BRANDY

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Brandy has more sources than any other class of distilled spirits made in the United States and may be divided into two classes, grape brandy and fruit brandy. American grape brandy is produced from grape wine and is distilled mostly in continuous stills. It is almost always artificially colored with caramel and aged generally in new plain white oak barrels. Fruit brandy is made more often from apples, but includes the distillate from many other fruits and berries. Fruit brandy is usually made in other states than California, which produces practically all the grape brandy of the United States. Fruit brandy is generally distilled in pot stills at a lower proof than grape brandy and is aged principally in charred barrels from which it obtains its color.

As far as can be determined there is a small amount of methanol in all authentic brandy; grape brandy contains an average of less than 0.05 per cent and fruit brandy, an average of about 0.1 per cent. Fruit brandy ages and develops congenerics and extracts color and solids at about the same rate as whisky and rum in the same sort of package. Grape brandy in the plain packages changes more slowly and more gradually.

French Cognac brandy is in a class of its own. It is clearly distinguished by a uniform and unique character not found in any other brandy. American grape, apple, and other fruit brandies are distinct from any other brandy in that they possess the unmistakable natural flavor and pleasant aroma of the fresh fruit from which they are distilled. This flavor is not lost but rather enhanced during natural aging.

Of the various groups of congenerics characteristic of brandy, the esters are of most importance and are generally more abundant in brandy than in any other distilled spirit.

THE general term "brandy" is applied to the product obtained from distilling wine or the fermented juice of any fruit. The more limited definition of the United States Pharmacopœia (*10*) for brandy, intended for medicinal purposes, is "spiritus vini vitis, an alcoholic liquid obtained by the distillation of fermented juice of sound, ripe grapes and containing, at 15.56° C., not less than 48 per cent and not more than 54 per cent by volume of ethyl alcohol. It must have been stored in wood containers for a period of not less than four years."

In some countries "brandy" refers only to the distillate from grape wine. In the United States and other countries which raise large quantities of other fruits, the fermented juices of these fruits are utilized for brandy. Next to grapes are apples, as an important source of brandy; of less importance are peaches, apricots, blackberries, prunes, cherries, and other fruit. Even in countries producing fairly large quantities of brandy from other fruits, grape brandy is much more important commercially.

Of all the distilled liquors produced and stored in the United States, brandy ranks next to whisky in quantity. At the end of April, 1938, our stocks of whisky amounted to approximately 471,000,000 gallons, and of all kinds of brandy, to about 7,500,000 gallons (including fortified brandy). From July 1, 1937, to April 30, 1938, 1,500,000 gallons of beverage brandy were withdrawn and tax was paid at the rate of two dollars per gallon. In the same period 18,500,000 gallons of fortifying brandy were withdrawn, and tax was paid at ten cents per proof gallon, for the purpose of increasing the alcoholic content of wines (*11*).

The production of brandy in the United States is rapidly regaining its preprohibition importance, both as regards quantity and quality. In 1900 something over 1,000,000 proof gallons were made, and by 1914 production had increased to 3,750,000 gallons of taxpaid beverage brandy. During the prohibition period, legal production of brandy was reduced to an insignificant volume. Under special permits, however, two plants were allowed to make 25,000 gallons each per year for warehousing and aging, medicinal, and other nonbeverage uses. After the repeal of prohibition 2,500,000 gallons of beverage brandy were distilled in 1933. By 1934 approximately seventy brandy distilleries were operating, mostly in conjunction with wineries.

A large amount of the postrepeal brandy is now old enough to meet the U. S. P. age requirements for medicinal brandy and to be bottled in bond according to the United States internal revenue provisions. At present most domestic brandy is being bottled under the "taxpaid" regulations (U. S. Treasury Decisions 4561, U. S. Internal Revenue Regulations 15).

California, with over 80 per cent of all the brandy made in the United States, is the largest producer in the world. Most of the California production is grape brandy, but important quantities are also distilled from apples, peaches, apricots, and other fruits in this state (Tables I and II).

France is by far the leading exporter of brandy to the United States; its Cognac has an overwhelming lead over all other foreign types. Greece, the second largest exporter to this country, sends us only about one tenth as much as France. Still smaller amounts are imported from Spain, Germany, Italy, and several other countries.

Purpose of the Investigation

It is hoped that this intensive study of the chemical composition of present-day brandy made in or imported into the United States will furnish some accurate information concerning the differences between the foreign and domestic types, furnish a comparison between the brandies made from the various fruits, and show the principal chemical differences between French Cognacs, "California cognacs," and Armagnac. It is the purpose to ascertain whether methanol is a natural inherent and ever-present ingredient of all grape and other fruit brandies, and to determine quantitatively its

general occurrence in all kinds and types of foreign and domestic brandy. A study is made here of the changes taking place during storage of grape and apple brandy in various kinds of commercial storage packages, the gains and losses of alcohol, color, and congenerics going on during this storage, and various other factors involved. Tables I and II are presented to show the complete chemical analyses of the youngest and oldest brandies made by practically every brandy distiller in the United States, in order to give the reader an idea of the present composition of American brandies. These chemical data are intended to assist the chemist to detect adulteration, mislabeling, unauthorized rectification, and fraud in brandies, and to assist in the establishment of the most accurate standards for its identity.

No opinion is intended, either expressed or implied, as to the quality of any of the various types of brandy here examined. The author is entirely neutral, and results obtained and the conclusions drawn are altogether factual.

California Brandy

The California Mission fathers first distilled brandy from crude pot stills during the seventeenth and eighteenth centuries, and Sutter erected the first brandy distillery in 1843. However, the production of significant quantities of brandy in California began after 1870.

There are at present one hundred and five brandy distilleries in California. Nearly half of them are located in three counties: twenty-one in Fresno in the central part of the state, seventeen in San Joaquin to the north, and eleven in San Bernardino to the south.

California grape brandies fall roughly into three classifications—fortifying brandy, commercial beverage brandy, and grappa.

Fortifying brandy was formerly made principally from pomace mash, but fresh must is now used to a considerable extent. It is distilled at very high proof, between 180 and 190 (90 to 95 per cent alcohol); it is, therefore, quite neutral and has few of the characteristics associated with beverage brandy. It is generally not aged in wood but rather stored in metal drums. Ordinarily, fortifying brandy is used as soon as it is made to increase the alcohol content of sweet wines and thus preserve them. Small amounts are reduced in proof and aged similarly to ordinary beverage brandy. Rectifying establishments use minor amounts as bases for some of their products.

Commercial beverage brandy is the most important class, and this paper is mostly concerned with this group which includes "California cognac" (*13*), ordinary grape brandy, and muscat brandy. These brandies are usually distilled below 175 proof in order to hold their desired flavors. It is barreled at about 102 proof. The water used for reducing the proof must be quite pure and free from odors, oil, and iron particularly.

Grappa brandy is made principally from pressed pomace which has been stacked in carefully protected piles into which secondary fermentation takes place and develops unusual flavors. After several months it is mixed with water, lees, and other residues of wine grapes, distilled in a pot still for singlings, and doubled in a continuous still below 160 proof in order to keep as much flavor as possible. Barrel 3744 (Table V, U. S. Brandy 4) is such a product, except that it was doubled at 180–185 proof.

In 1937 the grape crop of California was estimated at 2,300,000 tons. It is believed that the 1938 crop will be even larger. About 600,000 tons are made into wine and brandy.

The most important varieties of grapes used in California brandy making are the muscat, zinfandel, Freisa, Alicante, Carignane, Petite Sirah, Mission, Thompson, Tokay, and Malaga.

For every 35 proof-gallons of beverage brandy, approximately 1 ton of grapes is used. To make brandy clean, sound distilling material (must) from good grapes is required. It has been found a serious mistake to make brandy merely to salvage unsalable wine.

California grapes as a rule furnish ample natural yeast so that a great many fermentations are spontaneous, particularly among smaller producers. However, the larger plants usually prepare a supply of "starter" at the beginning of their crushing seasons. One or more barrels of fresh juice are thoroughly sterilized and then inoculated with the desired variety of pure wine yeast culture, supplies of which may be obtained from certain laboratories and commercial sources. Additions of such starters to supplies of juice ready to be made into wine causes vigorous initial fermentation and thereby helps to avoid infection from bacteria or wild yeasts which might harm the flavor of the wine. Urea, ammonium compounds, and phosphates are occasionally employed to stimulate fermentation.

Stills now in use in California for different kinds of brandy vary from a few simple pot and worm stills with capacities as low as 10 gallons per hour to large sixty-chambered duplex continuous stills producing up to 350 gallons per hour. Most of the stills are continuous, and have capacities of 120 to 150 gallons per hour, of the types known as De Valle, Sanders, Krenz, Ergot, Hebert, Barbet, and others. At present one hundred and one continuous stills (mostly Krenz) are operating in California as compared with only about ten pot stills. Some special patented pomace stills are in use for producing grappa and fortifying brandy.

General opinion among experienced California distillers is that their commercial brandies should be distilled at about 155 to 175 proof in order to obtain the maximum bouquet, grape flavor, and other desired characteristics. The proof of distillation must be low enough to have ample congenerics upon which the grape flavor and bouquet largely depend. Brandy distilled at higher proof is increasingly neutral and approaches ordinary alcohol (neutral spirits) in its general qualities. This type of brandy rarely improves much on aging.

Apple and other fruit brandies are generally distilled in smaller pot stills at less than 160 proof.

Receiving tanks for newly distilled beverage brandy, although sometimes of wood, are more frequently of copper or are tin-lined in order to avoid discoloring the brandy when the proof is reduced to 100–105 proof before the brandy is placed in wooden barrels.

Larger producers store their brandy mostly in new plain barrels made of white oak. The barrels should be well seasoned and under no circumstances used green. Plain barrels are also re-used, but common opinion is that new cooperage is preferable for aging brandy. Occasionally old whisky barrels, either planed or with charred staves, are used, but charred barrels tend to impart to the brandy characteristics more often associated with whisky than with brandy. Some paraffined barrels are also used, usually to store grappa.

Beverage grape brandy is usually colored with caramel. The addition of oak chips to brandy in barrels has been tried but has largely been abandoned because of the excessive woody taste imparted by this treatment. The wood chips generally used are toasted or lightly charred; they add tannins, acids, solids, but principally color.

Some brandy warehouses are artificially heated, and a few maintain hot rooms. In southern California, temperatures during the summer often reach 110° F., and natural aging occurs rapidly and satisfactorily under such conditions.

Quick aging is rarely practiced, since most distillers believe that any harsh treatment is detrimental to the natural delicate flavor of the brandy. Occasionally, however, treatments are tried on the distillery premises for new brandy, such as

Table I. Analyses of Oldest and Youngest Brandies Found on Distillery Premises during Fall, 1937

	Proof	pH	Total Acids	Volatile Acids	Esters	Fusel Oil	Solids	Alde-hydes	Furfural	Methanol	Color in Half-In. Cell	Caramel Present
			Grams/100 liters (not calcd. to proof)							%		

California Grape Brandy

Analyses of 114 brandies, practically all distilled during 1933–37 in continuous stills (proof of distillation 135 to 190). Most samples were aged in new plain barrels; some were obtained from paraffined, charred, and re-used barrels. There were abnormal samples; one contained 28 depth of color. Others contained 385 fusel oil, 70 and 94 (respectively) aldehydes, 48 furfural, 374 esters, which were not used in maximum or average. Any solid content beyond 220 grams per 100 liters was considered added material, and was not averaged.

Maximum	125	5.67	101.0	88	180.4	250	210	24.0	5.0	0.188	18.0	Yes
Average	103.7	4.42	54.8	42.9	68.9	90.7	130	10.7	1.7	0.048	7.6	Yes
Minimum	99.4	3.85	4.8	4.8	20.2	14.1	48	1.4	Trace	Trace	2.5	No

California Peach Brandy

Oldest produced 11-9-34; youngest, 11-15-38. Distilled under 160 proof. Cooperage, plain, mostly re-used; 1 paraffin barrel. One sample omitted due to low pH and acid content 175, which charred the solids on evaporation.

Maximum	153.4	6.0	204.0	172.8	337	249.9	184	16.5	10.0	0.42	10	Yes
Average	118.4	4.62	85.6	71.6	162.5	169.2	95.7	9.9	3.8	0.28	5.4	Yes
Minimum	101.1	4.37	7.2	7.2	20.5	110.9	6	4.6	2.0	0.10	0	...

California Apricot Brandy

Oldest produced 3-10-37; youngest, 8-7-37. Distilled mostly under 160 proof. All plain cooperage. One sample omitted due to low pH and acid content of 163, which charred the solids on evaporation.

Maximum	102.2	4.68	127.2	103.2	431.2	385.4	155.0	24.4	4.0	0.34	8	Yes
Average	101.2	4.09	71.7	52.6	226.1	179.8	105.0	19.1	1.8	0.20	6.2	Yes
Minimum	98.8	3.35	42.0	33.0	55.4	98.6	56.0	12.8	1.0	0.08	2	Weak

New Jersey Apple Brandy

Analyses of 25 brandies made 1934–37, mostly 1936–37. Principal cooperage, new charred, with occasional re-used charred barrel. All derived coloring from charred barrel. Proof of distillation, 105 to 133, occasionally higher.

Maximum	136	4.96	126	101	283	225	150	24.6	8.4	0.13	19.0	No
Average	110.3	4.66	55.9	45.9	88.7	142	104.5	7.86	2.7	0.058	8.83	No
Minimum	98	4.36	144	13.5	28	67	12	3.2	1	0.03	2.0	No

Connecticut Apple Brandy

Analyses of 10 brandies made 1934–37, mostly 1937. Aged in new charred cooperage. Proof of distillation, 110 to 160. All color due to charred barrels. Two high ester contents, 1,260 and 328, were omitted.

Maximum	121	4.85	141.6	139.0	131.1	383	160	36.6	2	0.06	10	No
Average	107.5	4.50	68.6	64.8	107.8	139.4	81.3	12.7	7.4	0.02	5.9	No
Minimum	91	4.31	24.0	22.0	77.4	86.2	12.0	5.3	14	Trace	1.0	No

Pennsylvania Apple Brandy

Oldest produced 10-5-35; youngest, 2-18-38. Samples taken Feb., 1938. Distilled under 160 proof. Plain and re-used cooperage.

Maximum	127.1	5.55	84.0	64.8	111.8	198.9	170.0	7.3	4.0	Pos.	10	No
Average	111.9	4.80	42.3	33.3	71.8	155.6	56.5	4.6	1.8	Pos.	4.8	No
Minimum	101.5	4.20	6.7	4.8	46.1	84.5	2.8	2.6	0.4	Pos.	2.5	No

New York Apple Brandy

Oldest produced 1-18-34; youngest, 11-17-37. Re-used and charred cooperage.

Maximum	115.2	5.65	96.0	82.8	109.1	198.9	225.3	9.7	1.6	0.09	14	No
Average	104.5	4.80	46.2	39.8	91.4	166.6	88.7	4.9	1.2	0.03	66	No
Minimum	99.5	4.42	12.0	12.0	70.4	149.6	2.0	1.3	0.0	Pos.	0	...

Kentucky Brandy

Distilled in 7-action continuous pomace still and doubler during fall of 1934 and 1935, at less than 160 proof (except peach and pear); stored in re-used charred barrels. The 0.6% methanol in some samples was the highest found for any brandy, and was undoubtedly due to the fact that the pomace material was distilled with the fermented cider. When the whole crushed fermented mash of any fruit is distilled, the methanol content in the resultant brandy is always above normal.

Apple, max.	99.6	5.60	45.6	41.6	35.2	160	130	5.7	0.7	0.42	6.0	Yes
Apple, av.	90.4	5.25	27.9	25.4	27.8	134.1	101.2	4.3	0.34	0.26	4.4	No
Apple, min.	85.0	4.67	22.8	21.6	22.0	125	84	3.5	0.2	0.15	2.5	Yes
Peach, av.	90.2	5.04	51.6	50.7	70.8	40.5	113	2.9	0.2	0.60	4.5	Yes
Pear, av.	92.5	4.94	34.8	34.1	37.3	90	65	1.8	0.6	0.63	3	Yes

Washington Apple Brandy

Analyses of 8 brandies. Oldest produced 2-13-36; youngest, 11-16-37. Proof of distillation, 104 to 190. Mostly pot stills, some with columns attached. Barrels plain, charred, and re-used. Two samples omitted because of low pH (2.4–2.6), containing free H_2SO_4; solids were acid-charred.

Maximum	173.4	6.2	60.0	40.8	118.8	299.2	88.0	16.4	10.0	Pos.	2	No
Average	127.9	5.11	22.5	17.1	73.7	189.0	31.2	11.8	5.6	Pos.	2.1	No
Minimum	104.8	3.85	7.2	6.0	48.4	130.2	4.0	5.7	1.5	Pos.	0	...

Maryland and Virginia Apple Brandy

Analyses of 8 Virginia brandies; oldest produced 10-28-35 (pot still, charred and re-used cooperage); youngest, 5-19-38. Analyses of 2 Maryland brandies, produced 11-20-34 and 10-22-36 (pot still, charred cooperage).

Va., av.	101.3	4.48	6.48	53.1	90.8	170.0	71.4	6.85	1.6	0.43	4.2	No
Md., av.	97.2	4.49	66.0	55.2	41.3	125.8	135.6	8.45	1.5	Pos.	8.25	No

Oregon Apple Brandy

Five samples taken Jan., 1936. Distilled in pot stills with semicolumn and columns; proof of distillation, 106–140. All charred barrels, minimum acid and maximum pH due to one sample of newly distilled apple brandy from try box at 180 proof. Oldest produced 10-25-35; youngest, 1-6-38.

Maximum	180.8	6.68	74.4	60.0	95.0	316.8	164.0	11.2	2.0	Pos.	13.5	No
Average	119.6	4.59	35.0	26.9	62.6	205.2	61.6	7.0	0.8	Pos.	4.3	No
Minimum	102.6	3.80	4.8	4.8	34.3	137.3	2.0	2.2	0	Pos.	0	...

filtrations through activated carbons, oxidation with hydrogen peroxide, and other oxidizing agents, and addition of oak chips. As far as can be determined, none of this sort of brandy has been produced on an important commercial basis.

In order to determine the character and chemical composition of the brandy made in this country at present, two hundred and sixty samples were taken by government gagers; one sample each of the oldest and youngest brandy was selected from practically all of the operating distilleries in the United States during November, 1937, and at later dates. The complete chemical analyses of these brandy samples are given in Tables I and II. It must not be interpreted that all of the samples are considered authentic standard brandy, although with comparatively few exceptions most of them are. Ten samples have abnormal solid content (240 to 900 grams per 100 liters), and for this reason all were technically rectified because unauthorized soluble solid substances had been added.

In Tables I and II certain samples of grape, peach, cherry, and apple brandies had low initial pH readings, which usually were accompanied by extracts (solids) that turned black on evaporation, as a result of the dehydrating and charring action of free sulfuric acid found in the brandy. These solids are sharply acid (sour) to the tongue. These brandies show a total acid–volatile acid ratio far from normal. Investigation of the source of these brandies indicated that sulfur compounds had been used during some stage of their preparation before distillation.

The various reasons given for the presence of free sulfuric acid in these brandies were that sulfur dioxide gas and liquid and solid sulfites were used in the treatment of defective wines and in some instances were added over a period to preserve sound dry wines. Sulfur compounds were added in some cases to the fermenting must, and in several instances the presence of sulfuric acid was the result of unusual heavy sulfur spraying on grape vines, especially to combat mildew. There was no case where it could be shown that sulfuric acid was added as such to brandy after distillation.

Some distillers believe that the sulfur dioxide gas, introduced occasionally during the preparation of the wine prior to distillation, is lost before the brandy is distilled; but the examination of these samples shows clearly that some of it at least is retained dissolved as sulfurous acid in the wine. During the distillation of the wine into brandy, the sulfur dioxide gas goes over into the brandy, and there it is slowly oxidized into sulfuric acid which remains permanently in the brandy:

$$H_2O + SO_2 \longrightarrow H_2SO_3$$
$$2H_2SO_3 + O_2 \longrightarrow 2H_2SO_4$$

This highly ionized acid is responsible for the low pH of the brandy, due to the relatively high hydrogen-ion concentration.

It was found in this laboratory that when wine lees from certain types of California grape wines, particularly the dry wine lees, are distilled at not too high proof, the resulting brandy may have a taste and aroma quite like the French Charente Cognac. It is more likely to have this character when distilled from pots than from column stills. Fire-heated pot stills are more productive of this flavor.

Here probably lies the principal difference between French Cognac and California brandy. During the distillation of the former, some of the ingredients of the heterogeneous lees material break down to produce a very small amount of an oily, highly flavorous substance such as was found by repeated distillation and fractionation of imported authentic Cognac. A similar treatment of California brandy failed to produce such an ingredient.

Probably the oldest and most often quoted reference to the composition of brandy is that of Ordinneau (*7*); he gave a quantitative estimation resulting from the concentration and fractionation of a large quantity of old Cognac brandy. Among the congenerics he found was ethyl acetate as the principal ester and *n*-butyl alcohol as the principal higher alcohol, with amyl alcohol in lesser amount. He also identified small amounts of the esters of propyl and butyl alcohol and oenanthic ether.

Trost (*9*) in 1935 identified by spectrographic methods the higher alcohols of Cognac brandy as consisting mainly of amyl and heptyl alcohols.

TABLE II. AVERAGES FOR OLDEST AND YOUNGEST MISCELLANEOUS FRUIT BRANDIES FOUND ON DISTILLERY PREMISES IN NOVEMBER, 1937

	Proof	pH	Total Acids	Volatile Acids	Esters	Fusel Oil	Solids	Aldehydes	Furfural	Methanol	Color in Half-In. Cell	Date Produced
			Grams/100 liters (not calcd. to proof)							%		
Calif. persimmon	94.8	4.40	105.6	94.8	105.6	77.4	98.0	14.3	1.2	0.075	3.0 (no caramel)	1-19-35; plain cooperage
Calif. date	119.3	4.31	135.6	123.6	222.2	66.8	82.5	10.8	6.0	0.625	2.6 (no caramel)	7-30-36 and 6-30-37; plain cooperage; 160 proof
Calif. orange	187.8	4.97	12.0	8.4	102.7	182.6	2.0	16.7	0	0.10	0	9-23-37 at 188 proof; metal drum; fortifying brandy
T. H. pineapple	101.4	7.53	45.6	40.8	69.5	177.8	112.0	69.5	0.8	0.031	7.5 (caramel)	12-24-36 at 160 proof; plain cooperage
La. blackberry	127.2	4.12	24.0	16.5	58.1	112.3	25.0	12.1	1.5	Trace	0.5 (no caramel)	7-27-37 at 154 proof; 10-28-37, re-used cooperage
Calif. prune	126.6	4.23	49.1	43.5	94.8	117.5	118.4	13.1	3.28	0.22	6.7 (caramel)	8-18-36, 3-20-37, 11-19-34, 7-1-36 & 4-30-37 at 160–190 proof; 4 plain, 1 re-used cooperage
Calif. raisin	108.0	4.66	99.6	80.4	301.4	111.7	140.0	12.1	2.6	Pos.	2.6	7-30-36 & 1-13-36 at 160–190 proof; 1 re-used, 1 charred cooperage and chips
Ore. Pear	137.3	4.83	46.8	37.2	151.3	168.9	161.0	10.3	3.0	Pos.	7.3	11-22-36 & 11-1-37 at 124–155 proof; 1 charred, 1 re-used cooperage
Wash. cherry	140.3	2.96	105.6	55.2	153.9	124.9	75.0 (acid-charred)	16.9	0.3	Pos.	0.75 (no caramel)	10-8-37 & 11-29-37 at 139–144 proof; re-used cooperage; abnormal due to free H_2SO_4
Calif. fig	102.2	3.26	120.0	93.6	142.6	112.6	180	19.2	1.6	Pos.	7.5 (off-shade caramel)	3-1-37 at 160 proof; plain cooperage
Penna. peach	101.6	4.49	70.4	60.0	125.5	110.9	84	4.6	1.4	Pos.	3.0 (no caramel)	9–20–35

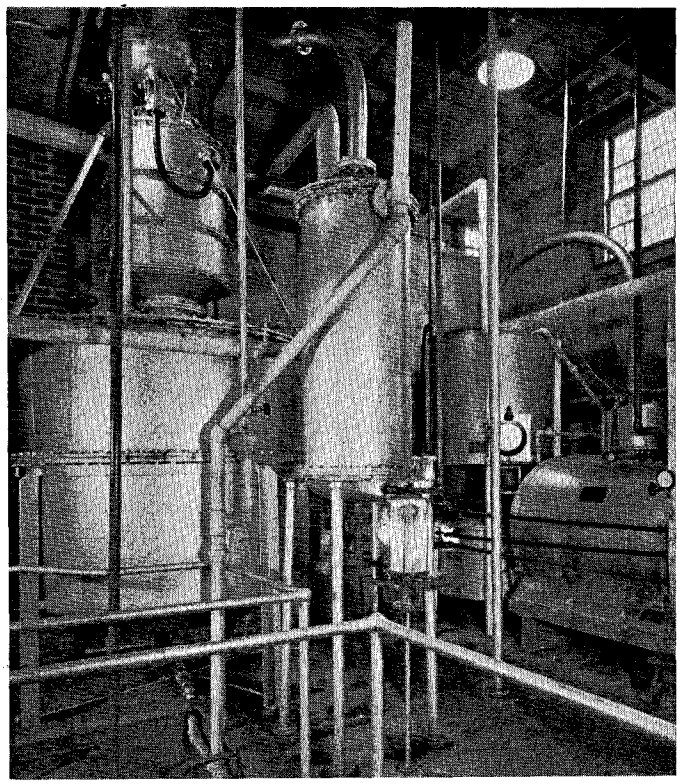
The California brandy left after the experiments for determining the changes taking place in assorted barrels was combined by the author and distilled in simple stills and then fractionated in efficient column stills. It was found that the principal ester in quantity in this California brandy was ethyl acetate, the principal aldehyde, acetaldehyde, and the principal higher alcohol, amyl alcohol. Four liters of combined heads, tails (sample 87577), and crude fusel oil from brandy distillery 1 were fractionated repeatedly with the same conclusions. Propyl, butyl, and amyl alcohol were isolated and identified, but no hexyl or heptyl alcohol was found in the quantity of brandy material taken.

Tolman (*8*) pointed out the difference in composition between the portions of the distillates from a simple (pot) still and those from a column still. In the pot still the alcohol goes over at about 160 proof, the proof gradually becoming less and less; the esters and aldehydes go over in the first portions, and the fusel oil, in spite of its much higher boiling points, goes over with the alcohol. This is due, it is thought, to the solubility of the higher alcohol vapors in ethyl alcohol. In the column still there is complete separation of the aldehydes and esters in the first fraction, and a comparatively pure neutral alcohol in the middle run. The higher alcohols apparently form mixtures of minimum boiling points with water and distill over with the last portions of the alcohol and water at an increased temperature, but lower than the boiling points of the propyl, butyl, and amyl alcohols or of water (*17*). Water is the principal final fraction.

A study of the separate portions obtained by the fractionation of California grape brandy shows that its characteristic flavor is not due to any single ingredient, but rather to a combination of numerous natural compounds.

Besides California, eight other states produce brandy, most of which is made from apples. These states are listed in order of their producing volume with the number of distilleries operating in each state: New Jersey, eleven; New York, five; Washington, five; Oregon, four; Virginia, four; Connecticut, three; Pennsylvania, two; and Maryland, one. Although the stills used in these fruit centers are mostly pot stills, (simple or with refluxing and other rectifying attachments), there seems to be a slow trend towards continuous stills.

Tables I and II give the analyses of brandy from nearly all of the distilleries listed. Most of this brandy is characterized by a clear, ripe, fruit bouquet.



Courtesy, Laird and Company

DISTILLATION ROOM OF A NEW JERSEY APPLE JACK DISTILLERY

Apple Brandy

Probably one of the oldest and most typical American industries is the commercial distillation of apple brandy, commonly known as applejack. Apple brandy was in commerce before the American Revolution (*6*). Although nearly all of three thousand named varieties of apples may be made into brandy, the late varieties with richer flavor and aroma are more often used. The carefully selected ripe (not green or overripe) washed apples are ground quite fine and pressed into juice which contains from 80 to 90 per cent water, 8 to 17 per cent sugar (*d*-fructose, *d*-glucose, and sucrose), and 2 to 8 per cent total acids. After the usual natural fermentation, the hard cider is allowed to settle, and the clear fermented liquid is racked or filtered from the sediment or sludge which consists principally of yeast cells, pectins, and albumins. The cider may be distilled at once or after prolonged storage. Although some continuous stills are used, the principal method is to distill the fermented apple juice into low wines in a simple pot still, the proof being about 60. The low wines are now redistilled into brandy of about 110 to 133 proof. Usually the heads and tails of the second distillation are eliminated. The total distillate is run in a cistern where it is cut under the supervision of a government gager to about 105 proof and filled into white oak barrels. If the period of aging is to be two years or less, a new charred barrel or recharred barrel is used; if it is to be stored for a longer or indefinite period, a re-used charred barrel or a plain barrel is more likely to be used.

Although ethyl acetate is the principal ester in quantity, the higher ones are the more important esters in apple brandy, because they furnish most of the flavor and bouquet; they include, among others, amyl and isoamyl acetate, ethyl and amyl valerate.

In the analysis of certain pot-still apple brandies (Table I) a comparatively high fusel oil content (137–299 grams per 100 liters) was found in these brandies that had apparently been distilled at high proof. This may be surprising to those always associating a low fusel oil content with high-proof distillates. In the distillation of brandy, small amounts of natural congenerics such as acids, esters, fusel oil, aldehydes, methanol, and other compounds are really separated from ethyl alcohol with surprising difficulty when we consider the wide range of their boiling points. Fusel oil is generally found in the tails, but it may also appear in the heads under certain conditions. Redistillation in these pot stills actually served to concentrate the higher alcohols.

Control of Brandy Production in the United States

The manufacture of brandy in the United States is subject to very close supervision by internal revenue officers in order to safeguard the revenue and ensure compliance with the law and regulations respecting the kinds of materials used, the process of manufacture, and the marking and branding of the

product at the time of manufacture and packaging [Section 3255, Revised Statutes, as amended; Treasury Department Regulations 7 (1930 edition); Gauging Manual, as amended (1934 edition)]. The bottling of brandy is also subject to supervision by internal revenue officers in order to ensure compliance with the labeling requirements of the Federal Alcohol Administration. Brandy is produced in a closed process of distillation. Any materials which do not change the character of the brandy or remain incorporated in the finished product may be used to purify and refine brandy in the course of original manufacture [Section 3244, Revised Statutes, as amended (Third Subsection)]. After production it may be reduced in proof with pure water only in the receiving cistern, under the supervision of a government officer. Also following its production, a small quantity of caramel or burnt sugar (but nothing else) may be added to brandy on the distillery premises, under supervision of a government officer, for the sole purpose of coloring the product to meet trade requirements.

Brandy of France

COGNAC. France was the first country to become noted for its brandy. It is said that France also originated its commerce, its first regulations, the use of the white oak barrel, brandy bottle, and caramel, the significance of the stars to indicate standard blends and ages, and the name "Cognac." The distillation of spirits from wine in France was recorded as early as 1620. At first, distillation was resorted to in order to prevent wines from spoiling and to reduce their volume. The reduction in volume facilitated storage and transportation, which was somewhat difficult in those early times. In this manner France became the mother of brandy. Almost all the brandy produced there is manufactured from wine made from grapes. In fact, a popular French definition of brandy is "spirit distilled from grapes."

The best known brandy of France is *eau-de-vie de Cognac* popularly known simply as Cognac. This brandy appeared in commerce late in the seventeenth century. Approximately 98 per cent of the French brandy imported into the United States is Cognac. These importations have increased from about 250,000 gallons in 1934 to nearly 750,000 gallons in 1937. (For comparison, the withdrawals of domestic tax-paid beverage brandy in the United States amounted to approximately 2,000,000 gallons in 1937.) Cognac is defined as "brandy distilled from grapes gathered within the legally defined boundaries of the Charente district" (*5*).

The French Government has taken precautions to restrict the use of the name "Cognac" and protect the quality of the products entitled to bear this name. The localities where Cognac may be produced and the kinds of grapes that may enter into its production are rigidly prescribed. The manner of distillation, the kind and degree of storage, and the method of blending are all subject to government supervision.

The region qualified officially to furnish Cognac is known as the Charente and is subdivided into four main districts—the Grande Champagne, Petite Champagne, Borderies, and Bois. In this small section of southwestern France, more than seventy thousand people derive their livelihood from the production of this particular brandy.

The French Government, through its excise officers, also ensures that the brandy is properly distilled and stored and is not tampered with or adulterated. On May 1, 1909, the Cognac district was delimited, the *Acquit Regional Cognac* was created, and certain regulations and restrictions regarding Cognac were established. A law of August 4, 1929, established a "yellow golden certificate" (*acquit regional Jaune d'Or*) to control the movement of Cognac and Armagnac brandies. Neither of these brandies may be removed from their respective districts of production unless accompanied by proper evidences of their authenticity, and the *certificates d'origine* must follow the brandies wherever they go.

Through treaties and trade agreements with other countries, application of the word "Cognac" to brandies produced in other European countries has also been generally eliminated. In the past, brandy labeled "Cognac" has been made in nearly every wine-producing country, including Germany, Greece, Italy, Spain, Uruguay, and the United States.

There is no question that there is a difference in taste, aroma, and other characteristics between French and "California Cognacs." There seems to be no disposition on the part of the California distillers to imitate French Cognac, but simply to make a type of brandy of their own such as they have made and marketed for more than fifty years under the name of "California cognac." In general, it has been the practice to call all types of California brandy "cognac," except the kinds made from muscat or other highly flavored grapes and the other specially classed brandies such as lees, pomace, or grappa.

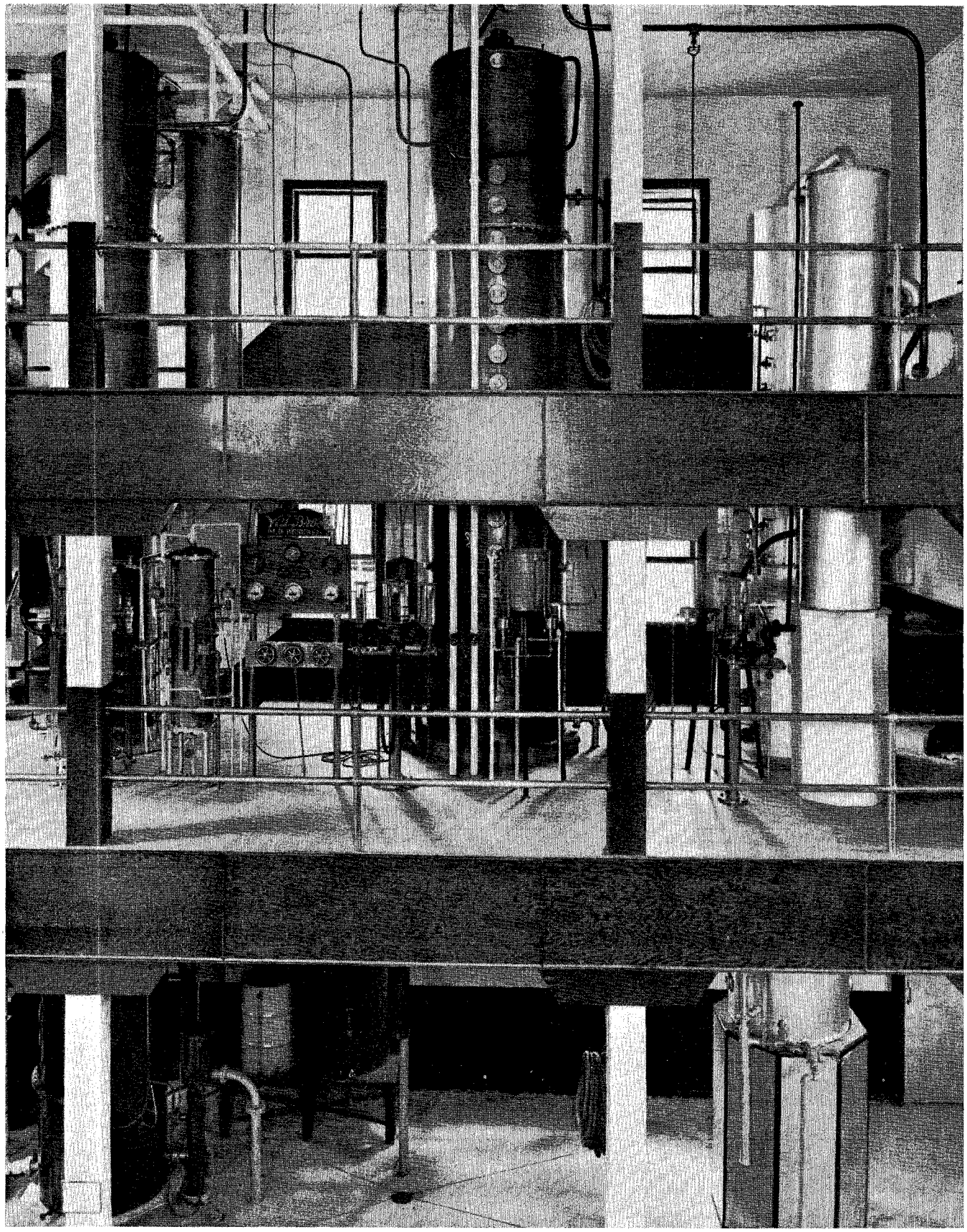
The difference in flavor between French and California Cognacs has been explained by the variations in soil, climate, kinds of grapes used, practices of wine making, method of distilling, blending, and aging.

On July 29, 1938, the United States Treasury Department issued notice that the designation of domestic brandy as cognac would no longer be permitted (*13*).

Only white wines from special varieties of white grapes may be legally used in the manufacture of Cognac. These grapes are usually characterized by their rather low sugar content, and for the production of Cognac brandy, they must be grown in the Cognac district; no red or black grapes are permitted to be used for this purpose even if grown in the Charente section.

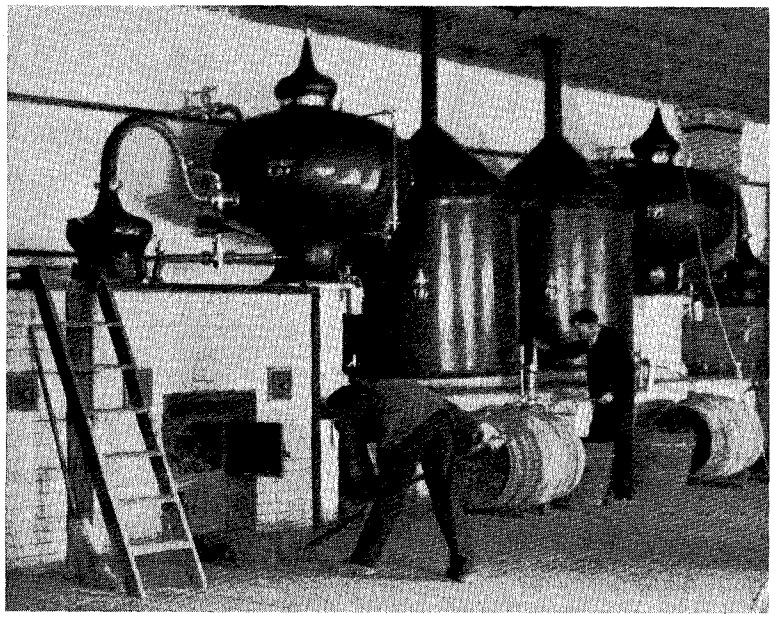
In 1709 all of the vineyards in the Cognac region were destroyed by severe frosts. After surviving droughts, wars, and other vicissitudes of nature and man, the vines in this area were again almost completely ruined by the phylloxera blight which began in 1872. Through these catastrophes the evolution of the grape continued. The Pineau grape, originally used in the first known Cognacs, was replaced by the Balzac. This in turn was succeeded by the Folle Blanc, a round, yellow-green grape with a sugar content of about 17 per cent. Although the Folle Blanc is said to be the most important kind grown for Cognac at present, recent information indicates that this variety is undergoing slow replacement by the St. Emilion because the latter has greater resistance to gray rust disease. A French decree of May 15, 1936, limits the varieties of grapes as follows: "All wines intended for the manufacture of brandy under the controlled name of Cognac, of Cognac brandy, and Charente brandy, shall exclusively be derived from the following wine stocks: St. Emilion, Folle Blanc, Colombar, Blanc Rame, Jurancon Blanc, Montils, Lemillon, and Sauvignon." All of these varieties may also be found cultivated in relatively small quantities in California. In the nearly 200,000 acres of vineyards of the Cognac region at present the principal grape stocks are the Colombar, the Folle Blanc, and the St. Emilion.

The smaller Cognac producers crush their grape gently and allow the juice to ferment naturally in vats or barrels. Because of numerous insect and bacterial pests, fermentations of fruit juices are more difficult to control than are those of molasses and grain. Consequently, the larger concerns frequently reduce the danger of bacterial and mold infection by treating the casks and vats with sulfur dioxide (burning sulfur) and then induce fermentation by means of a pure yeast culture such as is obtainable from the Pasteur Institute and other sources. The stems and skins may be pressed with the grapes, but these solid materials are usually separated from the juice



Courtesy, Padre Vineyard Company

A CALIFORNIA BRANDY DISTILLERY WITH A MODERN TYPE OF CONTROL BOARD



Courtesy, Schieffelin & Company

DISTILLATION ROOM IN A FRENCH COGNAC DISTILLERY

before the latter has begun to ferment. Only the pure grape juice may be fermented. Wines made by the addition of sugar or other foreign material cannot be used for distilling Cognac. The French law forbids their use. Following its natural course, fermentation is usually completed in two to three weeks.

The wines for Cognac are characterized by low alcohol contents, generally about 8 per cent by volume, and a high acidity, of the order of 1.2 per cent, as tartaric acid. However, it is estimated that of the wines of Charente, one third is distilled into Cognac, one third is consumed locally, and one third is used for blending and for making Champagne and sparkling wines.

The wine for Cognac is never drawn. Its lees are included in the distillation charge and contribute largely to the characteristic Cognac flavor.

Practices regarding predistillation storage of the wine vary; but as a rule, as soon as the vintage is well over and fermentation is finished, distillation is begun. Sometimes because of local conditions there may be a lapse of several months before some wines are distilled.

It is generally conceded by Cognac distillers that larger stills do not produce the kind of brandy they want as well as do small stills and that the brandy produced by chambered, patent, or continuous stills is not the type desired. Consequently most of the Cognac stills are the old form of copper pot or kettle stills with relatively small capacities ranging from 120 to 200 gallons. Thousands of grape growers have their own stills and distill their brandy; other small producers avail themselves of the licensed portable stills whose owners transport them through the district, carrying on distillation operations on a "custom" or fee basis. Even larger producers use the small-capacity stills, arranging them in batteries of as many as ten or more units. About eight hundred small pot stills operate yearly in the Cognac region.

Some of the stills have rather small rectifying columns connected to the pots. Many of the older stills are the Mareste type, designed especially for Cognac. These stills range in capacity from 5 to 25 hectoliters (120 to 650 gallons). They consist of a pot and a gooseneck connected with a worm which is water-cooled. Some types of stills are direct-fired, others are heated by means of steam coils or jackets. The production of 1 gallon of Cognac requires about 8 gallons of wine.

The French Government regulations determine that there should be "two distillations in the old established way." Three or four portions of wine are distilled separately, and the first distillates are combined to form the *brouille*. The *brouille*, which is usually cloudy and contains up to 30 per cent of alcohol, is then redistilled. The first few liters of the heads are put aside, and the "heart" of the distillation, which is the future Cognac, is preserved. Great care is taken that the brandy is not distilled too rapidly lest some of the valuable volatile esters be lost and the flavor thereby impaired. Distillation is stopped when the distillate is about 100 proof. The residue left in the still, known as tails or *feints*, is combined with the heads and fresh *brouille* for the next redistillation. The alcohol content of the heart ranges between 50 and 80 French degrees (100 to 160 proof). Larger distillers may reduce the proof with distilled water, smaller ones frequently use rain water; usually this is done later in the warehouses when blending starts.

Cognac, like any other brandy, may be consumed immediately, but by aging it becomes softer, more delicate, and much more pleasant in taste.

The Limousin white oak wood that is used for making the barrels or casks for Cognac is split into staves in the forests and aged about two years before the casks are made. Some of the larger Cognac concerns maintain or control their own forests in order to have suitable and ample wood for casks and barrels.

Smaller distillers also frequently make their own casks, many of them in larger sizes of over 100 gallons capacity. The wood for Cognac cooperage is never charred, and many of the storage casks are re-used for long periods. Ordinarily new barrels are first scalded and then soaked with water and with diluted Cognac (40 proof) brandy. The treatment with Cognac is sometimes omitted, but under no circumstances may neutral spirits be used for the preliminary soaking of new barrels. Such practices are forbidden by law.

The small distillers generally hold their brandies only until they are purchased by the wholesalers and blenders.

The final maturing after the blending process always takes place in new white oak barrels with an average capacity of 75 gallons. Limousin white oak, a particularly light colored variety, is preferred for the final cooperage. The smaller barrels are preferred to the 150-gallon puncheons frequently used for new distillates because aging proceeds more rapidly in the smaller containers.

The freshly filled barrels are stored at first in dark rooms, frequently in buildings without windows and on the ground floor. The atmosphere is always rather damp, and consequently the alcohol content, or proof, of the Cognac generally decreases rather than increases as is the case when American brandy, rum, or whisky is aged in dry and warmer storage. After different periods of time, depending on the views of the owner or his experts, the Cognac may be removed to dry storage, but in any event efforts are made to maintain as constant a temperature as is possible.

Very old Cognacs are usually transferred to large glass containers to prevent excessive losses of alcohol. Such old Cognacs, known as *bonifiers*, are filtered and used for blending purposes. It is estimated that stocks of Cognac now in stor-

age and maturing in the Charente region amount to approximately 22,000,000 gallons. The average annual production is about 4,500,000 gallons.

In marketing Cognac, labels bearing stars usually indicate that the products are between four and ten years old. Those marked with letters are between ten and fifty years old.

The storage warehouses in which Cognac is made uniform and matured are under strict government control. Only Cognac, pure cane sugar or sirup, and caramel coloring may be used for blending. Any additions of neutral spirits, brandy from other than the Cognac region, concentrates of any kind, vegetable extracts, or any other foreign materials are strictly forbidden under severe penalties. Cognac, like other French brandies, is generally more highly colored with caramel than American brandies. Cognac may also legally contain 2 per cent of cane sugar or sirup, but nothing else.

In the production of Cognac, constancy and uniformity of the finished product, as judged by taste and aroma, are sought rather than any definite specification based on analyses. Even the control of the product and the detection of fraud in France are more often based on the judgment of experts by taste than on the analyses of chemists.

The most useful single chemical standard appears to be that of the ester determination. This congeneric may vary somewhat from season to season and is influenced also by the speed of distillation. At one time 80 parts of esters (calculated as ethyl acetate) per 100 liters of absolute alcohol were suggested as the minimum permissible content. This standard was fairly well agreed to by most producers, although it was shown that in some instances esters fell as low as 65 parts per 100 liters of absolute alcohol. As far as is known this standard was never actually enforced, although it is believed to be included in the basis of judgments of analysts determining the authenticity of Cognacs.

Table III shows that all authentic Cognacs examined in this investigation had not less than 40 parts of esters per 100 liters of 100 proof alcohol, or 80 parts of esters per 100 liters of absolute alcohol. Esters in all brandy are formed by the combining of organic acids with alcohol (mostly ethyl) and acetic acid to form ethyl acetate, which produces what is commonly described as a fruity odor. A much more important and characteristic aroma and taste of brandy is furnished by other esters produced by the much slower combinations of higher alcohols and acids.

ARMAGNAC. Another group of French brandies take their name, "Armagnac," from the region in which they are produced. This district lies in the southwestern part of the country, below Bordeaux. The principal city in the district is Condom. Exclusive right to the use of the name "Armagnac" in connection with brandies has been reserved by law to the products of this district, which is even smaller than the one in which Cognac originates.

The Armagnac district has much the same conditions of soil and climate as the Charente region. The processes of making brandy are similar in both districts, and the strict governmental regulations apply in about the same manner to all steps involved in making and marketing the two kinds of brandy. Despite the general similarities in methods of production in the Cognac and Armagnac districts, experts readily distinguish between the two kinds of brandy. Some authorities ascribe the distinguishable characteristics of Armagnac to the practice of storing and aging it in long re-used casks of black Gascony oak from the native forests of that region.

In the South of France many of the wines have a pronounced earthy taste. When brandy is made from such wines, considerable rectification is required to reduce the objectionable flavor. For this reason, although pot stills are generally used in other parts of France, more complicated patent or continuous stills are commonly utilized in the southern areas. For this reason the rather neutral south of France brandies are easily distinguished from the more flavored Cognacs and Armagnacs.

COMPARISON OF CALIFORNIA AND FRENCH BRANDY. Table III contains the average analyses of practically all of the authentic French Cognac brandy imported into the United States, and of three typical Armagnac brandies. The analyses are also given of a specially selected group of California brandies, several of which were labeled "California cognac" before repeal, the other samples represent typical California brandies which the producers wished to call "California cognac." These figures are given as an analytical comparison with French Cognacs and Armagnacs.

By the use of efficient all-glass fractionating stills, equipped with 3-foot columns, 0.5 inch in diameter, and closely packed with glass one-turn helix contact rings, information was obtained as to the composition of California brandy and French Cognac and as to which portions give the characteristic taste and aroma of each.

Two liters of each type of brandy were used for fractionating; the Cognac was a composite of the samples in Table III, and the California brandy a composite of the most typical samples shown in Table V.

The heads, ethyl alcohol, water, and residue which represented more than 96 per cent of the brandy in each case were

TABLE III. STANDARD FRENCH BRANDIES AS IMPORTED IN 1938 COMPARED WITH "CALIFORNIA COGNAC"

	True Proof	Apparent Proof	pH	Total Acids	Volatile Acids	Esters	Fusel Oil	Total Solids	Aldehydes	Furfural	Ash	Methanol	Color in Half-In. Cell
				Grams/100 liters (not calcd. to proof)								%	
A. French Cognac[a]													
Minimum	79.1	73.8	3.76	26.4	21.0	36.1	89.8	624	6.3	1.0	6.0	0.011	12.5
Average	84.6	80.7	4.14	51.5	34.2	44.3	103.9	975	8.6	1.3	12.7	0.017	17.2
Maximum	88.2	82.2	4.98	110.4	72.0	58.1	127.0	1,368	14	3.0	28.0	0.027	26.0
B. French Armagnac													
Minimum	84.4	80.4	3.70	62.4	43.2	49.3	91.5	886	8.7	0.6	19.0	0.021	12.5
Average	84.8	81.0	3.77	64.0	43.2	52.8	94.4	929	9.1	0.7	19.0	0.026	15.8
Maximum	85.8	82.2	3.88	67.2	45.6	59.8	96.8	962	9.5	1.0	20.0	0.031	17.5
C. "California Cognac"													
Minimum	..	88.8	4.04	21.6	19.2	17.6	14.1	62.0	2.3	0.4	4.0	0.013	4.0
Average	..	92.3	4.29	57.0	47.2	48.5	85.5	155.7	7.9	0.18	10.95	0.038	7.6
Maximum	..	101.2	4.58	86.4	64.8	77.4	126.7	338.8	14.0	4.0	23.2[b]	0.062	12.5

[a] Analyses of 20 authentic Charente Cognac brandies include all usual qualities and ages, and bear the general quality and age letter brands, such as 3 Star, 5 Star, XO, V. S. O. P., V. E., V. F. C., V. V. S. E. P., E. S. T. P., S. V., etc. The ages are from 3 to 50 years. All are colored with caramel, which constitutes most of the color, but have some aged-in-wood color as well. The ash is distinctly brown and rich in iron content. It is believed that most of this inorganic ash material was dissolved during storage in glass bottles, which were dark colored in all cases.

[b] Ash abnormal because brandy remained in glass 17 years.

TABLE IV. ANALYSES OF 25 GREEK GRAPE BRANDIES IMPORTED IN 1937-38[a]

	True Proof	pH	Total Acids	Volatile Acids	Esters	Fusel Oil	Solids	Aldehydes	Furfural	Color in Half-In. Cell	Color Tests
			Grams/100 liters (not calcd. to proof)								
Maximum	94.0	5.77	103.2	70.8	79.2	121.4	4,040	23.6	2.4	26.0	Caramel with age color
Average	89.1	4.41	51.94	33.76	40.5	58.0	1,651	13.8	1.0	15.1	Caramel with slight age color
Minimum	81.0	3.28	21.6	6.0	7.9	10.6	198	4.0	Trace	8.0	All caramel

[a] On account of the relatively high solid content, the ordinary hydrometer gave only an approximate estimate of the alcoholic contents. The aberration due to added material was sometimes as much as 17 proof. The aged-in-wood color was usually absent or present in very small amounts. The methanol content varied from a mere trace to 0.05%; it was generally less than in any other brandy. The various ages claimed were from 4 to 25 years. Three samples contained a solid content of 198, 202, and 204 grams per 100 liters. These products were specially made to meet the American standards for straight brandy.

rather similar; the principal difference lay in the few cubic centimeters found at the end of the alcohol and beginning of the water portions. Although in each case the higher alcohols consisted principally of amyl alcohol, there was a higher proportion of propyl and butyl alcohols in Cognac and an absence of the banana-like aroma of amyl acetate which was so prominent in the fraction just preceding the amyl alcohol fraction of California brandy. This acetate, it is thought, is produced to some extent by the multiple refluxing of the acetic acid in the presence of the amyl alcohols in the continuous stills.

The greatest difference between these two brandies was 0.4 cm. of a clear yellow oil obtained from the Cognac after the fusel oils were exhausted and at the beginning of the aqueous portion. No such portion was obtained from California brandy. This ingredient had a powerful aroma of Cognac and was present in whole Cognac to extent of 20 grams per 100 liters.

Greek Brandy

At present Greece ranks second among the countries shipping brandy into the United States. It is estimated that Greece has stocks of more than 1,000,000 gallons of brandy, over 60 per cent of which is three years old or more. Greek brandy is interchangeably labeled "Greek brandy" or "Greek cognac." The so-called Greek cognac has no special place of origin as the Cognac of France, and may be made anywhere in Greece. Rarely is the Greek cognac like the French Charente Cognac in taste or aroma. The analyses may be compared by the data in Tables IIIA and IV. On the whole the Greek products seem entirely different from brandies produced in other countries.

The Greek brandy industry operates under the immediate control of its government. The product is technically wine spirits until three years after its distillation, when it becomes officially known as brandy. Any "harmful coloring" or any "flavoring ingredients" are strictly prohibited in Greece. A moderate technical control of brandy is maintained by the State Chemical Laboratory. This government laboratory also keeps a record of the Greek wine spirits produced and disposed of.

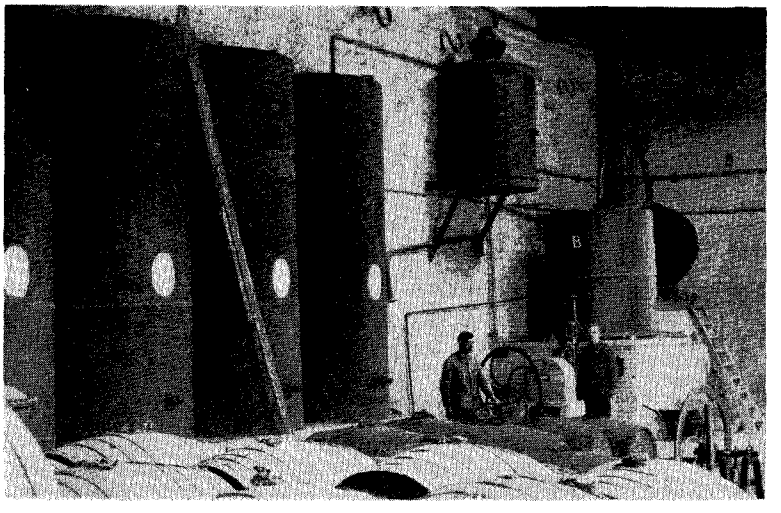
The principal cities in the brandy centers are Piraeus, Athens, and Au Piree. Brandy distilling is an old industry, and a number of the plants are now well over a century old. Distilling brandy is somewhat of an art or a trade, and a majority of the employees spend most of their lives in the plants. Sons, fathers, and grandfathers often work together and follow or take the place of one another in the same plant. Some of the larger brandy distilleries have an annual capacity of 500,000 gallons. A large number of French Cognac brandy pot stills are in use.

A characteristic factor, which has a decided influence on the finished product, is that the brandy is stored in large oak barrels ranging in capacity from 400 to 2,000 gallons (1,500 to 7,500 liters). This large volume reduces the amount of contact of the liquor with the wood, and only a small amount of extractives are obtained. These large barrels or casks are often in continuous use for fifty years or more; they naturally have very little effect on the brandy in so far as the congenerics, tannins, and coloring matters extracted, added, or developed during the aging of the brandy are concerned. Recently some distillers shipping brandy to America have begun to use the standard 60-gallon (240-liter) barrel. In Greece, as in France, no cask or barrel used for brandy is charred inside.

The companies usually manufacture their own barrels from large white oak staves, imported chiefly from Yugoslavia and Russia; some of the wood used for brandy boxes comes from Rumania.

The selection and blending of wine to be used for the distillation of wine spirits play a major part in the brandy industry. The wine that is distilled may be made from over fifty varieties of grapes, and comes from nearly all of the principal wine-producing districts of Greece. The wine is distilled within the year of its production. Wine more than a year old is rarely distilled, and then usually to clear the stocks left from the previous season.

The white wines of Attica, which are said to possess a fine aroma, are used mostly for brandy. The stars found on the

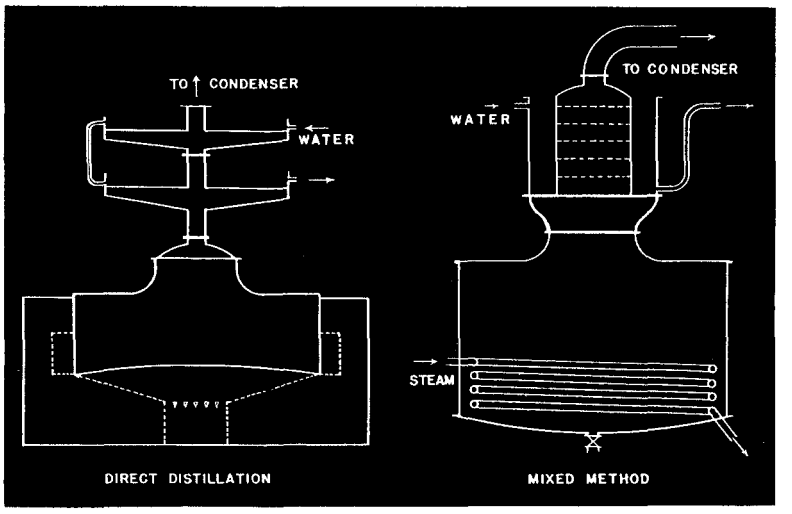


Courtesy, Panayiotis Barbaressos

A CORNER OF A DISTILLATION ROOM IN ONE OF THE RURAL GREEK DISTILLERIES

Greek brandy labels indicate the age of the brandy in a general way; three stars usually mean from four to seven years old; five stars over seven years old; and on older brandy may be found the letters "V. O.," "V. S. O. P.," and other designations indicating unusually old brandy. Some Greek brandy on the market has claimed unusual age (over 25 years) without the presence of any unusual concentration of congenerics. This is accounted for by the small influence the very large cask has on congeneric development.

The Greeks apparently object to the oaken or wooden taste in their brandy; it is interpreted as bad quality, and its sale to Greeks is difficult. In order to avoid this taste, they employ the very old barrels for aging; before any newly made barrels are used, they are washed and soaked thoroughly with hot water and live steam, which extracts a great deal of the available tannin and some of the natural coloring material.



Courtesy, Barbaressos Bros.

FIGURE 1. TWO METHODS OF DISTILLING GREEK BRANDY

Brandies are produced in all the provinces and from the distillation of wines of various varieties of grapes which are different from and contain a larger amount of sugar than the French Charente brandy grapes. The must of Greek grapes contains 220 to 275 grams per liter of fermentable sugar (glucose and levulose) and gives to the wine, after fermentation, from 13 to 14 per cent alcohol by volume. Fermentation takes place at the time of the crop (August to September) at the usual temperature of 32° to 36° C. (90° to 97° F.). The acidity of the Greek grapes and wine is low, varying from 1.7 to 3.5 grams (as sulfuric) per liter of wine; as a result, there is a tendency to low ester development. It is said that the dry climate and high temperature that prevails in Greece prior to the vintage (June, July, and August) has an important bearing on the wines and the brandy distilled from them. The fermentations are all spontaneous. Cultivated pure yeast cultures are rarely employed. The brandies are always lighter in body and weaker in taste than the French Cognac brandies, even when made the same way.

The Greek Government issues certificates (*A postagma inou*) for genuine brandy stating that "the receptacle or bottle contains brandy produced from the distillation of wine and has remained for over three years in oaken barrels for maturity." The certificates do not mention the proof under which the wine is distilled, because it is expressly stated in Greek Law No. 971 governing the alcoholic beverages that "no genuine brandy can be produced under degrees higher than 80 alcohol degrees (160 proof)."

After distillation, the genuine Greek brandy receives no preliminary treatment, such as the addition of chips, chemicals, or charcoal, but goes direct into the aging barrels. Caramel and sugar are added only when the brandy is ready to be given to the trade. There are three general methods of distilling brandy in Greece.

CHARENTE METHOD. The plant of this system consists of a 500-liter still body, a cylindrical or spherical pot cover, and a supply pipe which carries the vapors of the distilled wine to the cooling coils. The system is warmed by direct fire. The classical method of distillation in this type of pot still consists of two distinct periods of distillation.

During the first period they distill the wine and collect the distilled alcoholic liquid, which amounts to about one third of the wine that has been put into the pot. This liquid, which contains the whole of the alcohol existing in the distilled wine, shows a strength of 25 to 35 per cent by volume (that is, 50 to 70 proof). Three such distillations take place which give a quantity equal to the whole capacity of the pot still (that is, 500 liters).

The second distillation period consists of distillation of the products of the first period. In this second period is distilled the brandy itself, which is taken at 67 to 72 per cent alcohol by volume (134 to 144 proof).

At the beginning of the second distillation period, special attention must be paid to separating the first fraction that begins to run out of the cooling plant and contains the aldehydes. This fraction has an acute and disagreeable odor and is designated by the term "head."

When the first fraction is collected and put aside, the second fraction (the true brandy) begins to collect. In Greece this second part of the liquid is designated by the term "body."

At the end the third fraction of the liquid, designated by the term "tail," is collected and put aside because it contains the substances that are distilled at higher temperatures and may include most of the fusel oil.

DIRECT DISTILLATION. By this method (Figure 1) the production is effected by one single distillation. During the distillation there are separated the first part of the running liquid (the head), the middle part (the body) which represents the brandy taken at 70 to 72 per cent alcohol by volume, and the third part (the tail).

MIXED METHOD (POT AND COLUMN). By this method (Figure 1) both the distillation and separation are effected the same way as in the direct distillation method. A column is provided with five rows of disks placed over the body of the pot. The whole column is surrounded by water, and the system is warmed by the circulation of steam in a pipe coil. The brandy produced by this method has 72 to 78 per cent alcohol by volume. The head and tails are eliminated as in the other two methods.

From Table IV, which represents practically all of the brands of Greek brandies imported into the United States, there are certain outstanding features: The Greek brandies, as a rule, are much higher in solid content than the French Cognacs; they have a generally lower acid and ester content, but are usually higher in aldehydes, there is a tendency for the Greeks to use more caramel per unit than any other producers. The brandy or grape taste and aroma are not as pronounced as in French Cognac; yet Greek brandy seems, in general, to be nearer French Cognac in taste than to any other class of brandy. Because of the practice of aging in large old casks, there is very little color in the brandy due to the wood. Although pot stills of the cognac type are the rule in Greece, about one third of the Greek brandies in Table I were distilled in highly rectifying (patented) stills, and hence are weak in natural brandy flavor. The principal character of many of the samples was obtained by the ingredients added after the product was distilled. Some of the ingredients found in these brandies were imitation brandy flavor, anise, wine, and cream of tartar. Two samples were so high in solid content that they were classed as liqueurs or cordials.

Table V. Changes Taking Place during Storage of California Brandies

Sample No.	Date Taken	Proof	pH	Total Acids	Volatile Acids	Esters	Fusel Oil	Solids	Ash	Alde-hydes	Fur-fural	Color in Half-In. Cell	Approx. Age
				Grams/100 liters (not calcd. to proof)									
U. S. Brandy No. 1 (Serial No. 7724)													
Grape brandy made from wine distilled in a copper continuous still using beer column only and stored in re-used plain barrel. Brandy was colored with caramel at time of filling. Samples gave positive tests for methanol (0.05%). Ash was white and contained some iron; most of this inorganic matter apparently came from the bottle. The barrels were set aside in U. S. bonded warehouses for experimental purposes. Proof of distillation, 168–178. Exclusive of samples taken, 6.43 wine gallons of brandy were lost from the barrel in 4 years.													
50592	10-31-34	100	6.78	3.6	3.6	24.6	75.2	57.8	9.0	2.0	0	5	New
57282	5-22-35	100	5.50	9.6	7.2	25.8	76.6	68.0	6	3.0	0	4.5	6 mo.
63728	12-20-35	100	5.12	14.4	13.2	26.0	77.2	70.0	6	3.2	0.14	5.0	1 yr.
71107	7-8-36	100.6	5.00	16.8	15.6	26.3	77.4	79.2	7	3.4	0.16	5.0	1½ yr.
74256	11-13-36	101.5	5.00	19.2	18.8	26.3	79.2	72	6	3.4	0.16	5.0	2 yr.
77919	5-6-37	101.5	4.92	21.6	20.4	26.4	82.2	82	9	3.0	0.2	5.5	2½ yr.
83420	11-3-37	101.6	4.85	24.0	21.6	29.0	82.7	84	6	3.3	0.3	5.0	3 yr.
88958	5-3-38	102.3	4.83	26.0	22.8	30.4	83.5	88	17	3.5	0.4	5.5	3½ yr.
93456	11-3-38	102.8	4.82	27.6	25.3	31.7	84.5	94	4.0	3.7	0.4	6.0	4 yr.
U. S. Brandy No. 2 (Serial No. 2107)													
Grape brandy distilled from wine in one continuous distillation at about 163 proof. Aged in new plain white oak barrel and colored with caramel at time of filling. Samples gave positive tests for methanol (0.085%). Ash was white and due mostly to inorganic matter extracted from glass bottle as a sample and also to some matter extracted from the original barrel during aging. Exclusive of samples taken, 8.44 wine gallons of brandy were lost from the barrel in 4 years.													
51370	11-17-34	100.3	5.35	8.4	7.2	40.5	79.2	65.6	27	2.0	0.5	2.5	New
56883	5-16-35	101.8	4.01	40.8	32.4	44.9	83.1	104	19	6.0	0.7	5	½ yr.
64995	1-9-36	102.8	3.96	62.4	46.8	58.1	85.3	172	17	7.9	1.4	10	1 yr.
71106	7-10-36	103.4	3.95	67.2	49.2	58.9	86.2	180	16	7.7	1.4	10.5	1½ yr.
74259	12-3-36	103.4	3.93	69.6	52.8	59.8	88.9	194	18	7.8	1.4	10.5	2 yr.
77964	5-4-37	104	3.92	74.4	56.4	62.5	100	198	21	8.4	1.2	11.5	2½ yr.
83269	11-4-37	104.6	3.91	76.8	62.2	66.6	102	214	15	9.8	2.0	12.0	3 yr.
88992	5-3-38	104.6	3.91	76.8	64.8	67.8	103.4	215	15	10.8	2.0	13.0	3½ yr.
93285	11-3-38	105.1	3.90	79.2	65.4	71.3	104.3	230	14	11.2	2.0	13.5	4 yr.
U. S. Brandy No. 3 (Serial No. 18965)													
Grape brandy distilled in a copper continuous still at about 180 proof. Aged in new plain barrel and colored with caramel at time of filling. Samples gave test for methanol (0.085%). Ash was white and due to inorganic matter extracted from the glass and also from the barrel. Solids in sample 51368 due to caramel. Exclusive of samples taken, 8.36 wine gallons of brandy were lost from the barrel in 4 years.													
51368	11-10-34	100.3	6.48	4.8	3.6	47.5	63.4	42.6	8	4.2	0.3	4	New
56885	5-11-35	99.4	4.67	16.8	15.6	47.5	64.1	58.0	7	5.3	0.5	4.5	½ yr.
64239	11-12-35	99.8	4.55	43.2	32.4	45.8	66.3	84.0	8	6.9	1.0	5.5	1 yr.
71111	5-12-36	99.8	4.52	40.8	36.0	49.3	68.6	97.2	6	6.9	1.2	6	1½ yr.
74254	11-12-36	100.9	4.46	48.0	42.0	49.3	70.1	104.0	7	8.1	1.2	6.5	2 yr.
77968	5-1-37	101	4.46	50.4	44.4	53:7	72.2	104.0	8	8.4	1.2	6.5	2½ yr.
83267	11-2-37	102.4	4.45	55.2	50.4	53.7	75.7	118.0	7	8.5	1.2	7.0	3 yr.
88986	5-3-38	103.0	4.44	55.2	50.8	54.5	78.2	129	9	8.8	1.3	7.5	3½ yr.
93294	11-3-38	104.2	4.43	60.0	54.0	57.2	79.2	144	6	9.7	1.5	7.5	4 yr.
U. S. Brandy No. 4 (Serial No. 4252)													
Brandy distilled 4-8-37 from wine and then run through a Hebert continuous still at 188 proof. Aged in new plain barrel. All samples contained earamel coloring and gave positive tests for methanol (0.05%). Exclusive of samples taken, 4.47 wine gallons of brandy were lost from the barrel in 19 months.													
77885	5-1-37	101.8	5.02	4.8	3.6	14.1	22.9	51	4	6.7	0.5	5	1 mo.
80648	8-3-37	101.0	4.63	25.4	21.6	14.1	24.6	73	3	8.4	0.6	5.5	4 mo.
81212	8-27-37	101.6	4.63	26.4	22.9	14.1	26.4	77	6	8.4	0.6	6.0	4¾ mo.
84379	12-3-37	101.6	4.57	31.2	25.3	15.0	26.4	80	6	7.4	0.6	6.0	7¾ mo.
86161	2-3-38	101.6	4.57	33.6	27.6	15.8	26.4	88	4	8.5	0.7	6.0	10¾ mo.
89024	5-2-38	101.4	4.55	38.4	28.8	18.5	28.0	92	5	7.5	0.7	6.5	13¾ mo.
91229	8-2-38	101.8	4.55	38.4	28.8	22.9	28.4	92	4	7.8	0.8	6.5	16 mo.
93230	11-2-38	101.9	4.53	40.8	36.0	22.8	28.6	98	6	8.9	0.8	7.0	19 mo.
U. S. Brandy No. 4 (Serial No. 3744)													
Brandy distilled 11-19-36 from wine lees and pomace in pot still, cut in proof, and doubled through Hebert continuous still at 180–185 proof. Classed as grappa. Aged in paraffined barrel. Sample contained no caramel coloring. All gave positive tests for methanol (0.05%). Exclusive of samples taken, 1.1 wine gallons of brandy were lost from the barrel in 2 years.													
75649	2-24-37	101.8	5.04	9.6	9.6	29.9	66.4	2	2	16.6	Trace	0.2	3 mo.
77883	5-1-37	101.8	4.87	9.6	9.6	31.6	66.9	8	7	16.5	0.3	0.2	6 mo.
80646	8-3-37	101.4	4.65	12.0	12.0	31.7	66.9	8	5	16.3	0.7	0.3	9 mo.
81210	8-27-37	102.0	4.65	19.2	13.2	31.7	66.4	8	3	16.3	0.7	0.3	9¾ mo.
84377	12-3-37	102.2	4.60	19.2	14.4	33.0	66.4	11.0	5	16.1	0.8	0.3	12¾ mo.
86163	2-3-38	102.2	4.62	19.2	15.6	35.0	66.4	14.0	6	16.1	0.8	0.3	15¾ mo.
89022	5-2-38	102.2	4.60	21.6	16.8	36.0	66.9	14.0	3	16.2	0.8	0.4	18¾ mo.
91227	8-2-38	102.4	4.60	24.0	19.2	36.1	66.9	22.0	3	16.2	0.8	0.5	21¾ mo.
93226	11-2-38	102.6	4.60	26.4	24.0	36.1	66.9	22.0	4	16.2	1.0	0.5	24 mo.
U. S. Brandy No. 5 (Serial No. 6113)													
Cognac type brandy distilled at 177 proof and aged in new plain white oak barrel. Brandy was colored with caramel; gradual increase in color was due to aging in wood. It does not have the taste and aroma of French Cognac. Samples gave positive tests for methanol (0.065%). The ash was pure white and gave a positive test for iron. The barrel and the bottle probably both furnished this inorganic matter. Exclusive of samples taken, 4.44 wine gallons of brandy were lost from the barrel in 2 years.													
72948	10-16-36	101.8	5.39	8.4	8.4	21.0	71.0	70	12	13	0.4	7.5	New
75258	1-29-37	101.8	4.95	16.8	15.6	22	72.2	92	14	13.2	0.6	7.5	3 mo.
77886	5-3-37	101.8	4.50	24.0	20.4	26.4	73.0	99	11	12.4	0.8	7.5	6 mo.
80781	10-3-37	102.0	4.47	33.6	30.0	27.3	73.7	112	12	13.1	1.2	7.5	12 mo.
85870	2-1-38	102.0	4.48	45.6	39.6	29.9	73.9	118	13	13.9	1.4	8.0	15 mo.
88956	5-2-38	102.5	4.46	48.4	41.0	33.4	74.2	122	9	12.4	1.0	8.0	18 mo.
91379	8-2-38	102.8	4.45	50.4	45.6	34.3	75.4	128	8	13.1	1.0	8.5	21 mo.
93368	11-3-38	102.8	4.42	55.2	48.0	35.5	75.7	144	10	14.1	1.2	9.5	24 mo.
U. S. Brandy No. 6 (Serial No. 3493)													
Cognac type brandy distilled at about 187 proof in a continuous still and aged in new charred white oak barrel. Light caramel coloring added, but color in older samples was due mostly to the aging in charred wood. It has not the taste and aroma of Cognac but a predominating charred barrel taste. Samples gave a positive test for methanol (0.09%). The ash was white and gave a small positive test for iron. It is believed that both the barrel and the bottle furnished this inorganic matter. Exclusive of samples taken, 4.14 wine gallons of brandy were lost from the barrel in 2 years.													
76301	3-9-37	101.2	4.87	24.0	19.0	15.0	10.6	62	7	3.6	4	5.0	4 mo.
77966	5-5-37	100.8	4.67	33.6	30.0	15.0	10.6	70	7	3.6	5	6.0	6 mo.
80703	8-5-37	101.0	4.50	48.0	40.8	20.2	10.6	106	9	4.5	6	7.5	9 mo.
83271	11-4-37	101.6	4.45	55.2	48.0	20.2	10.6	124	9	5.5	6	10.0	12 mo.
85989	2-2-38	102.0	4.40	60.0	48.0	22.9	10.6	128	8	5.8	6	10.3	15 mo.
88990	5-3-38	101.8	4.40	62.4	48.0	28.2	12.0	135	7	6.3	6	10.5	18 mo.
91543	8-3-38	102.8	4.38	64.8	55.2	29.3	12.3	148	7	6.3	6	11.0	21 mo.
93287	11-3-38	103.5	4.35	70.8	57.9	33.4	12.3	164	6	7.3	6	12.5	24 mo.

Methanol in Brandy

During the fermentation and distillation of fruits such as plums, apples, grapes, peaches, apricots, and other fruits, a very small amount of methanol is formed. For the past twenty years or more, numerous articles have been published in several languages concerning its presence in brandy, and the various means for its detection and quantitative determination. Wilson (*16*) developed an excellent quantitative method which subsequently became a tentative method of the Association of Official Agricultural Chemists (*1*). Wilson also furnished a brief review of previous methods and a comprehensive list of selected references.

Inasmuch as the apparatus used in the Wilson method, based on the Zeisel-Fanto (*18*) principle, is rather elaborate and would not usually be set up by brandy distillery laboratories doing control and limited research work, a simpler method was proposed and used by Beyer (*2*). A colorimetric process based on the Georgia-Morales method (*4*) for the quantitative determinations of methanol was used in all of the brandies analyzed for this report.

During 1929 and 1930, seventy-two samples of brandy were taken from representative packages (part of all of the legitimate brandy in the storage in government-supervised concentration warehouses throughout the United States), in order to determine its quality, general condition, and fitness for medicinal use. This information was utilized to determine whether or not any brandy would be allowed to be imported into or manufactured in the United States for medicinal purposes during the prohibition period. It was found that most of this brandy was well aged and of a good grade, and was representative of approximately 10,000 barrels and about 500,000 gallons (when filled) of legitimate brandy (mostly grape and some apple). Most of it was produced in the fall seasons of 1911 to 1917, and a small amount was made between 1918 and 1923. All of these samples contained from positive traces to very small quantities of methanol. The samples were tested, qualitatively only, by the Georgia-Morales method (*4*).

Plum, apple, and other fruit brandies usually show more methanol than grape brandy. This may be accounted for by the fact that the latter contains less pectin and is usually more highly rectified during its distillation, more often with the elimination of some of the heads.

Espinosa (*3*) suggested that the high tartaric acidity in the presence of steam hydrolyzes the pectins, favoring methanol formation, and that it is possible to separate methanol from the ethanol by continual retrogression without modification of the apparatus now in use in distilleries, if there is a good rectifying column.

The presence of methanol in brandy may serve as a valuable index as to whether its origin is fermented fruit. Brandies made in various ways with neutral spirits as a base are not likely to show the presence of methanol.

The lower methanol content found in Cognac and Greek brandy may be due to the fact that the distillers eliminate more of the heads during distillation. The heads usually contain a higher proportion of methanol, the lowest boiling of all alcohols. By the setting aside of the first heads, a considerable portion of the aldehydes is also lost.

Tables I and II show the actual amount of methanol in commercial brandies. The methanol content of the Kentucky fruit brandies reached 0.6 per cent; this was no doubt due to the fact that all of this brandy was distilled from a fermented mash of the whole fruit in a pomace still. When fruit brandy is distilled from cider and other fermented fruit juices, the average methanol content is actually less than 0.1 per cent. The average methanol content of grape brandy is less than 0.05 per cent. Mallory and Beyer also found Mexican tequila to contain from 0.10 to 0.17 per cent methanol.

The procedure of analysis of brandy for methanol content is outlined under "Methods of Analyses." Figure 2 shows the simple distilling apparatus devised by G. F. Beyer and used for the quantitative determination of methanol in these brandies. The method has been improved by the use of a more efficient still, a constant-temperature room, and the neutral wedge photometer.

Changes in Brandy during Storage

In order to determine the changes taking place in California grape brandy during storage, fourteen barrels (only seven are shown in Table V) of commercial brandy were set aside for observation and analysis in United States Internal Revenue bonded warehouses, in the six principal brandy centers of California (Table V). This brandy was made by six of the leading distilleries, representing about half of all the commercial grape brandy produced in California. In this group all of the various kinds of barrels commonly used for storing beverage brandy are represented.

The producing distilleries are numbered 1 to 6, and each barrel is identified by its serial number. All of the brandy was colored with caramel, except the two lots of grappa that were stored in paraffined barrels by distillery 4. Grappa brandy is always sold with as little color as possible.

The changes taking place in stored brandy are similar to those in whisky and in rum. New charred barrels cause the most extensive changes; new plain barrels, re-used barrels, and paraffined barrels are next in order of changes. Even

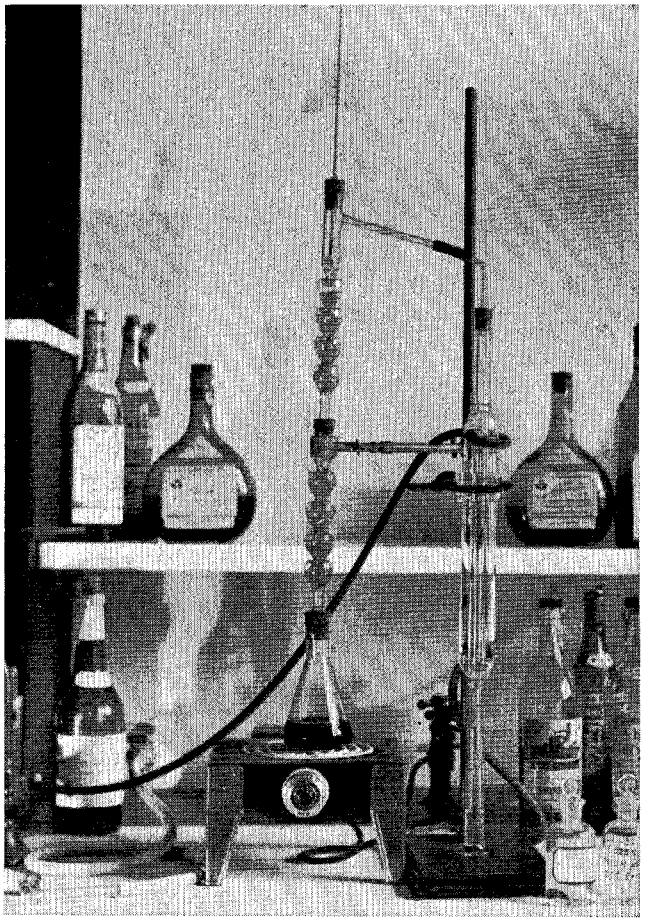


Photo by A. A. Spear

FIGURE 2. APPARATUS FOR THE QUANTITATIVE DETERMINATION OF METHANOL IN BRANDY

in the paraffined barrels, a gradual change takes place in the brandy, resulting in a slow increase in congenerics, a slight increase in color, and a small loss of volume. There is more furfural in the brandy aged in charred barrels and less in the brandy aged in plain re-used barrels.

The brandies from distilleries 1, 2, and 3 were sampled every six months, and those from distilleries 4, 5, and 6, every three months.

One of the most apparent changes is in the ester–total acid relation. In the new brandy the esters are usually present in larger amounts, but during the aging in barrels, the ester increase is much less than the acid increase; after a year or so in storage, these values are not so far apart. Generally, however, the esters exceed the acids in brandy. There was no apparent change in the methanol content during the aging periods.

The series of analyses shown during the successive months of aging is typical of nearly all of the California grape brandy. Most of this brandy is aged in new plain barrels and resembles the brandies from distilleries 2, 3, and 5. The greater part of this kind of brandy is marketed when it is about two years old.

The tables show that the increases in proof, acids, esters, fusel oil, solids, and other ingredients are slower in the plain packages used for brandy and the increases are more uniformly distributed over the whole period of aging, than in the case of whisky or rum. These latter spirits are aged mostly in new charred cooperage where the greatest changes occur during the first six months.

Caramel

Brandy is unique among the distilled liquors of the United States in that it may be colored with caramel (burnt sugar) without incurring a rectification tax, provided it is added at a certain specified stage of manufacture. This practice dates back a half century or more, and is a privilege allowed brandy distillers in the United States to enable them to compete with certain imported brandy that is similarly colored. Caramel coloring must be added at the time the newly made beverage brandy is filled into barrels on the distillery premises. It must be a true coloring substance and used for the purpose of producing color only. Inasmuch as the addition of caramel adds solids, it is important in brandy analyses to know how much of the total solid content of a sample is due to caramel added and how much to the extraction from the wooden barrel during aging. No artificial coloring except caramel was found in any brandy analyzed here.

Experiments with most of the commercial caramels sold for spirit coloring showed that the usual amount required is about 4 fluid ounces per 50-gallon barrel of colorless brandy. This produces a depth of color of 6 to 12 in the half-inch cell of the Lovibond tintometer (brown series 52), and this amount of caramel coloring furnishes at the same time a total solid content of 56 to 78 grams per 100 liters of brandy.

In order to obtain the rigidly correct proof of a sample of brandy, it should be carefully distilled. The addition of 6 ounces of caramel coloring to a 50-gallon barrel of brandy produces a solid content of 0.068 gram per 100 cc. and causes an aberration of proof of 0.25. The addition of 0.25 gram per 100 cc. of sugar produces an apparent loss of proof of 1°.

The ash content in brandy is usually small and tends to increase with any forced aging such as heat treatments in barrels or in the presence of oak chips and during long periods in glass containers.

Imitation Brandy

Brandy is not imitated as extensively as some other liquors, but adulteration and substitution are practiced to some extent. Imitations are usually produced from neutral spirits or highly rectified grape spirits to which have been added essences consisting of ethyl acetate mixed with esters of higher molecular weight having a grapelike character. Special mixtures comprising imitation brandy flavor containing grapeseed oil and other essential oils are sometimes employed. The use of vanillin, grains of paradise, carob bean, and St. John's head, and the addition of wines to brandy are the older methods of building up brandy character. Brandy is deemed an imitation if any sort of distilled spirit is added other than brandy, or if it is distilled from a fermented mash of fruit, sugar, and dextrose. Vegetable and fruit infusions and solid and liquid wood extracts are sold for the purpose of simulating French Cognac. In some instances these substances are so adroitly blended with brandy or neutral spirits that they are almost impossible to detect, although in most instances such brandies are obviously not real. These devices constitute rectification under the internal revenue laws and must be labeled "imitation" under the Federal Alcohol Administration regulations (*12*).

Methods of Analysis

The methods for all brandy analyzed here were substantially those of the A. O. A. C. (*1*) and those described in the work of Valaer and Frazier (*15*) and Valaer (*14*):

PROOF. Pycnometers were used except when the solids were greater than normal (0.2 per cent for aged brandy), in which case the liquor was distilled and the pycnometer used.

ACIDS. Total acids were determined by adding 50 cc. of water and 25 cc. of brandy to an Erlenmeyer flask, and the mixture was titrated with 0.1 *N* sodium hydroxide and calculated as acetic acid.

Volatile acids were determined by distillation with steam (using a tube apparatus), until no further volatile acids were distilled. The volatile acids were calculated as acetic.

The volatile acids in most of the brandies of Table V were also checked by evaporating the brandy just to dryness, adding 10 to 15 cc. of boiled distilled water, and again evaporating to dryness. The residue was dissolved in 25 cc. of neutral alcohol (50 per cent), diluted with 50 cc. of water, and the fixed acids were titrated with 0.1 *N* sodium hydroxide. The difference between this figure and that obtained for the total acids represents the volatile acids. It has been recommended by the associate referee on "Volatile Acids in Distilled Spirits" that this method be studied further with the view of adopting it as an official A. O. A. C. method.

PH. This figure, which has become almost routine in spirits analysis, was determined by a Leeds & Northrup potentiometer; it proved a valuable aid in indicating the available acidity and in detecting the presence of any highly ionized acids.

ESTERS. The official method was used (*1*).

TASTE AND ODOR. These properties of brandy are so characteristic and so difficult to imitate that they play an indispensable role in the ultimate analysis of brandy.

COLOR. Depth of color was determined in a half-inch standard cell and by the use of the Lovibond tintometer, using the brewer's scale, brown series 52 (*15*).

ALDEHYDES. *Reagents.* Standardize a 0.05 *N* sodium thiosulfate solution against a 0.05 *N* potassium dichromate solution as follows: Place 20 cc. of the 0.05 *N* potassium dichromate solution in a glass-stoppered flask and 5 cc. of a 15 per cent potassium iodide solution. Add 2.5 cc. of concentrated hydrochloric acid and dilute with 100 cc. of carbon-dioxide-free water, then titrate the liberated iodine at once with the thiosulfate solution until the yellow color has almost disappeared; add a few drops of starch indicator and continue, with constant shaking, the addition of thiosulfate solution until the blue color just disappears.

Standardize a 0.05 *N* iodine solution against the thiosulfate solution.

Add about 5 to 10 per cent of alcohol to an approximately 0.05 *N* sodium bisulfite solution; the alcohol keeps it from deteriorating so fast. The strength of this solution should always be determined in terms of the iodine solution with each series of aldehyde determinations.

Determination. Run 50 cc. of sample into an Erlenmeyer flask and add 10 cc. water, distill off 50 cc. or slightly more and transfer it to a glass-stoppered flask or bottle, and add about 150 cc. of carbon-dioxide-free water. With a pipet add 25 cc. of the bisulfite solution and allow the mixture to stand for about 30 minutes,

shaking occasionally. Add an excess (about 30 cc.) of the standard iodine solution, then titrate this excess with the thiosulfate solution and calculate as acetaldehyde. Each cubic centimeter of 0.05 *N* solution used is equivalent to 0.0011 gram of acetaldehyde.

Do not add the starch indicator until the yellow color of the iodine solution has almost disappeared. As the end point is approached, the solution will have a decided violet tint rather than a blue, as is customary with iodine and starch. If the end point is in doubt, add a little more of the starch indicator. The formation of a bluish violet color indicates that the end point has not been reached.

Always run a blank on the bisulfite solution along with each series of aldehyde determinations.

This method or one based on the same principle is being recommended by the associated referee on "Aldehydes in Whisky and Other Potable Spirits," A. O. A. C.

METHANOL. Place 25.0 ml. of brandy in a 250-ml. Erlenmeyer flask and connect with any efficient laboratory fractionating column for the purpose of increasing the percentage of total alcohols present.

The efficiency of the column should be tested by distilling a sufficient quantity of a solution containing approximately 50 per cent alcohol. The column should be sufficiently efficient to produce consistently a distillate containing 92–93 per cent alcohol.

Distill off 5.0 ml. very slowly and dilute to approximately 35 per cent total alcohols. Place 4.75 ml. water in a 6-inch Nessler tube and add 0.25 ml. of the diluted distillate with a 1-ml. pipet graduated in hundredths. Add 2.0 ml. of a 3 per cent potassium permanganate solution containing 15.0 ml. of sirupy phosphoric acid (85 per cent) per 100 ml. and mix thoroughly without inverting the tube. Allow to stand 10 minutes with occasional shaking and then add 2.0 ml. of a solution containing 5 grams of oxalic acid in 100 ml. of 1:1 sulfuric acid. As soon as the color is discharged, add 5.0 ml. of a modified Schiff's reagent prepared by dissolving 0.2 gram of Kahlbaum's rosaniline hydrochloride in 120 ml. of hot water. Cool, add 2.0 grams of sodium sulfite previously dissolved in 20.0 ml. of water, and then add 2.0 ml. of concentrated hydrochloric acid. Dilute this solution to 200.0 ml., mix, and store in a cool place in glass-stoppered amber bottles.

The maximum color is scarcely produced in less than about 60 minutes, when the sample should be compared with a set of standards that vary from each other by 0.025 per cent methanol by volume.

Standards containing more than 0.15 per cent methanol produce a color too intense for accurate color comparison. Therefore, any samples containing more than this quantity of methanol should be diluted with 35 per cent ethyl alcohol before testing. The standards may be prepared so that 5.0 ml. will contain the proper amount and concentration of alcohols.

Conclusions

1. The difference between the brandies made in France, Greece, Spain, California, and other parts of the United States is easily distinguishable.

2. The esters appear to be the most important natural ingredient from which brandy derives its general characteristics.

3. The kind of cooperage has much to do with the quality and flavor of brandy. Charred barrels usually furnish too much wood flavor, re-used barrels barely enough. New plain barrels are the standard containers for the storing and aging of grape brandy.

4. Brandy flavor, in general, is more delicate than that of other distilled spirits and is easily affected by impure water, certain metals, and improper wooden containers; it is rarely improved by the usual quick-aging methods.

5. American brandy is distilled, aged, and bottled at higher proof than most other American or foreign distilled spirits.

6. A small amount of methanol is apparently inherent in all authentic brandy; it is generally less in grape than in other fruit brandy.

7. With the exception of apple brandy and some other fruits that are distilled at a low proof (well below 160) to obtain maximum flavor and are stored in new charred barrels for aging and to produce color, practically all other brandy, both foreign and domestic, is colored with caramel.

8. Ethyl acetate is the most abundant and most easily formed ester during aging. The higher esters are formed more slowly and produce more characteristic flavors. Both ethyl acetate and higher esters are present in brandy at the time of distillation.

9. Principally because plain white oak barrels are almost universally used for storing and aging grape brandy, the development of acids, esters, solids, color, and proof is less at any time during a four-year storage period than is the case in the aging whisky or rum.

10. At least one important natural ingredient can be isolated from France's Cognac brandy which is not found in any other brandy and from which a great deal of the characteristic taste and aroma of cognac are obtained.

During the vintage season of 1938 there were distilled 9,500,000 proof gallons of commercial brandy, about five times as much as in any previous year. Its quality was assured by requiring fresh, sound, ripe grapes, a low proof of distillation (average 167), new plain washed barrels, a standard color, and pure water. It will be nearer in character to brandies 2, 3, and 5 of Table V.

Each of the six distilleries of the group shown in Table V set two barrels aside for aging, but the changes taking place during the aging in each set were so similar that it was considered necessary to show only the analysis of one barrel from each distillery.

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