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Conditions ~~E~~ffecting the Production of Denatured
Alcohol in the Northwest.

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Conditions Affecting the Production of Denatured Alcohol in the Northwest

It is not the purpose of this bulletin to discuss in a technical manner, either the production or the applications in the various arts and industries of Industrial or Denatured Alcohol. The aim is rather to present in the simplest manner possible certain general considerations relative to both the production and uses of this comparatively little known and appreciated article of commerce. The making of alcohol, and its denaturing, preparatory to placing it upon the market for industrial purposes, is a comparatively new business in any part of the United States. We have yet to learn of any such alcohol being made in the northwest. It is for sale however, in the local drug stores, and doubtless can be secured through them in any quantity desired. Inquiry at one or two of the stores in Moscow developed the fact, that it is held at \$1.00 per gallon, and practically no sales. These conditions probably prevail throughout the northwest. Now, it is folly to think for a moment that industrial alcohol purchased at this price can compete successfully with gasoline, or coal oil in heating, lighting, or for power purposes, even at the extremely high prices our people have to pay for the rather inferior grades of the last mentioned commodities. On the other hand, it is folly to assume that alcohol will never be able to successfully compete with those petroleum products. We say it is folly to assume this, because in other countries it has been demonstrated time and time again that where alcohol is produced in sufficient quantities, and proper appliances for using it have been devised and introduced, it has supplanted to a great degree both kerosene and gasoline, where these were once used exclusively. Of this we will speak later. The conditions we have now before us, relative to the production and uses of alcohol, are somewhat peculiar, and briefly stated are: We have secured from congress the enactment of a law permitting quite liberal regulations relative to the production and denaturing of alcohol for industrial purposes, and find now that we have not provided ourselves with the appliances necessary for its use. We mean by "appliances" lamps, stoves, engines, etc., for it is from its use in these every day household and farm necessities that the people will be most benefitted eventually. We venture to say that those industries in which alcohol is a necessity, from the very nature of the article manufactured, even

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though a high tax must be paid upon it, have experienced no difficulty in making use of the denatured product. It is quite possible that we will have to send to Germany for the first appliances to make use of this new fuel and light, for in that country they have been developed successfully and are extensively used. Just so long as we have to do that, however, we fear that the use of denatured alcohol will remain a novelty in so far as it effects our every day life. It is hardly fair to our own manufacturers moreover, to assume that they will permit the Germans, or any other people for that matter, to sell us what they can just as well make at home. Indeed a number of American manufacturers have already commenced the introduction of engines, to be operated by alcohol instead of gasoline or kerosene, and there is no reason why they should not manufacture stoves and lamps for the special use of alcohol. Once its use has been started in any section we do not doubt its rapid increase.

Certain general principles and facts relative to the production and denaturing of alcohol, as well as to its uses after denaturing, we think ought to be made a part of our common stock of knowledge, and for the purpose of making it such this bulletin is written. Should the individual reader desire more detailed information upon the subject we respectfully invite him to communicate with the department of Chemistry of the Experiment Station, whereupon he will be supplied with the information desired, or we will co-operate with him in securing the information elsewhere.

When the subject of untaxed alcohol was before Congress last, a great deal was said and written upon the matter that had only the proverbial grain of truth in it. Many people, especially farmers, were lead to believe that, should the bill then before Congress become a law, the fuel, light, and power problems for them would be solved. In other words, the impression was quite prevalent then, that since there were so many farm products from which alcohol can be made, almost any farmer could secure plenty of it from some product of his farm that ordinarily goes to waste and use it for heating and lighting his dwelling, and for fuel in the motor which was to run all his farm machinery. Of course these ideas emanated from some ultra enthusiast who was none to careful to post himself upon the facts of the case. It scarcely need be said here that we are in no immediate proximity to so fortunate a

state of affairs. True there are many farm products that can be used in the manufacture of alcohol, but at the same time comparatively few of them can be so used with profit to the farmer. This condition of affairs calls for some serious thinking on the part of those interested in getting alcohol into general use. Furthermore it is practically certain that the solution of the problem—for such it has really become—for one section of the country, will not prove to be its solution in other sections; taking for granted of course that its production will become universal, as we believe it must, if any substantial advantage is to be gained over the petroleum spirits. Corn will undoubtedly be the product from which Industrial alcohol will be made in the Mississippi valley, while cane molasses will probably be its source of manufacture in the extreme South, just as it is now the source of the rum made in Cuba. Here in the northwest, it is harder to predict just what crop or crops will eventually prove best adapted to this purpose. Not that there is a lack of material from which alcohol can be made, but because of the high prices prevailing for it for other uses. It should be thoroughly understood that the "refuse" of the farm will provide only a small fraction of the alcohol demanded, if that substance ever comes into general use. This simply means that in each section certain crops will have to be grown for the express purpose of being converted into alcohol, just as corn and barley are now grown in certain localities for the purpose of being converted into whisky and beer. There will be certain advantages in this however, for should a crop like potatoes be grown for spirit producing purposes, here in the northwest, it is not too much to expect that it can be so improved from year to year as to make it more profitable for this purpose, just as has been the case in Germany where they now have a potato raised for spirit producing purposes that is much richer in starch than those grown in this country, and also much richer than the original stock. It may be said in passing, that it is this same susceptibility of improvement by selection, and other means, that made it profitable for farmers to grow sugar beets for sugar making purposes.

As indicated above, we desire this bulletin to go before the people in as untechnical language as is consistent with the scope of the subject, and without going into extended detail, to make clear what is meant by the terms industrial and denatured alcohol. In the furtherance of this latter idea it seems desirable to say something here about the origin of

alcohol and what it is, and also to mention some of the forms in which it is most familiar to people in general.

There are several kinds of alcohols, but the one we are speaking of here is the one commonly meant when no prefixing word is applied in connection with that term. To distinguish it from the other kinds of alcohol, it is sometimes spoken of as grain alcohol, ethyl alcohol, spirits of wine, etc. It must not be confused with the compound obtained by the destructive distillation of wood and known as wood or methyl alcohol. The two compounds have decidedly different properties. The term "grain" was probably applied to it because it is produced in large quantities from common grains, such as corn and barley. We might just as properly speak of it as fruit alcohol; for it is also produced in large quantities from our common fruits, grapes, apples, etc. Note that we say, is *produced* from these sources; for alcohol as such does not exist naturally in any of these products, but is formed by fermentation from the sugars contained in them.

Practically every one is familiar with the fact, that in many of the common beverages, alcohol is one of the main, if not the most important constituent present. We wish to emphasize the fact, that, while these beverages contain vastly different amounts, the compound itself is the same in composition wherever found. In a general way these beverages may be considered as belonging in one of two classes; those produced by simple fermentation, and those produced by the distillation of the fermentation products. Needless to say those of the second class are much richer in alcohol than are those of the first-class.

Wine, representing the first-class, is the product resulting from the spontaneous fermentation of the juice of the grape (or more broadly speaking of any fruit.) By fermentation we mean here the changing of the grape sugar found normally in the grape into carbon dioxide and alcohol. The grape has a composition approximating the following: grape sugar 14.36 per cent, free acid (tartaric) .79 per cent, nitrogenous material .59 per cent, non nitrogenous extract 1.96 per cent, skins and kernel 3.60 per cent, ash .50 per cent, water 78.17 per cent (Konig.) The juice or must resulting from the pressing of the grapes, is allowed to ferment in large vats. During the process, the sugar may or may not all be transformed into alcohol, depending somewhat upon the kind of wine desired. The liquid portion is then drawn off for

further fermentation and is finally bottled. Wine so obtained varies in alcohol content between five and fifteen per cent.

There are several sources from which the distilled liquors or spirits may be, and in practice are, obtained. These sources are of especial interest to us here, for from some one or more of them we must also expect to derive our Industrial alcohol. The raw materials from which they are made may be classified (as they are by Sadtler) first, alcoholic liquids, themselves the product of fermentation, and mentioned in the preceding paragraph. These require only to be submitted to distillation in order to produce a stronger spirit. Second, solid or liquid materials containing some variety of sugar whether cane sugar, grape sugar, or maltose, which is directly or indirectly fermentable. Third, starch containing cereals, and materials capable of being transformed by diastase or dilute acid into a fermentable sugar. Whatever the source, the first step, that of fermentation, is pushed to the utmost limit in order to get as much alcohol as possible.

The brandies are made by subjecting wine to distillation and of course are much richer in alcohol than are the wines, the percentage being raised from five to fifteen per cent in the wine, to forty to fifty per cent in the brandy.

As an example of the second class of raw materials from which spirits may be obtained, we may mention the molasses from both cane and beet sugar factories. In Cuba the former is used extensively for the production of rum, and of course from that source a purer alcohol is readily obtained by redistillation. In certain parts of Europe, the molasses from the beet sugar factories is used in the same manner. Considering the number of beet sugar factories here in the northwest, we are inclined to believe that a great deal of the molasses resulting from the manufacture of beet sugar can be made available for conversion into alcohol. There is a distillery located near San Francisco, California which is making use of molasses shipped over from the Hawaiian Islands and we are informed that a great deal of the alcohol resulting from the fermentation and distillation of this molasses is denatured and sold for industrial uses. This product we understand retails there for \$0.50 per gallon. And, although this price is still too high to permit of its general use for lighting and heating purposes, it shows the great difference in prices ruling there and here.

Another common product of the farm, the potato, may be looked to as being a possible source of Industrial alcohol, and as this is typical of the third class of raw materials mentioned above, the process by which alcohol is derived from it will be briefly described. The potatoes are thoroughly washed to remove any adhering dirt or gravel, then placed in a steam cooker, where the steam under some pressure accomplishes the thorough rupturing, and disintegration of the starch cells. The cooked mass is then stirred and forced through a sieve in the bottom of the cooker, and the pulp is conveyed to a vat where the fermentation takes place later. Here a suitable amount of malt is added, for converting the starch to sugar, then a quantity of Brewers' or compressed yeast, which starts the fermentation. After fermentation is completed, the potato spirit is distilled as in any other case. In Germany a large proportion of the denatured alcohol is made from this potato spirit.

The best forms of stills are now so constructed that it is possible to get, upon the first distillation, a product containing from ninety to ninety-five per cent of alcohol by volume. These stills are somewhat complicated. The product from the simpler stills has to be redistilled in order to get an alcoholic strength of this degree. By certain chemical processes, not necessary to describe here, we can get an absolute alcohol.

In the preceding pages we have indicated some of the raw materials from which alcohol can readily be obtained, and outlined the processes by which it is obtained in practice. It should be understood now, that from whatever source it is derived, a product of high proof can be obtained only by distillation. The law prohibits the withdrawal from bond, of spirits less than 180° in proof for denaturing purposes (except in case of rum, which shall be not less than 150° in proof.) This means that for industrial purposes the distiller must produce a comparatively high proof product. This however, with modern stills and methods of management, is not a very difficult matter. A high proof alcohol however should not be confused with the term industrial alcohol, as will become clear presently.

Ever since the government in 1861 found it expedient to replace a tax upon distilled spirits, that tax has been maintained to the detriment of certain industries which find it necessary to use alcohol in large quantities. Notwithstanding the burden laid upon them, the tax has been gradually raised until now it is \$1.10 per proof gallon. (The proof gal-

lon being one that contains 50 per cent by volume of pure alcohol.) On one pretext or another the Government had failed to exempt from this tax, the alcohol so necessary in certain manufacturing processes and, as no really good substitute is known for many purposes to which alcohol is put, the injury done to American Industry is a real one. So too, although alcohol previous to 1861, was known to be quite an important source of light and heat, the tax place upon it rendered its use for those purposes out of the question. We are simply forty-six years behind the times in our use of it in stoves and lamps in this country. In spite of the tax, however, the demand for high proof spirit in certain industries has also steadily increased. Needless to say these industries are the ones in which alcohol is absolutely necessary, viz., in the manufacture of chemicals, such as ethers, and chloroform, in varnish works, smokeless powder factories, in making the fulminates, aniline colors, etc. The reason given for this state of affairs is interesting if not convincing to the friends of free, or untaxed alcohol. That reason, when separated from a multitude of other matters, was that no substance could be added to high proof spirits that would render the mixture entirely out of the question for use in beverages, and at the same time not impair its usefulness in the arts and industries. A reason which has no foundation on fact as the English, German, and French people have demonstrated during the last two decades by actual experiment and trial. They have accomplished the results desired by a comparatively simple mixture that is added to high proof alcohol, and as a result, we find that in each of these countries the use of alcohol has been more highly developed than elsewhere. Indeed in these countries, spirit, so treated, has become an extremely valuable article of commerce; as it is used for heating, lighting, and power purposes and, although produced there under conditions somewhat different than it can be in this country, the evidence of its popular use was so overwhelming, that our government finally acceded to a popular demand, and as a result we have the denatured or industrial alcohol act of June 1906.

This brings us to the point of stating, what has doubtless been inferred by the reader from the preceding paragraphs, just what we mean by denatured alcohol. We have shown how spirits of a high degree of proof can be, and in practice are made from the raw materials mentioned. To render this alcohol unfit for use as a drink or to prevent its being

added to other alcoholic beverages, something is added of so vile an odor or taste as to make it out of the question for any one to drink it. When so treated alcohol is said to be denatured i. e. has undergone a radical change in its nature, and denatured alcohol is industrial alcohol when used in the various arts and industries.

Since this bulletin will doubtless fall into the hands of many who are not at all familiar with the law (or its subsequent amendment) which permits the manufacture of alcohol for the express purpose of being first denatured and then used industrially, we will insert here certain sections of both the original law of June 1906, and its amendment of February 1907.

Section I. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after January first, nineteen hundred and seven, domestic alcohol of such degree of proof as may be prescribed by the Commissioner of Internal Revenue and approved by the Secretary of the Treasury, may be withdrawn from bond without the payment of the internal revenue tax, for use in the arts and industries, and for fuel, light, and power, provided said alcohol shall have been mixed in the presence and under the direction of an authorized Government officer, after withdrawal from the distillery warehouse, with methyl alcohol or other denaturing material or materials, or admixture of the same, suitable to the use for which the alcohol is withdrawn, but which destroys its character as a beverage and renders it unfit for liquid medicinal purposes; such denaturing to be done upon the application of any registered distillery in denaturing bonded warehouses specially designated or set apart for denaturing purposes only, and under conditions prescribed by the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury.

The character and quantity of said denaturing material and the conditions upon which said alcohol may be withdrawn free of tax shall be prescribed by the Commissioner of Internal Revenue, who shall, with the approval of the Secretary of the Treasury, make all necessary regulations for carrying into effect the provisions of this Act.

Section II. That any person who withdraws alcohol free of tax under the provisions of the Act and regulations made in pursuance thereof, and who removes or conceals same, or is concerned in removing depositing, or concealing same for the purpose of preventing the same from being denatured under governmental supervision, and any person who uses alcohol withdrawn from bond under the provisions of section one of the Act for manufacturing any beverage or liquid medicinal preparation, of knowingly sells any beverage or liquid medicinal preparation made in

whole or in part from such alcohol, or knowingly violates any of the provisions of this Act, or who shall recover or attempt to recover by redistillation or by any other process or means any alcohol rendered unfit for beverage or liquid medicinal purposes under the provisions of this Act, or who knowingly uses, sells, conceals or otherwise disposes of alcohol so recovered or redistilled, shall on conviction of each offense be fined not more than five thousand dollars, or be imprisoned not more than five years, or both, and shall in addition, forfeit to the United States all personal property used in connection with his business, together with the buildings and lots or parcels of ground constituting the premises on which said unlawful acts are performed or permitted to be performed: Provided, that manufacturers employing processes in which alcohol, used free of tax under the provisions of this act, is expressed or evaporated from the articles manufactured, shall be permitted to recover such alcohol and to have such alcohol restored to a condition suitable solely for refuse in manufacturing processes under such regulations as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, shall prescribe.

The friends of untaxed spirits were not entirely satisfied with the provisions of this Act. It has been their contention that, to become generally useful, alcohol will of necessity have to be somewhat of a local product. For example, if the people here in the northwest expect to realize any great benefit from untaxed spirits, they will necessarily have to be produced here. That this is a reasonable contention we have no doubt, for if alcohol is manufactured in the central states alone for instance, we will have to pay its cost of transportation to this section in addition to the cost of manufacture, thus leaving us no better off than we were before the passage of the Act, speaking of course with reference to its contemplated competition with coal oil and gasoline. It was feared, and probably with good reason, that since there were so many restrictions placed upon the distillers, and so much of the work of denaturing had to be personally supervised by a government official, in bonded, denaturing warehouses to be provided by the distiller himself, the expense attached to the business would discourage a man from undertaking the business on a comparatively small scale. The natural result would be more or less of a monopoly of the business by the large firms in comparatively few districts, with but slight advantage to those who it was hoped would profit most by the new industry, i. e. the consumers. In brief it was hoped, for at that time, and it is still believed to be essential to the industry, that to a great degree the consumer must be the producer.

This presumably was finally the opinion of Congress, for that body, in March 1907, passed an amendment to the original Act, which is designed to foster and encourage the production of spirits for industrial purposes only, by a considerable number of small distilleries, and these well distributed throughout the United States, rather than by the larger concerns. The Amendment is here given:

Amendatory Act of March 2, 1907:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That notwithstanding anything contained in the Act entitled "An Act for the withdrawal from bond tax free of domestic alcohol when rendered unfit for beverages or liquid medicinal uses by mixture with suitable denaturing materials" approved June seventh, nineteen hundred and six, domestic alcohol when suitably denatured may be withdrawn from bond without the payment of internal revenue tax and used in the manufacture of ether and chloroform and other definite chemical substances where said alcohol is changed into some other chemical substance and does not appear in the finished product as alcohol: Provided, That rum of not less than one-hundred and fifty degrees proof may be withdrawn for denaturation only, in accordance with the provisions of said Act of June seventh, nineteen hundred and six, and in accordance with the provisions of this Act.

Section II. That the Commissioner of Internal Revenue with the approval of the Secretary of the Treasury, may authorize the establishment of central denaturing bonded warehouses, other than those at distilleries, to which alcohol of the required proof may be transferred from distilleries or distillery bonded warehouse without the payment of internal revenue tax, and in which such alcohol may be stored and denatured. The establishment, operation, and custody of such warehouses shall be under such regulations and upon the execution of such bonds as the Commissioner of Internal Revenue with the approval of the Secretary of the Treasury, may prescribe.

Section III. That alcohol of the required proof may be drawn off, for denaturation only, from receiving cisterns in the cistern room of any distillery for transfer by pipes direct to any denaturing bonded warehouse on the distillery premises or to closed metal storage tanks situated in the distillery bonded warehouse, or from such storage tanks to any denatured bonded warehouse on the distillery premises, and denatured alcohol may also be transported from the denaturing bonded warehouse, in such manner and by means of such packages, tanks or tank cars, and on the execution of such bonds, and under such regulations as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, may prescribe. And further, alcohol to be denatured may be withdrawn without the payment of internal revenue tax from the distil-

lery bonded warehouse for shipment to central denaturing plants in such packages, tanks and tank cars, under such regulations, and on the execution of such bonds as may be prescribed by the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury.

Section IV. That at distilleries producing alcohol from any substance whatever, for denaturation only, and having a daily spirit producing capacity of not exceeding one hundred proof gallons, the use of cistern or tanks of such size and construction as may be deemed expedient may be permitted in lieu of distillery bonded warehouses, and the production, storage, the manner and process of denaturing on the distillery premises the alcohol produced, and transportation of such alcohol, and the operation of such distilleries shall be upon the execution of such bonds and such regulations as the Commissioner of Internal Revenue, with the approval of the Secretary of the Treasury, may prescribe, and such distilleries may by such regulations be exempted from such provisions of the existing laws relating to distilleries as may be deemed expedient by said officials.

Section V. That the provisions of this Act shall take effect on September first, nineteen hundred and seven.

The amendment, it will be noticed, provides for the establishment of a central denaturing plant, i. e. a plant in a certain section to which alcohol from the small distilleries in the surrounding country may be shipped for storage and denaturing. Thus removing from the small distiller the burden of providing a warehouse for denaturing purposes in connection with his distillery. It seems reasonable to assume that such a centrally located denaturing plant will act as a sort of stimulant to the production of spirit on a small scale by many of the farmers in its vicinity; much as does the operation of a canning factory in any community encourage the production of fruits and vegetables for canning purposes. It is fair also to assume that alcohol distributed from such a central depot, could be retailed at a lower price to those near it, than would be the case if it had to be transported for a couple of thousand of miles before it reaches the prospective consumer. The Act further provides that the small distiller producing alcohol for denaturing only, may be exempted from some of the more stringent regulations regarded as necessary with reference to those distilleries producing alcohol for all kinds of uses. The commissioners of Internal Revenue, in whom is vested the authority to carry out the provisions and spirit of the Act, has done so with perhaps as liberal rules and regulations as are advisable at this time. It is quite possible, and probable, that as the industry

grows, any hampering regulation or restriction will be removed in so far as it can be without seeming to encourage fraud in evading revenue laws.

The regulations here spoken of may be obtained upon request of the Treasury Department at Washington, D. C. and of course no one should enter upon the business of distilling or denaturing without first consulting with that department and obtaining all the information possible as to the relation his contemplated business will sustain to the United States Government. For purposes of general information we will call attention here to some of these rulings, and urge those especially interested to secure a copy of the same from the department mentioned above.

By virtue of the authority granted him by the Act of March 2, 1907 the Commissioner exempts distilleries of a spirit producing capacity of not exceeding one hundred proof gallons per day, to be known as Industrial distilleries, from the more stringent regulations governing the large distilleries. All stills must be registered and the person desiring to register as a distiller of Industrial alcohol, must set up his still on his own land or on land controlled by himself. In the event he does not own the land, or if there is a mortgage or other lien upon it, a written consent of the owner or mortgagor must be obtained and filed, just as is the case with grain distillers registered for the production of spirits for tax payment. An Industrial distillery may produce spirits for denaturing only, but from anything whatever containing fermentable matter which upon proper fermentation will produce alcohol. The proof of alcohol manufactured for denaturing will not in any case be less than 180° except in case of rum which shall be not less than 150° in proof.

The fermenters, mash tubs, and receptacles for holding the materials in process of fermentation, must be so placed and arranged in the distillery as to be easily accessible. Before beginning operations the distillery shall be visited by an officer of the government, designated by the collector of that district, who shall examine into the plant and ascertain if all has been built according to the regulations, and if so whether it is advisable to permit the applicant to proceed with the business without the presence of a store keeper's gauger. The distiller must also execute a bond in the penal sum of not less than the tax on the spirits that can be produced at the distillery if operated at its full capacity for thirty days.

Industrial distilleries are divided into two classes. Those of a daily spirit producing capacity of fifty gallons or less, shall constitute the first class, and those of a daily spirit producing capacity of more than fifty proof gallons, and not more than 100 proof gallons shall constitute the second class. To distilleries of the first class, store keeper's gaugers shall not be assigned unless for good and sufficient reasons the Collector is of the opinion that fraud might be practiced upon the Government. In such cases a regularly appointed store keeper's gauger shall be appointed. To distilleries of the second class a store keeper's gauger must be appointed, unless the Collector deems it unnecessary, in which case he notifies the Commissioner to that effect.

At distilleries of either the first or second class, no work of any kind connected with the business, may be done in the absence of the distiller or his duly authorized agent. Any dereliction of duty on the part of the distiller or his agent shall be held to be sufficient cause for canceling his permit to operate without the presence of an officer of the Internal Revenue department. The distiller must keep a record of all material received, of all used, of all the alcohol produced, and at those distilleries operating without the presence of an officer, must submit to the revenue officers, all books and accounts or records of any kind relating to the material received and used by him, in the manufacture of alcohol, and also of the spirits disposed of by him.

There may not be manufactured at Industrial distilleries any spirits except as can under the law be denatured; that is to say there may not be manufactured at these distilleries alcohol of less than 180° proof, or rum of less than 150° proof. In case of distilleries at which no officer is assigned the distiller is not restricted to any periods of operation. He may operate on such days (except Sunday) and for such periods of time each day as he may wish. But a correct account must be kept of the work done, the material used, and the alcohol produced. At those distilleries to which an officer is assigned, the distillery, when not suspended as in the manner provided for by law, must operate regular every day except Sunday.

Our Industrial distilleries will then be more or less strictly under the supervision of the Internal Revenue Department. Under the rules and regulations of that department the owners of industrial distilleries must equip and operate their plants. There is one thing however,

which we fear, will operate against the establishment of individual farm distilleries, and that is the outlay in money required to purchase and set up the machinery and other necessary appliances. Contrary to an apparently general idea, the cost of a still capable of producing a high proof product, even though its daily capacity be not over twenty-five to thirty gallons, is considerable. This, when added to the cost of the other machinery necessary, renders it too expensive a project for the individual farmer. We are confident, however, that this objection may be overcome in one of two ways. First, as the cost of a simple still is not great, a number of farmers could each manufacture a low grade of alcohol, then take this to what might be termed a community still of the more complicated kind, where the low proof alcohol might be converted into the high proof article. It might be found feasible too, to have the entire product denatured at the community still and returned to the producers of the raw material or sold elsewhere. The second plan to suggest itself is that of a centrally located still, where all the alcohol necessary for a certain district could be made from the various products grown for it. Thus a distillery would become established in a certain locality much as does a sugar factory or cannery. Or [the whole thing might be made a joint stock company, the producers of the raw materials to hold the majority of the stock shares. But, we repeat, whatever be its manner of manufacture, it must be produced in the section where used, if any real advantage is to accrue in its use.

Now as regards the efficiency of alcohol for heating, lighting and power purposes, happily we do not have to turn to foreign sources for the figures necessary for illustration. We quote now from a work entitled *Denatured or Industrial Alcohol*, by Herrick.

"In order to ascertain the cost of lighting by alcohol as compared to that of kerosene, the most widely used illuminant, careful duplicate photometric tests were made by the Electrical Testing Laboratories of New York and the reports of such tests were submitted by the author at the Congressional "free alcohol" hearings held in Washington, D. C., February-March, 1906.

"The first test, made February 2, 1906, gave the following data:

Lamp	One gallon will last		Candle Power	Candle P. Hours
	hrs	min		
Alcohol.....	58	52	25	1471
Oil.....	87	0	9	783

The specific gravity of the denatured alcohol used in the above test was 0.8180 or about 94.5 percent by Tralles' scale. The specific gravity of the kerosene used was 0.7930, and it was purchased from a local dealer.

"This test included the French "Boivin" incandescent-mantle alcohol lamp and a flat wick kerosene lamp such as is in common use in this country, using a good quality of alcohol and kerosene. The deduction to be made from this report is that if we had two lamps of equal candle power and equal capacity, one burning alcohol and the other kerosene, the alcohol lamp would burn nearly twice as long as the kerosene lamp.

"This is shown by the figures, because had the kerosene lamp been 25 candle-power it would have burned about thirty-one hours as against about fifty-nine hours for the 25 candle-power alcohol lamp.

"In order to determine just exactly what burners of identical shape would burn of alcohol and kerosene in a given time, a second test was made March 3, 1906, by the same authorities, as follows:

Lamp	One gallon will last		Candle Power	Candle P. Hours
	hrs	min		
Alcohol.....	57	5	30.35	1732
Oil.....	28	40	30.8	883

"The kerosene used in the above test was purchased from a dealer in the vicinity. The specific gravity of his kerosene was 0.7950. The specific gravity of the denatured alcohol used in this test was 0.8240, or about 92.6 per cent by Tralles' scale.

It is also a matter of interest to know that extended photometric tests were made in 1900 by Professor E. Rousseau, of the University of Brussels, Belgium, to determine the comparative value of alcohol and kerosene as illuminants. In the first series of such tests he used alcohol of 96.4 per cent in strength, and in the second series alcohol of 94.2 per cent in strength by the centesimal alcoholmeter. These tests demonstrated a difference in favor of alcohol of fully two to one, and are confirmed by the American test just given. The author quoted from this report of Professor E. Rousseau at the Congressional "Free Alcohol" hearings held at Washington, D. C., February-March, 1906.

"The American test, mentioned above, in which a round-wick, central-draft kerosene-burning lamp was used, in comparison with the "Boivin" incandescent—mantle alcohol lamp using a Welsbach mantle, shows conclusively that with two lamps of equal candle power and equally capacity

a gallon of alcohol possesses about twice the illuminating value of kerosene. These lamps are shown in Figure 81. The "Boivin" alcohol burner in the lamp tested is easily regulated by means of a vapor screw valve so that the amount of light furnished can be diminished or increased at pleasure. The consumption of alcohol is also correspondingly diminished or increased. Under all circumstances these photometric tests show alcohol to possess about twice as much value as kerosene for lighting purposes. Denatured alcohol therefore can easily compete successfully with kerosene at twice the cost per gallon. Moreover kerosene can only be increased to one half the selling price of denatured alcohol for illumination purposes at any given time, as these figures show. In discussing the comparative costs of alcohol and kerosene for illuminating purposes there are a number of features to consider besides the simple economics of the matter. These may be considered as follows:

(a) "Safety of the Alcohol Lamp.—The alcohol lamp is much safer than the kerosene lamp, as a fire started from alcohol is readily extinguished by water, which mixes with alcohol in all proportions. Such is not the case with kerosene, as the throwing on of water only serves to spread the fire.

(b) "Quality of Light Furnished.—The white light furnished by the alcohol lamp is akin to daylight in its quality, and being also extremely steady and uniform, it is preferable to the yellow light of the kerosene lamp.

(c) "The Heat Given off by Radiation—This is much less in the case of the alcohol lamp than from a kerosene lamp of equal candle power, because the flame of the kerosene lamp owes its luminosity to the particles of carbon present, which, not being perfectly burnt, become incandescent in the flame and radiate of necessity a considerable degree of heat, as any one who has read beside the usual large round-wick kerosene lamp, such as was used in these photometric tests referred to, can testify. These conditions do not occur in the alcohol lamp, as the mantle becomes incandescent and not the flame. The flame of alcohol when burned in the wick lamp is, as is well known, of a pale bluish color and practically non-luminous. Hence the adaptation of the incandescent mantle to the alcohol lamp made it a commercial success, as has been shown.

(d) "Maintenance of the Alcohol Lamp.—As the alcohol lamp burns no wick, it is free from this troublesome feature invariably connected with the use of kerosene. The alcohol lamp does not smoke and is practically odorless. The fitting on of the mantle is easy and simple. The occasional replacing of the suction-wick used in the reservoir (body) of the lamp is quickly accomplished. The lighting of the alcohol lamp is more easily done than with kerosene, as the removal of

the chimney or raising it is unnecessary. There is also much less vitiation of the atmosphere from burning denatured alcohol than in the case of kerosene as we shall show later."

With respect to the use of alcohol as a fuel, both for heating and power purposes, the evidence at hand is not so much in its favor, wherever its efficiency has been compared to that of gasoline. At the Iowa State College, certain comparisons made there seem to indicate that it has a heat value of approximately 70 per cent of that of gasoline. And when used in engines designed for gasoline, 188° proof alcohol has, not to exceed 85 per cent of the value of gasoline for power purposes. This fact however, need not necessarily be considered a bar to the introduction of alcohol into the field of heat and power production. It is safe to assume that its actual efficiency for both purposes will in the near future be greatly enhanced, both by improved methods of denaturing, and improvement in the styles of burners on those contrivances designed for its use. In substantiating this claim, we have only to call attention to the improvements made in recent years on the gasoline motors over those made when gasoline was first made use of for power purposes. Even though it can not be made to equal gasoline in efficiency by any contemplated improvements in denaturing or in the types of engines used, it will still, we believe, become an active competitor with that product of our crude oil fields. The supply of gasoline in this country must not be considered inexhaustible. In fact, if the upward trend of prices of gasoline during the last ten or fifteen years indicates anything as to the future of this product for power purposes, it is that it will soon be too expensive an article to use. While of course we recognize that there are many factors entering into the problem of a choice of fuels in any locality, or for any specific purpose, still, we can hardly think of thirty five to forty cent gasoline as being the cheapest fuel we may have at hand. Moreover, for many purposes, and by many persons, the cost of a fuel will not be the only consideration when a choice between two or more articles can be made. Here, just as truly as in the case of lighting; the cleanliness, lack of odor, and above all, the safety assured in the use of alcohol will be a great inducement to its wide spread use. It is interesting to note here the portions of the total consumption in Germany and France, that is made use of for heating and lighting. The figures were given by M. Siderski, at a recent meeting of the Society of

French Agriculturists, to show the growth of the manufacture, and use of denatured alcohol in Germany and France. They are quoted from "The American Sugar Industry and Beet Sugar Gazette."

GERMANY		
	Total Consumption	Used for Heating and Lighting
	* Hectol	Hectol
1900-1901	1,155,869	728,300
1901-1902	1,110,050	704,400
1902-1903	1,278,712	900,200
1903-1904	1,391,895	984,200
1904-1905	1,398,486	980,100
1905-1906	1,477,354	1,015,900

FRANCE		
	Total Consumption	Used for Heating and Lighting
	Hectol	Hectol
1900-1901	251,565	153,003
1901-1902	325,660	227,253
1902-1903	374,598	262,036
1903-1904	423,561	289,748
1904-1905	472,239	315,179
1905-1906	545,464	Not given

* The Hectol is equivalent to 26,41 gallons.

It will be noticed that during the years for which the statistics are given, there has been a steady increase not only in the total consumption, but also in the amounts used for heating and lighting. It is not to much to expect that our people will make equally as good use of what to them is now a new product.

In conclusion, we would urge upon our farmers, especially those of the wheat growing sections, where it is the custom to allow large tracts of land to lie fallow each year, to give this matter serious attention. Why should not the cultivation of this land be made imperative each year by the growing upon it of some crop that would not only "rest" the land but return good wages for the time and labor spent upon it? In this connection, certain field trials carried out on the Experiment Station Farm during the years 1902 and 1903, are quite pertinent to the subject in question, because they indicate quite forcibly the value of thorough cultivation of summer fallows—such cultivation as would be imperative if a crop like potatoes were grown upon them. In the spring

of 1902, three one fifth acre plats were treated in the following manner: No. 1 was summer fallowed in the ordinary Palouse way, i. e. was plowed, and then harrowed occassionally during the summer. No. 2 was planted to corn and cultivated thoroughly. No. 3 was planted to potatoes and likewise cultivated. In October all three plats were sown to wheat, (Webb's Square Head.) At harvest time in 1903, there was taken from each of these plats the following yields of grain: from No. 1, 260 lbs; from No. 2, 390 lbs; from No. 3, 520 lbs. Aside from the feeding value of the potatoes raised on No. 3 (in this case the potatoes were very profitably converted into pork) it should be noticed that this plat produced just twice as much wheat in 1903 as did No. 1 which, as stated above, was summer fallowed in the ordinary way the preceding year. Could anything speak more plainly in favor of this solution of the summer fallow problem!

As soon as possible the Chemistry Department of the Experiment Station, will secure some of the ordinary appliances for using Denatured Alcohol, and will give them practical tests with reference to their efficiency and usefulness. The alcohol for this purpose will be produced from some one or more of Idaho's farm crops, which it is believed will eventually be grown extensively for the express purpose of being converted into alcohol for industrial purposes.