U. S. DEPARTMENT OF AGRICULTURE.

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H. W. WILEY, CHIEF OF BUREAU.

A STUDY OF CIDER MAKING

IN

FRANCE, GERMANY, AND ENGLAND,

WITH

COMMENTS AND COMPARISONS ON AMERICAN WORK.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., July 15, 1902.

Sir: I have the honor to transmit herewith, for your examination and approval, the manuscript of a bulletin prepared by Mr. William B. Alwood, special agent of the Department of Agriculture, on cider making in France, Germany, and England.

I recommend that this manuscript be published as Bulletin No. 71 of the Bureau of Chemistry.

Respectfully,

H. W. Wiley,
Chief.

Hon. James Wilson,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

VIRGINIA AGRICULTURAL EXPERIMENT STATION,
Blacksburg, Va., June 23, 1902.

SIR: In pursuance of a commission from the Secretary of Agriculture, dated September 13, 1900, appointing me a special agent in the Division of Chemistry, and of your official instructions of the same date, I beg to submit the accompanying report, comprising a partial study of the cider industry in Europe, which has been prepared for the U. S. Department of Agriculture.

The present paper comprises only a part of the work authorized by the commission issued to me, and carried on under conjoint direction. The aim has been to present a practical and popular treatment of the subject, so far as the time at my disposal permitted me to carry the inquiry. Necessarily this report must be fragmentary and incomplete, as one person could not possibly cover the entire ground in a single season.

From the complex nature of the work undertaken, it has seemed best to present two reports—the present one dealing with the economic and practical data collected, and a second report dealing with the more technical study of methods of fermentation and related matters, such as a study of the organisms commonly found in apple juice, and the importance of the isolation, culture, and employment of pure yeasts in the manufacture of ciders and other fermented beverages made from fruit juices. A discussion of the organisms causing mal-fermentations will also be attempted.

Very respectfully submitted.

WM. B. ALWOOD,
Special Agent.

DR. H. W. WILEY, *Chief, Bureau of Chemistry,*
U. S. Department of Agriculture.

PREFACE.

The manufacture of cider is an important adjunct to fruit growing in the United States. A well-made cider is a beverage which is appreciated by all and one which is within the reach of every possessor of an orchard. Cider is also a beverage which may be manufactured without the supervision of the excise officials. It is thus an industry which can be widely extended and whose development will make the growing of fruits more profitable.

It is evident that the principles which underlie the conduct of the fermentation of apple juice in order to secure a product of a definite chemical composition also apply to the juices of other fruits, such as pears and peaches, and thus a bulletin of this description affects, in general, the fruit interests of the country wherever the juices of fruits are employed for potable purposes.

Up to the present time the manufacture of cider in the United States has been conducted largely by empirical methods. Little has been done toward the study of the chemical composition of the fruits, the fresh juices, the fermenting musts, or the finished products. What is true of wines is also true of ciders and other fermented fruit juices, viz, that their excellence and healthfulness are dependent entirely upon their chemical composition. The changes which take place in fruit juices during fermentation are essentially chemical, and are produced by ferments, which in these instances may be regarded as chemical reagents.

In order that the manufacture of cider may be conducted in a more systematic and scientific manner in this country, it was deemed desirable to study the best processes employed in foreign countries, especially in England, France, and Germany, which are the principal cider-producing countries of the world. To this end, Mr. William B. Alwood was employed by the Secretary of Agriculture as a special agent to act under the direction of the Chief of the Bureau of Chemistry, and was detailed to study the actual processes of manufacture in the countries named, as well as to conduct extensive experiments here. Mr. Alwood, in addition to collecting valuable information of a practical nature, has also brought together the scattered chemical data found in difficultly accessible reports and papers, so as to make them available for use.

It is evident that a careful study of the data thus collected will be of great service to our own manufacturers in showing them the methods which experience and scientific studies in foreign countries have determined to be the best for the production of a wholesome and palatable article.

This bulletin serves as an introduction to a more detailed study of the best methods of fermentation, cellar treatment, and preservation of cider products, together with a more detailed chemical study of the fruits, the musts, and the finished beverages.

H. W. Wiley,
Chief of Bureau.

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INTRODUCTION.

In the United States cider has been in the past too generally regarded as a product of very little importance from a commercial standpoint, and it has been too often so made that most persons of cultured taste have looked upon it with little approval when offered as a beverage. Yet from the etymology of the word it is certain that the name is very ancient, and that cider was the wine or strong drink, "shekar," of the Phoenicians, and was well known by the Aryan race which populated northern Europe before the dawn of history. A study of the words used to denote the apple and the beverage made from it shows that the fruit and the wine were known before the races of northern Europe separated into Slavonians, Germans, and Celts, and that the ancient Britons introduced the fruit into the British Isles before the Roman conquest.[a] The word *cider* as used by English-speaking people is the same as the Latin *cicera*, Spanish *sidra*, Italian *sidro*, and French *cidre*.

The German language, on the other hand, seems never to have contained the word cider as a pure German word, but the beverage made from the fruit of the apple is classed as a wine (*apfel wein*).

BEGINNING OF THIS INVESTIGATION.

The subject of working up the low-grade apples left as an unmerchantable residuum of the apple crops grown in the United States has for some years attracted the attention of the writer, and experimental work on this subject has been done in the horticultural department of the Virginia Agricultural Experiment Station for the past eight years. Several preliminary reports of this work have been published[b] from time to time, intended to encourage local efforts to utilize the large quantities of unmerchantable fruit produced every year when there is a fruit crop.

These preliminary efforts served to awaken a strong interest in the possibilities of making a pure sound cider from our apples, which

[a] Sir George Birdwood quoted by Cooke in "Cider and Perry," p. 3.
[b] Bulletins 48, 57, and 71, Va. Agr. Expt. Station.

might serve as a light American wine so cheap and wholesome as to be usable by everybody, and as a secondary product from such fermented cider a fine apple vinegar to displace the enormous quantities of chemical vinegars which find sale in those States where their manufacture and sale are not restricted by statute.

The importance of utilizing our low-grade apples can only be appreciated after realizing the probable quantity of this fruit produced in the United States.

QUANTITY OF APPLES PRODUCED IN THE UNITED STATES.

It is impossible to present an accurate estimate of the apple crop of the United States. The Census Bureau has not in the past gathered statistics concerning this crop which can be said to cover this subject with any degree of completeness; nor has the Department of Agriculture been able up to the present time to furnish the data desired. The difficulties grow out of the nature of the crop itself. The apple is a fruit grown almost over the entire cultivated area of the country, but in many instances only in a haphazard manner and as a crop of secondary importance; hence any attempt to deal with it accurately from a statistical standpoint must of necessity fail because of the immense labor involved and the lack of definite information among the farmers themselves as to the amount of their crops.

The growth, however, of commercial orcharding, along with the practice of packing and handling the merchantable crop in barrels and boxes, has made it possible to gather with some degree of accuracy statistics of the merchantable apples which enter into commerce. These statistics have been collected by the Orange Judd Publishing Company with perhaps more care than by any other concern in the country, and from their tables[a] the following data are taken:

The greatest crop ever recorded in this country appears to have been that of 1896, and comprised 69,070,000 barrels. It also appears that the average merchantable crop of the country is in round numbers 50,000,000 barrels, or about 140,000,000 bushels, annually.

If this quantity enters into commerce through avenues sufficiently definite to give it a place in the statistics of trade, how shall one estimate the millions of bushels which are unmerchantable, or which enter commerce untraced and unrecorded?

It is, then, very evident that we have no means of estimating with reasonable accuracy the grand total of our apple crop; but well-informed persons will, I think, agree to the statement that, on the whole, not more than about 60 per cent of the fruit actually grown in this country finds its way into channels of commerce in such a manner as to appear in general statistics. If this be a fair supposition, then nearly 100,000,000 bushels of this fruit are either consumed without having

[a] American Agriculturist, October 27, 1900, p. 398.

passed through the channels of commerce mentioned above or go to waste on the farms where grown.

DISPOSITION OF THIS FRUIT.

First of all, a large part is consumed where grown or in local markets. Large quantities are consumed in the manufacture of evaporated fruit and of cider, both for drinking purposes and for conversion into vinegar. In certain districts large quantities of low-grade fruit are used for canning and making marmalades, butters, jellies, etc. A great quantity of this unmerchantable fruit, especially in the South, goes into the preparation of sun-dried fruit. In some years 200 tons of this sun-dried fruit are shipped from the little station of Christiansburg, Va., 8 miles from the experiment station at Blacksburg.

Perhaps the data[a] in regard to merchantable fruit produced have been collected with as great accuracy in Virginia as in any other State. These data show that our crop of 1897 reached about 281,889 barrels. These figures are not quite high enough for that year, as the total merchantable crop was about 300,000 barrels. Supposing this to have been 60 per cent of the total crop, about 1,400,000 bushels of apples were produced in Virginia that year. Of this quantity about 600,000 bushels were locally consumed or went to waste. Formerly the estimates were much larger, being based on the Eleventh Census,[b] but we now know that the census figures of 1890, so far as they relate to apple production in Virginia, are inadequate.

Excepting the sun-dried, evaporated, and canned fruit, the apple products just enumerated are generally adulterated in the United States, either by the use of other than vegetable substances or by the mixture of different fruit and vegetable substances, and the use of various preservatives and substances which, if not preservative, serve to mask defects in quality and cheapen methods of manufacture. This adulteration has become so notorious as to greatly injure a legitimate trade which should be a most proper and natural outlet for this large portion of our apple crop which falls below merchantable grade.

The important practical bearing of these secondary industries upon fruit growing in our country has led the writer for a number of years past to devote some attention to their study, with a view to determining the principles which lie at the basis of the practical manufacture of these products on the farms or in small cooperative factories placed in the midst of the districts which furnish the raw material.

To this work the authorities of the Virginia Agricultural Experiment Station have given all the support possible with the funds available, and the work has progressed sufficiently to enable us to give practical instruction of a reliable character to our students, especially along the lines of canning and making butters and marmalades. But on some

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[a] Bulletin 101, Va. Expt. Sta. [b] Bulletin 48, Va. Expt. Sta.

lines we had up to the spring of 1900 made little or no progress, most conspicuous among which were the practical methods of fermenting ciders and vinegars, and the biology of the alcoholic and acetic ferments.

All questions relating to products from fruits received consideration in my work abroad, but particular attention was given to a practical examination of the methods of manufacturing cider in France, Germany, and England, and a study of the biology of alcoholic and acetic fermentation of fruit juices, either for the manufacture of beverages or vinegar. This paper deals with the cider investigation in its practical bearings, and other questions of interest are reserved for a subsequent report.

ACKNOWLEDGMENTS.

In the investigations made abroad I was almost without exception received in the most cordial manner by both public officers and private individuals whom I had occasion to call upon for assistance; and while I can not mention by name all persons who gave assistance, I wish to extend special thanks to the following:

The diplomatic and consular officers of our Government at London, Paris, Frankfort, and Berlin extended every courtesy, aiding me by introductions and by furnishing special information, all of which assisted very much in the accomplishment of the work in hand.

In England I was received in a most courteous manner and, barring some slight exceptions, was shown over the factories and given such information as was desired. Among those who thus assisted I wish to mention especially the following:

Major Craigie, of the board of agriculture; Mr. F. H. Hall, of the agricultural college at Wye; Hon. C. W. Radcliff Cooke, of Hellens, near Dymock, Herefordshire; Mr. Charles D. Wise, of Winchcombe, Gloucestershire; Mr. F. J. Lloyd, London, consulting chemist of the Bath and West Society; R. Neville Grenville, esq., Butleigh Court, Somersetshire; Mr. Frederick George Farwell, Bath; Mr. A. E. Beach, Winchcombe, Gloucestershire; Mr. T. W. Beach, Ealing Road, Brentford, London; Mr. H. P. Bulmer, Ryelands, Herefordshire; Mr. Henry Weston, Much Markle, Herefordshire; Mr. John Watkins, Withington, Herefordshire.

In France I was very courteously received by Mr. Leon Vassillière, director of agriculture in the ministry of agriculture, and by him introduced to others. Prof. A. Kayser, of the National School of Agriculture, Paris, extended every courtesy in his laboratory, and permitted me to note the methods of his work and study the literature of his department. Mr. A. Truelle, of Trouville, Calvados, assisted me in securing information and special literature. Mr. A. Power, director of the Grand Cidrerie at Saint Ouen-de-Thouberville, permitted me to study the methods of the factory, and gave much assistance. Mr. E. Hérissant, director of the Practical Agricultural School of Three Crosses, at Rennes, Brittany, in like manner explained

FIG. 1.—MAIN BUILDING, ROYAL POMOLOGICAL SCHOOL, GEISENHEIM, GERMANY.

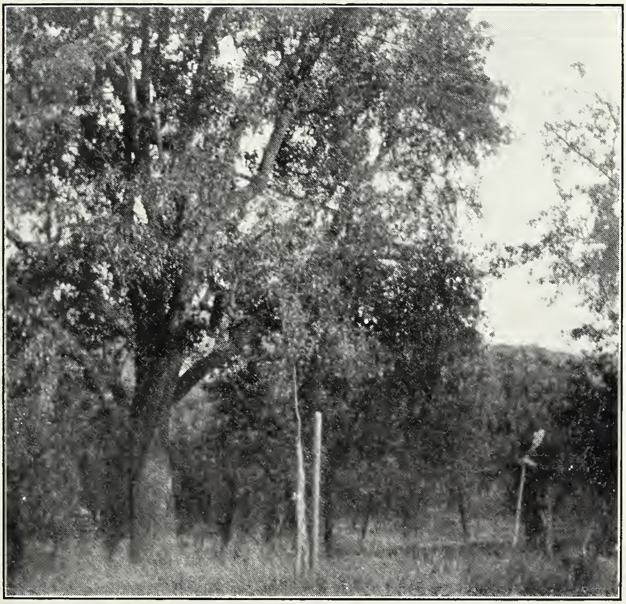

FIG. 2.—GIANT TREE OF PYRUS (SORBUS) DOMESTICA, TAUNUS, GERMANY.

the methods of his work, both in studying varieties of cider apples and making cider, and secured special literature for me. Mr. Isidore Guibout, and his son, Mr. Joseph Guibout, peasant farmers of Danestal, Calvados, gave me every opportunity to study the conditions and technique of cider making on the peasant proprietors' places. Mr. J. M. Buisson, secretary of one of the horticultural syndicates of France, extended many courtesies, and introduced me to many men from whom information could be obtained.

In Germany I am first of all indebted to Director R. Goethe, of the Royal Pomological School, at Geisenheim (Pl. I, fig. 1), for courtesies extended at that institution. I am also especially indebted to Prof. Dr. Julius Wortmann, director of the laboratory of plant physiology at Geisenheim, for his assistance in regard to every part of my inquiry and for instruction while working in his laboratory. From Prof. Dr. Richard Meissner, then assistant to Professor Wortmann, I received much personal assistance and kindly counsel. Prof. Dr. Paul Lindner, of Berlin, also extended courtesies at the Imperial High School for Fermentation Work, for which I am deeply indebted.

Of the manufacturers in Germany I wish to especially remember the Brothers Freyeisen, of Frankfort, for permitting an examination of their work and factories in detail. Acknowledgments are also due to Mr. Fritz Batz, Neuenhain, Taunus, and Mr. C. H. Schmidt, of Schierstein, Rhinegau, for extending like courtesies at their factories.

CLASSIFICATION OF CIDERS.

Wines have long since become well recognized by specific names which, within limits, denote certain characteristics, more or less constant; but with the fermented juice of the apple in the past all has been cider, whether good, bad, or indifferent; and even yet only those who are well informed on the question are aware that there are ciders and ciders.

To the fact that ciders have not in the past been developed on special lines and classified, we owe much of the misunderstanding in regard to the possibility of making a good beverage from apple juice; but to the fact that so much vilely adulterated or chemically concocted stuff is put on the market as a drink, we owe, in much greater degree, the general misunderstanding in regard to this product in our country.

IN FRANCE.

The French attempt to classify ciders as "pure juice," "marchand," and "boisson." To say that this classification is well observed is wide of the truth. The first named is intended to be pure cider of a special quality, made from the finest fruit. It should contain 6 or 7 per cent of alcohol, and may be made as still cider—i. e., fermented "dry" (sec); as "mousseux," cider bottled before all the sugar is exhausted, and so handled as to develop and retain a certain quantity of gas; or as cider "champagnisé," which has received more special treatment than ordinary "mousseux" and often is, in fact, dosed with sugar to fortify it.

The cider "marchand," or simply cider, should contain from 4 to 5 per cent alcohol, and is made from fruits of medium quality; or, as more often happens, if rich enough, it is diluted by mixture of the second pressing with pure juice. This is the cider of commerce as it ordinarily leaves the manufacturer, but after it pays the octroi or tax and enters into consumption in the city, it may be, and often is, diluted and becomes quite a different article from that which leaves the manufacturer.

The "boisson," as applied to a cider, means the juice of second or even third pressing of the pomace. It is fermented comparatively "dry," contains about 2 to 3 per cent of alcohol, and is the ordinary cider of the common people, especially laborers in both country and city, in the cider districts. It is often furnished in large quantities to the farm laborers, and if so handled as to retain considerable gas, or artificially charged, it is an agreeable light drink. "Boisson" is also very often called "petit cidre" (small cider).

A poor cider is made from the unpared chopped American dried apples and from the dried cores and parings we sell to France, by treating this stock as follows: About 10 kilos (22 pounds) of the dried stock are macerated in a vat containing one hectoliter (about 26 gallons) of water with addition of some raisins or sugar to suit the taste of the manipulator, and this is then permitted to ferment slightly in mass to extract the desired substances, and the liquid is expressed and treated as in case of low-grade cider. The beverage made in this manner is restricted by law to 3 per cent alcohol content and is a cheap drink, used mostly at low-class restaurants and for laborers. This low-grade apple stock sent to France is also used to macerate with hard cider to restore in part its quality by inducing new fermentation; but not the slightest evidence was found to substantiate the supposition heretofore frequently advanced, that this poor apple stock, or that even good sun-dried apple stock is used to make French wines or to adulterate them.

IN GERMANY.

Cider is classified in Germany into common cider, or "apfel wein," "export apfel wein," and "champagner apfel wein." One also constantly meets with such names as "Speierling apfel wein," "Boersdorfer apfel wein," and others. These grades of cider do not correspond closely with the classes or grades of French or English ciders. These names are, in fact, more to be relied upon as having a definite meaning so far as the strength and purity of the article is concerned.

The common cider of Germany is made just as they make ordinary light wines, and their cider is, in fact as well as in name, a wine. It will show from 3.75 to 4.50 or nearly 5 per cent of alcohol, varying with the character of the fruit, and the ordinary cider is a dry, light wine of very insipid taste to the American palate when not charged with carbon dioxid. These ciders are kept in casks and drawn as wanted.

The "export apfel wein" is made practically in the same manner from selected fruit, but is either bottled when there is still sugar enough to saturate it with gas or is saturated artificially. It may show 4.5 to 5 or 5.5 per cent of alcohol and is a still light wine.

The "champagner apfel wein" or "schaum apfel wein" is much like champagne from grape wines. At a proper stage the cider is clarified, sugared, and bottled, and carried through the processes described hereafter.

The "Boersdorfer apfel wein" is simply a name given to indicate a product supposedly made from the Boersdorfer apple, but it was not evident that this brand had any special qualities not found in a good export grade.

The "Speierling apfel wein," however, is a cider made by using a small proportion of the juice from the wild fruit known to botanists as *Pyrus* (*Sorbus*) *domestica*. This tree was found growing to giant proportions on the Taunus mountains about Soden. The fruit when fully ripe and touched by frost becomes very mellow and has an agreeable flavor, but before ripening it is characterized by a pungent, acrid juice so rich in tannin as to remind one of the unripe American persimmon in its effect on the mucous membrane of the mouth. The juice of this wild fruit is added to apple juice in small quantity, not over 5 per cent, and by reason of the tannin contained is thought to produce a finer cider, which is more easily clarified, and to furnish in the finished product a superior flavor and bouquet. (Pl. I, fig. 2.)

It can not be said that the German ciders appeal to the American palate, with the exception of their champagne ciders and the very finest of the other grades; but that they are well-made standard goods is most certainly true.

In Germany great quantities of fresh, partly fermented cider are offered at the restaurants in the fall season. This they call "rauscher" or "süss apfel wein" (smoking or sweet cider). The brothers Freyeisen stated that they sold ordinarily about 5,000 hectoliters of such cider each year in Frankfort during the making season. This would be about 132,000 gallons.

IN ENGLAND.

In England a strong effort is being made to bring about a better understanding of the importance of grading ciders in accordance with some standard. But it could not be learned that any generally accepted classification had been adopted, further than that the Bath and West Society, which holds the only fair at which any considerable exhibit of ciders is made in England, recognizes two classes, i. e., those showing 4 per cent of alcohol or more, and those which show less than 4 per cent of alcohol. The latter are called small cider by their chemist, but this word is not accepted in the English trade. From analyses made by the United States Department of Agriculture of samples selected at Bath, at the annual show in May, 1900, it appears that the classification that year was not based on accurate chemical data, or else the samples were confused in handling.

There were goods of both classes, bottled and in casks, and it appeared that the classification was rather artificial, being often determined, not by the quantity of alcohol a certain quality of juice will produce, but by the stage at which fermentation had been arrested. The analyses of ciders from the Bath and West exhibit of 1900 show conclusively that fermentation had not been normally carried out, but that it had been arrested by artificial means.

In fact the cider of commerce in England, except in some few cases, has no recognized standard. There seems to be a very unwise effort to cater to a demand for a sweet liquor showing only 3 to 4 per cent of alcohol. If made from a good quality of fruit and unadulterated, such cider must still contain considerable unfermented sugar, which renders it very unstable and difficult to handle in shipment, except as sterilized bottled goods, unless treated sufficiently with preservatives to check fermentation. There is another alternative equally bad, namely, to ferment the juice dry, dilute with water, and dose with saccharin to produce the sweet taste desired. It was said that this was practiced, but no proof of it was seen.

In England, however, excellent grades of bottled ciders were found, both still and gaseous. Some of these were made from special varieties of apples, as Foxwhelp, a very old English cider apple, or Kingston Black, but more often they were made from the mixed fruit of the district. Eight examples of these ciders are shown under sample numbers 32 to 39 (see p. 111). These were really fine ciders, some dry, some bottled with a small percentage of unfermented sugar, and others sugared in the process of champagnizing.

A sparkling cider is not necessarily a sugared article, but, if pure, is best produced by bottling before fermentation is complete. It is then a normal French "mousseux." This grade can, however, be produced by charging with gas artificially when bottled. A champagne cider is not, properly speaking, a pure cider, but is fortified by addition of sugar.

It appears that even in the best cider districts of England there are no really accepted names for ciders which can be depended upon by purchasers. The name of the maker is practically the only mark worthy of consideration. This state of affairs, however, is in fair way to remedy itself, as the industry is rapidly developing on special lines, and certain class designations, such as still ciders, sparkling ciders, champagne ciders (both dry and sweet), of approximate alcoholic strength, will soon come to be recognized in the trade. The Bulmers, at Hereford, seem already to have reached a high degree of perfection in the preparation of their goods, and Mr. Charles Dacres Wise, at the estate of Lord Sudley, in Gloucestershire, was putting up a very excellent grade of both still and sparkling ciders and perry, the latter being made from the fruit of the pear. Nothing so interesting in the way of a country plant was found as that of Hon. C. W. Radcliffe Cook, at Hellens, near Dymock, Herefordshire. This country gentleman, an ex-member of Parliament, was personally devoting himself to the manufacture of cider in a small way, with the most primitive machinery, and yet producing a good sound article. It was, however, at Butleigh Court, the country seat of R. Neville Greenville, esq., that the best experimental work on cider manufacture found in England was seen. These establishments will be mentioned more fully under a subsequent head.

PRINCIPAL CIDER-PRODUCING COUNTRIES OF EUROPE.

When this inquiry in Europe was begun, the writer was somewhat imbued with the notion, so prevalent in the United States, that cider making could only be regarded as a secondary affair, a method of utilizing inferior fruit in the manufacture of a product of some local value, but not as an industry of general importance. However important the saving of the low-grade or unmerchantable fruit might be to our growers, it had not seemed as though cider making could be ranked as a great industry. Interest in the matter had been mainly aroused by what seemed to be a scientific question of some moment, with fairly promising economic possibilities.

RELATIVE IMPORTANCE OF THE CIDER INDUSTRY IN DIFFERENT COUNTRIES.

In England evidences were found of an industry fairly well founded, and in France and Germany there exists a great industry already well developed and employing millions of capital in the aggregate, with large areas of country devoted to growing cider fruits as an industry.

France, by reason of the extent of its manufacture, is easily the leading cider country of the world, followed by Germany, England, Switzerland, United States, Canada, Austria, Grand Duchy of Luxemburg, and Spain, in order of importance.[a]

The acreage of orchards in France can not be stated with any certainty, but from estimates[b] of the total apple trees in Brittany, made by Frère Martial, of the Christian Brothers, of the Institute of Ploermel, it appears that in this province alone there are about 24,500,000 trees, and as this province makes about one-third the cider of France, a like ratio would carry the total number of trees up to about 75,000,000 for the entire cider country.

After several tours of the cider country of France the writer is prepared to believe that this grand total is not too high. In the Calvados country, at some places, the face of the country is a forest of fruit trees, and frequently the highways are also planted on both sides (Plate II).

The product of cider varies naturally with the quantity of fruit available from year to year, but the mean annual production of France for twenty years (1879–1898) was 297,946,000[b] gallons, and the maximum product during this time reached 695,388,430 gallons in 1893. From the French Government reports it appears that 1,021,090 persons were entered as manufacturers of cider in 1898. The year 1900 saw one of the greatest harvests ever known in France, and without doubt the fruit product surpassed all previous figures. Consul-General Hertslet, of the British consular service,[c] reporting in May, 1901, says that the production of cider in the 68 departments of France, in which apples are grown for this purpose, amounted to 647,000,000 gallons, in round numbers, from the apple harvest of 1900; but this estimate is doubtless not based on the final reports.

The above figures as to production, except the last statement, are taken from those published by the French ministry of agriculture, and are in no sense complete as to grand total. They represent the quantity which finds its way into commerce, so as to be reported to the Government, but take no account of the enormous quantity locally consumed. Each family in the great cider provinces of Picardy, Normandy, and Brittany, as a usual thing, makes its own cider or provides for the same in such a manner that it does not enter into the figures reported to the Government. It is probable that the official figures include very nearly the total of pure ciders, but the "boisson," or low-grade ciders, are practically not represented in these statements.

THE CHIEF CIDER-PRODUCING DISTRICTS.

There are many statements current in the different countries of Europe as to the peculiar importance of certain districts as regards

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[a] Truelle, address before International Congress on the Cider Industry, Paris, 1900.

[b] International Congress on the Cider Industry, Paris, 1900, pp. 72 and 87.

[c] British Diplomatic and Consular Reports, Miscellaneous Series, No. 552, May 6, 1901.

FIG. 1.—CIDER-APPLE TREES BY THE ROADSIDE, NORMANDY, FRANCE.

FIG. 2.—GLIMPSE INTO AN OLD PEAR ORCHARD, NORMANDY, FRANCE.

the excellence of their ciders. These statements at once recall statements of like nature in regard to the quality of grape wines of certain districts. In the case of wines it can not be questioned that experience has abundantly demonstrated the correctness of these claims. Soil and climate certainly play a very important rôle in the production of all fine wines. Do they play an equally important rôle in the production of ciders? The chemical data on varieties grown in different countries must in part answer this question.

It was not found that any investigator had really undertaken a serious inquiry into this matter, and the manufacture of cider can by no means be said to have reached a stage of perfection which warrants definite conclusions of like value to those which govern wine making. It is very evident, however, that in certain districts where grapes will not grow to such perfection as to admit of their culture as a wine fruit, apples have for ages taken their place. European peoples are without exception consumers of wines in considerable quantity, some nations much more so than others. Hence, wherever the grape wine can not be successfully produced, there has been a more or less persistent effort to supply the demand for wine by using a fruit which will thrive under local conditions.

The French Cider Districts.

In France the grape will not thrive in open culture to any extent in the northwestern and northern provinces. Hence the provinces of Brittany, Normandy, and Picardy, lying in this part of France, are the chief seat of the cider industry. These lie along the Atlantic Ocean, the English Channel, and the borders of Belgium.

Normandy is in fact the principal cider country of France, and it is here that one finds the industry best developed in all its details. Also in this province has been developed a large number of seedling varieties of apples with the sole idea of cider making, and, though the face of the country is often a forest of apple trees, one never finds dessert or culinary varieties growing in these open plantations. The idea of commercial apple growing, as developed in America, is wholly unknown to these people. If a proprietor desires table fruit it is grown in his garden on walls or trellises, or on the walls of his residence or outbuildings, always in the form of cordons, espaliers, etc., never in open field culture. In fact, the orchard culture proper is for cider making, just as farther south in France the country is in places occupied with vineyards for wine making.

The varieties are seedlings from the apples grown here for centuries. It is only during the last forty years that a study has been made of these various seedling varieties, and certain ones have been selected for propagation because of vigor, productiveness, and qualities desired in the processes of cider making. One finds certain varieties everywhere mentioned as the leading sorts, and these are largely propagated in nurseries.

The orchards everywhere have the appearance so characteristic of seedlings of *Pyrus malus* (Plate III), and do not take on the characteristic appearance of American cultivated orchards. The trees are often scrubby, rough, and thorny, and so overgrown with moss and mistletoe that they seem to fit in well with the surroundings. The climate is oceanic, moist, and often dull from cloudiness, but never subject to great extremes of temperature. Much of the strictly orchard area in Calvados is found on a moderately elevated plateau, characterized by low, undulating ranges of hills, with decidedly moist valleys.

In this connection some extracts are quoted from a work by M. de Beaumont on Normandy, in which he speaks especially of Calvados, the department in which, perhaps, better cider is made than in any other of France:

CALVADOS.

General aspect.—Calvados lies with an exposure to the north and extends to the hills of the Department of Orne on the south, and comprises many valleys and extensive plateaus. These valleys, which are watered by six streams flowing from south to north, are separated from each other by chains of slightly elevated hills which decrease in height to the shore, where they are suddenly transformed into high cliffs of 30 to 120 meters (100 to 400 feet). Thriving, fertile, rich in prairies, this district offers many aspects of a charming country.

The hills, the geological composition of which is very far from uniform, and which do not present the same characters in any two places, form three very distinct natural regions—the cretaceous, the calcareous, and the granitic.

The first comprises the eastern part of the department. Chalky formations dominate in the country known as "le Pays d'Auge," situated between the frontiers of Eure and the valley of the Dives. The arrondissements of Pont l'Evêque and Lisieux, almost entirely included in these limits, present vast chalky plateaus cut by deep valleys, showing a clayey or argillaceous deposit overlying the rock.

The second region where the limestone (great oolite, inferior oolite, marls, and sandstone) predominates, includes the arrondissement of Caen and a portion of those of Falaise and Bayeux.

All that portion of the Department of Calvados which comprises the division of Vire, the southern part of Bayeux, the western part of Falaise, and the southern part of Caen, under the name of Bocage, has a peculiar aspect. Its granites, gray and reddish in color, its schists, its arid plateaus scarred with great blocks of rocks, its houses constructed of materials of somber color, all present a rather melancholy aspect.

Climate.—Calvados, which is situated on the border of the sea and has no considerable elevations, enjoys a much milder climate than its geographical situation would warrant. It is part of the belt where the Seine or Parisian climate predominates, thus named because it is peculiar to the basin of the Seine, and particularly to Paris. In its general characteristics this climate is mild, but at the same time humid and variable.

In spite of its low elevation and the frequent rains (one hundred and thirty-five days in a year) maintaining a chilly humid atmosphere, the climate of Calvados is very healthy, this department occupying the first rank in the relative longevity in France. The western part of the canton of Tsigny and the country situated at the mouth of the Sougnes and the Dives are less favored than the rest of the department.

TYPES OF CIDER-APPLE TREES IN NORMANDY, FRANCE.

The spring here is cold and rainy, the fine season lasts for only a month and a half from June into August.'

The annual mean temperature of Caen is a little higher than that of Paris, which is 10.6° C. The winter on an average is less cold than at Paris and the summer is not so warm. The predominating winds come from the west, north, and south. Violent storms often desolate the fields at the time of the equinoxes. It rains oftener on the border than in the interior of the department. The rainfall is 74 cm. (29 inches) annually, being not quite equal to the average in France, which is 77 cm. (30 inches).[a]

A student of the geology of Normandy, M. de Caumont, has published a remarkable statement in regard to the influence of the soil upon the quality of these ciders in which he says:

The quality of the ciders produced upon different soils shows very great differences, as those who use these ciders have been able to determine by comparing the products of several cantons. These ciders, like wines, are more or less strong, and one is able to preserve them a greater or less time, according to the soil upon which they were produced.

If my observations have not deceived me, the presence of fragments of quartz and silicious (flint) rocks in the earth, is very favorable to the production of a good cider, that which above all has the most agreeable taste. Therefore, the best cider products in the arrondissements of Bayeux and of Caen are produced upon the mottled sandstone soils, earths covered very often with a great quantity of alluvium, with nodules of quartz and flint, or upon the hard limestones and lower oolite soils of a limestone and clayey character, which are covered up themselves with fragments of quartz and flint, as near Cartigny and the environs of Tsigny, and several communes of the cantons of Crevise, Littry, etc.

In the arrondissements of Lisieux and Pont l'Evêque the best productions are taken from the chalk formations covered with an argillaceous formation carrying flint nodules in quantity. * * *

These numerous observations lead us also to think that the apples harvested from a soil where lime is in excess, as upon the great oolite plains of Caen and of Falaise, are less sugary than these others which grow upon an argillaceous soil. The cider produced from fruits grown upon our limestone plains becomes acid at an earlier stage, and it is very inferior in quality to that made at Bessin and the regions of the chalk substrata like Lisieux and Pont l'Evêque. I have made these observations not only in Calvados, but in the commune of Orne, where the regions vary equally as much in their geologic characters as in Calvados.[a]

At Danestal, in Calvados, some days were spent during November observing the work of the small landed proprietors or peasants (Plate IV), and as this country is typical of the very best cider-producing area of France, the soil was carefully examined and its agricultural value ascertained.

The soil on warm southern and southeastern slopes was very rich in the first reaches above the streams, but grew thinner very markedly toward the summits of the low hills. The best soil was a rich brown loam, showing abundant nodules of flint, and at a depth of 12 inches or more a grayish sand became predominant. Along the upper slopes a gray soft sandstone showed occasionally and seemed to dip down into the hills as though erosion had carried away what was once the

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[a] Translation from manuscript notes furnished by M. Truelle.

higher levels. The abundance of flint nodules was everywhere a characteristic of the best lands.

The best exposures were generally planted in fruit trees and covered with heavy sod, most of the orchards being used as pastures. There was very little land under cultivation in crops.

The cold slopes were mostly thin lands and often seepy, and where set in orchards were decidedly inferior to southern slopes. The uplands varied in value from 500 to 1,200 francs per hectare ($40 to $100 per acre), and the richest valley lands were held at 4,000 to 5,000 francs per hectare ($300 to $400 per acre). These values lead one to wonder how anyone could carry on such apparently careless culture and continue to hold lands of such value.

The German Cider Districts.

In Germany as in France most of my time was given to specific investigations at those places which offered the greatest opportunity for practical and scientific work, viz, at centers where the bulk of the cider is made; hence, the Würtemberg cider districts of Germany were not inspected, but the related districts of Switzerland and a part of southern and central Bavaria were observed. In these nothing worthy of special mention was found. Everywhere, however, the wonderful opportunities for development which would be seized upon by a more versatile people were conspicuous.

At Frankfort-on-the-Main is found the center of the German cider industry. Here two firms alone were making over 1,300,000 gallons of cider annually; and from Frankfort to Wiesbaden, along the slopes of the Taunus Mountains, one finds a continuous apple country with numerous small establishments for the manufacture of cider. The industry here overlaps into the wine country, or Rhinegau proper, and extends even down to Schierstein, almost in sight of the world-famous Johannisburg wine district. But nowhere in Germany was found any area so peculiarly and distinctively a cider-producing country as in Calvados, France.

In Germany the tendency seems to be away from the small peasant proprietor, and toward a factory system founded upon the very best and latest investigations of modern science, while in France this is not nearly so much the case. Possibly this fact, coupled with the well-known orderly and methodical habits of the German, may account for the fact previously stated in this report, that in Germany standards of quality are better recognized than in any other European country. As already noted, the German considers his product a wine, calls it so, and makes it by certain definite methods.

The only apple-growing districts of Germany which were examined were (1) the Taunus country in Prussia, stretching from Frankfort to Wiesbaden, and (2) the Rhinegau, which extends from below Wiesbaden to where the Rhine breaks through the Niederwald below Rüde-

HOMES OF PEASANT CIDER MAKERS IN NORMANDY, FRANCE.

sheim. The Rhinegau is not, properly speaking, an apple-growing district, as here the grape overtops everything in importance, but I found the cider industry well represented as far down the Rhine as Schierstein.

The Taunus region is said by well-posted German students to be the best apple district in Germany. This district is not large, and comprises the western and southwestern slopes of the Taunus Mountains. The orchards occur occasionally even down on the more level drift soils of the floor of the Rhine Valley; but usually the flat lands along the Rhine are occupied by cultivated farm crops, or where spurs of the foothills jut down into the Rhine plain they are oftener occupied by vineyards than by orchards.

The Taunus Mountains are not high, being about 1,300 or 1,400 feet at Cronberg, and nowhere in this district do they rise above 2,000 feet. They slope gradually to the foothills and alluvial lands of the lower levels, presenting gentle grassy slopes and rolling uplands, generally easy to till and presenting no difficulties whatever for orcharding. The Rhine plain has here an elevation averaging about 300 feet above sea level.

The higher levels of the Taunus show some outcrops of shales, overlying igneous rocks of great variety, as gneiss, mica, and feldspathic schists. The slopes occupied by the great orchards show a clayey soil, with much gravel intermingled, and, while not very rich, good care has kept it well supplied with humus and in good condition. The trees are of great size and vigor, and so far as observed, the fruit growers do not have to contend with the numerous insect and fungous troubles met in this country. The exposure is ideal for fruit growing in a country so far north; and, in general characteristics, this would be considered a typically fine orchard section.

The Taunus country has climatic and soil conditions strikingly different from those found in the French orchard country. This German district has a continental climate more like that found in America than that of France, and the whole environment is essentially like that of many American orchard regions. The character of the apples grown and their chemical composition are much closer to American types than to French. Many varieties are grown for culinary and dessert uses, and the low-grade fruit, along with some distinctly cider apples, is employed for cider-making purposes.

In some places the orchards cover the hillsides, all types, ages, and qualities intermingled without much system. And here was seen for the first time the giant trees of *Pyrus* (*Sorbus*) *domestica*, whose fruits are used to mix with ordinary apples to produce the highest grades of cider. The lowland orchards did not have the vigorous appearance of those on higher levels, and often those in flat fields were heavily cropped under the trees, while the uplands were usually in grass.

That the quality of the German fruit is quite inferior for cider making to that of the best French fruit seems to be evident from chemical data given in this report. It does not appear, however, that the studies of the fruit and the ciders made therefrom in certain districts have been carried out with as much care, from the laboratory point of view, in Germany as in France, though German factory work seemed quite superior, as remarked above. There are certainly some very important points awaiting investigation in regard to the effect of soil and climate upon the composition of apples and the resultant qualities of ciders made therefrom. A comparative study of this sort on the German and French fruit would be interesting and yield data of much practical importance.

The English Cider Districts.

The wonderful variety of geological formations occurring in such a small country as England confuses the stranger and renders observations somewhat difficult. However, after traveling twice over the chief fruit sections of the country, the writer was able to discriminate somewhat as to the character of the orchard lands.

The best development of orcharding observed was in Herefordshire, Worcestershire, and Gloucestershire. The second best was in Somersetshire, though Devonshire which has a rather better reputation than Somersetshire, was not visited. The general statement current in England is that the orchard counties are Herefordshire, Devonshire, and Somersetshire, in the order named, but certainly portions of Worcestershire and Gloucestershire should not be omitted from this category.

In the excellent monograph of Dr. Henry Graves Bull, of Herefordshire, on the Vintage Fruits,[a] he points out that in the first two counties named the good orchard lands are situated on like geological formations, viz, the old red sandstone. In Herefordshire the great vigor and fruitfulness of the old orchards, on the fine rolling red lands, were specially noticeable, and the ciders made, especially at Hereford and at Hellens, near Dymock, were as fine as one often finds. Equal praise can, however, be given to the fine cider and perry made on the estate of Lord Sudley, near Winchecombe, Gloucestershire. But as soon as one mounts the Cotswolds he is aware that he is off the fruit lands.

The apple growing seen in Somersetshire did not impress one favorably, and the soil did not seem to produce anything like the fine trees observed in the more northern counties mentioned. It was rare, indeed, that the orchard plantings seemed to be placed with care, and the impression made was that as an industry there was no modern development perceptible. As to orchard growing in England, the best tech-

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[a] A popular treatise based on Dr. Bull's great monograph, The Herefordshire Pomona.

nical work seen was that of the Toddington Orchard Company at Lord Sudley's place in Gloucestershire.

Though there is much small fruit grown in Kent, one of the famous fruit counties of England, very few orchards of any note were found, and cider making is almost unknown. There are, however, in the county good, strong, retentive loam soils, which carry abundance of flint nodules and overlie chalk formations, as in the cider districts of France.

In England, as in Germany, very little attention has been given to the development of cider fruits as such, though in the former there are numerous good varieties to start from. The bulk of the product is made from the refuse of those varieties which are grown for table and culinary uses. Yet distinctly cider apples are constantly met with, and a few cider varieties have recently been imported from Normandy and are gaining in favor.

No definite statistics are available as to the production of cider in England, but Hon. C. W. Radcliffe Cooke, in a recent article in the Nineteenth Century, draws the conclusion that the total annual product is not less than 100,000,000 gallons, having a maximum value of £3,000,000 sterling, (nearly $15,000,000).[a]

CIDER APPLES.

It is doubtless correct to say that there are few distinctly cider fruits grown in the United States at the present time. Formerly this class of apples received more attention. Scions of European cider apples have been distributed of late years by the U. S. Department of Agriculture, but there are as yet no orchards of apples or pears grown distinctly for the manufacture of cider and perry known to the writer. In this regard the United States is at present in pretty much the same category as Germany. England is somewhat better off, as one finds there a few distinctly cider apples and perry pears in cultivation. France has, however, made long strides in this direction, as already noted.

It is of prime importance to consider here what constitutes a cider fruit, and compare the products of several foreign countries with that of our own in this regard.

There can be no question that the making of cider by the landed proprietors and peasants of France for many centuries from the seedlings of Normandy, Brittany, and Picardy may be credited with fixing the attention of the more critical students and cultivators of recent years upon the best characteristics of the French cider fruits. In these ancient seedling orchards and their descendants have been determined empirically the qualities which distinguish cider fruits (pommes à cidre) from table fruits (pommes à couteau) in France.

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[a] Nineteenth Century, August, 1901, p. 276.

The work of the past thirty years in France has been directed to the task of sifting from these hundreds of seedlings (pommes sauvage) those which best embody the desirable chemical constituents and which also show the other desirable characteristics of hardiness, vigor, productiveness, proper season of blooming and maturity of fruit, adaptability to certain soils, keeping qualities, etc.

Among those who have led in the critical study of cider fruits of France might be named Messrs. Hauchecorne, de Boutteville, Truelle, Lechartier, Hérissant, Power, Andouard, Hubert, Beaurepaire, Séquin, and many others. A greater amount of work by far has been devoted to a study of the chemical composition of varieties, their description, classification, etc., than to strictly experimental researches upon cider-making problems proper. It seems that little is now to be desired, so far as relates to analyses, classification of varieties, etc., but that much is wanting in the French work relating to real studies of soil and climatic influences and the practical problems of handling and working up the crop. Much has, it is true, been written on these problems, but there is a dearth of facts in such literature as is obtainable.

The French cultivators have now a great number of what appear to be the best cider fruits in the world ready at their hands, and they owe a great debt of gratitude to the unselfish work of the gentlemen named above for their often unremunerated critical studies, made at the expense of much time and labor. In this regard M. Truelle, a pharmacist, of Trouville, Calvados, is perhaps the most shining example.

There have been no such elaborate studies made of German cider fruits, nor of the low grades of commercial fruits so largely used in cider making in that country, although chemical data on the German fruits is not wanting. Professor Kulisch has made at the Royal School of Geisenheim somewhat extensive chemical examinations of varieties of apples.

In England until quite recently no critical study of cider fruits was known, but now, under the auspices of the Bath and West Society, supplemented by a royal grant in aid, Mr. F. J. Lloyd, of London, is making chemical studies which have already advanced to a stage where they furnish very useful data for comparison.

IMPORTANT CHARACTERISTICS OF CIDER APPLES.

The French students of this subject and also the French manufacturers of cider rank the value of varieties in accordance with their content of (1) sugar, (2) tannin, (3) mucilage, and (4) acid. They also insist upon the fruits being of fine flavor and fragrant. To a stranger the most striking characteristic of many of the French varieties is their delicate, bitter-sweet flavor, and the powerful and peculiar odor which they exhale when lying in bulk ripening.

The writer can not refrain from observing that apparently the French attach entirely too slight importance to the acid content of cider fruits. French apple must sometimes turns black as ink in the presence of air because of rapid oxidation of the tannin; yet it is easily shown that a higher acid content will prevent this. From some statements made it would appear that they consider 0.1 to 0.2 per cent of acid sufficient.

The Germans rank the chemical constituents in importance as follows: (1) sugar, (2) acids, and (3) tannin. They pay practically no attention to determining mucilaginous substances. Their apples are so different in character (as will be seen in later discussion) that these constituent elements may not be strongly developed in them. They also claim that nitrogenous and mineral compounds are important as nourishment for the yeast organisms. The acid content is considered important in Germany, and at Geisenheim the percentage of acid demanded is 0.6 to 0.8 per cent. While they insist upon the importance of tannin, they do not rate it so highly as the French.

No English student of the subject appears to have discussed these points from an original standpoint. However, Thomas Andrew Knight was the first to call attention to the value of the densimeter as an instrument to test the quality of must.

In the United States we have no technical literature of any moment covering this subject. It appears that Americans have proceeded on the idea that the sugars are the only substance of prime importance in an apple must. Tannin appears to be regarded as objectionable. Acid is apparently regarded as an element which it is necessary to eliminate as far as possible. The character of our fruits may have had something to do with this, but it is rare that our fruits show too much acid, and it is more to be noted that they seldom or never show enough of the very important element, tannin.

Sugar content of the fruit.—During the process of fermentation cane sugar and possibly some of the pectose bodies are converted into fermentable sugars, and practically the total sugar content of the apple is thus rendered subject to the breaking down process called fermentation. Pasteur's statement of the products resulting from the fermentation of fruit sugars per 100 parts is as follows:

	Per cent.
Carbon dioxid gas (CO_2)	46.67
Alcohol	48.46
Glycerin	3.23
Succinic acid	.61
Matter consumed by ferment organisms	1.03

While this statement is now disputed in some particulars, it is used here to indicate the probable results which may be expected from complete fermentation of the sugar content of any fruit juice. It is, then, from the sugars that all the alcohol is derived, and also the car bon dioxid gas, the first being that which gives the strength to the beverage, the second that which renders it sparkling and piquant if retained in the liquor. The glycerin helps to give body and flavor to the liquor. It is derived partly from the alcohol and doubtless in part from the organic acids present in the must.

Tannin, or tannic acid, in the fruit.—This is the substance so readily recognized in unripe persimmons or in the bark tissues of oak trees. In fruits it tends to give a bitter taste and to pucker the mucous membranes of mouth and throat. It is undoubtedly the relatively large amount of this constituent which gives to the bitter-sweet apples of France their peculiar character. This element is of great importance in the composition of any fruit for wine and cider making purposes, because of its action in coagulating albuminous elements in the must, thereby assisting to clarify the liquor, its wholesomeness to the system, and its effect in conserving a certain portion of the sugar from too rapid fermentation, thus adding very materially to the soundness and keeping qualities of the beverage. The writer is inclined to agree with the French that this element is more important than the acid. Three to five parts per 1,000 of tannin (0.3 to 0.5 per cent) is a sufficient quantity. American fruits fall far below this standard.

Acids in the fruit.—These exist in the apple and pear chiefly as malic acid, but possibly also as tartaric to a small extent. Their importance in a cider fruit is very considerable. If acid is not present in sufficient quantity, the oxidation of the tannin will be so rapid as to turn the must black, or blackening may even occur in the finished cider. Also the refreshing quality of a cider as a summer beverage is largely due to its acid content. American apples usually contain sufficient acid.

Mucilage in fruit.—The practice of determining this substance as mucilage in apple must seems only to be followed by the French chemists. Whether their determinations are comparable with the determinations of pectin by other chemists can not be here stated. These substances, give body to the cider and are important constituents of good cider fruits.

COMPARISON OF CIDER APPLES.

FRENCH STANDARDS.

It is a matter of unquestionable importance to compare the fruits of the three prominent European cider-producing countries with one another and with our home fruits as to chemical composition. The French students of the subject have attempted to set standards by which varieties should be selected. The following is quoted from M. Hauchecorne ("Le Cidre" p. 9), in which he gives what he has determined to be an average composition based upon analyses of many French varieties:

Specific gravity		1.067 to 1.080
Water	per cent	80
Sugar (fermentable)	do	17.3
Tannic acid	do	.5
Mucilage or pectose	do	1.2
Free acids (organic) calculated as sulphuric	do	.107
Earthy matters, etc	do	.893
Total	do	100.000

The same author continues (p. 119):

Cider apples designed for making a beverage of superior quality, from the point of view of its hygienic quality and of its conservation in a commercial condition, should be prepared from fruits which yield a must of 1.075 density in order to obtain a sufficient percentage of alcohol.

One should search persistently for varieties which show at least 5 parts of tannin per 1,000 and 12 to 15 parts of mucilage, this latter being desirable because of its value to give smoothness and body to the beverage. The acidity should not be less than 1.071 parts per 1,000 in order to insure a good fermentation, and the fruits should be fragrant.

At the International Congress on Cider Fruits held at Paris October 11–13, 1900, M. de Messenge de Beaurepaire, in a paper entitled "Principles which should serve as a basis for determination of the best varieties of cider fruits," enunciated the following general principles:

Varieties should be divided into four categories, according to the nature of the beverage desired, as follows:

1. Varieties of apples or pears destined to make a delicate quality of cider or perry.
2. Varieties destined for the manufacture of champagne cider or perry.
3. Varieties destined to make a full-bodied, strong alcoholic cider or perry.
4. Varieties for distillation of brandy.

To whatever use one intends to put the fruit, all good varieties should satisfy the four following conditions:

(1) Good flavor of pulp and juice.

(2) A sufficient quantity of juice, falling not below 55 per cent of weight of fruit.

(3) Good color of juice, above all with the apple, but not so important for the pear, as the juice of the latter is often quite pale.

(4) Juice easy to extract from the pulp.

He proceeds to particularize as to the chemical qualities of each category of fruits as follows:

1. Cider apples and perry pears, for a fine and delicate beverage, should show a medium density, i. e., ranging from 1.057 to 1.064, and not exceeding 1.069; sugar content, medium, 12.5 to 14.5; tannin (maximum), 0.3 per cent; flavor, sweet, slightly bitter. The distinctive qualities should be a clearly defined, delicate aroma and a sugary flavor.

2. Varieties designed for champagne should be as above except that there should be absolutely no bitter taste.

3. Varieties destined to make a strong alcoholic beverage should show density, 1.065 and above; sugar, 14.3 per cent and above; tannin (minimum), 0.2 per cent and above, the more the better; flavor, unimportant, except that it must not be acid; strong and penetrating aroma; the controlling qualities being richness in sugar and tannin.

4. Varieties destined for making distilled liquor should show a minimum density of 1.070 and 15.5 per cent of sugar, the richer the better. The other characters noted do not play an important role in this category.[a]

If the density and sugar content given in the first category are only medium for French fruits, in what category can one place German and many American and English cider fruits? The French have adopted a high standard in quality of fruit, and the chemical analyses reported by the numerous investigators bear them out in this position. Do these qualities result from peculiarities of soil, or have these century-old seedling races of French apples acquired certain characteristics which can now be perpetuated in other lands by ordinary propagation? Can their seedlings, when grown in other countries, become the foundation stock of seedling races of apples which will show such wonderful richness in saccharine matter and tannin as their parent stocks?

After thirty years of study along what these French investigators seem to consider preliminary lines, but which has yielded already the best technical literature in the world on the subject, the Association Française Pomologique appointed a commission, composed of its best scholars and cultivators, to undertake a critical study of all the data, and also to conduct an original investigation of all promising French cider fruits with a view to correcting the nomenclature and establishing a standard list with authentic information as to quality and character of fruit and character of plant, so that cultivators shall have a definite guide to aid them in making plantings. The fruit of each variety selected for the standard list is reproduced in color for the bulletin of the association and modeled for the permanent collection. After four years of study this commission has made considerable progress. On its organization at Mans in 1898, the commission adopted the following outline of points on which the varieties of fruits should be judged:

(1) Vigor of plant.

(2) Natural resistance of same to fungous and insect attack.

(3) Fertility (productiveness).

(4) Quality, based upon the richness of the fruits in useful substances, but, above all, upon its known practical value as a cider fruit.[b]

Out of the immense number of French cider fruits the commission decided that only 40 or 50 varieties of apples should be admitted to the permanent list, and 8 or 10 of pears, and that each subsequent year not over 5 or 6 varieties might be added to the list, and that these must be voted upon for three successive years before they could be considered as finally accepted. Up to the present the records only show 36 varieties of apples definitely admitted, and of these but 12 have yet been voted for reproduction by colored plates and models.

[a] Condensed free translation from Proceedings of International Congress, Paris, 1900, pp. 48–50.

[b] Bul. de l'Ass. Fr. Pom., **16**: 35.

These 12 varieties represent perhaps the best known and most carefully studied French cider apples. The chemical data which appear in the accompanying table have been collected from the bulletin of the Association Française Pomologique.

For most of these varieties a very considerable number of analyses are reported. Of these analyses the maximum and minimum determination for each substance are given, and then the mean of all the determinations of each substance. While there are some very striking differences between the determinations given in a number of instances, yet it is perhaps fair to say that the mean results ought to be reliable for the average composition of these varieties. Certainly no such elaborate data are at hand for the compilation of average composition of cider fruits of any other country.

To one familiar only with our best American varieties it is quite startling to note specific gravity determinations reading as high as 1.133 and total sugar 24.31, as shown by Saint-Laurent, and 1.134 specific gravity, sugar 26.35, as shown by Bramtôt. Rousse falls but little below these. The above figures are, it is true, the maximum given, but the means for sugar of these varieties—16.51, 19.05, and 17.19 grams per 100 cc of must—are so far above the averages of American or German fruits that the comparison is equally striking.

The mean acid content is very low, falling far below the German theoretical mean desired. In tannin these varieties exceed by far those of other countries, but yet rarely show a quantity sensibly above the theoretical minimum of 0.2 per cent demanded by the French standard, and only in one case, Bramtôt, reaching a mean which approximates the theoretical maximum quantity desired under the French standard.

The varieties in the following table are arranged in accordance with the French seasons for cider apples:

Table I.—*Maximum, minimum, and mean composition of 12 French cider apples, specially selected as standard sorts by the Association Française Pomologique.*

Variety.	Number of analyses.		Specific gravity.	Grams per 100 cc of must. Total sugar.	Acid.	Tannin.	Mucilage.	Season of maturity.
Blanc-Mollet	13	Maximum	1.0740	16.71	.970	.564	2.10	First season—Sept. 20 to Oct. 15.
		Minimum	1.0550	9.30	.071	.065	.20	
		Mean	1.0637	13.48	.240	.297	.62	
Reine des Hatives	10	Maximum	1.0820	19.00	.830	.415	1.00	Do.
		Minimum	1.0510	9.30	.044	.140	.25	
		Mean	1.0619	13.06	.288	.254	.51	
Saint-Laurent	21	Maximum	1.1330	24.31	.730	.699	1.97	Do.
		Minimum	1.0610	12.63	.090	.096	.04	
		Mean	1.0800	16.51	.276	.244	.74	
Bramtôt	58	Maximum	1.1340	26.35	.960	1.055	1.09	Second season—Oct. 15 to Nov. 10.
		Minimum	1.0500	9.41	.085	.133	.01	
		Mean	1.0880	19.05	.219	.529	.35	

TABLE I.—*Maximum, minimum, and mean composition of 12 French cider apples, specially selected as standard sorts by the Association Française Pomologique*—Cont'd.

Variety.	Number of analyses.		Specific gravity.	Grams per 100 cc of must. Total sugar.	Acid.	Tannin.	Mucilage.	Season of maturity.
Omont[a]	3	Maximum	1.0690	14.92	.370	.300	1.65	Second season—Oct. 15 to Nov. 10.
		Minimum	1.0630	12.90	.310	.245	.62	
		Mean	1.0660	14.19	.330	.266	1.04	
Doux-Normandie	10	Maximum	1.1010	18.32	.385	.210	1.12	Third season—Nov. 10 to Dec. 1.
		Minimum	1.0530	11.27	.080	.061	.17	
		Mean	1.0739	14.80	.186	.119	.51	
Rousse	17	Maximum	1.1050	24.00	.810	.395	1.45	Do.
		Minimum	1.0580	10.81	.105	.045	......	
		Mean	1.0808	17.19	.282	.200	.61	
Ambrette	8	Maximum	1.0860	19.00	.520	.302	.68	Fourth season—December and January.
		Minimum	1.0610	12.34	.079	.079	.10	
		Mean	1.0695	15.48	.177	.165	.31	
Argile	31	Maximum	1.0880	19.45	.480	.524	1.71	Do.
		Minimum	1.0600	12.61	.064	.051	.02	
		Mean	1.0725	15.76	.177	.176	.85	
Bedan	75	Maximum	1.0936	21.94	.397	.825	1.71	Do.
		Minimum	1.0470	10.68	.015	.008	.02	
		Mean	1.0685	14.89	.140	.196	.62	
Doux-Geslin	33	Maximum	1.1070	21.60	.740	.866	1.60	Do.
		Minimum	1.0530	10.80	.079	.091	.12	
		Mean	1.0791	16.60	.233	.407	.46	
Marabot	13	Maximum	1.0870	17.85	.368	.630	1.28	Do.
		Minimum	1.0570	10.81	.082	.092	.20	
		Mean	1.0670	14.77	.205	.287	.67	
Average of means			1.0725	15.98	.229	.262	.59	

[a] Taken from Power, Vol. II, "Best cider fruits."

In addition to the list of 12 varieties shown in this table there are 24 other varieties of apples already admitted to the standard list by the commission of the Association Française Pomologique, and 7 cider pears are provisionally admitted. Strange as it may seem, 2 of the varieties of apples admitted to the list (Fréquin-Lacaille and Muscadet de la Sarthe) could not be identified in the present state of the nomenclature so as to give the chemical composition of the must. Of the pears admitted provisionally the analysis of but 4 could be ascertained with certainty from the literature examined.

The chemical composition of varieties given in the subjoined Table II is largely taken from Volume II of Mr. G. Power's exhaustive treatise on the "Best cider fruits." In every case where more than one analysis is noted the average is given from Mr. Power's work. Where but one analysis is noted, the figures are in every case except one quoted from Messrs. Séquin and Pailheret, of the National School of Agriculture at Rennes. One analysis—that of the variety Havardais—is quoted from the work done by Mr. Pic at the Practical School of Agriculture of the Three Crosses near Rennes. These two schools just outside of Rennes are now doing an immense amount of work on the investigation of cider fruits. When possible, the average of analyses covering a period of years is quoted.

TABLE II.—*Composition of French cider fruits admitted to the provisional list of the Association Française Pomologique.*

Fruit and variety.	Number of analyses.	Specific gravity.	Grams per 100 cc of must.			
			Reducing sugar, total.	Acid, as sulphuric.	Tannin.	Mucilage.
APPLES.						
Amère (petite)	1	1.0860	19.09	0.114	0.116	0.450
Binet Blanc ou Doré	5	1.0750	17.13	.220	.188	.596
Binet Rouge	3	1.0740	15.30	.236	.271	.827
Binet Violet	2	1.0770	14.00	.303	.276	1.755
Chérubine	4	1.0680	14.60	.227	.244	.621
Doux-Amer-Gris	3	1.0850	18.64	.270	.419	.347
Doux-Courcier	1	1.0873	18.30	.123	.378	1.392
Doux (petit)	1	1.0572	11.69	.132	.110	.364
Fréquin-Audièvre	5	1.0700	15.10	.230	.302	.678
Fréquin-Lajoye	2	1.0600	12.80	.183	.376	.317
Fréquin-Lacaille[a]	......	....	....	....	....	....
Gilet-Rouge	7	1.0610	12.29	.395	.140	.558
Grise-Dieppois	5	1.0940	20.24	.118	.368	1.130
Havardais	1	1.0508	11.76	.079	.111	.604
Hommet	1	1.0847	15.74	.164	.089	1.364
Jambe-de-Lièvre	5	1.0650	13.42	.254	.193	.690
Joly-Rouge	4	1.0670	14.34	.185	.212	.799
Médaille-d'Or	6	1.0900	18.60	.216	1.107	.524
Michelin	4	1.0710	15.92	.183	.432	.553
Moulin-à-Vent	9	1.0730	16.57	.293	.350	.758
Muscadet (petit)	5	1.0710	15.16	.228	.210	.392
Muscadet-ou-Antoinette[a]	......	....	....	....	....	....
Precoce-David	4	1.0720	16.28	.137	.259	.804
Tardive de la Sarthe	1	1.0710	15.21	.141	.213	.964
Averages	......	1.0732	15.55	.192	.289	.735
PEARS.						
Billé[a]	......	....	....	....	....	....
Carisiblanc	3	1.0540	12.48	.303	.256	.283
Cheunevière	1	1.0742	13.91	.205	.034	.936
Crapaud	1	1.0577	11.00	.338	.027	.246
Croixmare[a]	......	....	....	....	....	....
Navet[a]	......	....	....	....	....	....
Souris	3	1.0650	15.00	.251	.665	Trace.
Averages	......	1.0627	13.09	.274	.245	.366

[a] Analyses not found.

GERMAN STANDARDS.

The Germans do not appear to have attempted a study of varieties of apples and pears for cider purposes in anything like the comprehensive manner of the French students. It seems that the German cultivators have worked on other lines than those of the French. To an American it appears that ordinary orcharding in Germany is about as far advanced as it was in the United States twenty or thirty years ago, before the wonderful development of commercial orcharding in this country. There are many good varieties of grafted fruit, and these are cultivated at times in considerable areas, but neither orcharding for table fruits nor for cider fruits is well developed in Germany, except where the dessert fruits are grown in what we would call garden culture on walls, trellises, etc.

The German cider fruits, so far as they can be differentiated from dessert fruits, are occasional seedlings of no peculiar character or special value. There are certainly no varieties to compare with the special varieties recorded in the French literature and shown at the

French pomological congresses. In fact, the Germans use their chance seedlings and the refuse of their table fruits for cider about as we do in America. But the great manufacturing establishments draw supplies by rail from Russia, Austria, and Switzerland in large quantities, and much of this fruit may be of a more special grade for cider than that seen growing in the Taunus and Rhinegau regions of Germany. These establishments also draw supplies from western France whenever crop failures in nearer regions render this necessary.

The chemical data on German varieties are also meager, or at least so scattered that nothing approaching full data could be collected during the time of the visit. Later correspondence with very reliable book dealers has failed to develop this information as fully as could be desired.

There are 53 different sorts or varieties of German-grown apples mentioned by Dr. Cluss[a] in his recent work on cider making in Germany. Of these 29 were analyzed by Professor Kulisch at the Royal School of Pomology at Geisenheim. Out of 17 varieties analyzed by Professor Behrend at Hohenheim, Würtemberg, 13 seem to be sorts not included among those examined at Geisenheim. These doubtless fairly represent Würtemberg cider fruits. Dr. Kramer's analyses of cider fruits at Steiermark, quoted by Dr. Cluss, give 11 out of 15 varieties reported upon, which are not included in either of the above-cited lists. Thus we have 53 varieties represented in the following tables, which, from the German literature consulted, seem fairly to represent the range of German apples in the best cider districts.

Director Goethe, of the Lehranstalt für Obst-und Weinbau at Geisenheim, says the Schafnase and Rhine Bohnapfel in Nassau, the White and Red Treierischer wine apples in the Rhine provinces, and the Luiken and little Langsteil in Würtemberg are the best six German cider apples.

TABLE III.—*Analyses of German cider-apple must made at Geisenheim, 1889–90, by Professor Kulisch.*[b]

Name of variety.	Specific gravity.	Grams per 100 cc of must.				
		Grape and fruit sugars.	Cane sugar.	Total reducing sugar.	Total solids.	Acid, as sulphuric.[c]
Köstlicher	1.0451	8.72	1.28	10.07	11.70	0.153
Edelroter	1.0470	7.80	2.12	10.04	12.20	.241
Kasseler Reinette	1.0496	6.82	3.71	10.73	12.86	.270
Bohnapfel	1.0532	7.19	3.29	10.66	13.80	.716
Gäsdonker Reinette	1.0533	8.47	2.31	10.90	13.82	.541
Winter-Rambour	1.0549	8.69	3.72	12.61	14.24	.087
Schiebel-Taubenapfel	1.0591	7.12	5.46	12.87	15.33	.592
Süsser Hoolart	1.0605	8.36	4.52	13.12	15.69	.138
Roter Eiserapfel	1.0642	8.35	4.64	13.23	16.65	.526
Dunchapfel	1.0681	9.94	3.51	13.64	17.69	.665
Graue Fr. Reinette	1.0869	13.12	4.49	17.85	22.61	.687
Sommer Zimtapfel	1.0495	8.80	0.75	9.59	12.82	.592
Kaiser Alexander	1.0560	8.96	2.32	11.40	14.53	.482
Burchardts Reinette	1.0538	8.26	2.89	11.30	13.96	.351
Batullenapfel	1.0540	7.85	2.65	10.64	14.02	.424
Schmidt-Reinette	1.0492	9.03	1.75	10.87	12.75	.409

[a] "Die Apfelweinbereitung," Dr. Adolf Cluss, 1901.
[b] Apfelweinbereitung. Dr. Cluss, pp. 24–25.
[c] Calculated at Blacksburg, Va.

TABLE III.—*Analyses of German cider-apple must made at Geisenheim, 1889–90, by Professor Kulisch*—Continued.

Name of variety.	Specific gravity.	Grams per 100 cc of must.				
		Grape and fruit sugars.	Cane sugar.	Total reducing sugar.	Total solids.	Acid, as sulphuric.
Gelber Bellefleur	1.0510	7.38	2.12	9.61	13.24	.504
Fette Goldreinette	1.0488	7.77	2.47	10.37	12.66	.255
Langer Gr. Gulderling	1.0535	8.62	3.19	11.98	13.87	.511
Goldzeugapfel	1.0600	10.32	2.88	13.35	15.58	.482
Muskat Reinette	1.0639	7.08	6.17	13.58	16.58	.453
Ananas Reinette	1.0724	11.02	3.91	15.14	18.82	.372
Grüner Fürstenapfel	1.0519	8.65	1.74	10.48	13.46	.767
Winter Gold Parmäne	1.0654	9.20	5.33	14.81	16.89	.402
Dunkapfel	1.0615	9.79	1.95	11.84	15.97	.789
Leichter Matapfel	1.0516	9.27	2.03	11.40	13.37	.402
Champagner Reinette	1.0510	7.87	2.85	10.87	13.24	.643
Canada Reinette	1.0667	9.94	4.96	15.16	17.32	.555
Baumanns Reinette	1.0507	8.44	2.44	11.01	13.15	.329
Averages	1.0569	8.72	3.15	12.04	14.78	.460

TABLE IV.—*Analyses of German cider-apple must, 1890, by Professor Behrend, Hohenheim, Würtemberg.*[a]

Name of variety.	Specific gravity.	Grams per 100 cc of must.		
		Grape and fruit sugars.	Cane sugar.	Total sugars.
Rheinische Schafnase	1.054	7.64	3.73	11.37
Goldparmäne	1.056	8.07	4.82	12.89
Rheinisches Bohnapfel	1.057	9.93	3.49	13.42
Gelber engl. Gulderling	1.043	6.62	2.63	9.25
Jane Hure	1.066	12.31	2.52	14.83
Berner Grauchenapfel	1.050	6.79	3.44	10.23
Pomeranzenapfel	1.059	6.22	6.51	12.73
Rother Eiserapfel	1.059	7.06	4.37	11.43
Englische Spitalreinette	1.072	9.37	4.89	14.26
Kleiner Fleiner	1.059	8.81	2.48	12.29
Carpentinapfel	1.068	7.99	5.52	13.51
Kugelapfel	1.054	8.40	3.31	11.71
Glanzreinette	1.063	9.63	4.10	13.73
Trierischer Weinapfel	1.059	8.66	4.54	13.20
Königlicher Kurtzstiel	1.082	13.04	5.60	18.64
Kleiner Langstiel	1.056	8.97	2.95	11.92
Casseler Reinette	1.055	10.73	1.36	12.09
Average	1.059	8.89	3.89	13.38

[a] Obstweinbereitung, Antonio dal. Piaz, p. 88.

TABLE V.—*Analyses of German cider-apple must, 1892, by Dr. Kramer, Steiermark.*[a]

Name of variety.	Specific gravity.	Grams per 100 cc of must.	
		Total sugars.	Acid.
Muskatellerapfel	1.047	10.00	0.54
Holzapfel, Spitz	1.052	10.50	.75
Holzapfel, rothgestrieft	1.053	10.70	.45
Holzapfel, rothgestrieft	1.054	11.00	.36
Hanapfel	1.067	13.60	.20
Steierischer Maschauzker	1.050	10.10	.55
Champagner Reinette	1.043	9.40	.81
Canada Reinette	1.050	10.10	.64
Weiser-Winter Taffetapfel	1.044	8.85	.72
Englische Winter Gold Parmäne	1.055	11.10	.54
Rother Streifling	1.051	10.20	.70
Heiderapfel	1.049	11.10	1.20
Damason Reinette	1.068	13.80	.80
Edelborsdorfer	1.055	11.10	.61
Gelber Weinapfel	1.061	12.60	.72
Average	1.053	10.94	.64

[a] Obstweinbereitung, Antonio dal. Piaz, p. 89.

Pyrus (*Sorbus*) *domestica.*—Strange to say, no modern German writer on cider making appears to notice this very important fruit, so largely used to tone German ciders. It is known popularly as the Speierling, Speierlingbaum, Speierling crab, etc., and is a native forest tree of central Europe, but was not observed in France.

Whether it has been always intentionally planted in the orchards of the Taunus or is partly wild is doubtful, for it is not usually seen in the regular rows, but in odd nooks here and there. On the borders of mountain ravines it is a most beautiful and luxuriant tree 20 to 40 feet high and loaded in the fall with small pyriform fruits about half the size of Seckel pears. These become yellowish in color and fall to the ground late in autumn, where, after some days, one can pick them up and eat them with considerable relish; but if plucked from the tree or eaten before they become mellow, the result on the mucous membranes is about the same as that of biting a green persimmon.

This fruit is gathered in quantity just at maturity and before ripening begins, and it is then used to fortify the best grades of ciders. Either the fruits are crushed with the apples in certain proportions or are ground separately and the must added to apple must in definite proportions. The latter is believed to be the better mode of blending, and it is the one pursued in the large establishments of Freyeisen Brothers at Frankfort. They had great casks of this must in reserve in a very cool cellar more than 50 feet below the surface of the earth, which they were using to blend with the finest apple juice to make the high-grade "Speierling apfel wein." As nearly as could be determined about 1 part in 20 of this must from Sorbus fruits was added to the apple juice.

It seems astonishing, considering the great importance of this fruit, that no recent writer should have treated it in the German literature and that not a single analysis of the fruit or juice could be found. About a century ago J. L. Crist wrote quite comprehensively of its use in making wine and in blending with apple juice, but gave no chemical data. It is supposedly used at present to tone up German ciders in tannin, thus adding piquancy and flavor to the product. The sugar content of the fruit could not be ascertained. Director Goethe, of Geisenheim, kindly furnished an article written by G. W. Eichenauer, of Cronberg, Taunus, in which he discusses this fruit from a gardener's standpoint, but does not give critical data on its composition. He states that cider made by properly blending it with ordinary stock is worth twice as much as it would have been otherwise and will keep much longer. If it is the tannin principle alone which makes this fruit so valuable, certainly it is time we in the United States looked more to the selection of varieties rich in this substance or resorted to wild fruits, such as the native persimmon, *Dyospyrus virginiana*, to obtain it.

ENGLISH STANDARDS.

Any attempt to study the cider apples of England, or table varieties for that matter, is greatly complicated by the endless maze of names of similar orthography which have been given to apples, both cider and table varieties, and by the fact that there is no recognized authority on the nomenclature of orchard fruits in the entire country. Every local community appears to delight in applying names of its own choosing to the fruits grown, and there seems to be no general disposition to reduce the nomenclature to a system under some competent authority, as for instance, a national committee on pomological nomenclature. Of recent writers on pomology in its broader sense, there are very few, but the older works, as those of Knight, Marshall, Evelyn, and others are classics of their time.

The best modern treatment of the subject of pomology, in a somewhat limited sense, which was secured is The Apple and Pear as Vintage Fruits, by Robert Hogg, LL. D., and Henry Graves Bull, M. D., a charmingly prepared general dissertation upon the subject of cider and perry making, with critical notes and cuts showing many varieties of cider fruits. In the way of recent literature, the Bath and West Society deserves great praise for the efforts it is making to develop a reliable literature on modern cider making. In fact, it is putting forth an effort to arouse the popular interest so necessary to the future progress in pomology as an art, and more specifically as it relates to cider making as an important industry.

However, in this literature it does not appear that a successful attempt has been made to establish a standard toward which the growers of cider fruits should direct their attention. The nearest approach to a standard as to quality of cider fruits which was found in the works mentioned is in the report of the committee of the Woolhope Club, which visited the congress of the pomological societies of France, at Rouen, in October, 1884. When this committee determined to select a set of French varieties of apples for introduction into Herefordshire they laid down the following rules:[a]

(1) The fruit must possess the very best quality of juice.

(2) The trees must be hardy, vigorous, and fertile.

(3) They must bloom at varying intervals.

(4) The fruit must attain maturity in late autumn or winter.

(5) The varieties must have obtained the highest reputation in the Norman orchards.

The fact that these gentlemen from Herefordshire recognized the importance of securing some of the best Norman varieties of cider apples for introduction into England indicates that some of the best English growers are alive to the importance of producing fruit of high quality for the upbuilding of the cider industry. But such apples are already very common in England. The oldest English writers tell

[a] Hogg and Bull, Vintage Fruits, p. 88.

us of fruits yielding must of 1.091 specific gravity, which, if correct, is hardly surpassed in our day in any country.

There is a large group of varieties of apples cultivated in England chiefly for cider, the names of which are made up of some English word prefixed to the word Norman or Jersey, as Cherry Norman, Broad-leaf Norman, Chisel Jersey, Red Jersey, etc. These apples all possess the peculiar bitter-sweet taste which characterizes so distinctly many of the most famous French cider apples. An interesting question arises in this connection as to whether these apples are ancient importations from Normandy and the Channel Islands. In the work on Vintage Fruits, quoted above, the opinion is given that they are not. This is based on comparisons made in 1884 at the congress of Rouen; which really prove nothing further than that they are not recent importations. It appears, after extensive comparisons, that this peculiar race of apples so common in Normandy has had a common origin, either in England or in France, indications all pointing to the latter country. Interchanges between England and the mainland have been such for many centuries that the parent stocks of the present race of bitter-sweet apples in England may very easily have been derived from French sources. Then there is the other argument, that all the historically old English cider apples, like Foxwhelp and Red Streak, which go back some two centuries in the literature, give no hint, either in chemical composition or quality, of common origin with the bitter-sweet varieties of France.

From what was seen of these fruits in England it appears that if seedlings had been freely grown from them and well selected, as in France, England would to-day have as good a race of cider apples as France has.

But are the bitter-sweets so essential? This question is not settled. In Germany scarcely a trace of this peculiar quality was found in the cider fruits, yet they make most excellent cider in Germany. Also in Gloucestershire and Herefordshire, England, most excellent ciders were sampled, in whose making no particular attention was paid to the using of bitter-sweet fruit. The question is an important one, and, with a view of giving it ample study, the writer has procured and is growing a collection of French and English cider apples representing the bitter-sweet and other old types.

It has been necessary to examine a considerable mass of data in the attempt to select a representative list of English cider fruits. Mr. F. J. Lloyd has examined and reported upon such a large number of varieties in his work for the Bath and West Society that it is possible to use but a small fraction of his data. Hence an attempt has been made to select a set of varieties which shall represent the old renowned cider fruits and the more recent sorts which are coming prominently into notice. Among the varieties selected, the Blenheim Orange, which is an old popular variety grown for general purposes, and used as a cider fruit also, has been selected for special presentation. Foxwhelp is the oldest, historically, of famous English cider apples, and Kingston Black is a very prominent recent variety. The others represent the English-grown bitter-sweet apples, and a number of them are given because of their present prominence. However, no variety known to be of recent French introduction is used in the table, though several of these recent introductions are now beginning to figure in the English cider factories.

The chemical data are taken wholly from Mr. F. J. Lloyd's analyses, published in the reports of the Bath and West Society. The writer has compiled from his data analyses covering as many years as could be obtained for each of those varieties selected to represent English cider fruit.

TABLE VI.—*Analyses of English cider apples by Mr. F. J. Lloyd.*

Variety.	Year.	Specific gravity.	Grams per 100 cc.					
			Total solids.	Total sugars.	Fruit sugars.	Cane sugar.	Acid, as sulphuric.[a]	Tannin.
Blenheim Orange	1897	1.0683	16.64	14.35	10.00	4.14	0.577	0.140
	1898	1.0674	15.66	14.04	10.64	3.24	.424	.078
Average		1.0678	16.15	14.19	10.32	3.69	.500	.109
Broadleaf	1897	1.0578	14.22	12.50	(b)	(b)	.172	.300
	1898	1.0612	14.62	13.25	10.64	2.51	.234	.302
Average		1.0595	14.42	12.87	(b)	(b)	.203	.301
Cherry Norman	1898	1.0636	15.82	13.26	11.11	2.05	.277	.310
Chisel Jersey	1897	1.0542	13.50	12.90	11.11	1.71	.226	.264
	1898	1.0682	17.06	15.96	14.08	1.79	.226	.370
	1899	1.0611	15.68	14.84	11.90	2.80	.234	.174
Average		1.0612	15.41	14.57	12.36	2.10	.228	.269
Foxwhelp	1895	1.0565	13.84	12.98	(b)	(b)	.146	.230
Kingston Black	1897	1.0606	14.86	14.06	10.64	3.24	.351	.126
	1898	1.0691	16.90	15.37	10.84	4.31	.416	.182
	1899	1.0667	16.64	14.84	11.90	2.80	.446	.110
Average		1.0654	16.13	14.75	11.12	3.45	.404	.139
New Cadbury	1897	1.0539	12.68	10.82	9.06	1.68	.702	.174
	1898	1.0642	15.68	14.81	12.50	2.20	.226	.232
	1899	1.0601	14.00	12.66	8.76	3.74	.174	.122
Average		1.0594	14.12	12.76	10.77	2.54	.367	.176
Red Jersey	1897	1.0596	14.50	14.03	10.87	3.01	.219	.124
	1898	1.0611	14.98	13.94	12.04	1.85	.226	.314
	1899	1.0667	16.76	13.46	12.18	1.22	.204	.230
Average		1.0625	15.41	13.81	11.70	2.03	.216	.223
White Jersey	1896	1.0581	14.68	13.25	(b)	(b)	.160	.150
	1897	1.0519	12.68	12.26	8.65	3.43	.190	.210
	1898	1.0642	15.74	14.00	11.62	2.26	.307	.114
Average		1.0580	14.36	13.17	10.13	2.84	.219	.158
Butleigh No. 14	1897	1.0790	20.24	18.58	13.18	4.94	.153	.300
	1898	1.0933	23.22	20.51	18.18	2.22	.292	.380
	1899	1.0925	24.34	23.32	18.88	4.22	.351	.206
Average		1.0883	22.59	20.73	16.75	3.79	.265	.296
General average		1.0642	15.82	14.30	11.65	2.77	.282	.221

[a] Calculated at Blacksburg, Va. [b] Only total sugars given.

Early in the nineteenth century much interest was manifested in the United States in the culture of cider apples, and in the manufacture of this beverage at a few points. Perhaps Newark, N. J., was one of the most noted centers of this infant industry. In New England, however, the cider fruits were cultivated, and the Massachusetts Agricultural Society showed considerable interest in encouraging these efforts. From scraps of information and brief references, it also appears that Virginia planters were interested, and rated good cider highly.

William Coxe was one of the first to write on this subject, so far as the early literature available shows. His treatise on Fruit Trees is dated 1817, and in it he speaks of the high quality of Hewes Virginia Crab and the Harrison apple for cider making. The latter is of New Jersey origin, and helped to make the quality of New Jersey ciders recognized in the early days of our history. Coxe also mentions the Newtown Pippin and Winesap, both well recognized to-day as yielding cider of high quality, but lacking in the element of tannin. The Hagloe Crab, an old English cider crab, is constantly mentioned in the early literature, and the Vandevere is also spoken of as a cider fruit.

In the change of habits which came over our people about the middle of the past century, cider gradually lost its place as a beverage, used alike by the well-to-do and the laboring classes, and the art of making it seemed to fall into desuetude. The country people and a number of large commercial establishments have continued to make a beverage from apple must, but, in the main, it is very inferior in quality. Even the varieties of fruit best suited for making this beverage have almost been lost to our pomology, and later writers rarely mention them. Yet it can scarcely be contended that our people use less fermented beverages or less ardent spirits than formerly.

The early American writers of consequence are Coxe and Thatcher, and these gentlemen did little more than copy the best English and French writers of their time, weaving in some local experience. Of real technical study there was none. The writings of Thomas Andrew Knight, and articles in Willich's Domestick Encyclopedia, furnished the basis of these early dissertations. Many of the principles laid down by these old writers contain the germ of the best practice of the present day. Strangely enough, the new encyclopedia of horticulture (Bailey's) does not contain the word cider as a subject.

It has already been stated that we have not at present in the United States a distinct industry in the growing of cider fruits. Yet it is true that some of our crab apples, and some varieties of apples also, have been cultivated to a limited extent for cider and are considered valuable for this purpose, but it is seldom that they are grown to any large extent.

So far as the writer has learned there is no technical literature dealing especially with the chemistry of American apples, either for cider production or the manufacture of other products. Hence, at present it is not possible even to suggest a standard composition for American fruits used in making cider. Even partial analyses of the old fruits mentioned above could not be found, save of Hewes crab. Such analyses as have been made, up to a very recent date, are fragmentary and incomplete, and little attempt has been made to collect them. In 1886 Mr. Edgar Richards, then an assistant chemist of the United States Department of Agriculture, made analyses of the whole fruits of 16 varieties of apples, and the results of his analyses are given below, so far as they concern this inquiry. These results can not be incorporated in the tables of average composition of must from American apples because the fruit and not the expressed juice was analyzed:

TABLE VII.—*Analyses of whole fruits of apples by Edgar Richards, Division of Chemistry, U. S. Department of Agriculture, 1886.*

Variety.	Total solids.	Total sugar.	Reducing sugar.	Sucrose.	Acid as sulphuric.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Fall pippin	12.81	10.14	7.40	2.60	0.577	0.354
Smokehouse	12.26	10.72	10.30	.40	.468	.262
Maiden Blush	12.00	9.79	8.80	.94	.767	.245
Northern Spy	13.43	10.41	10.25	.15	.395	.291
Ben Davis	14.14	10.63	8.00	2.50	.395	.283
King	14.11	8.55	7.55	.95	.314	.231
Smith Cider	13.49	8.99	8.32	.64	.453	.275
Rambo	15.40	11.75	9.67	1.98	.292	.295
Blush pippin	13.17	8.66	8.43	.22	.863	.353
Paradise Sweet	14.68	10.61	7.52	2.94	.138	.235
English Redstreak	13.43	11.04	8.63	2.29	.395	.325
Winesap	16.55	11.90	9.40	2.38	.490	.279
Nonesuch	14.58	12.02	10.80	1.16	....	.228
Golden pippin	12.95	10.03	7.69	2.23	.607	.249
Lobster White	10.60	9.84	6.89	2.81	.285	.255
Virginia crab	13.65	12.90	10.24	2.53	.409	.240
Averages	13.57	10.49	8.74	1.67	.457	.274

Recently, however, the Pennsylvania Agricultural Experiment Station has taken up this line of work, and during 1899 Mr. C. A. Browne, jr., made a fairly complete study of 25 varieties of apples grown mostly upon the agricultural college farm, Center County, Pa.

His work was first published as Bulletin No. 58, Pennsylvania department of agriculture, December, 1899. From this source are quoted the data derived from Mr. Browne's analyses as to the average composition of the whole fruit of these 25 varieties of apples:

	Per cent.
Inorganic matter:	
Water	83.57
Ash	.27
Organic matter:	
Total solids	16.43
Invert sugar (grape and fruit sugar)	7.92
Cane sugar (sucrose)	3.99
Total reducing sugar (after inversion)	12.12
Acid, as malic (free)	.61

The points in the above which interest cider makers are the total sugars, which, when the cane sugar is converted into reducing sugar, show an average of 12.12 per cent of fermentable sugar. This is undoubtedly a high average for American apples. The free acid, 0.61 grams per 100 grams of fruit, is also high, nearly reaching that of the German apples and being 0.2 to 0.4 grams above that of the French. The tannin was not determined. On page 29 of the same bulletin Mr. Browne gives the analyses of the fresh must as expressed from the fruit of 10 varieties of apples, including a number of the best-known summer and winter sorts. This table is quoted in part below.

TABLE VIII.—*Analyses of must of American apples by C. A. Browne, jr., Pennsylvania Agricultural Experiment Station, 1899.*

Variety.	Season.	Specific gravity.[a]	Per cent solids.	Grams in 100 cc of must.				Per cent of ash.
				Total reducing sugar.	Invert sugar.	Cane sugar.	Acid as sulphuric.[b]	
Red Astrachan	Summer	1.05177	12.78	10.69	6.87	3.63	0.833	0.37
Early Harvest	do	1.05382	13.29	11.67	7.49	3.97	.658	.28
Yellow Transparent	do	1.04880	11.71	10.24	8.03	2.10	.628	.27
Early Strawberry	do	1.04809	11.81	9.90	5.47	4.21	.570	.24
Sweet Bough	do	1.04839	11.87	10.85	7.61	3.08	.073	.—
Baldwin	Winter	1.07222	16.82	15.39	7.97	7.05	.487	.26
Ben Davis	do	1.05249	12.77	11.16	7.11	3.85	.336	.28
Belleflower	do	1.06130	14.90	13.61	9.06	4.32	.424	.28
Talpahocken	do	1.05587	13.94	12.95	9.68	3.11	.190	.24
Unknown variety	do	1.05761	13.75	12.95	10.52	2.31	.321	.26
Averages		1.05523	13.36	11.94	7.78	3.76	.453	.27

[a] Corrected by author's request—factor, —0.0014. [b] Calculated at Blacksburg, Va.

The average sugar content in 100 cc of apple must for the 10 varieties given, as shown by Browne's table, is 11.94 grams reducing sugars, which for practical purposes may be read per cent. This is a low sugar content even compared with German averages. The average acid, 0.62 grams in 100 cc of must, is high. From must of this average composition one might expect to produce a cider of 5 per cent alcohol, with still a little sugar left unfermented. With such must undiluted, there is no reason to say that a cider of proper strength can not be produced.

In the department of horticulture of the Virginia Agricultural Experiment Station the writer has for the past fourteen years been bringing together a large collection of pome fruit trees, more especially of apples. This collection now contains 375 varieties of apples, including crabs, collected from various portions of America and Europe. Many of these are now coming into full bearing, and Prof. R. J. Davidson, chemist of the station, has begun an exhaustive investigation of the chemical composition of the fruits. This investigation is not undertaken solely with a view to studying cider making, but for the general purpose of accumulating scientific data for our studies of these fruits in all lines as commercial fruits and as raw material for the manufacture of various products. The following tabular statement furnished by Professor Davidson is useful here for the further consideration of American standards and for comparison of foreign and American varieties:

TABLE IX.—*Analyses of apple must by R. J. Davidson, Virginia Agricultural Experiment Station, Blacksburg, 1901.*

CRAB APPLES.

Variety.	Specific gravity.	Grams per 100 cc of must.					
		Total solids.	Total sugar.	Reducing sugar.	Cane sugar.	Acid, as sulphuric.	Tannin.
English crab	1.053	12.68	9.60	6.31	3.14	0.31	0.018
Hyslop	1.065	14.88	11.84	6.80	4.78	0.59	0.098
Kentucky Cider crab	1.066	15.42	12.25	8.75	3.33	0.52	0,023
Maiden Blush	1.066	16.03	12.63	7.85	4.54	0.33	0.083
Montreal Beauty	1.045	10.90	8.09	5.31	2.64	0.35	0.070
Averages	1.059	13.98	10.88	7.00	3.68	0.42	0.060

APPLES.

Variety.	Specific gravity.	Total solids.	Total sugar.	Reducing sugar.	Cane sugar.	Acid, as sulphuric.	Tannin.
Albemarle pippin	1.062	11.48	9.40	6.14	3.10	0.30	0.022
Arkansas (Black Twig)	1.051	12.05	10.86	7.00	3.67	0.30	0.021
Baltzby	1.046	10.76	8.76	5.23	3.35	0.47	0.015
Ben Davis	1.046	10.69	6.74	5.06	1.60	0.32	0.022
Bonum	1.060	14.23	11 37	7.72	3.47	0.27	0.002
Emperor Alexander	1.060	13.78	10.52	9.24	1.22	0.46	0.030
Eureka	1.057	13.19	10.00	7.10	2.76	0.61	0.030
Gano	1.046	10.16	8.61	5.53	2.93	0.30	0.026
Lawver	1.049	11.96	9.91	8.05	1.76	0.34	0.032
Loy	1.052	11.76	7.08	5.43	1.57	0.37	0.017
Mann	1.061	14.08	10.35	7.43	2.77	0.42	0.016
Nero	1.046	10.61	8.58	6.77	1.72	0.26	0.030
Northern Spy	1.053	11.73	8.82	5.36	3.29	0.50	0.026
Peck Pleasant	1.054	12.60	10.23	5.32	4.66	0.35	0.016
Ridge pippin	1.051	11.73	8.66	4.69	3.77	0.32	0.030
Rome Beauty	1.048	11.37	8.70	6.24	2.17	0.27	0.030
Sharp	1.051	11.96	10.00	8.09	1.81	0.50	0.018
Smith Cider	1.062	13.31	9.93	8.63	1.24	0.48	0.026
Stark	1.058	15.05	13.31	9.26	3.85	0.42	0.013
Tolman Sweet	1.055	12.42	9.76	5.98	3.59	0.15	0.024
Walbridge	1.051	11.57	9.18	7.94	1.18	0.44	0.022
Willow Twig	1.053	12.11	9.12	6.87	2.14	0.53	0.028
Yates	1.052	12.33	10.00	6.79	3.05	0.34	0.018
York Imperial	1.050	11.91	10.12	7.08	2.89	0.22	0.018
Averages	1.053	12.19	9.58	6.78	2.65	0.35	0.022

These analyses are the results of but one season's work, and hence do not warrant extended discussion or comparisons with the analyses of fruits from other sections of this country or from foreign countries. It is distinctly noticeable that the crabs show a better analysis as cider fruits than the apples. In this latter list, however, there are no distinctly cider varieties. While there are a large number of these special sorts in our plantations, none have yet fruited. A number of analyses of fruits from the station orchard were made at the Bureau of Chemistry, United States Department of Agriculture, and these are here inserted, forming Table X. The averages of specific gravity readings at the two places are remarkably close, but in other points there are differences to be accounted for, partially at least, by the fact that the varieties examined in the two laboratories were only in part the same.

Table X.—*Analyses of apple must by J. S. Burd, Bureau of Chemistry, United States Department of Agriculture, 1901.*

Variety.	Specific gravity.	Grams per 100 cc of must.					Per cent of ash.
		Total solids.	Total sugar.	Reducing sugar.	Cane sugar.	Acid, as sulphuric.	
Baldwin	1.0514	13.64	11.72	5.40	6.01	0.45	0.25
Bonum	1.0585	14.93	11.36	9.46	1.81	0.38	0.26
Bullock's pippin	1.0534	14.72	11.35	6.25	4.84	0.31	0.25
Emperor Alexander	1.0594	15.27	11.12	7.22	3.71	0.54	0.87
Eureka	1.0561	14.35	11.61	7.16	4.23	0.68	0.37
Gano	1.0424	10.97	8.12	5.72	2.28	0.29	0.24
Grimes Golden	1.0704	18.81	14.05	7.33	6.39	0.54	0.30
Jonathan	1.0504	13.18	9.52	6.76	2.63	0.19	0.87
Lankford	1.0506	13.42	10.10	7.93	2.07	0.36	0.25
Missouri pippin	1.0489	12.08	9.77	5.57	3.99	0.44	0.31
Nansemond Beauty	1.0510	13.18	10.09	7.15	2.80	0.47	0.33
Nero	1.0462	12.00	9.09	7.63	1.39	0.29	0.24
Northern Spy	1.0519	13.77	9.77	6.10	3.50	0.51	0.32
Peck Pleasant	1.0529	14.05	10.18	6.18	3.80	0.35	0.24
Roxbury Russett	1.0574	12.87	10.84	5.15	5.41	0.46	0.25
Smith Cider	1.0589	13.08	10.73	7.77	2.82	0.48	0.37
Tolman Sweet	1.0527	14.60	10.29	6.33	3.77	0.16	0.28
Via	1.0445	11.74	8.41	7.14	1.21	0.18	0.24
White Winter Pearmain	1.0527	12.75	10.86	6.91	3.76	0.28	0.28
World's Wonder	1.0521	12.37	10.21	7.55	2.53	0.44	0.24
Yates	1.0519	12.55	10.34	6.89	3.28	0.33	0.26
Averages	1.0535	13.39	10.45	6.84	3.48	0.37	0.33

HARVESTING, TRANSPORTATION, AND STORAGE OF CIDER FRUIT.

If quality in cider fruit is such a prime consideration, then anything which acts either to enhance or to deteriorate the same must receive attention. There is much discussion of this point going on in foreign journals, and the standard literature of this subject contains many notes thereon. The discussion hinges about certain principal questions, as: (1) What is the proper season to gather the fruit? (2) Shall it be hand picked or shaken? (3) Shall it be kept in piles out of doors on the ground? or (4) shall it be kept on raised temporary structures, so as to protect the fruit entirely from contact with the earth? or (5) should it be removed at as early a date as possible into storage buildings?

Because of the fact that general culture of orchards for dessert fruit has not reached that stage of development in Europe which it has in the United States, they seem not to have worked out a system of harvesting fruit at all comparable to ours, nor does it appear that the harvesting and handling of cider fruits require such a system. Yet there are some important considerations to be observed.

The early fruit which is turned into cider is generally treated with very little consideration. It is allowed to fall to the ground from the effect of natural ripening, and is either worked up from time to time or allowed to lie until such a time as it is convenient to whip off that which still hangs on the trees, and all is then worked together. This gives an uneven condition of fruit, and produces a poor product, which is fermented rapidly and used for a cheap trade. Such fruit appears to be handled in most countries just as we ordinarily handle our entire crop of cider apples in this country. The fruit lies in heaps on the earth, quite regardless of unclean conditions, and is then ground without regard to uniformity of ripeness or blending for quality.

The following discussion relates to observations made on the main cider crop. The practice of different countries varies much on some points and will be noticed separately so far as there is ground for so doing.

Considerable importance is attached to observing the maturity of the fruit. The French especially argue that both the sugar content and the quality of the product are affected thereby. The first will doubtless be readily admitted by all, and the second in part, but further investigation is needed before all that is claimed can be admitted. While the fruit should certainly be mature—that is, it should have reached the perfection of its growth—it should not be allowed to ripen and fall from the tree, as this will lead to very irregular ripening and yield at no time a satisfactory amount of evenly ripened fruit in proper condition for grinding.

The French lay great stress upon gathering and ripening in bulk, as they claim in this manner to secure the most perfect development of the delicate aroma which is such a marked characteristic of the best Normandy varieties. Their method is generally to dislodge the fruit by shaking and by the use of poles at about the stage of maturity which in America we recognize as right for gathering and barreling. In many places this fruit is left in huge piles under the trees until late in the season, though this is not considered the best practice. The better method, which seems to be quite well observed by larger growers, and especially by those concerns which manufacture large quantities of cider, is to bring the fruit quite promptly into the lofts over the cider mills. This was the only house-storage method observed in France.

It is well to explain here that the small cider apples grown in France bear shaking and beating off far better than would the large apples in our country, and further, the orchards are almost invariably set in heavy sod, which is an advantage in this method of harvesting. Their apples are often very firm at maturity, and some of them have a tough texture which resists rough handling well. It was surprising to see how little inclined the fruit is to decay from the effect of bruises and other slight injuries.

The storage lofts in France were ordinarily fitted with bins or partitions for the separation of apples of various qualities, so that they could be properly blended in grinding. Here were seen great structures 100 feet long or more and 30 or 40 feet wide piled with apples to a depth of 4 to 6 feet, and such a loft in late November filled with this ripening fruit is pervaded by an aroma sometimes quite oppressive and not easily characterized. When the room is not too close the odor is decidedly pleasant. Some makers are very careful to store the fruit only a foot or two deep, but this is the exception.

The invariable custom, so far as observed, was to run the fruit by gravity from the loft storerooms into the grinders, whence the pomace falls into vats before going to the presses. The fruit is ground from these upper-floor storerooms as it ripens some varieties not coming to their best until January or February. In the peculiar climate of Normandy and Brittany there seems to be very little danger of the weather becoming sufficiently severe to harm the fruit materially.

The growers of this fruit are very largely the small peasant proprietors and small tenants, with here and there a large estate. The small growers are referred to in French literature as "recoltants." Often these peasant proprietors make up their own fruit and that of neighbors; hence the cider houses of these small makers are very common in some parts. But there is a tendency to commercialize, and more and more the fruit goes to the large manufacturer. To these it is hauled in carts (Pl. V, fig. 2) loose or in sacks, the latter being the most popular method. These sacks are hoisted to the upper floor of the factories and distributed to the proper storerooms. There is also in France another class of cider makers, who buy the partly fermented juice from the small growers and blend and work it up to suit the trade they wish to supply. These are known as "commerçants." They often make an excellent article, but they are also charged with a vast amount of trickery in the production of sophisticated goods.

There is, in the great crop years, an extensive railway commerce in cider apples, both to local points and to the near or distant states. The shipments are made loose in what we call box cars, and also loose or in sacks on flat cars (Pl. V, fig. 1). The method of shipping in sacks seems to be preferred in France and might well be copied in this country. The Germans appear to prefer handling the fruit loose. No railway commerce in cider apples was seen in England. In 1900 such an immense crop was harvested in Normandy that the local railways were literally blocked with fruit, as is sometimes the case on American roads when great quantities of coal are carried.

At the local factories visited in France great stress seems to be laid upon gathering the late fruit when perfectly dry and storing at once in the bins, where more or less of it lies until January and February. There appears to be very little tendency to decay. The cider maker judges the ripeness of the fruit, or its fitness for grinding, by pressing with the thumb until the juice exudes or by breaking the fruit in half and crushing one portion in his hand with a wringing motion. Great stress is laid upon grinding at the best period of ripeness in order to secure all the juice possible by expressing. Cleanliness is the rule in the handling of fruit in France, yet some dirty bad work was seen,

FIG. 1.—TRAIN LOADED WITH CIDER APPLES IN SACKS, FRANCE.

FIG. 2.—OX CART USED FOR HAULING APPLES IN GERMANY.

the fruit being dumped into filthy receptacles, and ground and pressed in a very unsanitary condition.

In Germany there is, in the first place, much less specialization in the growing and handling of cider fruits, and there appears to be much less manufacturing of cider by small landed proprietors. There were, however, small makers everywhere, but they ordinarily purchased their fruit as miscellaneous stock from various sources, and paid no attention to storing and maturing the same by a definite system, but ground it up as needed.

The large factories, as far as observed, also handled the fruit less carefully than in France. It was purchased in wagonloads and carloads and dumped into great bins on the ground, covered or uncovered. While, on the whole, it was handled in a cleanly manner, no attention seemed to be paid to keeping it dry, or to the fine points of ripening the fruit. At one large factory 100,000 kilos (100 tons) of fruit arrived daily, mostly by carloads, and was dumped into a great open bin, where the fruit lay in the open from a few inches to several feet deep until wanted for grinding.

As cider apples are an incidental and not a special crop in Germany, it will be understood that harvesting is largely a matter of convenience rather than system. The refuse of dessert fruit, together with the inferior varieties and purely cider fruits, are collected as suits the growers' convenience, and disposed of at the factories or manufactured at home if the grower is also a cider maker. Cider making in Germany shows a strong tendency toward the factory system, and the makers have the technique of fermentation well worked out, but that they handle a fruit inferior to that of the French and with much less care is certainly true.

In England the manufacture of cider is very largely in the hands of the farmers, though the factory idea is developing. One sees chiefly the same old customs of harvesting and handling the fruit that have prevailed for centuries. There is in general no attempt at storage. The low-grade fruit (refuse from what the English call "pot fruit," i. e., dessert and cooking grades) is gathered in miscellaneous piles in the orchard, and either ground from these piles or drawn away and sold to the factories. At the best mills the fruit is graded somewhat, so as to properly blend the same at grinding, but even at these the fruit may be seen lying in heaps on the sod in the orchard or near-by lots until late in November. This practice gives to this fruit a very decided earthy flavor and odor, and in some cases it is largely damaged by decay. At Butleigh Court the fruit is stored in a loft over the press-room, and is kept in clean, dry condition.

A method advocated by some in England is to make temporary bins in the field by using hurdles for sides and bottom, the bottom piece being elevated somewhat from the ground and all lashed together as shown in the illustration (fig. 1). This temporary rack is matted on the bottom and sides with straw and the fruit is then poured in. Such an arrangement permits of holding the fruit quite clean, and it can be covered with straw to protect from early freezes.

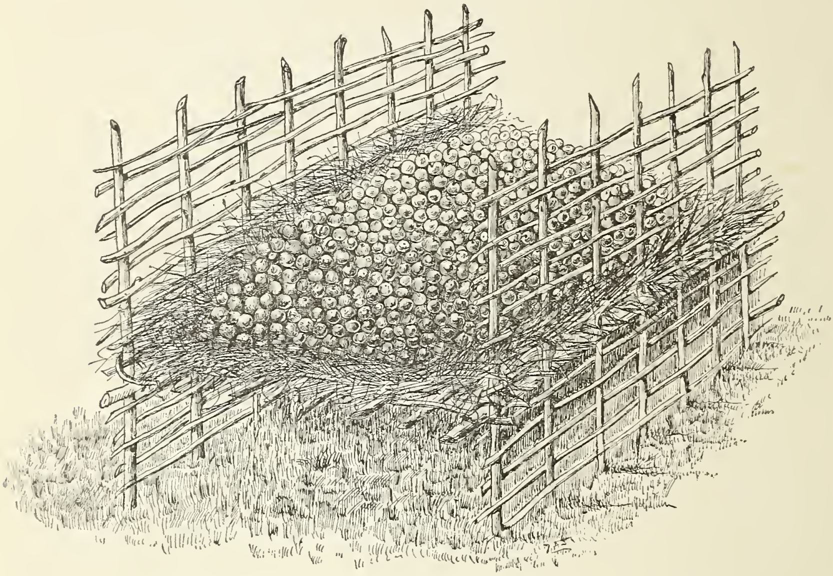

Fig. 1.—Bin made of hurdles for outdoor storage of apples, used in England.

The English customs of handling fruit are in the main about the same as those in the United States. There is little or no shipping of cider fruit, such as there is in France. It may be proper to say here that the French system of sacking this fruit in the orchard for transportation, either by wagon or rail, seems to be well worthy of adoption by us.

CIDER-MAKING ESTABLISHMENTS.

The present manufacture of cider in Europe embraces establishments ranging all the way from the most primitive farm affairs to the most elaborate modern factory. Primitive methods of manufacture play a very important part in the grand total of product, and the users of primitive apparatus in many cases make an article equal to the best product of modern factories.

Notwithstanding the tendency everywhere manifest toward the modern factory system, it seems that the cider industry is so peculiarly adapted to the farm that it should be the effort of orchardists, or at least of small communities, to conduct this work at home, and by making superior cider, vinegar, etc., from unmerchantable fruits, secure to themselves the very satisfactory profits which accrue to such a business rightly conducted.

In starting a cider-making establishment there are several points of importance which should be more or less observed. These are: (1) Supply of fruit; (2) supply of pure water easily carried into the factory under some pressure; (3) the lay of the ground in regard to drainage, and the building of cellars or basement rooms; (4) convenience for disposal of product, proximity to railroad station, etc.

These conditions are of equal importance to the small maker and to the large factory.

PRIMITIVE METHODS AND APPLIANCES.

Persons employing very old methods of manufacture were observed in each of the three countries visited, but particularly in France, where there is in common use the old "tour à auge" mills; in fact, a

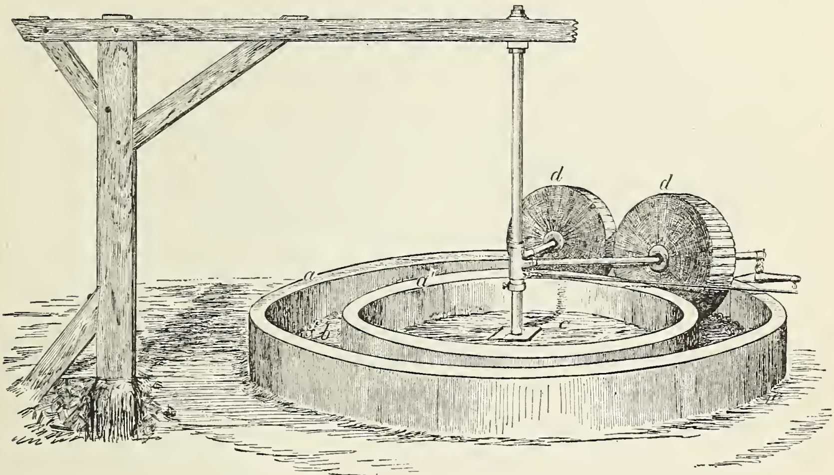

FIG. 2.—The "tour à auge" apple crusher, Normandy, France.

modification of them is in use in some of the large factories driven by steam power. This machine is also in use in England, but to a very limited extent. In Germany, ancient hand devices were in use, but the "tour" was not seen. This very ancient device for crushing fruits before expressing the must is shown in the accompanying illustration (fig. 2). It is constructed of stone or of wood or by putting on a heavy layer of cement over an iron form. Necessarily the trough must be made of some material that will not be acted upon by the fruit juices. The plan of construction and the operation are very simple. The entire apparatus is ordinarily about 16 feet in diameter. The outer and inner walls (fig. 2, *a*, *a'*) are about 30 inches high, and inclose a circular trough (*b*), in which the grinding or crushing is done. This trough usually narrows toward the bottom, being about 20 inches wide at the top and 14 inches at the bottom. The inner wall is almost perpendicular: but the outer slopes decidedly toward the center of the trough, which varies in depth, but 14 inches is the usual depth. Within the inner circle, or cistern (*c*), rises a vertical column to a support above, and to this is attached the radial arms which carry the crushers (*d*). This inner space or cistern is sometimes used as a receptacle for the fruit before grinding. The fruit falls by means of a chute from the storage loft into this cistern as desired, and from it is put into the grinding trough with a wooden shovel.

The rollers or crushers are usually made of a firm heavy wood with a somewhat corrugated surface. Rollers are also made of granite, but this makes them very heavy, and they are said to crush the seeds of the fruit, which is not desired. These huge wheels are about 3 feet in diameter, and about 6 inches to 9 inches on the faces. They are set so that they do not trail, thus covering all the bottom surface of the trough. A small device, not shown, follows after the crushers and scrapes the pomace and uncrushed fruit down into the bottom of the trough.

"Tours" were seen with only one large broad-faced crusher, and with various other modifications, but the one figured seems to be of the typical form. Where used in steam mills, they are rigged with the crushers exactly opposite each other, on fixed radial bars, and the perpendicular shaft is turned by a pinion wheel. In this manner they are driven at rather high speed, and are used principally to remix pomace with water for the second and third pressings.

The "tour," as shown in the illustration, is typical of those used by the small peasant proprietors in France. It is worked by a horse which patiently plods around its limited circle, becoming so used to the work as to require no attention. In fact, he soon learns to forage on the fruit by twisting his neck so as to gather the pomace from the front crusher as it revolves. Hence he is not removed for feeding until the day's work is done.

The fruit is thrown into the trough 2 to 3 inches deep and the horse is put in motion, and during the grinding, the attendant is busy with other duties, as fitting up the "cheese," bearing away the cider, etc. The fruit will be reduced to pulp in twenty or thirty minutes, varying with its texture. The attendant then turns on a scraper, attached at the rear of the rollers, which shoves the pomace into a heap at the side adjacent to the press. From here it is lifted with a wooden shovel to the press platform. The cheese is laid up very much as with us—viz, wrapped in special cloths—each section or lozenge 4 to 5 inches deep. Instead of cloth, straw is often used to divide the mass of the cheese into layers.

To put up a cheese with straw divisions, a bed of straight straw is spread on the press platform, and a mass of pomace is evenly distributed over it to the depth of 4 or 5 inches. This is then covered with a second layer of straw, and the operation is repeated. The straw is laid on very carefully, radiating outward, the butts projecting a bit over the edge of the cheese. The workmen are very adept in laying up the cheese in this fashion, and produce a remarkably true even block of pomace. When completed, the edges are cut down straight, and the pomace and bits of straw are spread on top of the cheese, and then all is ready for the application of pressure. The interposed beds of straw serve excellently to drain the cheese when under pressure. Indeed, this method has strong features to commend it.

After removing the pomace the trough is resupplied with fruit, and the operation is repeated. Thus one hand attends to the crushing, lays up the cheese, presses out the must, and bears it away, in this way working up about 2½ tons of fruit daily. The fruit is ground in batches, as just described, and the results of four or five lots go to make up one cheese. When this is completed, the horse is removed, and the press is started on the cheese.

There are many styles of presses used, but one of very ancient type is worthy of rather extended description. The particular one here described bore dates which indicated that it had been in use for two hundred years, and this style was formerly the only power press used.

The essentials of this structure are two immense beams of oak. These beams are 14 inches square and 20 feet long. One constitutes the base and rests on a firm foundation to which it is securely attached. On this a short distance from one end is made fast the platform which supports the cheese. The other beam is freely movable. At the end just to the rear of the cheese platform the free beam moves up and down between two strong uprights, which are mortised through at intervals to permit of heavy cross bars being inserted to support the beam at any desired height. The other end is unattached, save that a large wood screw passes through it and enters a huge block on top of it, which block is threaded and acts as a nut. This wooden screw is attached to the lower beam, but works freely in a socket.

While the cheese is building, the upper beam is elevated, front and rear, out of the way. When ready to apply pressure, the end nearest the cheese is let down on the heavy blocking which covers the latter, and is then securely "blocked" by means of cross bars so it can not rise. Then the other end is lowered until the beam rests fairly on the blocking over the cheese. Its very weight causes the must to flow freely at once, but power is now gradually applied by running down the wooden nut until it rests on the beam, then turning the great wooden screw slowly, by means of levers inserted in large augur holes through the same, until this beam comes into a horizontal position. The pressure is applied very slowly, the attendant bearing off the must, as it flows, to the casks in the adjacent fermentation room. When the flow of must becomes much reduced, the screw is loosened, the front end of the pressure beam is raised, and this causes the rear end to fall lower, so that it can be again blocked down, after which the pressure is reapplied. This operation is repeated until the cheese is pressed sufficiently, when it is allowed to drain for some time, frequently over night, after which the pomace is removed, remashed in the "tour," and repressed. When reworking this pomace, an amount of water is added equal to about one-fifth of the juice which has been expressed from it. In practice, the amount of must secured by the second pressing is about equal to the water added. This reworking of the pomace completes the usual routine, and a cheese of fresh fruit is now

FIG. 3.—Primitive apple grater in use in Germany.

ground, and laid up as before. By this system, about 400 gallons of first and second pressings are obtained daily with the labor of practically but one man and one horse. With this lever press the use of a rack or frame of any kind to hold the pomace is impracticable. Evidently these latter appliances have come into use along with the direct screw press.

A few illustrations (figs. 3, 4, and 5) showing primitive methods in use in Germany are reproduced from Johannes Böttner's recent book on cider making, but there is so little in these to commend that they will not be discussed. They are sufficiently self-explanatory.

It may not be known to many Americans that John Bartram, the pioneer American botanical collector, made and used a "tour à auge" cider mill on the banks of the Schuylkill in the early days of Pennsyl-

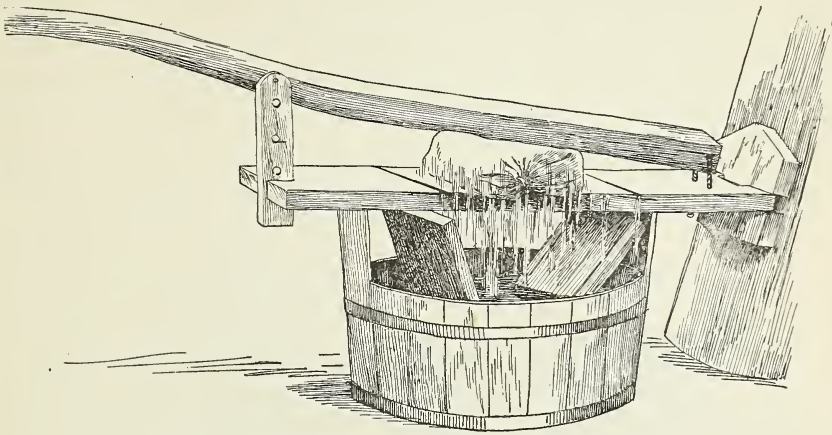

Fig. 4.—Primitive single-lever cider press in use in Germany.

vania. The circular trough, hewn in the great rock on the bank of the river, yet remains; also the rock-hewn cistern—mute witnesses to his ingenuity. From these portions one can in imagination easily recon-

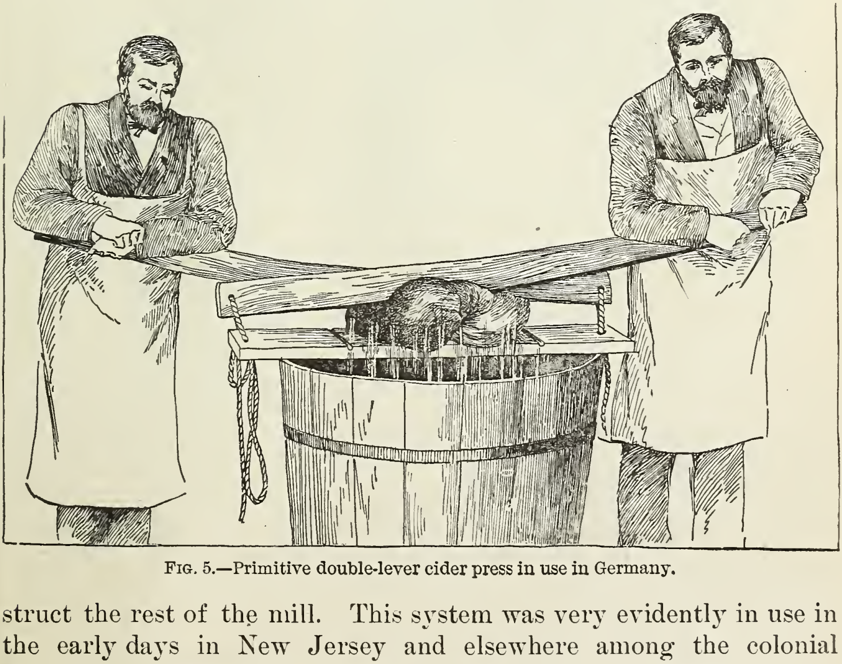

Fig. 5.—Primitive double-lever cider press in use in Germany.

struct the rest of the mill. This system was very evidently in use in the early days in New Jersey and elsewhere among the colonial farmers for crushing their fruit, but no description or detailed account of its use in America has been found.

MODERN METHODS AND APPLIANCES.

There is a wide range of procedure in grinding and pressing cider fruit between the distinctly primitive appliances and methods and those of the modern factory system. Machines of small and medium capacity are numerous abroad, and range from the smallest handmills of the meanest construction, with wooden rollers for crushing the fruit, to the finest hand and power machines of the best scientific construction.

As a general thing the mills which employ a hopper into which the fruit is thrown, whence it is fed (by gravity) onto a rotary grating or crushing device, marks the initial departure of modern machines from primitive ones. Of such machines there is a great variety in use in Europe, but there is very little to commend in them with one exception, to which attention will be called hereafter. Many of these mills were either American machines or modifications of well-known American types, which do not need to be described here. But there is one type of rotary grinding or crushing machine found very commonly in Germany, but much less frequently in France and England, which appears to deserve description and illustration. The origin of this mill is uncertain, but it is thought to be German. It can readily be used for either hand or power work. This mill is called in German the "greif" (grip) fruit mill, and it is probably the best type for use in ordinary work. It is shown as used for hand work in figure 6. In principle this mill goes back to that of the ancient "tour à auge," viz, that of crushing the fruit instead of rasping or grating it, but it appears to accomplish this with greater perfection. The capacity, of course, depends on the size of the mill.

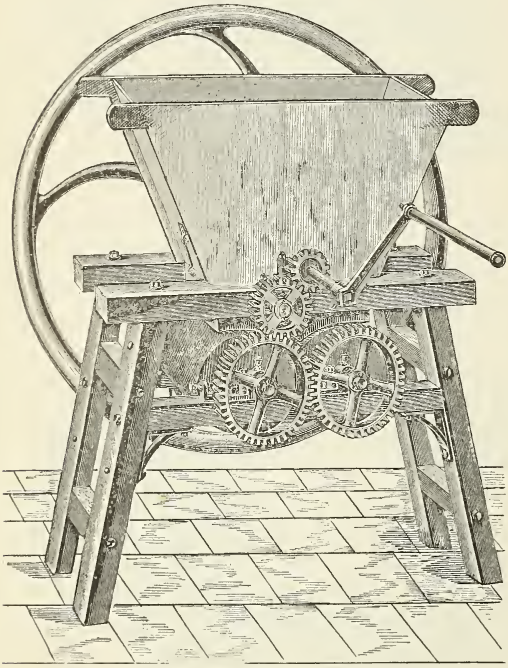

Fig. 6.—The "greif" apple crusher of Germany.

In general, experienced persons admit the desirability of preventing, as far as possible, the contact of the pomace and must with metals such as iron. With the mills known as graters, which are now practically the only important kind of mills on the American market, this end is not secured, for the pulp is all brought into contact with metal surfaces. With the "greif" machine this is not the case to the same extent. A further disadvantage of the grater mill, of perhaps more importance from a practical standpoint, is that the best grater mills will not continue to prepare the pomace in the best manner unless the grater knives are frequently reground. This requires time and skill, and is a distinct drawback to their use in the ordinary country factory. The "greif" mill, on the other hand, can be adjusted for fine or coarse pomace, as may be desired, in a minute, and it has the still more important advantage of reducing the fruit to pomace by bruising or crushing the tissues.

The "greif" mill in general aspect appears not unlike many American hand or small power mills, but in the essentials it is entirely different. The fruit when thrown into the hopper, falls upon a slotted bottom (fig. 7). This may be made of hard wood or of metal. There is also a board slotted to correspond to the bottom at the back side of the hopper, which deflects the fruit forward, so that it only comes onto the slotted bottom at the front side of the hopper. The crank or driving wheel is attached to a shaft (*d*), which rests just over the slotted bottom of the hopper, and to this shaft are attached slightly curved arms (*e*), 6 to 8 inches long, which, as the shaft revolves, catch the fruit and crush it through the slots in the bottom of the hopper. One of these arms can be seen in the section of the hopper shown in figure 8. Thus the fruit is more or less broken before it comes in contact with the crushers.

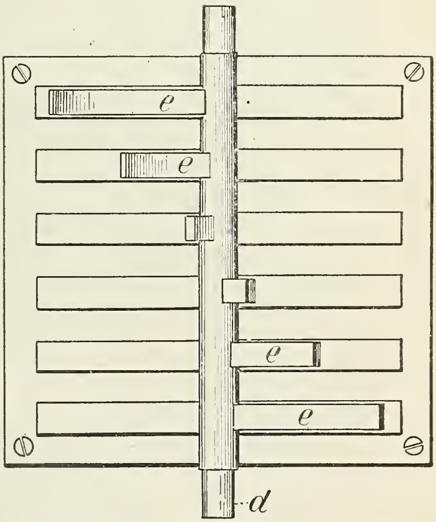

Fig. 7.—Slotted bottom of hopper used in "greif" machine.

The two stone rollers which crush the fruit are shown in perspective and cross section in figure 9, and in situation at *a*, figure 8. They are made of granite or of millstone grit, and mounted on shafts. The surfaces are cut with a slight spiral corrugation. By use of a regulating screw (fig. 8, *f*), one of these rollers can be made to approach the other, so as to regulate the crushing of the fruit as may be desired. The French and German operators wish to pulp the fruit as finely as possible without crushing or grinding the seeds.

The feeding arms (fig. 7, *e*) are placed spirally around the shaft (*d*), so that only one is delivering fruit at the same moment, but this position insures a constant feed, and the size of the slots is such that no whole fruit can be delivered to the crushers. By means of the cog gearing driven from the shaft to which is attached the crank or drive wheel, the crushers are made to revolve inward at the desired rate of speed. The spiral corrugations are so cut that they cross each other at an angle which adds very materially to the crushing or pulping effect of this mill.

So far as was observed, this apparatus seems well adapted either to hand or power work, and gives good results. Its most important

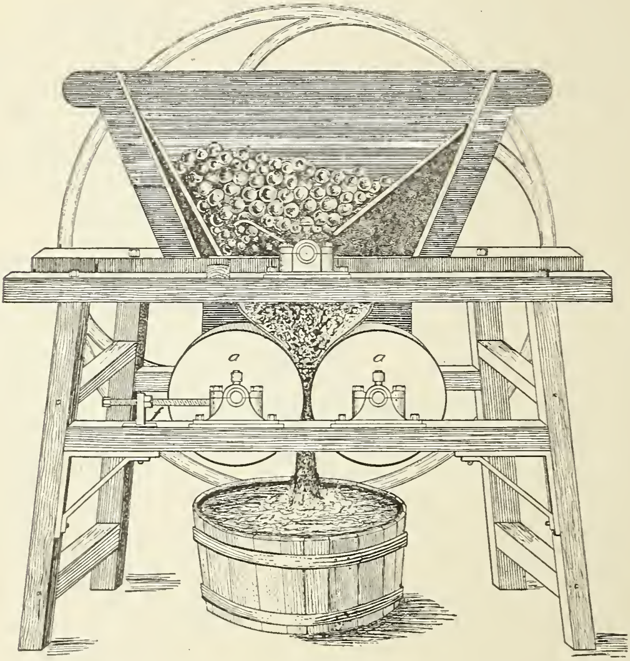

Fig. 8.—"Greif" apple crusher, sectional view of hopper.

advantages are, (1) the pomace is not brought so much in contact with metal surfaces, as is the case with grating mills; (2) it can be regulated to grind fine or coarse very quickly and with certainty, and (3) the operator is entirely freed from the task of removing and grinding knives.

It should be noted that the fruit must be carefully freed from stones, sticks, and the like, or a breakdown of the working parts is sure to occur. The grater mills, with spring adjusted concaves, are not nearly so liable to such mishaps.

This German mill appears to be coming into favor in England. The ordinary mills of other styles presented no points of special importance.

FIG. 1.—ITINERANT CIDER MAKERS AT WORK IN STREETS. STRAW USED IN BUILDING UP CHEESE, RENNES, FRANCE.

FIG. 2.—SIMILAR OUTFIT MOUNTED FOR TRAVEL, WAITING FOR A JOB, TROUVILLE, FRANCE.

American mills and presses are to be seen in use in different parts of the country. The presses used ordinarily with medium-sized modern machines are of the screw types, either with a descending screw or a screw firmly set in the base of the press and with falling head blocks.

In France most of the small mills are of the grater type, with adjustable concaves for pressing the fruit firmly against the grinding cylinder. These machines are scarcely worthy of special illustration, but the very common custom of making cider in the streets of the small towns and cities of the French cider districts is so unique as to deserve some notice.

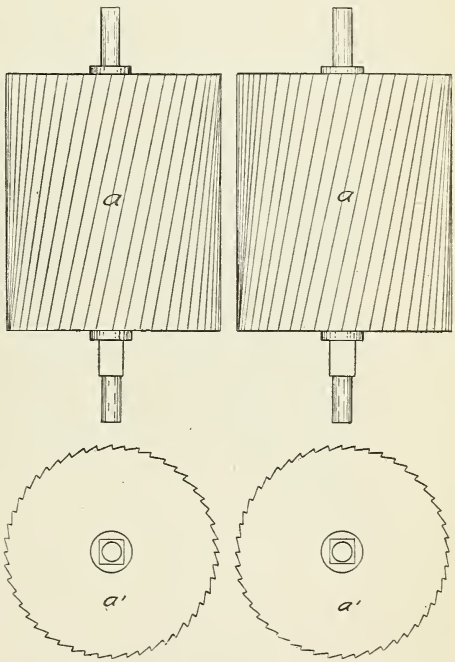

Fig. 9.—Crushing cylinders of the "greif" machine.

It is a very common sight in Rennes, Trouville, Nantes, and other west coast towns to see small outfits placed in the street (Plate VI) or on the sidewalk grinding and pressing small quantities of fruit for the householders or the small shopkeepers. The mills present ordinarily no features that are unusual and are quite uniformly graters operated by hand. Sometimes the frame is mounted on wheels or wooden rollers so that it can be trundled from place to place. The presses likewise are at times mounted on wheels, as shown in the illustration. Practically all presses used for street work are of the central screw type, the power being applied by means of a huge nut which is turned down by means of levers. The cheese is either laid up in a crib frame or with straw divisions, as previously explained.

FACTORY SYSTEMS.

In the three leading cider-producing countries of Europe are to be found well-developed factory systems differing considerably from one another. Hence it is necessary to take up several types which present certain characteristics and treat each separately.

FRENCH FACTORIES.

Although there is much to commend in the cider fruits, the factories, and ciders of the French, yet there was much one could not commend in their systems of manufacture. It is proposed to notice, first of all, one of these factories run on what seemed to be questionable methods. There is a very modern school of French cider makers, whose claims and pretentions deserve more than passing notice, especially since it is proposed to introduce their system into the United States.

The system referred to is known in France as the Noël system, and involves pretended secret processes which it is claimed perform wonders in the handling of cider fruit, the storage and keeping of ciders, etc. The writer had several conferences with the promoters of this scheme in Paris, and was offered full instruction in the methods for a period of seventy or eighty days for 30,000 francs, on condition that the methods should never be divulged! During these conferences

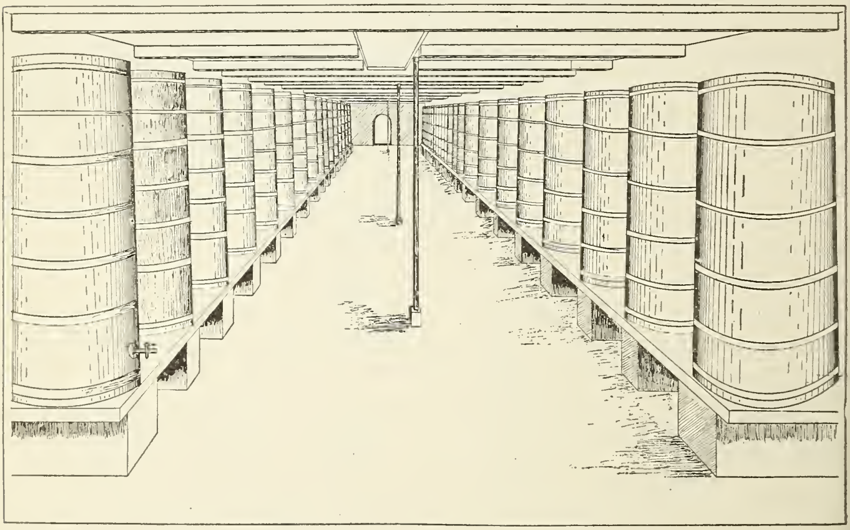

FIG. 10.—Fermentation and storage room, Noël system, France.

and later in visiting some of the factories it was ascertained that the so-called system consisted of nothing peculiarly valuable. The procedure was much the same as in other factories. The fruit was ground and pressed, then the pomace was exhausted by diffusion with warm water, a method often used in France, and the resulting musts were united and sugared to a condition which would make a fair cider. A great pretense was made of securing valuable principles lost to others by exhausting the marc in warm water. By sugaring up the weak must secured by exhausting the pomace with water, about double the quantity of cider is made that can be usually obtained by using pure juice. This is truly an old secret! However, the plan of one factory which was twice visited is quite unique, and for that reason is presented somewhat fully. The building is a fine new brick structure in a suburb of Versailles. The surroundings are much like those of a home. The family lives in the front of the structure, and here the office is also located. Extending back from the front is a rectangular structure two stories high and about 40 feet wide by 150 feet long. The lower story of this rear structure comprises one large room with very heavy brick walls without windows. This room is entered from the front by large doors, and has a rear door of smaller size. Along the sides of this room, against the walls, are ranged great tanks about 60 in number with total capacity reaching possibly 200,000 gallons.

The illustration (fig. 10) shows a perspective view down the center of the room. Each tank is furnished with a faucet near the bottom, and a glass tube communicating with the interior rises the full height of the tank, showing at a glance the height of the liquor within. The top is tightly closed, but a manhole for entering the tank and taps for introducing the must are provided. The center of this room is occupied by casks, pumps, and paraphernalia for racking and handling the cider. Also great cart loads of fruit in sacks are brought from the railway station, driven to the center of this floor, and elevated to the upper story by a power lift, worked by a gasoline engine in the second story.

The second story is used to store fruit, and here is also located the grinder, the gasoline engine which furnishes all the power for the plant, and the tubs or tanks for exhausting the pomace. The fruit for grinding is thrown into a tank of water in which rests the lower end of an elevator screw which lifts it to the grinding cylinders. From the grinder the pomace falls into the press, where it is made up into cheeses after the American fashion and pressed immediately. The object of throwing the fruit into the tank of water is to wash it, which is fairly well accomplished by the motion of the elevator screw.

The exhaustion of the pomace after pressing is accomplished by diffusion with warm water, as already stated. The operations of blending and sugaring were not shown, nor were the details of the system of fermenting and racking explained other than in vague terms. However, the must is both fermented and stored on the first floor and is run off into casks for market as desired.

The product, as sampled in several stages of manufacture, was very inferior, and had little resemblance to that of standard Normandy ciders. This factory is making about 200,000 gallons of cider annually. The construction of the factory, arrangement of machinery, tanks, etc., is quite unique, and apparently advantageous.

A characteristic of the French "cidreries" was the almost total absence of cellars. Thus, in the factory just described the storage is wholly above ground. This is the rule in France, while just the opposite is true of Germany.

La Cidrerie de l' Union Agricole.—The best type of factory examined in the French cider country is that of an agricultural union at St.

Ouen-de-Thouberville, a short distance from Rouen. This establishment, built and operated upon a cooperative plan, is a model in its mechanical appointments, and the technique of its operations seemed to leave little to be desired. The general manager is Monsieur Gustave Power, the noted authority on pomology, whose books have been officially adopted by the minister of agriculture for use in the schools of France. The writer was most courteously received by this cultured gentleman, and given every facility to examine and study the details and methods of the establishment, which is, perhaps, representative of the best type in France.

The ground plan of the main factory is shown in figure 12. In total dimensions, the building is approximately 300 feet long by 100 feet wide. A study of the vertical longitudinal section (fig. 11) will help to give a clear idea of the plan and workings of this factory. It will be seen that to the rear of the main operating room of the ground floor one can step up a few feet into the main fermenting room, or down a few feet into a half-cellar used for the finishing processes of fermentation and for storage. The surface of the ground slopes from the front to the rear of the building, so that this lower room ends at ground level. This gives an important advantage in the ease with which the finished product can be loaded on trucks for transport.

The operation of this factory will be better understood by following the usual course of the fruit and must as they pass through the several processes to the finished product. The carts laden with apples in sacks enter the shed in front of the factory, and by a hoist, operated from the main shaft within, the fruit is lifted to the second floor, where it is weighed and put in bins according to varieties and quality. These bins cover nearly all of the second floor, and are only 18 inches deep, strict rules as to methods of storage being observed. With the fruit thus distributed, it is possible to observe critically its condition and to grind as it comes to proper maturity; also the careful distribution in accordance with the quality makes it easy to blend the fruit so as to produce desired grades of must.

When ready to grind, the fruit is measured to the machine in proper proportions. The grinder stands at the floor level of this storeroom. Formerly the fruit was washed, but now this is only resorted to in case of necessity. The fruit is, however, run over a slatted "way" or chute in its progress to the cylinders and much trash is screened out, an attendant watching that foreign substances likely to damage the grinders do not pass. From the grinders the pulp drops into a chute, which delivers it at the pleasure of the operator into one or another of the several pomace vats. The custom is to fill one after another of the vats, the pulp being allowed to remain for some hours before pressing. This maceration of the pulp in its own juice is thought to aid in extracting the sugar content and to give better color to the must through certain chemical changes caused by the action of

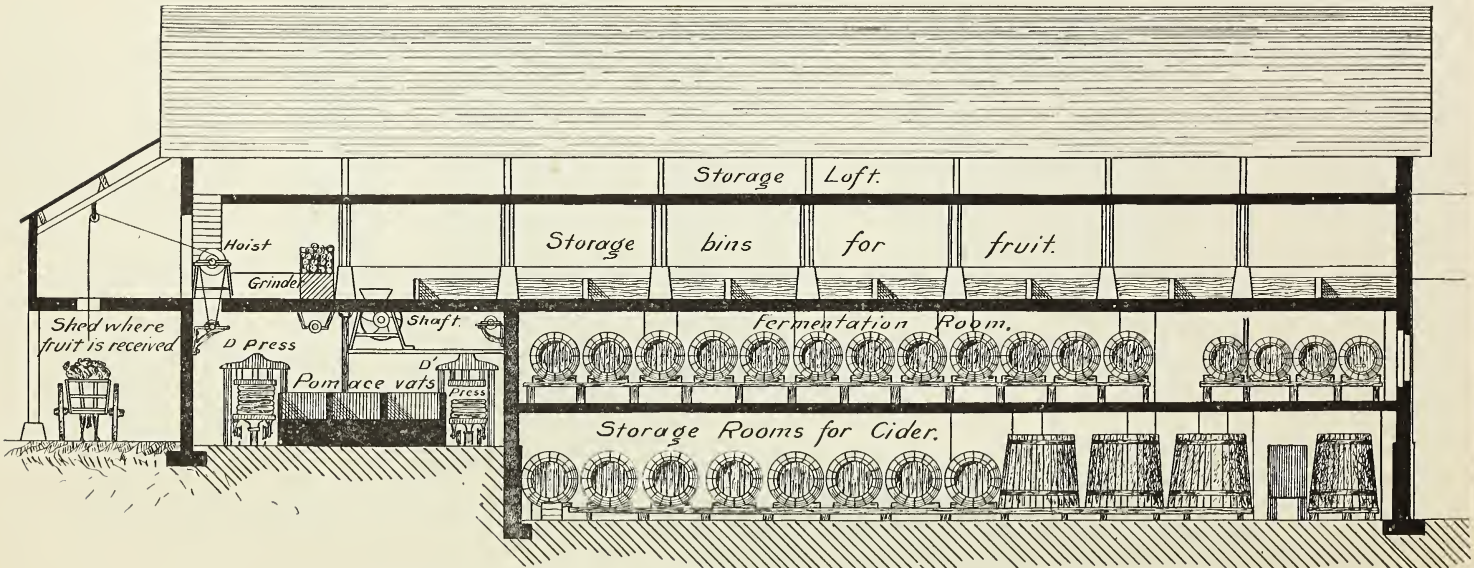

FIG. 11.—Vertical section of factory of the "Union Agricole," St. Ouen-de-Thouberville, near Rouen, France.

the air on the crushed tissues. The pulp is not, however, and never should be, allowed to ferment before pressing.

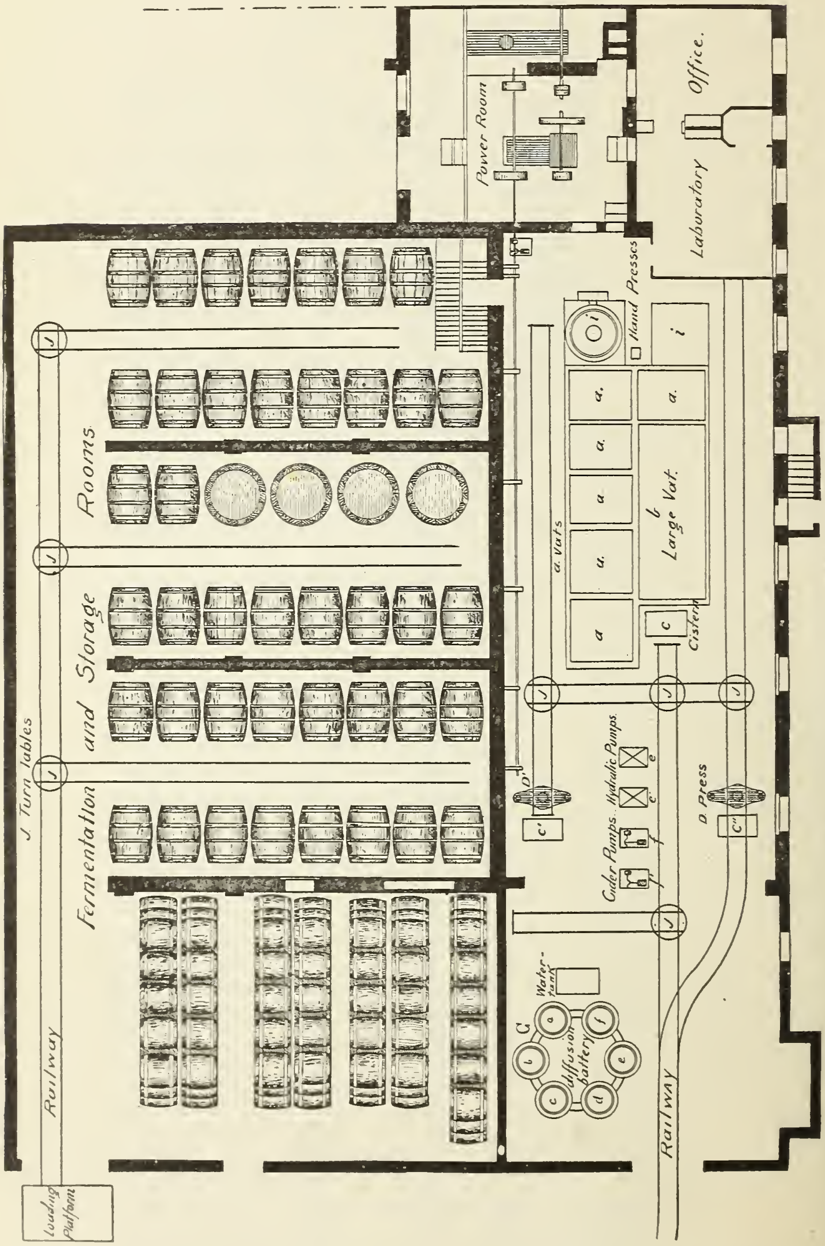

FIG. 12.—Ground plan of factory of the "Union Agricole."

The pulp vats at this factory were made of porcelain tiles carefully set in cement. A drain pipe was arranged to carry the must, which always flows from freshly crushed fruit, into a cistern at the left of these vats. From here it was pumped into the large casks in the fermentation room. The large vat (fig. 12, *b*) is provided for the maceration of pomace after it has been through the press.

When the pulp is thought to be in condition for the press a small car is run alongside and the pulp is laid up in cheeses on a form, using coarsely woven press cloths just as is done in the best American factories. When this car is loaded it is run onto the press (*D′*, figs. 11 and 12), and the hydraulic pump is put in motion, the car and its load of pulp being lifted by the upward thrust of a hydraulic piston after the manner so common in this country. In this factory the hydraulic presses were rated at 200,000 pounds direct pressure.

While this load of pulp is under pressure another car is loaded ready to take its place. On being released from the press the car is run alongside the large vat and the pressed pomace is discharged into it, carefully cut up with a shovel and wet with weak must or water, the amount of liquor added being about equal to the pure juice expressed. This round of operations is repeated until the day's grinding is exhausted, and the pomace from the first pressing then rests in the large vat macerating in water or weak must until thought ready for pressing a second time. The must from the fresh pulp in the vats and cistern is united in the great casks of the fermentation room as pure juice. This is destined for the highest grade cider.

After eight to ten or twelve hours maceration the pomace is again subjected to pressure on a different press (*D*, fig. 11) from that used for pure juice, and the must is received in another cistern near by and pumped into another set of casks. This must is used to make a second grade of cider, the "boisson" of the laborers. But this does not complete the operation. Again the pomace undergoes maceration with water or weak must, being then pressed a third time. The must from this pressing is very weak, its specific gravity being 1.010 to 1.016. This must is used to macerate the pomace after the first pressing, thus adding very materially to the quality of the must derived from the second pressing.

The pomace is no longer of any value for cider purposes. It may, therefore, be discharged by running the car outside the factory, or it may be ground anew and washed to separate the seeds, which return no small income, as they are in great demand by nurserymen for growing stocks. These seeds are known in commerce in this country as French "crab seed," but they are really seeds of the cultivated apple and not of crabs.

A second method of extracting the juice from the apple pulp is also employed in this factory, viz, diffusion. The diffusion battery (*G*, fig. 12) is located at the extreme left of the main operating room. It consists of 6 tanks, about 3½ to 4 feet high, mounted on a turntable.

Immediately at one side and just above the level of the tanks is a reservoir for water. This may be supplied warm or cold.

To put this apparatus in operation, 5 of the tanks are filled with cut or pulped fruit. These are so connected that the fluid will circulate from one tank to another by means of a tube connected at the bottom of the first and delivering the flow near the top of the second, and so on around the circle. By the time the fluid flows out from the bottom of the fifth tub it is well charged with the soluble matters contained in the fruit, i. e., sugars, acid, tannin, mucilage, etc. But it can never be made to equal in richness the product of the first pressing from the same fruit.

As soon as the fruit in the first tank is exhausted by this washing with water, the stream is turned into the second, and the sixth tank, now freshly filled with pulp, is put in service as the final member of the battery. Then the first tank is emptied and refilled with fresh fruit to take the last place in the series, when the third tank becomes the first cell in the battery. Thus the operation proceeds indefinitely. It should be said that the richness of the must delivered at the exit from the fifth cell always determines when a fresh tub or cell must be "cut in," as the flow through the last tub of fresh fruit strengthens the must very much. The strength or richness is taken by specific gravity very readily.

The manufacture of cider by the diffusion method is carried on in France to a considerable extent, but its present importance does not appear to warrant extended discussion here. It may be worthy of study, but all the indications seem to point to its failure to produce a genuine high-grade cider.

In the factory at St. Ouen-de-Thouberville two hand presses were provided as a reserve to be used in case of accident to the hydraulic presses.

The main operations prior to fermentation have now been outlined. The must of the several grades has been delivered by pumps to the large casks in the fermentation room (figs. 11 and 12). Through each section of this part of the building runs a main brass pipe connecting with the pumps. The flow is readily turned into the desired section by valve cut-offs, and in each section the must is delivered to the receptacles by rubber tubes which can be attached to the "main" at convenient points. Each cask as filled is marked with the date and such other data as are necessary to guide the operator in the details of the fermentation. At the same time proper entries are made in the factory journal for future reference.

The technique of fermentation is not discussed here, as it will be treated further on in this report. It should be added, however, that Mr. Power was using casks usually of 600 liters capacity or larger, open vats made of slate, and great tanks by way of experiment during the first fermentation; but his preference was for the casks.

From the upper room, where the first fermentation occurs, the cider runs by gravity at first racking to the room below, which is a sort of half cellar. Here it usually rests until it is finished cider. The railways shown on the ground plan are in this lower room and serve to carry the finished cider in casks of proper size for transportation to a platform at the lower side of the factory, from which they are rolled onto the great carts without lifting, an advantage of considerable importance.

The space shown in the illustration, however, is not sufficient for the product of this factory, and five cisterns adjoining the lower storeroom augment the storage capacity by 60,000 gallons. These are made of slate laid in cement, and the cider stored in them keeps perfectly. When it is necessary to bring them into use, the cider flows by gravity to them from the lower storeroom. They are carefully closed as filled, and only opened as it becomes necessary to pump the cider out for commerce. This factory has a total annual capacity of about 350,000 gallons. The laboratory is of very great importance, and here Mr. Power makes analyses of fruits and of the product at various stages of manufacture so that all may be well governed.

GERMAN FACTORIES.

Among German cider makers of the Taunus and Rhinegau districts to propose fermenting the must in other than good cellars would be heretical. The cellar is here the first essential. Everywhere the small proprietor and the great manufacturer work on essentially the same principles. These cellars are most excellently built of good masonry, the walls being finished in hard mortar and the floors in cement, as though they were intended to endure for ages. Drainage, ventilation, hoists, and the like are carefully looked after.

Dr. Cluss, in his recent work on cider making, bemoans the carelessness and lack of method observed in some parts of Germany, but in the districts visited by the writer the people have the details well in hand. Only a few types of factories which illustrate those seen can be taken up in this report.

The mills most generally in use in Germany for grinding or crushing the fruit are either single-cylinder rasping or grating mills or two-cylinder crushers ("greif" mills.) The simple grater mill serves its purpose very well, but the consensus of opinion seems to be decidedly in favor of the stone cylinder crusher (figs. 6–9). This mill, in different sizes, was found in use, some being driven by small steam or gasoline engines. In fact small factories with good appliances and good cellars are quite common in the territory visited.

The German cider maker may have a building devoted entirely to that purpose, as the large makers invariably do, or, as in the case of farmers and other small makers, he may use only a portion of a building, the balance being used for other purposes. The grinding and pressing rooms may be additions built onto another structure, the cellar extending under the whole. In no case was fruit seen stored in upper rooms or lofts, but usually on the floor of the operating room or in bins adjacent. The small makers seem to make little or no provision for storage, and the grinding and pressing, so far as observed, were conducted on the ground floor. In the small plants this requires only a moderate amount of floor space, the power plant and grinder being near each other and the presses adjacent. The pulp was almost invariably allowed to stand for some hours before pressing. The Germans usually have large tubs, holding, say, 10 hectoliters (264 gallons) of fruit pulp, and into these the crushed fruit is at once placed as soon as it falls from the mill. Even the largest factory visited, having an annual output of over 500,000 gallons of cider, pursues this rather cumbersome method. In large factories this requires a great amount of floor space and seems to necessitate an enormous waste of labor, but it is thought satisfactory by the proprietors. Small plants usually grind only enough fruit to make one or two cheeses at a time, and hence proceed at a rate which, in this country, would be considered wasteful of time.

The manner of laying up the cheese is in the main the same as in our best appointed mills in which cribs are still used to hold the pulp during pressing. The cheese cloth has not made headway in Germany. The cribs, usually circular, are very well made.

After maceration for a period varying from twelve to twenty-four hours, the pulp is brought to the press and submitted to as heavy pressure as possible by hand power, the drop screw press being largely used, but also those with the screw on a central stem. The pressure is applied for a considerable period until the cheese is carefully drained; then the pomace is thrown up and finely broken, and either macerated with water, as in France, or allowed to rest for a period when it is pressed a second time in a stronger press. The Germans do not use much water in macerating pomace for repressing; in fact, a very small amount was used where the operations were observed. The best German factories inspected did not use water at all, but these were equipped with hydraulic as well as hand presses, and the pressing was completed at a pressure of 250 atmospheres on the hydraulic presses.

The differences between French and German fruit in sugar content have some bearing on the use of water in macerating. At no time was must observed flowing from the press in German mills which was above 50° Oechsle (1.050 specific gravity), and if, after watering slightly, a second pressing of 40° to 45° Oechsle (1.040–1.045 specific gravity) could be obtained, the two runs were united and fermented together. This was the practice in small factories.

The largest German factory visited, that of the Freyeisen Brothers, Frankfort, is possibly the largest in the world. Its annual output is about 25,000 hectoliters (660,000 gallons). Unfortunately plans of this building were not to be had, and it was too extensive for the writer to attempt making drawings. The working equipment consists of one grinder, a large number of mash tubs in which the pulp is macerated, 22 presses (6 of these hydraulic), teams, tools, etc. A force of 160 laborers is employed. In this factory, and also in most of the smaller German factories visited, the fruit is washed before grinding, usually in the manner already described, namely, by dumping it into a great vat of water and elevating it from this to the grinder by a screw rotating in a half cylinder.

The workmen carry the apples from the bins in wooden vessels resembling tubs, holding about a bushel, and dump them into the washing vat. The pulp is taken in like vessels as it falls from the grinder and carried by the workmen to the macerating vats. From these, after maceration for about twenty-four hours, it is again filled into the tubs and carried to the presses. The pressure is applied slowly, and the pulp is allowed to drain a long time. Then the pomace is cut up fine, put into another press, and re-pressed without addition of water. The third and last pressing is accomplished at 250 atmospheres. No further use is made of the pomace. The must averages about 1.050 specific gravity.

To an American the work of this factory seems to be conducted on an exceedingly laborious plan. The impression obtained was that this old firm, which had been in business about a century, had at various times grafted on new ideas and appliances, without at any time really reconstructing and modernizing the plant. In like manner, the cellars appeared to have been added to until they honeycombed the earth, and extended vault below vault to a depth of 17½ meters (56 feet) below the surface of the factory yard. This bewildering maze of cellar vaults, full of great casks, each holding 2,000 liters (528 gallons) or more, over 900 in all, served to store the product; but a great quantity of cider is sold while still in first fermentation for use in the restaurants of Frankfort as sweet or smoking cider.

The methods of handling the must are now to be considered. The pressing of the pomace, as explained above, generally occurs on the ground floor immediately over the cellar. To this first cellar the fresh must is conducted through rubber pipes, either by gravity or by pumping, and is put directly into the great casks in the fermentation room.

It is the German custom not to fill the casks so full that there will be any discharge of froth or top lees through the bunghole, 6 or 8 inches of clear space being left in the top of each cask. As soon as a cask in the fermentation room is filled, it is fitted with the ventilating funnel (fig. 16). Nearly all good cider factories are provided with cellars at least two stories in depth, so that the room for final fermentation and storage is immediately below the first cellar.

The construction and arrangement of typical German cellars are shown in figures 13 and 14. The most ordinary place visited had one good cellar, and places of the next higher grade uniformly had two-story cellars. The great factories have still deeper cellars, as that of the Freyeisen Brothers already mentioned.

The chief advantage of the cellar is the ease with which temperature can be controlled. For instance, in the upper cellar, by introducing air through ventilating flues (fig. 13 *h*), it is possible to raise or lower the temperature in accordance with the condition of the atmosphere, and once the proper temperature is reached its maintenance is fairly

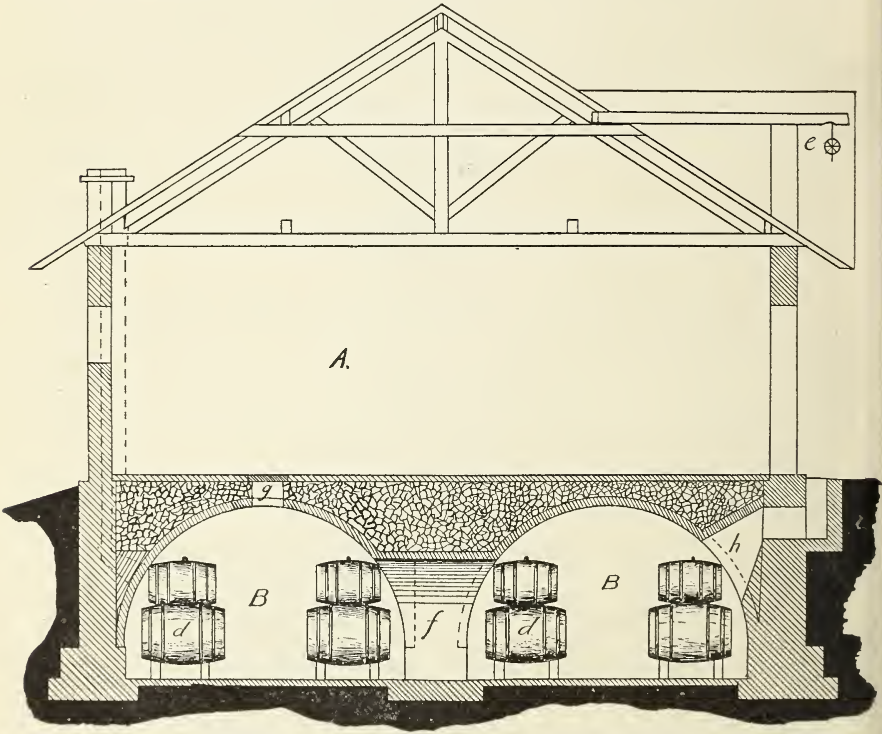

Fig. 13.—Vertical cross section of small German cider factory with arched cellars.

easy. However, in the cold season, if the temperature falls too low, resort is had to a heating apparatus. The temperature which the Germans seem to prefer for the fermentation room (B, figs. 13 and 14) is 15° to 18° C. (59° to 65° F.), the lower figure being preferred if active fermentation starts promptly at this temperature. In the lower cellar (*C*, fig. 14) or finishing room a temperature of 8° to 10° C. (45° to 50° F.) is preferred. Still lower temperatures are obtained in late fall and winter.

The comparative ease with which the cider can be piped from one cellar room to another under this German system is very apparent.

The liquor must, in the course of its progress to a finished product, pass from a warmer to a colder temperature, and this is here accomplished by gravitation. The hoist (fig 14, *e*) at last lifts the finished product from the lowest room to the ground floor. Naturally the great casks are never disturbed except for purposes of repair or renovation. The finished product is either bottled direct in the storage room or transferred to smaller casks for transportation. Manholes are provided in the floors of each room to permit the passage of the pipes, etc., used in handling the product.

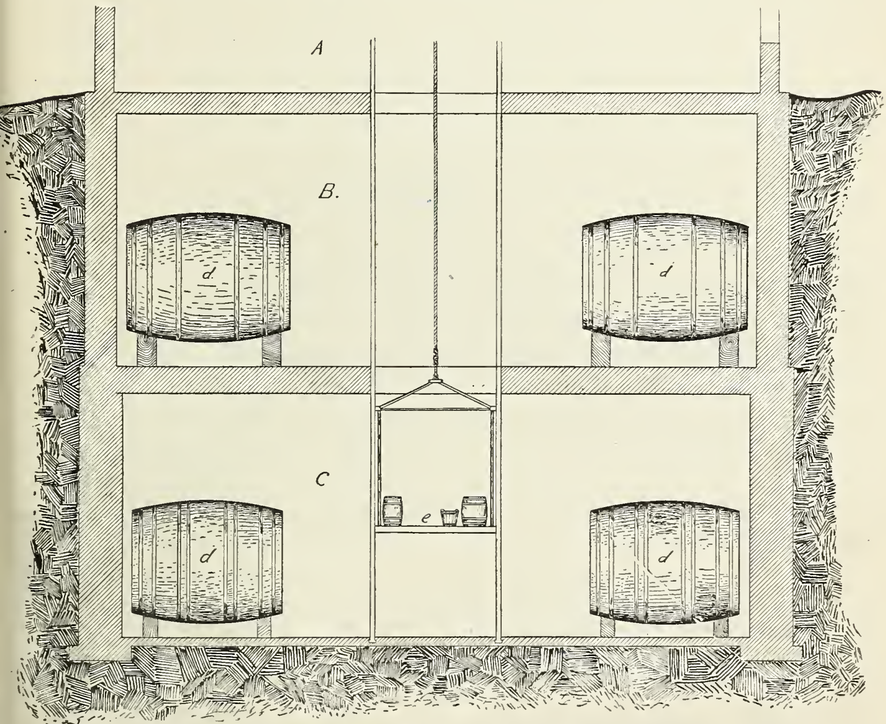

FIG. 14.—Vertical cross section of two-story German cider cellar.

ENGLISH FACTORIES.

There is little that is distinctive about English cider factories. This does not imply that there are not good factories in England; on the contrary, some of the finest products observed anywhere were those of English factories. But there is no definitely recognized standard in regard to either apparatus or buildings and cellars for either small or large factories in England. The best factories seen were copied from those of the French champagne makers of Epernay; but as to mechanical devices or details of arrangement, they show little that is new or of peculiar importance. The cellar plays but a small part with the average English cider maker. Some important details, however, in the handling of must and in fermentation processes were observed.

The English factories grind largely with graters and rasping cylinders, though the German "greif" machine (figs. 6, 7, 8, and 9) is coming into use. As before mentioned, the "tour à auge" was seen in use in England.

The English rarely press the pomace but once, and almost no maceration of the pomace with water was observed. The quantity of juice extracted from the fruit varies, according to the statements made, from 60 to 90 per cent of the weight of fruit, but the latter figure is so high as to inspire grave doubt as to its correctness. The presses used are mostly old-style hand and power screw presses. Not a hydraulic press was seen in use in the island. The system of handling the fruit at the large factories seems particularly objectionable. It was in most cases lying in great heaps in the yards or lots adjacent to the mill, and in many cases a considerable percentage of it was far gone with decay.

On a tenant farmer's place in Herefordshire was seen one of the largest plants visited in England, and a few words of description will give an idea of its management. The fruit lies in immense piles in the orchard on a rise of ground which extends up to the factory sheds. When needed, the fruit is shoveled into a long inclined chute that carries it to the grinders below, which are of the stone-crusher type. The pulp falls into a great vat, whence it is shoveled onto the presses. Two sprocket-geared power presses are used, and the cheeses are laid up in cloths as with us. In this factory the pomace is soaked and re-pressed.

The must is pumped by power apparatus to an adjacent shed, where it is received in great slate vats and wooden tanks, and in these it is carried through the first fermentation. From there the cider is pumped to a more permanent building for ripening and storage. The storage tanks range in capacity from 100 to 4,500 gallons each. Fermentation is controlled by filtering and racking, as is usual in England, and a pasteurizer also is in use, but no opportunity offered to observe the effects of its use.

When desired for market the cider is blended in large vats to suit the demands of the trade and then pumped through the Invicta filter into casks for shipment. Thousands of gallons of supposedly finished cider were to be seen stored in 50-gallon casks in the open, merely covered over with boughs and straw, and it was said to keep well under this treatment.

The power used in operating this plant is a traction engine of about 15 horsepower, such as is in general use on English farms for thrashing and doing various kinds of heavy work. The whole plant was very badly placed as to detail of structures and conditions for handling the product properly. Practical duplicates of this factory were observed elsewhere, and very fair cider was made on a large scale, but no really fine products from such plants were observed.

The best large factory visited was at Hereford City, but here admittance to the operating rooms and cellars was refused, though an extended interview on the methods was given. These operators are patterning wholly after the French champagne makers. They have extensive cellars in which their product is finished at a temperature of 47° to 50° F. They explained their system of blending the must before fermentation, which, by the way, is one of the most important operations in determining the grade of product produced.

On the estate of Lord Sudley, in Worcestershire, some very interesting and decidedly successful amateur work in cider making was observed. Here the manager of the estate, Mr. Charles D. Wise, has for several years been studying and experimenting on the manufacture of fine bottled cider and perry, and he has succeeded remarkably well in some particulars. He has installed a small plant in a great circular brick structure, formerly used as a riding school. Here he grinds the fruit on a grater machine, using a portable farm engine. The pulp is pressed by a hand-power screw press, and the must is carried through the first fermentation in great tubs or vats. As soon as the lees are well separated, the cider is racked off and then filtered by gravity through wood pulp. This is accomplished by the use of a great tub elevated about 10 feet above the floor. In it is fitted a false perforated bottom, a few inches above the real bottom, and between these is placed the filtering medium. The tub is filled with cider, and the clarified product is received below and placed in large casks about the course of the riding school to mature.

The cider is permitted to remain in these casks from one year to eighteen months before bottling. Apparently very little technique is employed, but some of the product is excellent. How much failed to turn out well was not ascertained.

The experiments on cider making in England, conducted conjointly by the Board of Agriculture and the Bath and West Agricultural Society, are carried on at Butleigh Court, the country seat of R. Neville Grenville, esq., in Somersetshire, near Glastonbury (Pl. VII). Mr. Grenville is personally interested in this work, and has devoted considerable time and money to it, and Mr. F. J. Lloyd, of London, a consulting chemist, has supervised for the authorities the more technical aspects of the work. The reports on this work can be found in full in the annual volumes of the Bath and West of England Society.

The cider house at this place is equipped in part on French models. The fruit is stored in a loft, and is ground on a machine at the level of the upper floor, whence the pulp falls to the press below. The grinder is of the German pattern with stone rollers. The pulp is pressed on a hand-power screw press at about 40 tons pressure. The cheese is laid up in cloths and well pressed, but only once, the pomace being then used to feed the cattle on the place.

The must is pumped back into the upper story and placed in open tanks (here called "keeves") of about 60 to 75 gallons capacity. In these the must is carefully watched, and the top lees are skimmed off until the cider reaches a state of limpidity which warrants racking off. At this stage the liquor is drawn off in pipes to the lower room and either placed directly in casks for maturing or run through the Invicta filter, according to circumstances: that is, if the cider can be drawn clear, it is best run directly into casks, but, if "troubled," it is filtered and then run into casks. The storage casks range in size from 100 to 250 gallons.

In this small factory all the critical data which should govern the technique were observed, as, for instance, the chemical composition of the fruit and the specific gravity of must at grinding and at each stage of fermentation. A most elaborate cellar record is kept of the casks in the storage rooms and regarding the results of bottling at various times. It is too soon to speak positively of the lessons to be learned from these examinations and observations, but it is certainly by such observations and studies that the knowledge of the subject is to be advanced.

The product sampled at Butleigh Court was of fine quality but, as elsewhere, there were "misses" in some cases. Accommodations for accurate cellar work are needed.

PRODUCTION OF THE MUST.

The appliances used in reducing the apples to pulp and expressing the juice therefrom have already been described. Yet several important points in relation to the production of the must remain to be discussed.

RIPENESS OF THE FRUIT.

The ripeness of the fruit, or its condition in relation to those obscure processes which go on after maturity in the pome fruits and bring them into their most favorable condition as to quantity of sugar and quality of juice, is a very important consideration in this connection. It was especially noted in the French factories that they did not grind the fruit until it was in perfect condition as to ripeness, but comparatively little attention was paid to this matter in the German and English factories visited.

The important fact that the sugars in fruits increase to a maximum point, which is doubtless reached at or near the stage of perfect ripeness, ought not to be lost sight of either in cider or vinegar work. There are, however, very few valuable data concerning the composition

FIG. 1.—BUTLEIGH COURT, SOMERSETSHIRE, ENGLAND, SEAT OF ENGLISH CIDER EXPERIMENT STATION.

FIG. 2.—THE CIDER-APPLE ORCHARD AT BUTLEIGH COURT.

of apples during the process of ripening. This is an important field for critical study which ought to give results of decided economic value.

MIXING VARIETIES OF APPLES.

Under the comparison of the composition of fruits, the great variability of different kinds of apples has been shown. But there are other characteristics of apples which can not be expressed in terms of chemical data, such as their taste and aroma, and these factors have to do with making a good cider in only a lesser degree than sugars, acids, and tannin. The blending of fruits at grinding appears to be an almost universal practice in France. Every maker appears to exercise his own judgment about the proportions of the several varieties to be used, sampling the fruits by taste and smell. There are, for instance, many French varieties which have a very high content of tannin. These are not used separately in cider making, but are mixed with sweet and acid fruits to secure a proper average composition. The question of blending or not resolves itself finally to this: Can we hope to secure by selection a perfectly proportioned fruit as to its chemical composition and other qualities, or not? This desideratum is certainly far from being realized at present.

In Germany very little special attention is paid to the subject of blending except in the use of *Sorbus domestica*, as already noted. In this they have a fruit of the greatest importance, a fact which did not appear to be fully realized. The ordinary German varieties of apples present few characteristics to lead one to a study of blending.

In England the best makers talk about blending, but handle their really good varieties in such a bad manner, in many cases, as to leave little chance of realizing the best results. At one of the best English factories visited the manager explained that he ground the varieties separately, expressed the must, tested it as rapidly as possible, and blended as it was run into the fermentation casks. This is certainly the most scientific method of blending.

Some French writers recommend for the best standard ciders to use one-third sweet fruit to two-thirds bitter fruit, and for household use two-thirds sweet and one-third bitter fruit; but such attempts at exact proportions are worthless. The whole question must be determined on the spot for the particular fruits in hand. However important this question may be in relation to standard products, no really important data regarding it were obtained.

Unfortunately in the United States we have so few distinctively cider fruits in cultivation and so few technical data in regard to our common varieties that advice on this point must await further investigation. Meanwhile, good judgment applied along the lines here indicated will be a better guide than figures as to proportions of this or that variety.

WASHING THE FRUIT.

In many places in Germany and some places in France washing the fruit before grinding was found to be largely practiced. Where the fruit is actually soiled this operation is greatly to be commended, but it was practiced in many places regardless of this point. To run all fruit through a washing vat simply as a part of a system seems to be unwarranted on several grounds: (1) It is useless in case of fruits that have been harvested in a proper condition; (2) if elevated directly from the washing vat to the grinder the fruit carries with it considerable water, which reduces the specific gravity or richness of the must, and (3) there is every probability that washing reduces considerably the yeasts present on the fruits. This under some conditions is of critical importance, and needs to be considered in relation to the practice of sowing the must with active yeast cultures.

There are heard in discussion and found in the literature of the subject statements about drying the fruits after washing, but this does not seem to be practiced, nor was a mill seen constructed with any idea of permitting the fruits to dry before crushing. If the water is not frequently changed in the tank it will soil rather than clean the apples. Fruit carrying impurities should never be stored or ground with clean fruit even after it has been washed, as to do so is simply to furnish to the must the organisms of mal-fermentation and other substances, which will most likely prove harmful. The international cider congress held at Paris in October, 1900, expressed by vote the opinion that washing fruits before grinding ought only to be practiced where cleanliness made it necessary.

GRINDING OR CRUSHING THE FRUIT.

The end in view in reducing the fruit to pulp is to make it possible to extract the juice by pressure. Some fruits can be more or less perfectly pressed without grinding, but this is not possible with the apple. The cells of the apple hold their juices quite tenaciously, and must be definitely ruptured. Hence the method which will most perfectly rupture the constituent cells is probably the best to employ. As previously stated, perhaps the German "greif" mill accomplishes this purpose better than those of any other type. This view was advanced by German and English cider makers, and indorsed to some extent by the French.

It was everywhere stated by the best makers that the seeds must neither be cut nor crushed to any extent, because their oily and nitrogenous constituents directly injure the ciders by contributing flavoring matter of an unpleasant nature and nitrogenous substance in which the organisms causing putrescence find a desirable medium for development. This opinion was universally accepted in all the factories visited, although this view is contrary to that of the early English and

American writers. The chemical analyses of seeds of pome fruits indicate that the opinion is based on good grounds. The delicate fruit aroma yields the bouquet desired in the cider. The oily principle in the seeds tends to destroy this, and certainly nitrogenous matter is not desirable to any extent in must which is to be fermented into a beverage. There is ordinarily plenty of nitrogenous matter in apple must to support yeast growth. However, slightly contradictory as it may seem, the French makers aim to crush the seeds for the preparation of "boisson," claiming that, as the pomace is largely deprived of its aromatic constituents when the pure juice is extracted, the oil in the seeds adds to the quality of this low-grade cider.

The fineness of grinding affects to some extent the facility with which the juice can be expressed. If the pulp is too mushy, it presses badly, especially when the cheese is made up in cloths. In this matter there is a proper mean, which no one seems to be able to define in an entirely satisfactory manner. It is often expressed in this form, that not over 2 per cent of the seeds should be cut or crushed in reducing the fruit to pulp for first pressing.

For preparing must by the diffusion process, mentioned elsewhere in this report, the fruit is not ground or crushed as for pressing, but it is cut or shaved into thin slices, as it is found that with these extraction by diffusion goes on more perfectly than with pulped fruit.

MACERATION OF PULP.

The Germans are strong advocates of maceration, i. e., allowing the fruit to stand in its own juice, because by this process they believe the sugar is more perfectly extracted. They claim that the juice acts upon the unbroken cells and assists in liberating their liquid contents. This would certainly be true if fermentation were fairly begun before pressing. The writer's experience is against permitting the pulp to ferment before pressing, but these questions need to be approached from the standpoint of scientifically conducted experiments before much can be said that is definite.

MM. Séguin and Pailheret, at the National Agricultural College, Rennes, France, have made a number of experiments in a small way upon this question and they have found in every instance that maceration increases the totals of sugar, acids, mucilage, and ash in the must, but decreases the tannin, and leaves, finally, an almost colorless must. This latter point is contrary to the German opinion. The French do not generally practice maceration of the pulp before pressing. In the writer's opinion maceration for more than eight or ten hours is liable to stock the whole mass of pulp with many undesirable organisms and render control of the fermentation far more difficult than it would otherwise be unless the pulp is sown at once on grinding with pure cultures of yeast.

EXPRESSING THE MUST.

The older methods of laying up the pulp preparatory to pressing possess no particular merits to call for further remarks than those already made.

The modern, double-acting, ratchet screw presses, so much used by the French, and the hydraulic press, or some better form of machine, must be the presses of the future. Hand hydraulic presses are in use in France, and in all the medium-sized and large factories these modern machines must make headway against the obsolete and laborious hand presses of the old style.

When the fruit is carefully pulped in the most correct manner, and subjected to from 80 to 100 tons direct pressure for a sufficient length of time, the possibility of again manipulating this pomace so as to derive sufficient must to warrant the effort is indeed slight. This is especially true when the pulp is well laid in thin lozenges in the coarsely woven seine-twine cloths used in the best American mills. Hair cloths and various devices are used abroad, but none of these compared well with our best American cheese cloths.

SOAKING THE POMACE.

One must distinguish clearly between the after maceration of the pomace and the maceration of the pulp in its own juice. The later operation is better named "soaking." If there is any method by which the pomace can ever be handled with a view to more perfectly exhausting it than is accomplished by direct pressing, it would seem that soaking in warm water is by far the most promising one.

If American fruits were as rich in saccharine properties as the French appear to be, it is possible that a considerable quantity of the juice of second pressing or of the must extracted by diffusion could be mixed with the rich juice of first pressings and still produce a must sufficiently rich for good cider or vinegar. The imperfect methods of expressing the juice employed in many places abroad give to this question more importance than it has with us; but the question of its utility or nonutility in large factories is yet to be settled after more technical investigation.

FERMENTATION OF CIDER.

In the minds of some, fermentation is a very simple operation. Mr. A. Hauchecorne says in his elementary treatise on cider:[a] "The art of making good cider is very simple, and includes the following four conditions: Ripe fruits, clean water, a barrel free from taints and odors, and later racking off." On the other hand, Mr. G. Power[b] says: "Of all the operations necessary in the manufacture of cider, the fer-

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[a] Le Cidre, p. 7.

[b] Culture du Pommier et Fabrication du Cidre, 1: 102.

mentation is certainly the most difficult and the most important. This is true of all beverages, but with cider one encounters difficulties of a special nature." Dr. A. Cluss,[a] writing of North Germany, says:

We shall now speak of fermentation and the management of the cellar, those factors which have the greatest influence upon the resultant product, and * * * in which the greatest faults have been committed. One can say without exaggeration that the misfortunes in making cider, about which so many moan, are due not to the poor raw material nor to faults in the pressing, but almost without exception to ignorance of the foundation principles of fermentation, and especially to the bad condition of the cellars and cellar utensils which universally prevails.

The above quotations illustrate the extremes of opinion on this subject. Everyone in the United States who has tried to make fine sound cider will, I think, agree heartily with Power and indorse without exception the views of Dr. Cluss.

ROOM, VESSELS, AND APPLIANCES USED.

The first object to be kept in view in the construction of a fermentation room is the control of temperature conditions; the second, convenience of location to the general operating room and to the final storage room; and the third, facilities for maintaining perfect cleanliness and ventilation.

As types of factories meeting these requirements to a considerable extent, the factory at St. Ouen-de-Thouberville, France, and the German factories having single and double cellars may be cited.

On beginning the season's work the fermentation room should be put in perfect order as to cleanliness, the walls and floors being newly whitewashed. The casks or vats should be put in the most perfect order, cleansed carefully inside and out, and arranged with reference to the convenience of filling, racking off, and other operations.

TEMPERATURE OF FERMENTATION ROOM.

On this point the Germans are much more careful than the French or English. The French structures are largely exposed to the influence of daily fluctuations in atmospheric conditions, and whenever there is a considerable daily variation in the temperature it is quite impossible to carry on an even, well-ordered fermentation.

The alcoholic ferments (commonly called yeasts), like all other plant organisms, have an optimum temperature for growth, and it has been determined that this temperature is about 18° to 24° C. (65° to 75° F.). But it is also true that, at this temperature, the growth of the yeast plants is apt to be very rapid, producing a rather too violent fermentation which disturbs the orderly management of the must. At a lower temperature fermentation can be carried on in a more orderly way, if once well started, hence, 13° to 18° C. (55° to 65° F.) has been

[a] Apfelweinbereitung, p. 61 *et seq.*

found a more desirable temperature for the main fermentation room. At a temperature reduced much below the minimum given the must will not start a proper fermentation, and when it is introduced into the casks—especially if they are large ones—at a lower temperature, some difficulty will be experienced unless the must is artificially warmed. This can be accomplished by warming a portion and pouring this into the casks, but this portion of the must should never be heated to a temperature above 50° or 60° C. (120° to 140° F.).

VESSELS USED IN FERMENTATION.

Many styles of casks or vats for the first fermentation are in use. In England open vats were frequently seen. These were of wood and slate, and held from 60 to several hundred gallons. They were placed in the workrooms, or in rooms adjacent thereto, or out of doors under a shed roof. Many English makers, however, carry on the first fermentation in casks both small and large. Some use inferior 50 to 60 gallon casks lying in a shed, or in the open, but the best makers use larger casks or vats holding 100 to 500 gallons, and even larger ones for the tumultuous fermentation. Those who use the open vats quite generally allude to this part of the process as "keeving" the cider, plainly a corruption of the French word "cuvage."

French makers very largely ferment first in immense casks holding from 500 to 1,200 gallons, but they also occasionally use great wooden and slate vats open at the top.

In Germany only large casks are used, holding 500 to 2,000 liters (132 to 528 gallons). In fact, the German system of fermentation admits of nothing else but casks. These are uniformly closed to guard against the entrance of germ-laden air. Much has been said in the literature of the subject concerning the various kinds and sizes of vessels used for fermenting the cider. The size of the vessels is of the very greatest importance. Every maker whose work is worthy of commendation was observed to be using large vessels for fermenting the must. About 500 liters (132 gallons) was the smallest size recommended, and above this they ran to 6,000 liters (1,585 gallons).

There are several reasons which have more or less weight in emphasizing the necessity of having large vessels. One of the first is that a large quantity of must brought into a cask at proper temperature is much less subject to atmospheric changes and, hence, a safe, even fermentation can be carried on with greater certainty. There is also a very persistently repeated statement that the fermentation of the must in these large casks produces a marked effect upon quality. It can be readily understood that the use of these very large vessels will produce a considerable quantity of finished product of like character which can not be so well accomplished in small vessels. There will also be less dregs in proportion to the quantity of must if one employs large vessels instead of small ones. The control of a large cask requires no more attention, and often not so much as a small one.

FILLING THE VESSELS.

A convenient method of filling the vessels plays a very important part in handling the must. In many places this is accomplished by power pumps, which deliver the must to the receptacles placed in adjacent rooms or in another building. When the press room is over the fermentation room, filling is accomplished by gravity. Hose pipes are largely used for this work, but brass or copper must be used for all metal fittings. The less the must comes in contact with the air after it leaves the press the less liable it is to be contaminated with various undesirable organisms. The pumps and pipes used must be kept scrupulously clean.

The height to which the cask is filled with must bears upon the method of fermentation to be employed. In England the old practice of running the barrels or casks full so that they would "work themselves clean" is still in use to some extent, as it is in this country, but all progressive makers in England and elsewhere have abandoned this practice. Whatever modern system one may follow, the vessel is never filled so full that it will run over during the tumultuous fermentation. In the use of open vats the English almost invariably fill within several inches or a foot of the top and skim the lees which rise one or more times, thus exposing the must to the air and also causing the lees to be mixed more or less through the liquid. In England no attempt was made, so far as observed by the writer, to control the exit of gas or entrance of air further than to prevent the entrance of insects by some sort of temporary covering.

The French ferment almost universally in large casks or closed upright tanks, and it is rare indeed one sees an open vat. But when such vats are used, they permit the top lees to rest unbroken, forming a "head," the so-called "chapeau," over the liquor. In casks they usually leave a space of 8 inches to 1 foot below the bung unfilled. This permits the head to form without any overflow of lees.

In Germany they invariably leave a space of from 8 to 12 inches below the bung unfilled, but with an entirely different end in view from that of the Frenchman. The latter makes much of the proper appearance of the "chapeau," or top lees, and it is an article of his faith that this cover shall not be broken or permitted to fall back into the liquor. But the Germans, on the contrary, purposely preserve these lees from overflow and desire them to fall back through the liquor and rest at the bottom of the cask. They argue that this secures inclusive fermentation, and utilizes all alcoholic material in the top lees which would be lost by skimming or by drawing the liquor away from the lees.

CONTROLLING THE EXIT AND ENTRANCE OF GASES.

When fermentation occurs in the open vats, or "keeves," naturally one can not control the contact of air with the surface of the must. But the French, by permitting the top lees to rest, in a large measure guard the liquor from contact with the air. The reasons for thus guarding the must do not appear to be recognized by English makers, but are quite generally considered in France, and very strictly so in Germany. If the must is fermented in closed vessels, it is a very simple matter to guard the entrance from germ-laden air by the use of simple devices such as are shown in the accompanying illustrations.

In figure 15 is shown a device which was found in use to some extent

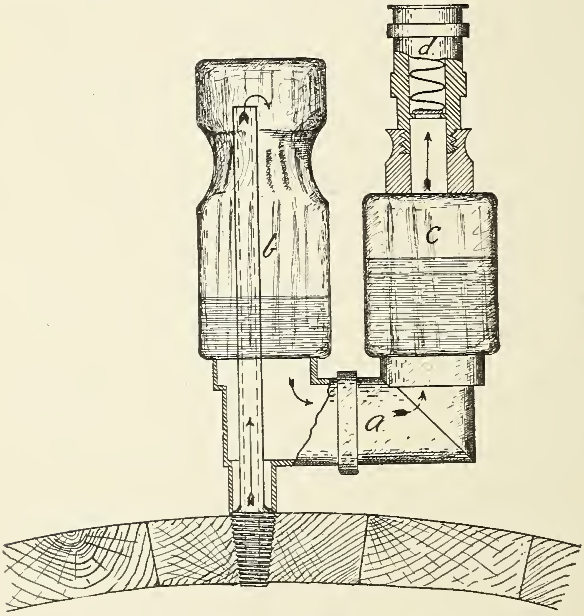

Fig. 15.—Noël device for ventilating fermentation casks.

in France, the character of which will be quite readily understood from the illustration. The metal base (*a*) screws into the cask and carries two connected glass chambers (*b* and *c*). The metal cap (*d*) unscrews to allow the entrance of liquid to the control chamber (*c*). When the cask is filled to the proper height, the bunghole is securely closed, and this device is either screwed into a small central opening in the bung or into a hole in the cask near the bung. The liquid desired for purifying the air—either 30 per cent alcohol or 10 per cent sulphuric acid—is poured into the chamber (*c*) until both glass chambers are about half full; then the apparatus is ready for operation. Should the pressure decrease in the cask by reason of falling temperature air can only enter by passing through this apparatus in a course contrary to the arrows, and hence will be washed clear of germs. On the increase of pressure through fermentation activity the gas passes out at low pressure by depressing the liquor in (*b*) until it gains exit, as indicated by the arrows. This is the Noël air controller; but in the writer's work it has proved entirely too complicated and too difficult to keep clean for practical use. The principle of air control is undoubtedly correct, but it is better accomplished by some of the following devices:

The German "fermentation funnel" (fig. 16) is a simple and far better device for controlling the air. This is a pottery or porcelain device having a central tapering stem (*a*) with a basin-like vessel (*b*)

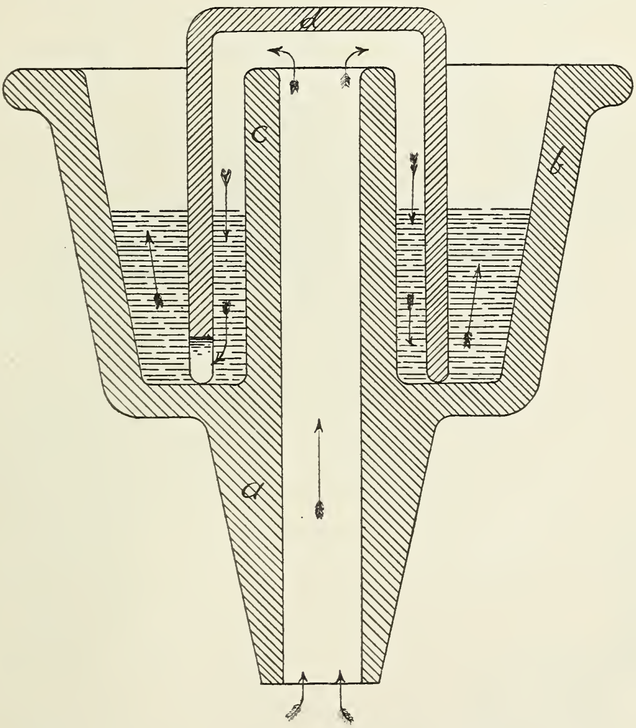

FIG. 16.—German earthenware ventilating funnel—vertical section.

around its upper end. The central stem (*c*) rises nearly to the height of the outer rim, and is hollow. Over this hollow stem rests a removable cap (*d*), which extends to the bottom of the basin. The lower rim of this cap where it rests under the liquid is notched for the passage of gases, as indicated by the arrows. This device is inserted in the bunghole of the cask, and by reason of the tapering stem can be made to fit quite tightly; but it is always better to use some paraffin wax around it. The control liquid is placed in the outer basin until it is about one-third full; then the cap is put on and the device is ready for operation. While this is an awkward looking device, it is the best known to the writer for practical work. The large central opening permits the operator to take the temperature of the must, or remove samples for examination at pleasure without displacing the entire apparatus, and it can be quickly and perfectly cleaned.

A third device (fig. 17), also of German origin, answers a good purpose, especially in laboratory work, but it is not recommended for cellar work. This is called the glycerin control tube. It is made of glass, and is operated by inserting the stem through a bung (*a*). Glycerin or one of the liquids mentioned above is introduced at the funnel (*b*) until the bulb (*d*) is half full. The principle is exactly the same as with the previous devices. Should the pressure decrease in the vessel air can enter through the liquid by reason of the enlargements (*d* and *e*). The enlargement (*c*) permits the escape of gas from the vessel without driving out the control liquid.

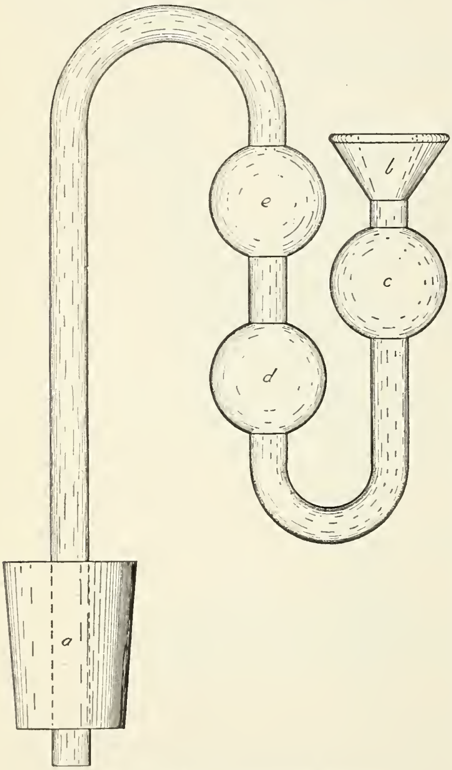

FIG. 17.—Glycerin ventilating funnel.

A very simple device is shown in figure 18. This consists simply of a bent tube inserted in a perforated bung, the outer end being so placed that it rests below the surface of the liquid in a basin. This device is very faulty because if, for any reason, pressure decreases in the cask the liquor from the basin will be drawn into the must. In practice the best devices are found to be of the greatest assistance in indicating the activity of the fermentation. To the practiced operator they become at once the barometer which warns him of danger or assures him of the proper progress of fermentation.

VENTILATING BUNGS AND SPIGOTS FOR CASKS.

In connection with the subject of fermentation funnels, the use of a ventilating bung should be mentioned. After the first fermentation has subsided and the liquor has been placed in casks for the second fermentation, it is desirable to close the casks tightly—at least so as to exclude as far as possible the entrance of air. Yet in so doing one can not be certain but that a sufficiently strong fermentation may set in to spring the staves or head of the cask. This misfortune is obviated by using some sort of a safety vent.

The best simple vent for this purpose that was seen is the Noël vent bung (fig. 19). A central opening of sufficient size is cut about half way through this bung and then is continued at a diameter about one-half as great the rest of the way. On the shoulder thus formed a valve (*a*) is placed and held by the spiral spring seen in the cross

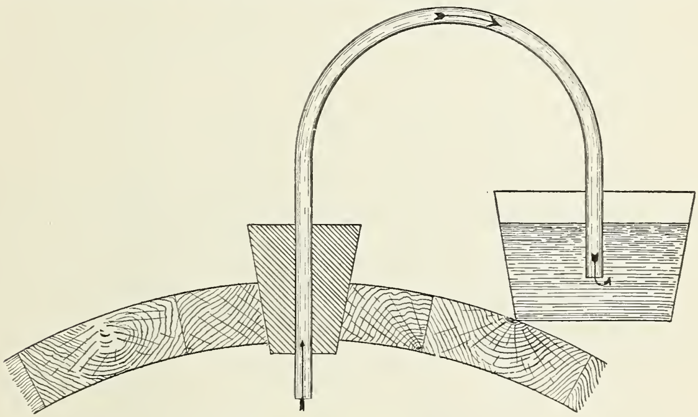

Fig. 18.—Bent ventilating tube.

section. The spring is supported above by a metal plate screwed over the opening in the top of the bung. The spring should be of sufficient strength to hold 2 to 4 pounds of pressure, and the mechanism of the valve and its seat should be so perfect as to prevent the ingress of air. If the bung is sterilized and driven tightly into place, it will insure proper ventilation of the barrel or cask and protect the liquor very well from the entrance of extraneous organisms.

One of the most important considerations about the fermentation casks is the means of drawing off the liquor readily when this becomes necessary. Many instances were seen in England and Germany where the fermentation was carried on in barrels and casks which had but one opening, namely, the large bunghole; hence, in racking off, it was necessary to introduce a pipe at this opening, lower it to what was considered a proper position, and then siphon off the liquid. This method is extremely faulty, however, because of the disturbance of the top lees and the difficulty of determining the depth to which the tube should be lowered into the vessel so as not to take up the dregs.

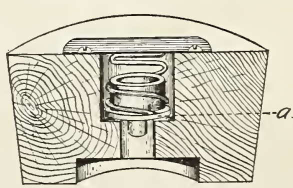

Fig. 19.—Noël ventilating bung.

Every vessel used for fermenting the must should be furnished with a spigot so situated that it will draw off the liquor as near to the dregs as can be safely accomplished without disturbing them. If this spigot can be furnished at the outer end with a hose connection of proper size the liquor can be run directly to the cask designed for second fermentation in those buildings where successive cellar stories are used. In this case it is necessary to fit a glass bulb into the hose so as to watch the condition of the liquor as it flows. If the must is transferred to vessels on the same level a pump is generally used. The French makers commonly place spigots in all vessels employed for fermentation work. These enable them to note precisely the condition of the must without disturbing the lees. The large casks should also be uniformly fitted with manholes in order that they may be readily cleaned after use.

THE CHARACTER OF THE MUST.

On bringing the must into the casks or vats for fermentation, it is of prime importance that the operator should know its composition as nearly as may be. To determine this accurately is the work of a chemist, but at no factory visited was there evidence of the employment of a chemist for this purpose. True, a number of the proprietors are themselves analysts.

USE OF DENSIMETERS.

Everywhere in Europe the makers use, with more or less care, some form of must spindle or densimeter for estimating the sugar content of the juice. Those most commonly used are the ordinary specific gravity spindle, the Oechsle spindle (which, in fact, is the same thing with the first two figures on the left omitted), and the Beaumé must spindle. The last is not a convenient form of spindle, as may be seen from Table XI. Its degrees do not permit of ready comparison with other standards.

It is the custom to take the density of the fresh must on one of these spindles and mark the result on the casks. Some makers keep a record of the casks by number in a cellar book, and enter not only these data, but notes on the fruit used, the character of the fermentation as it progresses, and all subsequent readings of density and manipulations of the cider. Also the records of temperature of the must and cellar are kept. Without some such system intelligent control of the work is impossible.

The following table gives a comparison of the readings of the three spindles mentioned, the proximate percentages of sugar at the different densities, and the approximate percentage of alcohol which will result from its fermentation at each reading of the densimeter:

TABLE XI.—*Readings of different densimeters and approximate solids and sugar content, with the indicated percentage of alcohol after fermentation is completed.*

Specific gravity.	Oechsle.	Beaumé.	Solids.	Sugar.	Alcohol.
	Degrees.	*Degrees.*	*Per cent.*	*Per cent.*	*Per cent.*
1.040	40	5.7	10.0	8.00	4.0
1.041	41	5.8	10.3	8.21	4.105
1.042	42	5.9	10.5	8.42	4.21
1.043	43	6.1	10.7	8.63	4.315
1.044	44	6.2	11.0	8.84	4.42
1.045	45	6.3	11.2	9.05	4.525
1.046	46	6.5	11.5	9.27	4.635
1.047	47	6.6	11.7	9.49	4.745
1.048	48	6.7	11.9	9.71	4.855
1.049	49	6.9	12.2	9.93	4.965
1.050	50	7.0	12.4	10.15	5.075
1.051	51	7.1	12.6	10.38	5.19
1.052	52	7.3	12.9	10.61	5.305
1.053	53	7.4	13.1	10.84	5.42
1.054	54	7.5	13.3	11.07	5.535
1.055	55	7.7	13.6	11.30	5.65
1.056	56	7.8	13.8	11.54	5.77
1.057	57	7.9	14.0	11.78	5.89
1.058	58	8.1	14.3	12.02	6.01
1.059	59	8.2	14.5	12.26	6.13
1.060	60	8.3	14.7	12.50	6.25
1.061	61	8.5	15.0	12.75	6.375
1.062	62	8.55	15.2	13.00	6.50
1.063	63	8.7	15.4	13.25	6.625
1.064	64	8.9	15.7	13.50	6.75
1.065	65	9.0	15.9	13.75	6.875
1.066	66	9.1	16.1	14.01	7.005
1.067	67	9.2	16.3	14.27	7.135
1.068	68	9.4	16.6	14.53	7.265
1.069	69	9.5	16.8	14.79	7.395
1.070	70	9.6	17.0	15.05	7.525
1.071	71	9.8	17.3	15.32	7.66
1.072	72	9.9	17.5	15.59	7.795
1.073	73	10.0	17.7	15.96	7.98
1.074	74	10.1	17.9	16.23	8.115
1.075	75	10.3	18.2	16.50	8.25

WHAT IS A STANDARD MUST?

To this query the investigations made have given no answer, nor does the literature materially aid one. There have been presented in some of the preceding sections many analyses of apple must made in different countries, and hundreds more could be quoted. These analyses differ widely from the standards of the tables arranged by different authors to show the saccharine content of a fruit juice in comparison with specific gravity. Unfortunately, the methods and the instruments used are far from uniform in the various laboratories where these determinations have been made, and the chemists making them must necessarily vary in skill and precision; hence a mere inspection and comparison of these data do not lead to a true conclusion in regard to the composition of apple must. But this is the best that can be done at present, and the averages of the data previously presented are assembled in Table XII to serve our purpose in discussing the probable standard sugar content of a must:

Table XII.—*Average composition of apple must for different countries.*

Countries.	Number of varieties.	Number of analyses.	Specific gravity.	Total sugar.	Average total sugar.	Acid.	Tannin.
				Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
French standard list	12	292	1.0725	15.98	15.76	0.229	0.262
French provisional list	24	79	1.0732	15.55		0.192	0.289
German (Kulisch)	29	29	1.0569	12.04		0.460	....
German (Behrens)	17	17	1.0590	13.38	12.12	....	....
German (Kramer)	15	15	1.0530	10.94		0.64	....
English (Lloyd)	10	24	1.0652	14.56	14.30	0.303	0.220
American (Browne)	10	10	1.0552	11.94		0.453	....
American (Davidson)	24	24	1.0530	9.58	10.66	0.35	0.022
American (Department of Agriculture)	21	21	1.0535	10.45		0.37	....

From a comparison of the analyses given it is evident that the juice of the apple varies in average sugar content in relation to specific gravity in the different countries and in different parts of the same country. In fact a wide variation may be found in comparing different varieties of apples from the same orchard. This is a matter not yet properly investigated, but the existence of such variation must be conceded. Hence no strictly standard table of sugar contents in relation to specific gravity is possible.

Careful inspection of the published tables on specific gravity and relative sugar content, and a study of the actual analyses of apple must available, lead one to believe that the theoretical sugar content usually given is too high. In Table No. XI, there is given for comparison the approximate sugar content which, in the writer's opinion, is likely to be found in normal apple must at the different densities indicated. True, the sugar percentages adopted in this table are empirical, but they are such probable averages within a small percentage of error that they are used to construct a table (No. XIII) to be used as a cellar guide in fermenting cider. This table appears to serve a very definite purpose, first, as a guide in the technique of fermentation, and, second, to assist in some measure in elucidating the further discussion. Table No. XI aids the manipulator of the must to estimate with considerable accuracy the sugar in the fresh must, and Table No. XIII assists him in watching intelligently the progress of fermentation. Thus, by the latter table, he is able to ascertain quickly the approximate quantities of sugar and alcohol in a fermenting must of known original density.

Attention was called to the presentation of these data in this form by the work of Mr. F. J. Lloyd, consulting chemist on cider experiments of the Bath and West of England Society. The work done under his direction on cellar records and technique was observed carefully, and the ideas presented in his table and remarks in the journal of the above society for 1896 (pp. 139–164) are considered as very important. The same may be said of his other papers. The writer was not able, however, to adopt the figures of Mr. Lloyd's table for determining the percentages of sugar and alcohol in fermenting must of a

TABLE XIII.—*For determining approximately the percentage of sugar and alcohol in a fermenting must of known original density at a temperature of 15° C. (59° F.).*

Original hydrometer reading.	Hydrometer readings during fermentation.																													
	1.070		1.065		1.060		1.055		1.050		1.045		1.040		1.035		1.030		1.025		1.020		1.015		1.010		1.005		1.000	
	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.	Sugar.	Alcohol.
1.040	...	...	...	...	...	...	...	...	...	...	...	...	8.00	0.0	7.00	0.50	6.00	1.00	5.00	1.50	4.00	2.00	3.00	2.50	2.00	3.00	1.00	3.50	0.0	4.00
1.041	...	...	...	...	...	...	...	...	...	...	...	...	8.01	.10	7.01	.60	6.01	1.10	5.01	1.60	4.01	2.10	3.01	2.60	2.01	3.10	1.01	3.60	.01	4.10
1.042	...	...	...	...	...	...	...	...	...	...	...	...	8.02	.20	7.02	.70	6.02	1.20	5.02	1.70	4.02	2.20	3.02	2.70	2.02	3.20	1.02	3.70	.02	4.20
1.043	...	...	...	...	...	...	...	...	...	...	...	...	8.03	.30	7.03	.80	6.03	1.30	5.03	1.80	4.03	2.30	3.03	2.80	2.03	3.30	1.03	3.80	.03	4.30
1.044	...	...	...	...	...	...	...	...	...	...	...	...	8.04	.40	7.04	.90	6.04	1.40	5.04	1.90	4.04	2.40	3.04	2.90	2.04	3.40	1.04	3.90	.04	4.40
1.045	...	...	...	...	...	...	...	...	...	...	9.05	0.0	8.05	.50	7.05	1.00	6.05	1.50	5.05	2.00	4.05	2.50	3.05	3.00	2.05	3.50	1.05	4.00	.05	4.50
1.046	...	...	...	...	...	...	...	...	...	...	9.07	.10	8.07	.60	7.07	1.10	6.07	1.60	5.07	2.10	4.07	2.60	3.07	3.10	2.07	3.60	1.07	4.10	.07	4.60
1.047	...	...	...	...	...	...	...	...	...	...	9.09	.20	8.09	.70	7.09	1.20	6.09	1.70	5.09	2.20	4.09	2.70	3.09	3.20	2.09	3.70	1.09	4.20	.09	4.70
1.048	...	...	...	...	...	...	...	...	...	...	9.11	.30	8.11	.80	7.11	1.30	6.11	1.80	5.11	2.30	4.11	2.80	3.11	3.30	2.11	3.80	1.11	4.30	.11	4.80
1.049	...	...	...	...	...	...	...	...	...	...	9.13	.40	8.13	.90	7.13	1.40	6.13	1.90	5.13	2.40	4.13	2.90	3.13	3.40	2.13	3.90	1.13	4.40	.13	4.90
1.050	...	...	...	...	...	...	...	...	10.15	0.0	9.15	.50	8.15	1.00	7.15	1.50	6.15	2.00	5.15	2.50	4.15	3.00	3.15	3.50	2.15	4.00	1.15	4.50	.15	5.00
1.051	...	...	...	...	...	...	...	...	10.18	.10	9.18	.60	8.18	1.10	7.18	1.60	6.18	2.10	5.18	2.60	4.18	3.10	3.18	3.60	2.18	4.10	1.18	4.60	.18	5.10
1.052	...	...	...	...	...	...	...	...	10.21	.20	9.21	.70	8.21	1.20	7.21	1.70	6.21	2.20	5.21	2.70	4.21	3.20	3.21	3.70	2.21	4.20	1.21	4.70	.21	5.20
1.053	...	...	...	...	...	...	...	...	10.24	.30	9.24	.80	8.24	1.30	7.24	1.80	6.24	2.30	5.24	2.80	4.24	3.30	3.24	3.80	2.24	4.30	1.24	4.80	.24	5.30
1.054	...	...	...	...	...	...	...	...	10.27	.40	9.27	.90	8.27	1.40	7.27	1.90	6.27	2.40	5.27	2.90	4.27	3.40	3.27	3.90	2.27	4.40	1.27	4.90	.27	5.40
1.055	...	...	...	...	...	...	11.30	0.0	10.30	.50	9.30	1.00	8.30	1.50	7.30	2.00	6.30	2.50	5.30	3.00	4.30	3.50	3.30	4.00	2.30	4.50	1.30	5.00	.30	5.50
1.056	...	...	...	...	...	...	11.34	.10	10.34	.60	9.34	1.10	8.34	1.60	7.34	2.10	6.34	2.60	5.34	3.10	4.34	3.60	3.34	4.10	2.34	4.60	1.34	5.10	.34	5.60
1.057	...	...	...	...	...	...	11.38	.20	10.38	.70	9.38	1.20	8.38	1.70	7.38	2.20	6.38	2.70	5.38	3.20	4.38	3.70	3.38	4.20	2.38	4.70	1.38	5.20	.38	5.70
1.058	...	...	...	...	...	...	11.42	.30	10.42	.80	9.42	1.30	8.42	1.80	7.42	2.30	6.42	2.80	5.42	3.30	4.42	3.80	3.42	4.30	2.42	4.80	1.42	5.30	.42	5.80
1.059	...	...	...	...	...	...	11.46	.40	10.46	.90	9.46	1.40	8.46	1.90	7.46	2.40	6.46	2.90	5.46	3.40	4.46	3.90	3.46	4.40	2.46	4.90	1.46	5.40	.46	5.90
1.060	...	...	...	...	12.50	0.0	11.50	.50	10.50	1.00	9.50	1.50	8.50	2.00	7.50	2.50	6.50	3.00	5.50	3.50	4.50	4.00	3.50	4.50	2.50	5.00	1.50	5.50	.50	6.00
1.061	...	...	...	...	12.55	.10	11.55	.60	10.55	1.10	9.55	1.60	8.55	2.10	7.55	2.60	6.55	3.10	5.55	3.60	4.55	4.10	3.55	4.60	2.55	5.10	1.55	5.60	.55	6.10
1.062	...	...	...	...	12.60	.20	11.60	.70	10.60	1.20	9.60	1.70	8.60	2.20	7.60	2.70	6.60	3.20	5.60	3.70	4.60	4.20	3.60	4.70	2.60	5.20	1.60	5.70	.60	6.20
1.063	...	...	...	...	12.65	.30	11.65	.80	10.65	1.30	9.65	1.80	8.65	2.30	7.65	2.80	6.65	3.30	5.65	3.80	4.65	4.30	3.65	4.80	2.65	5.30	1.65	5.80	.65	6.30
1.064	...	...	...	...	12.70	.40	11.70	.90	10.70	1.40	9.70	1.90	8.70	2.40	7.70	2.90	6.70	3.40	5.70	3.90	4.70	4.40	3.70	4.90	2.70	5.40	1.70	5.90	.70	6.40
1.065	...	...	13.75	0.0	12.75	.50	11.75	1.00	10.75	1.50	9.75	2.00	8.75	2.50	7.75	3.00	6.75	3.50	5.75	4.00	4.75	4.50	3.75	5.00	2.75	5.50	1.75	6.00	.75	6.50
1.066	...	...	13.81	.10	12.81	.60	11.81	1.10	10.81	1.60	9.81	2.10	8.81	2.60	7.81	3.10	6.81	3.60	5.81	4.10	4.81	4.60	3.81	5.10	2.81	5.60	1.81	6.10	.81	6.60
1.067	...	...	13.87	.20	12.87	.70	11.87	1.20	10.87	1.70	9.87	2.20	8.87	2.70	7.87	3.20	6.87	3.70	5.87	4.20	4.87	4.70	3.87	5.20	2.87	5.70	1.87	6.20	.87	6.70
1.068	...	...	13.93	.30	12.93	.80	11.93	1.30	10.93	1.80	9.93	2.30	8.93	2.80	7.93	3.30	6.93	3.80	5.93	4.30	4.93	4.80	3.93	5.30	2.93	5.80	1.93	6.30	.93	6.80
1.069	...	...	13.99	.40	12.99	.90	11.99	1.40	10.99	1.90	9.99	2.40	8.99	2.90	7.99	3.40	6.99	3.90	5.99	4.40	4.99	4.90	3.99	5.40	2.99	5.90	1.99	6.40	.99	6.90
1.070	15.05	0.0	14.05	.50	13.05	1.00	12.05	1.50	11.05	2.00	10.05	2.50	9.05	3.00	8.05	3.50	7.05	4.00	6.05	4.50	5.05	5.05	4.05	5.50	3.05	6.00	2.05	6.50	1.05	7.00

known original specific gravity. But by a study of the principle involved in this table, and by comparison with standard tables on specific gravity and relative sugar content, and the actual analyses, Table No. XIII has been constructed. By it an operator may determine at any reading, between 1.040 and 1.070 on a standard hydrometer, the probable sugar content present, and the approximate alcoholic strength of the liquor. Thus he is enabled to know how the fermentation is progressing. As a cellar guide this will be a very important help, and by reference to it the later discussion on the manipulation of the must will be more intelligible.

As a basis for this table it was assumed that a must reading 1.040 specific gravity, contains 8 per cent of sugar. Kramer says 9 per cent, but this is surely too high for apples. Power says 8.9 per cent, which is also too high, at least for American fruit. Kramer's table then allows 1 per cent increase in sugar for each 5 points (0.005) on the hydrometer, but this if logically carried out requires that the nonsaccharine solids increase proportionally more rapidly than the saccharine substances. Analytical data are against this theory; hence, it has been estimated that the sugars increase 1.05 per cent for the first 5 points above 1.040, and beyond that at an increasing ratio found by adding an additional 0.05 per cent of sugar for each subsequent 5 points (0.005) on the hydrometer.

But turning to the subject of relative decrease in sugar content below 1.040 it becomes necessary to allow a loss of 1 per cent for each 0.005 on the hydrometer in order to exhaust the 8 per cent of sugar at unity—1.000 on the hydrometer. Yet, as there are solids other than sugar present, it is altogether improbable that this will show the true percentages if the liquid is considered to be water; but it really consists of a mixture of two liquids, water which constitutes much the greater part, and alcohol which is lighter than water and which enters into the mixture in a constantly increasing proportion as fermentation progresses. Hence, for a must originally showing 8 per cent of sugar, it is probable that unity (1.000 on the hydrometer) will about bring it to dryness;[a] but by the same reasoning richer musts will not come to entire dryness at unity. This the table shows when carried out on the principle that for each 1 per cent of sugar lost, 0.5 per cent of alcohol is formed. This ratio of alcohol for fermentable sugars is only approximately correct.

In using this table as a cellar guide, one notes in the left hand column the hydrometer reading corresponding with the original density recorded for the must, and then finds in the box heads the present reading of the hydrometer; the figures for sugar and alcohol percentages at the intersection of the lines from these two readings will show approximately the present condition of the must as to alcohol and sugar content.

[a] In the technical phrase of fermentation work "dryness" means total absence of sugar.

FORTIFYING THE MUST.

In this connection a few observations on the subject of fortifying the must will be apposite. This practice was not observed either in England or Germany. Doubtless it may be done in these countries, especially in case of perry (pear cider), but it did not seem to be a part of the regular system of cider making. In France, on the contrary, sugaring up the weak must obtained from second pressing seems to be an important part of the business, and is so regularly practiced that the government makes a special rebate of the sugar tax on sugar so used. The government agents, however, very carefully see to it that all sugar withdrawn from bond for this purpose is denaturalized by addition of must, so that it can not possibly be resold in the markets. For 1898 (the figures for that year being the latest obtained) the government officers reported 188,760 pounds of sugar withdrawn for cider making, and 80,262,771 pounds withdrawn for sugaring wines.

An apple must reading 1.040 on a standard hydrometer can, if properly handled, be made to produce a cider approximating 4 per cent of alcohol, but it will be rare indeed that this result will actually be reached in practice. Hence it appears that a must reading at that figure is about the minimum in quality which can be properly employed for cider without fortifying, and this grade should be used only to prepare a cider for local consumption. This is not because a high percentage of alcohol is so desirable, but because it is not desirable to push the fermentation of a cider to the limit where there is no saccharine substance left for the yeast to subsist upon, that is, until the liquor is absolutely "dry."

If the cider is properly handled, the yeast will not entirely cease to be active for several years after bottling. This activity is of the greatest value in preserving the bouquet of the cider and keeping it sound. But if it is desired to produce a stronger cider from a low-grade must, reading approximately 1.040, one can add about 3 ounces of crystallized sugar per gallon for each 1 per cent of alcohol desired in addition to the normal quantity resulting from fermenting the natural must. This, however, denaturalizes the cider, and should not be resorted to in excess of 1 per cent increase of alcohol.

The French say the sugar should be inverted before using, but this seems doubtful, as the yeast will accomplish this itself, and probably the sugar will be consumed more slowly.

STERILIZING THE MUST BY HEAT.

This process is mentioned only to condemn it so far as cider making is concerned. Not a single maker worthy of credence in the factories visited abroad recommends or uses this method. It has been suggested as a means of controlling the initial fermentation, because, after sterilizing by heat, one can sow yeasts into the must as desired, and thus bring about a fermentation at will, but the cooked taste contributed to the must by heating is difficult if not impossible to overcome. Heating or pasteurizing to check fermentation or insure keeping of cider is also just as faulty, and is never necessary in a properly managed cellar, unless one desires to preserve a partially fermented cider. For this purpose pasteurization at 60 to 70° C. is practicable with goods which have sufficiently fermented in bottles to become sparkling.

THE USE OF SPECIAL YEASTS.

Having brought the fresh must into the casks or vats for fermentation, the modern cider maker has to consider not only the temperature of the must and of the room and the various other conditions already discussed, but also another question of very great importance: Shall the fermentation be left to the organisms normally present on the fruit and those which may at the time of grinding and pressing enter the must from contact with the air, the machinery, and the vessels? Every cider maker knows that under proper temperature conditions fermentation will quickly ensue after the juice has been placed in a receptacle. But the operator untrained in the scientific phases of this subject may not know how readily numerous undesirable organisms gain access to the fruit juice. These objectionable organisms are sure to be present upon the fruit, and especially so if unclean and unsound fruit is used. Or they may be present in parts of the machinery, especially if any parts have been left uncleaned after previous usage; and, what is perhaps still more important, these organisms may be present in great number in unclean barrels, casks, or other vessels.

The numerous organisms (microscopic plants), both useful and harmful, which grow readily in fruit must can not be discussed here. Suffice it to say that the quality of the resultant product *depends upon whether desirable or undesirable organisms gain the mastery in the must during initial fermentation.*

In order to insure the ascendency of the true yeasts in the early stages, and thus give them the control of the entire process of fermentation, there has recently been developed the practice of sowing the must with pure cultures of yeasts. Very often now special races of yeasts are used in order to secure certain desired qualities of bouquet, etc., in the finished product. This practice is based upon the same principles as those which induce the good housewife to employ a proper yeast culture to make bread for the table.

The discussion of this question in its various phases will not be undertaken here, but it should be noted that the practice of using pure and special cultures of yeast is becoming more and more common in foreign countries. In Germany practically all the important factories visited employ these cultures, which are obtained in small flasks from the Royal Pomological School at Geisenheim. The French makers are not at all unanimous in regard to the importance of using pure yeasts, and, from the observations made, it appears that very few use them intelligently. This is probably one of the important reasons why French ciders lack that standard character so observable in German ciders.

Below is given a free translation of the directions for using pure yeast cultures sent out by Dr. Wortmann from Geisenheim to all purchasers of the same:

DIRECTIONS FOR THE EMPLOYMENT OF PURE YEASTS IN THE FERMENTATION OF MUST.

The flask containing the pure yeast should not be opened until just before using. Until then, in case it can not be used immediately, it should be kept standing in a cool, dry place (preferably an ice chest); but it will not serve as a good starter if left longer than two weeks, because the organisms decrease in vitality with time.

Some days before the beginning of the real vintage, prepare about 10 gallons of freshly pressed must and boil it about five minutes (but not in a copper vessel), then put this boiled must into a wooden vessel, preferably a keg, while it is yet hot, and, after covering it with a clean linen cloth, let it cool off again to room temperature (about 20° C. or 68° F.). Just as soon as cool enough, the contents of the flask of yeast should be poured into the must.

During transportation a fresh-growing culture will have developed a strong pressure, and, therefore, in opening the flask the yeast may be partly lost through discharge caused by the gas. To obviate this, first bore through the stopper with a corkscrew, and let the flask stand some minutes until the carbon dioxid gas escapes, when there will be no danger. Open the flask in such a way that it is held with the mouth inclined over the vessel containing the cooled must. The flask should be rinsed out once with must; the keg or vessel should then be well covered and kept at room temperature, free from dust, until the must shows violent fermentation, which will be in two or three days.

The use of this 10 gallons of pure yeast culture will now be according to the quantity of must which is to be fermented. With ordinary must—that is, must reading 1.050 to 1.060 specific gravity—1 gallon of the fermenting must is sufficient for from 250 to 300 gallons of fresh must, and will bring it into fermentation promptly. With larger quantities of must, one should take a proportionally larger quantity of the fermenting culture first made.

For large establishments, a culture of 50 or 100 gallons can be first made by boiling the necessary must, putting it while hot into a perfectly clean but unsulphured barrel or cask. Sow as soon as cool with the yeast culture and handle just as directed above.

This large culture of must fermenting with the pure yeast can serve as a supply from which the necessary quantity for starting the vats can be taken as needed, but fresh must should be boiled, cooled, and added to it as often as any of the culture is removed for use.

In this manner one can draw from this supply according to his needs. So long as the fermentation is kept very active and the bung or opening well guarded, the culture will remain pure enough for practical purposes.

As the pure yeast is only efficacious if it comes in contact with fresh must, so one can, in case the pulp is allowed to ferment before pressing, by the prompt addition of the yeast to the pulp as ground, control the fermentation in the same. But in this case the addition of the pure yeast in the proportional quantities must be made to the pulp as ground. This operation is especially necessary in the preparation of red wine.

As by the addition of pure yeast fermentation starts up sooner, and also runs its course more quickly, the temperature of the fermenting rooms must not be too high, or else too violent a fermentation will be induced. It is sufficient to warm the fermenting rooms or cellars to about 55° to 60° F. Also it is best to leave plenty of space in the casks for foam and vegetable matter thrown up by fermentation.

With pure yeast cider will be finished earlier and clear itself sooner than when fermented without the addition of pure yeast; therefore, with this method cider must be racked off earlier than in case of spontaneous fermentation.

OBSERVATION AND CONTROL OF FERMENTATION.

The theoretic discussion of the physical phenomena involved in this process is not to be attempted here, and the brief discussion given is only warranted in such a report as this for the sake of rendering comprehensible the operations and details described.

DEFINITION AND DESCRIPTION OF FERMENTATION.[a]

There was a time when this word was used to indicate the entire range of chemical changes which might occur in organic substances. To-day, with more exact knowledge on the subject, fermentation is limited to those changes which are induced by the growth of microscopic plants in organic substances. In the case of fruit juices, these organisms are bacteria and the true fungi, principally the latter. The fungous organisms considered belong to the group known as the Saccharomyces, or yeast fungi, to other closely related nonmycelial forms, and to the Mucorini and some few other true mycelial forms.

Fermentation as relates to the physical phenomena involved may be defined as the breaking up of organic substance in solution as a result of the chemical activities of certain substances secreted during the growth of these microscopic plants; and alcoholic fermentation, as the result of the breaking up of sugars into alcohol and carbonic acid, caused by the action of zymase, a ferment secreted during the growth of the yeast plants. Incidentally, sugar may be broken up into alcohol and carbon dioxid by a few other fungous forms. The yeasts, or Saccharomyces proper, are, however, the true alcoholic ferments. Other forms need be only incidentally considered. The normal substratum, or place of growth of the yeasts proper, is the sugar solutions contained in the juices of fruits, or sugary compounds, in whatever parts of various plants they may occur. As a result of the growth of these yeast fungi, alcohol and carbon dioxid are formed. The first remains in the liquid and the second largely escapes as a gas. Theoretically, about 51.11 parts of alcohol will be formed and about 48.89 parts carbon dioxid. Or we may say in general terms that the alcohol formed by properly controlled fermentation will practically equal one-half the sugar destroyed. The yeasts are said to consume a small percentage of the alcohol.

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[a] Adapted from a paper presented by the writer before the American Pomological Society, September, 1901.

The following is quoted from Dr. Cluss:[a]

Under fermentation in its widest sense we understand every change in a substance that is brought about, either directly or indirectly, by the activity of low plant forms. Under fermentation in a narrower sense, or alcoholic fermentation, we understand every change in a substance by which certain kinds of sugar are decomposed through the activity of germs, so that, as the principal products of this decomposition, alcohol and carbonic-acid gas appear.

In alcohol fermentation, as in every form of fermentation, we must consider three principal factors:

(1) The fermentation material, or the substance which is to be decomposed.

(2) The fermentation products; that is, those bodies that arise from the decomposition of the sugars.

(3) The controlling organisms of the fermentation; i. e., those plant forms which cause the decomposition.

The fermentation material for alcoholic fermentation is provided by certain kinds of sugar, but not all kinds of sugar are capable of being fermented. Among those that can be fermented are grape sugar, fruit sugar, malt sugar, and cane sugar. But while in the brew mash and in the wort of the breweries malt sugar predominates, in fruit juice grape sugar and fruit sugar play the principal rôle as fermentation material.

The principal products of alcoholic fermentation are ethyl alcohol (badly named alcohol) and carbon dioxid (CO_2); but there are also small quantities of sulphuric acid, glycerin, and other by-products, among these being certain aromatic substances of great importance in wine fermentation. If the sugar were separated evenly into alcohol and carbon dioxid, then out of 100 parts of grape sugar there would arise 51.11 parts of the former and 48.89 parts of the latter. But only about 94 or 95 per cent of the sugar is consumed in the pure alcoholic fermentation, and the remaining part serves for the building up of these minor products and for the nourishment of the yeast germs. Thus it must be concluded, according to Pasteur, that out of 100 parts of grape sugar arise 48.5 parts alcohol, 46.6 parts carbonic acid, 3.3 parts glycerin, and 0.6 part sulphuric acid, while about 1 per cent of the original sugar is used for the building up of the yeast cells.

We have the yeasts in the widest sense of the word—that is, the different kinds of fungi, as the sprouting fungi, mold fungi, and splitting fungi, which may form alcohol; but above all the rest the sprouting fungi, as the yeast in a narrower sense of the word, play the most important role.

While the stages of fermentation as they should normally occur in the casks or vats will now be dealt with, it should be noted that there is always a possibility that mal-organisms may at any time gain control of the must and produce results very different from those desired. These accidents of the fermentation room are due to some of the fungous plants and bacteria which are constantly associated with the true alcoholic ferments under all ordinary conditions.

FIRST OR TUMULTUOUS FERMENTATION.

Given the proper temperature conditions, apple must at once takes on a very active fermentation, which has been variously denominated as "tumultuous," "stormy," etc. The activity is greater in weak, acid juice than in rich must of good quality. Its progress is marked

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[a] Free translation from Dr. A. Cluss, "Apfelweinbereitung," pp. 63–64, 1901.

by the very rapid increase of the yeast plants, as a result of which a sort of boiling of the liquid is produced, much carbonic acid gas is liberated, and the minute bubbles of this gas rise through the liquid and escape with a hissing sound, often alluded to as the "singing of the cider." This development of the yeast is likely to be altogether too tumultuous if the temperature is high; hence the importance of regulating the temperature. If the characteristic fermentation supervenes within twenty-four to forty-eight hours, it is a sign that proper progress is being made. The liquid at once becomes turbid and much disturbed, and small particles of vegetable matter rise to the surface, accompanied by more or less viscid mucilaginous material, all of which is really borne upward by the escaping gas. At first this surface material is light and frothy, but should assume more and more the character of a well-defined crust or covering, the "chapeau" so often mentioned by the French. This, however, is not considered important by some. The English makers seem to be pleased if the head forms well in their "keeves," because they can then skim it off and be rid of so much of the lees, but if it does not form they make no effort to secure its formation. On the other hand, the French maker, if the head or "chapeau" does not form, at once concludes that his must is sick, and takes steps to set it right. It may be that unfavorable temperature is the sole trouble, or at other times there really is a lack of proper yeast organisms in the must.

No one appears to explain this matter of the formation of top lees or "head" on the basis of observed facts, nor does it appear that any sufficiently critical chemical study has been made of the subject. From all the observations made this seems to be a very important feature of the first fermentation, and it should be thoroughly studied. Some of the remedies proposed by the manufacturers for application in case the head does not form properly, appear not to deserve serious consideration, namely, the addition of small quantities of ashes boiled in cider, or of clay. The only result of such substances would be to neutralize the acids, which, as a rule, would prove quite injurious to the growth of the yeasts. In fact, the writer has fully proven that neutralizing the acids checks the normal fermentation very decidedly. It is also proposed by some makers to add a portion of the head from a properly fermenting cask; and this has some element of sound sense in it, because one would thus sow the must with vigorous yeasts, but he would also sow it with many other organisms, probably some undesirable ones.

The German makers care little or nothing about the formation of the head or top lees, for reasons already explained, but they watch carefully to see that the must comes into strong fermentation, and if this does not occur at the proper time they sow strong yeast cultures into the must, correct the temperature if necessary, and, as a yeast stimulant, they sometimes use ammonium chlorid. Whether this is used to any extent in the factories was not ascertained, but it is used in critical work. The quantity used may vary, but ought to range between one-half and 1 gram per liter (2 to 4 grams to the gallon).

Under proper conditions the tumultuous fermentation subsides in ten days to two weeks. The time required may be even longer, but it should not exceed three weeks. The English makers in general seemed not to have a very definite idea of the duration of this period. In fact, their practice of skimming the head tends to defeat the completion of this first stage, and constantly agitates the liquor and sets up secondary fermentation, so that the cider does not clear itself of lees, and become limpid. The German cares not a fig about this, and permits the head to fall back through the liquor to the bottom. He is thoroughly logical and practical in what he does, but he makes a different product from English, French, or American cider. After a careful study of all the points involved, the writer has adopted the French views about observing the formation of the head and the subsequent treatment of the cider.

The close of the first period of fermentation is marked by the practical cessation of the escape of gas; the cider ceases to "sing;" the head, if fermentation has been normal, loses its frothy character, becoming brownish, and it may crack in places; the larger lees, which were not upborne by the gas, and the yeast cells subside and rest at the bottom of the cask, and suddenly the cider becomes limpid and a clear beautiful amber in color. The taste has improved and is somewhat piquant, but the liquor is yet sweet and very fruity in flavor. The specific gravity will have fallen 20 or 30 points, the alcohol test will show 2 to 2.5 per cent, and to many palates the cider is in fine condition for drinking.

To determine the condition of fermenting cider accurately is the work of experience, and as an aid in examining the juice the spigot previously mentioned becomes important. From this a small amount of the cider can be drawn in a glass vessel as the indications point to quiescence, and by carefully observing its freeness from lees, the color, absence of effervescence, specific gravity, etc., one may judge its condition accurately and determine when it is ready to rack off. This is the moment to draw the cider from between the lees. A few days' delay, or any disturbance of the cask, may throw down the head, and thus the liquor at once becomes troubled and the after fermentation sets in. If this happens, recourse must be had to the filter, or the German method, described hereafter, must be followed.

If the first fermentation is well accomplished, one is now on the high road to success, but the after operations are so critical that only an expert may properly weigh them.

RACKING OFF.

The drawing of the limpid cider from between the top and bottom lees is, to the Frenchman, the critical operation of cider making. Its correct attainment has a value easily realized by one who has gone through the troubles incident to the use of filters. If the vessel used for first fermentation is properly furnished with a spigot, the cider may be drawn into wooden vessels and poured through a wooden funnel into a properly prepared cask near by. This is very commonly the practice among the small French farmers. Or it may be drawn into a larger wooden vessel and pumped to the cask prepared for it in the adjoining room or building for further fermentation. This is a very common practice in factories in France and England.

In case the casks are unprovided with spigots, one must siphon the liquor out or draw it off with a pump. Both of these methods are objectionable, because one must in either case insert a hose at the bung through the top lees, which operation more or less disturbs the cider, and, if the cider runs directly into the cask provided for second fermentation, it is impossible to observe the character of the liquor as it passes, and therefore difficult to rack it off properly. The sole object of racking off is to free the liquor from lees and the superabundance of yeast cells so that the secondary fermentation may progress quietly. If a portion of the lees and the deposited yeast is carried over, the operation has resulted in little good and a second more or less violent fermenation may supervene. In fact, this second fermentation may be very dangerous if albuminous substances have been carried over or if one allows the lees to enter the cask into which the cider is drawn.

AVOIDANCE OF CONTACT WITH AIR.

An important precaution mentioned by several well-posted makers, but which was scarcely observed at all, was that, in racking off, the cider ought not to come in contact with the air any more than can possibly be avoided. The reason for this is that the liquor at this stage is saturated with carbonic acid gas, which is the greatest safeguard against the growth of mal-organisms; hence, if it can be drawn directly into the receptacle provided for second fermentation without loss of the gas or direct contact with the air, much has been gained in regard to the safety of the further processes. This can be readily accomplished wherever the factory is constructed so that the fermentation room is over the finishing or final storeroom. When one is ready to rack off, a hose connection should be made with the spigot, or by siphon if casks are not provided with spigots, and the hose should run directly into the receptacle in the room below. If this is done it will be necessary to introduce near the spigot or siphon a section of glass tube, so that the operator may constantly observe the character of the liquor as it passes, and at once cut off the flow if undesirable particles are passing. In siphoning, a perfectly clean hose should be carried almost to the bottom of the receptacle, so the cider shall not fall or be agitated in any manner. It is an excellent plan to fill the clean vessel with carbon dioxid gas before racking into it, and then the cider will not have an opportunity to absorb oxygen in the least.

Racking off by the method here described, viz. drawing the cider from between the two lees, requires the most careful observation and control. (It should be said here that we do not yet know whether a head will always form on must from our ordinary American apples. The experiments made by the writer thus far are not conclusive, and a chemical and biological study of the subject is yet to be made.) Working by this method it is possible that one will find more refuse or residuum remaining from each cask than he cares to lose, but this possible loss does not compare with the loss occasioned by the labor and difficulties encountered in the use of filters, though these may appear to use the stock a little more closely.

If the fermentation casks are properly fitted, the cider is drawn down until the top lees and bottom lees practically meet. This is determined by observing when the particles begin to pass from the spigot or siphon. One can draw quite closely by putting the last few gallons into a vessel for subsidence to take place before adding to the clear liquor. The lees should be removed at once from the casks, and instead of being thrown away they may all be put together in a vat to undergo further fermentation with a view to the production of vinegar. This material should not, however, remain in or adjacent to the rooms where the cider is processed. The large fermentation casks should all be provided with manholes so situated that the lees can be quickly removed, and the vessel cleansed when it is at once ready to receive fresh must again.

If one does not follow the plan of separating the liquor from the lees as above given, there are only two alternatives, viz, the German method of inclusive fermentation or the use of the filter, largely resorted to by English makers, and to some extent by French. The latter is a very troublesome and laborious process.

SECOND FERMENTATION.

Having delivered the liquor in a fairly bright limpid condition into the casks in the room designed for second fermentation, which is usually also the storeroom for the finished product, a few precautions should be observed:

1. The vessels should be filled full and carefully bunged to exclude air and all manner of germs, so that the second or after fermentation may still be wholly controlled by the yeast colonies carried over in the liquor racked off. There will always be sufficient of these floating in

the liquor at this stage to control the fermentation if the liquor has been properly guarded from contamination.

2. In bunging the vessels tightly, provision must still be made for the escape of gas due to fermentation. There may for a few days be a fairly active fermentation, especially if the liquor was much exposed to the air, but this will soon subside under proper conditions. One of the special funnels or air-control devices previously described may be used, and will assist very much in warning the cellar man of what is going on in the casks. A small apparatus such as the glycerin funnel (fig. 17) will answer very well for this period of slow fermentation, but the crockery funnel (fig. 16) renders sampling the cider much easier.

3. The temperature of the room must be watched and controlled, and from this rule there is no exception if a sound product of fine quality is desired. Invariably the temperature should be lower during the secondary fermentation than during the first period. A temperature of 8° to 10° C. (40° to 50° F.), as shown by the observations made in France and Germany, appears to be the most desirable for this period. It requires a good cellar indeed to reach the minimum here mentioned, but 45° F. can be reached, and at this temperature the yeasts work properly, and many disturbing organisms, as, for example, the vinegar ferment *Bacterium aceti*, are quite reduced to dormancy. If the temperature can be gradually reduced to 40° F. as the cider reaches maturity, its safety from mal-fermentation is thereby well insured, because the organisms concerned in diseases of cider do not thrive well at this low temperature.

SECOND RACKING OFF.

If the must has fermented in an orderly manner and been drawn off as outlined above, no second racking is required until the fermentation is practically completed. But if a troubled fermentation follows the first racking off, then the cider must be very carefully watched and the temperature kept from rising above the limits mentioned. It will be well to use under these circumstances some means of "fining" or clarifying the cider so as to produce entire subsidence of the particles held in suspension in order that a second racking off may occur as soon as possible. The cider must be freed from the lees and as far as possible from albuminous matters, or it can not progress properly to the completion of its period of fermentation.

Much prejudice exists abroad against the use of animal substances, as gelatin, white of egg, and the like, for fining cider. The French use quite freely preparations of the bark of certain species of oak. But as the active principle in these is the tannin, it would seem better to use the commercial tannin itself. Our American fruit is so weak in tannin that the addition of this substance will doubtless be found advantageous, as it appears to steady the tendency to too rapid fermentation and total destruction of the sugar; and, best of all, it helps to coagulate the albuminous matters, and thus to precipitate them, carrying down at the same time other matter held in suspension.

The dose of tannin should be about one-half a gram per gallon according to French standards, but our fruit may require more for the best results. This may very properly be added as soon as the must is run into the vessels for the first fermentation, but it is mentioned here especially as a remedy when a second troubled fermentation sets in. Stir the amount of tannin needed for a cask into a small quantity of cider and then add to the cask, and agitate by inserting a clean strip of wood and stirring the cider thoroughly. After treating a cask in this manner watch it carefully and rack off just as soon as the cider becomes limpid. The cider will, during this period of disturbance, have fallen in specific gravity. This should be carefully noted, and the liquor should be transferred as quickly and quietly as possibly into a cask suitable for the still fermentation.

The second racking off, when it occurs in normal process of fermentation, is usually accomplished from three to five months after the first, and the liquor should then have cleared out bright and fine, with beautiful color, and have begun to form the bouquet of finished cider. The specific gravity will vary from 1.001 to 1.003, and the cider is now ready to go into the casks designed for transportation or into bottles. The English bottle at much higher specific gravity, but this would undoubtedly be a wrong practice in our climate. The racking into these final receptacles should be accomplished with the utmost care to guard the liquor from contamination, and, if possible, the work should be done in cool, bright weather with high barometer, because climatic conditions affect the stillness of the liquor in the casks.

When ready the cider can be put in barrels or casks to suit the needs of the trade, but these must be cleaned in the most careful manner; and, in order to secure the cider from the effect of air, the outer surface of the casks should be carefully scraped to expose the fresh grain of the wood and then treated to a coat of hot tallow. This, if well applied, will render them quite impervious to air, and thus practically seal up the cider. The modern paraffin-coated barrels would answer well for this purpose. The utmost care should be observed to use perfect bungs. There must be no seepage, and cloths must not be used around the bungs, for these will be constantly moist, and thus furnish a direct conduit for vinegar germs to enter the cider. The bungs may be very properly dipped in boiling tallow or paraffin before use.

If the cider is bottled, this should be accomplished with the utmost care, taking pains to conserve the carbon dioxid in the cider, and not to permit it to come in contact with the air. The corks used should be the best champagne corks and may be dipped in 50 per cent alcohol just as used. This will free them of germs. They should be inserted with a regular corking machine. The bottles should be left standing upright for a few days until the liquor is quiet, and may then be laid on the side.

LAGER FERMENTATION.

Whether in casks or bottles, the cider is now left in the storage room to ripen. This is called by the Germans "lager fermentation." The temperature should be kept as near 40° F. as possible, and the vessels (casks or bottles) should remain undisturbed. The cider will soon become sparkling, and in two to four months will be in condition for use.

If racked into these final receptacles at the density mentioned, the air being carefully excluded, the result will be a cider which will, in a measure, champagnize itself, and retain some sugar for a long time; but if left in casks with the wood pores open, the cider will eventually become quite "dry" (free from sugar), the gas will gradually be lost, and the product will be a still, hard cider. This sort of cider is little relished by most people, and unless preserved by some chemical reagent or charged with carbonic-acid gas at intervals, it will be turned to vinegar whenever temperature conditions favor the growth of the vinegar ferment.

GERMAN METHOD OF FERMENTATION.

As already stated, the German makers pay no attention to the formation of head or top lees, and make no effort to draw the cider from between the lees. Their cider is, therefore, different in character from English, French, or American cider. Their method of treating the must doubtless accounts, at least in part, for this difference.

The fresh must is run into the fermentation cask until it comes within about 12 inches of the bung, and then, if yeasts are used, these are sown at once, using about one part of the strong culture, heretofore mentioned, to 100 parts of must. A ventilating funnel is now fitted tightly into the bunghole, a 5 per cent solution of sulphuric acid being used in it to prevent the entrance of organisms from the air.

Fermentation progresses under the methods above discussed, but nothing is done to the liquor until it has fermented out nearly to dryness and becomes still. The top lees are permitted to fall back through the liquor and settle to the bottom along with the yeasts. When the liquor is quite still, some makers follow the practice of filling the cask to the bung with cider, so as to avoid having an air space, and then closing the bunghole sufficiently tight to prevent access of air. Bunging at this period is dangerous, unless a vent is provided for by means of a ventilating bung.

There seems to be little uniformity of practice among the Germans about racking off. Some racked as early as December, and then again about March, while others racked off three or four months after putting the must in casks, and then again the next autumn, if the liquor was not bright at first racking. Many makers filtered at first racking and put the cider down in casks to await bottling or preparation for transport in other vessels.

The writer invariably found the ordinary finished German ciders poor in color and flat in taste to the American palate. They partake of the character of very light still wines, devoid of the piquancy and astringent character ordinarily expected in ciders. This does not alter the statement heretofore made that German makers produce a standard article of rather more definite character than those produced in the other countries visited, and they champagnize their ciders in a quite perfect manner.

PRESERVING CIDER IN STORAGE.

In the German cellars great care is taken to sulphur and double sulphur the casks, especially as the cider is drawn from one to another in

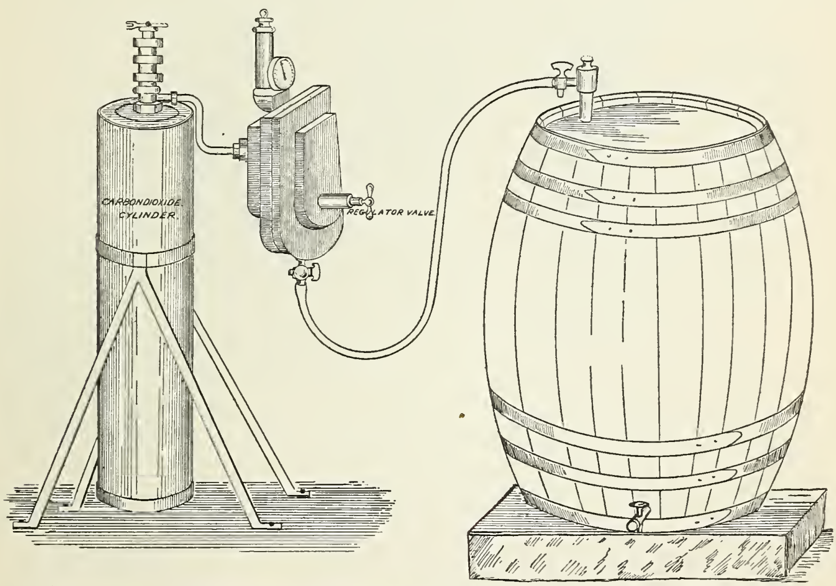

FIG. 20.—Device for maintaining covering layer of carbon dioxid as cider is withdrawn.

a nearly "dry" condition. They also resort largely to the employment of carbonic acid gas as a preservative. This is applied from cylinders of carbon dioxid either to barrels to fill up the vacant space as the cider is drawn (fig. 20), or to charge the cider in storage (fig. 21).

A cylinder of this kind may be attached to several casks at once so that the overflow of gas from the first goes to the second, and so on. As soon as the first cask is sufficiently charged, it is disconnected and tightly bunged, and the operation is continued by adding other casks to the circuit and dropping off those charged until the work is completed. The bungs used while charging with gas are double perforated, as shown, and glass tubes, with small rubber hose connections, are used to convey the gas from the cylinder to the casks. The device

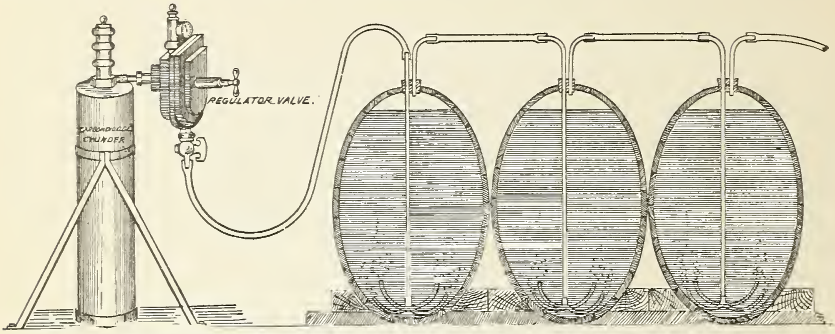

FIG. 21.—Devise for charging casks with carbon dioxid in storage cellar.

at the bottom is a 4-way rubber cross which admits of using four short distributing pipes in the liquor. As this joint is made with rubber connections, it is perfectly flexible and can easily be inserted and removed from the casks.

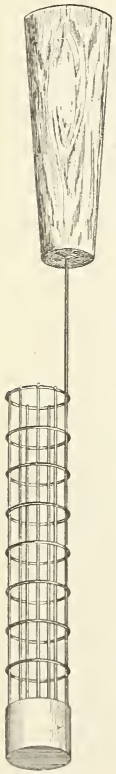

FIG. 22.—Device for burning sulphur match in casks.

The device shown in figure 22 is used to sulphur the casks. This may be used when cleaning barrels to destroy fungous organisms, but it is chiefly used abroad to sulphur the casks just before running the liquor into them, both at first and second fermentation. Thorough sulphuring will largely destroy the vegetable organisms which may be present in the casks. If they are not afterwards rinsed carefully, too much sulphur may remain in the casks so that the after fermentation will be hindered and a taste of sulphur may even be contributed to the cider. Perfectly clean water should be used for rinsing. The sulphur match is placed in the cup, then lighted, and is lowered burning into the cask until the tapering bung closes the opening. It will burn until the oxygen is exhausted, when it should be removed. By this device none of the sulphur is permitted to fall into the cask.

FILTERING OR CLARIFYING THE CIDER.

The best English and French makers agree in the statement that filtering of ciders is a very laborious and unsatisfactory process, resulting usually in loss of quality to the product. The Germans, on the contrary, are more favorable to the filter. Filtering cider appears to be a process much more difficult, ordinarily, than filtering wine made from grapes, and should be avoided if possible. The reason for this is the presence of mucilaginous substances in the liquor. However, unless a cider can be racked quite free from the lees at the first racking, or at most a second racking, there is sure to be difficulty in securing a bright product unless the filter or some other method of clarifying is resorted to. The use of tannin to assist in clarifying ciders has already been mentioned.

Filters of various types are in common use in the different countries visited, some being very primitive, while others are the best up-to-date appliances seen.

The bag filter.—Of primitive filters, the most simple was a device in form much like the insect nets used by entomologists to catch butterflies (fig. 23). The cloth used was linen, of such a texture as to thoroughly strain the finest particles out of the cider. It is sometimes called forfar. These conical bags are about a foot in diameter at the

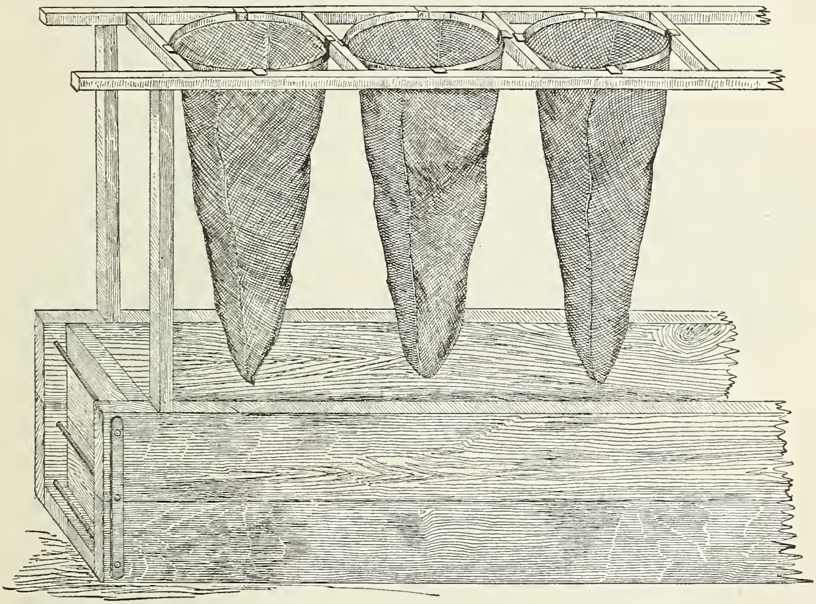

Fig. 23.—Linen sack gravity filter.

larger end and taper to a point, the length being about 18 to 36 inches. They were used in considerable numbers, supported on a rack over a vat, as indicated. The flow through these bags is slow, and the cider is so much exposed to the air that if there is any tendency to mal-fermentation this process must surely increase the trouble. The cloths need frequent washing to clear them of lees, but should not be treated with hot water. This device was in use in both small and large factories in England, sometimes with fresh must, but usually when racking the first time. It is not commended for use in America.

Tub filter.—The best simple device seen was a large tub or vat with a finely perforated false bottom, supported several inches above the true bottom, the space between being packed with wood pulp which served to strain or filter the cider almost perfectly. This was observed in an English factory where the must was fermented in open "keeves," the head being skimmed off until active fermentation had subsided, and the product being then run through this filter and put into casks for ripening. This apparatus does good work, but the cider is much exposed to the air.

The cellulose power filter.—Some of the English makers have come to use the German filter shown in figure 24. This is made by Otto Fromme at Frankfort, and is the best device observed. It is, however, costly, and a force pump is required to drive the liquid through the filter, or the liquid must be drawn from some height in order to give the necessary pressure. This is also a wood pulp or cellulose filter. The pulp is arranged between perforated disks, and the machine permits of dismounting and washing the parts and the pulp at will. In some English factories attempts were made to filter

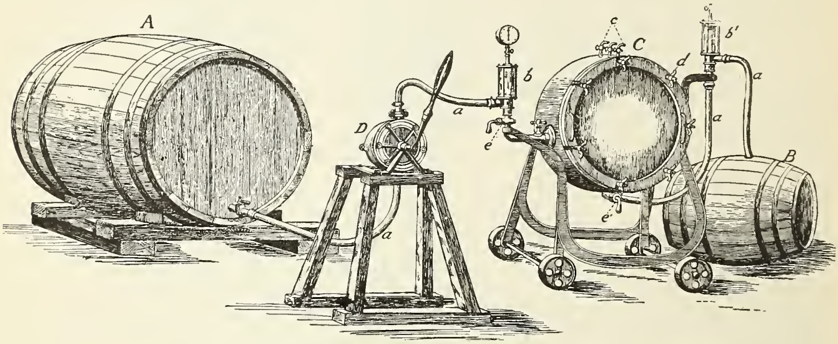

FIG. 24.—Cellulose power filter used in Germany.

the fresh juice with this machine, but this generally resulted in failure, and besides was very wearing on the apparatus. Fresh apple must is very difficult to filter because of the pectose or mucilaginous substances it contains. The use of any of the above filters does not appear to be practicable except when the must has been fairly well fermented, and has freed itself in this manner of a large part of the parenchymatous tissues and albuminous matters present therein.

Asbestos sack filter.—The French use a filter (fig. 25) which they claim will remove all insoluble matters from the fresh must, and leave it clear and limpid as it goes into the cask. No demonstration of this was seen, but this filter (Filtre Maignen) is much used in France, and appears to be a good, cheap filter. It is made from asbestos. A fairly closely woven asbestos sack, 10 or 12 inches in diameter and of any desired length, is tied tightly at one end; then in the bottom of this is placed an openwork disk, and a string is tied above the same so as to nearly draw the sides of the sack together; above this is placed a second disk; and so on until the filter sack is filled. The open end of the sack is then tied tightly around a metal fitting which connects with a rubber pipe, and to this pipe a pump is attached. The filter is placed in the tub or vat as shown (fig. 25), and the suction of the pump draws the must through the parts of the asbestos sack and disks, largely freeing the same from floating particles of whatever nature. In some styles of this device a second asbestos sack of coarser weave is drawn over this accordion-like device, and serves to still further assist in straining the liquor. Possibly when the cider is drawn into an open tub at racking off, and this filter is carefully used, the liquor can be filtered bright.

This style of filter is readily cleansed, it only being necessary to untie the sack, remove the disks, and wash all the pieces carefully. Salt water, used warm, is said to accomplish this much better than fresh water. Filters of this pattern may be connected up in sets on

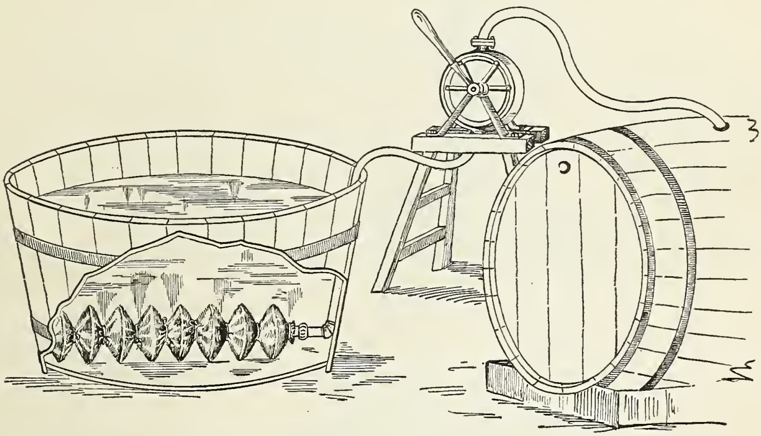

Fig. 25.—Asbestos sack filter—"Filtre maignen."

a main pipe, or on a central disk of metal, and the capacity may be thus greatly increased. It should be added that all metal parts of connections, pipes, pumps, etc., must be of brass, or other material which will not be attacked by acids.

German asbestos filter.—The Germans use chiefly but two filters, viz, the one made by Fromme (shown at figure 24) and another small affair (fig. 26). The latter is an asbestos filter, but works solely by gravity, as indicated. A self-regulating (*b*) valve governs the inflow at the top, hence it can be set to work on a cask and left to itself until the receptacle into which the filtrate runs is filled. This device is of small capacity, but does good work. The cylinder is packed with asbestos which can be removed, washed, and re-used.

Both of these German filters are constructed with the idea of protecting the cider from the air, as it is in nowise exposed by their use except when it is delivered into the cask. This is a point of much importance, especially among the Germans, as their cider is fermented nearly to dryness before filtering, and hence is less able to protect itself by the regeneration of abundant carbonic acid gas. For this reason the Germans advocate charging the casks with carbonic acid gas before running the cider into them.

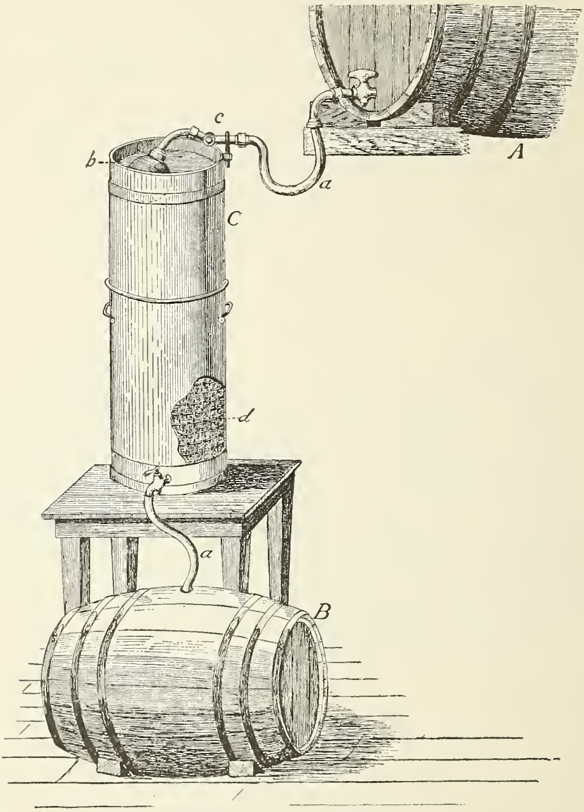

Fig. 26.—Asbestos gravity filter.

THE CHEMICAL COMPOSITION OF CIDER.

It will doubtless be clear to every one who has manufactured ciders, or followed the foregoing discussion, that it is not possible to fix upon a certain chemical composition and say this represents what should be considered a standard cider. Chemical analyses, however, reveal what it is exceedingly important to know, viz, the sugar, alcohol, and acid contents, with other data of possibly less importance. Without these data one is completely in the dark as to whether the product has been properly or improperly fermented, and no technical progress in the study of methods is possible. Chemical analyses rightly interpreted will also aid the consumer in distinguishing pure from sophisticated ciders.

The complete study of this subject is yet to be undertaken, but representative samples of ciders were collected by the writer in the different countries visited and forwarded to the Bureau of Chemistry, United States Department of Agriculture, for analysis. To these samples have been added a number of typical samples of American ciders collected during the year 1901. The analyses of these ciders, with explanatory remarks, are given in the tables which follow:

TABLE XIV.—*Composition of ciders: Analyses of French samples by Bureau of Chemistry, United States Department of Agriculture, 1901.*

Sample No.	Name or brand.	Specific gravity.	Per cent alcohol by volume.	Grams per 100 cc.						Source and remarks.
				Alcohol.	Total acids.	Volatile acids.	Reducing sugars.	Extract.	Ash.	
13	Cidre mousseux..	1.0040	6.30	5.00	0.3234	0.1824	0.4483	3.2948	0.2942	M. Gibout-Roux, Danestal, Calvados. Dry sparkling cider, 1 year old; not typical mousseux of France.
14	Cidre marchand..	1.0111	3.72	2.95	.4303	.2868	1.8970	4.0650	.1950	Same source. An ordinary cider in which first and second pressings have been united, 1 year old.
15	Boisson............	1.0101	2.81	2.23	.4263	.2952	1.5888	3.4692	.1838	Same source. Second and third pressings mixed, 1 year old.
40	Cidre mousseux..	1.0101	6.05	4.80	.4214	.2100	2.5100	4.9500	.2120	Paul Santier, Rouen. A typical French champagne cider, 1 year old.
41	Cidre marchand..	1.0004	6.45	5.12	.4214	.1910	.0900	2.5100	.2710	Same source. Standard pure juice, Normandy cider.
47	Cidre ordinaire ..	1.0061	5.00	3.97	.2725	.1070	1.4300	3.3800	.1930	A. Power, St. Ouen-de-Thouberville-Eure. Ordinary marchand cider, 4 months old.
48	Cidre supérieur...	.9998	5.90	4.68	.2882	.1240	.0990	2.0800	.1820	Same source. A fine grade of marchand cider, 4 months old.
	Averages...	1.0059	5.18	4.11	.3691	.1995	1.1519	3.3927	.2194	

TABLE XV.—*Composition of ciders: Analyses of German samples, Bureau of Chemistry, United States Department of Agriculture, 1901.*

Sample No.	Name or brand.	Specific gravity.	Per cent alcohol by volume.	Grams per 100 cc. Alcohol.	Total acids.	Volatile acids.	Reducing sugars.	Extract.	Ash.	Source and remarks.
1	Common apfel wein.	1.0023	5.93	4.71	0.2954	0.0864	0.1286	2.2140	0.2636	C. A. Smith, Schierstein. Dry cider, 1 year old.
2	Speierling apfel wein.	1.0002	7.15	5.68	.2867	.0696	.1272	2.3186	.2539	Same source. Said to be made from Speierling and apple.
3	Common apfel wein.	1.0032	4.94	3.92	.4018	.0552	.1234	2.4110	.2812	Friedrich Groll, Weisbaden. Low grade dry cider, 1 year old.
4	.....do	1.0027	5.83	4.63	.3553	.0108	.3062	2.7722	.2305	Heinrich Merten, Erbenheim. Standard dry cider, new made.
5	.....do	1.0003	5.97	4.74	.3224	.0564	.0211	2.2142	.2834	Fritz Batz, Neuenhain. Standard dry cider, 1 year old.
6	Export apfel wein	.9997	6.30	5.00	.2254	.0360	.0435	2.2333	.2544	Same source. Export special stock, 1 year old.
7	Schaume apfel wein.	1.0221	10.67	8.47	.3773	.1068	7.9104	9.2274	.2106	Same source. Champagne cider, heavily sugared, 1 year old.
9	Export apfel wein	.9997	5.70	4.52	.2254	.0576	.0524	2.0201	.2236	Gebrüder Freyeisen, Frankfort. Select dry cider, 1 year old.
10	Speierling apfel wein.	1.0004	5.85	4.64	.2631	.0396	.0187	1.9158	.2352	Same source. Dry cider from *Sorbus domestica* and apples, 1 year old.
11	Borsdorfer apfel wein.	1.0000	5.81	4.61	.2548	.0360	.1221	1.9438	.2346	Same source. From German Borsdorfer apple, 1 year old.
12	Champagner apfel wein.	1.0178	8.03	6.37	.2573	.0420	5.6544	7.3464	.1842	Same source. A sugared champagne cider, 1 year old.
	Averages...	1.0044	6.56	5.21	.2968	.0597	1.3189	3.3288	.2414	

TABLE XVI.—*Composition of ciders: Analyses of English samples by Bureau of Chemistry, U. S. Department of Agriculture, 1901.*

Sample No.	Name or brand.	Specific gravity.	Per cent alcohol by volume.	Grams per 100 cc. Alcohol.	Total acids.	Volatile acids.	Reducing sugar.	Extract.	Ash.	Source and remarks. [Nos. 22 to 31 from Bath and West Show, 1900; Nos. 55 to 61 from Bath and West Show, 1901.]
22	Devonshire cider, first prize.	1.0222	4.16	3.30	0.2548	0.0672	4.7414	7.2136	0.2420	Rated by official chemist of Bath and West Society above 4 per cent alcohol.
23	Devonshire small cider, second prize.	1.02[illegible]	3.14	2.50	.3822	.1356	5.1895	7.6544	.3080	Rated below 4 per cent alcohol.
24	Devonshire small cider, first prize.	1.0312	2.76	2.19	.3283	.0588	6.5366	9.2004	.2500	Do.
25	Herefordshire small cider, second prize.	1.0304	1.72	1.37	.2377	.0840	6.1282	8.5132	.2852	Do.
26	Herefordshire cider, first prize.	1.0325	2.75	2.18	.2989	.0780	6.3584	9.3126	.2708	Rated above 4 per cent alcohol. Champion prize cider, 1900, Bath and West Show.
27	Somersetshire cider, second prize.	1.0266	3.85	3.06	.2107	.0504	5.2148	8.1472	.3152	Rated above 4 per cent alcohol.

TABLE XVI.—*Composition of ciders: Analyses of English samples by Bureau of Chemistry, U. S. Department of Agriculture, 1901*—Continued.

Sample No.	Name or brand.	Specific gravity.	Per cent alcohol by volume.	Grams per 100 cc. Alcohol.	Total acids.	Volatile acids.	Reducing sugar.	Extract.	Ash.	Source and remarks. [Nos. 22 to 31 from Bath and West Show, 1900; Nos. 55 to 61 from Bath and West Show, 1901.]
28	Somersetshire cider, first prize.	1.0307	4.25	3.38	.3185	.1116	5.7760	9.9912	.3886	Do.
29	Somersetshire small cider, first prize.	1.0371	2.86	2.27	.2597	.0768	7.4659	10.8164	.3116	Rated below 4 per cent alcohol.
30	Somersetshire small cider, second prize.	1.0220	3.37	2.68	.2407	.0828	4.5548	6.9672	.3040	Do.
31	Somersetshire small cider, reserve.	1.0367	2.75	2.18	.3259	.0402	7.6946	10.5228	.2856	Do.
32	Standard still cider from cask.	.9997	6.83	5.47	.2818	.1020	.0325	2.1458	.2666	H. P. Bulmer & Co., Hereford. A very good dry cider, 1 year old.
33	Cherry Pearmain cider, sparkling.	1.0251	5.87	4.65	.2391	.0756	3.3121	5.9816	.2450	Same source. In grade is equal to best French mousseux or champagne cider; 1 year old.
34	Holmer Perry, sparkling.	1.0167	6.11	4.85	.2999	.1630	3.4064	6.4502	.2772	Same source. Very good champagne Perry, doubtless sugared, 1 year old.
35	Foxwhelp and Kingston Black cider.	1.0206	4.85	3.85	.2867	.0636	4.5392	6.9924	.2680	Same source. A special brand of sweet cider, 1 year old.
36	Standard sparkling cider.	1.0152	4.93	3.91	.5366	.3228	1.3488	6.0354	3.666	Toddington Orchard Co., Winchecombe, Gloucestershire. Nearly dry mousseux or champagne cider, very good, 3 years old.
37	Standard dry cider	1.0065	4.93	3.91	.3112	.0768	.9200	3.2532	.3146	Same source. Good still, dry cider, 2 years old.
38	Champagne Perry	1.0129	6.01	4.77	.3577	.1296	.8768	4.8166	.3928	Same source. Fine grade of champagne Perry, probably sugared, 2 years old.
39	Standard new cider.	1.0185	4.19	3.33	.3627	.1218	3.2416	6.0570	.3238	Same source. Newly bottled cider, would become sparkling.
55	Herefordshire small cider, second prize.	1.0292	3.15	2.50	.2568	.0610	5.5000	9.0200	.2230	Bath and West Show, 1901. Rated below 4 per cent alcohol.
56	Herefordshire small cider, reserve.	1.0304	1.60	1.27	.3567	.0640	4.4200	8.5500	.3050	Do.
57	Somersetshire cider, first prize.	1.0380	4.55	3.62	.3862	.0530	7.1300	12.1200	.3250	Rated above 4 per cent alcohol.
58	Somersetshire cider, second prize.	1.0244	3.80	3.02	.2823	.0950	3.5600	7.9800	.2580	Do.
59	Somersetshire cider, reserve.	1.0304	4.15	3.30	.3371	.0480	4.4000	9.3800	.3390	Do.
60	Somersetshire small cider, first prize.	1.0398	2.55	2.02	.4704	.0520	5.7800	11.4900	.1980	Rated below 4 per cent alcohol.
61	Somersetshire small cider, second prize.	1.0172	3.60	2.86	.2803	.0620	2.7700	6.1900	.2870	Do.
	Average....	1.0249	4.11	3.14	.3161	.0910	4.4375	7.7920	.2940	

Table XVII.—*Composition of ciders: Analyses of American samples by Bureau of Chemistry, U. S. Department of Agriculture, 1901.*

Sample No.	Name or brand.	Specific gravity.	Per cent alcohol by volume.	Grams per 100 cc.						Source and remarks.
				Alcohol.	Total acids.	Volatile acids.	Reducing sugar.	Extract.	Ash.	
49	Sparkling draft cider, extra dry.	1.0053	5.87	4.66	.2979	.0890	1.1500	3.3900	.2830	Genesee Fruit Co., Rochester, N. Y. A fair, slightly gaseous cider, 1 year old.
50	Sparkling draft cider.	1.0101	5.57	4.42	.3508	.1340	2.1100	4.6700	.2880	Same source. More sparkling than above; 1 year old.
51	Plain fermented cider.	.9987	7.83	6.22	.3626	.0860	.0000	2.3600	.2920	Same source. Perfectly dry, still cider, 1 year old.
52	Crab-apple cider	1.0178	5.51	4.37	.2372	.0490	3.3400	6.7000	.2770	Same source. A sparkling cider of mousseux or champagne grade, 1 year old.
53a	Paulding Pippin cider, 1900.	1.0289	2.16	1.71	.4567	.0250	5.9900	8.2300	.2410	H. Paulding, jr., Huntington, L. I., N. Y. A sweet mousseux cider, 1 year old.
53	Same, 1899	1.0292	3.92	3.12	......	.0220	5.1700	9.0300	.2830	Same source. Almost identical in character, but greater alcoholic strength; 2 years old.
	Average	1.0150	5.14	4.08	.3410	.0590	2.9600	5.7300	.2770	
	Sauternes[a]	1.0040	5.54	4.43	.3500	......	.9800	2.6000	......	Made with pure yeast culture by Professor Alwood. A fine dry champagne cider.
	Vallée d'Auge[a]	1.0030	6.51	5.20	.4800	......	.2000	2.2400	......	Made with pure yeast, as above. A very dry sparkling cider.

[a] Samples of cider made at Virginia Agricultural Experiment Station; analyses made by Professor Davidson.

Discussion of these tables is hardly necessary further than to call attention to salient facts relating to the specific gravity, alcohol, and sugar content. The French and German ciders are remarkably alike in regard to specific gravity and the indications are that these ciders are fermented practically dry. The analyses show this to be the case. There are two German samples—Nos. 7 and 12—with comparatively high specific gravity, and these show a considerable percentage of sugar still unfermented, in fact a very much larger percentage than is necessary to produce the desired result, namely, to champagnize the cider. The French cider, No. 40, is a champagne cider with a much smaller sugar content. It is a question of the taste of one's customers whether such highly sugared champagne ciders as these two German samples should be made. In the writer's opinion the French sample is better; and it has been definitely proved at Blacksburg that a fine gaseous or champagne cider can be made without the addition of sugar. The French samples are strikingly high in volatile acids, which would indicate the presence of acetic acid. The cellar methods may account for this.

The two analyses given at the bottom of the table of American samples are ciders made at the experiment station at Blacksburg, Va. Both were prepared from samples of the same must, handled side by side, until finished. Each was sown with a culture of pure yeast, the one a yeast isolated from a French Sauterne wine, the other from a Normandy cider of the Vallée d'Auge district. The first resulted in a fine cider of beautiful color, gaseous, and with flavor like champagne, the other in a very fine, dry cider, sparkling and gaseous. Sugaring ciders for champagnizing is a doubtful practice, and the best-posted makers abroad insist that the true future of cider making lies along the line of fully fermented dry ciders.

The analyses of English ciders show wide variations in their composition. The samples Nos. 22 to 31 and 55 to 61, inclusive, were taken at the Bath and West Show, the first set in 1900 and the second in 1901. Both sets of samples reveal similar characteristics—high specific gravity and in the main low alcohol and high sugar content. These are simply incompletely fermented ciders, either filtered as clear as possible of yeasts and held in highly sulphured casks, or treated with chemicals to check fermentation. Nos. 32 to 39 are samples taken at factories, as revealed by the notes, and are among the very best ciders collected, and show the possibilities of English cider fruits.

WORKS OF REFERENCE.

As mentioned previously in the discussion, the French literature on cider making is very voluminous, but it can not be said that it is all of great value. In fact there is an enormous literature on every phase of the subject, expressing every shade of opinion, so that one is at great loss what to commend. Consequently there is given in the subjoined list only a few references, and these are to those sources which were found to be most useful and reliable. The first work is now out of print and can rarely be found. The others are mostly easy to obtain.

Of the German literature it must be said that it is not abundant nor very rich in actual observations made on growing the fruit and making the cider, nor in technical investigations of a chemical nature or otherwise. The books presented in the list are mostly compilations by persons more or less familiar with the actual practice of cider or wine making.

The recent English literature is practically all found in the Journal of the Bath and West of England Society and the other two works named. There is an older English literature on the subject, which is practically inaccessible.

FRENCH WORKS.

L. de Boutteville et A. Hauchecorne. Le Cidre. A treatise based upon the papers and discussions delivered before the Cider Congresses held at Rouen 1864 to 1875. This is perhaps one of the most important papers in the French literature, comprising the most elaborate notes upon varieties and their chemical composition.

A. Truelle. Guide pratique des meilleurs fruits de pressoir, employés dans le pays d'Auge. L'enseignement de la pomiculture et de l'industrie cidrière en France

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et à l'étranger. (Congrès international pour l'étude des fruits de pressoir et de l'industrie du cidre, Paris, 1900, pp. 127–326.) (In this treatise the author gives the most elaborate bibliography extant of works in all languages on cider making and related subjects.)

Dr. Dennis-Dumont. Propriétés médicales et hygiéniques du cidre. Caen. Without date. (In this Dr. Dumont presents a considerable array of facts concerning the healthfulness of cider as a common beverage.)

Bulletin de l'Association pomologique de l'ouest. (This is the publication of a society organized in 1883 under above title, which continued up to 1897, during which time it published annual volumes containing many papers of value.)

Bulletin de l'Association française pomologique pour l'étude des fruits de pressoir et l'industrie du cidre. (This is the proceedings of a society organized in 1897, which continues to meet annually and publishes a journal containing papers by the best investigators, practitioners, and writers on this subject.)

G. Power. Traité de la culture du pommier et de la fabrication du cidre. Tome 1. Monographie des meilleures variétés de pommes à cidre. Tome II. (These two volumes constitute the best work on this subject in the French language, considered as a text-book.)

G. Jacquemin. Les fermentations rationnelles. (In this large work M. Jacquemin deals extensively with the employment of pure yeast in the manufacture of wines and ciders, and summarizes much of the best literature on the subject.)

L. Séguin et F. Pailheret. Études sur le cidre. (This work gives an account of the studies made by the authors on the manufacture of cider by diffusion, at the national school of agriculture at Rennes, France, and as an appendix, the most complete table of the analyses of cider fruits that the writer has yet seen.)

Bulletin du Ministère de l'Agriculture. (This publication is issued in serial numbers from the ministry and contains many important articles, among others all of Professor Kayser's work.)

Le Cidre. (A monthly review devoted to the industry of cider making.)

Le Cidre et le Poire. (A monthly review similar to the last named.)

GERMAN WORKS.

Dr. A. Graeger. Die Obstweinkunde, oder Bereitung aller Arten Wein aus Beeren Stein und Kernobst, als auch aus den Blüten, Blättern und Wurzeln einiger Pflanzen.

Johannes Böttner. Die Obstweinbereitung. Anleitung zum Keltern des Apfelweins und der andern Obst, etc. Sechste Auflage.

Prof. Dr. Behrend. Untersuchung von in Württemberg produzirten Obstweinen. (Mittheilungen aus Hohenheim.) Obstweine aus reinen Obst-Arten, ausgestellt von dem Technologischen Institut der Königlichen württembergischen landwirthschaftlichen Akademie in Hohenheim, etc.

Prof. Dr. Julius Wortmann. Anwendung und Wirkung reiner Hefen in der Weinbereitung. (Studies from the Laboratory of Plant Physiology, Geisenheim.)

Dr. Adolf Cluss. Die Apfelweinbereitung. (A general treatise on cider making, written in a plain style.)

Antonio dal Piaz. Die Obstweinbereitung nebst Obst- und Beerenwein-Brennerei. (A compilation.)

ENGLISH WORKS.

R. Hogg and H. Graves Bull. The Apple and Pear as Vintage Fruits. (The best recent English work, which treats both of cider fruits and cider making.)

Journal of the Bath and West of England Society, established 1777, and Southern Counties Association. Vol. IV, 1894, and subsequent numbers.

Cooke, C. W. Radcliffe. Lecture on Cider before the Society of Arts. A Book about Cider and Perry. (A plain, practical treatise by a country gentleman who makes good cider.)

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