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LIQUEFIED PETROLEUM ("BOTTLED") GASES

Abstract

This paper discusses the liquefied petroleum gases now becoming so popular for domestic and industrial use when distributed in tanks or "bottles" in districts beyond the reach of city gas mains. The composition, manufacture, properties and methods of distribution of these gases are described. The cost and uniformity of service and the selection and adjustment of appliances are discussed. The principal dealers are listed, with the character of the product supplied and the territory within which service is rendered by each.

Contents

The Constituents of Petroleum Gases and Some of their Properties

Natural gas and petroleum as they occur in nature consist of mixtures of many substances, called "hydrocarbons" by the chemist, the compositions of which vary in a regular manner, beginning with methane which has one atom of carbon and four of hydrogen in each molecule and is represented by the symbol CH_4. The first six members of the series and the symbols representing their compositions are as follows: Methane, CH_4; ethane, C_2H_6; propane, C_3H_8; butane, C_4H_{10}; pentane, C_5H_{12}; hexane, C_6H_{14}. In the case of butane and higher members of the series different arrangements of the atoms in the molecule are possible and cause slightly different properties. Ordinarily these different "isomers" are not separated, the only common exception being that "isobutane" is sometimes separated from "normal butane".

Methane is the principal constituent of the vast quantities of natural gas distributed from the wells through pipes and is a so-called "permanent" gas, which means that at ordinary temperatures it cannot be liquefied by applying pressure, no matter how great. It is nearly as hard to liquefy, by a combination of great pressure and low temperature, as is air. Hexane, at the other end of the list given, is a liquid which boils at 69°C (156°F) and is one of the principal constituents of ordinary gasoline. Gasoline itself is a mixture containing, in the main, hexane and still higher members of the hydrocarbon

series, but sometimes having appreciable amounts of pentane. The compounds intermediate in composition and properties between methane and hexane are those with which we are concerned as constituents of commercial "bottled gases".

Ethane can be liquefied by pressure alone at temperatures as high as 32°C (90°F), but if metal containers are to be filled with the liquid they must be of excessively heavy construction to be safe at temperatures to which they would be frequently exposed if made an article of commerce. Ethane is, therefore, seldom distributed alone and is of importance in this discussion only as its presence in solution in propane and butane affects their properties. It has a popular interest as the main constituent of the fuel used to propel the "Graf Zeppelin" during its flight around the world.

Propane is a gas at atmospheric pressure at all temperatures likely to be encountered in the United States, but can be liquefied by moderate pressure and is safe in a container of reasonable strength. Under practically all probable conditions of domestic use a cylinder of liquid propane will, therefore, deliver a continuous supply of gas at a pressure ample for its effective utilization. Normal butane boils at about the freezing point of water and, since its evaporation cools it somewhat, its liquid cannot be made to supply gas at a satisfactory pressure unless the surroundings of the container are at a temperature considerably above that point. Isobutane is slightly more volatile than normal butane; pentane boils at about 36°C (97°F) and is, therefore, a liquid at atmospheric pressure within the usual range of indoor temperatures.

Several of the characteristic properties of the hydrocarbons from ethane to pentane are listed in Table 1.

Table 1

Property	Ethane	Propane	Normal Butane	Normal Pentane
Boiling point	-127°F	-48°F	33°F	97°F
Heating value				
*Btu/cu.ft.of gas at 60°F	1782	2575	3350	---
Btu/lb.	22,200	21,600	21,300	21,000
Btu/gal.of liquid	---	96,000	107,800	113,200
Lb.per gal.of liquid at 32°F	---	4.444	5.06	5.39
Vapor pressure				
Temperature		Atmospheres		
-48°F	6.8	1.0	0.15	0.02
0°	16.3	3.0	.59	.11
+32°	24	4.9	1.0	.24
70°	38	9.1	2.2	.62
100°	--	13.8	3.5	1.05
150°	--	25	7.1	2.4
Temperature		Lb./sq.in.gauge		
-48°E	85	0	negative	negative
0°	225	29	"	"
+33°	338	57	0	"
70°	544	119	18	"
100°	--	188	37	0.7
150°	--	353	90	21
Critical temperature (above which gas cannot be liquefied by compression)	90°F	204°F	307°F	387°F
Specific gravity of gas (air = 1)	1.05	1.56	2.1	2.6
Volumes of air required for complete combustion of 1 volume of gas	16.7	23.8	31.0	38.2

* Btu is the abbreviation for British thermal unit and is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

These products in liquid form in the cylinders are not explosive except as any other confined gas, carbon dioxide or ammonia for example, is explosive. If a cylinder is heated the pressure increases, and in case one is in a fire it will eventually rupture with the effect of a boiler explosion, and will suddenly release a large amount of combustible gas, unless a safety device first relieves the pressure. Mixtures of the gas with air will also burn with explosive force just as in the case of any other combustible gas. The material is not explosive by itself, however, in the sense that acetylene is; and it is probably as safe to use with proper equipment as any other form of fuel. These petroleum gases are not poisonous, but their leakage should be guarded against as carefully as that of manufactured gas because of the fire hazard which any gas leak introduces. They are heavier than air and tend to flow along the ground when released in quantity instead of rising as ordinary manufactured fuel gas or natural gas does.

Manufacture of the Liquefied Petroleum Gases

The natural gases which constitute the principal source of the liquefied petroleum gases have been used for many years as a source of gasoline. Because the richest of these gases were drawn from the top of the casings of oil wells, they were called "casing-head gases" and the gasoline separated both from them and from "dry" natural gas (unaccompanied by oil) was called "casing-head gasoline". Casing-head gasoline, more recently named and now generally called "natural" gasoline as distinguished from the gasoline made in refineries, was separated from the

gas (1) by compression and cooling or by compression alone, (2) by dissolving under pressure in an oil somewhat less volatile than kerosene, from which it could subsequently be distilled, or (3) by "adsorbing" in a porous material such as "activated" charcoal, from which it was later driven by steam. In every case the higher hydrocarbons, pentane, hexane, etc., which were wanted as gasoline were accompanied by more or less of the lower hydrocarbons, propane and butane, which were not wanted because they made the gasoline too volatile. Originally the natural gasolines were allowed to "weather", that is, the dissolved propane and the other gases were allowed to escape at ordinary temperature and pressure, accompanied by a large amount of the gasoline vapor, until the gasoline was stable enough for sale. Eventually the process of submitting these escaping gases to "fractional distillation" was introduced, primarily for the purpose of recovering the gasoline they carried with them. Fractional distillation (or rectification) is the general process for separating liquids of somewhat different boiling points which occur together in solution by repeatedly evaporating and condensing portions of the mixtures. It is a process widely applied in the chemical industries; its most familiar examples are the separation of alcohol and water, and the preparation of oxygen by the fractional distillation of liquid air.

At first fractional distillation appears to have been used only to prevent the loss of gasoline during the removal of propane and butane, which were returned to the natural gas

line. Later the mixture of propane and butane with some ethane and pentane, liquefied together, began to find a market; but it was not long before the advantages of a complete separation of the gases, and their marketing as separate products, became apparent. This complete separation, like the partial separation first used, is accomplished by fractional distillation. At the present time both the mixed gases and the pure substances propane, butane, and pentane, are being marketed in large quantities.

Available Supply of Liquefied Petroleum Gases

The following information from a recent news bulletin of the Bureau of Mines shows the rapid development, in recent years, of the sale of these liquefied gases.

Table 2

Marketed Production of Liquefied Petroleum Gases

Year	Gallons
1926	465,068
1927	1,091,005
1928	4,523,899
1929	9,925,698

Nearly all of the present commercial supply is obtained from natural gas, but gases produced in petroleum refineries constitute a large potential source of the material. It is reliably estimated that available sources in this country are capable of supplying liquefied petroleum gases having a heating value considerably in excess of the total manufactured gas supply. This means that all homes in the United States

not now connected with mains supplying natural or manufactured gas, could readily be supplied with bottled gas service for the domestic uses for which fuel gas is commonly employed in cities.

Uses of Liquefied Petroleum Gases

The most important use of liquefied petroleum gas promises to be that of bringing the advantages of gas service for cooking, water heating, and refrigeration to homes beyond the reach of city gas mains. For these domestic uses a supply of propane is almost ideal. It is as satisfactory in every respect, except cost and the inconvenience of replacing empty cylinders, as the best manufactured or natural gas service. The cost of this service, relative to that of another gas supply, can be computed by comparing the cost per heat unit (not the cost per cubic foot). Actually, because of the uniform composition of propane and because of the uniform pressure assured by regulators and an always adequate pressure at the source of supply, it is possible to design and adjust appliances to burn propane much more accurately than is the case with appliances connected to the usually variable city gas supply; and this results not only in more uniform service but, if full advantage is taken of the possibilities by the designer of the appliance, in an important improvement in the efficiency with which the gas is used.

Pure butane is not much used for isolated domestic service because temperatures too low to give adequate pressure are frequently encountered. Butane, therefore, finds its market principally for the enrichment of city gas supplies and for use by industries which arrange to maintain the desired pressure

either by heating the liquid or forcing it to the burners under pressure provided mechanically. It has been extremely satisfactory for such service because of its uniformity.

Butane is also being extensively used to supply gas service from a central station to communities too small to support a manufactured gas plant of the usual type. In these small plants butane is usually mixed with air in certain proportions, and the mixture is metered to the customers as in the case of any other city gas supply. The air in this case serves mainly to prevent the condensation of the butane. Whereas pure butane cannot be supplied without condensing at a temperature below 33°F, a mixture of butane and air having, for example, a heating value of 300 Btu per cubic foot can be delivered without condensation at a temperature of -46°F. These mixtures of butane and air have proved economical for small communities because the plants in which they are prepared are simple, inexpensive, and practically automatic in operation.

Pentane is used to a considerable extent for supplying individual dwellings by passing air through the pentane container (usually bubbling it through the liquid) and using the resultant mixture of air and pentane vapor as the mixtures of butane and air are used from the small city plant. This system, of course, requires a means for mechanically supplying air under pressure. Aside from this requirement, the principal disadvantage of the system is the variability of the mixture with variations of the temperature of the pentane. Usually the pentane tank is buried deeply in the ground to reduce temperature changes.

The pentane systems are essentially the same as the systems for supplying air saturated with gasoline which have been in use in many places for thirty years or more. Old plants of this type can be used with pentane with an improvement in constancy of the gas supplied. If the substitution of pentane is made, appliances will generally have to be readjusted to take more air into the burner because of the greater proportion of fuel in the mixture supplied to the burner.

Petroleum gases which have not been completely separated into their constituents, but remain mixtures, are practically as useful for enrichment of manufactured gas supplies as are the pure hydrocarbons, but their use for individual domestic supplies involves considerable difficulty. If such mixtures are allowed to evaporate in the cylinders the gas first delivered is mainly ethane and propane; that delivered when the cylinder is nearly discharged is mainly butane and pentane. Such a variation in composition is too great to permit the satisfactory adjustment of appliances, hence liquid mixtures of this character are taken from the bottom of the container and vaporized in the line to the burner, usually in a specially arranged vaporizer heated by the burner itself. No appreciable change of composition then results during the discharge of the cylinder. A mixture of this kind may contain enough ethane and propane to give a satisfactory working pressure. Otherwise, the necessary pressure may be supplied by pumping air into the supply tank. Systems for the use of these mixtures were employed

several years before pure propane became commercially available, and several clever inventions were made to cope with the manifest difficulties involved in the control of pressure, the danger of leakage of the liquid from the house piping, etc. Many of the old systems using mixtures appear to have given very satisfactory service, but they can hardly be regarded as serious competitors of a propane system unless there is a considerable difference in the cost of fuel in their favor.

Systems for Maintaining the Supply of Gas

Two systems are in use for maintaining service. In the system more commonly employed, two cylinders of the fuel gas are installed in a metal cabinet outside the owner's home. Gas is used from one cylinder until it is empty. The other cylinder is then turned on, and the empty cylinder is returned to the dealer and a full one put in its place. In the less commonly used system, a single large cylinder is installed and periodically filled from a service truck, the amount of fuel supplied being determined by weighing the cylinder before and after it is filled.

The single cylinder system is obviously impracticable unless enough customers are grouped near together to justify the operation of a delivery truck to supply them. Where customers are closely grouped, the single-cylinder system should have considerable advantages of convenience and economy. The two-cylinder system is available anywhere.

Purchase of gases.- In all cases, liquefied petroleum gases should be purchased by weight. The reading of a pressure gauge gives no indication of the amount of fuel in a container until it is practically empty. The capacities of cylinders range from 25 to 150 pounds; the ones more commonly used contain 60 and 100 pounds. The cost of pure propane for domestic use ranges from about 8 to 15 cents per pound depending upon locality and source of supply. Pentane and mixed hydrocarbons are usually cheaper. For purposes of comparison it may be noted that propane at 10 cents per pound costs $4.63 per million Btu. The 600 Btu gas supplied in Washington, D. C., at $1.00 per thousand cubic feet costs $1.67 per million Btu. Kerosene at 10 cents per gallon costs 78 cents per million Btu. Electricity at 3 cents per kilowatt hour costs $8.57 per million Btu. Relative efficiencies in use are, of course, to be taken into account in judging the cost of service.

Selection and Adjustment of Appliances for the Use of Liquefied Petroleum Gases

The cost of liquefied petroleum gases is such as to justify considerable care in the selection of the appliances with which they are used. In general, the recommendations of the company supplying the fuel should be followed, but the purchaser should have in mind the fact that an appliance built to burn propane differs from one for manufactured or natural gas only in the change of a few simple dimensions, mainly drill sizes, and that these differences do not justify any large increase in cost over an appliance of similar quality designed for use with the usual city supplies. The appliance and its accessories including

pressure controls should be carefully adjusted by an expert after installation,and should not be changed by the user without consulting the company which supplies the gas.

Effect of Impurities in Propane

If the gas is evaporated in the supply tank and drawn from the top, it is essential that the liquid be propane of fairly high purity. Otherwise, a decided change in composition will result during the discharge of the fuel. The presence of a little ethane may cause a great deal of trouble from backfiring (flashing back) or blowing from the ports (burner openings) when a fresh cylinder is first connected. The presence of butane, on the other hand, will result in improperly aerated flames and incomplete combustion, particularly when the fuel is nearly exhausted. Table 3 shows the variation in the composition of the gas drawn at constant temperature from a cylinder filled originally with propane containing ten per cent of ethane. Table 4 gives similar data for variation in composition of gas drawn from a supply of propane contaminated with a similar amount of butane.

It is not to be supposed, because these examples are given, that commercial propane is likely to contain as much as 10 per cent of another hydrocarbon. Much of it is at least 99 per cent pure and is practically indistinguishable in use from the absolutely pure substance.

Table 5 is given to show the different extents to which impurities affect the constancy of composition of the gas in the case of a single-cylinder system. If half the fuel is used after each filling, with propane containing 10 per cent

of butane, the variation in composition during use is only about ten per cent of that which results if the double-cylinder system is employed. Obviously, the smaller the fraction of the supply used between replenishments, the more uniform is the supply.

Table 3

Composition of liquid and vapor during the vaporization of a liquid containing at the start 90 per cent of propane and 10 per cent of ethane. (Vaporization at 70°F)

Liquid remaining % of original	Ethane in vapor %	Ethane in remaining liquid %
100	32.4	10.0
90	26.7	7.2
80	20.0	5.3
70	15.2	3.9
50	6.4	1.6
30	1.2	0.29
20	0.35	0.08
10	0.04	0.004

Table 4

Composition of liquid and vapor during the vaporization of a liquid containing at the start 90 per cent of propane and 10 per cent of butane. (Vaporization at 70°F)

Liquid remaining % of original	Propane in vapor %	Propane in remaining liquid %
100	97.4	90
75	96.6	88
50	95.3	83
36	94.0	79
25	91.2	73
15	87	62
10	80	46
5	65	20
2	17	5
1	3	0.8

Table 5

Composition of liquid and gas in a container repeatedly filled with a mixture of 90 per cent of propane and 10 per cent of butane if one-half of the material is used from the container after each filling

No. of fillings	Composition after filling		Composition when container is half empty	
	% propane liquid	% propane vapor	% propane liquid	% propane vapor
1	90.0	97.4	83.0	95.3
2	86.5	96.4	76.9	93.1
3	83.5	95.5	72.9	91.5
4	81.5	94.8	69.2	90.0
5	79.6	94.2	67.3	89.1
8	77.2	93.2	63.3	87.5
10	76.4	92.9	62.4	87.2
20	76.1	92.8	62.2	87.0

Table 6 is given to show the effect on the operation of a burner of varying the composition of the mixture from propane to butane. For a burner to remain in perfect adjustment without changes by the operator, the "Btu per hour" (Column 4) and the "per cent of air required for combustion" (Column 5) which is injected as primary air (air which enters the burner with the gas) should remain unchanged. The extreme variation shown in the tables is too great for satisfactory service.

Similar data are given in Table 7 for the gases prepared by bubbling air through pentane at different temperatures. The importance of placing the pentane container where the temperature will be as uniform as possible is clearly shown. At a depth of 6 feet the average ground temperature varies about 20°F between winter and summer, the maximum varying, of course, with latitude.

An attempt is made in Table 8 to list the principal dealers in liquefied petroleum gases and systems for using them. The list, while probably incomplete, will enable the reader to identify many of the gases commonly sold under trade names, and to ascertain a source of supply convenient to his home.

Table 6

Properties of mixtures of gaseous propane and butane. Under operation of burner it is assumed that a burner is adjusted with pure propane to give 10,000 Btu per hour and 60 per cent of the air required for combustion is primary air.

% propane in mixture	Heating value Btu/cu.ft.	Specific gravity (Air = 1)	Operation of a burner Btu/hr.	Operation of a burner Primary air % required for combustion
100	2575	1.562	10,000	60
90	2652	1.613	10,130	59
75	2769	1.689	10,340	58
50	2963	1.810	10,680	56
25	3156	1.941	10,990	55
0	3350	2.067	11,300	53

Table 7

Composition and other properties of air saturated at different temperatures with pentane vapor. Under "operation of burner" it is assumed that a burner is adjusted for a mixture saturated at 70°F to give 10,000 Btu per hour and to take 60 per cent of the air required for combustion as primary air (including the air in the gas supply)

Temp.	% pentane in mixture	Specific gravity (Air = 1)	Heating value Btu/cu.ft.	Operation of a burner Btu/hr.	Operation of a burner Primary air % required for combustion
32°F	24	1.38	985	4600	134
50°	38	1.60	1560	6700	90
70°	62	1.97	2540	10,000	60
97°	100	2.57	4100	14,100	41

Table 8

Commercial Liquefied Petroleum Fuels (Bottled Gases)

for Domestic Use

Listed under their trade names

<u>Blaugas</u>* Pittsburgh Thermoline Co., 45 S.20th St.,Pittsburgh,Pa.
Propane, delivered as gas from top of cylinder.
Two cylinder service.
Local delivery maintained at Akron, Canton, and Cleveland, Ohio, Greenwich, Conn., Kane, Philadelphi and Pittsburgh, Pa. Consumers in Kentucky and Indiana supplied by freight shipments.

Northwest Blaugas Co., St.Paul, Minn.
Propane, delivered as gas from top of cylinder
Single drum system within 25 miles of warehouses.
Two cylinder system in other sections.
Distributed mainly in Minnesota, Wisconsin, North Dakota and South Dakota. Available in many other states.

Omaha Blaugas Co.,28th and Boyd St.,Omaha, Nebr.
Two cylinder system.
Distributed throughout Nebraska and Iowa. Outside of 50 mile area around Omaha and Nebraska the customer pays transportation charges each way.

* The term, "Blaugas", named for its inventor, was originally applied to gases of varied composition made by "cracking" oil. The term signified the process of manufacture rather than the character of the product. Several companies which had built up a trade in "Blaugas" continued the name after the process of manufacture was abandoned.

<u>Blu Spot</u>
<u>Blu Flame</u> Universal Bottled Gas Corp.,Rochester, N. Y.
Mostly isobutane, delivered as liquid from bottom of cylinder, vaporized at burner. Pressure in cylinder 70 lbs. per sq.in. at 70°F.
Two cylinder service.
Distributed from Maine to Florida east of Mississippi River, especially New England, New York, Pennsylvani New Jersey, Maryland, Indiana and Florida.

<u>Bluflame</u> The Blueflame Gas and Range Co., Toledo, Ohio.
Propane, delivered as gas from top of cylinder.

<u>Delcogas</u> Delco Light Co., Rochester, N. Y.
Mostly pentane. Air under pressure bubbled through liquid. Rich mixture of gas and air taken from top of tank.
Single underground fuel tank.

Table 8 (Continued)

Flamo Standard Oil Co. of Calif., Standard Oil Bldg., San Francisco, Calif.
Propane, delivered as gas from top of cylinder.
Two cylinder system.
Distributed in California, Oregon, Washington, Nevada, Arizona, Western Idaho and Southwestern Utah. Also the Hawaiian Islands and Southwestern Alaska.

Fuelite Fuelite Natural Gas Corp., 705 Main St., Waltham, Mass.
Propane, delivered as gas from top of cylinder.
Two cylinder system.
Supplies radius of 25 miles from Waltham. There are a number of distributors throughout New England and New York.

Heatwave Rockgas Products Co., P.O. Box 4136 Bellevue District, Pittsburgh, Pa.
Pentane. Air under pressure bubbled through liquid fuel. Rich gas-air mixture taken from top of tank.

Hi-Heat Gas Hi-Heat Gas Co., 21 E. 40th St., New York, N.Y.
A mixture of which one sample supposed to be typical contained approximately two-thirds butane and one-third propane, with about 5 per cent ethane. Delivered as liquid from bottom of cylinder and vaporized at burner by special device. Pressure 68 lbs. per sq. in. in cylinder at 70°F.
Two cylinder system.
Distributed in New England, New York, New Jersey and Pennsylvania.

Hydro-Pep The Hydro-Pep Liquid Gas Co., 600 E. Poplar Ave., Arkansas City, Kan.
National Lighting Co., Arkansas City, Kan.
Mixed gas obtained by generating acetylene and passing it through pentane or gasoline using the Webb apparatus.
The National Lighting Co. also makes an automatic machine for using pentane by forcing air into the liquid, the mixture of air and pentane being taken from the top of the tank.

Nugas Nugas Corporation, Bradford, Pa.
Propane, delivered as gas from top of cylinder.
Two cylinder system.
Sold through authorized dealers located in 13 states, mainly New England, New York, New Jersey and eastern territories.

Table 8 (Continued)

Philgas — Philfuels Co., Bartlesville, Okla.
Propane, delivered as gas from top of cylinder.
Single drum system.
Truck delivery over established routes from local stations. These stations are established at numerous places in the United States and in some parts of Canada.

Protane — The Protane Corp., 1816 Raspberry St., Erie, Pa.
Mixture of propane, butane and pentane, delivered from the bottom of the cylinder as a liquid and vaporized at burner in valve of special design. Pressure in cylinder 15 to 18 lbs. per sq. in. at 70°F.
Two cylinder system.
Distributed north of the Mason and Dixon Line and east of Mississippi. Also Florida, Iowa and Gulf Coast Texas and California.

Pyrofax — Carbide and Carbon Chemicals Corp., 30 E. 42nd St., New York City.
Propane, delivered as gas from top of cylinder.
Two cylinder system.
Distributed to all parts of the country from a large number of warehouses.

Rockgas — Rockgas Products Co., P.O. Box 4126 Bellevue Branch, Pittsburgh, Pa.
Propane, delivered as gas from top of cylinder.
Two cylinder system.
Sold throughout eastern United States by Rockgas distributors. Western territory covered in same manner by the Imperial Gas Co., Long Beach, Calif.

Shellane — Shell Petroleum Corp., Shell Bldg., St. Louis, Mo.
Propane, delivered as gas from top of cylinder.
Two cylinder system.
Distributed in southern part of Minnesota, northern part of Iowa, southern parts of Michigan and Wisconsin and northern parts of Illinois and Indiana.

The Carolina Suburban Gas Co., Greensboro, N.C.
Distributes Shellane throughout North Carolina, southern Virginia and northern South Carolina.

Skelgas — Skelly Oil Co., El Dorado, Kan.
Propane, delivered as gas from top of cylinder.
Two cylinder system.
Distributed in territory which includes the Mississippi Valley north of the Texas line. This territory is subdivided into seven zones each functioning as a complete unit. Sales made through specially selected dealers.

Table 8 (Continued)

Stargas — Lone Star Gas Co., 1915 Wood St., Dallas, Texas.
Propane, delivered as gas from top of cylinder.
Two cylinder service.
Distributed in Texas. Delivery to customers' premises within radius of 15 to 20 miles from a distributing point. Other areas supplied by shipping cylinders to nearest freight station.

Suburban Gas — Suburban Gas Co., Belleville, N. J.
Propane, delivered as gas from top of cylinder.
Distributed in southern counties of New York and in New Jersey as far south as the Atlantic City section.

Tirrill Gas — Tirrill Gas Machine Corp., 50 Church St., New York.
Pentane. Air under pressure bubbled through liquid. Rich gas-air mixture taken from top of cylinder.
Distributed to any locality. Branch offices are located in principal parts of the country.

Thermoline — See "Blaugas".

Tru-Gas — Viking Gasoline Corp., Charleston, W. Va.
Mixture of propane and butane. Delivered as liquid from bottom of cylinder and vaporized in expansion chamber.
Sold only to distributors.

Vaporol — Viking Gasoline Corp., Charleston, W. Va.
Probably pentane. For use in any common type of gas machine.
Not distributed by retail.

Vapyre — Vapyre Corporation, Pleasantville, N. Y.
About 40 per cent propane and 60 per cent butane.
Single cylinder system with provision for charging storage cylinder from portable cylinder where truck delivery is unavailable.
Liquid delivered from bottom of cylinder in unit quantities and completely vaporized in a special device. Vapor pressure at 70°F about 70 lbs. per sq. in.