# ODI RESUME

INVESTIGATION : EA92-044 DATE OPENED: 18-DEC-92
SUBJECT : THROTTLE STICKING
PROMPTED BY : PE92-065
PRINCIPAL ENGINEER: G. PERSON DID INVESTIGATOR: J. ABBOTT

MANUFACTURER: TOYOTA
MODEL YEAR(S): 1987-1989 VEHICLE POPULATION: 813,879
MODEL(S): CAMRY, CELICA WITH 2.0L ENGINE

SYNOPSIS: STICKING THROTTLE CAN CAUSE UNWANTED ENGINE POWER.

FAILURE REPORT SUMMARY

| | ODI | MANUFACTURER | TOTAL |
|---|---|---|---|
| COMPLAINTS: | 53 | 503 | 556 |
| ACCIDENTS: | 3 | 27 | 30 |
| INJ ACCID: | 1 | * | 1 |
| # INJURIES: | 1 | * | 1 |
| FAT ACCID: | 0 | * | 0 |
| # FATALS: | 0 | * | 0 |
| OTHER: | 0 | 0 | 0 |

DESCRIPTION OF OTHER: * ACCIDENT REPORTS NOT YET ANALYZED.

ACTION: OPEN EA

BRCH CHF Richard Boyd DATE 12/18/92
DIV CHF Louis J. Brown DATE 12/18/92
OFC DIR [signature] DATE 12/18/92

SUMMARY: THE HIGH NUMBER OF COMPLAINTS INDICATE THAT THE INVESTIGATION SHOULD BE UPGRADED TO THE ENGINEERING ANALYSIS LEVEL FOR FURTHER INVESTIGATION.

THE MANUFACTURER STATED THAT THE ACCIDENTS IN WHICH THE DRIVER ALLEGE THROTTLE STICKING AS A CAUSE OF THE ACCIDENT ARE, IN FACT, CLASSIC SUDDEN ACCELERATION ACCIDENTS CAUSED BY PEDAL MISAPPLICATION. ACCORDINGLY, THE MANUFACTURER FEELS THAT THIS THROTTLE STICKING PROBLEM, WHICH IT ALLEGES IS CAUSED BY CARBON BUILDUP IN THE THROTTLE BODY, IS NOT SAFETY RELATED. THIS CONCLUSION CANNOT BE CONFIRMED AT THIS TIME FROM THE INFORMATION AVAILABLE.

12/21

# ODI RESUME

INVESTIGATION: EA92-044 DATE CLOSED: 31-JAN-94
SUBJECT : Throttle Sticking
PROMPTED BY : PE92-065

PRINCIPAL ENGINEER: George Chiang DID INVESTIGATOR: J. Abbott

MANUFACTURER : Toyota
MODEL(S) : Camry and Celica
MODEL YR(S) : 1987-1989
VEHICLE POPULATION: 891,558

SYNOPSIS: The throttle allegedly fails to return to the idle position or becomes stuck in the idle position. Reports of "sudden acceleration" (unwanted full power acceleration from a stationary or slow speed accompanied by apparent brake failure) are not the subject of this investigation.

FAILURE REPORT SUMMARY

| ASIS: | ODI | MANUFACTURER | TOTAL |
|---|---|---|---|
| COMPLAINTS: | 123 | 618 | 741 |
| ACCIDENTS: | 4 | 4 | 8 |
| INJ ACCID: | 1 | 0 | 1 |
| # INJURIES: | 1 | 0 | 1 |
| FAT ACCID: | 0 | 0 | 0 |
| # FATALS: | 0 | 0 | 0 |
| OTHER: | 0 | 0 | 0 |

DESCRIPTION OF OTHER:

ACTION: This Engineering Analysis has been closed.

BRCH CHF JW for RB 1/31/94 DATE
DIV CHF Louis J. Bowers 1/31/94 DATE
OFC DIR 1/31/94 DATE

SUMMARY: The carbon buildup problem does not appear to create significant safety problems. A specific defect pattern was not found among the complaints which identify specific defect related problems. No safety-defect trend has been detected. Further commitment of agency resources to determine whether such a trend may exist does not appear to be warranted. (See the attached Engineering Analysis Closing Report) 1/31/94

U.S. Department of Transportation
**National Highway Traffic Safety Administration**

# Memorandum

Subject: Throttle Sticking on 1987 Through 1989 Toyota Camry and Celica Vehicles Equipped With Electronic Fuel Injection (EFI) Systems, EA92-044

Date: JAN 31 1994

From: George D.C. Chiang
Safety Defects Engineer (Litigation)

Reply to Attn. of: NEF-12gdc
EA92-044

To: Louis J. Brown, Jr.
Chief, Defect Evaluation Division

Thru: Richard P. Boyd
Chief, Vehicle Control Branch

**SYNOPSIS**: The throttle allegedly fails to return to the idle position or becomes stuck in the idle position. Reports of "sudden acceleration" (unwanted full-power acceleration from a stationary or slow speed accompanied by apparent brake failure) are not the subject of this investigation.

Seven hundred forty one reports including 8 accidents resulting in one injury were received from all sources alleging throttle sticking on the 891,558 subject vehicles. Most complaints describe only symptoms, and or identify vehicle components based on speculation. Approximately one third of the complaints appear to be related to a carbon buildup problem in the Throttle Body Assembly. A number of different causes appear to have produced the remaining reports, such as cruise control malfunction, linkage interference with some objects, damaged accelerator cable, etc.

Testing performed by VRTC verified that carbon buildup can result in throttle sticking, but only near the idle position. It requires a higher-than-normal pedal force to "unstuck" the throttle plate, 27 lb. on one test and 30 lb. on the other. Throttle sticking due to carbon buildup can only progress slowly over thousands of miles as the carbon deposits increase from an initial thickness of zero, giving drivers adequate warning to have it corrected before it becomes a problem. The ODI survey revealed that when the gas pedal became stuck, many drivers applied a higher-than-normal accelerator pedal force to "unstick" the pedal. Fifty five percent depressed the gas pedal all the way to the floor, however many drivers indicated that they placed the transmission in "Park" before taking such action or depressed the gas pedal all the way to the floor before the car was started. Twenty eight percent gradually/carefully depressed the gas pedal more, until the car started to move. Eighty eight percent of the owners/drivers stated that their cars had been repaired at the Toyota dealers more than once for a sticking gas pedal. Carbon cannot cause the throttle to stick at a high power position due to the geometry of the components.

**CONCLUSIONS**:

- The carbon buildup problem does not appear to create significant safety problems.

- A specific defect pattern was not found among the complaints which identify specific defect related problems.

**BASIS FOR CLOSING**: It is recommended that this Engineering Analysis be closed because no safety-defect trend has been detected. Further commitment of agency resources to determine whether such a trend may exist does not appear to be warranted.

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# ENGINEERING ANALYSIS CLOSING REPORT

**SUBJECT:** Throttle Sticking--1987 Through 1989 Toyota Camry and Celica Vehicles Equipped With Electronic Fuel Injection (EFI) Systems.

**EA No:** EA92-044 **Date Opened:** 18-DEC-92 **Date Closed:** JAN 31 1994

**BASIS:** This Engineering Analysis was upgraded from PE92-065 (Alleged throttle sticking in 1987 through 1989 Toyota Camry and Celica vehicles equipped with 2.0L engine), based on the high number of complaints concerning an accumulation of carbon in the throttle body assemblies utilized in the subject vehicles that may result in throttle sticking problems.

**THE ALLEGED DEFECT:** The throttle allegedly fails to return to the idle position or becomes stuck in the idle position. Reports of "sudden acceleration" (unwanted full-power acceleration from a stationary or slow speed accompanied by apparent brake failure) are not the subject of this investigation.

**DESCRIPTION OF THE THROTTLE CONTROL SYSTEM:** The subject vehicles have a 2.0 or 2.5 liter engine equipped with Toyota Motor Company's (Toyota) Electronic Fuel Injection (EFI) System. This system is a multi-port type fuel injection system which utilizes several fuel injectors. Each injector is located near the engine's four or six intake ports. Engine power output is controlled by a butterfly-type throttle plate, located in the throttle body assembly (TBA), which controls the air flow rate into the combustion chambers. The fuel injectors do not control power output, since they merely provide the correct amount of fuel for the incoming air flow.

A drawing of the subject TBA is provided in Attachment A. The throttle plate is supported by a single rotating shaft which passes through the TBA. Springs normally keep the throttle shaft in the idle position (almost fully closed), except when the accelerator cable (activated by the driver's foot on the accelerator pedal), or the cruise control cable (on vehicles with cruise control) pull on the lever attached to the end of the throttle shaft.

An Idle Speed Control (ISC) Valve attached to the bottom of the TBA permits a limited amount of air to bypass around the throttle plate. The position of this plate is controlled by the computerized engine management system to maintain the correct idle speed and prevent engine stalling under various conditions, such as when the air conditioning compressor places an additional load on the engine. The ISC and the computer which controls ISC are not capable of producing high engine power output, even in the event of worst case malfunctions, because the idle air bypass passage is much smaller than the throttle bore.

A throttle position sensor (TPS), which provides an electrical signal indicating the throttle position to the engine management computer, is also attached to the TBA. The TPS is also incapable of producing high engine power output because it is only a sensing device.

**CORRESPONDENCE:**

| | | | Confidentiality | | |
|---|---|---|---|---|---|
| **ODI to Mfg.** | **Mfg. to NHTSA** | **Mfg. to ODI Supplement** | **Date Requested** | **Date OCC Response** | **Items Confidential** |
| 3/12/93 | 4/28/93 | 5/21/93, 6/15/93 | NA | NA | NA |

**PROBLEM EXPERIENCE:** Table I is based primarily on reports of symptoms which may have been caused by throttle sticking incidents. Since, in many instances, the actual cause of the reported problems was not identified, or was only assumed, it is likely that some of the reports may have involved other problems. Reports of "sudden acceleration" are not included in the table.

**TABLE I**

| CONSUMER COMPLAINTS AND OTHER REPORTS | | EA OPENED | | EA CLOSED | |
|---|---|---|---|---|---|
| | | ODI | MFR | ODI | MFR |
| TYPE OF REPORT | CONSUMER COMPLAINTS | 43 | 439 | 123 | 618 |
| | FIELD REPORTS | * | * | * | * |
| REPORTED RESULTS | PROPERTY DAMAGE ACCIDENTS | 4 | 4 | 4 | 4 |
| | INJURY ACCIDENTS (INJURIES) | 1 | | 1 | |
| | FATAL ACCIDENTS (FATALITIES) | | | | |

* The field reports are included in the consumer complaints.

PHONE SURVEY: In January 1994, ODI conducted a telephone survey of many owners/drivers of the subject vehicles, who have previously complained of throttle sticking problem to the Office of Defects Investigation (ODI) or Toyota. The purpose of the survey was to obtain detailed information concerning throttle sticking phenomena. A total of 116 phone calls were made and 65 owners/drivers responded, representing a 56 percent return rate. The survey results are summarized as follows:

1. The gas pedal sticking problem appears to be a reoccurring phenomena. Eighty-eight percent (57) of the owners/drivers stated that their cars had been repaired at Toyota dealers more than once for a sticking gas pedal. The period between the repairs ranged from 9,000 to 12,000 miles or 6 to 12 months. About 61 percent (35) paid the Toyota dealer at least once for the repair service including throttle body cleaning or replacement.

2. When the gas pedal became stuck, many drivers applied a higher-than-normal accelerator pedal force to "unstick" the pedal. Fifty-five percent (36) depressed the gas pedal all the way to the floor, however, many drivers indicated that they placed the transmission in "Park" before taking such action or depressed the gas pedal all the way to the floor before the car was started. Twenty-eight percent (18) gradually/carefully depressed the gas pedal more, until the car started to move.

3. After "unsticking" the gas pedal, 35 percent of the drivers reported the car moved forward smoothly, and 37 percent reported that the car jerked/jumped forward suddenly.

4. The gas pedal sticking problem is a gradual and noticeable problem. Many owners said once the gas pedal began to stick, it grew progressively worse as time went by (55 percent). The majority indicated that the gas pedal would tend to stick more in the morning or when the engine was cold (72 percent).

**VEHICLE POPULATION:** **TABLE II**

| 1987-1989 TOYOTA VEHICLES SOLD WITH EFI ENGINES | | | | | |
|---|---|---|---|---|---|
| MODEL | ENGINE | MODEL YEAR | | | |
| | | 1987 | 1988 | 1989 | TOTAL |
| CAMRY | 2.0L | 175,373 | 198,017 | 215,767 | 589,157 |
| | 2.5L | NONE | 21,138 | 56,541 | 77,697 |
| CELICA | 2.0L | 93,127 | 69,626 | 61,969 | 224,722 |
| | 2.5L | NONE | NONE | NONE | NONE |
| TOTAL | | 268,500 | 288,781 | 334,277 | 891,558 |

**SERVICE BULLETINS:** There have been no relevant service bulletins issued by Toyota pertaining to the throttle body or throttle sticking.

**WARRANTY:** A total of 30,237 warranty claims were received by Toyota for repair or replacement of TBAs due to any reason on the 891,558 subject 1987 through 1989 vehicles, representing a 3.4 percent warranty rate.

**PART SALES:** Toyota's parts distributor sold 7,778 replacement TBAs to dealers and the service industry. These parts fit the 891,558 subject vehicles, representing a 0.87 percent TBA replacement rate.

**DESIGN, MATERIAL, AND/OR PRODUCTION MODIFICATIONS:** In its letter dated May 21, 1993, Toyota claims that there have been no changes or modifications made by Toyota, or on behalf of Toyota, to the throttle body, the throttle control cable and throttle return springs, which could relate to throttle sticking.

**TESTING:** Vehicle Research and Test Center (VRTC)

Date of Test Request: December 14, 1993 Date Report Received:

Description: A 1989 Toyota Celica (VIN:JT5ST62K3K7348642) with 48,400 miles was leased from the original owner. The owner had complained that the throttle did not always open very easily especially when the engine or weather was cold. An ODI engineer found that when the throttle became stuck, the gas pedal had to be applied very hard or repeatedly to open it. The car had been taken to the Toyota dealer at least five times since new to correct the throttle sticking problem. The owner reported each time the problem began with a slight delay of gas pedal response and gradually became worse. After the Toyota dealer cleaned the throttle body, the problem would temporarily disappear for a number of months. All of these symptoms were verified by an ODI investigator before the test vehicle was tested at VRTC. Since the throttle did not stick when the engine was warm, it was speculated that uneven thermal expansion might distort the TBA because the different materials of the throttle plate and the throttle bore have different thermal expansion coefficients.

The vehicle was inspected and tests were performed to measure the accelerator pedal force required to "unstick" the pedal, pedal force, pedal travel distance, vehicle speed and acceleration, and other related parameters. The complaint TBA was removed and inspected after the tests were completed. The throttle shaft and TBA housing bearing areas were examined, and the throttle shaft, throttle plate, and relevant TBA housing dimensions were measured.

Results: It was found that the throttle would only stick when the engine was cold. The throttle failed to open from the normal idle position after the driver stepped on the accelerator pedal with normal pressure (4 to 10 lb.) Depressing the pedal repeatedly or with a higher-than-normal pedal force (27 lb. on one test and 30 lb. on the other) caused the throttle to "unstick" and open. After that, the throttle operation became normal and returned to the idle position when the higher-than-normal pedal force was released. There were no instances of excessive or uncontrollable vehicle acceleration.

Inspection and measurement of the TBA revealed that small polished marks and carbon deposits on one side of the throttle plate and polished marks and carbon deposits in the throttle body bore were noted in the area where the throttle plate contact the bore when the throttle is closed or almost closed. The minimum clearance between the throttle plate and the corresponding throttle bore increased as the throttle was opened, indicating that rubbing contact was greatest at the closed throttle position. Carbon depth at edge of the throttle plate was measured to be 0.02 inch. No other abnormalities were found.

**FAILURE MODES:** Based on VRTC's examination of the TBA from the test vehicle, it appears that carbon buildup and cold temperature in the TBA can cause polished marks on the throttle plate and TBA bore in the area where the sides of the throttle plate contact the bore (near the throttle shaft) when the throttle is closed. The interference contact of the throttle plate and bore surfaces plus carbon deposits in the TBA apparently result in increased friction between the plate and the bore. In some cases, this may prevent the throttle from

opening with a normal pedal force, while in other cases, it may prevent the throttle return springs from closing the throttle plate completely. Additionally, misadjustment or dislocation of the throttle stop screw may affect the stop position of the throttle plate at idle.

All gasoline engines equipped with direct multi-port fuel injection systems, especially those equipped with exhaust gas recirculation device, are susceptible to the formation of carbon deposits downstream of the throttle plate. Fuel which is injected into the intake air flow is carried into the engine's combustion chambers by the air flow whenever the engine is running. However, when the engine is shut off and the air flow stops, gasoline vapors near the fuel injectors are permitted to diffuse throughout the entire intake tract area, up to the closed throttle plate. Some of the gasoline vapor condenses into liquid as the engine cools, and deposits form when the volatile components of the gasoline evaporate. This does not normally cause a problem in engines with carburetors or with throttle body fuel injection systems, because gasoline washes the intake tract surfaces, including the throttle area, when the engine is re-started. However, this washing action does not occur near the throttle plate area in engines equipped with multi-port fuel injection systems, which have the fuel injectors downstream of the throttle plate, because only clean air goes through the throttle.

Many other cars sold during the 1980's (e.g., BMW and Audi cars equipped with Bosch fuel injection systems) also developed carbon deposits, and the manufacturers of those vehicles issued service bulletins which describe procedures for removing the deposits. The major oil companies have responded to this problem by including new chemical additives to modern gasoline to minimize the formation of such deposits. As a result, carbon deposit buildup is occurring less often.

**WARNING SYMPTOMS:** When carbon deposits occur, it is a gradual process, since many cycles of stopping and starting the engine are necessary to build up a substantial thickness of such deposits. Thus, any throttle sticking that results from carbon buildup begins as a slight delay of accelerator response and gradually becomes worse during a substantial number of driving cycles. In responding to the ODI survey, many owners and drivers of the subject vehicles mentioned that the accelerator pedal sticking problem was getting worse as time went by before any repairs were performed. Ninety-two percent of the owners brought their cars to the Toyota dealer for repair.

**CONTRIBUTING FACTORS:** The brand of gasoline used can be a relevant factor, since different brands contain different types and quantities of additives. Also, the number of times that the engine is stopped and started, and how long it is stopped, is significant, since small quantities of deposits may form during each off cycle. Further, the tight tolerance between the throttle plate and the bore may be an additional factor, since this may cause polish marks on the plate and bore during throttle operations at low temperature.

**MANUFACTURER'S EVALUATION OF THE ALLEGED DEFECT:** Toyota claims that carbon buildup in vehicles with fuel injected engines has been an industry-wide problem, but one which is not safety related. Toyota states in its letter of December 2, 1992, that, "It is generally known that various deposits accumulate in the air intake system (including on the throttle valve) and fuel injection system of virtually all vehicles, especially those equipped with exhaust gas recirculation emission control systems . . . When such deposits cool after the vehicle's having been parked for several hours, usually overnight, they may become stiff. Such stiff deposits could affect the accelerator pedal operability on the next cold start. In other words, the driver would not experience any accelerator pedal operability problems while driving." Toyota believes that vehicle operators would experience a gradual change of accelerator pedal feel on cold start because the carbon deposits accumulate slowly over time.

Toyota also claims that all but a few complaints concerned an operability problem involving the first application of the accelerator pedal after the vehicle had been parked for several hours or more. Additionally, Toyota noted that many drivers characterized "hard to depress" or "stiff accelerator pedal" as throttle sticking.

**ANALYSIS:**

Carbon Buildup: The warranty rate, of 3.4 percent for TBA repair or replacement, is high. The sale of 7,778 replacement TBAs also suggests that many vehicle owners have complained of performance problems, since servicing which requires TBA removal is not normal. However, TBAs may be repaired or replaced for several reasons (e.g., to correct a rough idle condition).

The VRTC tests demonstrated the "throttle sticking closed" condition would cause most drivers to have repairs made, since the throttle became unstuck when 30 lb. of accelerator pedal force was applied and the driver would notice the higher-than-normal pedal force required to move the vehicle during cold starts. In responding to the ODI survey, most of owners (92 percent) did take the vehicle to a Toyota dealer for the throttle sticking problem. However, drivers generally can easily cope with such problems by repeatedly depressing the accelerator pedal with a higher-than-normal pedal force on cold start with the automatic transmission placed in "Park" or before the car is started, which is similar to the practice most drivers used to release the automatic choke during cold start.

It appears highly unlikely that carbon buildup could cause the throttle to become stuck in a high-power open position for several reasons. If a carbon buildup occurs, it develops gradually, usually requiring thousands of miles of vehicle use before it begins to produce noticeable symptoms. The only time additional fuel, which could become a carbon residue, can come in contact with the throttle plate area of the TBA is when the engine is not running and the throttle is in the closed position. If the resulting deposits were sufficiently severe to immobilize the throttle, it would be stuck in the closed position, as many complaints

indicated. However, those deposits, which would interfere with throttle plate movement, are apparently scraped away when the driver steps on the accelerator pedal repeatedly or with a higher-than-normal pedal force to "unstick" the throttle. It appears that such scraping action probably caused the polished marks and polished surface which were found on the edges of the throttle plate and on the throttle bore of the TBA examined by VRTC. Such polished marks, together with carbon deposits, can increase friction substantially, apparently to the extent where a higher-than-normal accelerator pedal force is required to overcome the increased friction. This analysis is consistent with the performance of the test vehicle, which had a throttle stuck at the idle position, but opened whenever the driver depressed the accelerator pedal repeatedly or with a high pedal force on cold start.

Only one complaint TBA was tested by VRTC, but a more severe condition is not likely to develop on other vehicles unless performance similar to this test vehicle was permitted to worsen, since carbon can only build up gradually.

The exact number of consumer complaints received by the National Highway Traffic Safety Administration and Toyota which relate to carbon buildup problems cannot be determined accurately, because most of the complaints describe only symptoms and not the resultant repair. In some instances, automobile mechanics cleaned, adjusted, and replaced several items to restore normal engine performance. Reports of throttle sticking symptoms which may not have been related to carbon buildup were also included in Table I. A review of the complaint reports revealed that about one third of the complaints and reports (about 207) included in Table I resulted from carbon buildup causing the throttle sticking closed condition, and only ten complaints allege a "throttle sticking-open" condition which may be related to carbon buildup.

It appears highly unlikely that the throttle sticking closed condition resulting from carbon buildup could cause injury producing accidents for two primary reasons, even though two accidents were reportedly caused by throttle sticking resulting from carbon buildup. First, the level of higher-than-normal accelerator pedal force needed to overcome the binding of the throttle plate would only occur the first time the driver pressed on the accelerator after starting a cold engine. Such actions typically happen before the car is started or while the transmission is still in the "Park" or "Neutral" position. Second, any increased acceleration caused by a sticking throttle are easily controlled by normal braking.

Other Possible Causes of Throttle Sticking Symptoms:

Most of the consumer complaints in Table I contain only a description of symptoms (about 500 complaints reported stuck accelerator pedal), but several different causes were identified for some of the complaints. For example, two complaints allege that the cruise control linkage cable became stuck, one of which was an aftermarket cruise control that was improperly installed. Some complaints involve unique problems such as accelerator cable

binding and needing to be rerouted; and warped throttle body causing binding and a broken plastic clamp that holds the throttle cable. For these complaints a specific defect pattern was not found.

**REASON FOR CLOSING:** No safety-defect trend has been detected. Further commitment of agency resources to determine whether such a trend may exist does not appear to be warranted.

George Hettinger — 1/31/94
Safety Defects Engineer — Date

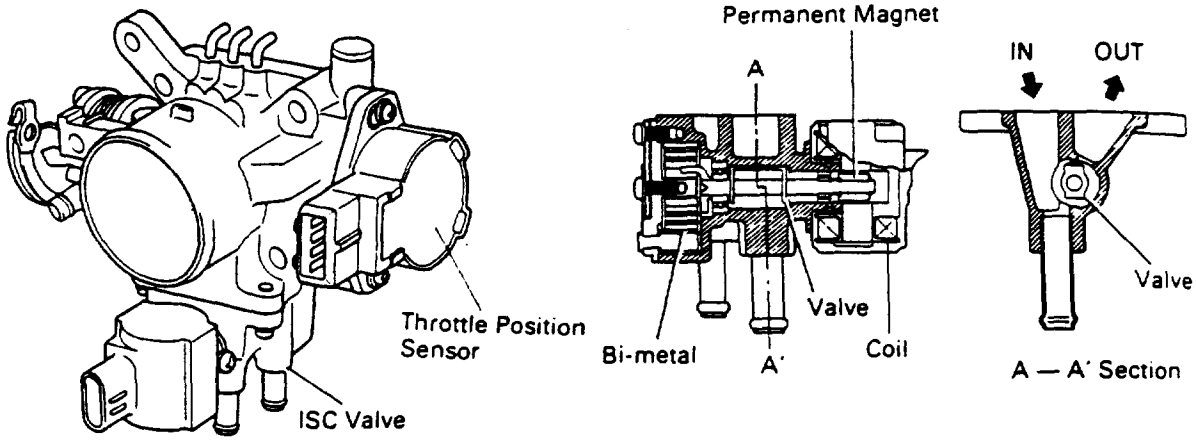
I Concur:

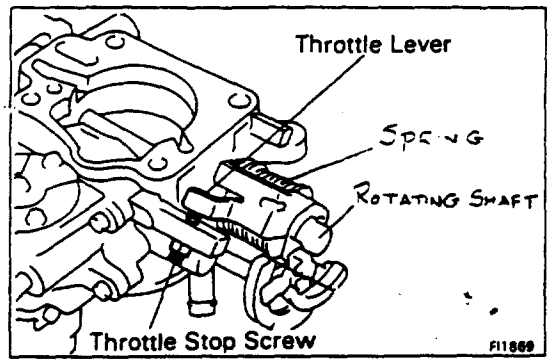
JA for RB — 1/31/94
Chief, Vehicle Control Branch — Date

Louis Brown Jr. — 1/31/94
Chief, Defect Evaluation Division — Date

[signature] — 1/31/94
Director, Office of Defects Investigation — Date

# Throttle Body




ATTACHMENT A