drawbacks. Of late years a process has been discovered whereby these disadvantages, as far as industrial spirit is concerned, are entirely overcome. It has been known for some time that certain micro-organisms (or rather the enzymes contained in them) possess the power of converting the starch directly into ferment­able sugar, and further of splitting up the latter into the usual products of alcoholic fermentation. Among the organisms of this description first known may be mentioned the moulds, *Aspergillus Oryzae* and *Eurotium Oryzae.* Later A. L. C. Calmette dis­covered a mould to which he gave the name *Amylomyces Rouxii,*which was employed by A. Collette and A. Boidin for producing alcohol on an industrial scale. Since then Boidin has discovered another mould to which he gave the name of *Mucor ß,* which possesses advantages over the other micro-organisms named inasmuch as it works more rapidly and in a more concentrated wort. The amylo process, as this method of producing alcohol is termed, is now worked on a very large scale in many countries. The process consists in inoculating a sterile (mostly maize or rice) mash in a closed vessel with a very small quantity of the spores of the mould, passing filtered air through the liquid for a certain time, thus causing the material to develop very rapidly, and subsequently inducing fermentation by the addition of a pure yeast culture. The mould is of itself capable of fermenting the sugar produced, but it is found that the yeast acts more quickly, and will stand a greater percentage of alcohol, than the former. The whole process occupies about five days. The advantages accruing from operating, as is the case in the amylo process, with sterile worts are enormous, inasmuch as undesirable bacterial and side fermentations are impossible. The quality and yield of the alcohol is, owing to this fact, considerably improved. The fact that no malt is employed leads to a further very considerable economy. The general course of operations in the amylo process may be gathered from fig. 10. The maize or other raw material is steeped in the vessels AA with a sufficient quantity of dilute acid to convert the secondary into primary phosphates. When the steeping operations are complete the material passes into the converters BB. After conversion is completed the disintegrated material passes into the vessel C, and thence by means of the pipe D to the fermenting vessels EEE. After fermentation is completed the wash passes to the still F.

It is impossible at present to employ the amylo process in its most satisfactory form in the United Kingdom owing to the fact that it is necessary in order to take full advantage of the process to employ a thick wort, *i.e.* one from which the husks have not been removed. The gravity of a wort of this descrip­tion cannot be taken by the saccharimeter prescribed by the spirit Acts, but no doubt this difficulty will in time be over­come. The average yield by the amylo process is from one to one and a half gallons a cwt. of raw material more than is the case with the processes ordinarily employed in the United Kingdom.

*Distillation of Industrial Alcohol.—*A still intended for the distillation of industrial alcohol should be so devised as to yield a spirit of the greatest strength and purity in the most economical manner. Stills are now constructed which yield in one opera­tion a spirit containing up to 98% of absolute alcohol, and free from all but the merest traces of aldehyde, fusel oil, &c. (fore­shots and tailings). An excellent still of this kind is that of R. Ilges. He takes advantage of the fact that if a liquid containing 15% of alcohol is boiled, the quantity of fusel oil in the vapour is equal to the amount in the remanent fluid, and that if the percentage of alcohol is less than 15% the amount of fusel oil in the vapour is greater than that in the liquid. It is therefore possible, by working on proper lines, to remove the whole of the fusel from the mash by a single operation. By subjecting the vapours so obtained to a carefully regulated dephlegmation, the fusel oil condenses, together with the steam and a certain proportion of alcohol—in practice 15%. By further cooling the liquid so obtained the fusel separates out, and, being specific­ally lighter, rises to the surface of the watery spirit, and is then easily removed. This form of still is so arranged that any change from the correct temperature necessary for the adequate separa­tion of the concentrated " feints ” into two layers is automatically corrected by the admission of more or less cooling liquor to the refrigerating pipe coiled round the dephlegmating column. The “ foreshots " (aldehyde, &c.) are removed by submitting the alcoholic vapour passing through the main dephlegmator to further purification. The Ilges apparatus yields three con­tinuous streams of fine spirit, fusel oil, and foreshots respectively.

*By-products of Fermentation and Distillation.—*The main con­stituent of spirits is, of course, ethyl alcohol—spirit of wine— but all spirits contain small but varying quantities of by-products and it is by these that the character of a spirit is determined. The by-products are mainly formed during fermentation, but are also to a certain extent pre-existent in the raw materials, or may be formed during the operations preceding and succeeding fermentation. The nature of the by-products is complex, and varies sensibly according to the raw materials employed and the methods of malting, mashing, fermentation and distillation.

The by-products may be classified as follows: (*a*) higher alcohols—usually going under the name of fusel oil; (δ) esters; (*c*) fatty acids; *(d)* fatty aldehydes and acetals; (*e*) furfuryl aldehyde; (*f*) terpene, terpene hydrate and ethereal oils; and (*g*) volatile bases. The *higher alcohols* consist of mixtures of fatty alcohols (CnH2n + 1OH), containing three or more atoms of carbon in which, as a rule, amyl alcohol (C5H11OH) predomi­nates. The fusel oil of British pot-still spirits is chiefly composed of amyl and butyl alcohols, whereas in patent spirits propyl alcohol preponderates, that is, in the finished or fine spirit, since the fusel oil separated from patent spirit in the course of distil­lation consists mainly of amyl and butyl alcohols. Broadly speaking, the higher alcohols present in pot are of higher mole­cular weight than those in patent spirits. Potato fusel contains a high proportion of isobutyl alcohol, grain fusel of n-butyl alcohol. The *acid* present in spirits is chiefly acetic acid, but small quantities of other acids are also found. The esters, formed by the interaction of alcohols and acids chiefly during the fermenting and distilling operations, consist almost entirely of fatty acid radicles in combination with ethyl and, to a minor extent, amyl alcohol. Ethyl acetate (acetic ester) is the main constituent of the esters, the others being mainly ethyl valerate, butyrate and propionate. Oenanthic ether (ethyl pelargonate) is one of the characteristic esters of brandy. *Furfuryl aldehyde* (furfurol) is a characteristic product in pot-still spirits, although it occurs to a greater or less extent in patent spirits according to the degree of rectification. It is probable that the furfural is formed by the splitting up of a part of the pentoses contained in the wort. It was formerly thought that its occurrence in relatively large quantities in pot-still spirits was due to the char­ring effect of the action of the fire gases on the carbonaceous matter adhering to the bottom and sides of the still, but the author has shown that this is not the case, in as much as he has found that spirits distilled by means of a steam jacket instead of direct fire contain quite as much furfurol as those distilled in the old way. *Terpene* and *terpene hydrate* are characteristic constituents of grain fusel. Although the *ethereal oils* appear to play an important part in determining the character of a spirit, too little is at present known of these substances to warrant any closer description.

*Effect of Mahiring on the By-products.—*That potable spirits (excepting, of course, pure alcohol) and wine are greatly improved by age is an undeniable fact, and one that has been recognized for many hundreds, and even thousands, of years. Thus in the gospel of St Luke we have the statement " that no man having drunk old wine, straightway desireth new: for he saith,