burgischer Carbidwerke for the preparation of nitrolim with an output of 2,500 tons per annum, near Bromberg, in North Germany, which is also completed, while the large works of the Cyanid Gesell-

schaft for an output of over 15,000 tons of nitrolim at Alz-Fluss, in Bavaria, are at present in construction. In the United States of North America the American Cyanamide Company has taken up the manufacture

of nitrolim, and is constructing on the Canadian side of the Niagara Falls works of a present capacity of from 5,000 to 6,000 tons per annum, to be enlarged later to an output of 40,000 tons.—Page's Weekly.

THE PROCESS OF COAL WASHING.*

DESCRIPTION OF THE APPARATUS EMPLOYED.

BY SAMUEL DIESCHER, SR.

THE washing of coal began with the use of coke for smelting purposes, particularly in blast furnaces. In Europe it has been practised about 75 years, because of the large amount of impurities in the coal mined there. Besides volatile matter and carbon, bituminous coal contains ashes and sulphur; both undesirable in the process of iron smelting. The ashes are partly slate and to a smaller extent are in combination with the pure coal. Some of the slate is separate and some attached to coal. It is impracticable to pick all the slate from the coal, as much of it is in too small pieces. The same is true of sulphur in the form of iron pyrites. As both these minerals are detrimental in the production of pig iron, means are necessary to eliminate them from the coal prior to its conversion into coke.

The wet concentration of various ores by means of hand screens was practised centuries ago in European mines. Later the screens were enlarged and mechanically operated. Hence the art was already known when the use of coke in the smelting of iron ores was initiated and it was found that the European coal was not pure enough. The adaptation to coal of the means employed in concentrating ores was only a small step and thus came about the art of coal washing. By crushing the coal, before washing, to sizes not exceeding $\frac{3}{4}$ -inch cubes, the slate and iron pyrites are split off and subsequent washing separates them sufficiently to afford good blast furnace coke.

Sulphur occurs in the coal in combination with lime, as gypsum, which is very difficult to eliminate by the washing process, because it tends to float, and also in combination with organic matter which cannot be removed by any mechanical process. The sulphur occurring as pyrites is largely roasted out in the coke oven, but the other two combinations remain with the coke. Another impurity in coal is what the miners call "bone," which is a combination of earthy matter and bitumen. Some mines contain much, others scarcely any. The nearer its specific gravity is to that of coal, the more difficult it is to wash out.

The more ashes and sulphur in coke the less its market value. With the content in ashes, increases also the quantity of limestone that must be put into the furnace. It takes 2 pounds of limestone for every pound of ashes in the coke, and then again it takes coke to melt that additional limestone. A little limestone must be added also to take up the sulphur in the coke, but still some joins the iron, making it red short.

Fortunately the extensive deposit of pure coking coal in Pennsylvania in the Connellsville region for many years satisfied the demand for coke for blast furnace use. Now, however, it is necessary to draw upon other localities where the coal is suitable after being

Endres, who, previously employed at the Prussian government mines, brought drawings and photographs with him and put them to use. During 1871 and 1872 he built several more washing plants; some in connection with so-called "Belgian ovens," that is, retort

FIG. 3.—PLAN AND SECTIONAL ELEVATION OF A TYPICAL MODERN JIG.

ovens, of the type used for utilizing the by-product from the coking process. These were built at Hazelwood and Hollidaysburg, Pa., Irondale, Ohio, and Equality and Joliet, Ill. A purely washing plant was erected near Mansfield, now called Carnegie, Pa. Soon after the Alpsville plant was put into operation, two companies of St. Louis, Mo., erected extensive washing and coking plants at East St. Louis, Ill. All the plants named have since been dismantled, chiefly because of the panic from 1873 to 1879, when there was no market for washed coke, Connellsville coke being sold at 90 cents a ton at the ovens. During 1879 the iron and coke business renewed, and the price of coke rose from 90 cents to \$6 per ton. Consequently, for a couple of years, some demand existed for coal-washing machinery, chiefly by the furnace companies maintaining coke works for supplying their own furnaces. During the last eight years the demand for coke has so increased that washing machines are now being erected at various places.

The washing process is based upon the difference in the specific gravities of the various minerals mixed with the coal as it is mined. These average:

Coal	1.3
Bone	1.4 to 1.8
Slate	2.3 to 2.7
Pyrites	3 to 5

If subjected to the action of a rising current of water the coal rises quickest, the bone next, then the slate, and finally the pyrites.

For many decades ore and quartz were separated in sieves submerged in water and jigged up and down until the quartz, being the lighter, collected on top and the heavy ore settled on the screen. Later on, larger screens were employed and suspended from counterbalanced overhead levers or flexible rods, relieving the operator from holding the sieve. Still later the screens were driven by power. The next step was the invention of the Harz jig, Fig. 1, which originated in the mining region of the Harz Mountains in Germany. Originally it was used exclusively for concentrating ores, but was later adopted also for washing coal. This machine consists of a tank divided into two compartments near the top by a short partition; one contains a screen dipping toward the front, and

the other a wooden piston operated by an eccentric. The front of the screen compartment is cut down below the other sides and provided with a shelf for the overflow to run out over. The water enters the tank through a pipe in the rear, below the piston.

The operation of the machine is as follows: After the tank is filled to overflowing the supply of water is continued and coal is admitted through the hopper at the rear of the screen. With every down stroke of the piston the water rises through the screen and lifts the coal and its impurities, gradually spreading them over the screen until the space above is filled even with the overflow line. From then on, the washed coal is carried over the shelf by the current. While the material travels from the rear toward the front, the whole mass is lifted and dropped many times; with every upward movement the lighter bodies rise quicker and higher, and with every downward movement the heavier particles sink faster and lower, separating the materials in horizontal layers according to their specific gravities. The pyrites, being the heaviest, will lie directly upon the screen, the slate above it and the coal above the slate.

In Fig. 1 will be seen a gate attached to the inner side of the front of the screen compartment for discharging the refuse at periods of 5 to 15 minutes, depending upon the proportion of refuse in the coal. The refuse drops into the narrow compartment in the front below the overflow shelf, which holds approximately half an hour's accumulation, and is periodically emptied through another gate at the bottom. There is also a valve in the bottom of the tank, through which any fine material which drops through the screen is from time to time discharged.

It is obvious that opening of the refuse gate must be properly timed. If too infrequent the refuse may accumulate until it passes over with the washed coal; if too frequent coal is discharged with the refuse. The close attention required from the operator prevents his taking charge of more than four jigs. Some modern washeries have 20 or more jigs, necessitating five or more men to attend them. To provide an automatic continuous discharge for the refuse, the Harz jig was variously modified. It was supposed that the reciprocating piston would oscillate the water in the tank uniformly, but the main body of water remains at rest and only that part displaced by the piston and supplied through the pipe is set in motion. This water chooses the shortest course, which is around the lower edge of the partition; therefore most of it passes through the rear half of the screen, near the coal chute. Proper washing requires uniform action of the

FIG. 2.—LUHRIG'S ATTEMPT TO IMPROVE THE HARZ JIG.

FIG. 1.—THE HARZ JIG AS APPLIED TO THE WASHING OF COAL.

purified. The first attempt in this country to wash coal was made in 1870, when a small washery was erected at Alpsville, about 24 miles from Pittsburg. This plant washed slack from the local mines, and the product was converted into coke at the same place. It was built by a German mining engineer, John J.

* Abstract of a paper read before the Engineers' Society of Western Pennsylvania.

accumulation of heavy refuse there. In short, the force of the current is greatest where the load is least, and least where the load is greatest.

Lührig undertook to remedy the evil by inclining the screen toward the rear, as in Fig. 2, so that the greatest depth and heaviest load came where the current is strongest. This would have been very good had a slate trap been located there, because the refuse travels toward that point, but instead he used a bed of feldspar all over the screen, made the holes in the latter large, and let the refuse drop through into the chamber below, to be removed by a continuous drain from the machine. On such machines all sizes of coal, up to above $\frac{3}{4}$ -inch mesh, were washed. The holes in the plates which formed the screen were 1 inch square, and the feldspar the size of walnuts. On account of the large holes and the coarseness of the feldspar a considerable quantity of coal dust goes with the refuse. An establishment using 16 of these jigs has three additional jigs for washing the refuse to save the coal it contains. There is also Lührig's jig intended for washing coarse coal, which is the same as the Harz jig; that is, its screen inclines toward the front and it has slate grates there and uses no feldspar.

Fig. 3 gives a sectional elevation and plan of a typical modern jig. The characteristic feature is that the screen is narrow and long; it is never over 24 inches wide, but may be as much as 6 feet long. The piston is of the same dimensions as the screen and is parallel with it. This jig may be used with or without a feldspar bed, in which latter case the refuse is removed at the overflow end of the screen. In either case the screen is level. If feldspar is used, the refuse drops through holes in the screen. Feldspar is advantageous chiefly in washing material from a $\frac{1}{4}$ -inch mesh downward, including dust. If used for larger sized coal the refuse must be washed to save the coal that drops through the screen.

The most rational way to obtain uniform action of the current is to locate the piston directly below the screen and make it practically of the same dimensions as the latter. Fig. 4 gives a front elevation, plan, and end section of such a machine. With this construction the screen may be of any size and shape and yet work uniformly as long as the piston is of approximately the screen's dimensions. This machine may be built with or without valves in its plunger. Without valves the water displaced by the down stroke of the piston passes into a secondary compartment and returns again with the rise of the piston. If there are two jigs in one tank the pistons work in opposition, one rising while the other descends, thus the water displaced by one fills the space vacated by the other. If the piston has valves, the water supply for a group of two or four jigs within one large tank is all led into a common compartment from which each jig draws its supply. The valves are either of steel plate or thin iron castings.

The periodical removal of the refuse collected in the compartment shown at the front of the Harz jig is a drawback, and is frequently obviated by employing a short conveying screw and a small elevator that con-

and is surrounded by a sheet-iron cylinder, open at top and bottom, which is considerably larger in diameter and higher than the pipe, and is also adjustable in height to insure its greatest efficiency. As seen in Fig. 5, the adjusting is by screws and nuts which suspend the cylinder from an iron bar laid across the screen compartment of the jig. The passage of the refuse between the lower edge of the cylinder and the surface of the screen is regulated according to the quantity to be discharged through the central pipe in a given time. The refuse drops into the space below

Fig. 5.

Fig. 6.

Fig. 7.

DETAILS OF THREE DIFFERENT SCHEMES FOR EFFECTING AUTOMATIC CONTINUOUS REFUSE REMOVAL.

the screen, whence it is removed either periodically or continuously in one or the other manner referred to before. With every upward current the refuse within the cylinder rises above the top edge of the pipe and as the particles toss each other laterally, a portion enters the pipe and is thus removed. This device is good for washing ore where the bulk treated is small compared with the quantities of coal that must go through a jig during a given time; for this reason it is not used much in the coal washing process.

Another device better adapted for coal is shown in Fig. 6. This is an oblong box, open at the top and bottom and provided with vertical sliding gates, about 5 or 6 inches wide, which are raised by the operator sufficiently to admit the refuse as fast as it is brought upon the screen with the coal. An iron baffle at the opening in the front plank accumulates the refuse until even with its upper edge, the additional refuse being discharged with every revolution of the eccentric shaft.

Fig. 7 is a section of a trap with two gates. Its feature is an overflow shelf projecting some distance into the screen compartment and provided with an adjustable gate equal in length to the width of the jig screen. Another gate, located where the refuse drops into the refuse compartment, or to a conveying screw and elevator, performs the function of a baffle. All these traps are based upon the same principle—namely, that sinking the lower edge of the cylinder in Fig. 5 or that of the gates in Fig. 6 or that of the cup in Fig. 7 a certain depth into the material on the screen leaves just opening enough for the refuse to enter the trap at the rate it is admitted with the coal. With every upward current some of the refuse within the

coarser and accordingly larger amount of coal is treated during a given time. For this reason the box is extended beyond the middle of the screen, because the coarsest and heaviest refuse drops earliest, and to forestall a detrimental accumulation of this heavy stuff a large gate is provided at that particular point of the machine.

A well-working jig will wash about 4 tons of Pittsburgh coal per square foot of jig screen in 10 hours. The process is slower the more bone the coal contains, and the finer the coal must be crushed to separate the

impurities preparatory to washing. It is an advantage to crush all coal to a certain maximum size, as, for example, to pass a $\frac{1}{2}$, $\frac{5}{8}$, or $\frac{3}{4}$ -inch mesh. If there is no provision made for washing the fine coal, from $\frac{1}{4}$ -inch mesh down, in separate machines, it may be washed together with $\frac{1}{2}$ -inch or even larger coal, but only on a level screen; otherwise much of the fine coal is sucked through the screen whenever the current passes backward. A slanting jig screen, unlike a level screen, always has its highest part exposed, or uncovered by refuse. To save the fine coal that drops through the screen is not advisable, because much sulphur and fine slate is mixed with it and would impair the purity of the coke if saved.

The first washeries built in this country were very simple compared with the large modern plants established at some of the coke works in Westmoreland County, Pennsylvania, and elsewhere. Provisions for collecting and saving sludge add greatly to the cost and complication of such plants, as does also the present tendency to place heavy machinery in the third or fourth story of a wooden building. Matters can be very much simplified by washing the fine coal separate from the coarser coal, and passing it over slanting draining screens, directly as it leaves the jigs. This does away with the expensive and trouble-breeding sludge basins. The water can be used over after passing through a comparatively small settling tank having means for continuously removing sediment. In this case the coarse coal would be conducted directly into the elevator booth, and the water would flow back to the centrifugal circulating pumps, to be used over again.

The quantity of water used in washing coal is, if none is wasted and none used over, approximately $1\frac{1}{2}$ gallons per minute for every ton of coal washed in 10 hours. Where water is scarce and must be used repeatedly, the continuous supply required is from 10 to 20 per cent of the above amount. Water for washing coal should be renewed as often as conditions permit, for more or less sulphur and fine refuse is always suspended in it which is bound to affect the quality of the product. A great variety of conditions contingent to different localities have their influence upon the cost of construction of coal washing plants. Approximately a plant will cost from \$35 to \$50 for every ton of its washing capacity in 10 hours. Thus a plant washing 500 tons in 10 hours, at say \$45 per ton, will cost \$22,500.

Mr. T. U. Walton, of Sydney, has published an account of a remarkable deposit found in the brass tubes of a small locomotive that had been working for some time. It was in the form of a dense black scale, thicker than the walls of the tubes, and similar to gas-black in appearance. On analysis, it was found to consist of 88.89 per cent of fixed carbon, 2.98 per cent of volatile hydrocarbons, and 8.13 per cent of ash. As the ash in the coal used was about 4 per cent higher than that of the deposit, coal dust could only have been the source of part of the deposit, the remainder probably consisting of gas carbon derived from the condensed hydrocarbons. A considerable loss of heat would probably result from this coating of the tubes with a thick layer of a material of low heat-conductive power. In experiments made in the University of Illinois, by Messrs. Schmidt and Snodgrass, it was found that the loss of heat with a scale $\frac{1}{8}$ inch thick was from 10 to 12 per cent, or considerably less than was anticipated. A further conclusion arrived at was that the structure of the deposit had far more influence than the thickness upon the loss of heat, and that the chemical composition was only of importance in this respect in so far as it influenced the structure.

Fig. 4.—PLAN, FRONT ELEVATION, AND END SECTION OF A DOUBLE JIG GIVING UNIFORM ACTION.

tinuously removes the refuse at the rate at which it is produced. One of the oldest devices for continuous and automatic refuse removal is shown in Fig. 5. It consists of an iron pipe, usually about 3 inches in diameter, that projects upward through the jig screen about 2 inches, depending upon the size and average specific gravity of the refuse. It is adjustable through a threaded socket secured in the center of the screen,

trap moves into the collecting chamber, or elevator, leaving insufficient to resist the lateral pressure exerted by the outer material, and thus while the latter sinks with the downward current, as much refuse will enter as has been discharged at the preceding rise of the material.

The device in the jig shown in Fig. 4 is larger than usual, because it is on a very large screen where a

WOOD PRESERVATION.*

THE MEANING OF DECAY AND HOW IT MAY BE CHECKED.

BY W. F. SHERFEESE.

It is easy to see that if the length of time timbers can be used is doubled, only half as much timber will be required as before and only one-half as much money will need to be spent in the purchase of timber. This is the chief gain in treating wood with preservatives. Yet there is another and important one. Many woods, which for a long time were considered almost worthless, can be treated and made to last as long as the scarcer and more expensive kinds. This of course means that the consumer will have the choice of a much greater number of woods than he had before and at less cost.

Wood preservation, then, prolongs the life of timbers in use, reduces their cost, and gives to the user a wider choice of woods than ever before.

Methods of preservation must be varied for different localities and different kinds of wood.

WHAT DECAY IS.

The decay of a plant body, such as wood, is not an inorganic process like the rusting of iron or the crumbling of stone, but is due to the activities of low forms of plant life called bacteria and fungi. Bacteria are among the simplest of all forms of life, often consisting of but a single cell, microscopic in size. Sometimes several such cells may be attached to each other, and so form a thread or filament. Usually they are colorless, and multiply by the division of the parent cell into other cells, which, in turn, divide again.

Fungi, although much more complicated than bacteria, are also low in the scale of creation when compared with familiar flowering plants and shrubs. They consist merely of tiny threads or hyphæ, which are collectively known as the mycelium. In many of the higher forms of fungi the threads grow together to form compact masses of tissue. Familiar examples of these forms are the toadstools which grow on damp, rotting logs, and the "punks," or "brackets," on the trunks of trees in the forest.

The causes of decay in wood, however, are not these fruiting bodies themselves. Spores, very primitive substitutes for seed, which are borne in the countless compartments into which the under surfaces of the fruiting bodies are sometimes divided, are produced in infinite number, and are so fine that they can be distinguished only by the microscope. When seen in bulk they appear as the finest dust. Like dust, they are carried by the wind and strike all portions of the surrounding objects. Few species of fungi successfully attack healthy living trees, and only a comparatively small number can attack and destroy wood. Yet the spores of some find a lodging in dead portions of a tree or in cut timber, and, if the wood is moist and in the right condition for the spore to grow, it germinates and sends out a thin, filmlike white thread, which, by repeated branching, penetrates the entire structure of the wood. These are the real agents of decay.

This is not the only way that a fungus can enter a sound stick of timber; for if a good stick is lying close to a rotting one, the mycelium may grow over or through the moist ground and so reach the sound stick, which it immediately attacks. Sometimes, too, when a tree is cut it already has a fungus growing in its wood. If the fungus happens to be a true parasite—that is, if it can grow only in living tissues—it will die when the tree is felled; but if it has been accustomed to growing in the heartwood of the tree, which is practically dead, it may continue to live and develop even after the tree has been sawed into timber.

Wood is composed of minute cells. The chief material of the cell-walls is a substance called cellulose, and around this there are incrustated many different organic substances known collectively as lignin. Most of the wood-destroying fungi attack only the lignin; others attack the cellulose alone, while a third class destroy all parts of the wood structure. The lignin and the cellulose are dissolved by certain substances secreted in the fungi, and thus serve as food for the fungus growth. In this way the fungi can develop until they extend throughout every portion of the timber. After a time the amount of fiber changed into food and assimilated by the fungus causes the wood to become discolored. Discoloration may also be produced by pigments in the fungus or secreted by it. Finally so much of the wood fiber is eaten away or changed in composition that its strength is greatly diminished, the texture becomes brittle and disconnected, and the wood is said to be "rotten."

But food is not the only thing that a fungus requires

for its growth and development. It must also have heat, air, and moisture. If any one of these is lacking the fungus cannot develop. The necessary heat is supplied by almost every climate, and it is only in rare cases, as under water or deep under the surface of the ground, that air can be excluded from the timber. Of the four requirements, therefore, two are beyond control. It is only by depriving the fungi of food or moisture that the destruction they cause can be prevented.

HOW DECAY CAN BE RETARDED.

By Seasoning.—The simplest way of prolonging the life of timber exposed to the attack of wood-destroying fungi is to reduce the moisture content of the wood. The amount of water in green timber varies according to the part of the tree from which the wood is cut. The outer layers of the trunk are composed of sapwood, the cells of which contain large amounts of organic substances which serve excellently as food for the fungi. Moreover, sapwood always contains a large amount of water. It is the portion of the tree, therefore, most susceptible to attacks from fungi. Heartwood, which can usually be distinguished from sapwood by its darker or more reddish color, contains, on the other hand, much less moisture. It is therefore more durable than sapwood. But because its pores are stopped up by germs and resins it dries out much less rapidly than the more porous sapwood. In almost every case as much care should be taken thoroughly to dry out the heartwood as in the case of the moister sapwood.

By piling the timber so as to permit free access of air all around it the moisture content of timbers of certain sizes can be reduced to about 15 or 18 per cent. Of course the climate has a great influence on the rate at which the wood dries out and the total amount of moisture it loses.

The moisture content of air-dry wood can be still further reduced by kiln-drying; and this is employed to a considerable extent, but usually for other purposes than increasing the durability of the wood. Moreover, either air-dry or kiln-dry wood has the power to reabsorb moisture when exposed to the atmosphere in damp situations, and so the benefits of drying, as far as durability is concerned, are only moderate. Yet the increased life which it gives is, in nearly all cases, more than sufficient to repay the added cost of seasoning.

The strength of partially seasoned timber, other things being equal, increases as the amount of moisture it contains decreases. Thoroughly seasoned timber of small sizes is sometimes three or even four times as strong as the same timber, when green. Moreover, during the process of drying out, important but little understood changes take place in the organic contents of the wood cells, by which the wood is not only rendered less attractive to fungi, but is made more permeable and so better prepared for preservative treatment. All timber should be thoroughly seasoned before being exposed to decay.

An exterior coating secured by dipping a post in a thin solution of cement or other material that will harden on the post is not an effective protection, because in shrinking or swelling the wood forms cracks through which decay enters.

By Chemical Impregnation.—By far the best method of checking the growth of fungi, however, is to deprive them of food. This can be done by injecting poisonous substances into the timber, and so changing the organic matter from foods suitable for fungi into powerful fungicides. It is a mistake to suppose that the germs of decay are inherent in the wood, and only need an opportunity for development to bring about its destruction. Several processes for the preservation of wood have been founded on the false assumption that it is necessary to destroy the "germs" in the interior of the timber. The impression doubtless arose from the fact that, after a stick of timber begins to rot, it is impossible to tell just where the fungus spores germinated and gained entrance into the timber. Moreover, the fact that the interior of the wood may have reached an advanced stage of decay before there are any external evidences of the fungi—such as fruiting bodies, or films of mycelium—tends to convince the casual observer that decay starts from the interior. Yet the wood-destroying agencies start from the outside. This explains the efficacy of certain paints which merely form a superficial coating over the surface of the timber, but which are poisonous enough to prevent the spores from germinating, or the hyphæ of most forms of wood-destroying fungi from penetrating

into the unprotected wood in the interior. The ancients were in the habit of painting their statues with oily and bituminous preparations to preserve them from decay. The great wooden statue of Diana at Ephesus, which was supposed to have descended miraculously from heaven, was protected from earthly decay by oil of nard. Pettigrew extracted the preservative fluids from the heart of an Egyptian mummy that had resisted decay for over 3,000 years, and found that decomposition immediately set in. This showed that it was the presence of the antiseptics which prevented decay, and not a chemical change of the tissues.

PRESERVATIVES AND PROCESSES IN THE UNITED STATES.

Of the many antiseptics which have been proposed for the preservation of timber only four have been largely used with success in the United States. These are creosote, zinc chlorid, corrosive sublimate (bichlorid of mercury), and copper sulphate. At the present time copper sulphate has fallen into almost total disuse, and corrosive sublimate is restricted to two plants in New England. The use of this latter is the so-called "kyanizing" process which is so frequently referred to in all the literature of wood preservation. In general, the process consists in steeping the timber in a dilute solution of corrosive sublimate long enough to insure thorough penetration.

Creosote and Zinc Chlorid.—Thus in the United States creosote and zinc chlorid are the only preservatives in common use. There are many other patented substances known by various names; but most of them have for their base one or the other of these two preservatives. Creosote is a by-product of coal tar, which is produced at most plants for the manufacture of illuminating gas and at by-product coke-oven plants. This tar is distilled, and during the process the condensed vapors are run into three separate vessels and thus separated into the light oils of coal tar or naphthas, the dead oil of coal tar or creosote, and pitch. Creosote is not a simple substance like zinc chlorid. On the contrary, it contains a large number of constituents of great chemical complexity.

Wood tar, when distilled in a similar manner, gives "wood creosote," which like that derived from coal tar, possesses strong antiseptic properties. There is also on the market a so-called creosote, a by-product of water-gas tar or tar manufactured from kerosene oils, which for wood preservation is probably inferior to the true creosote. In general, however, by "creosote" is meant the dead oil of coal tar.

Zinc chlorid is obtained by dissolving metallic zinc in hydrochloric acid. This is further diluted by water before it is used for wood preservation.

Just as there are two preservatives in common use, so there are two principal methods of injecting them into the timber. These may be called the "pressure-cylinder method" and the "open-tank method." A third process, known as the "brush method," is used to a more limited extent.

The Pressure Processes.—Up to very recent times the pressure-cylinder method was used almost exclusively in the United States. With creosote it is known as the Bethell process, and with zinc chlorid the name of Burnettizing is applied. The timber to be treated is placed on iron trucks or "cylinder buggies" and drawn by steel cables into huge horizontal cylinders, some of which are 8 or even 9 feet in diameter and more than 150 feet long. These are capable of withstanding high pressure, and their doors are so arranged that, after the timber is drawn in, they can be closed and hermetically sealed. It is the common practice in this country—a practice which long experience in Europe, as well as in America, has proved to be unwise—to treat the timber before it has had time to dry out in the open air. The following is the usual method. After the doors are closed live steam is admitted into the cylinder, and a pressure of about 20 pounds per square inch is maintained for several hours, the exact time depending upon the individual opinion of the operator, as well as upon the moisture content and size of the timber under treatment. In some cases the steam pressure is allowed to go considerably above 20 pounds, but there is constant risk of injuring the strength of the timber. When the steam is at last blown out of the cylinder, the vacuum pumps are started and as much of the air as possible is exhausted from the cylinder and from the wood structure. This process also continues for several hours. Finally, after the completion of the vacuum period, the preservative is run into the cylinder and the pressure pumps are started and continued until

* Abstracted from a Forest Service circular published by the United States Department of Agriculture.