ART. V. EXPLOSIVE GAS GENERATED WITHIN THE HOT WATER PIPES OF HOUSE HEATING APPARATUS.—BY A. H. MACKAY, B. A., B. SC., LL. D., F. R S. C.

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I have in the glass jars before you a few liters of gas collected from the highest radiator of the hot water system warming my house. The furnace is an upright one with the water heated between its double walls, large enough to heat a house of eight or nine ordinary rooms during our winters. Anthracite coal is generally used for fuel. In two other neighboring houses I have found the same gas produced under the same circumstances, in one case the heater being of a different pattern and by a different maker, but heating the water in the same manner, by circulation around the heated interior metal walls of the furnace. I have not made a general investigation of hot water systems, so that my experience is limited by the three cases which I have found so similar, which suggests the question, are all water heating furnaces producers of similar gas?

Owing to some peculiarity in the manner in which the highest radiators were set in these cases, the gas produced was there collected until it interfered with the circulation of the hot water, when the gas used to be liberated by turning a small tap in the radiator and the circulation of the water was restored. Some of this gas being collected without the admixture of air was fired, and burned like hydrogen without explosion. A match was then applied to the tap from which the gas was being set free. A roaring jet of blue flame was instantly projected to a very considerable distance and continued burning until it was followed by the water after the exhaustion of the gas. The gas when escaping unburned had a peculiar odor suggesting a hydrocarbon compound, which you can test from the samples enclosed in the bottles before you.

The gas was observed to accumulate more rapidly, interfering with the circulation of the water through the coils, when anthracite coal was used than when bituminous coal was used. The water was also more prone to "boil" in the furnace in these cases, from the greater heat of the anthracite. I have not the time and conveniences now to make an accurate analysis of the gas. My investigation is only preliminary, and my object in bringing it now before the Institute is to stimulate the collection of other observed facts in connection with the phenomena. Roughly then, we can here observe the following reactions of our gas.

1. By uncorking these small bottles you can observe the peculiar naptha-like odor characteristic of the gas. This suggests the presence of at least a small portion of some hydrocarbon.

2. I now remove the stopper from this large inverted glass jar, and placing this lighted candle to its mouth we find it takes fire and burns at the mouth of the jar like so much pure hydrogen Putting the candle up into the jar above the pale, blue fire plane separating the outside air from the gas within, the light is extinguished. The gas cannot support combustion. We readily relight our candle, however, at the nearly invisible flame yet playing at the mouth of the jar. The blue flame has quite an intense heat. See, the mouth of the jar cracks. A drop of water rolling down its inside to the mouth of the jar, heated nearly to redness, is responsible for this.

3. I now apply a light to this jar containing two parts of the gas and five parts of air. We have a gentle explosion with the usual pale flame, and the sides of the jar are temporarily bedewed. Let us next in the same manner fire this strong, wide mouthed jar wrapped in a towel to prevent danger from flying glass should the shock of the explosion be too much for its strength. We have it in two parts ofour gas with one part of oxygen. The report of the explosion is deafening. Is it pure hydrogen ?

4. Here is some transparent lime water. I pour some of it into this transparent glass jar. I shake up the lime water with

the enclosed air of this room which is pretty pure. The lime water is still transparent. The test is too crude, of course, to show the existence of the small percentage of carbonic dioxide in the air of the room. I breathe once into the mouth of the jar and then shake up the lime water with the enclosed air. It has instantly become quite milky. This lime water is, therefore, a test good enough to indicate the existence of carbon dioxide if it should be present in a percentage as great as is found in air that has been breathed and not largely diluted with pure air. I therefore burn an inverted jar of the gas as in our first experiment. If there is a hydro-carbon or carbon monoxide present, they will be converted into carbon dioxide; and if the proportion of carbon is at all considerable, its presence in the heated and burnt air of the jar may possibly be demonstrated The shaking up of the jar still leaves the lime water transparent, which seems to suggest that the carbon compounds, if present, cannot exist in any large quantities.

5. Into this jar let us inject some pure nitrogen dioxide. As the two transparent gases mix no change can be detected. But, if the smallest bubble of air is injected the presence of oxygen is indicated by the production of the characteristic fumes of nitrogen tetroxide. Therefore we conclude that the gas contains no oxygen when collected with due precautions.

Our provisional conclusion from these rough experiments is, that the gas is chiefly, if not altogether, hydrogen.

The origin suggested is the decomposition of the water by the over-heated metal in its circuit through the furnace, and the conversion of metallic iron into its hydrated ferric oxide. If so, we must expect that for every liter of gas produced, over one and two thirds grams of iron are corroded; that is, for every cubic foot of gas nearly seven hundred grains of iron—690 grains more exactly.

The conclusions finally suggested are, that conditions preventing the rapid formation of this gas (1) will lengthen the term of service of furnaces; (2) will obviate the danger of explosions when air, owing to low water, may accumulate with the gas in the coils, and is liberated at night with a light in the hand; and (3) will preclude the occurrence of accidents from horizontal taps throwing unexpectedly a stream of explosive gas against a lamp held carelessly in the hand of a person "letting the air off" from a radiator. A general knowledge of the character and properties of such gases is the best safeguard of the public interests from such accidents when the heating of houses by hot water is becoming so universal.