October 13, 1949

Mr. Peter Altman,
Vice President,
Continental Motors Corporation,
1470 Algonquin,
Detroit 14, Michigan.

Dear Mr. Altman:

I shall undertake to answer the questions in your letter of October 1 as well as I can. I have no information on the characteristics of the type of engine which you describe, with respect to the composition of the exhaust gases. I should imagine that Mr. Bartholomew of Ethyl Corporation might have some information on engines of this general type, and therefore he might be able to give you some answer to your question #3. I would have sent him a copy of my letter, in the hope that he would follow up and answer this question, except for the fact that I did not wish to presume to discuss your problem with anyone else without your consent. It might be suspected that the exhaust gases would contain a very appreciable concentration of carbon monoxide, - that is to say, several per cent. This may be a wild guess on my part, since I am not an engineer, but the exhaust gases of automobiles contain carbon monoxide within the limits of 3 to 7 per cent under somewhat variable operating conditions. The two-cylinder engine may give rise to more or less carbon monoxide than do automobile engines, for all I know on the subject.

1. I know of no procedure that would reduce the percentage of carbon monoxide in exhaust gases, other than that of regulating carbureter mixtures so as to obtain maximum combustion. So far as I know, there is nothing that can be added to gasoline that will materially influence the percentage of carbon monoxide or that would in any way neutralize its harmful effect. Undoubtedly the carbon monoxide issuing through the exhaust system could be oxydized, catalytically, to carbon dioxide, but this would require the passage of the entire exhaust gases through a chamber in the exhaust system in which an adequate quantity of catalyst was kept in an active form at all times. The lead compound in the exhaust could be removed effectively by electrostatic precipitation. This has been done experimentally, but it requires relatively expensive equipment and also very good maintenance. This, I suspect, would contribute unduly to expensive and troublesome maintenance operations. It seems quite unlikely to me that any additive in the fuel could be expected

to solve either of these problems. The only answer to that at present is that of suitable local or general ventilation. The exhaust gases can be piped out of the building in which they are created, and in engine operations of this type it is customary to connect the exhaust system with pipes or ducts leading to stacks on the outside. Tunnels and certain types of enclosed spaces in which there is heavy vehicular traffic are ventilated in such manner as to dilute the exhaust gases to safe levels. All of the experimental evidence, as well as the experience of the years, has indicated that if the carbon monoxide is diluted to a safe level, the hazard of exposure to lead is wholly negligible. Therefore, the question is that of diluting the carbon monoxide to the safe level. This brings us to your question #2.

The concentration of carbon monoxide in the air which is generally regarded as safe for an 8-hour period of exposure is 100 parts per million by volume. This standard is based on sound physiological principles, and it is a satisfactory standard except at high altitudes and under the conditions of reduced oxygen pressure, wherever this might occur. It is based on the fact that carbon monoxide combines with the hemoglobin of the bbod, as does oxygen, but with approximately 250 times the avidity characteristic of oxygen. Therefore, there is a virtual competition between the carbon monoxide in the air and the oxygen in the air, and if the carbon monoxide is present in the air in excess of the standard referred to, oxygen will be excluded to such degree that the individual suffers some of the symptoms of asphyxiation. A little calculation will serve to show what I mean. Assuming that the oxygen concentration of the atmosphere is 20% in round numbers, 1/250th of this concentration of carbon monoxide (0.08% of carbon monoxide in the atmosphere) will saturate 1/2 of the hemoglobin of the blood if given sufficient time. This will have essentially the same effect as reducing the concentration of oxygen in the atmosphere by 1/2, although systemic effects will be more serious than that of merely dropping the concentration of oxygen. Actually the concentration of carbon monoxide in the atmosphere breathed over an 8-hour period must be so low as to provide a negligible amount of saturation of the hemoglobin with carbon monoxide. Anything in excess of a few per cent of such saturation will give rise to symptoms.

I trust that this will give you some help, but if I have misunderstood your questions in any manner, I should be glad to elaborate on what I have said.

Very truly yours,

Robert A. Kehoe, M. D.

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