TECHNICAL REPORT

REPORT NO.

4511.33

SUBJECT

A676 BENDIX FUEL INJECTION SYSTEM EVALUATION

ENGINEERING DIVISION

CHRYSLER CORPORATION

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TECHNICAL REPORT

No. 4511.33

Issued By Engine Development Laboratory

Dept. 831

SUBJECT

A676 BENDIX FUEL INJECTION SYSTEM EVALUATION

MODEL

LP, LD, LS and LC76-300
High Performance

DESCRIPTION

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Technical Reports and Standards Department

Date 6-1-60

10-18 (4/58)

10-20 (4/58)

CHRYSLER CORPORATION
ENGINEERING DIVISION
TECHNICAL REPORT

Report No. 4511.33
Date 6-1-60
Project or Charge No. 8316442

SUBJECT:

Bendix Fuel Injection, "Electrojector", Development - Optional Equipment for Plymouth, Dodge, and DeSoto 361 cu.in. "B" Engine and 392 cu.in. D.R.S. C300D Engine Models.

OBJECT:

To develop the "Electrojector" fuel injection system for "L" Series high performance engine production.

CONCLUSIONS:

1 - No actual rating results were obtained for the 361 cu.in. "B" engine or the 392 cu.in. C300D engine when operating satisfactorily with the "Electrojector" fuel injection system, because no fuel injection equipment was developed that would give reproducible fuel flow. However, had the equipment been available, the performance would have been approximately equivalent to the output of a standard twin carbureted engine. Net output would have been improved by the elimination of intake manifold heat.

2 - The following general conclusions were made during the development of the "Electrojector":

a - Although good cylinder to cylinder mixture distribution under WOT conditions was obtained at most speeds, total fuel delivery over the speed range did not match the engine requirements in a satisfactory manner.

b - Timed fuel injection did not provide good road load fuel economy due to the difficulties of controlling short pulse time, nozzle leakage and production flow limits.

c - Excess fuel flow return to the car tank, necessary for vapor lock prevention, was detrimental also to fuel economy since it lost fuel by evaporation ("weathering").

d - This system required mixture compensation devices for part load, idle, cold start, warm-up, acceleration, ambient air temperature and pressure.

e - The cyclic timing of the fuel injected into the port had no effect on WOT or part throttle, steady state engine performance.

RECOMMENDATION:

It is recommended that no future development of the "Electrojector" system be undertaken.

TEST PROCEDURE AND DISCUSSION:

Initially, the program intended to develop the Bendix injection system to a level of dependable operation and adequate F/A distribution before final calibration of the system at WOT and part throttle. However, the system was never fully reliable in operation and was quite spasmodic in the degree to which it fulfilled the distribution requirement. The procedure actually followed, therefore, consisted of intensive development up to and after release of the system to production, coupled with the best compromise WOT and part throttle mixtures that could be obtained on a piece by piece, individual kit basis.

Given below is a table of the tests performed on this system by Department 831 together with a table of system and test installation photographs. The plotted results from the above tests and the photographs are on file in Department 831. In general the results of Department 831 tests can be summarized as follows:

WOT Fuel Metering

By using sets of matched injectors, it was possible to obtain satisfactory cylinder to cylinder F/A distribution. However, the speed to speed distribution did not meet engine requirement due to a tendency of the system to lean out at moderately high speeds. This "lean out" condition was due to a decrease in injector valve open time (pulse time) which in turn was traced to electronic output decay of the injection time control (modulator box). Although many circuit modifications were made, no positive correction of this difficulty was ever tested. This WOT lean out condition resulted in the need for excessive low speed enrichment in order to obtain adequate high speed (4000 rpm and above) fuel flow.

Part Throttle Steady State Fuel Metering

Slight internal injector leakages and slight variations in minimum pulse times, which were not controlled by the electronic system, resulted in large percentage variations of road load fuel flow per injector. It should be recalled that the small amount of required road load fuel was being metered through eight injectors! Consequently fuel economy comparable to carburetion was not obtained. Also, the target production fuel flow limits for the injected system were $\pm$ 6% relative to mean limit. This $\pm$ 6% variation (twice current carburetion tolerance) could only be obtained by use of complete matched sets of equipment. Replacement of individual components required readjustment of the system.

Transient and Special Condition Fuel Metering

The transient, part throttle, and special condition fuel meter was to be accomplished by using sensor units (sensing the special condition) to electronically modify the WOT fuel flow and give a net correct fuel flow (pulse time). These

sensor units consisted of;

(a) Acceleration switch controlled by manifold vacuum diaphram.

(b) Cold Start activated by starter electrical circuit.

(c) Warm-Up potentiometer activated by bi-metal temperature element.

(d) Idle trimmer and switch incorporated manual biasing of electrical circuits.

(e) Part Load potentiometer responsive to manifold vacuum.

(f) Intake Air temperature sensing thermistor.

(g) Altitude compensator. Aneroid biasing of electrical circuits.

The altitude compensator was located in the modulator box while the balance of the sensors were located on the primary throttle body. (See Figure #2 and #3) All of these mixture modifying sensors proved to be required for satisfactory driveability. With the exception of the temperature and idle devices, all of the sensors were still in need of further development at the time the project was discontinued.

Fuel Supply System

This system, consisting of tank mounted pump, pressure regulator - vapor separator, and fuel lines as shown in Figure #1, was a constant fuel flow rate arrangement which returned excess fuel to the supply tank. This arrangement led to "weathering" and general warm-up of fuel (particularly at idle and light load conditions) which would result in a decrease in overall fuel economy. This condition was never fully evaluated.

Injection Timing

For a fuel injection system that injected into the port such as the electrojector system, it was found that the timing of the injection had no noticeable effect on WOT and partial load, steady state engine performance.

For added information on specific system components reference can be made to the following reports and/or projects.

Project No.	Report No.	Author	Subject
8326431		E.P. Wise	Preliminary Investigation - Bendix Fuel Injection
8326440		E.P. Wise	Phase I -
8327413		J.O. Sarto	Phase II -

Project No.	Report No.	Author	Subject
8327502		J.O. Sarto	Production Improvement -
8326312	4809.9	W.A. Hunter A.D. Hayes	Fuel Supply System, Phase I -
8327304	4809.9	W.A. Hunter A.D. Hayes	Fuel Supply System, Phase II -
8327312	4809.9	W.A. Hunter A.D. Hayes	Production Improvement
8326439		G.W. Sheardown	Cold Start and Warm-Up, - Phase I
8327415		G.W. Sheardown	Cold Start and Warm-Up, - Phase II
7516208 7516222 7517010 7517022		G. Michel C. Lalone	Electrical Components -
8546102	4511.28	K.A. Graham	Development of Injector Valves -

Bendix Electronic Fuel Injection - SAE Paper presented in January, 1957

Chrysler Corporation Training Center
Fuel Injection Manual - August, 1957

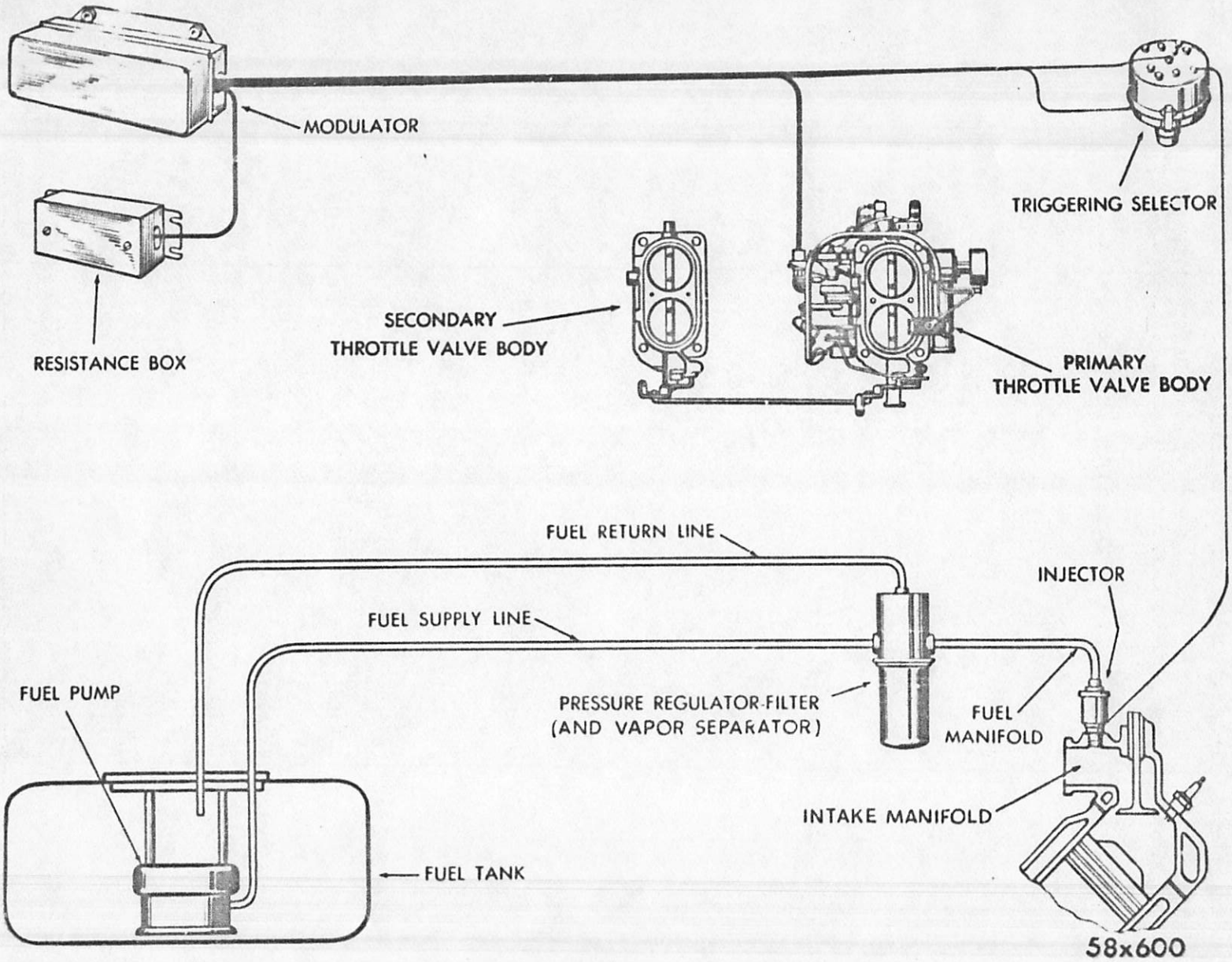

Fig. 1—Schematic of Fuel Injection

SHEET NO. 5

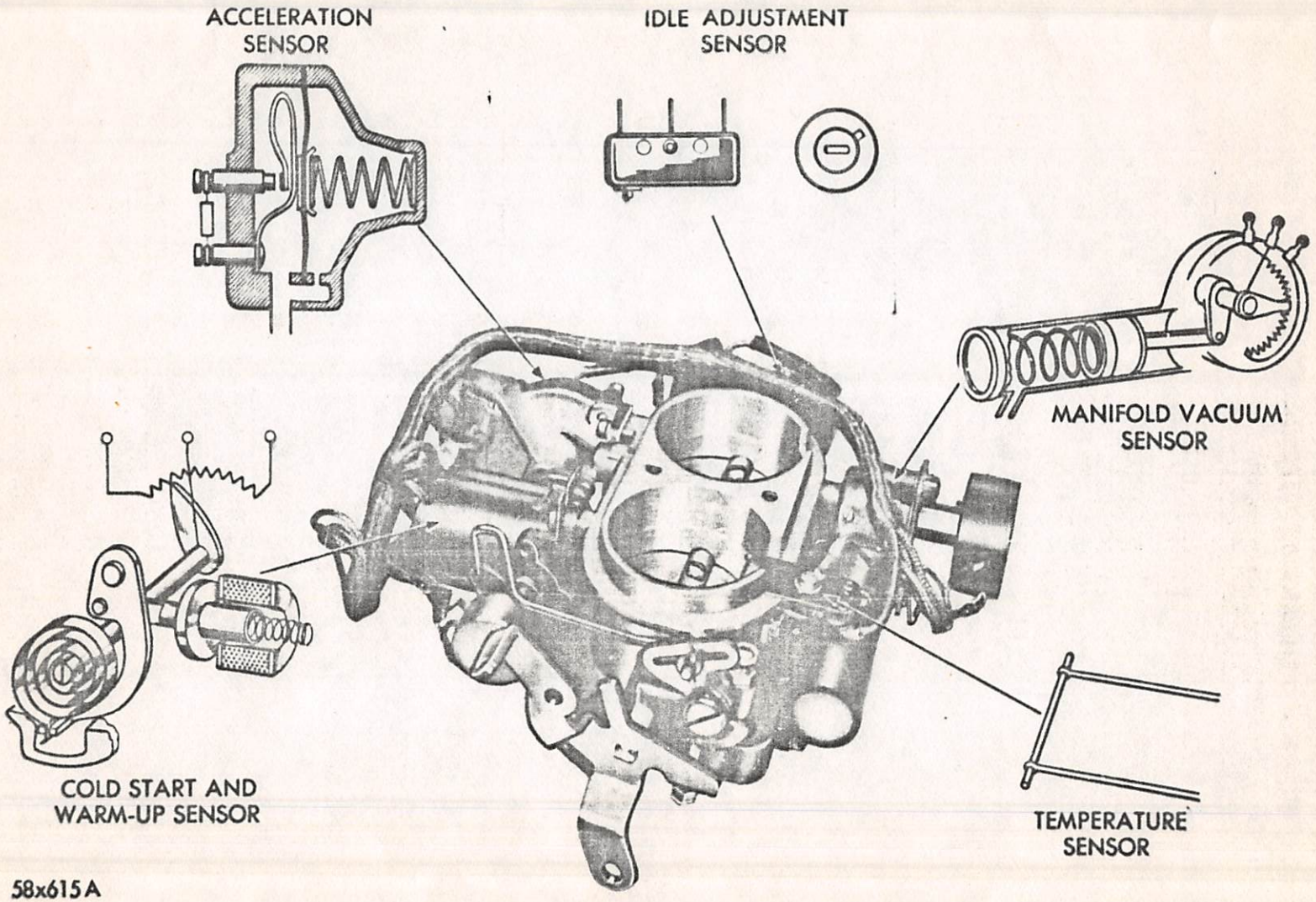

FIG. 2 —PRIMARY THROTTLE BODY AND SENSORS

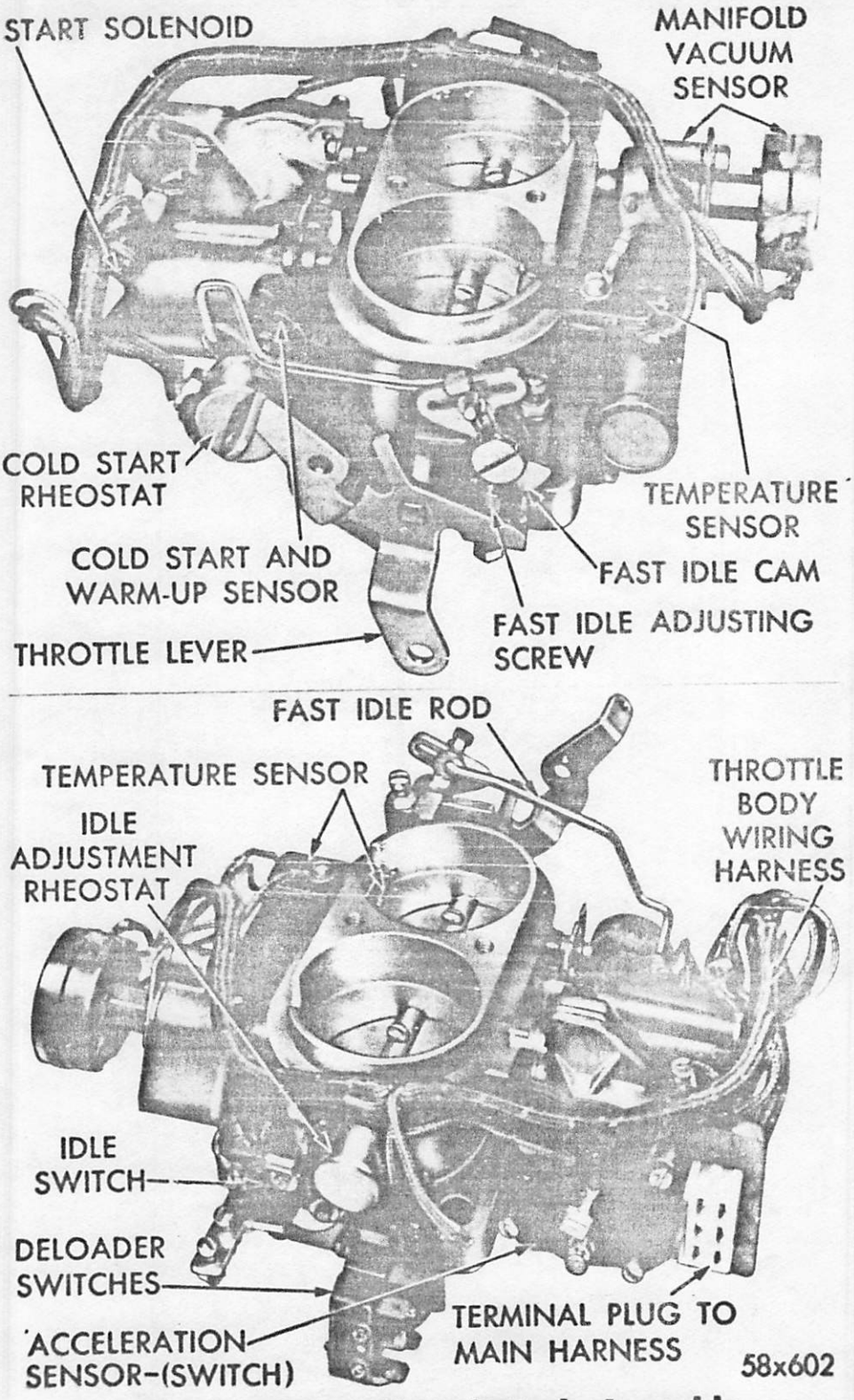

Fig. 5—Primary Throttle Body Assembly

SUMMARY

DEPARTMENT 831 A676 BENDIX FUEL INJECTION TEST PROGRAM

Test No.	Date	Model	Project No.	Engine Used	Test General Title
1602	2-8-57	C300DFI	8316442	NE57-5241	Part Throttle F/A Distribution
1607	2-18-57	"	"	XIM-1 EX.32	Bendix Prototype System Performance
1626A	3-2-57	"	"	"	First Dyn. Check of Full Bendix w/5 B Nozzles
1663	3-15-57	"	"	"	12% Lean Nozzle Test
1666	3-16-57	"	"	XIM-1 EX.31A	Idle Requirements
1692	3-30-57	"	"	XLC3 EX.16	System Performance
1752	5-13-57	"	8327413	XLC3 EX.19	Phase II System Performance
1803	7-2-57	"	"	"	OK Sample Calibration
1814	7-19-57	B Engine	"	A652 EX.25	W.O.T. Calibration
1815	7-22-57	C300D FI	"	XLC3 EX.19	Altitude Simulation
1819	7-30-57	B Engine	8316442	A652 EX.25	Ignition Requirement
1830	8-21-57	C300D FI	81CW0266070	XLC3 EX.15	Production Part Evaluation
1831	8-22-57	B Engine	81CW0266027	A652 EX.25	Production Part Evaluation
1833	8-26-57	B Engine	"	"	Production Part Evaluation
1874	11-5-57	C300D FI	8327413	XLC3 EX.19	No. 8 Spark Plug Fouling Investigation
1897	11-21-57	C300D FI	8336304	"	Engine Heat Rejection
1898	11-22-57	C300D FI	8158056	"	Water Pump Evaluation

SHEET NO. 8

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PHOTOGRAPH INDEX

Neg. Number	Title
8310-36	Schematic of Fuel Injection
	Fuel Injection Wiring Diagram
8310-46	With Combined Starter and Ignition Switch
8310-36	With out Combined Starter and Ignition Switch
8310-40	Fuel Pump Assembly
8310-41	Fuel Manifold - C300D Car Installation Side View
8328-1	Fuel Manifolds - C300D Mock Up - Front View
8328-2	Fuel Manifolds - B Engine Mock Up - Front View
8317-26	Intake Manifold - Single Throttle Body C300D Mock Up
8317-25	Intake Manifold - Dual Throttle Body C300D Mock Up
831037	Fuel Pressure Regulator, Vapor Separator and Filter
8310-39	Primary Throttle Body Assembly
8310-44	Primary Throttle Body and Sensors
8310-45	Cold Start and Warm-Up Sensor
8310-43	Trigger Selector
8310-42	Injector Assembly
8317-516	"B" Engine "Electrojector" Dynamometer Installation - Front View
8317-522	"B" Engine "Electrojector" Dynamometer Installation - Left Side View
8317-521	"B" Engine "Electrojector" Dynamometer Installation - Right Side View
8317-519	"B" Engine "Electrojector" Dynamometer Installation - Left Rear Quarter View
8317-527	" " " " " " " " " " " " " " - Right Rear Quarter View
8317-526	" " " " " " " " " " " " " " - Front Top View
8317-523	" " " " " " " " " " " " " " - Rear Top View
8317-524	" " " " " " " " " " " " " " - Right Top View

PHOTOGRAPH INDEX

Neg. Number	Title
8317-528	Gas Tank and Fuel Pump Simulation - Dynamometer Installation, Side View
8317-518	Gas Tank and Fuel Pump Simulation - Dynamometer Installation, Top Quarter View
8317-515	Altitude Simulation, "Electrojector" Dynamometer Installation, Right Rear Quarter View
8317-512	" " " " " " " " " " " " " " " " Left Rear Quarter View
8317-517	" " " " " " " " " " " " " " " " Left Front Quarter View
8317-513	" " " " " " " " " " " " " " " " Full Rear View
8317-514	" " " " " " " " " " " " " " " " Exhaust Evaluation Tank