the following table of ratio of carbonic-acid gas in the atmosphere at the points named :

On the Thames, at London	0·0343
In the streets of London	0·0380
Top of Ben Nevis	0 0327
Dress circle of Haymarket theater (11:30 P. M.)	0·0757
Chancery Court (seven feet from the ground)	0·1930
From working mines (average of 339 samples)	0·7853
Largest amount in a Cornish mine	2·0500

In addition to the consumption of oxygen and production of carbonic acid by the use of common gas, the gas itself, owing to defectiveness of the burner, is projected into the air. Now, considering the deleterious nature of all illuminating gases, the reasons for perfect ventilation of rooms in which natural gas is used for heating and culinary purposes are self-evident, not alone as a protection against explosions, but for the health of the occupants of the house, remembering that a larger supply of oxygen is said to be necessary for the perfect combustion of natural than of common gas.

Carbonic oxide, formed by the consumption of carbon, with an insufficient supply of air, is the fatal poison of the charcoal furnace, not infrequently resorted to, in close rooms, as a means of suicide. The less sufficient the air toward perfect combustion, the smaller the quantity of carbonic acid and the greater the amount of carbonic oxide. That is to say, at the time of ignition the chief product of combustion is carbonic oxide, and, unless sufficient air be added to convert the oxide to carbonic acid, a decidedly dangerous product is given off into the room. Yet, by means of a flue to carry off the poisonous gases from burning jets, the combustion of gas, creating a current, is made an aid to ventilation. Unfortunately, this important fact, if commonly known, is not much heeded by heads of families or builders of houses. But in any large community where gas comes into general use as an article of fuel, this fact will gradually become recognized and respected.

The property of indicating the presence of very minute quantities of gas in a room is claimed for an instrument recently described by C. Von Jahn in the *Revue Industrielle*. This is a porous cup, inverted and closed by a perforated rubber stopper. Through the perforation in the stopper the interior of the cup is connected with a pressure gauge containing colored water. It is claimed that the diffusion of gas through the earthenware raises the level of the water in the gauge so delicately that the presence of one-half of one per cent. of gas may be detected by it. Other instruments of a slightly different character are credited by their inventors with most sensitive power of indicating gas-leakages, but their practical efficiency remains to be demonstrated. An automatic cut-off for use outside of houses in which natural gas is consumed has been invented, but this writer knows nothing of either its mode of action or its effectiveness.

The great economic question, however, connected with the use of natural gas is, how will it affect the industrial interests of the country? There are grounds for the belief that a sufficient supply of natural gas may be found in the vicinity of Pittsburg to reduce the cost of fuel to such a degree as to make competition in the manufacture of iron, steel, and glass, in any part of the country where coal must be used, out of the question. Such a condition of affairs would probably result in driving the great manufacturing concerns of the country into the region where natural gas is to obtained. That may be anywhere from the western slope of the Alleghanies to Lake Erie or to Lake Michigan. And, if the cost of producing iron, steel, and glass can be so cheapened by the new fuel, the tariff question may undergo some important modification in politics. For, if the reduction in the cost of fuel should ever become an offset to the lower rate of wages in Europe, the manufacturers of Pennsylvania, who have long been the chief support of the protective policy of the country, may lose their present interest in that question, and leave the tariff to shift for itself elsewhere. It should be remembered that natural gas is not, as yet, much cheaper than coal in Pittsburg. But it may safely be assumed that it will cheapen, as petroleum has done, by a development of the territory in which it is known to exist in enormous quantities. It is quite possible that, instead of buying gas, many factories will bore for it with success, or remove convenient to its natural sources, so that a gas well may ultimately become an essential part of the "plant" of a mill or factory. Even now coal cannot compete with gas in the manufacture of window glass, for, the gas being free from sulphur and other impurities contained in coal, produces a superior quality of glass; so that in this branch of industry the question of superiority seems already settled.

Having said thus much of an industry now in its infancy but promising great growth, I submit tables of analyses of common and of the natural or marsh gas, the latter from a paper recently prepared by a committee of the Engineers' Society of Western Pennsylvania, and for the use of which I am indebted to that association:

COMMON GAS.

Hydrogen	46·0
Light carbureted hydrogen (marsh gas)	39·5
Condensible hydrocarbon	3·8
Carbonic oxide	7·5
" acid	0·6
Aqueous vapor	2·0
Oxygen	0·1
Nitrogen	0·5
	100·0

Natural gas is now conveyed to Pittsburg through four lines of 5⅝ inch pipe and one line of eight inch pipe. A line of ten inch pipe is also being laid. The pressure of the gas at the wells is from 150 to 230 pounds to the square inch. As the wells are on one side eighteen and on the other about twenty-five miles distant, and as the consumption is variable, the pressure at the city cannot be given. Greater pressure might be obtained at the wells, but this would increase the liability to leakage and bursting of pipes. For the prevention of such casualties safety valves are provided at the wells, permitting the escape of all superfluous gas. The enormous force of this gas may be appreciated from a comparison of, say, 200 pounds pressure at the wells with a two ounce pressure of common gas for ordinary lighting. The amount of natural gas now furnished for use in Pittsburg is supposed to be something like 25,000,000 cubic feet per day; the ten inch pipe now laying is estimated to increase the supply to 40,000,000 feet. The amount of manufactured gas used for lighting the same city probably falls below 3,000,000 feet.

TABLE OF ANALYSIS OF NATURAL GAS—FROM VARIOUS SOURCES.

Petroleum is composed of about 85 per cent of carbon and 15 per cent of nitrogen.

CONSTITUENTS.	1. Petrolia, Canada.	2. West Bloomfield, N.Y.	3. Olean, N.Y.	4. Fredonia, N.Y.	5. Pioneer Run, Venango Co., Pa.	6. Burns's Well, near St. Joe, Butler Co., Pa.	7. Harvey Well, Butler Co., Pa.	8. Cherry Tree, Indiana Co., Pa.	9. Leechburg, Pa.	10. Creighton, Pa.	11. Penn Fuel Co.'s Well, Murraysville, Pa.	12. Fuel Gas Co.'s Well, Murraysville.	13. Roger's Gulch, Wirt Co., W. Va.	14. Gas from Marsh Ground.	15. Baku, on the Caspian Sea.	16. Gas occluded in Wigan cannel-coal.	17. Blower in coal-mine, South Wales.
	Chiefly marsh-gas, with ethane and some carbonic acid.			A mixture of marsh-gas, ethane, and butane.	Chiefly propane, with small quantities of carbonic acid and nitrogen.					Trace of heavy hydrocarbons.	Marsh-gas, with a little carbonic acid.		Chiefly marsh-gas, with small quantities of nitrogen and 15·36 per cent carbonic acid.				
Hydrogen		....	....			6·10	13·50	22·50	4·79	....		19·56		....	0·98	....	....
Marsh-gas		82·41	96·50			75·44	80·11	60·27	89·65	96·34		78·24		47·37	93·09	80·69	95·42
Ethane		....	....			18·12	5·72	6·80	4·39	....		....		....	....	4·75	....
Propane		....	....			trace.	....	....	trace.	....		....		....	....	....	....
Carbonic acid		10·11	....			0·34	0·66	2·28	0·35	3·64		....		3·10	2·18	6·44	0·60
Carbonic oxide		....	0·50			trace.	trace.	trace.	0·26			....		....	....	....	....
Nitrogen		4·31	....			....	....	7·32	....			....		49·39	0·49	8·12	3·98
Oxygen		0·23	2·00			....	....	0·83	....			2·20		0·17	....	....	....
"Illuminating hydro-carbons."		2·94	1·00			....	....	....	0·56			....		....	3·26	....	....
		100·00	100·00			100.00	99·99	100·00	100·00			100·00		100·03	100·00	100·00	100·00
Specific gravity		0·693	0·692			0·6148	0·5119		0·5580	0·5923	0·56						

1. Fouqué, "Comptes Rendus," lxvii, p. 1045.
2. H. Wurtz, "Am. Jour. Arts and Sci." (2), xlix, p. 336.
3. Robert Young.
4. Fouqué, "Comptes Rendus," lxvii, p. 1045.
5. Fouqué, "Comptes Rendus," lxvii, p. 1045.
6. S. P. Sadtler, "Report L, 2d Geol. Sur. Pa.," p. 153.
7. S. P. Sadtler, "Report L, 3d Geol. Sur., Pa.," p. 152.
8. S. P. Sadtler, "Report L, 3d Geol. Sur., Pa.," p. 153.
9. S. P. Sadtler, "Report L, 3d Geol. Sur., Pa.," p. 153.
10. F. C. Phillips.
11. Robert Young.
12. Rogers.
13. Fouqué. "Comptes Rendus," lxvii, p. 1045.
14. Bischof's "Chemical Geology," I, p. 730.
15. Bischof's "Chemical Geology," I, p. 730.
16. J. W. Thomas, London, "Chemical Society's Journal," 1876, p. 793.
17. Same, 1875, p. 793.

About fifty mills and factories of various kinds in Pittsburg now use natural gas. It is used for domestic purposes in two hundred houses. Its superiority over coal in the manufacture of window glass is unquestioned. That it is not used in all the glass houses of Pittsburg is due to the fact that its advantages were not fully known when the furnaces were fired last summer, and it costs a large sum to permit the furnaces to cool off after being heated for melting. When the fires cool down, and before they are started up again, the furnaces now using coal will doubtless all be changed so as to admit natural gas. The superiority of French over American glass is said to be due to the fact that the French use wood and the Americans coal in their furnaces, wood being free from sulphur, phosphorus, etc. The substitution of gas for coal, while not increasing the cost, improves the quality of American glass, making it as nearly perfect as possible.

While the gas is not used as yet in any smelting furnace nor in the Bessemer converters, it is preferred in open hearth and crucible steel furnaces, and is said to be vastly superior to coal for puddling. The charge of a puddling furnace, consisting of 500 pounds of pig-metal and eighty pounds of "fix," produces with coal fuel 490 to 500 pounds of iron. With gas for fuel, it is claimed that the same charge will yield 520 to 530 pounds of iron. In an iron mill of thirty furnaces, running eight heats each for twenty-four hours, this would make a difference in favor of the gas of, say, 8 × 30 × 25 = 6,000 pounds of iron per day. This is an important item of itself, leaving out the cost of firing with coal and hauling ashes.

For generating steam in large establishments, one man will attend a battery of twelve or twenty boilers, using gas as fuel, keep the pressure uniform, and have the fire room clean as a parlor. For burning brick and earthenware, gas offers the double advantage of freedom from smoke and a uniform heat. The use of gas in public bakeries promises the abolition of the ash-box and its accumulation of miscellaneous filth, which is said to often impregnate the "sponge" with impurities.

In short, the advantages of natural gas as a fuel are so obvious to those who have given it a trial, that the prediction is made that, should the supply fail, many who are now using it will never return to the consumption of crude coal in factories, but, if necessary, convert it or petroleum into gas at their own works.

It seems, indeed, that until we shall have acquired the wisdom enabling us to conserve and concentrate the heat of the sun, gas must be the fuel of the future.—*Popular Science Monthly.*

CLOSING LEAKAGES FOR PACKING.

By L. C. Levoir.

The mineral asbestos is but a very poor packing material in steam-boilers. Moreover, it acts as a strong grinding material on all moving parts.

For some years I have tested the applicability of artificial precipitates to close the holes in boilers, cylinder-covers, and stuffing boxes. I took, generally with the best success, alternate layers of hemp-cotton, thread, and absorbent paper, all well saturated with the chlorides of calcium and magnesium. The next layers of the same fiber are moistened with silicate of soda. By pressure the fluids are mixed and the pores are closed. A stuffing box filled with this mixture has worked three years without grinding the piston-rod.

In the same manner I close the screw-thread hole in gas tubes used for conducting steam. I moisten the thread in the sockets with oleic acid from the candle-works, and dust over it a mixture of 1 part of minium, 2 parts of quick-lime, and 1 part of linseed powder (without the oil). When the tube is screwed in the socket, the powder mixes with the oleic acid. The water coming in at first makes the linseed powder viscid. Later the steam forming the oleate of lime and the oleate of lead, on its way to the outer air, presses it in the holes and closes them perfectly.

After a year in use the tubes can be unscrewed with ease, and the screw threads are perfectly smooth.

With this kind of packing only one exception must be made—that is, it is only tight under pressure; condensation or vacuum must be thoroughly avoided.—*Chem News.*

LUMINOUS PAINT.

In answer to various inquiries concerning the manufacture of this article, we give herewith the process of William Henry Balmain, the original discoverer of luminous paint, and also other processes. These particulars are derived from the letters patent granted in this country to the parties named.

Balmain's invention was patented in England in 1877, and in this country in 1882. It is styled as Improvements in Painting, Varnishing, and Whitewashing, of which the following is a specification:

The said invention consists in a luminous paint, the body of which is a phosphorescent compound, or is composed in part of such a compound, and the vehicle of which is such as is used as the vehicle in ordinary paint compounds, viz., one which becomes dry by evaporation or oxidation.

The object or article to which such paint or varnish or wash is applied is itself rendered visible in the darkest place, and more or less capable of imparting light to other objects, so as to render them visible also. The phosphorescent substance found most suitable for the purpose is a compound obtained by simply heating together a mixture of lime and sulphur, or carbonate of lime and sulphur, or some of the various substances containing in themselves both lime and sulphur—such, for example, as alabaster, gypsum, and the like—with carbon or other agent to remove a portion of the oxygen contained in them, or by heating lime or carbonate of lime in a gas or vapor containing sulphur.

The vehicle to be used for the luminous paint must be one which will dry by evaporation or oxidation, in order that the paint may not become soft or fluid by heat or be liable to be easily rubbed off by accident or use from the articles to which it has been applied. It may be any of the vehicles commonly used in oil-painting or any of those commonly used in what is known as "distemper" painting or whitewashing, according to the place or purpose in or for which the paint is to be used.

It is found the best results are obtained by mixing the phosphorescent substance with a colorless varnish made with mastic or other resinous body and turpentine or spirit, making the paint as thick as convenient to apply with a brush, and with as much turpentine or spirit as can be added without impairing the required thickness. Good results may, however, be obtained with drying oils, spirit varnishes, gums, pastes, sizes, and gelatine solutions of every description, the choice being varied to meet the object in view or the nature of the article in hand.

The mode of applying the paint, varnish, or wash will also depend upon the circumstances of the case. For example, it may be applied by a brush, as in ordinary painting, or by dipping or steeping the article in the paint, varnish, or wash; or a block or type may be used to advantage, as in calico-printing and the like. For outdoor work, or wherever the surface illuminated is exposed to the vicissitudes of weather or to injury from mechanical contingencies, it is desirable to cover it with glass, or, if the article will admit of it, to glaze it over with a flux, as in enameling, or as in ordinary pottery, and this may be accomplished without injury to the effect, even when the flux or glaze requires a red heat for fusion.

Among other applications of the said invention which may be enumerated, it is particularly advantageous for rendering visible clock or watch faces and other indicators—such, for example, as compasses and the scales of barometers or thermometers—during the night or in dark places during the night time. In applying the invention to these and other like purposes there may be used either phosphorescent grounds with dark figures or dark grounds and phosphorescent figures or letters, preferring the former. In like manner there may be produced figures and letters for use on house-doors and ends of streets, wherever it is not convenient or economical to have external source of light, sign-posts, and signals, and names or marks to show entries to avenues or gates, and the like.

The invention is also applicable to the illumination of railway carriages by painting with phosphorescent paint a portion of the interior, thus obviating the necessity for the expense and inconvenience of the use of lamps in passing through tunnels. It may also be applied externally as warning-lights at the front and end of trains passing through tunnels, and in other similar cases, also to ordinary carriages, either internally or externally. As a night-light in a bed-room or in a room habitually dark, the application has been found quite effectual, a very small proportion of the surface rendered phosphorescent affording sufficient light for moving about the room, or for fixing upon and selecting an article in the midst of a number of complicated scientific instruments or other objects.

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