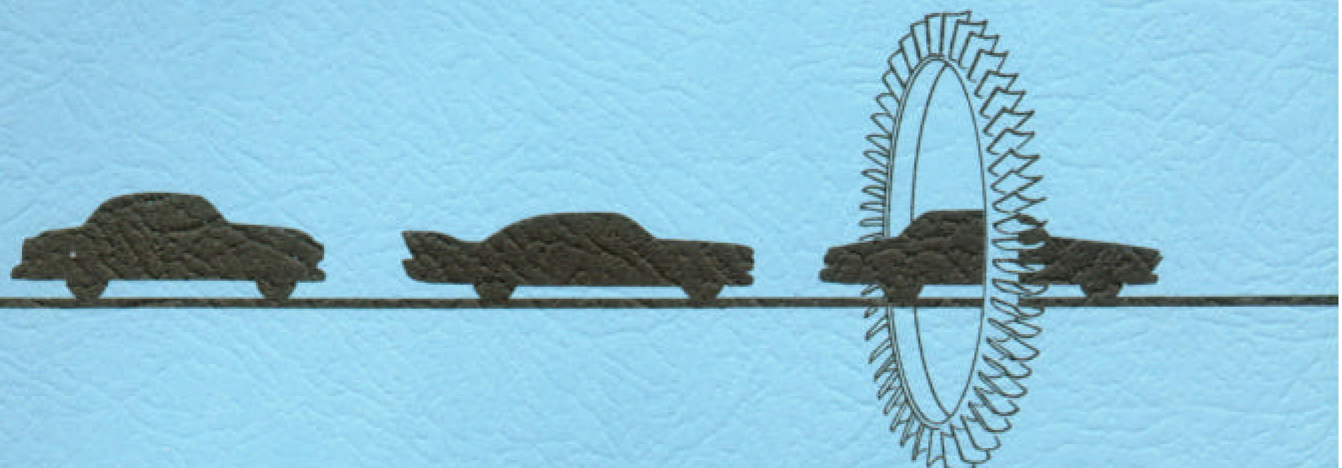

GAS TURBINE VEHICLES

by Chrysler Corporation

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by

CHRYSLER CORPORATION

MARCH 1954 - JULY 1962

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A review of gas turbine-powered vehicles shown publicly by Chrysler Corporation.

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CHRYSLER CORPORATION
ENGINEERING DIVISION
Technical Information Section

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PREFACE

This is a review of turbine vehicle milestones. Specifically, the purpose of this booklet is to present a chronological collection of photographs depicting various vehicles in which Chrysler Corporation has tested and displayed gas turbine engines.

Pictorial emphasis is on the vehicles. The booklet is not intended to serve as a history of the Corporation's gas turbine engine program. Information of this type is contained in other publications.

CONTENTS

Today, it is obvious that the advantages of the gas turbine over the conventional engine are, indeed, real. Some of these advantages are:

. The number of parts is reduced 80%

. Low-temperature starting difficulties are eliminated

. The engine will not stall with sudden overloading

. Operates on wide variety of fuels

. No warm-up period is necessary

. Anti-freeze is not needed

. Oil consumption is negligible

. Exhaust gases are cool and clean

. Instant heat is available in the winter

. Tuning-up is almost eliminated

. Engine operation is vibration-free

. Engine weight is reduced

. Maintenance is reduced considerably

. Engine life-expectancy is much longer

THE FIRST TURBINE CAR

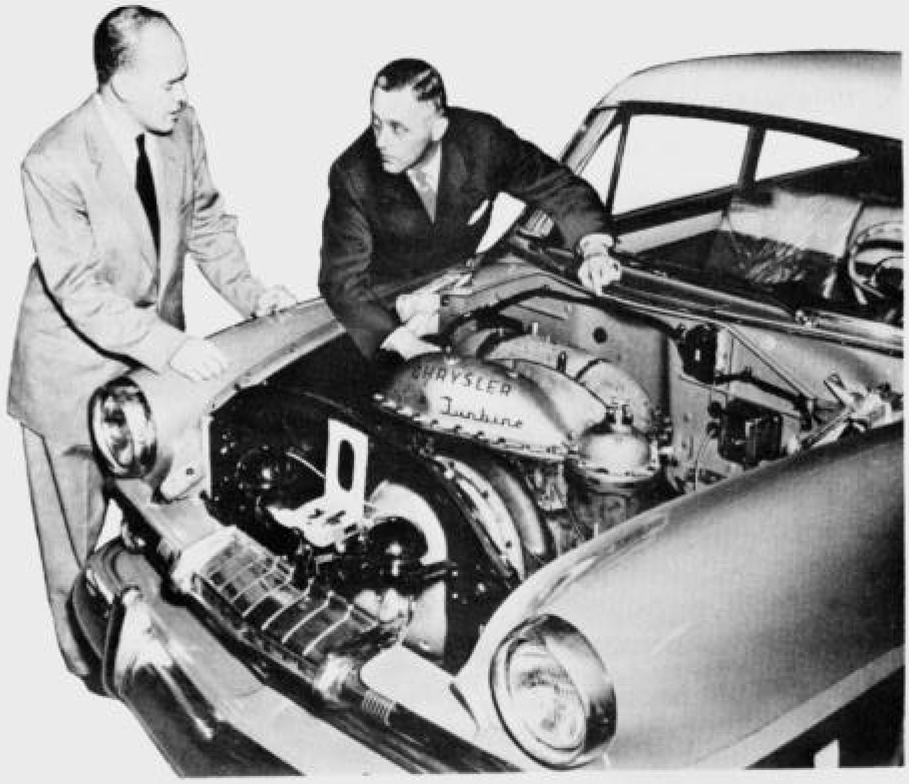
March 25, 1954 was a very important date in automotive gas turbine history: Chrysler Corporation disclosed the development and successful road testing of a 1954 production model Plymouth sport coupe which was powered by a turbine engine. The same car was on display from April 7 through 11 at the Waldorf-Astoria Hotel in New York City. And, on June 16, 1954, it was demonstrated publicly at the dedication of the Chrysler Engineering Proving Grounds near Chelsea, Michigan.

1954 PLYMOUTH TURBINE GETS A PROVING GROUNDS WORKOUT

This car marked the first attempt by an American automotive firm to install a gas turbine engine in a production automobile.

The engine was rated at 100 shaft horsepower. Although built essentially as a laboratory development tool, it was considered to be "a milestone in automotive power engineering" because it embodied solutions to two of the major problems long associated with vehicular gas turbines--high fuel consumption and scorching exhaust gas.

The key feature which contributed to removing these technical barriers was the revolutionary new heat exchanger, or regenerator. It extracted heat from the hot exhaust gases, transferred this energy to the incoming air, and thus lightened the burner's job of raising the gas temperature. The result was conservation of fuel as well as lower exhaust temperatures.



TURBINE ENGINE FITS NEATLY INTO 1954 PLYMOUTH

A gas turbine engine without a regenerator would have required several times the amount of fuel normally used in a regenerator-equipped engine. The extra fuel would be required to heat the gases to operating levels.

The regenerator also performed another important function. It reduced the exhaust gas temperature from about 1200 degrees F at full engine power to a safe level of less than 500 degrees F. Even more important, at idle the temperature was reduced to 170 degrees F. By the time the gases pass through the exhaust ducts to the atmosphere, the temperature was reduced even further.

Even with these breakthroughs, a great deal of work and many development problems still remained. On the date of the original turbine disclosure (March 24, 1954), Chrysler Corporation stated: "Whether we ultimately shall see commercial production of gas turbines for passenger cars depends on the long-range solution of many complex metallurgical and manufacturing problems. There is no telling at this time how long it will take to solve these problems."

Almost a year later, the same basic engine was installed in a 1955 Plymouth. This car, although never displayed at public exhibits, was used for driving evaluation tests on Detroit area streets.

DETROIT TRAFFIC TEST FOR 1955 PLYMOUTH TURBINE

THE 1956 CROSS-COUNTRY ENDURANCE TEST

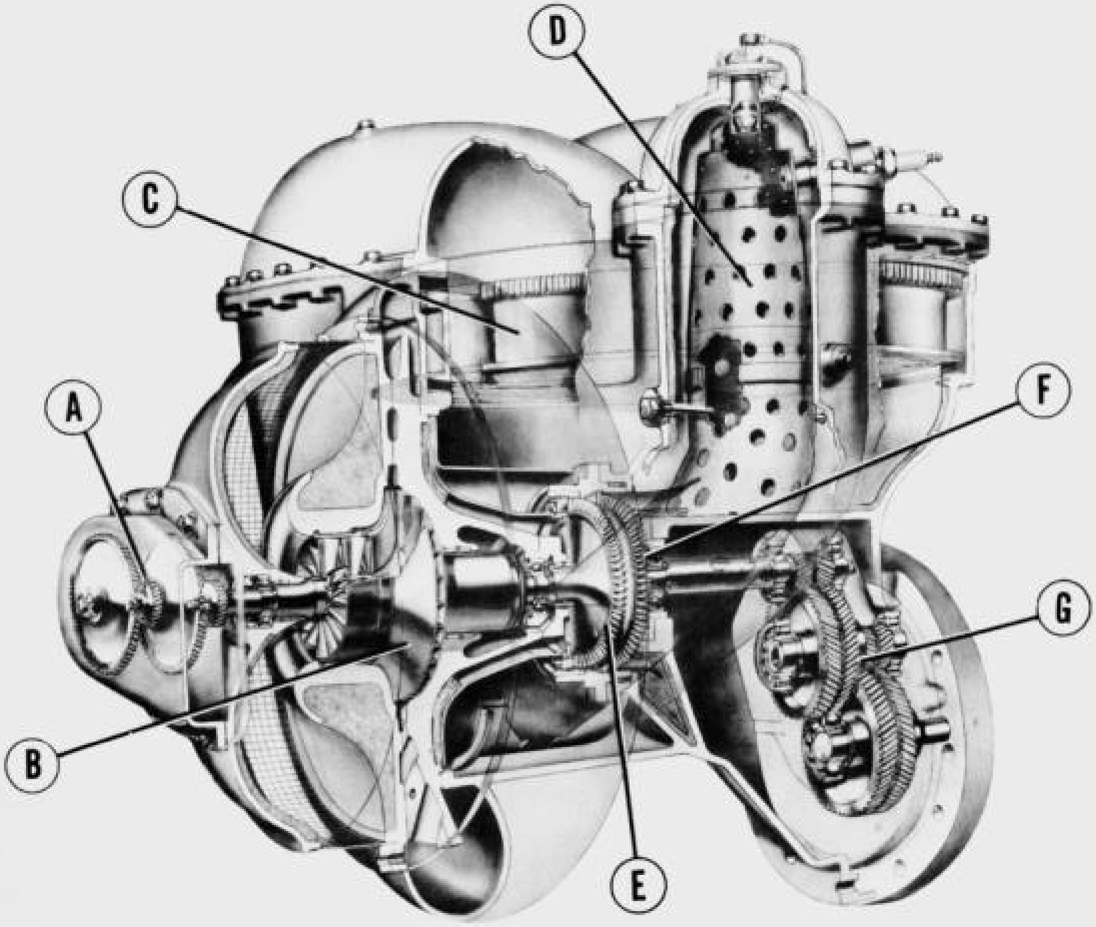
In March, 1956, another historic event took place--the first transcontinental journey of an automobile powered by a gas turbine engine.

1956 TURBINE SPECIAL EN ROUTE CROSS-COUNTRY

The turbine car--a four-door 1956 Plymouth sedan, a standard production model in every respect except for the revolutionary Chrysler-developed power plant--departed from the Chrysler Building in New York City on March 26. On March 30, four days and 3,020 miles later, it completed the cross-country endurance test when it arrived at the City Hall in Los Angeles, California. The purpose of the run was to test the turbine's durability, acceleration, fuel economy, control in traffic, action on steep grades, and operation under various climatic conditions. It marked another Chrysler Corporation "first" in the automotive record books and was considered a successful test.

Over the entire trip, fuel economy averaged approximately 13 miles per gallon using mostly "white" (unleaded) gasoline and some diesel fuel. The run was interrupted only twice for minor repairs which did not involve the turbine engine (a faulty bearing in the reduction gear and an intake casting were replaced). The engine itself and its basic components performed very well and without failures of any kind.

The engine was basically the same as used in the 1954 Plymouth. However, it reflected progress in the following major points: engine friction was greatly reduced; considerable work had been done with plain bearings instead of more expensive types of anti-friction bearings; the combustion system was improved, and engine controls were developed further. Automatic controls allowed the driver to operate the turbine car just as he would a conventional automobile.



MAIN COMPONENTS OF THE FIRST GENERATION GAS TURBINE ENGINE were: (A) Accessory Drive Gears; (B) Compressor Impeller; (C) Regenerator; (D) Combustion Chamber; (E) First-Stage Turbine, which drives the compressor impeller and accessories; (F) Second-Stage Turbine, which supplies power to the transmission; and (G) Double-Stage Reduction Gearing to the transmission.

THE SECOND GENERATION TURBINE

Basing their calculations on extensive test data and performance results of the 1956 cross-country trip, Chrysler engineers designed and developed a second engine. After extensive laboratory tests, it was installed in a standard production 1959 Plymouth four-door hardtop.

1959 PLYMOUTH TURBINE SPECIAL READY FOR ROAD EVALUATION

In December, 1958, this latest Turbine Special made a 576-mile test run from Detroit to New York. The results showed significant improvements in fuel economy.

This second generation turbine (also a laboratory development tool) operated in the 200 horsepower range; and, although it was improved in almost every respect, two areas were particularly outstanding--efficiency and materials.

Three major engine components (compressor, regenerator and burner) showed significant improvements in operating efficiency. The compressor efficiency was brought up to 80 per cent, a 10 per cent increase. The regenerator or heat exchanger unit reclaimed almost 90 per cent of the heat energy in the exhaust gas whereas peak efficiency in the 1956 cross-country run was around 86 per cent. Burner efficiency also was improved so that it was approaching the point of ideal combustion.

Less apparent, but fully as important as the engine design advances, was the progress in turbine metallurgy. Prior to this time, automotive turbine metals were similar to those used in aircraft jet engines. Although these existing materials certainly were adequate for test engines, they would not be suitable for automotive production for two key reasons: cost, and the simple fact that neither production capacity nor the available world supply of the required alloying materials could support such a program.

Through Chrysler metallurgical research, new materials were developed which: contained plentiful and relatively inexpensive elements; could be fabricated by conventional means; and had excellent resistance to heat and oxidation at elevated temperatures. Applications for these new materials were combustion chamber liners, turbine wheels and blades, etc.

The accompanying illustration shows a three-inch disc of the new material (left), with a disc of high-grade stainless steel (right). Both samples were exposed in air to temperatures above 2,000 degrees F in an electric furnace for 150 hours. At the end of that time, the new Chrysler-developed material showed no distortion or disintegration, while the effect on the stainless steel sample is apparent.

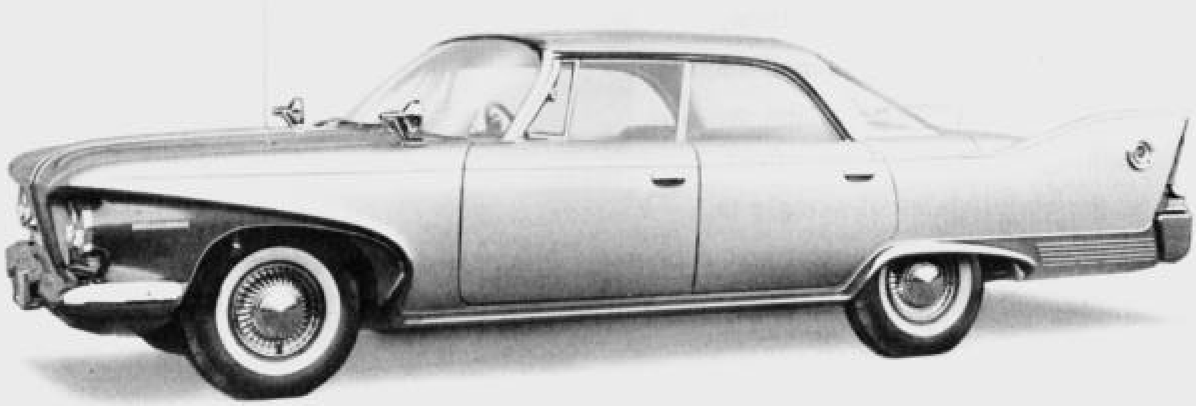
METALLURGICAL BREAKTHROUGH

A TRIO OF GAS TURBINE VEHICLES

Encouraged by previous progress, Chrysler engineers designed the third generation of the turbine and introduced it in three different vehicles. The initial showing was to newsmen on February 28, 1961. The vehicles were displayed publicly in Washington, D. C., March 5-9, 1961, in conjunction with the Turbine Power Conference of the American Society of Mechanical Engineers, co-sponsored by the Department of Defense.

TURBOFLITE--ADVANCED POWER, ADVANCED STYLING

The first of these gas turbine vehicles was an experimental sports car called the "Turboflite" (shown above). In addition to the engine, other advanced ideas of the car were the retractable headlights, a deceleration air-flap suspended between the two stability struts, and an automatic canopied roof. This "idea" car received wide public interest and was shown at auto shows in New York City, Chicago, London, Paris, etc.

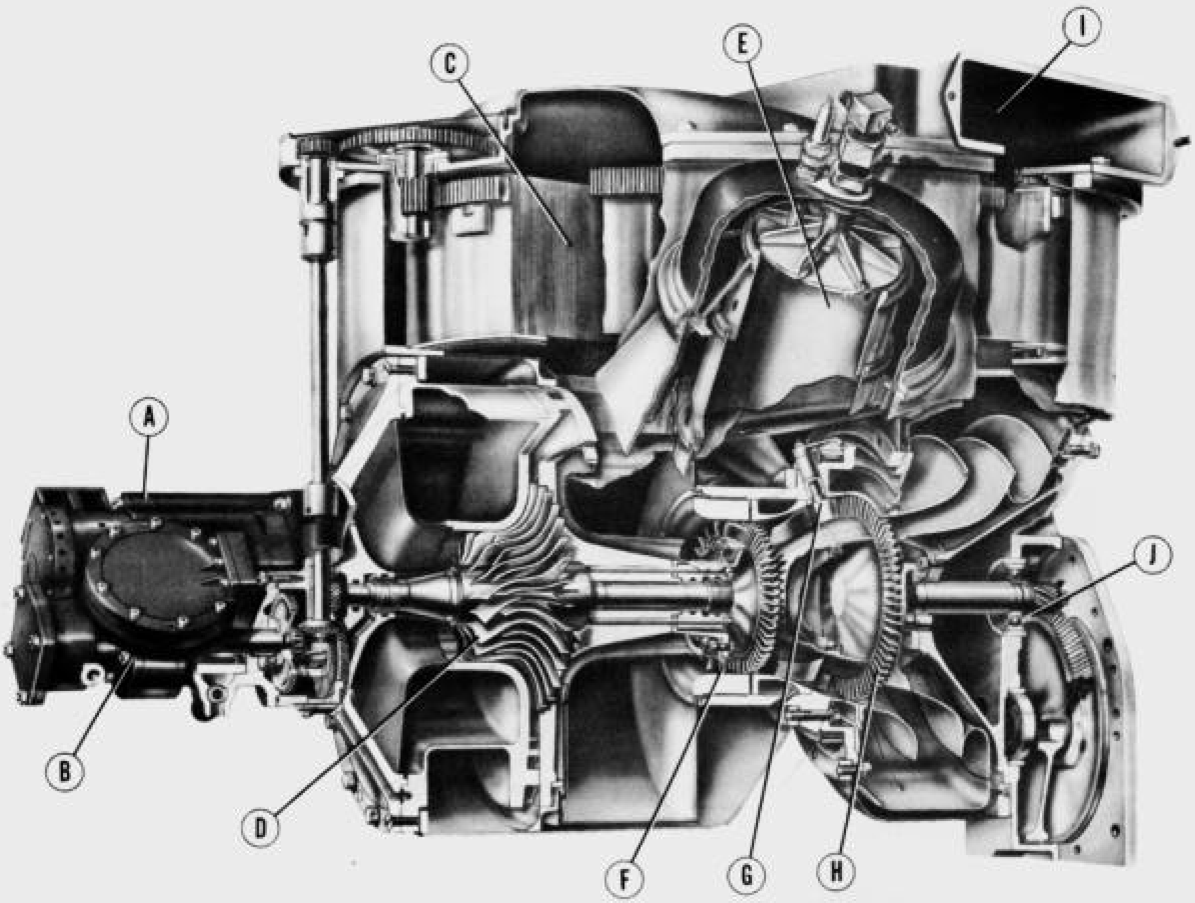


1960 TURBINE-POWERED PLYMOUTH

The second of the vehicles was a 1960 Plymouth (shown on the previous page) which was standard in every respect except for the engine and minor exterior styling modifications.

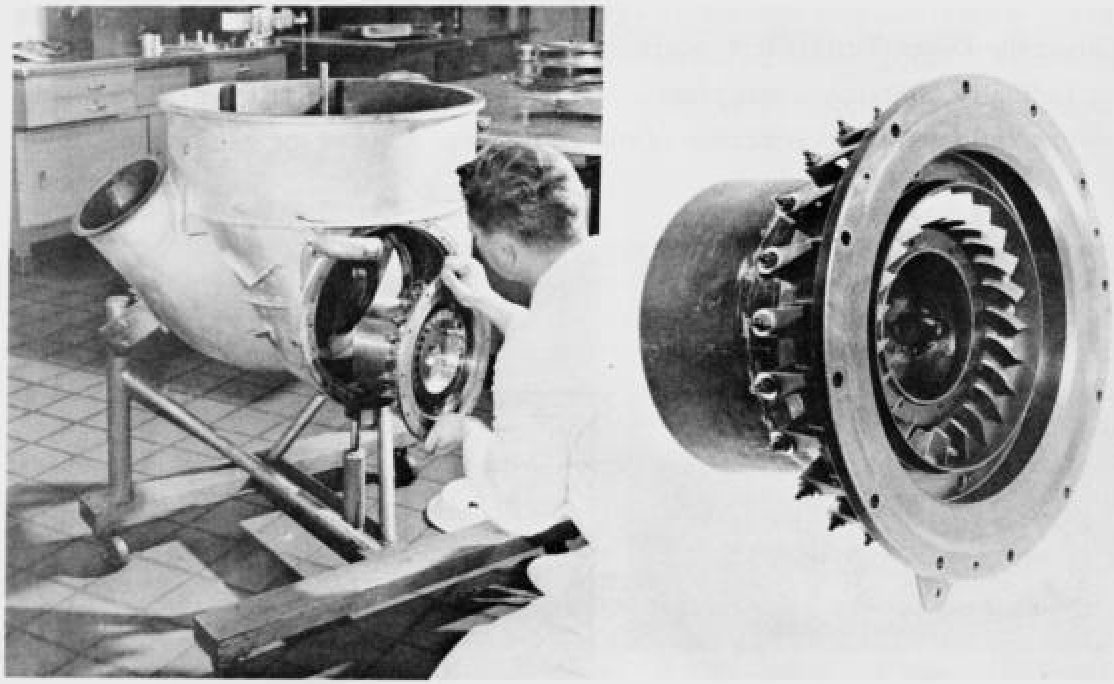
The final member of this trio was a two-and-a-half-ton Dodge truck which was a standard production vehicle--except for its gas turbine engine. This application demonstrated the turbine's versatility and adaptability because the engine in this truck was basically the same as those in the passenger cars.

TURBINE POWER FOR 1960 DODGE TRUCK



MAIN COMPONENTS OF THE CR2A gas turbine are: (A) the starter-generator; (B) fuel pump; (C) regenerator; (D) compressor impeller; (E) combustion chamber; (F) first-stage turbine, which drives the compressor impeller and accessories; (G) variable second-stage nozzle; (H) second-stage turbine which supplies power to the driveshaft; (I) one of two exhaust outlets; (J) single-stage helical reduction gear of 8.53-to-1 ratio which reduces power turbine rpm of 39,000 to 45,730, to a rated output speed of 4,570 to 5,360 rpm.

The key to the excellent performance and economy of the third generation gas turbine (called the CR2A) was its new variable turbine nozzle mechanism.



THE VARIABLE NOZZLE MECHANISM is installed by a research engineer in the rear of the CR2A-turbine engine housing (left). The nozzle mechanism (right) acts in shutter fashion to provide engine braking, improve acceleration and increase fuel economy by controlling and directing the angle of the jet stream to the power turbine blades.

The automatic second stage turbine nozzles provided optimum results throughout the entire operating range of the engine. Thus, economy, performance, or engine braking could be maximized as required by the driver. For example, one area of performance is what is termed acceleration lag--the time it takes the compressor section to reach operating speed after the accelerator pedal is depressed. The first turbine engine had an acceleration lag of seven seconds from idle to full-rate output; the second engine required three seconds to achieve maximum vehicle acceleration, while this new engine required less than one and one-half seconds to accomplish the same performance.

A FINAL PHASE OF RESEARCH AND DEVELOPMENT

After months of test and development work, a CR2A gas turbine engine was installed in a modified 1962 Dodge.

Called the Dodge Turbo Dart, styling modifications to the car were adapted to reflect its radically different power plant. The bladed wheel motif of the grille and wheel covers reflected the appearance of the vital components of the gas turbine.

COAST-TO-COAST TEST VEHICLE—1962 DODGE TURBO DART

The car left New York City on December 27, 1961, to begin a coast-to-coast engineering evaluation. After traveling 3,100 miles through snowstorms, freezing rain, sub-zero temperatures and 25 to 40 mile per hour head winds, it arrived in Los Angeles on December 31.

The turbine had not only lived up to all expectations but had exceeded them! An inspection showed every part of the engine in excellent condition. Fuel economy was consistently better than a conventional car which traveled with the turbine car and was exposed to the same conditions.

A CONSUMER REACTION TOUR

Another experimental turbine-powered car--the Plymouth Turbo Fury--joined the Dodge Turbo Dart, and the two turbine-powered cars began extensive consumer reaction tours at dealerships throughout the country in cities such as Los Angeles, San Francisco, Kansas City, St. Louis, Cleveland, Detroit, Chicago, etc. Two other turbine cars, a second Dodge and a second Plymouth, were added during the month of April in order to expand coverage of the tours.

1962 TURBINE TWINS

The tour schedule was similar in each area. When the cars arrived in a given city they were first displayed to members of the local press. The press events involved explaining the turbine and answering questions, giving each newsman a ride in one of the cars, and, in some cases, staging special tests. After members of the press had viewed the cars, they were then displayed at various dealerships.

One of the key reasons for these tours and exhibits was to elicit and evaluate consumer reactions to the turbine. The cars have been shown at Plymouth and Dodge dealerships in approximately 90 major cities in the United States and Canada.

STOPOVER POINTS ON CONSUMER REACTION TOUR

During this time hundreds of thousands of people came to see the turbine vehicles, and public interest was intense and serious. When asked, "if this car were offered for sale to the motoring public, do you think you would buy one?" 30 per cent of the turbine viewers said "yes" they would definitely buy one and 54 per cent answered they would think seriously of buying one.

As a result, on February 14, 1962, Chrysler Corporation announced that it would build 50 to 75 turbine-powered passenger cars for sale to selected customers in the latter part of 1963. Typical motorists will be offered an opportunity to purchase turbine cars for use under a variety of driving conditions. Qualifications of the initial buyers will vary: high-mileage drivers, city and country dwellers, people in areas where it is dry, where it is cold, etc. Concrete evidence concerning public acceptance of this revolutionary type of automotive power plant thus will be obtained before plans are made for possible volume production.

On February 14, 1962, in Chicago, Chrysler Corporation exhibited another gas turbine vehicle--the Dodge Turbo Truck. This medium-duty truck (also equipped with the CR2A experimental engine) had just completed a 290-mile test run from Detroit to Chicago.

TURBINE PULLING POWER TESTED IN 1962 DODGE TURBO TRUCK

From February 17 through 25, three gas turbine-powered vehicles (the Plymouth, Dodge, and Dodge Truck) were exhibited at the Chicago Automobile Show.

On March 7, 1962, George J. Huebner, Jr., Executive Engineer of Research for Chrysler Corporation, received an award from the Power Division of the American

GEORGE J. HUEBNER, JR. RECEIVES AWARD FOR GAS TURBINE LEADERSHIP

Society of Mechanical Engineers "for his leadership in the development of the first automotive gas turbine suitable for mass-produced passenger automobiles." It was the first such award ever given to an automotive engineer.

A LOOK TO THE FUTURE

The preceding information has summarized the progress made in Chrysler turbine vehicles of the past and present. However, the story would not be complete without a brief glance to the near future. Engineering and styling staffs recently completed design of the limited-production, gas turbine car mentioned previously. The program now has advanced to the stage where production preparations are under way. The turbine car will be entirely new in appearance and will be powered by a new engine--Chrysler's "fourth generation" gas turbine.

In the space of less than twenty years, Chrysler research and engineering has been able to develop a power plant that can compete with and, in many respects, perform better than the piston engine which has been in automotive use over three times as long.

Moreover, although the progress of the gas turbine and its advantages are impressive, Chrysler engineers are confident that they have by no means reached the full design potential of this engine. Additional progress in improved component efficiencies (particularly in the compressor) and the future possibility inherent in increased operating temperatures, are extremely promising. For example, a 400-degree increase in nozzle inlet temperature would mean a 40 per cent increase in specific output for a given size power plant, or conversely, a reduction in size for a fixed horsepower. The same 400 degrees would, at the same time, improve fuel economy over 20 per cent without needing to take advantage of any further increase in component efficiency. Chrysler Research scientists, who are working with materials that will make this possible, feel that the problems associated with these higher temperatures do not appear any more difficult than the problems already solved.

The tremendous potential of the turbine to satisfy the characteristics desired in a power plant fires the imagination and the energy of Chrysler engineers. They feel that the turbine has great promise for propelling automobiles more smoothly, more economically, and more dependably.

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