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SUPER-FUEL

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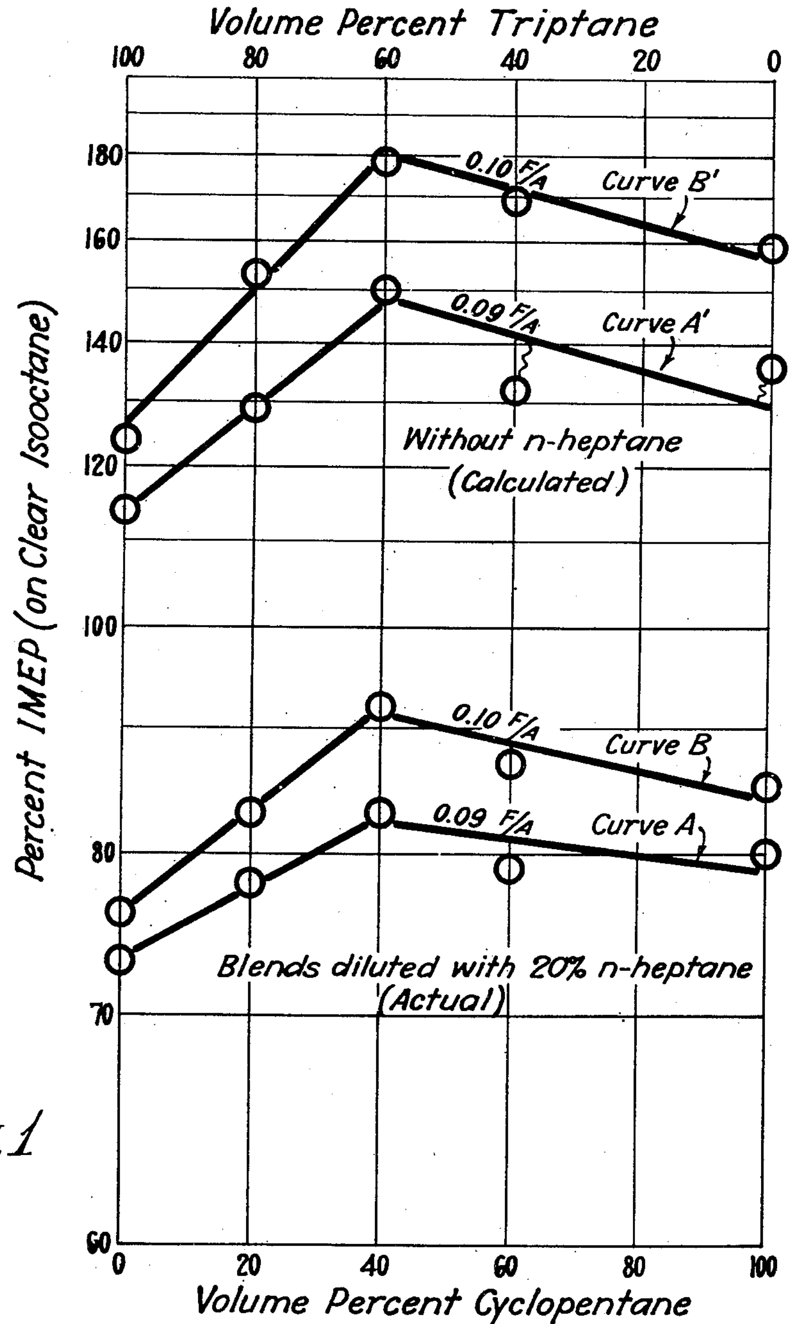
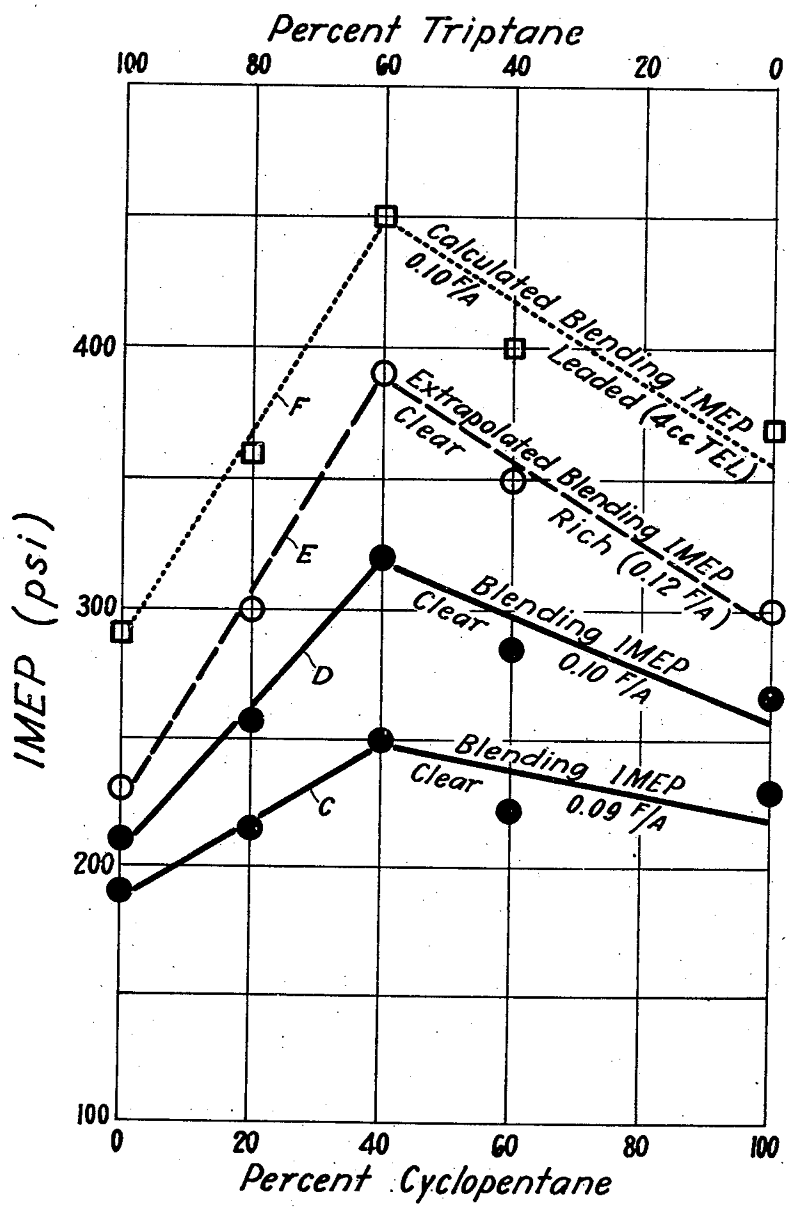


Fig. 1

17.6 ENGINE RATINGS OF
CYCLOPENTANE-TRIPTANE BLENDS
(Fuel to Air Ratio Shown)

INVENTOR.
Robert F. Marschner
BY Donald E. Payne
Attorney



17.6 ENGINE RATINGS OF CYCLOPENTANE-TRIPTANE BLENDS

Fig. 2

INVENTOR.
Robert F. Marschner
BY Donald E. Payne
Attorney

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SUPERFUEL

Robert F. Marschner, Homewood, Ill., assignor to Standard Oil Company, Chicago, Ill., a corporation of Indiana

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This invention relates to a super fuel for high compression, internal combustion, spark ignition engines and the invention pertains more particularly to a fuel which will give maximum power output, particularly in aviation engines.

Isooctane has been employed as a standard for rating the potential power output of a motor fuel and isooctane has been blended with many other hydrocarbons in the manufacture of aviation gasolines. Thus in my United States Patent 2,407,716 I have shown the remarkable properties of blends of isooctane with cyclopentane and dimethyl butanes. Triptane has been considered the ultimate as a super fuel for high compression engines as pointed out, for example, in "The effect of the molecular structure of fuels on the power and efficiency of internal combustion engines" by Charles F. Kettering (Industrial and Engineering Chemistry, volume 36 (1944) pages 1079–1085). Many blends or mixtures of hydrocarbons have been proposed for high compression aviation engines but heretofore none of them has been superior in power output to triptane or a cyclopentane-dimethyl butane mixture. The object of this inventoin is to provide a motor fuel with a greater power output than any motor fuel heretofore known.

Power output is conventionally measured by the "indicated mean effective pressure" (or IMEP) in pounds per square inch because for any particular engine running at constant speed the horsepower varies directly with the IMEP. The absolute values of IMEP depend of course on the particular engine and conditions employed for testing and usually a fuel is rated on the comparative basis with isooctane. An object of my invention is to provide a motor fuel which will have maximum power output or IMEP under conditions approximating those employed for making specification tests with fuel: air ratios of the order of about .08 to .14, maximum power output being in the range of about .12 to .13 (i. e. 0.12:1 to 0.13:1).

I have discovered that a mixture of about 25% to 75% by volume of triptane and about 75% to 25% by volume of cyclopentane, particularly when the triptane: cyclopentane ratio is approximately 6:4, provides a motor fuel whose IMEP is substantially greater than that of either component of the mixture or any other known clear motor fuel or motor fuel blend. By adding lead tetraethyl to the triptane-cyclopentane blend in amounts of 2 to 6 or preferably about 4 cc. of lead tetraethyl fluid per gallon of said fuel blend, the IMEP can be still further increased

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so that it can exceed that of any "leaded" fuel heretofore known to the art.

It has been shown that when triptane is admixed or blended with isooctane the IMEP of the various blends falls along a substantially straight line—i. e., the effects of these two components are simply additive and the larger the amount of triptane in the blend the larger will be the IMEP of the blended fuel. Similar effects have been shown for blends of isooctane and dimethyl butanes. However, a 6:4 triptane-cyclopentane blend has an IMEP or potential power output which is substantially greater than that of either component of the blend so that increasing the triptane content of the blend beyond such optimum actually decreases the IMEP of the blended fuel. For maximum power output the blend should thus have at least 25% and preferably about 40% of each component.

The invention will be more clearly understood from the following detailed description and from the accompanying drawings which form a part of the specification and in which

Figure 1 is a graph showing engine ratings of cyclopentane-triptane blends as compared with isooctane at fuel:air ratios of .09 and .10, and

Figure 2 is a graph showing engine ratings of cyclopentane-triptane blends in absolute values of pounds per square inch and also indicating the effect of higher fuel:air ratios and added lead tetraethyl to the blends.

My invention will be illustrated by comparative tests made in an engine simulating the standard 3-C test engine on fuel blends containing 100% triptane, 80% triptane:20% cyclopentane, 60% triptane:40% cyclopentane, 40% triptane:60% cyclopentane, and 100% cyclopentane. In the actual test procedure the above blends were cut back or diluted with exactly 20.0% added normal heptane in order that comparative tests could be made in the available test engine. Such diluent was employed because both cyclopentane and triptane are extremely sensitive and because the blending effects are smaller at severe engine conditions (high temperature). Since the abnormal behavior of cyclopentane is difficult to distinguish in unsupercharged tests, it was considered impractical to establish the presence of synergism with the straight fuels. It did not seem probable that the presence of lead would alter the nature of the blending curve and it was believed to be more reliable as well as easier to run these tests on unleaded blends. From the mass of data and correlations known to the art in this field the IMEP of straight triptane-cyclopentane blends with and without added lead tetraethyl can be reliably calculated from the data obtained in tests as actually conducted.

The tests were conducted in an engine of 17.6 cubic inches displacement under conditions selected to simulate rich mixture specification test conditions; the engine was run at 1800 R. P. M. with a jacket temperature of 300° F., an air inlet temperature of 225° F. and the spark advanced 26 degrees. Such conditions might be described as being intermediate in severity. That section of the IMEP vs. fuel to air (F./A.) curve between about .085 and .102 was determined. Values of fuel:air ratios of .09 and .10 were obtained by plotting and interpolation. The data obtained in these tests are as follows:

Ratings of clear cyclopentane-triptane blends

[All blends tested in presence of 20% normal heptane diluent.]

Vol. percent cyclopentane	0	20	40	60	100
Vol. percent triptane	100	80	60	40	0
IMEP of diluted blends					
at 0.09 F/A	122	130	139	131	133
at 0.10 F/A	128	141	156	147	143
IMEP of diluted blends relative to clear isooctane					
at 0.09 F/A	73	78	83	79	80
at 0.10 F/A	76	83	92	87	85
Calculated IMEP of undiluted blends relative to clear isooctane					
at 0.09 F/A	114	129	150	132	136
at 0.10 F/A	124	153	178	169	159
Blending IMEP of undiluted blends [1]					
at .09 F/A	190	216	250	222	229
at .10 F/A	210	258	320	286	267
at .12 F/A (extrapolated)	(230)	(360)	(390)	(350)	(300)
Calculated blending IMEP of undiluted blends with 4 cc. of lead tetraethyl fluid per gallon					
at .09 F/A	270	300	350	310	320
at .10 F/A	290	360	450	400	370
at .12 F/A (extrapolated)	(320)	(420)	(550)	(490)	(420)

[1] Assuming 50 IMEP for n-heptane under these conditions, and employing reciprocal IMEP formula.

The above data are plotted in Figure 1, the lower curves representing actual data and the upper curves representing the calculated comparison of the tested blends (in the absence of normal heptane) with clear isooctane. Curves A and A′ represent data obtained with fuel to air mixtures of about .09. Curves B and B′ represent fuel to air mixtures of about .10. It is surprising that 100% triptane should have a lower IMEP rating than 100% cyclopentane; this anomaly may be due to the particular test conditions in the presence of the normal heptane diluent. The most surprising fact brought out by the data is that there is an optimum blend of cyclopentane with triptane which has a substantially higher IMEP or potential power output than that of either component of the blend. For optimum IMEP both components should be present in amounts of at least about 40% with a range of 25–75% triptane with 75–25% cyclopentane showing a power output which is superior to that of either component of the blend.

In Figure 2 similar data are plotted with the IMEP indicated in pounds per square inch and with additional points indicating the IMEP obtainable. Thus curve C and curve D correspond to curves A′ and B′ of Figure 1. Curve

E illustrates the effect of raising the fuel:air ratio to .12 using unleaded blends. Curve F illustrates the effect of adding 4 cc. of lead tetraethyl fluid per gallon of the various blends where the fuel to air ratio is about .10. It will thus be seen that the triptane-cyclopentane blends herein described are remarkably superior in potential power output to any motor fuel heretofore known to the art.

As hereinabove pointed out, each component of the triptane-cyclopentane blends should be present in an amount of at least 25% and preferably at least about 40%. The addition of tetraethyl lead in amounts of 2 to 6 cc. per gallon markedly improves the potential power output. For maximum power output the fuel:air ratio should be in the range of about .12 to .13. For maximum power output the leaded blend should be substantially free from other hydrocarbons or diluents. However, the blends herein described may be employed with other aviation base stocks particularly when the base stocks are employed in amounts less than 50% of the total fuel. The small amounts of dimethyl butanes which are frequently obtained along with cyclopentane are not particularly deleterious.

It should be noted that the super fuel hereinabove described contains no aromatics and olefins and hence has maximum heating or fuel value and maximum stability against gum formation, discoloration or other deterioration.

I claim:

1. A motor fuel for a high compression, internal combustion, spark ignition engine which motor fuel consists essentially of a mixture of triptane and cyclopentane, each being present in the mixture to the extent of at least 25 volume percent.

2. A motor fuel for a high compression, internal combustion, spark ignition engine which motor fuel consists essentially of a mixture of triptane and cyclopentane, each being present in the mixture to the extent of at least about 40 volume percent.

3. A motor fuel for a high compression, internal combustion, spark ignition engine which motor fuel consists essentially of triptane and cyclopentane wherein the triptane:cyclopentane ratio is approximately 6:4.

4. A motor fuel for a high compression, internal combustion, spark ignition engine which motor fuel consists essentially of 60 volume percent triptane and 40 volume percent cyclopentane with approximately 4 cubic centimeters of lead tetraethyl fluid per gallon of triptane-cyclopentane mixture.

ROBERT F. MARSCHNER.

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