be procured whereby no sacrifice would be entailed for lightness.

The race for the Vanderbilt cup will be run this year on Long Island on October 6, and will be the only real international race of the year. At least four countries—France, Germany, Italy, and America—will be represented by five cars each. The rules governing the race will be practically the same as heretofore, and the course will be nearly the same as that of last year.

In contrast to the races just mentioned, there is now being conducted in this country and Canada the third annual tour of the American Automobile Association, which includes the contest for the Glidden trophy. This trophy is awarded annually to the touring car which makes the best performance in a 1,000-mile tour. Contrary to what was the case last year, the present contest is being conducted with some resemblan reliability run. The cars are required to make an average speed of nearly 20 miles an hour, and checking stations are located every 25 or 30 miles apart. No repairs, adjustments, or replenishments are allowed in the garage, but these must all be made during the cars' running time. While such a rule does very well for a high-speed race, in the present instance it tends to incite racing. This is not what is desired. Furthermore, the penalization of all cars that do not pass the checkers and arrive each day at the specified times, has not had the effect of stopping racing on the part of the contestants. This was shown on the first day's run of 135 miles from Buffalo to Auburn, New York. The contestants invariably reached the vicinity of the checking stations a considerable length of time in advance. They would then wait until the exact minute when they were due before they would pass the checker. From the working of this system during the first day's run, it would seem that a better way to attain uniform speed on the part of the contestants would be to oblige them to follow a pacemaker provided with an accurate speedometer. This would effectually stop all racing, save on the part of cars which broke down, and were obliged to make up time, if possible. A test of this character should be made to give all the information possible to be obtained from the actual running of cars under touring conditions. Official observers should be provided, and an accurate record kept of all stops, breakdowns, repairs, fuel and oil consumption, tire trouble, etc. With a loss of a specified number of points for all such happenings, it would be an easy matter to pick out the winning car. Besides this there would be considerable valuable information obtained regarding the different makes of cars, both domestic and foreign. In the present event but five foreign cars figure. While light cars are not excluded, they are decidedly in the minority. Almost all of the cars are of the four-cylinder type, and there is one new six-cylinder model of a type which will be marketed next year.

The result of the first day's run was the disablement of three of the cars, owing, it is said, to the roughness of the course. One of these broke its rear axle, another broke a spring, and the third gave out from some cause not as yet recorded. One of the steam cars of a well-known make was burned, owing to its catching fire while the gasoline tank was being filled. This accident was no doubt due to gross carelessness, as the make of car in question is well known for its reliability. Of the 69 starters, only 8 were absent at the end of the second day's run. Out of 51 contestants, 20 had perfect scores.

AN ELECTRIC EXAMINATION OF EUROPEAN MINERAL WATER.

An electrical method of estimating the proportion of mineral matter contained in spring water has been devised by M. F. Dienert, of Paris, and presented to the Académie des Sciences. The subterranean water encounters soluble elements in the soil, and the solubility is increased by the presence of carbonic acid. Thus carbonate of lime and silica, which are but slightly soluble in pure water, are much more so in presence of the gas. In a given soil and for a certain pressure of carbonic acid gas, the underground waters contain a determined proportion of dissolved bodies, and we may estimate the average amount by means of the electric conductivity, using for this purpose the Kohlrausch method, which has already been used here. For several years past M. Dienert has been employing this method in order to follow the daily variations in the composition of the springs which supply the city of Paris. Thus we have a good check upon the variations in the mineral matter, and if these are great, we afterward seek the causes. The electric method is much more sensitive than chemical analysis. In cases where we find 50 ohms variation in electrical resistance, this being very clearly shown in the Kohlrausch apparatus, for the same water chemical analysis gives uncertain results, seeing that they fall within the limit of error. As an example, we may mention the values of the resistances of some of the springs which supply the city. The Breuil spring, for instance, has had about a uniform value, except in times of freshets, during the last three years, and its resistance is maintained very closely between 2,695 and 2,720 ohms. The Dhuys spring keeps between 2,120 and 2,140 ohms, while the Lunain spring lies between 2,350 and 2,375 ohms. Thus we find that some springs have a very constant mineral value. It is to be remarked that all these springs are very pure and usually contain colon bacilli when their resistance remains constant. Variations of the latter may be traced to different causes, such as were observed for several years past. These causes are due either to changes in the underground condition or again to the infiltration of surface water.

A KEROSENE-OIL LAMP.

Experiments with a new lighting system have been carried out in Scotland, in which kerosene oil is used. The oil is stored in a tank, which is accommodated in the base of the standard carrying the lamp. In the top of this reservoir is a cylinder filled with compressed carbonic-acid gas, with a small oil container at the bottom holding from one-half to two gallons of oil, which automatically flows thereto from the larger receptacle. A reducing valve connects the oil container with the carbonic acid gas cylinder, and a fine tube leads to the burner, which has a vaporizer consisting of a jet and an air-mixing chamber, while the burner is fitted with an incandescent gas mantle. The oil is forced from the oil container to the vaporizer through the fine tube by the pressure of the carbonic-acid gas. On reaching the vaporizer the oil is converted into gas and passes through the flame spreader, where it combines with the air, and thence to the incandescent mantle. The lamp is economical in consumption, a light of 200 candle-power being obtained for 45 hours with a consumption of one gallon of oil, and the light is clear, bright, and of great penetrative power.

INDUSTRIAL ALCOHOL: HOW IT IS MADE AND HOW IT IS USED.

The development of the use of denaturized alcohol for industrial purposes has probably reached a higher plane in the German Empire than in any other country. It took its rise from the fact that Germany is dependent upon outside sources for its supply of petroleum and petroleum products. When the explosive motor came into general use for governmental and military purposes, the German government realized that in case of war it might be shut off from these sources of supply, and that, therefore, it was advisable to procure a substitute for the mineral hydrocarbon fuel. With the active co-operation of the German Emperor, the growth of the alcohol industry for commercial purposes was both rapid and widespread. The government encouraged the invention and manufacture of alcohol motors for stationary and automobile purposes, of illuminating devices, cooking utensils, and other apparatus employing alcohol as a fuel. Extensive laws regulate the production and use of denaturized alcohol, and for several years it could be obtained in large quantities and at low cost. Unfortunately, the alcohol industry in Germany to-day has gradually come under the control of a trust and, in consequence, the prices have risen so rapidly that many of the benefits arising from the untaxed alcohol system have been lost. In France, England, Austria, Belgium, and other countries, the use of denaturized alcohol is extensive and it is employed in thriving and valuable industries, regulated by wise laws to safeguard the public and to prevent fraud. The passage of the free-alcohol bill in this country promises much good, and as very little is known regarding the subject on this side of the Atlantic, we must draw from the knowledge of the European manufacturers and users for information upon the product.

During the height of the interest aroused among the public in the earlier phases of the denaturized alcohol propaganda in Germany, the press of many countries was full of accounts concerning the sources from which alcohol might be derived, and an apparently authentic account was at one time circulated, in which it was stated that large quantities were produced from such substances as peat and garbage. It appears, however, that alcohol is not made on an industrial scale in Germany from peat or from garbage of any kind. Aside from the small amount that is produced for drinking and medicinal purposes from prunes, grapes, cherries, and other fruits, the great sources of alcohol for industrial and other uses are potatoes, grain, and the molasses derived as a secondary product from the manufacture of beet sugar. The crude molasses left as a refuse product of the raw beet-sugar manufacture contains from 40 to 50 per cent of sugar which cannot be crystallized, and this can also be utilized as a material for the production of alcohol. The spirits distilled from grain and molasses and the small quantities made from cherries, grape-must, plums, etc., are used mainly for drinking and the manufacture of medicines, perfumes, vinegar, and various other food preparations. The great source of industrial alcohol is from potatoes, and it is used for heating, lighting, and motor purposes, and for a vast number of applications in chemical and industrial manufactures. An interesting consular report from Maracaibo states that successful attempts have recently been made to produce alcohol from the hitherto useless bulb or husk inclosing the coffee bean. Should this report prove true, the alcohol industry will have received a new and vast source of supply, which will prove of great value, especially in coffee-growing countries.

Alcohol may be produced from substances containing sugar, or from those containing starch which may be converted into sugar. It may be similarly derived from cellulose, for instance, in the destructive distillation of wood, which results in the production of wood alcohol and various other substances. It can be obtained by distillation or by fermentation, but usually results from a combination of both. In making spirit from beets, sulphuric acid is used during the fermentative process, which is effected by adding yeast to the *wort*. The latter is the result of a process of saccharifying the starch in the substance undergoing distillation. The alcohol results from the decomposition of sugar, which by the process of fermentation is resolved into carbonic acid and alcohol. Sugar is, therefore, the direct source of alcohol, and for this reason sweet vegetables and fruits may be converted into spirits. The starch is readily converted into sugar by means of the substance called *diastase*, which is found in malt and in germinating seeds generally. It is for this reason that starchy vegetables, such as potatoes, as well as sweet vegetables, may be used in the manufacture of spirits. In using starchy vegetables, however, the intermediate process mentioned above of saccharifying the starch, technically known as *mashing*, is necessary. This consists in mixing the raw grain, or other substance, properly ground, with malt and with water at a temperature of about 150 deg. F. In using potatoes these are usually steamed before the malt is applied, for they contain a much smaller proportion of starch than the cereals, and by steaming the starch cells are thoroughly broken and the starch is reduced to a condition in which it is easily acted upon. The saccharine infusion resulting from the *mashing* is that technically known as the *wort*.

The fermentation is effected by adding either brewer's or compressed yeast to the *wort*, or to a saccharine liquid obtained from molasses, beets, or other sugar-producing fruits or vegetables. The fermentation process is carried to its furthest limit in order to produce the greatest amount of alcohol, and the liquid thus prepared for distillation is technically known as the *wash*. The *still* is the apparatus in which the wash is reduced to vapor and then condensed. Essentially and in its oldest form, the *still* consists of a copper vessel provided with a closed head and connected with a spiral tube called the *worm*. The latter is cooled by means of circulating water or refrigeration, and when the heat is applied at the still the spirit begins to rise in vapor along with more or less steam, and passes through the worm, where it becomes condensed by the cold, and trickles down into the *receiver*. The product of the first distillation is impure, and redistillation at a lower temperature is necessary to deprive it of the water and of the oils which have passed with the alcohol. To-day, by means of fractional stills the process has been greatly improved, and the alcohol may be obtained cheaply and of a high grade.

The industrial uses of alcohol are many and varied, as was demonstrated by an exhibition in Germany a few years ago, which was devoted exclusively to alcohol, its production and its uses for industrial purposes. While the general use of alcohol for industrial purposes, heating, lighting, and a vast range of chemical and other manufacturing purposes has steadily increased in Germany, the percentage of the whole product that is used for motor purposes is relatively small and, so far from increasing, is said to be rather diminishing, though to just what extent it would be difficult to prove. A few Germans, from patriotic motives, use alcohol for driving automobiles, freight wagons, motor boats, and farming machinery. It has been found by elaborate tests that the economy of alcohol as a fuel for gas motors is largely increased by its being carbureted through admixture with a certain percentage of benzole or other product of mineral oil. For a time it was believed that this admixture of benzole could not be safely carried beyond 20 per cent, but more recent experience has shown that a mixture of equal parts of alcohol and benzole can be used, especially in large motors, with entire safety and economical results. For automobile purposes the usual proportion is now about 30 per cent of benzole or gasoline, but at the previous cost of alcohol it could not compete on the score of economy with mineral hydrocarbons in a country where they were either produced or imported free of duty.

The industrial applications of alcohol are numerous; the chemical industries lead. Of these, the manufacture of vinegar from alcohol and acetic acid is one of the most important. This industry is mainly the growth of the period since 1887, and its extent may be

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daga Lake near Syracuse to Lake Ontario at Oswego; and the Champlain, 66 miles long, which furnishes a navigable waterway from the upper Hudson near Troy to Lake Champlain. Each may be called a branch of the Erie for the reason that boats passing through the Oswego Canal enter the main channel by way of Onondaga Lake, while boats from Lake Champlain bound southward and westward enter the Erie near the southern terminus of the Champlain Canal. The value of these branches is indicated by the fact that they furnish the interior of New York State its only water connection with Lake Ontario and the St. Lawrence River, and are the means of considerably swelling the traffic of the main canal, since they also give it a connection by water with Canada.

The main canal and branches will be of uniform depth and breadth on the bottom. Vessels drawing 11½ feet of water can pass from one end to the other of the system, while the width at the bottom will be at least 75 feet. Generally speaking, this means that the main canal will be enlarged to about four times its present transportation capacity. At present the depth ranges from 7 to 9 feet, about one-third of the waterway being of the latter depth, to which it was excavated by the expenditure of $9,000,000 appropriated for this purpose in 1894. When the historic "Seneca Chief," the first boat to carry freight and passengers upon it, made the trip from Buffalo to Albany, the canal was but 28 feet in width on the bottom, 70 feet on the surface, while its average depth was not over 4 feet. The demands of commerce so crowded it with traffic, that only ten years later the New York legislature authorized the enlargement which approximately represents the dimensions of the canal prior to the enlargement of 1895—a work which was not completed until 1862.

The barge of the future, however, will have a cargo capacity of 33 1-3 times the original craft, 22 2-3 times the boats of the period between 1830 and 1850, ten times those in service between 1850 and 1862, and four times as great as the average boat in present use. What is perhaps more significant, however, is the extent of the cargoes which can be shipped at one time by a fleet of tows of the new boats. The majority of the towing vessels are intended as cargo carriers, but provided with engines sufficiently powerful to pull from two to three boats in addition, moving at a rate of from 4 to 6 miles an hour. Thus from 12,000 to 15,000 bushels of wheat can now be transported from Buffalo to New York at a single shipment if desired. The present plan will probably be followed in making up tows for convenience and economy. This means that a single series of barges will carry enough grain to load an ocean steamship of 4,000 tons capacity. A very large fleet of vessels of this kind is plying across the Atlantic in the so-called "tramp" service, for it has been demonstrated that they can be constructed and equipped with engines which make them among the most economical freight carriers in the world. A single barge of the new type will carry sufficient cargo to fill the hold of many of the three-masted schooners in the American coasting trade, while a tow of four would be sufficient to load the largest square-rigged sailing vessel which plies out of New York. If one of the newer transatlantic steamships, which have been especially designed for carrying freight, were to be chartered to take wheat, for instance, exclusively, a flotilla of twenty-five of these canal boats would be sufficient to complete her cargo, or six tows, while two or three barges would carry enough grain to fill the cargo space which is devoted to this cereal on the ordinary Atlantic liner.

The cost of transportation of wheat on the present canal averages 87 cents a ton, or 1.9 mills per ton per mile—a little less than a fifth of a cent. Upon this and other statistics a calculation has been made that when the proposed improvement is completed, the maximum cost of transportation will be 26 cents a ton, or 0.52 of a mill per ton per mile. In other words, the improvement will cut down the cost of transportation to nearly 25 per cent of the average rate at present based on the ton mile. Contrasting this with the cost of railroad transportation, an idea can be gained of the competition which the enlarged waterway will offer land transportation routes. The reports of the principal railroad lines running out of Buffalo show that the average cost of carrying wheat is about 6 mills per ton per mile—three times as much as the present canal rate, and nearly twelve times as much as the rate on the enlarged canal. In other words, one of the newer canal barges would carry a cargo equal to a train of fifty cars at the same cost of hauling five with the locomotive.

The paramount object in the culture of the grape in most parts of the world has been the obtaining of wine. The extent of this will be surprising and hardly believed by those not acquainted with the statistics. Thus, for instance, there are annually produced on the globe over 4,000,000,000 gallons of wine. Of this amount, the United States produces only about 50,000,000 gallons.

INDUSTRIAL ALCOHOL: HOW IT IS MADE AND HOW IT IS USED.

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estimated from the fact that there is consumed in Germany annually for the manufacture of vinegar 16,000,000 liters (4,224,000 gallons) of alcohol. The oldest application is in cooking. In the new alcohol cooking lamps, some of which are regulatable, the alcohol is gasified before burning. In some the Bunsen principle is used; the alcohol before burning passing through a tube where it entrains with it the necessary quantity of air. For cooking purposes alcohol has great advantages; it is cleanly in application and instantly at disposal. There are also alcohol heating stoves, but they are as yet too dear to come into general use. For lighting, alcohol has only recently been used. The first incandescent alcohol lamp dates from 1895, but was not successful. The Auer lamp is better. It gives 60 to 62 candle-power and burns per hour about 13 quarts of alcohol, but has the disadvantage of requiring a permanent gasifying flame. The Helft lamps do their gasifying without a special flame, and if kept clean and in good condition give no trouble. The cost of light is 30 per cent cheaper than with petroleum. There is, however, this objection, that it takes 1 to 1½ minutes to get the flame going. Other excellent lamps adapted for the use of alcohol are in operation in Germany to-day, such as the Phoebus and the "Bogenlicht."

The use of alcohol for motors is recent. Experiments by Prof. Ernst Meyer show that the alcohol motor has a thermic efficiency of 39½ per cent, a result excelled only by the Diesel among motors using liquid fuel. The reason for this is that alcohol, containing as it does 8 to 9 per cent of water, permits a high grade of compression, without danger of premature ignition. As alcohol is not so rich in carbon as petroleum and benzine, it burns more cleanly. Prof. Meyer obtained from a motor of 20 effective horse-power a consumption as low as 8.8 pounds of 90 per cent alcohol with full load. Per horse-power per hour this cost is one cent; and the alcohol, giving only 5,600 heat units, was compared with petroleum, which gives 10,000 to 11,000. An important advantage of alcohol, which applies specially to its use in motor carriages and in engines for operating creameries and small manufacturing plants in premises adjacent to dwellings, is its absolute cleanliness and freedom from the mephitic odors which render hydrocarbon engines so offensive to many people.

The following list of the industrial uses of alcohol in England must be regarded rather as indicative than comprehensive, since the spirit is now used in a very great variety of ways in the numerous industries: Artificial lubricants, furniture polish, finish, varnish, lacquers, enamels, celluloid, zylonite, gunpowders, aniline colors, dyeing and preparation of colors, dissolving resins for hat makers, collodion, goldbeaters' skin, filling spirit levels, floating mariner's compass, extracting vegetable alkaloids, making vegetable extracts (dry), manufacture of transparent soap, quick-drying paints, preserving objects of natural history, chemical and anatomical research, sulphuric ether, chloral hydrate, chloroform, fulminating powder, liniments of soap, compound camphor, aconite and belladonna, hypersperm oil, etc.

For industrial purposes, and to render alcohol impossible of consumption as a beverage, the spirit may be either methylated or denaturized. Methylated means the addition of wood alcohol (methyl alcohol) to the spirit (ethyl alcohol). Wood alcohol is a poisonous substance, and at the same time possesses an extremely disagreeable taste, which renders it impotable. The denaturization of alcohol signifies the addition of such substances other than, or together with, wood alcohol, which render the ethyl alcohol unfit for use as a drink. The following are some German methods of rendering alcohol impotable:

I. Complete denaturization is accomplished by the addition to every 100 liters (equal to 26½ gallons) of spirits:

(*a*) Two and one-half liters of the "standard denaturizer," made of 4 parts of wood alcohol, 1 part of pyridin (a nitrogenous base obtained by distilling bone oil or coal tar), with the addition of 50 grammes to each liter of oil of lavender or rosemary.

(*b*) One and one-fourth liters of the above "standard" and 2 liters of benzole with every 100 liters of alcohol.

Of alcohol thus completely denaturized there was used in Germany, during the campaign year 1903-4, 931,406 hectoliters denaturized by process (*a*), as described above, and 52,764 hectoliters which had been denaturized by process (*b*). This made a total of 26,080,505 gallons of wholly denaturized spirits used during the year for heating, lighting, and various processes of manufacture.

II. Incomplete denaturization—i.e., sufficient to prevent alcohol from being drunk, but not to disqualify it from use for various special purposes, for which the wholly denaturized spirits would be unavailable—is accomplished by several methods as follows, the quantity and nature of each substance given being the prescribed dose for each 100 liters (26½ gallons) of spirits:

(*c*) Five liters of wood alcohol or one-half liter of pyridin.

(*d*) Twenty liters of solution of shellac, containing 1 part gum to 2 parts alcohol of 90 per cent purity. Alcohol for the manufacture of celluloid and pegamoid is denaturized.

(*e*) By the addition of 1 kilogramme of camphor or 2 liters of oil of turpentine or one-half liter benzole to each 100 liters of spirits. Alcohol to be used in the manufacture of ethers, aldehyde, agarcin, white lead, bromo-silver gelatins, photographic papers and plates, electrode plates, collodion, salicylic acid and salts, aniline chemistry, and a great number of other purposes, is denaturized by the addition of—

(*f*) Ten liters sulphuric ether, or 1 liter of benzole, or one-half liter oil of turpentine, or 0.025 liter of animal oil.

For the manufacture of varnishes and inks alcohol is denaturized by the addition of oil of turpentine or animal oil, and for the production of soda soaps by the addition of 1 kilogramme of castor oil. Alcohol for the production of lanolin is prepared by adding 5 liters of benzine to each hectoliter of spirits.

The whole amount of incompletely denaturized alcohol of the several grades above described which was consumed in Germany last year was 385,946 hectoliters, equal to 10,227,569 gallons. In addition to all the foregoing, 21,779 hectoliters of alcohol were used duty free and without denaturization of any kind for governmental or public purposes, such as hospitals, government laboratories, and for the manufacture of fulminates and smokeless powder.

Testing the Size and Heat of High-Tension and Low-Tension Ignition Sparks.

In a recently published article on ignition systems for gasoline engines, that well-known expert, Mr. Charles E. Duryea, gives the following interesting test for showing the efficiency of the contact and jump spark. It is a fact that with the contact or make-and-break spark a much smaller lead is required with any engine than must be used if the engine is equipped with the jump spark. The reason for this becomes apparent after one has made the experiment described by Mr. Duryea.

"Pass a strip of paper between the points of a jump spark plug and the paper will be perforated by the sparks, leaving a line of minute holes. To get the actual size of the spark in the cylinder the points should be separated ¼ inch or more, for it is well known that the compressed air is an insulator, and that engines which frequently miss on full charges will fire regularly when throttled, thus proving that there is a larger and better spark when there is no compression.

"To test the make-and-break spark in a similar manner, connect one wire from such a system to a piece of sheet metal on which is placed a sheet of thin paper, preferably held about 1/32 inch above the metal. Connect the other wire to a common pin and push the latter through the paper. Then pull the pin away quickly. A large spark will follow, burning a hole through the paper, frequently ⅛ inch in diameter. Compare the area of this hole with that of the minute perforation made by the jump spark, remembering that the make-and-break spark is also longer, and it will be seen that the volume and heat of the make-and-break spark is much larger, on which account it will fire a less perfect mixture."

The Current Supplement.

The current Supplement, No. 1594, contains an unusual number of striking articles and papers. Among the more important may be mentioned the splendid address of Mr. S. S. Wheeler on Engineering Honor. Mr. John M. Thomson's paper on the Chemistry of Artists' Colors in Relation to their Composition and Permanency is concluded. The last installment of Mr. Dugald Clerk's paper on Internal-Combustion Motors is likewise published. Probably few people ever stop to think what a wonderful organ a bird's bill really is. Mr. B. S. Bowdish, in an instructive and pleasantly-written article, explains the various functions which the bills of different birds must perform. A valveless air pump is described by the Berlin Correspondent of the Scientific American. Atmospheric electricity in trees is the subject of an exhaustive paper.

The specific gravity of non-conducting materials is in many cases of vital importance. For marine work, especially, take, for instance, a steamer of the size of the "Teutonic," of the White Star Line, the difference in weight of the covering applied, which was of low specific gravity, effected a saving of over 100 tons in weight. If the work had been done with high specific gravity material, says Mr. Ashby W. Warner in a paper on "Non-conducting Work," read before the Cleveland Institute of Engineers, this steamer would have carried over 100 tons dead weight more than was necessary.