State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-137
Relating to Exemptions under Section 27156
of the Vehicle Code

CARTER AUTOMOTIVE DIVISION
ACF INDUSTRIES INCORPORATED
"ENGINE KNOCK ELIMINATOR"

Pursuant to the authority vested in the Air Resources Board by Section 27156 of the Vehicle Code; and

Pursuant to the authority vested in the undersigned by Sections 39515 and 39516 of the Health and Safety Code and Executive Order G-45-5;

IT IS ORDERED AND RESOLVED: That the installation of the "Engine Knock Eliminator" manufactured by Carter Automotive Division, ACF Industries Incorporated, of 9666 Olive Boulevard, St. Louis, Missouri 63132, has been found not to reduce the effectiveness of required motor vehicle pollution control devices and, therefore, is exempt from the prohibitions of Section 27156 of the Vehicle Code for 1983 and older model-year gasoline-powered motor vehicles, excluding the following:

1. General Motors Corporation vehicles with an "odd-firing" V6 231 CID engine;

2. Vehicles powered by a rotary engine;

3. Vehicles equipped with more than one ignition coil; and

4. Vehicles equipped with a closed-loop (computer controlled) carburetion system.

This Executive Order is valid provided that installation instructions for this device will not recommend tuning the vehicle to specifications different from those submitted by the device manufacturer.

Changes made to the design or operating conditions of the device, as exempted by the Air Resources Board, that adversely affect the performance of a vehicle's pollution control system shall invalidate this Executive Order.

Marketing of this device using an identification other than that shown in this Executive Order or marketing of this device for an application other than those listed in this Executive Order shall be prohibited unless prior approval is obtained from the Air Resources Board. Exemption of a kit shall not be construed as an exemption to sell, offer for sale, or advertise any component of a kit as an individual device.

This Executive Order does not constitute any opinion as to the effect that the use of this device may have on any warranty either expressed or implied by the vehicle manufacturer.

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF ANY CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF THE "ENGINE KNOCK ELIMINATOR".

No claim of any kind, such as "Approved by Air Resources Board" may be made with respect to the action taken herein in any advertising or other oral or written communication.

Section 17500 of the Business and Professions Code makes untrue or misleading advertising unlawful, and Section 17534 makes violation punishable as a misdemeanor.

Section 43644 of the Health and Safety Code provides as follows:

> "43644. (a) No person shall install, sell, offer for sale, or advertise, or, except in an application to the state board for certification of a device, represent, any device as a motor vehicle pollution control device for use on any used motor vehicle unless that device has been certified by the state board. No person shall sell, offer for sale, advertise, or represent any motor vehicle pollution control device as a certified device which, in fact, is not a certified device. Any violation of this subdivision is a misdemeanor."

Any apparent violation of the conditions of this Executive Order will be submitted to the Attorney General of California for such action as he deems advisable.

Executed at El Monte, California, this 17th day of October, 1983.

K. D. Drachand, Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF CARTER AUTOMOTIVE DIVISION'S "ENGINE KNOCK ELIMINATOR" FOR EXEMPTION FROM THE PROHIBITIONS IN VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA ADMINISTRATIVE CODE

October 17, 1983

Date of Issue: October 17, 1983

EVALUATION OF CARTER AUTOMOTIVE DIVISION'S "ENGINE KNOCK ELIMINATOR" FOR EXEMPTION FROM THE PROHIBITIONS IN VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA ADMINISTRATIVE CODE

by

Mobile Source Division

State of California
Air Resources Board
9528 Telstar Avenue
El Monte, CA 91731

SUMMARY

Carter Automotive Division (CAD) of ACF Industries, Incorporated, has applied for an exemption from the prohibitions in California Vehicle Code Section 27156. They have requested that their "Engine Knock Eliminator" (EKE) device be exempted for 1983 and older model-year gasoline-powered motor vehicles, excluding the following:

1. General Motors Corporation vehicles with an "odd-firing" V6 231 CID engine;
2. Vehicles powered by a rotary engine; and
3. Vehicles equipped with more than an ignition coil.
4. Vehicles equipped with closed-loop (computer controlled) carburetion systems.

Based on the following:

1. The comparative exhaust emission tests performed and submitted by CAD; and
2. The staff's engineering evaluation of the device

the staff concludes that the EKE will not have an adverse effect on exhaust emissions from vehicles for which exemption is recommended to be granted.

The staff recommends that CAD be granted an exemption for 1983 and older model-year gasoline-powered motor vehicles, excluding the following:

1. General Motors Corporation vehicles with an "odd-firing" V6 231 CID engine;
2. Vehicles powered by a rotary engine;

3. Vehicles equipped with more than one ignition coil; and

4. Vehicles equipped with closed-loop (computer controlled) carburetion systems.

The staff recommends that exemption application for vehicles equipped with closed-loop (computer controlled) carburetion systems be denied until CAD can demonstrate compliance with the requirements for the exemption for these vehicles. No evidence has been shown to demonstrate that the device will not have an adverse effect on these vehicles, knowing that these vehicles' ignition systems are controlled by computers.

The staff also recommends that Executive Order D-137 be issued.

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EVALUATION OF CARTER AUTOMOTIVE DIVISION'S "ENGINE KNOCK ELIMINATOR" FOR EXEMPTION FROM THE PROHIBITIONS IN VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA ADMINISTRATIVE CODE.

I. INTRODUCTION

Carter Automotive Division of ACF Industries, Incorporated, 9666 Olive Boulevard, St. Louis, MO 63132, has applied for an exemption from the prohibitions in California Vehicle Code Section 27156. The applicant has requested that their "Engine Knock Eliminator" be exempted for 1983 and older model-year gasoline-powered motor vehicles, excluding the following:

1. General Motors Corporation vehicles with an "odd-firing" V6 231 CID engine;
2. Vehicles powered by a rotary engine; and
3. Vehicles equipped with more than one ignition coil.
4. Vehicles equipped with closed-loop (computer controlled) carburetion systems.

CAD has submitted data of comparative hot start CVS-72 (1-bag) emission tests performed at their own test facility. Their tests were performed on several 49-state certified vehicles ranging in model-years and engine sizes.

II. CONCLUSION

Based on: (1) the comparative exhaust emission tests performed and submitted by CAD, even though they were from 49-state certified vehicles using the hot start CVS-72 procedures; and (2) the staff's engineering

evaluation of the device, the staff concludes that the EKE will not have an adverse effect on exhaust emissions from vehicles for which exemption is recommended to be granted.

III. RECOMMENDATIONS

Based on the above conclusion, the staff recommends that Carter Automotive Division be granted an exemption from the prohibitions in Vehicle Code Section 27156 for their EKE device for installation on 1983 and older model-year gasoline-powered motor vehicles, excluding the following:

1. General Motors Corporation vehicles with an "odd-firing" V6 231 CID engine;
2. Vehicles powered by a rotary engine;
3. Vehicles equipped with more than one ignition coil; and
4. Vehicles equipped with closed-loop (computer controlled) carburetion systems.

The staff also recommends that Executive Order D-137 be issued.

IV. DEVICE DESCRIPTION AND OPERATION

The EKE is an add-on device which senses engine detonation and electronically retards ignition timing to eliminate detonation. The major components of the EKE are a detonation sensor and an electronic control unit. The components are packaged with installation hardware and instructions and sold as a kit.

The detonation sensor has a 3/8" standard threaded stud designed to be bolted directly to any existing vacant 3/8"-16 threaded hole in the intake manifold or cylinder head where there is no interference with

throttle or choke mechanisms. The sensor senses engine vibration and generates an electrical signal to the electronic control unit. The knock sensor consists of an amplifier and a discriminator. The amplifier amplifies the intensity of the vibration for signal generation; whereas, the discriminator will discrete engine noise/vibration interference from engine detonation, thus, generating a voltage signal only under engine detonation conditions.

The electronic control unit is a transistorized module which interprets voltage signals from the knock sensor (during detonation) to retard ignition timing until detonation is eliminated. Once detonation is ceased, the ignition timing is slowly returned to OEM specification. The amount of retard is proportional to the strength and frequency of the engine knock. Although the maximum retard is about 15 degrees, the actual amount of retard is only enough to eliminate engine knock. CAD technicians claim that the retard control response (time required to retard timing by 15 degrees) is 0.5 seconds, and advance control response (time required to forward ignition timing to OEM specifications, up to 15 degrees) is 3.8 seconds. Ignition retardation is accomplished through the control unit by delaying the termination of current to the ignition coil and, thus, the ignition timing.

The control unit contains a four-, six-, and eight-cylinder rotating selector to accommodate all engine sizes.

Schematic diagrams showing EKE connection to standard breaker point or solid state ignition. General Motors Corporation, Chrysler and Ford electronic ignition systems are shown in the Appendices.

V. EVALUATION

CAD submitted data of comparative (without and with the device installed on test vehicles) hot start CVS-72 (1-bag) emission tests. Their tests were performed at their own test facility using 49-state certified vehicles. A list of the test vehicles and a summary of the test results are shown in the Appendices.

VI. DISCUSSION

CAD's comparative data shown in the Appendices indicate that their EKE device did not have an adverse effect on exhaust emissions from the vehicles tested. The vehicles tested were 49-state certified, rather than California-certified as required by the procedures, and contained breakerless electronic ignition systems. Since the principle and theory of operation of the ignition systems in 49-state and California-certified vehicles are similar, the staff accepted CAD's data for the evaluation of the device.

Based on an engineering evaluation of the designed operation of the device (retarding ignition timing during detonation only), the staff concludes that the EKE will also have no adverse effect on exhaust emission from vehicles equipped with breaker point type ignition system.

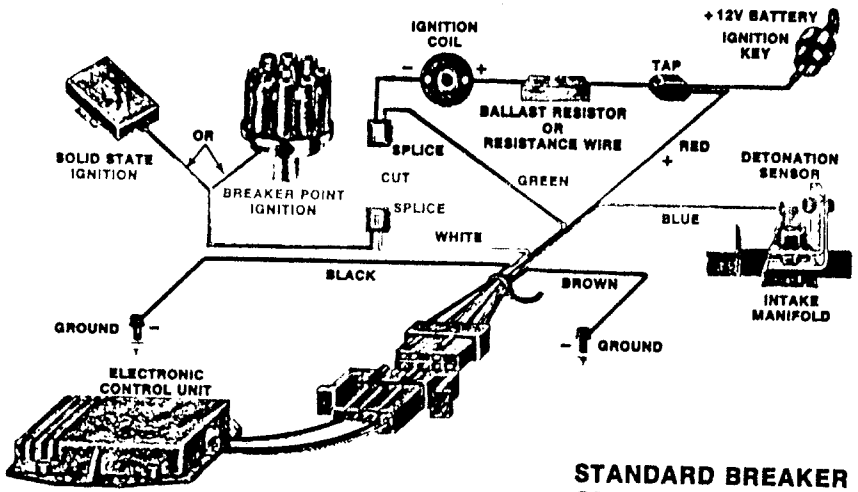
No comparative data was submitted by CAD on the effects of the EKE device on vehicles equipped with closed-loop feedback (computer controlled) systems. The staff cannot conclude that the EKE will or will not alter the designed operation of the vehicle's ignition system and adversely affect exhaust emissions, which is controlled by the computer. Until such time as CAD submits data to demonstrate that the EKE will not have an adverse effect on exhaust emissions from vehicles equipped with feedback systems, the staff recommends that exemption application for these vehicles be denied.

The staff is concerned about the effects of the ignition timing retardation by the EKE device may have on the vehicle's catalytic converter. The device is designed to retard ignition timing thus delaying the combustion process, only when detonation occurs.

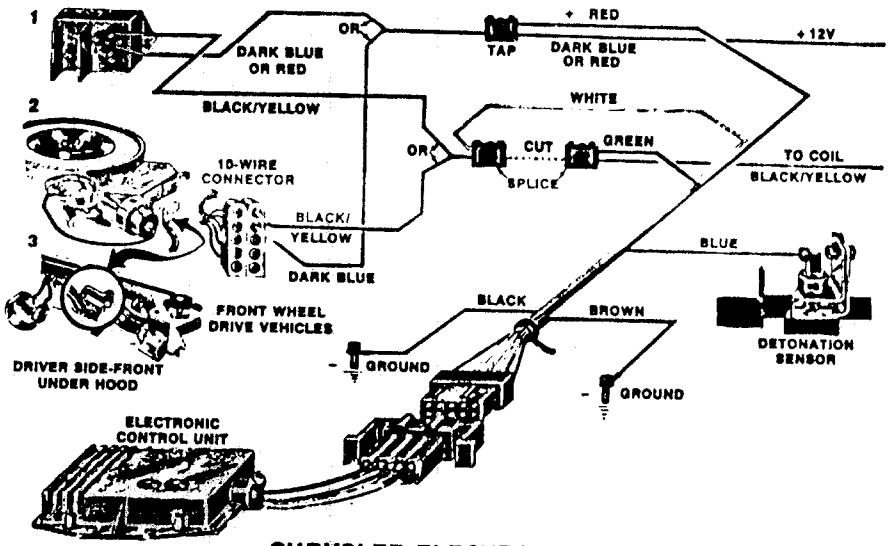
Since (1) the device returns the timing to OEM parameters within 2.8 seconds after detonation is suppressed, its operation will not cause significant increase in exhaust gas temperature which may affect the efficiency and durability of the catalytic converter and/or its substrate; (2) a previously evaluated and exempted add-on turbocharger kit which included this device did not show any break-down or overheating of the catalytic converter; and (3) CAD's research and development tests did not show any break-down or overheating of catalytic converter, the staff is of the opinion that the EKE device will not cause any problems for the catalytic converter due to some increase in exhaust gas temperature as a result of retard in timing when the device is functioning.

APPENDICES

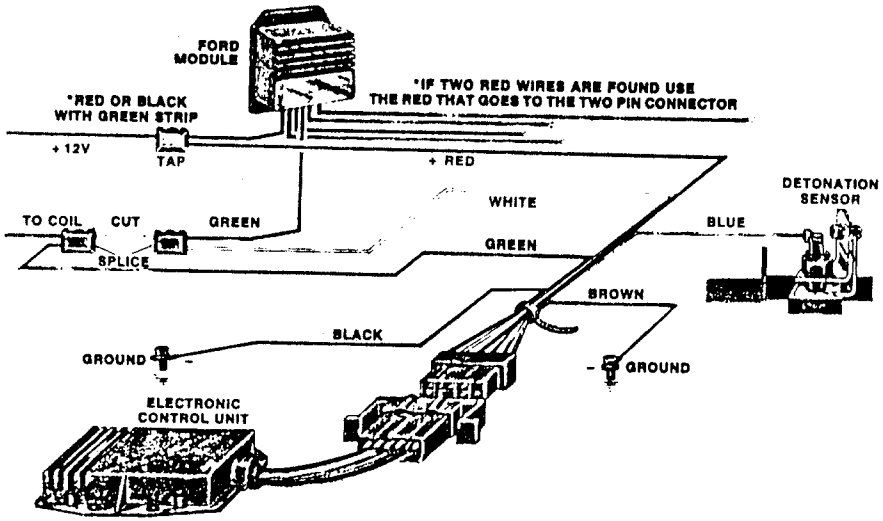
CONNECTION OF THE EKE DEVICE



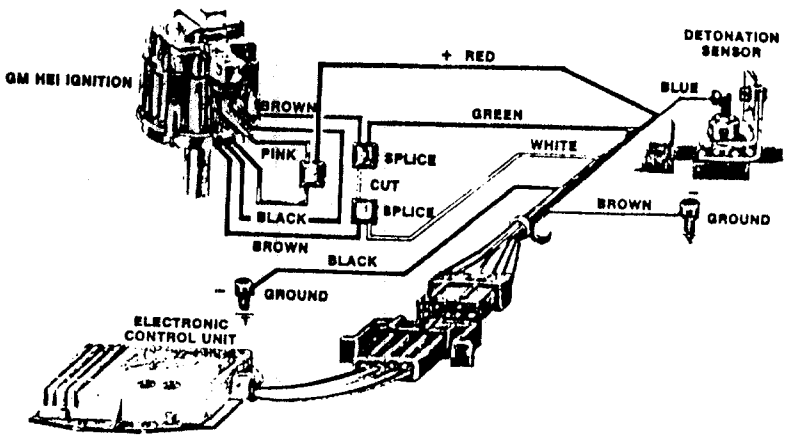
STANDARD BREAKER POINT OR SOLID STATE IGNITION



CHRYSLER ELECTRONIC IGNITION



FORD ELECTRONIC IGNITION



GM HIGH ENERGY IGNITION

DESCRIPTION OF TEST VEHICLES

EVALUATION OF CARTER AUTOMOTIVE DIVISION

"ENGINE KNOCK ELIMINATOR"

	Veh #1	Veh #2	Veh #3	Veh #4
Model-Year	1977	1978	1979	1980
Make	Volkswagen	Ford	Pontiac	Ford
Model	Rabbit	F-100 P-U	Grand Prix	Monarch
Engine Size	I-4, 1.7L	I-6, 300 CID	V8, 305 CID	I-6, 250 CID
ECS	OC	OC	OC	OC
Ignition System	Bosch electronic breakerless	Dura-Spark electronic breakerless	H.E.I. breakerless	Dura-Spark electronic breakerless

OC: Oxidation Catalyst

CAD's Emission Test Data

Evaluation of CAD's "Engine Knock Eliminator"

Hot Start CVS-72

Vehicle	Test Mode	Exhaust Emissions (g/mi) HC	CO	NOx	Fuel Economy (mpg)
#1	Baseline	3.54	5.4	1.6	23.9
	Device	2.99	5.7	1.6	23.8
#2	Baseline(1)	0.51	3.8	2.0	18.1
	Device(1)	0.49	3.4	1.9	18.0
#3	Baseline(1)	0.57	3.3	3.0	17.9
	Device(1)	0.47	2.5	2.8	17.8
#4	Baseline(1)	0.38	2.5	1.2	17.5
	Device(1)	0.34	2.0	1.1	17.3

(1): Averaged value of three tests.