ber. These investigations have been organized and outlined by Doctors von Schrenk and Hatt of the Bureau of Forestry.

This general plan was pursued during the last few months at the timber treating and testing station at St. Louis in accordance with the following outline:

(1) To determine the effect of the preliminary processes, such as steaming, on the mechanical properties of the timber.

(2) To determine the effect of preservatives on the strength of timber, eliminating the effect of the preliminary processes.

In order to determine the effect of these factors, the programme was divided into two parts—part 1, the effect of the preliminary process, and part 2, the effect of preservatives.

The effects of the preliminary process were determined only on loblolly pine. Both green and seasoned timber was used in determining the effect of preservatives. The preservative fluids investigated included only creosote and zinc chlorid.

In making comparative strength tests of treated and untreated timbers, it is necessary to eliminate as far as possible the variations due to the great differences in quality of individual pieces of wood. This was accomplished in this case by using 11-foot timbers cut at the same time from one forest site. In testing the influence of preliminary processes of seasoning, a 3-foot section was cut from one end of each timber and sawed up into test pieces, which furnished a basis of comparison between (1) the results of tests on these "control" pieces, and (2) the results on test pieces taken from the remaining 8-foot section after the latter had been subjected to the various preliminary seasoning processes in the treating cylinder.

In testing the effect of preservatives themselves the entire 11-foot timber was subjected to the preliminary seasoning processes, after which a 3-foot section was cut from the end of each timber. The 3-foot section thus having been subjected to the preliminary seasoning processes formed a basis of comparison with the remaining 8-foot section, which was treated with the preservatives. In this way the separate effects of the preliminary processes and the effects of the preservatives could be isolated and determined.

Because of an apprehension that defects of brittleness of treated timbers might not be evidenced by the ordinary tests under slowly applied loads, provision was made for both static tests and impact tests. The test pieces were subjected to crossbending strain, compression along the grain under both static and impact conditions, and under shearing parallel to the grain, and compression at right angles to the grain under static conditions. The data taken include the moisture conditions, specific gravity, and rate of growth. During the treating operations, records were kept of the temperature to which the timbers were subjected at all stages, the amount of water lost or gained, and of the amount of preservatives absorbed, as indicated by gross weight and subsequent chemical analyses of the test pieces.

Ordinarily the strength tests were made immediately after treatment in the cylinder. In order, however, to determine what weakness might be introduced by changes in the physical condition of the preservatives in the wood through lapse of time, a complete series has been set aside for subsequent operations. An additional set of test pieces has been loaded with different percentages of the strength, as exhibited under the ordinary tests, and this load allowed to act for long periods of time, the deflections being measured from day to day.

While this programme is not sufficiently advanced to allow the drawing of final conclusions, yet the preliminary results are fairly indicative of what may be expected. It is found that the steaming process weakens the resistance of the wood fiber to both static and impact loadings. It may be stated that this diminution of strength is very nearly in direct proportion to the length of time that any given steam pressure is applied. The diminution of strength was found to be 25 per cent after a pressure of 20 pounds was applied for ten hours to green loblolly pine, and 10 per cent when a pressure of 20 pounds was applied for four hours. This diminution of strength increased very rapidly when the pressure rose above 20 pounds, and amounted to about 25 per cent when a pressure of 50 pounds was applied for four hours.

It will be easily seen that when the conditions of time and pressure are made very severe, the conditions prevailing in a pulp mill industry will be approximated. Evidently it is well to avoid when possible the use of these preliminary steaming operations in the wood preserving industry.

With relation to the effect of preservatives themselves, the latter is distinct from the preliminary process. It may be said that the treatment with zinc chlorid does not seem to further reduce the strength of timber beyond the effect of the steaming process. This might have been expected when it is considered that the strength of the zinc chlorid solution ordinarily used does not exceed $2\frac{1}{2}$ per cent. The strength of timber that had been treated with the $2\frac{1}{2}$ per cent solution of zinc chlorid after having been steamed four hours at 20 pounds pressure was the same as that of timber which had been steamed without the subsequent application of zinc chlorid. The same statement may be made of timber treated with an $8\frac{1}{2}$ per cent solution of zinc chlorid. It may be that subsequently the crystallization of the zinc chlorid will weaken the wood fiber. This remains to be determined.

The effect of the creosote appears to be the same as that of an equal amount of water in weakening the

fiber. That is to say, the strength of creosoted timber is that of green timber. The difference is that while green timber gains strength upon seasoning, the creosote oil remains in the wood, and it appears from analysis of a pile 35 years old that the oil remains in a liquid condition. Consequently, comparison between seasoned timber and creosoted timber will always result to the disadvantage of the latter as far as its strength is concerned. In the case of creosoted wood, it also remains to determine what changes in the wood fiber take place through lapse of time in the presence of creosote oil.

It is expected that a bulletin will be issued upon the results of these investigations when the tests are completed. This bulletin will also contain the results of the investigations to determine the best methods of preserving wood so that the maximum impregnation may be obtained with the least expenditure of oil per cubic foot of timber.

THE PINTSCH SUCTION GAS PRODUCER.*

By S. F. SAEGER.

THE development of the gas producer has brought out a new type of gas engine. Producer gas requires an engine with high compression, large inlet valves and governor control on the admission of both air and gas and the development of the gas producer industry was greatly retarded by the fact that these engine conditions were not seen and met.

The idea of making the suction of the gas engine piston generate its own gas had been advanced, and was, in fact, patented by C. Wiegand in 1884, but after investigation on the part of several interested firms the scheme was dropped and the patents allowed to lapse. Wiegand was, however, close to the solution of the problem and failed only because of an incomplete understanding of the requisite conditions.

In the fall of 1900 the firm of Julius Pintsch, of Berlin, Germany, put upon the market a practical suction gas producer which overcame all of Wiegand's difficulties. This producer was simple in construction and operation, required little attention and gave a brake

or chimney, the middle a small tubular boiler, and the base section acting as a cleaning-pot and water seal when the engine is not running. By the passage of the hot gases coming from the generator through the flues of the boiler, the gas is cooled and steam is generated which is passed back under the grate for the purpose later described. The cleaning-pot or bottom section collects the heaviest dust and dirt coming over with the gas. By the admission of water to the cleaning-pot on shutting down, the rest of the apparatus is water sealed and the gas therein kept intact for starting again.

The scrubber should never feel more than warm to the hand, otherwise steam will pass through it to the apparatus beyond, carrying with it a considerably greater percentage of dust, and the gas will not be cool when it reaches the engine. The gas must reach the engine cool or the charge taken in will be a charge of expanded and rarefied gas and will not carry sufficient energy.

In the cleaner the gas gives up the last of its dust and moisture and emerges cool, clean, and dry.

The gas governor (a Pintsch patent) used on these plants is of great value. The engine, on its charging stroke, instead of drawing entirely from the producer draws its charge in part from the governor and the governor-spring then compensates this by drawing in a fresh charge from the producer. The resulting suction on the producer when the governor is used is a steady draft through the apparatus instead of the intermittent pull which is made by the suction stroke of the piston. This steady suction gives a steady, even draft through the fire, which is an essential condition for the continuous formation of gas of a uniform quality, and as shown by actual test gives an added economy of 10 per cent. Another great benefit derived from the governor is the ability to run any number of engines from a single producer with certainty of operation and without any loss in economy, it being only necessary to attach a governor to the individual gas main leading to each engine.

The theory of the formation of the gas is that, by limiting the amount of air admitted to the fire, complete combustion of the coal is not permitted and the

THE PINTSCH SUCTION GAS PRODUCER, 150-HORSE-POWER PLANT.

horse-power-hour in small units on one pound of Belgian anthracite. Four years' practical experience with this plant brought many improvements and the construction of the present Pintsch suction gas plant is as follows: In the illustration A is a blower, furnishing draft for starting the fire and raising the heat in the generator to the proper temperature for the production of gas; B, a generator, equipped with a grate on which the coal is burned, a hopper, which allows charging during operation, a window valve for inspection of the fire, and fire doors for poking down; C is a vaporizer fitted with a small tubular boiler for the generation of steam and a relief pipe or chimney for use when the engine is not running; D, a scrubber consisting of a coke tower with a water spray for washing the gas; E, a cleaner containing wooden trays covered with wood shavings or saw-dust through which the gas is filtered, giving up the last of its dirt and dust; F, a governor or pressure equalizer for maintaining a steady pressure throughout the apparatus.

To operate the plant, a fire is lighted in the generator and a small amount of coal added, the blower being run until the fire is burning strongly with the relief valve, R, open. After ten to fifteen minutes' blowing, the fire is sufficiently hot to give off gas; the relief valve is then closed and the gas allowed to pass through the apparatus, the blower being kept running at slower speed until the gas burns freely at a test cock beside the engine. The engine is then started, the blower stopped, and the formation of gas becomes automatic, the suction stroke of the engine furnishing the draft through the fire. In ordinary practice, the fire is left burning over night with limited draft and only a few minutes' blowing is required to brighten up the fire in the morning. The generator should be kept full of coal and the fire kept clean and bright. Since the apparatus is always under a slight vacuum, the fire doors can be opened at any time for cleaning out the fire.

The vaporizer is built in three sections, the upper being simply a chamber connected with the relief pipe

supply of oxygen being insufficient, carbon monoxide, CO, is formed instead of carbon dioxide, CO₂, while the steam formed in the vaporizer is led back under the grate and breaks up on striking the incandescent fuel, giving free hydrogen and carbon monoxide, the carbon monoxide and the hydrogen forming the power gas for the engine. The average gas with a good grade of anthracite should have a heat value of 130 to 140 B. T. U. per cubic foot and the constituents by volume should be as follows:

Carbon dioxide, CO ₂	6 per cent
Carbon monoxide, CO.....	24 per cent
Hydrogen, H	15 per cent
Nitrogen, N	55 per cent
Hydro carbon, CH ₄	trace
Oxygen, O	trace

Should the apparatus be of faulty design and more steam be admitted than the fire can break up, the effect will be a deadening of the fire and the diminution of the gas formed and in the end a complete shutting down. On the other hand, if an insufficient amount of steam is provided, the grades will burn out rapidly and the gas through a lack of hydrogen will be lacking in power. When anthracite is used the amount of water transformed should be from 0.8 to 1.2 times the weight of the coal burned.

The cleaner is often left off in the cheaper forms of apparatus, but an examination of the pipes on such a plant after a month's use will conclusively prove its necessity. Where water is an important factor the scrubber may be run hot and less water used, but it will be done at the expense of the cleaner, which will be forced to remove a greater percentage of dust, the same having been carried through to it by the non-condensed vapor; the sawdust and shavings would therefore require more frequent cleaning and renewal. Wherever necessary a cooling system can be installed and the water re-used after slight filtration.

As an example of the efficiency with which the gas in this apparatus is cleaned and dried an instance may be cited of an installation of Julius Pintsch at Heusy

* Abstract of a paper read before the Michigan Engineering Society. Our illustration is taken from Engineering News.

in Belgium, where a plant was run for an entire year without any cleaning whatsoever of either the engine or gas apparatus and the deposit of foreign matter found in the same at the end of the year was inappreciable. As for its reliability, a Pintsch producer and 50 horse-power Deutz engine was, in one instance, through necessity, run continuously night and day for nine months without a single stop for any cause whatsoever.

The superiority of the suction system over the old pressure type of gas producers has been conclusively demonstrated. There were originally many objections raised to the suction type and the idea of having the engine draw in its charge of gas, thereby making the draft for the fire and rendering the apparatus automatic, was considered impracticable. The point was raised that the gas being at less than atmospheric pressure would interfere with the satisfactory working of the engine. If it were impossible to regulate the admission of the air with the pressure of the gas this objection would hold true, but the same is taken care of by providing a separate air inlet on the engine which allows the formation of a suitable mixture in all cases.

The suction gas plant is simpler, cheaper, and requires less room than the pressure plants. It is more economical of fuel and requires less attention. It requires no separate steam boilers and there is no steam under pressure. It requires no large gas holders and there is no chance for gas to escape into any of the rooms of the building, as the whole apparatus is always under slightly less than atmospheric pressure and any leakage would be a leakage of air into the apparatus and not of gas out. A leakage sufficient to bring about a stoppage would have to be very large and could not occur in regular working except through some extraordinary accident.

The working of the Pintsch plant is practically automatic and the fire can be poked down and clinkers and ashes removed without causing any interruption to the production of the gas.

The air entering the producer below the grate is piped from outside the building so that any gas which might collect due to a sudden stoppage of the engine or a clogging of the pipes must escape through this inlet pipe to the outer air. Any irregularity is at once traceable by a series of gages which show the amount of vacuum at all times in the various parts of the installation.

It is a scientifically designed plant, thoroughly worked out and certain of operation, requires comparatively little room and is of such a character as to be a perfectly safe installation in office buildings, hotels, and the like, for which work it is in fact in wide use abroad, where Julius Pintsch has already installed over 2,000 plants ranging from 4 to 2,000 brake horse-power.

Julius Pintsch has built producers in single units up to 2,000 horse-power on the same lines as the smaller plants. These plants are operating with perfect success and consume only about $\frac{3}{4}$ pound of coal per brake horse-power per hour, the consumption decreasing with the increasing size of the unit. While this type of apparatus here illustrated has been spoken of as only available for anthracite coal it is with slight alterations equally available for any fuel that has not a tar base.

The consumption with gas coke, clean gas coke being advisable because of its freedom from sulphur, is in the 50 horse-power size 1.07 pounds per brake horse-power per hour, and about the same with charcoal. With pea anthracite at \$5 a ton, the fuel cost is $\frac{1}{4}$ cent per brake horse-power per hour.

To date, the use of bituminous coal is confined to large units. To successfully operate a gas engine the tar must be removed, which necessitates either an elaborate system of scrubbers and cleaners, or the combustion of the tar in the producer itself. Working on the latter principle Julius Pintsch now has in operation plants for both lignite and bituminous coal, and a plant of 400 brake horse-power is working admirably on bituminous coal with the very low consumption of 0.625 pound per brake horse-power per hour. With bituminous coal at \$3 a ton this brings the cost per brake horse-power per hour down to less than 0.1 cent, which, barring water power and natural gas, may be said to be the cheapest form of power yet known.

THE JUST-HATMAKER PROCESS OF MANUFACTURING MILK POWDER.*

By the English Correspondent of SCIENTIFIC AMERICAN.

IN the issue of the SCIENTIFIC AMERICAN for July 19, 1902, we described the experiments and successful manufacture of separated milk powder as devised by Dr. Joseph H. Campbell, of Jersey City, N. J. Simultaneously with these experiments, investigations to achieve the drying of full-cream milk as well as of separated milk were being conducted by Messrs. Just and Hatmaker in France, with conspicuous success.

The obtaining of milk in dry form is a great desideratum, not only on account of saving in bulk and convenience of transit, but hygienically. As has been pointed out by William S. Magill, M.A., M.D., of the University of Paris, and formerly bacteriologist of New York University, and chief of the Research Department of the Carnegie Laboratory, New York, certain improvements in ordinary cows' milk are absolutely imperative before it can be administered to infants with perfect safety. He has conclusively shown that milk as it comes from the cow always contains a large number of germs, and that such milk offers a most favorable medium for the rapid development of these germs, while there is time for their full development in nearly all cases, before the milk is actually consumed. These

germs in the milk not only live upon it, and thus impair its nutritive value, but, what is far more important, they leave in it all their wastes, which are poisonous and the most prolific cause of infant mortality.

Various efforts have been made to retard the development of these germs, and to reduce their number by refrigeration, pasteurization, and so-called sterilization, but with only a partial measure of success.

Messrs. Just and Hatmaker have solved the problem in their process by completely destroying the bacteria without in any way impairing any of the nutritive qualities of the milk.

The features of this process are its simplicity and its cheapness of operation. The product is obtained by the rapid evaporation of the water contained in the milk by the employment of a high temperature. The result is that all the solids of the milk are obtained in a dry, but otherwise unaltered condition, in light, flaky, form. These solids are soluble, odorless, light in color, completely sterile, and conservable. They have a perfectly natural and agreeable taste, and form a highly nitrogenous food-substance.

The success of the process consists in the rapidity with which it is carried out, and the high temperature employed, for if milk is dried slowly at a low temperature, the dry product undergoes serious transformations, is not rendered sterile, and has a disagreeable odor.

The apparatus is simple in design. There are two metal cylinders, measuring 60 inches in length, and each of 28 inches diameter, with highly polished exterior surfaces. These two cylinders are mounted on a rigid iron framework, and separated from each other by about one-eighth of an inch. They are gear-driven in opposite directions, at a velocity of six revolutions per minute. On the outside of each cylinder, at the top, and just coming into contact with it, is held a sharp knife. Between the two cylinders is placed a narrow trough pierced on either side with a longitudinal row of holes. The milk is fed into this trough, and sprays through the orifices onto the cylinder on either side.

Steam is admitted into the cylinders at a pressure of about 40 pounds, which gives a temperature to the outer surfaces of from 220 deg. to 230 deg. Fahrenheit.

The milk is sprayed continuously upon the hot cylinders, and the water is immediately evaporated and escapes in the form of steam through a ventilator mounted over the apparatus. The solid constituents of the milk remain in a uniform layer upon the polished surfaces of the cylinders, and are removed in a continuous sheet as the cylinders revolve, by the stripping knives, at the dairy of Messrs. Mignot & Plumey, Louviers, France. The dried milk is soft and friable and requires no grinding, being easily reduced to a fine uniform powder by being passed through a sieve.

The operation occupies less than thirty seconds, and a machine dries 70 gallons of milk per hour. It can be operated equally successfully with separated or with milk containing all or any part of its cream. One hundred pounds of full-cream milk yield about 12½ pounds of dry milk, containing about 30 per cent of butter, while 9 pounds of dry separated milk can be extracted from 100 pounds of liquid separated milk.

The paramount advantages of this product are its perfect solubility, which renders possible the rapid reconstitution of natural milk, with all its organoleptic properties—its assimilability, its perfect preservability, and its absolute sterility.

Owing to the high temperature of the cylinders, it might be thought that the albumen would be precipitated and the dry milk rendered insoluble and useless. But such is not the case. The addition of hot water of about 170 deg. F. to the dried milk causes it to dissolve instantly, without leaving any deposit. Furthermore, the odor and taste of the reconstituted milk are identical with the odor and taste of fresh milk. Chemical analyses made by experts have shown that no determinable changes take place in the milk solids. The average composition of the milk powder produced by drying full-cream milk is as follows:

	Per cent.
Casein	27
Butter-fat	28
Milk sugar	35
Milk salts	6
Moisture	4
	100

These are the same proportions in which the various nutritive substances exist in liquid milk.

But possibly the most important fact concerning the product is its complete freedom from bacteria, which constitute such a grave danger in milk. All the bacteria that are present in the liquid milk when it goes over the drying machine are completely destroyed, as Dr. Magill and other scientists, who have subjected the Just-Hatmaker product to extensive and exacting chemical, bacteriological, and clinical tests, have conclusively demonstrated. Germs cannot develop in dry milk. More than four hundred bacteriological examinations of it were made by the Carnegie Laboratory, by the Department of Health of New York city, by the Department of Bacteriology of New York University, and by the Department of Pathology of Cornell University, New York, and it was proved beyond any doubt that this dry milk is absolutely sterile when it comes from the drying machine. Living and virulent cultures of tubercular germs and of anthrax germs were further introduced into milk, which was then put over the drying machine, and the dry resultant product was found to contain no living germs. It was cultivated

for bacterial growth without any development, and guinea pigs were inoculated with it repeatedly without showing any pathological reaction whatever. That it remains sterile if protected from contamination by air bacteria was also shown by a box of the dried milk being sent round the world, and detained three weeks at Shanghai. Upon its arrival home, the powder was found to be absolutely sterile, stable, and in perfect condition.

In order to demonstrate the assimilability and physiological effect of the powder, a series of prolonged feeding tests were made in New York city during last summer, to determine these points. Under the supervision of officers of the Department of Health, 850 babies ranging from five days to two years old, and in average good health, were selected, for the most part from the poorer tenement house districts, and fed exclusively during the four hottest summer months upon this dry milk. Full cream-milk powder was used in part of the cases, but milk powder produced by drying mixtures of two-thirds full cream and one-third separated milk, or one-half full cream and one-half separated milk, was chiefly used. Sugar of milk was added according to the age of the infant, and to meet the ideas of the physician in immediate charge. The dry milk was left with the mothers either in a box or a sealed envelope, with directions to dissolve the prescribed quantity in hot water, and to give it to the infant at the times specified. It was imperatively ordered that any of the reconstituted milk that remained over after feeding should be thrown away. The results of this feeding of 850 infants, chosen from the poorer quarters of a great city, exclusively upon milk reconstituted from this dry milk, are unparalleled. Not one child died. With one exception all the children gained regularly in weight; one child lost 100 grammes in five days, but soon afterward re-established its good average. These practical experiments showed the important fact that the milk made from this dry milk does not clot in the stomach like ordinary milk, but in fine granular clots, which closely resemble those formed in human milk, and that its digestion is easy and complete.

The commercial advantages of this dry milk are obvious. It will keep indefinitely in an ordinary barrel or case. The expense and trouble of conveying and delivering milk in cans is dispensed with, as dry milk can be shipped in boxes or bags. It is lighter to handle, since the weight of dry milk is one-eighth of that of liquid milk, and it can be placed on the market in a variety of forms—compressed tablets, powder, or incorporated with chocolate and other foodstuffs—which renders it especially useful in numerous industries.

The cost and maintenance of the apparatus is small, and it occupies but little space. The total weight of the machine is four tons. It can be installed and operated in a space measuring 8 feet by 10 feet. The power that is requisite is from 4 to 5 horse-power, and about 840 pounds of steam at 40 pounds pressure is sufficient to dry 70 pounds of milk per hour. Furthermore, being quite automatic in its action, one operator can easily look after two machines.

This process is now in use in many of the best dairies in England, Ireland, France, Germany, Russia, Switzerland, Austria-Hungary, Italy, Australia, and the Argentine. It has been shown publicly at the Concours Aynoli in Paris, at the great German Agricultural Show at Dantzic, at the Show of the Royal Agricultural Society of England at London, and at the show of the Royal Lancashire Agricultural Society at Southport, England, and has been awarded several special medals.

THE CHEMISTRY OF PATINAS AND PAINTINGS.

EVERY casting of iron, zinc, brass, copper, bronze, and even silver comes from the mold covered with a "skin" composed of various substances which have been formed by chemical action between the metal and the material of the mold. In most cases this skin must be removed, for it makes the casting unsightly and its material unrecognizable. It is usually taken off by "biting" or etching with diluted acids, alkalis, or other solvents of the metal, combined with diligent washing and scouring and sometimes with mechanical treatment which may even take the form of actual chiseling. The etching liquid, of course, does not act quite uniformly, but lays bare the more or less crystalline structure of the metal, so that the mere removal of the skin produces a porous surface which is often only masked and seldom entirely obliterated by the file and burnisher. Here, then, at the outset, is the commencement of the complex process which eventually results in the formation of a patina.

There are, however, products of art manufacture which are perfectly smooth when made and are endowed with great powers of resistance to mechanical influences but which, nevertheless, become rough with age.

I speak particularly of porcelains. Their surface is perfectly smooth, for it is formed during the slow cooling of the kiln by the amorphous solidification of the glaze, which was fluid during the firing, and whose mirror-like surface has not been ruffled by contact with any solid body.

But very few porcelains retain this smoothness permanently, for, aside from the scratches made by sandy dust, which is harder than the hardest glaze, there is always a difference in composition and consequently in thermal expansibility between the glaze and the underlying substance. If this difference is great enough to be expressible numerically, the glaze soon scales off and the object is entirely ruined. With such

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.