The Action of Benzaldehyde on Phenanthrene in the Presence of Aluminium Chloride and Carbon Disulfide.—One molecule of phenanthrene was dissolved in one and a half of benzaldehyde and five volumes of carbon disulfide. One and a half molecules of aluminium chloride were then cautiously added. After the reaction was completed and the whole mass purified by means of water, alcohol and ether, it was further purified by dissolving in benzene and reprecipitating several times with alcohol. On adding about half of the necessary amount of alcohol to completely precipitate out the substance from the benzene, and filtering, the substance may be separated into two distinct compounds: the one precipitated out by the alcohol as a resin of unknown composition, and the other a brown powder obtained by evaporating off the alcohol and benzene.

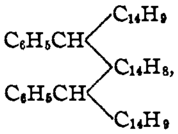
Diphenanthrenephenylmethane, $(C_{14}H_9)_2 : CH.C_6H_5$.—The above-mentioned brown powder was redissolved and reprecipitated several times by means of excess of alcohol. Analysis of the substance gave the following:

Calc. for $(C_{14}H_9)_2CHC_6H_5$, C = 94 59, H = 5.41; found, C = 94.19, H = 5.28
Molecular weight determination gave 445; calc. 444.

The purified substance was dark yellow powder melting and decomposing at 165°.

Dibenzalmesotriphenanthrene, $(C_6H_5CH)_2(C_{14}H_8)(C_{14}H_9)_2$.—The resinous substance above mentioned was purified several times by dissolving in benzene and reprecipitating by means of alcohol. The substance was finally obtained as a brown powder which melted at 195–197° with decomposition.

Calc. for



$$\begin{matrix} & C_{14}H_9 \\ C_6H_5CH< & \\ & >C_{14}H_8 \\ C_6H_5CH< & \\ & C_{14}H_9 \end{matrix}$$

, C = 94.65, H = 5.35; found, C = 94.45, H = 5.48.

Molecular weight determination gave 705; calc. 710.

We were unable to obtain any of these complex compounds in crystalline form. However, by reprecipitating several times as has already been indicated, they were from all appearances in pure form. It is unusual that these hydrocarbons, some of them at least, have a distinct color. Some of these colored substances are under investigation at the present time.

School of Chemistry, University of Minnesota,
Minneapolis, Minnesota.

[From the Chemical Laboratory, U. S. Bureau of Mines.]

THE SEPARATION OF THE CONSTITUENTS IN A NATURAL GAS FROM WHICH GASOLINE IS CONDENSED.

By George A. Burrell and Frank M. Seibert.

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In a previous communication[1] to This Journal the authors showed

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[1] This Journal, 36, 1537 (1914).

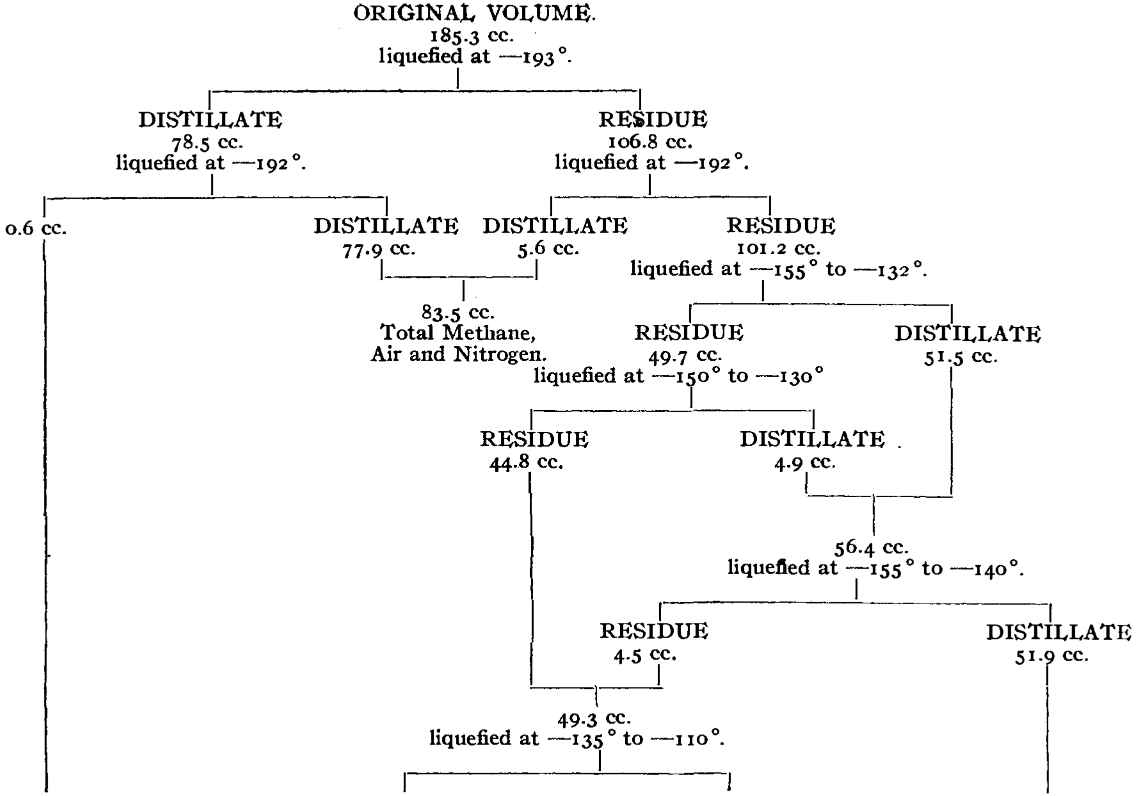
a method of separating the constituents in natural gas by fractional distillation in a vacuum at low temperatures. The gas experimented with was that used in Pittsburgh. Methane predominates in it with only small porportions of the higher paraffins. Not enough of the latter are present for the commercial condensation of gasoline. In this paper are shown the constituents in a natural gas that was obtained at a plant where the gas is treated for the condensation of gasoline. The procedure of separation is the same as that used in separating the constituents in the natural gas of Pittsburgh. Fig. 1 shows the various steps in the work. The original volume of the sample was 185.3 cc. At the temperature of liquid air 78.5 cc. of gas were removed, leaving a residue of 106.8 cc. Both the residue and distillate were reliquefied to obtain, as shown, by analysis pure methane mixed with air and nitrogen. This distillate amounted to 83.5 cc. Air had been accidentally introduced into the sample prior to the experiment. The final analysis was calculated air-free as given below to show the constituents originally present in the gas.

Second Series of Fractionations.—After the removal of the methane there remained a residue of 101.2 cc. containing ethane and higher paraffin hydrocarbons. This was liquefied and distilled and the distillate and residue from it liquefied and distilled again until finally at a temperature not higher than —140° there was obtained a distillate of 51.9 cc. that was pure ethane as nearly as could be determined by analysis. To this portion was added 0.6 cc. of ethane obtained in the first series of fractionations when the methane was separated. There resulted a total of 52.5 cc. ethane.

Third Series of Fractionations.—After the removal of the ethane there remained a total residue of 49.3 cc. consisting of propane and the higher paraffin hydrocarbons. The final fractionation in this series was made at a temperature not higher than —120° and resulted in obtaining 34.1 cc. of pure propane. It will be noted that the fractionations were carried to a point where only a small quantity (1.8 cc.) of propane was finally obtained.

Fourth Series of Fractionations.—After the removal of the propane there remained a residue of 15.2 cc. that contained the butanes and higher paraffin hydrocarbons. A separation of this residue into two portions was made by removing some gas with the pump at a temperature not higher than —95°. An analysis of the distillate was made, the result of which indicated butane chiefly. It is certain that some of the butanes remained in the residue and that the distillate of 9.3 cc. contained at least a small quantity of the pentanes, etc., hence it is better to simply call the 15.2 cc. residue butanes and higher paraffin hydrocarbons.

There follows the results of the fractionation analysis showing, under *A*, the paraffins in cubic centimeters, under *B*, the analysis in per cent. of the sample with air, and under *C*, the analysis calculated air-free. The


ORIGINAL VOLUME.
185.3 cc.
liquefied at —193°.
DISTILLATE
78.5 cc.
liquefied at —192°.
RESIDUE
106.8 cc.
liquefied at —192°.
0.6 cc.
DISTILLATE
77.9 cc.
DISTILLATE
5.6 cc.
RESIDUE
101.2 cc.
liquefied at —155° to —132°.
83.5 cc.
Total Methane,
Air and Nitrogen.
RESIDUE
49.7 cc.
liquefied at —150° to —130°
DISTILLATE
51.5 cc.
RESIDUE
44.8 cc.
DISTILLATE
4.9 cc.
56.4 cc.
liquefied at —155° to —140°.
RESIDUE
4.5 cc.
DISTILLATE
51.9 cc.
49.3 cc.
liquefied at —135° to —110°.

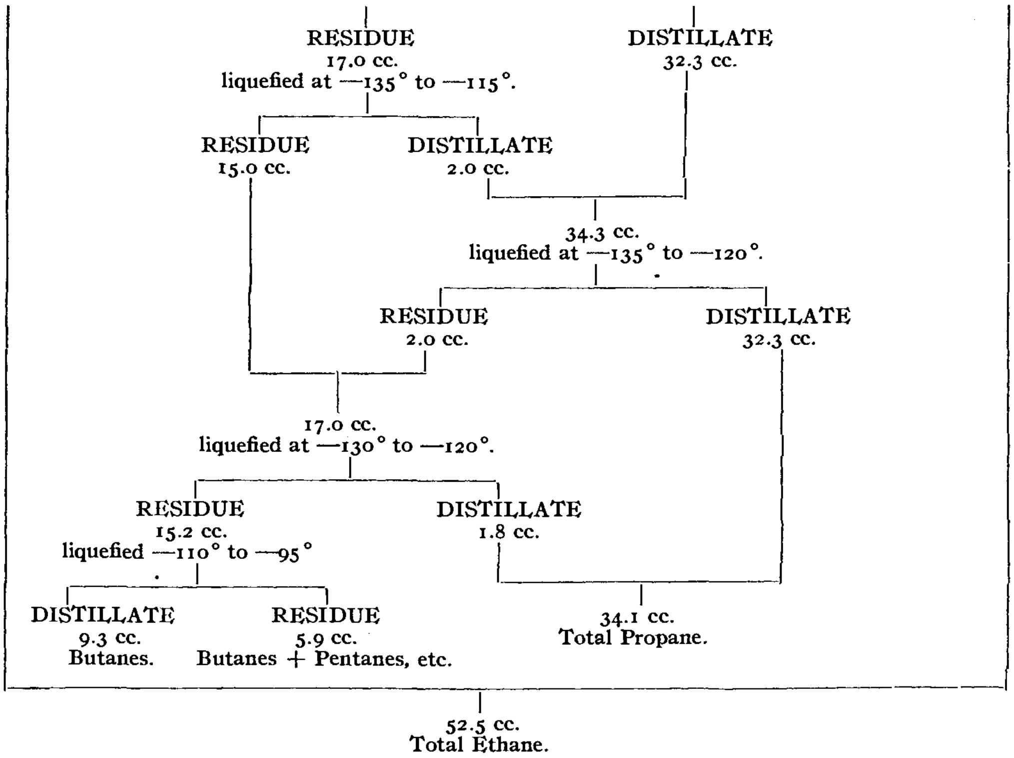


Fig. 1.—Fractionation analyses of natural gas.

air is foreign to the natural gas as it occurs in the wells and should, therefore, be eliminated. There is, however, about 1.0% nitrogen and about 0.03% carbon dioxide which are not shown in the analysis as presented.

FRACTIONATION OF NATURAL GAS FROM WHICH GASOLINE IS CONDENSED.

	A. Cc.	B. Per cent.	C. Per cent.
Air + nitrogen	24.5	13.2	....
Methane	59.0	31.9	36.8
Ethane	52.5	28.3	32.6
Propane	34.1	18.4	21.1
Butanes (chiefly)	9.3	5.0	5.8
Pentanes and hexanes	5.9	3.2	3.7
Total	185.3	100.00	100.0

For comparison there is shown the fractionation analysis of the natural gas of Pittsburgh.

FRACTIONATION ANALYSIS OF THE NATURAL GAS OF PITTSBURGH.

Constituents.	Per cent.
Nitrogen	1.6[1]
Methane	84.7
Ethane	9.4
Propane	3.0
Chiefly butane	1.3
Total	100.0

Considerable difference will be noted between the quantity of the different paraffins in this gas mixture and in the one first described. The natural gas of Pittsburgh is used in immense quantities in the east for domestic and other purposes. The other represents a gas used for the condensation of gasoline. Temperatures are in degrees centigrade. Experimental details are shown in a previous communication.[2]

PITTSBURGH, PA.

EXPERIMENTS ON THE NATURE OF THE PHOTOGENIC SUBSTANCE IN THE FIREFLY.

BY E. NEWTON HARVEY.

Received December 19, 1914.

Previous research on the subject of biophotogenesis has shown that at least three factors are necessary for the production of light, namely, water, oxygen and a photogenic substance. A fourth factor is probably also involved, an oxidizing enzyme, as in other organic oxidations. Concerning this enzyme nothing is known, at least nothing definite in the case of the firefly. Indeed Kastle's[3] observations indicate that in the firefly

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[1] Includes a trace of carbon dioxide, about 0.03%.

[2] *Loc. cit.*

[3] J. H. Kastle, Hygienic Lab., Washington, D. C., *Bull.* **59,** 92 (1910).