E.O. 3..

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-47-1
Relating to Exemptions under Section 27156
of the Vehicle Code

CAMBRIDGE AUTOMOTIVE ENGINEERING INC.
"ALLISON OPTO-ELECTRIC IGNITION SYSTEM"

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 Section 39515 of the Health and Safety Code and Executive Order G-30A;

IT IS ORDERED AND RESOLVED: That the installation of the "Allison Opto-Electric Ignition System" Model XR-700 manufactured by Cambridge Automotive Engineering, Inc., 1269 E. Edna place, Covina, California, 91722 has been found to not 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 1975 and older model year vehicles for the following applications.

Ignition System Make and Type	Control Rotor Part No.	Sensor Bracket Part No.
Ford 8 cylinder engines (two types-eccentric and pivotal concentric vacuum advance breaker plates).	216	208
General Motors 6 cylinder engines	214	209
Chrysler 6 cylinder engines	215	210
Chrysler 8 cylinder engines clockwise rotating distributor shaft	217	212
Chrysler 8 cylinder engines counter-clockwise rotating distributor shaft	217	211

This device is not approved for the following applications:

1) Those vehicles originally equipped with transistorized, capacitor discharge, breakerless or dual point ignition systems where one of the points is used to retard timing for emission control.

2) Those 1966 through 1970 vehicles equipped with a retrofit NOx device which incorporates retard of basic ignition timing (i.e., Carter, Echlin, GRANCOR (STP) - Air Computer, AQP - Electro-NOx and Kar Kit.)

The device consists of a light emitting diode and photocell sensor, a swirl cut control rotor, and a transistor switching module.

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

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 "ALLISON OPTO-ELECTRIC IGNITION SYSTEM".

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 Sacramento, California, this 23 day of August, 1976.

original signed by
Thomas C. Austin
Deputy Executive Officer-Technical

State of California

AIR RESOURCES BOARD

Staff Report

July 19, 1976

Evaluation of Cambridge Automotive Engineering, Inc.'s "Allison Opto-Electric Ignition System" for Exemption from the Prohibitions of Motor Vehicle Code Section 27156

I. Introduction

Cambridge Automotive Engineering Inc. of 1269 E. Edna Place, Covina, California, 91722 was issued an Executive Order number D-47 which is an exemption from the prohibitions of Motor Vehicle Code Section 27156 for the "Allison Opto-Electric Ignition System". The exemption was for 1975 and older model year vehicles except as follows:

1) Those vehicles equipped with General Motors 6 cylinder engines.
2) Those vehicles equipped with Chrysler Corporation 6 or 8 cylinder engines.
3) Those vehicles equipped with Ford 8 cylinder engines.
4) Those vehicles originally equipped with breakerless ignition systems or dual point ignition systems where one of the points are used to retard timing for emission control.
5) Those 1966 through 1970 vehicles equipped with "NOx retrofit devices" with a 4° retard in basic ignition timing (i.e., Carter, Echlin, STP Air Computer, Pure Power - Electro-NOx).

Cambridge Automotive Engineering Inc. has now applied (Exhibit A) for additional vehicle applications as follows:

1. Ford 8 cylinder (two types - eccentric and pivotal concentric).
2. General Motors 6 cylinder engines.
3. Chrysler 6 cylinder and 8 cylinder engines.

II. System Description

The Allison Opto-Electric Ignition System is a unit to replace the breaker points within a distributor. It consists primarily of a control rotor, a position sensor, and a transistor switching unit. This device utilizes the ignition coil supplied with the vehicle. The window shutter or the control rotor is placed over the cam of the distributor and has windows cut for 8 cylinder, 6 cylinder or 4 cylinder engine applications. The position sensor operates in conjunction with the control rotor and consists of a light emitting diode and an infrared detector. The signals derived by the position sensor are then fed to the power unit which accomplishes transistor switching of the primary coil of the ignition system.

This new application, which encompasses eccentric and pivotal-concentric vacuum advance breaker plate distributor designs, uses a swirl cut window shape for the control rotor to maintain the distributor spark advance characteristics. The transistor switching unit is the same as in the previous exemption and is the model 17 unit. The part numbers of the control rotor, sensor brackets, and vehicle usage are as follows:

Ignition System Make and Type	Control Rotor Part No.	Sensor Bracket Part No.
Ford 8 cylinder (two types-eccentric and pivotal concentric Vacuum advance breaker plates).	216	208
General Motors 6 cylinder engines	214	209
Chrysler 6 cylinder	215	210
Chrysler 8 cylinder clockwise rotating distributor shaft	217	212
Chrysler 8 cylinder counter-clockwise rotating distributor shaft	217	211

III. System Evaluation

A. Model 17

1. Applicants Test Data

The applicant submitted data for centrifugal and vacuum advance and electrical characteristics for the device when tested according to the Air Resources Board (ARB) preliminary "Guidelines for Testing and Criteria for Compliance of Ignition System Modifications" dated May 25, 1976. In order to evaluate the device the ignition system characteristics with and without the device are compared. The data submitted was for Chrysler 8 cylinder clockwise and counter clockwise, Ford 8 cylinder eccentric and pivotal concentric, General Motors 6 cylinder and Chrysler 6 cylinder distributors. A data summary is presented in Tables I, II and III. The spark timing data are considered within experimental and test variabilities. The spark energy data and parameters associated with the calculation of spark energy appeared excessively high compared to previous experience. It was also apparent that the data reported as spark voltage average, spark current average and spark duration when multiplied together did not equal the spark energy calculated by the applicant but was also excessively high. As a result no conclusion could be made regarding the applicants data on electrical characteristics.

2. ARB Confirmatory Tests

Confirmatory tests were conducted by the Air Resources Board Laboratory on an ignition system simulator which consists of a Sun distributor tester, Tektronix Oscilloscope, Sun Ignition Analyzer and associated accessories in accordance with the Air Resources Board (ARB) preliminary "Guidelines for Testing and Criteria for Compliance of Ignition System Modifications" dated May 25, 1976. Summaries of data obtained on 1973 Ford 8 cylinder, 1967 Ford 8 cylinder and 1972 Chrysler 8 cylinder distributors are shown in Tables IV and V.

Except for spark energy, the data was considered within experimental and test variabilities and is evaluated as meeting the Air Resources Boards criteria. The spark energy data at cruise conditions showed a 30.3% degradation from Original Equipment on the 1973 Ford and 36.5% degradation on the 1972 Chrysler. A discussion ensued with the applicant and Air Resources Board staff. It was discovered that at the cruise RPM condition, oscilloscope calibration for zero voltage was improper and as a result the energy data at the cruise condition was considered invalid.

Additional tests were made at the ARB laboratory to resolve the evaluation. These tests are referred to as test numbers 2, 3 and 4.

Test number 2 (Table VI) still showed a 40% energy degradation at cruise RPM on the 1973 Ford and 18.4% energy degradation with the 1972 Chrysler ignition systems. Further tests were made on the 1973 Ford ignition system to vary the baseline breakerpoint dwell at cruise RPM. At zero inches of mercury pressure on the vacuum advance mechanism the dwell was 28°. At 18 inches of mercury vacuum advance the dwell was 30°. This data summary of test number 3 is shown in Table VII. The same test was conducted 2 days later to evaluate data repeatability and the data summary of test number 4 is shown in Table number VIII.

A comparison of spark energy at cruise RPM (3000 crankshaft) for the various tests performed on the 1973 Ford distributor is shown below:

Spark Energy (Millijoules) at Cruise RPM
1973 Ford 8 Cylinder Distributor

Test No.	Baseline	Device	% Change
2*	17.0	10.2	-40%
3*	17.8	12.1	-32%
3**	18.5	12.1	-35%
4*	17.0	15.3	-10%
4**	17.8	15.3	-14%

*28° Dwell on Baseline Test
**30° Dwell on Baseline Test

This comparison shows that the device is inconsistent and unreliable due to the energy degradation. Conversely, a comparison of baseline energy shows excellent data consistency. These results are judged as not meeting the Air Resources Board Criteria of no more than 20% spark energy degradation from the O.E.M. ignition system. Excessive degradation of spark energy is expected to cause an increase in hydrocarbon emissions particularly with used vehicles having marginal ignition systems or during cold weather and cold engine operation.

B. Model XR-700

During the above testing and discussions with the applicant a new design was made by Cambridge Automotive in an attempt to eliminate the problems found with the Model 17 electronic module. The new design is identified as Model XR-700. The application amendment to submit the new model is shown as Exhibit B.

The design change added a transistor to the transistor switching circuit to provide a more complete and constant drive to the output transistor. This is intended to lower the saturation resistance of the output transistor and increase peak power to be delivered to the ignition primary coil.

1. Applicants Data

   The applicant submitted data for the design change to compare baseline and device electrical characteristics of Chrysler 6 and 8 cylinder, Ford 8 cylinder ignition systems. These data are shown in Tables IX and X. This data showed little or no degradation of spark energy, however the spark duration appeared longer than usual and the average spark voltage was lower (on the order of 500 volts) than is normally experienced.

2. ARB Confirmatory Tests

   The confirmatory tests were performed on a 1973 Ford 8 cylinder and a 1972 Chrysler 8 cylinder ignition system to compare spark timing and electrical characteristics with and without the device. A summary of data is shown in Table XI. The model XR-700 unit once again showed a degradation of spark energy at cruise (3000 RPM crankshaft) conditions as follows:

Spark Energy (Millijoules)

Ignition System	Baseline	Device	% Change
1973 Ford	20.1	11.4	-43.3
1972 Chrysler	21.2	13.3	-37.3

The spark energy degradation is judged as not meeting the Air Resources Board's criteria of no more than 20% degradation from O.E.M. The applicant was informed of these results.

C. Model XR-700 Redesigned

The applicant re-designed the electronic module so that the design features are as follows. The output integrated circuit is a Darlington configured type. A matching capacitor is used in parrallel with the output circuit to augment switching time and optimizes the peak power delivered to the primary of the ignition coil. In addition the ground wires from the coil to the switching transistor and switching transistor to ground have been changed from AWG #18 to AWG #14 wire size to reduce resistance. Further the circuit board connections to the switching transistor were improved to reduce resistance.

1. Applicants Test Data

The applicant submitted test data to compare spark timing and electrical characteristics of the ignition system with and without the device. The type of ignition systems tested were General Motors 6 cylinder, Chrysler 6 and 8 cylinder and Ford 8 cylinder. The summary of test data is shown in Tables XII, XIII and XIV. These results are considered within experimental and test variabilities and are evaluated as meeting the Air Resources Board's criteria for ignition system modifications.

2. ARB Confirmatory Tests

Since previous design problems were encountered spot check confirmatory tests were made on two ignition systems. These were the 1973 Ford and the 1972 Chrysler 8 cylinder types. The summary of test data is shown in Table XV. These results are considered within experimental and test variabilities and are evaluated as meeting the Air Resources Board's criteria for ignition system modification.

IV. Manufacturer's Claims

The benefits claimed by the manufacturer for his device are as follows:

A. The elimination of the cost of replacement parts and maintenance of Breaker-Points and Condensor.

B. Greater timing accuracy than O.E. Breaker-Point system.

C. Savings of fuel normally wasted due to timing change caused by contact Breaker-Point Wiper-Arm wear.

D. Elimination of emission level increases due to timing changes caused by contact Breaker-Point Wiper-Arm wear.

E. Increased RPM capability over Breaker-Point system.

F. More consistent spark output due to the elimination of typical contact Point erosion.

G. User benefits that are a natural by-product of any of the above these vary according to the application.

It is the staff's judgement that the installation of the device and the idea of breakerless ignition offers potential of reduced maintenance. Durability of the device was not investigated or substantiated. The electrical characteristics of this system do not indicate any significant benefit on performance, economy or emission reduction than would be obtained from a properly tuned engine.

IV. Conclusions and Recommendations

Based on the evaluation of the application and ARB test results, the Cambridge Automotive Engineering, Inc. - "Allison Opto-Electric Ignition System" Model XR-700 would not adversely affect the operation of OEM emission control systems applied for. The staff recommends that Cambridge Automotive Industries, Inc. be issued an exemption from the prohibitions of Section 27156 of the Motor Vehicle Code for its "Allison Opto-Electric Ignition System" Model XR-700 as listed in the introduction.

Table I-Cambridge Automotive Data Summary for the Model 17
"Opto-Electric Ignition System"

A. Centrifugal Spark Advance in Crankshaft Degrees

	1968 Chrysler-8 Cylinder (Clockwise Rotation)		1963 Chrysler-8 Cylinder (Counter Clockwise Rotation)	
Engine RPM	Baseline	Device	Baseline	Device
600	0	0	-2.0	0.0
1400	2.0	2.0	10.0	5.0
2000	6.0	4.0	10.0	9.0
2600	8.0	7.0	12.0	12.0
3000	11.0	9.0	14.0	15.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	0	0	0	0
9	0	0	0	0
12	0	0	13.0	12.0
15	16.0	14.0	13.0	13.0
20	22.0	20.0	13.0	13.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	2000	3100	2000	3100
3000	1500	1400	1500	1400

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	20	17	20	17
3000	25	17	25	17

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
600	44.0	69.8	44.0	69.8
3000	22.5	21.0	22.5	21.0

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device	Baseline	Device
600	21	24	21	24
3000	20	20	20	20

Table I (Cont'd)

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
600	16	20	16	20
3000	14	18	14	18

Table II-Cambridge Automotive Data Summary for the Model 17 "Opto-Electric Ignition System"

A. Centrifugal Spark Advance in Crankcase Degrees

Engine RPM	1968 Ford-8 Cylinder (Eccentric Breaker Plates) Baseline	Device	1972 Ford-8 Cylinder (Pivotal Concentric Breaker Plate) Baseline	Device
600	0	0	0	0
1400	8.0	10.0	5.0	4.0
2000	18.0	16.0	8.0	7.0
2600	20.0	19.0	12.0	10.0
3000	21.0	20.0	14.0	12.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	2.0	1.0	1.0	0
9	11.0	8.0	8.0	6.0
12	17.0	14.0	12.0	10.0
15	20.0	17.0	16.0	15.0
20	24.0	24.0	22.0	22.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	1600	2800	1600	2800
3000	1200	1500	1200	1500

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	18	15	18	15
3000	22	16	22	16

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
600	44.0	66.5	44.0	66.5
3000	36.0	30.0	36.0	30.0

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device	Baseline	Device
600	22	26	22	26
3000	19	21	19	21

Table II (Cont'd)

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
600	16	21	16	21
3000	13	15	13	15

Table III-Cambridge Automotive Data Summary for the Model 17
"Opto-Electric Ignition System"

A. Centrifugal Spark Advance in Crankshaft Degrees

Engine RPM	1961 Chrysler-6 Cylinder (Eccentric)		1968 General Motors-6 Cylinder (Eccentric)	
	Baseline	Device	Baseline	Device
600	-1.0	0	0	0
1400	10.0	7.0	12.0	11.0
2000	16.0	14.0	20.0	18.0
2600	19.0	17.0	22.0	20.0
3400	22.0	20.0	26.0	23.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	0	0	0	0
9	12.0	14.0	6.0	6.0
12	24.0	26.0	14.0	14.0
15	32.0	32.0	20.0	22.0
20	32.0	32.0	24.0	24.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	2200	3200	2100	3400
3500	1800	1900	1400	2100

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	20	17	20	12
3500	22	18	22	15

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
600	48.4	56.0	51.9	85.0
3500	36.2	31.4	25.2	36.2

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device	Baseline	Device
600	24	23	22	27
3500	19	12	16	19

Table III (Cont'd)

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
600	15	18	16	19
3500	13	11	12	16

Table IV-ARB Data Summary for the Allison Opto-Electric Ignition System (Model 17)

A. Centrifugal Spark Advance in Crankshaft Degrees

	1973 Ford-8 Cylinder (Pivotal Concentric)		1967 Ford-8 Cylinder (Eccentric)	
Engine RPM	Baseline	Device	Baseline	Device
600	0	0	0	0
1400	6.0	6.5	10.5	10.5
2000	9.5	9.0	16.5	14.5
2600	13.0	12.5	18.0	16.5
3000	16.0	15.0	19.0	17.5

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	2.0	.5	1.0	1.0
9	10.5	7.0	10.0	6.5
12	16.0	13.0	16.5	12.5
15	21.0	18.0	20.5	16.0
20	24.0	23.5	24.0	20.5

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	1200	1200	1300	1300
3000	1100	800	1100	900

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	50	100	50	80
3000	50	100	50	80

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
600	15.5	15.5	18.5	16.8
3000	18.5	12.9	18.5	15.5

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device	Baseline	Device
600	24.0	23.0	23.0	24.0
3000	20.0	19.0	20.0	20.0

Table IV (Cont'd)

G. Available Voltage in Kilovolts (simulating fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
600	18.0	15.0	17.0	15.0
3000	14.0	13.0	14.0	12.0

Table V ARB Data Summary for the Allison Opto-Electric Ignition System (Model 17)

A. Centrifugal Spark Advance in Crankshaft Degrees

1972 Chrysler-8 Cylinder (Eccentric)

Engine RPM	Baseline	Device
600	0	0
1400	19.0	18.0
2000	20.5	19.5
2600	24.0	22.5
3000	25.5	24.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device
3	0	0
6	0	0
9	1.0	0.5
12	9.5	8.5
15	20.0	19.5
20	20.5	20.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device
600	2000	2100
3000	1600	1200

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device
600	130	100
3000	130	100

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device
600	25.9	27.2
3000	31.0	19.7

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device
600	27.0	26.0
3000	24.0	18.5

Table V (Cont'd)

G. Available Voltage in Kilovolts (simulating fouled spark plug)

Engine RPM	Baseline	Device
600	17.0	17.0
3000	14.0	12.0

Table VI ARB Data Summmary for the Allison Opto-Electric Ignition System Model 17 (Test No. 2)

A. Centrifugal Spark Advance in Crankshaft Degrees

Engine RPM	1973 Ford-8 Cylinder Baseline	1973 Ford-8 Cylinder Device	1972 Chrysler - 8 Cylinder Baseline	1972 Chrysler - 8 Cylinder Device
600	0	0	0	0
1400	6.0	6.5	19.0	18.0
2000	9.5	9.0	20.5	19.5
2600	13.0	13.0	24.0	22.5
3000	16.0	15.0	25.5	24.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	2	0.5	0	0
9	10.5	7.0	1.0	0.5
12	16.0	13.0	9.5	8.5
15	21.0	18.0	20.0	19.5
20	24.0	23.5	20.5	20.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	1200	1200	2200	2200
600	1200	1150	2000	1900
3000	1100	800	1600	1500

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	60	70	120	110
600	60	70	120	110
3000	60	70	120	110

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
200	18.6	18.6	37.0	32.4
600	18.6	17.8	31.0	25.2
3000	17.0	10.2	21.2	17.3

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device	Baseline	Device
200	22.0	25.0	25.0	28.0
600	22.0	26.0	26.0	26.0
3000	18.5	23.0	23.0	19.0

Table VI (Cont'd)

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
200	17.0	14.0	14.0	16.0
600	16.0	16.5	16.5	16.0
3000	14.0	13.0	13.0	12.0

Table VII - ARB Data Summary for the Allison Opto-Electric Ignition System Model 17 (Test No. 3)

A. Centrifugal Spark Advance in Crankshaft Degrees

1973 Ford - 8 cylinder

Engine RPM	Baseline	Device
600	0	0
1400	6.0	6.5
2000	9.0	9.0
2600	13.0	12.5
3000	16.0	15.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device
3	0	0
6	2.0	0
9	10.0	7.0
12	16.0	12.0
15	21.0	18.0
20	24.0	23.0

C. Spark Duration in Microseconds

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	1800		1700
600	1300		1050
3000	1200	1250	1050

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	60		80
600	60		70
3000	60	60	70

E. Spark Energy in Millijoules

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	30.3		31.6
600	20.1		15.6
3000	17.8	18.5	12.1

Table VII - (cont'd)

F. Available Voltage in Kilovolts (with Load)

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	26.0		28.0
600	22.0		22.0
3000	18.5	18.5	18.5

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	17.0		17.0
600	16.0		14.0
3000	14.0	14.0	12.5

Table VIII - ARB Data Summary for the Allison Opto-Electric Ignition System Model 17 (Test No. 4)

A. Centrifugal Spark Advance in Crankshaft Degrees

1973 Ford - 8 cylinder

Engine RPM	Baseline	Device
600	0	0
1400	6.0	7.0
2000	9.0	9.0
2600	13.0	12.5
3000	16.0	15.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device
3	0	0
6	2.0	0
9	10.0	7.0
12	16.0	12.0
15	21.0	18.0
20	24.0	23.0

C. Spark Duration in Microseconds

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	1800		1700
600	1200		1200
3000	1150	1200	1150

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	60		80
600	60		80
3000	60	60	80

E. Spark Energy in Millijoules

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	30.3		31.6
600	17.8		17.8
3000	17.0	17.8	15.3

Table VIII - (cond't)

F. Available Voltage in Kilovolts (with Load)

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	26.0		28.0
600	22.0		21.0
3000	18.5	18.5	20.0

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline (0" Hg)	Baseline (18" Hg)	Device
200	17.0		17.0
600	16.0		14.0
3000	14.0	14.0	12.5

Table IX - Cambridge Automotive Data Summary for the Allison Opto-Electric Ignition System Model XR-700

A. Spark Duration in Microseconds

	Chrysler - 8 cylinder		1968 Ford - 8 cylinder	
Engine RPM	Baseline	Device	Baseline	Device
600	3600	3400	2600	2600
3000	1900	2100	1800	1600

B. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
600	40	50	40	40
3000	40	50	40	50

C. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
600	30.8	32.3	22.2	24.7
3000	13.7	16.8	13.0	12.0

D. Available Voltage in Kilovolts (with Load)

Engine RPM	Baseline	Device	Baseline	Device
600	31	31	23	23
3000	21	20	19	19

E. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
600	21	20	17	15
3000	15	13	14	13

Table X - Cambridge Automotive Data Summary for the Allison Opto-Electric Ignition System Model XR-700

Chrysler - 6 cylinder / General Motors - 6 cylinder

A. Spark Duration in Microseconds

Engine RPM	Chrysler Baseline	Chrysler Device	GM Baseline	GM Device
600	3700	3000	3700	3500
3400	2800	2200	2500	2100

B. Secondary Voltage Rise Time in Microseconds

Engine RPM	Chrysler Baseline	Chrysler Device	GM Baseline	GM Device
600	40	50	40	50
3400	40	50	40	50

C. Spark Energy in Millijoules

Engine RPM	Chrysler Baseline	Chrysler Device	GM Baseline	GM Device
600	29.9	28.5	33.3	36.8
3400	15.7	17.6	17.8	18.9

D. Available Voltage in Kilovolts (with Load)

Engine RPM	Chrysler Baseline	Chrysler Device	GM Baseline	GM Device
600	35	30	27	26
3400	20	20	21	21

E. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Chrysler Baseline	Chrysler Device	GM Baseline	GM Device
600	21	20	18	16
3400	13	13	13	13

Table XI - ARB Data Summary of the Allison Opto-Electric Breakerless Ignition System XR-700

A. Centrifugal Spark Advance in Crankshaft Degrees

Engine RPM	1973 Ford - 8 cylinder Baseline	1973 Ford - 8 cylinder Device	1972 Chrysler - 8 cylinder Baseline	1972 Chrysler - 8 cylinder Device
600	0	0	0	0
1400	6.0	6.5	18.5	18.0
2000	9.0	9.0	20.5	20.0
2600	13.0	12.0	24.5	22.5
3000	16.0	15.0	25.5	24.5

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	2.0	0	0	0
9	10.5	7.0	1.0	0.5
12	16.0	13.0	9.0	8.0
15	21.0	19.0	20.0	19.5
20	24.0	24.0	20.5	20.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	1400	1400	2300	2100
600	1200	1300	2000	2000
3000	1300	900	1600	1500

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	60	70	120	120
600	60	70	120	120
3000	60	70	120	120

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
200	21.7	20.6	36.3	30.9
600	18.6	18.4	29.6	26.6
3000	20.1	11.4	21.2	13.3

Table XI - ARB Data Summary of the Allison Opto-Electric Breakerless Ignition System XR-700 (cont'd)

F. Available Voltage in Kilovolts (with Load)

Engine RPM	Baseline	Device	Baseline	Device
200	22.0	21.0	25.0	27.0
600	22.0	21.5	26.0	26.0
3000	18.5	18.0	23.0	19.0

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
200	17.5	15.0	14.0	16.0
600	16.0	14.5	16.0	16.0
3000	14.5	12.0	13.0	12.0

Table XII - Cambridge Automotive Data Summary for the Allison Opto-Electric Ignition System Model XR-700 Redesigned.

A. Centrifugal Spark Advance in Crankshaft Degrees

	1968 General Motors - 6 cylinder		1961 Chrysler - 6 cylinder	
Engine RPM	Baseline	Device	Baseline	Device
600	0	0	-1.0	0
1400	12.0	11.0	10.0	7.0
2000	20.0	18.0	16.0	14.0
2600	22.0	20.0	19.0	17.0
3400	26.0	23.0	22.0	20.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	0	0	0	0
9	6.0	6.0	12.0	14
12	14.0	14.0	24.0	26
15	20.0	22.0	32.0	32.0
20	24.0	24.0	32.0	32.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	2800	2400	2000	2100
600	2000	1900	1800	1800
3500	1600	1600	1600	1600

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	40	30	40	40
600	40	35	40	35
3500	40	35	40	40

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
200	44.8	45.6	34.0	35.7
600	30.0	30.4	27.0	28.8
3500	20.8	22.4	22.4	22.4

Table XII - Cambridge Automotive Data Summary for the Allison Opto-Electric Ignition System Model XR-700 Redesigned. (cont'd)

F. Available Voltage in Kilovolts (with Load)

Engine RPM	Baseline	Device	Baseline	Device
200	24	27	25	25
600	25	24	24	23
3500	21	21	22	22

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
200	20	18	17	17
600	17	16	16	16
3500	13	13	15	15

Table XIII Cambridge Automotive Data Summary for the Allison Opto Electric Ignition System Model XR-700 Redesigned

A. Centrifugal Spark Advance in Crankshaft Degrees

Engine RPM	1963 Chrysler-8 Cylinder (Counter Clockwise) Baseline	1963 Chrysler-8 Cylinder (Counter Clockwise) Device	1968 Chrysler-8 Cylinder (Clockwise) Baseline	1968 Chrysler-8 Cylinder (Clockwise) Device
600	-2	0	0	0
1400	10.0	5.0	2.0	2.0
2000	10.0	9.0	6.0	4.0
2600	12.0	12.0	8.0	7.0
3000	14.0	15.0	11.0	9.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	0	0	0	0
9	0	0	0	0
12	13.0	12.0	0	0
15	13.0	13.0	16.0	14.0
20	13.0	13.0	22.0	20.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	2000	2000	2000	2000
600	1800	1800	1800	1800
3000	1600	1600	1600	1600

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	50	40	50	40
600	50	40	50	40
3000	40	40	40	40

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
200	30.4	33.0	30.4	33.0
600	25.2	27.0	25.2	27.0
3000	22.4	24.0	22.4	24.0

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device	Baseline	Device
200	25	29	25	29
600	23	23	23	23
3000	21	21	21	21

Table XIII (Cont'd)

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
200	17	16	17	16
600	16	16	16	16
3000	14	14	14	14

Table XIV-Cambridge Automotive Data Summary for the Allison Opto-Electric Ignition System Model XR-700 Redesigned

A. Centrifugal Spark Advance in Crankshaft Degrees

Engine RPM	1972 Ford-8 Cylinder		1968 Ford-8 Cylinder	
	Baseline	Device	Baseline	Device
600	0	0	0	0
1400	5.0	4.0	8.0	10.0
2000	8.0	7.0	18.0	16.0
2600	12.0	10.0	20.0	19.0
3000	14.0	12.0	21.0	20.0

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in. Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	1.0	0	2.0	1.0
9	8.0	6.0	11.0	8.0
12	12.0	10.0	17.0	14.0
15	16.0	15.0	20.0	17.0
20	22.0	22.0	24.0	24.0

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	1400	1000	1400	1600
600	1400	1000	1400	1400
3000	1000	1000	1000	1200

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	35	35	35	35
600	35	35	35	35
3000	35	35	35	35

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
200	22.4	27.2	22.4	27.2
600	22.4	22.4	22.4	22.4
3000	14.3	18.0	14.3	18.0

F. Available Voltage in Kilovolts (with Load)

Engine RPM	Baseline	Device	Baseline	Device
200	21	24	21	24
600	22	22	22	22
3000	21	20	21	20

Table XIV (cont'd)

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
200	16	16	16	16
600	16	15	16	15
3000	14	14	14	13

Table XV-Cambridge Automotive Data Summary for the Allison Opto-Electric Ignition System Model XR-700 Redesigned

A. Centrifugal Spark Advance in Crankshaft Degrees

Engine RPM	1973 Ford - 8 Cylinder Baseline	1973 Ford - 8 Cylinder Device	1972 Chrysler - 8 Cylinder Baseline	1972 Chrysler - 8 Cylinder Device
600	0	0	0	0
1400	6.0	6.0	18.0	17.0
2000	9.0	9.5	20.5	20.0
2600	13.0	14.0	24.0	23.0
3000	16.0	17.0	26.0	24.5

B. Vacuum Spark Advance in Crankshaft Degrees

Vacuum in Hg.	Baseline	Device	Baseline	Device
3	0	0	0	0
6	1.0	0	0	0
9	10.0	8.0	1.0	1.0
12	16.0	14.0	8.0	8.0
15	21.0	18.0	20.0	19.0
20	23.0	23.0	21.0	20.5

C. Spark Duration in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	1750	1500	2700	2300
600	1300	1250	1900	1700
3000	1200	1100	1600	1500

D. Secondary Voltage Rise Time in Microseconds

Engine RPM	Baseline	Device	Baseline	Device
200	50	70	120	120
600	60	70	120	120
3000	50	70	120	120

E. Spark Energy in Millijoules

Engine RPM	Baseline	Device	Baseline	Device
200	27.6	26.3	42.5	40.3
600	19.5	18.8	28.5	26.8
3000	16.8	16.2	20.8	19.7

F. Available Voltage in Kilovolts (with load)

Engine RPM	Baseline	Device	Baseline	Device
200	26	24	28	28
600	23	23	26	25
3000	18	19	25	23

Table XV (cont'd)

G. Available Voltage in Kilovolts (simulating a fouled spark plug)

Engine RPM	Baseline	Device	Baseline	Device
200	19.0	16.0	18.0	17.0
600	16.0	15.0	16.0	15.0
3000	13.5	13.0	14.0	13.5

EXHIBIT A

Cambridge Automotive Engineering, Inc.

March 11, 1976

Mr. G. C. Hass
Air Resource Board
Vehicle Admission Test Board
9528 Telstar Avenue
El Monte, CA 91731

Dear Mr. Hass:

Cambridge Automotive Engineering, Inc. does here by submit this application for amendment to Executive Order D-47 to include the following:

A. Ford 8 cylinder (two types - eccentric and pivotal concentric)

B. General Motors 6 cylinder engines

C. Chrysler 6 cylinder and 8 cylinder engines

This application has been prepared in an item by item accordance with the document received from your agency, dated March 2, 1976, addressed to ourselves, and signed by Mr. K. D. Drachand, of your agency.

Contained in the application are the following:

A copy of the aforementioned document, test data statements and documents in compliance with items 1-7 of said document, and one 4x4x6 cardboard box containing item 8 of said document, which is marked and labeled M-17 Allison Automotive Company, 1269 East Edna Place, Covina, CA 91722. Parts of this application contain documents and/or materials that are of a proprietary nature to Cambridge Automotive Engineering, Inc. and must be treated with strict confidence where their commercial value is concerned.

1269 E. Edna Place Covina, California. 91722 • (213) 339-4453

Anything that can be done to expedite our exemption will be greatly appreciated. We would also like to take this opportunity to thank your engineering staff for their consideration in answering our questions concerning this project.

Sincerely,

Craig S. Beshore
President

CSB:mc

enclosures

Exhibit A

INSTALLATION INSTRUCTIONS
FOR THE ALLISON OPTO-ELECTRIC IGNITION SYSTEM

(Follow instructions carefully...as this can be your LAST maintenance on your distributor)

READ THROUGH ALL INSTRUCTIONS BEFORE INSTALLATION.

BEFORE INSTALLATION: You must have the following information:

1. Proper timing setting (RPM and degrees), check car manual.
2. Be sure you know the correct timing performance for your specific engine. (i.e., Most vacuum lines are removed and plugged before timing and reconnected afterwards.)

Since you will want to achieve the maxium in performance and efficiency from your automobile...May we recommend a close inspection of your spark plugs and all ignition wires, including the coil wire. Replacement of doubtful or worn parts is your assurance of trouble-free, continuous operation (normally, if the spark plug wires are over 2 years old, they should be replaced). Also, the battery connections must be checked for corrosion and tightness.

TOOLS REQUIRED:

1. Timing light.
2. Drill with 1/8" bit, or prick punch, & hammer.
3. Small (1/8") screwdriver.
4. Medium (5/16") screwdriver.
5. Wrench suitable for use on distributor tie-down bolt.
6. 5/16" socket or open end wrench.

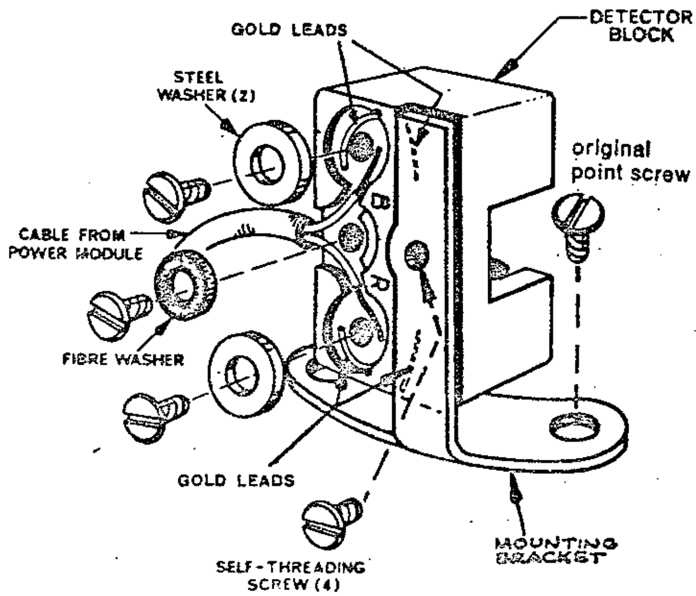
PARTS INCLUDED:

1 Power Module
1 Detector Block
1 Mounting Arm*
1 Control Rotor*
2 Steel Washers
1 Fiber Washer
4 4-40x3/16" Machine Screws
4 Sheet Metal Screws

*As per chart A per car

FIRST ASSEMBLY

1. Locate detector block. (See figure 1)
2. As per figure 1, carefully press the two gold leads down flat into their prospective areas on the "CABLE SIDE" of block. Keep gold lead ends INSIDE washer areas. Attach steel washers in place with 4-40x3/16" machine screws (DO NOT tighten screws or attach cable at this time).
3. On MOUNTING ARM SIDE, carefully press the two gold leads down flat into their prospective areas.



TO INSTALL

1. Make sure ignition key is in the "off" position (or electrical problems may result).
2. Remove distributor cap.
   NOTE: Owners of Chrysler Corporation V-8 automobiles must determine in which direction the distributor shaft rotates. This is easily accomplished by turning the engine over and observing the direction of the high-voltage rotor. Check if CLOCKWISE or COUNTERCLOCKWISE
3. Remove high-voltage rotor, breaker-points, lead wire, and condensor. (In case of dual points, both sets are removed.) Keep point and condensor screws for later usage; also, retain high-voltage rotor. (If shield-covers are present, discard them, because they are no longer necessary.) Remove lead wire from coil negative (-) side. If coil has tachometer wire, do not remove.
4. Clean distributor cam lobes and other oily or dirty areas.
5. If any distributor "grounding strap" is present, MAKE SURE that it is left in the same location as before.
6. Pass gray cable from the Allison Power-Module through the lead wire hole in the distributor body. (Remove grommets if necessary.) DO NOT mount Power-Module at this time. Pull 2 feet of cable through this hole. Also, pull the "PURPLE GROUND WIRE" from the Power-Module through the SAME hole. Attach this purple ground-wire to any screw on the breaker plate assembly, (i.e., the screw and hole where the condensor was mounted).
7. Attach the SMALL "Red" and "Black" wires inside the gray cable to the back of the detector block, as follows: (Refer to figure 1)

   BLACK to "B" on Block
   RED to "R" on Block

SECURELY fasten wire ends underneath washers and tighten screws. NOTE: DO NOT slip any insulation underneath washers. Bring insulation UP TO washer, make sure neither bare wire touches each other. Secure both insulated wires with fiber washer using the remaining 4-40x3/16 machine screw.

8. From Chart A, determine the correct part number of the detector block mounting bracket received to fit your model of automobile.

CHART A

AUTO MAKE
<u>TYPE IGNITION</u>

All Ford 8 cylinder eccentric and pivotal concentric vacuum advance breaker plate

Detector block mounting
bracket Part No. 208
Control rotor Part No. 216

All Chrysler 8 cylinder CLOCKWISE rotating distributors 273, 318, 340, and 360 cubic inch

Detector block mounting
bracket Part No. 212
Control rotor Part No. 217

All Chrysler 8 cylinder COUNTER-CLOCKWISE distributors 383, 400, 426, and 440 cubic inch

Detector block mounting
bracket Part No. 211
Control rotor Part No. 217

Chrysler 6 cylinder engines

Detector block mounting
bracket Part No. 210
Control rotor Part No. 215

General Motors 6 cylinder engines

Detector block mounting
bracket Part No. 209
Control rotor Part No. 214

9. Place this bracket inside the distributor in Exactly the same location and position that the set of points occupied.
10. Secure with original point-screw(s).
    From Chart A, determine the correct part number of the control rotor received to fit your model of automobile.
11. Now place the control rotor gently down over the shaft until it comes to rest on the top surface of the cam lobe section. Now gently rotate the control rotor until the "flats" of the cam lobe line up with the "flats" of the control rotor cup. Firmly press the control rotor down until it is COMPLETELY seated. DO NOT press down on rim of control rotor. (A socket or the high voltage rotor may be use to press down on the inside diameter of control rotor.)
12. Attach the completed detector block assembly to the detector block mounting bracket, EXACTLY as per illustration 1.
    Pass the 4-40x3/16 machine screw through the upright mounting arm while holding the detector block in position BETWEEN the control rotor and the mounting arm. Securely tighten the screw (making sure the gold leads are underneath the arm). Check to make sure that the detector block is NOT rubbing the rim of the control rotor.
14. Now replace the high-voltage rotor and make sure it is FIRMLY seated.
15. Mount power module, preferably, where there is good airflow. MAKE SURE THAT ALL THE WIRES FROM THE POWER MODULE HAVE SUFFICIENT SLACK AND NO TENSION. CABLES SHOULD NOT BE SPLICED. GRAY CABLE SHOULD NOT BE TAPED TOGETHER WITH BLACK WIRE.
16. Recheck gray cable and purple wire inside the distributor for slackness and Clearance from "rubbing" against the (revolving) control rotor and distributor shaft. Sufficient slack is necessary, as NOT to hinder breaker plate movement (vacuum advance).
17. Attach to the coil the Two remaining "Red" and "Black" wires from the power module as follows: (See figure 2)

    *BLACK wire to coil negative (-). (Dist. on some coils)
    *RED wire to coil positive (+). (Batt. on some coils)

18. Replace the distributor cap and secure.
19. Check for LOOSE spark plug and coil wires at the distributor cap and plug terminals. (NOW is the time to replace the spark plug wires and/or spark plugs, if necessary.) Also, check for placement and condition of the vacuum hose to the distributor.
20. A tachometer is connected the same as with points.
21. Removal of ballast resistor may result in the over heating of the ignition coil.

STARTING AND TIMING THE ENGINE

A. Connect the timing light
B. START ENGINE and time to manufacturer's specifications

The Allison "Opto-Electric" Ignition System has been designed and engineered specifically for use with ORIGINAL equipment, distributor caps, and high voltage rotors. Fitment is warranteed ONLY when used in conjunction with these ORIGINAL parts. If fitment problems occur, concult your Dealer's Parts Department for new parts of the ORIGINAL brand and manufacturer.

Caution: DO NOT touch heatsink while car is running or electric shock may occur.

NOTE: Due to inherent characteristics of the semiconductors in the power module, dwell meters will show a "misleading" reading. Actual dwell and advance curves meet the manufacturer's specifications.

Cambridge Automotive Engineering, Inc.

May 4, 1976

Mr. G. C. Hass
Air Resources Board
Vehicle Emission Test Board
9528 Telstar Avenue
El Monte, CA 91731

Dear Mr. Hass:

Please accept the following items as an amendment to our pending application dated March 11, 1976;

1. Electronic module marked Allison XR-700.

2. Description of the engineering model change of the Allison power module.

3. Results of tests conducted on the Allison XR-700.

4. Ignition system test data.

The reason for this amendment is that a design change had taken place in the interim which has material effect on the performance of our product. The enclosed material describes that change. All test data (Item 4) was obtained using the XR-700 configuration. It is also important to note that our new ignition system test data was obtained using the test and instrumentation schematic which is figure 2 of your document "Guidelines for Testing Ignition System Modifications". This is mainly of interest because our original data on Model 17 was obtained using a labortory test set up substantially different from the one described in your "Guidelines for Testing".

For these reasons, please substitute the enclosed ignition system test data, test no. 3 in its entirety, in place of any similar data previously submitted.

1269 E. Edna Place Covina, California. 91722 • (213) 339-4453

EXHIBIT B

If any additional information, test data, or calculations are needed, please let us know and we will reply immediately.

Thank you for your consideration in this matter.

Very Sincerely,

Craig S. Beshore
President

CSB:mc

enclosures

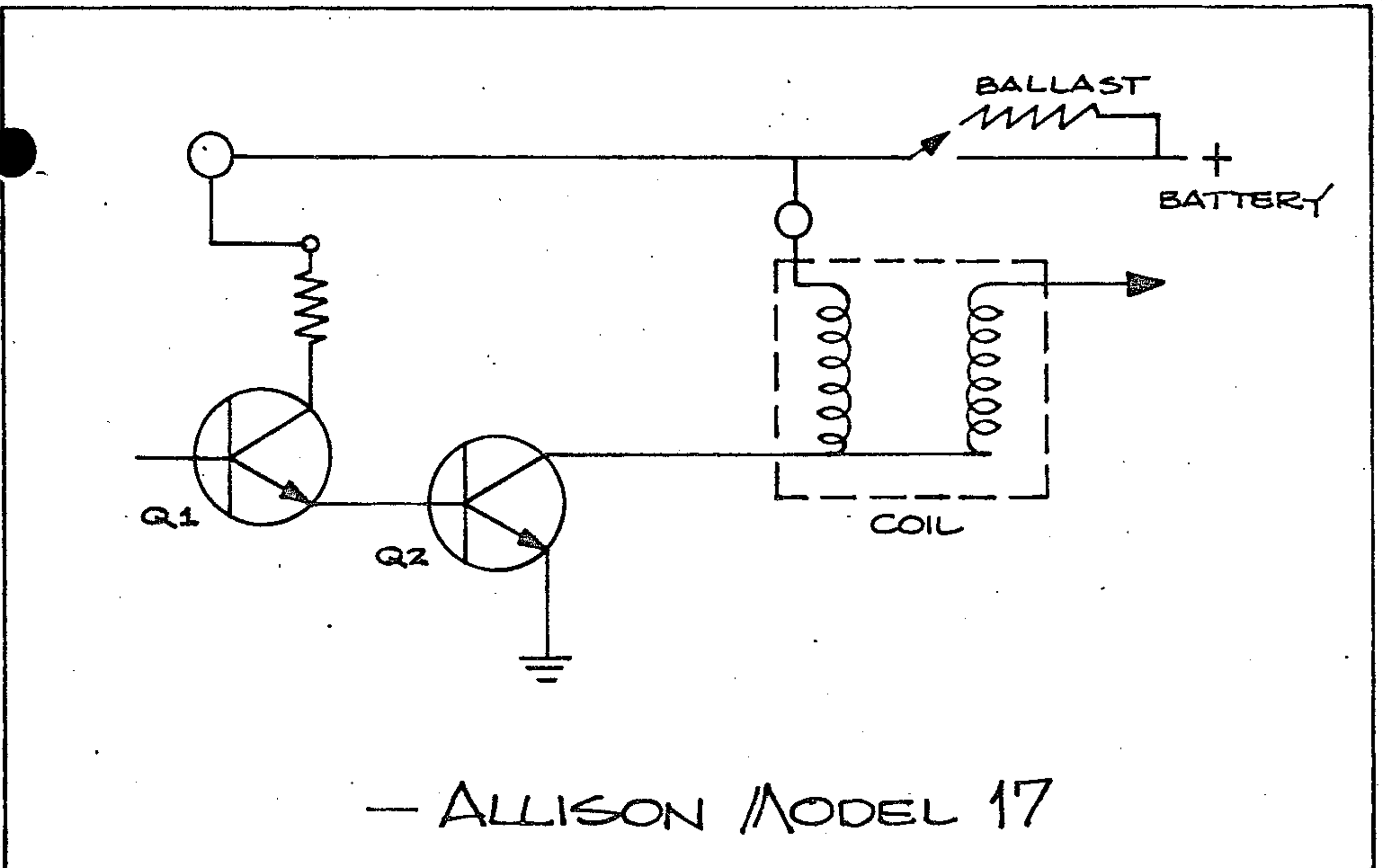
EXHIBIT B

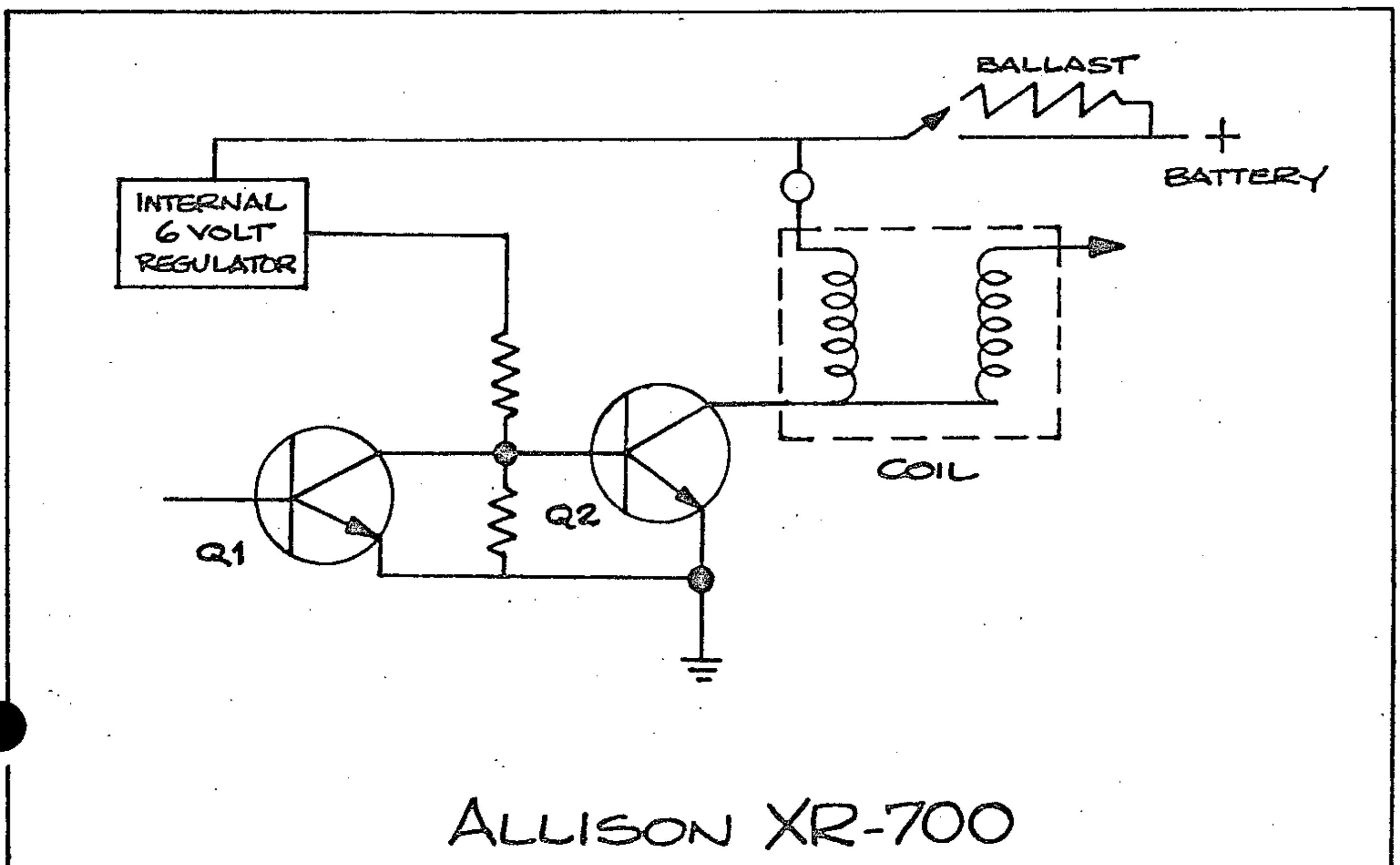
DESCRIPTION OF ENGINEERING MODEL CHANGE ON THE ALLISON POWER MODULE (MODEL 17)

Attached is figure 1 showing the changes in electronic design configuration between the Allison Model 17 and the new modified circut, the XR-700.

The new circut uses a common emitter configuration in the Q1 position. It also makes use of an internal 6 volt regulator to supply power for Q1 and subsequently, drive for the output transistor, Q2. Use of this new topology supplies more complete and constant drive for the output transistor, Q2. This effectively lowers the saturation resistance of Q2, which permits increased peak power to be delivered to the coil. This new capability, in conjunction with the internal 6 volt regulator, produces more constant power into the coil over a wider variety of battery voltages and the engine RPM's.

EXHIBIT B


BALLAST
+
BATTERY
COIL
Q1
Q2
— ALLISON MODEL 17


BALLAST
+
BATTERY
INTERNAL
6 VOLT
REGULATOR
COIL
Q1
Q2
ALLISON XR-700

Chron

STATE OF CALIFORNIA EDMUND G. BROWN JR., Governor

AIR RESOURCES BOARD LABORATORY
3 TELSTAR AVENUE
EL MONTE 91731
(213) 575-6800

August 26, 1976

TO: ALL HEAVY-DUTY GASOLINE ENGINE MANUFACTURERS
ALL LIGHT-DUTY TRUCK MANUFACTURERS
ALL PASSENGER CAR MANUFACTURERS
ALL MEDIUM-DUTY VEHICLE MANUFACTURERS

Enclosed is a copy of a Memorandum from George Lew to John McClendon which outlines a statistical method used by the Air Resources Board staff in the evaluation of durability data. This statistical method will be applied when durability data are evaluated.

If you have any questions regarding the above matter, please contact John McClendon of my staff by telephone (213) 575-6847.

G. C. Hass

G. C. Hass, Chief
Division of Vehicle Emissions Control

State of California The Resources Agency

Memorandum

To : John McClendon
Senior Engineer

Date : August 20, 1976

Subject: Method of Determining Outliers for Durability Vehicles

From : Air Resources Board
George Lew
Associate Engineer

Vehicle manufacturers are required by 40 CFR 85.075-7(b) and 40 CFR 85.175-7(b) to submit durability-data at 5000 mile intervals. In some cases, the data for a particular pollutant submitted appear to be anomalous when compared with other emission data generated by the same vehicle. The reason for this anomaly may be traced to a variety of reasons such as instrument malfunction, reading the wrong scale, etc. Under these circumstances, the manufacturers must void the test and have the vehicle retested. Often there is no plausible explanation for the anomalous data. Use of these anomalous points often biased the deterioration factors. These biased deterioration factors are hardly representative of the true deterioration of a particular emission control system. The exclusion of atypical data points would allow the determination of more realistic deterioration factors.

In determining an appropriate method for discarding data point outliers, the following assumptions are made regarding the analysis.

(1) A linear least squares line can be fitted through the data.

(2) The uncertainties lie with the exhaust gas measurements whereas mileage measurements are assumed to be essentially error free.

(3) The exhaust gas measurements variations are normally distributed where t-distribution statistics apply. The t-distribution is used because the number of data points are less than thirty.

The following steps describe the method used by the Air Resources Board New Vehicle Program Section staff in determining outliers in a set of durability-data. This method has been developed after discussions with the Data Analysis Section. A regression line is determined by the method of least squares for each pollutant. All suspected outliers must be included in these determinations. For each suspected outlier, calculate the difference between the actual measured point and the point predicted by the regression line at the affected mileage point. Dividing the difference by the unbiased standard error of the estimate normalizes the data variations and is the definition of the t-distribution. Therefore, we can now determine whether a point is statistically different. Using a t-distribution table with n-2 degrees of freedom where n is the number of data points, a statistical confidence level can be obtained. When the confidence level is at least 95% that a particular pollutant data point is an outlier, the entire emissions data measured at that particular mileage point are discarded. If the manufacturer can show sufficient justification that the other two pollutants measured emissions at the affected mileage point are not influenced by the anomaly, the data maybe included in the deterioration factor calculation after an evaluation by the ARB staff.

A sample calculation showing the above analytical method is shown in Appendix I.

Attachment (1)

Appendix I

Sample Calculation for Determining Outliers

The following data are used to determine if outliers exist:

System Miles	HC	CO	NOx
5006	0.582	7.48	1.34
10043	0.803	9.92	1.65
15005	0.794	8.90	1.48
19975	0.789	9.50	1.49
24969	0.800	20.80*	1.77
29977	0.635	4.13*	1.52
29997	0.650	6.18	1.68
35005	0.748	7.97	1.62
40010	0.611	8.70	1.63
44998	0.608	6.24	1.86
50029	0.595	7.02	1.88

*Suspected outliers

Fitting the above CO data by the method of least squares yields the following equation:

$$Y_{CO} = -0.000066358X + 10.6436 \qquad \text{Eq. 1}$$

The unbiased standard error of the estimate is defined as

$$\hat{S}yx = \left(\frac{n}{n-2}\right)^{1/2} \left(\frac{1}{n} \right) \left(n\Sigma y^2 - (\Sigma y)^2 - \left(\frac{(n\Sigma xy-(\Sigma x)(\Sigma y))^2}{n\Sigma x^2 - (\Sigma x)^2}\right) \right)^{1/2}$$

The $\hat{S}yx$ is a measured of the variations of the data point about the line.

For the above data, the $\hat{S}yx$ is 4.44077

The predicted CO emissions (based on Eq. 1) at the 24969 and 29977 mileage points are 8.9867 and 8.6542 grams/mile respectively. The difference between the actual measured point and the predicted point for the above data are 11.81 and 4.52 respectively. Dividing the difference by the $\hat{S}yx$ results in 2.66 and 1.02 respectively. Looking up these quotients in a t-distribution Table with n-2 degrees of freedom (the degrees of freedom in this case are 9) yields confidence levels of 97.4% at 24969 and 66.5% at 29977. Therefore, the 24969 data point is discarded while the 29977 data point is retained. The comparison of the old and new deterioration factors for this engine family is shown below:

HC		CO		NOx	
Old	New	Old	New	Old	New
1.000 (.8184)	1.000 (.8241)	1.000 (.7059)	1.000 (.7440)	1.285	1.297