, either in a platinum dish over a Bunsen burner, or in the combustion tube itself, in a current of oxygen. After a quantity of the ignited material has been prepared it should be mixed with water in a beaker and kept under cover as stock supply. To prepare the filter in the boat everything is put in position just as for a filtration and the suction started. The asbestos and water mixture, which should be pretty well diluted, is first stirred up well, in order to make some of it float, and then poured on the boat its whole length, taking care to have the asbestos evenly distributed. The suction removes the water as fast as it is poured on, and shows where to pour next. A filter about $\frac{1}{16}$ in. thick seems to work very satisfactorily. It is usually not necessary to make a fresh filter after each combustion, especially if the copper is completely dissolved before filtration, and if proper care is taken to wash the carbon clean. Under these conditions the same filter may be used over and over again by simply scraping off a little of the top and freshening it up with a little of the asbestos and water mixture after each combustion.

The drying of the carbon on the filter may be done either in the well-known drying oven with hot water or in the drying oven with hot air. We use the latter with an automatic regulator on the gas supply to maintain constant temperature.

The combustion train is shown in fig. 3. Beginning at the left hand, first are two gas holders, one for oxygen gas and the other for air. These are simple copper gas holders, with movable weights for pressure. They are adjusted so that the pressure will just cause the gas to bubble through the purifying potash bulb next to the combustion furnace, but not cause it to pass through the bubble tube containing iron sulphate just to the right of the combustion furnace. The connection between these gas holders and what we call the preheating furnace is by means of rubber tubes and a glass Y-tube. These rubber tubes should, of course, be closed by a cock or clamp, so that gas can be taken from either without contamination from the other. The preheating furnace is, as will be the tube. This leaves abundant space in the tube for the boat, which should be pushed in so as to touch the silver roll. Next beyond the combustion tube is a bubble tube, not quite half full of acid ferrous sulphate solution, which serves to catch any free chlorine which may escape from the combustion tube, and next beyond this is a bubble tube, not quite half full of silver sulphate and water, which serves to catch any hydrochloric acid that may come out of the combustion tube, or from the ferrous sulphate bubble tube. The solubility of the silver sulphate being rather meager, it is desirable to add some of the solid salt to the bubble tube in order to prevent the necessity of too frequent charging of this tube. Next beyond the silver sulphate bubble tube is an ordinary chloride of calcium tube. In order to save space, we prefer the U form. Next is the absorption potash bulb. We prefer the Geisler form, and have them made so that when filled they, with the prolong, weigh from 50 to 60 grams. The ordinary size weighs from 80 to 90 grams. Next is the prolong, which is simply a small chloride of calcium tube filled with granulated chloride of calcium only. Next is another ordinary chloride of calcium tube to protect the prolong from moisture from the aspirator bottle. This bottle finishes the train. It is provided, as will be observed, with inlet at the top and side outlet at the bottom,

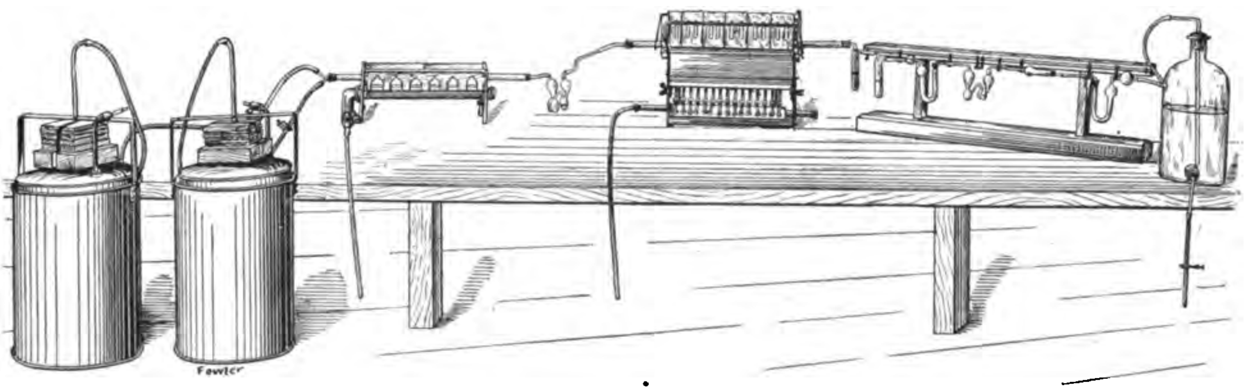


Fig. 3.

observed, a simple 12-in. Fletcher furnace, fitted with a porcelain combustion tube ⅝ in. in diameter and 20 in. long, which contains granulated oxide of copper for about 8 or 10 in. of its length inside the furnace. A second combustion furnace would do equally well for a preheating furnace. The corks used with this and also with the combustion furnace are rubber; also rubber tubes are used for connections. The placing of the porcelain tube in the preheating furnace should be such that not less than 4 or 5 in. of its length projects toward the combustion furnace, so that this end may not become heated, with consequent danger of volatilizing hydrocarbons from the rubber cork; also, to prevent overheating of the porcelain tube, the gas holes in the gas tube of the preheating furnace are stopped up about 2½ in. each way from the ends. Next beyond the preheating furnace is an ordinary Geisler potash bulb, which may be called the purifying potash bulb, properly filled with caustic potash solution, to retain any carbon dioxide that may be in the oxygen or air used, or that may be formed in the preheating furnace from the combustion or any vapors containing carbon in these gases. The connection between this potash bulb and the porcelain tube in the preheating furnace should be so arranged that the glass tubes, which are embraced with the rubber tube at the joints, should have square ends, and should touch, so as to avoid exposure of the current of gas to the rubber tube as much as possible. This same remark applies to all other rubber tube connections. Next beyond the purifying potash bulb is the combustion furnace. The 14-in. Bunsen furnace gives excellent results. We use coal gas for fuel. The combustion tube is royal Berlin porcelain, glazed inside and outside, ⅝ in. internal diameter, and 24 in. long. The tube should be placed symmetrically in the furnace—that is, should project 5 in. at each end. It should be prepared for use by placing a small plug of asbestos or three or four disks of copper gauze, which are large enough to fit tightly at a point 6 in. from the right-hand end of the tube. Then put in granulated oxide of copper, followed by another asbestos plug or copper gauze disks for 4½ in. toward the left-hand end of the tube. Then make a roll of metallic silver foil, 2 in. long, rolled moderately closely, until it almost fills the bore of the tube, and place this next to the material already in which latter is also provided with glass tube of sufficient length to give the necessary suction, and a clamp on the rubber hose connection to regulate the flow.

(TO BE CONTINUED.)

PHILLIPS'S FLYING MACHINE.

In our issue for June we presented illustrations of Phillips's flying machine, taken from *Engineering*, which give a very good idea of the general appearance of the machine. Since the publication of the above there has appeared in the London *Times* a description of the machine which, in some respects, is more complete than the one that we have already printed. We reproduce the more interesting details taken from the *Times*, referring our readers to our June issue for the illustrations of the machine.

The machine is built upon the principle of being sustained in its flight by means of induced currents acting upon slats or laths of wood arranged similarly to those of a Venetian blind, instead of the larger aeroplane to which designers of flying machines have usually had recourse. Not but that Mr. Phillips has used inclined planes, and used them of large size, too, but he has reduced their dimensions step by step, until the transverse sectional area of one of his present sustainers measures only 1½ in. in breadth by ⅛ in. in thickness at the front, tapering to nothing at the back. Broadly stated, the cross section of the slat is that of a knife-blade, with a thick edge at back and a thin one at front, and with the upper and under side of the slat curved, but both differently. The form, in fact, is such that when the machine is in motion the convex upper surface near the front or thick edge deflects the air upward, thus creating a partial vacuum on the upper surface of the slat. The under or concave surface of the slat is formed to a parabolic curve, which gradually puts the particles of air into motion downward, thus producing an excess of pressure on the under side of the slat. It thus follows that upon a forward motion being given to the machine, the horizontal air-pressure which is brought upon the slats becomes converted,