ENGINEERING

THE EDSEL

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THIS is the engineering story of the newest car introduced to the American public by a major automotive manufacturer in 19 years. The Edsel is new but actually it's the germination of an idea conceived by Edsel Ford who thought years ago that the company should have greater representation in the medium-price range. This idea was furthered by his son, Henry Ford II, in 1948 when another car was proposed to keep abreast of things in the automotive market.

With the decision to enter a new car in the medium-price field, attention was directed to the engineering and styling phases. Basic objectives were for the car to be entirely new but not to the extent of being radical; to be individually distinctive and yet maintain the traditional reliability and ruggedness characterized by the company's vehicles. The style was to be crisp and clean enough to warrant consideration of the more discriminate buyers who were looking for the extras in a medium-price car.

Body Structure

At this point, the engineering staff began advanced package studies and established design objectives. The first consideration in package development was room to provide the maximum seating comfort, adequate entrance room, and convenience and safety for passengers. Edsel package studies resulted in establishing basic dimensional limitations required to fulfill adequately engineering and styling needs and desires. Working from the ground up, it was ascertained that 6–7 in. should be provided for ground clearances; 5–7 in. for mechanical components such as driveshaft and frame members; 4–6 in. for seat deflection to provide seat comfort; 38–40 in. effective head room to accommodate passengers; and ½–1 in. roof thickness providing for headlining and sound-deadening material.

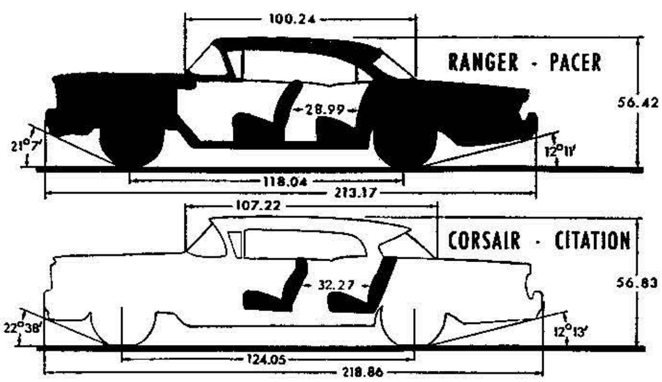

Fig. 1—Package comparison

Layouts were prepared to investigate wheelhouse clearances for wheel jounce, rebound, and tire chains, and to finalize placement of the exhaust system, spare tire, and fuel tank.

Studies resulted in two basic concepts: the 118-in. wheelbase Ranger-Pacer series and the 124-in. wheelbase Corsair-Citation series. A comparison of these packages reveals an overall length of 213.17 compared to 218.86 in., an overall height of 56.42 as compared to 56.83 in. and a greenhouse length of 100.24 on the Ranger-Pacer series as compared to 107.22 in. on the Corsair-Citation series (Fig. 1).

Proposed styles were under consideration simultaneously with advanced package development. With the dimensions set, the styling section proceeded to cut clay. The vertical grille theme evolved from comparison studies of horizontal and vertical arrangements. The vertical grille was a styling feature but not a styling problem alone. Adequate engine cooling, allowance for an air conditioning condenser, as well as structure to support the center impact ring were paramount considerations.

As styling designs progressed, the engineering staff worked hand-in-hand on the engineering im-

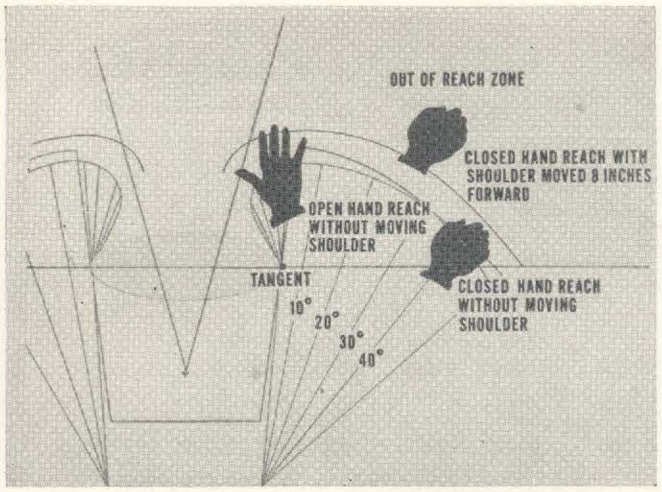

Fig. 2—Instrument panel motion study

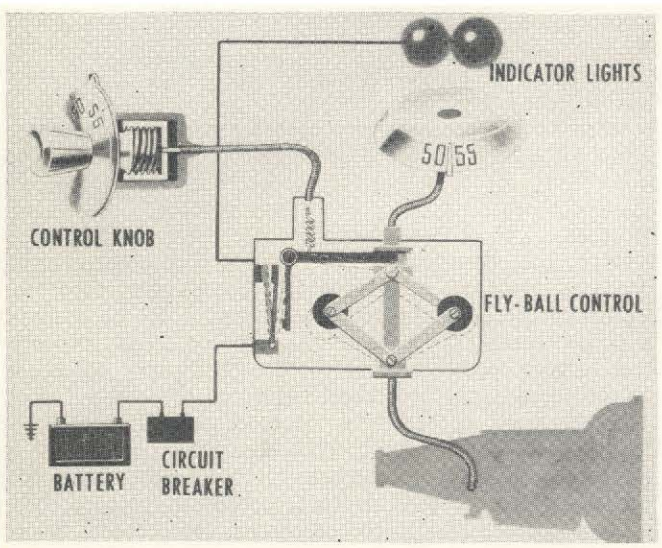

Fig. 3—Speed warning light operation

plications. Consideration was given to clearance for tire removal, particularly on the rear wheels, and turning clearances on the front wheels. Formed areas and sections were designed to please the eye and facilitate manufacturing. You can imagine the consternation when the styling section proposed beautiful varieties of rear-quarter treatment only to be told "it's too deep a draw to be practical." Other problems as the Edsel exterior took shape were bumper heights, angles of approach and departure, and the legal requirements for such items as head lamps, tail lamps, and license plate location.

Lower, longer, and wider bodies, featuring increased glass areas with longer and thinner framework, provide less opportunity to induce loading in the roof. The "dog-leg" characteristic of the roof supports, which is part of the price of the wrap-around theme, adds to this problem. Thus, the tendency is for the roof to carry, as the upper chord member, less than its potential share of the loads imposed on the body truss. These loads, incidentally, are steadily increasing along with car size and weight. All this would seem to imply a tendency toward either much heavier construction or less rigidity.

Actually, and fortunately, neither of these trends

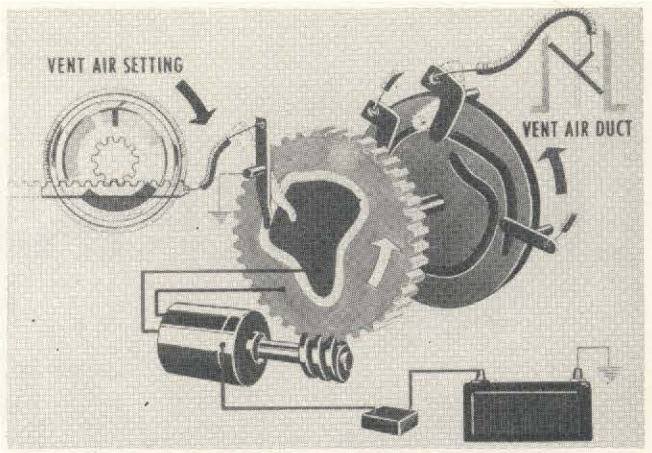

Fig. 4—Dial-Temp operation

has prevailed to any alarming extent. True, the weight of frames and other load-carrying structures has increased, but not out of proportion to the concurrent increase in useable space for passengers and luggage. Nor has there been any disposition to accept low standards of safety or comfort. After all, the acid test of a car's construction is its ability to filter out disturbances such as shake and harshness and to stand up in crash and rollover tests. It is fairly evident that as a result of increasing emphasis and concentrated effort over the past few years, today's cars are safer than ever. In the matter of shake, a vast amount of data has been obtained in our organization by the well-known ESTA[1] (Electronic Selected Threshold Analyzer) technique. Shake readings of recent car models show a definite tendency to decrease.

As each new styling feature makes its appearance, means must be found to minimize any adverse structural effects. Stiffness of the underbody has been one of the most productive countermeasures; the use of heavy box sections in the sills (often aided by increased chassis frame sections) has helped to make up for the loss or partial loss of center pillar structure. Heavier stock in front and rear pillars, a liberal use of gussets and bulkheads, plus boxing of the roof rails has largely offset the effect of dog-legs and thinner framing accompanying wrap-around windshields and rear windows. At the same time, manufacturers have developed means of dealing with increasingly intricate parts and assembly, thus promoting structural efficiency.

As a matter of interest, our laboratory results show that in overall car torsional stiffness, today's Edsel 4-door hardtop is practically equal to the standard 4-door and is only slightly less rigid in bending.

The front seats are somewhat different. (We attempted to have something different—but with increased utility and improved comfort.) We divided the seat into 1/3—2/3 proportions to more individualize the driver's area and to eliminate the split in the area of the third passenger.

The cushion back was constructed as follows: two formed-wire springs were used to provide pressure variance; a heavier, firmer spring in the lower section where pressures were greater and a lighter,

[1] "Measuring Car Shake," by R. J. Saxon. Paper presented at the SAE National Passenger-Car, Body, and Materials Meeting, Detroit, March 4, 1954.

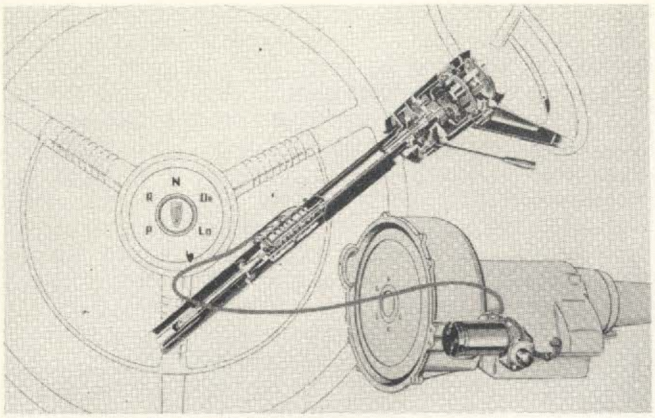

Fig. 5—Teletouch transmission selector

softer spring in the upper section where less resiliency was required. This sectional pressure development resulted after extensive studies to determine the best pressure distribution from the comfort and health standpoints.

Instrument Panel

The interior presented a challenge of a different nature to both the styling and engineering staffs. For example, safety considerations dictated replacement of sharp corners with rounded styled sections, and a great deal of effort went into analyzing motion studies to be sure that controls and instruments were as conveniently located as possible. From these studies, every effort was made to locate major controls in the most accessible area and major instruments in the most visible area. The key engineering problems, in styling any instrument panel, are finding a place for each desired item on the panel surface and providing sufficient space for the mechanisms, motors, bowden cables, and electric wires behind the panel (Fig. 2).

The most often referred to instruments are arranged in the upper portion of the instrument cluster. A speed-warning device has been incorporated in the floating drum-type speedometer as a visual driver aid and a definite safety feature. A selected maximum operating speed is preset by a dial just below the odometer; when the maximum operating speed is exceeded, a switch turns on a lamp and the speedometer face glows red. To accomplish this, a flyball-type governor is connected to the speedometer drive cable. The calibrated control knob on the instrument panel sets the spring tension on the flyball system, determining the speed at which the switch can be actuated. At low speeds, the flyball governor is held from operating the switch by the spring. As the speed increases, the force on the governor equals the spring tension, the contacts close, and the circuit is completed to light the lamps in the speedometer dome. This glow is readily visible and can be seen without diverting the eyes from the road. (See Fig. 3).

Ventilating System

Included in the instrument cluster is the Dial-Temp control for the heating and ventilating systems. The once-complicated, difficult-to-operate multiple lever controls have been eliminated. Heat or fresh air is brought into the car by simply turning a single control. The knurled bezel of the dial is the actual control and when rotated for a desired function brings into play an electric servo unit that actuates the valves for heating, defrosting, or ventilating. This servo mechanism is mounted behind the instrument cluster.

The heart of this system is the gear-driven control plate with preprogrammed cam grooves on one side and electrical contact surfaces on the reverse side. Rollers, connected to actuating arms and bowden wires, ride in the cam grooves and provide the necessary effort to operate the appropriate controls for the dialed function. These rollers are positioned in their proper location in the grooves, by the clockwise or counterclockwise rotation of the control plate. The direction of rotation is determined by a pressure arm which rides on the electrical contact surfaces of the plate. Fig. 4 shows how the servo operates the control for vent air.

When the knurled knob is manually rotated to the selected point of operation, the pressure arm is moved by means of a rack and pinion and a bowden cable. The pressure arm makes contact on one side of the contact plate causing current to flow through one field of the servo motor, thus rotating the motor in one direction and operating the control plate. When the knurled bezel is rotated to another selected point, the pressure arm makes contact on the other side of the contact plate causing current to flow through the other field coil of the motor, rotating the motor in the other direction and operating the control plate in the opposite direction.

The rotation of the motor is always such that the pressure arm seeks and finally comes to rest on the dead band of the contact plate.

Drive Controls

Drive controls for the Edsel "Teletouch" push-button shift are located in the center of the steering wheel. This location provides optimum accessibility for either the right or left hand. The various ranges—park, reverse, neutral, drive, and low—are selected by depressing the appropriate button. This closes the respective circuit that is continued through slip rings and brushes mounted in the steering column. These control circuits operate relays that actuate the motor mounted on the converter housing (Fig. 5). A powerful motor is used to provide the same ease of operation of disengaging the "park" position as the other functions. The control system has been carefully studied and fail-safe features incorporated throughout. A positive feed is used in contrast to a grounding system as customarily incorporated in horn circuits. This positive feed causes the system to remain in whatever position selected, even in the case of accidental grounds. Thus, there is no fear of a failure in the system causing the transmission to go into an unwanted gear accidentally. A dual switch, operated by transmission hydraulic pressure, inhibits the selection of "reverse" above 15 mph and inhibits the selection of "park" above 3 mph. This allows for sufficient "reverse" speeds to permit rocking the car out of mud holes and snow banks, but effectively prevents the transmission from being engaged in "reverse" at high forward speeds. The 3-mph inhibition in "park" prevents damage to the transmission by accidentally pressing the "park" button at high forward speeds. As an added safety feature, the "park" position can be actuated after the ignition is turned off, but it is impossible to actuate any

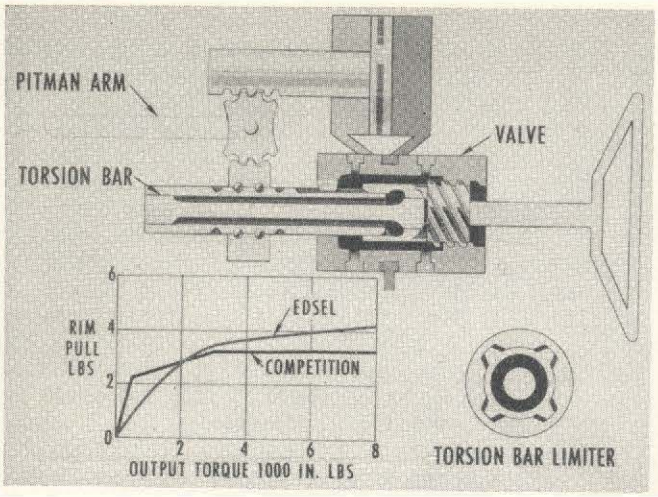

Fig. 6—Power steering operation

other position until the ignition switch is again turned on.

The "Teletouch" buttons are depressed below accidental strike distances in the center of the wheel. In case of major accident, an additional feature is the rubber rim around the controls to absorb any abnormal impact.

To maintain the push-button assembly in a stationary position, a unique planetary gear system is used. One sun gear is fixed to the stationary part of the steering column and another sun gear is fixed to the push-button assembly. A pair of planet gears revolve about these two sun gears with the rotation of the steering wheel. This assembly permits a direct drive from the steering wheel down through the steering column.

Power Steering

Throughout the automotive industry, the tendency is toward the integral-type power steering gear. The reasons for this trend are quite apparent: this type of unit permits neatness of installation, reduced vulnerability to damage from road obstructions, and improved returnability. The new integral-type steering gear in the Edsel cars features a torsion-bar type of hydraulic valve actuation to provide road feel.

The steering gear consists primarily of a gear reduction unit (the recirculating ball and nut type embodied in the standard steering gear), a power cylinder, and a hydraulic servo-control valve. The hydraulic valve, valve sleeve, and torsion-bar assembly are mounted on the end of the worm shaft and operated by the twisting action of the steering shaft on the torsion bar.

The torsion bar is restrained from twisting more than 9 deg either side of normal position to prevent overstressing the bar and permit manual steering. The valve spool moves 0.004 in. for each deg of twist of the torsion bar and approximately 0.036 in. for maximum 9-deg twist. The valve must move 0.008 in. resulting in a 2-deg twist of the torsion bar for intitial power assist. In normal straight driving, approximately ½–1 lb of pull is required on the steering wheel to control the car. Cornering effort is approximately 2–3 lb and maximum parking effort is 4–5 lb. Particularly noteworthy is the smooth transition from no power to full power with the torsion-bar action as compared to other systems.

On a right turn, for example, the valve spool moves up, allowing oil from the pump to enter the right side of the power piston. The oil on the left side of the piston is returned through the valve to the pump. Consequently, the power assist is to the right side of the piston, pushing it to the left and providing assistance in turning of the sector shaft. Restricting the oil flow to one side of the piston increases the oil pressure proportionally to the reaction of turning the front wheels. The action is reversed on a left turn. (See Fig. 6.)

A new concept in pump mounting and drive is introduced on the E-475 engine for power steering. The pump is integrally mounted on the engine front cover and driven directly by the crankshaft. The arrangement eliminates the conventional drive pulleys, belt, and pump mounting bracket. The use of a large diameter rotor in the pump makes possible adequate pressures even though the pump operates only at crankshaft speed. This results in increased durability of the pump. A large-capacity reservoir is used in conjunction with the integral pump; the reservoir is mounted higher than the pump which precludes aeration of the oil and improves accessibility.

Engine

Each of the two series of Edsel cars is powered by an engine designed specifically for it. The E-400 engine is in the Ranger-Pacer series and the E-475 engine in the Corsair-Citation series; both of these are 90-deg V-8 overhead valve engines with 10.5/1 compression ratios. The displacement on the E-400 is 361 cu in.; bore diameter is 4.05 in. with a stroke of 3.50 in., giving a bore-stroke ratio of 1.16. The maximum brake horsepower is 303 at 4600 rpm and the maximum torque is 400 lb-ft at 2800 rpm. The E-475 is a larger engine with a displacement of 410 cu in. The bore diameter is 4.20 in. and stroke is 3.70 in., giving a bore-stroke ratio of 1.135. Maximum brake horsepower of this engine is 345 at 4600 rpm and the maximum torque is 475 lb-ft at 2900 rpm.

The E-400 engine has cylinder heads with machined combustion chambers of the wedge design which provides accurate compression control. The combustion chambers in the E-475 engine are in the cylinder block and are machined at the same time as the cylinder bores. This was accomplished by designing the cylinder deck at a 10-deg angle to the top of the piston. The resulting wedge-shaped cavities form combustion chambers virtually free from pockets in which harmful deposits might accumulate.

A new innovation on the E-475 engine is the water-warmed intake manifold replacing the conventional exhaust-heated manifold. This results in better control of the fuel-air mixture temperature and, thus, improved distribution. It is accomplished by running the engine water from the rear of both heads under and along the intake manifold passages. These intake passages are large and smooth to allow unrestricted flow of the fuel-air mixtures. The manifold is so designed as to eliminate sharp turns or obstructions. Quick warmup is accomplished by the circulating system.

The water-warmed intake manifold is the first stage of the three-stage, parallel-flow cooling system in the E-475 engine. In this system, the water is circulated only through the cylinder heads and intake manifold during the first stage. Circulation is confined until the water temperature reaches approximately 140 F and thermostats in each bank of the cylinder block open. Cooling is now in the second stage; coolant is circulated through the manifold, cylinder heads, and block. The third or final stage comes into play when the water temperature rises to 180 F and the thermostat in the water outlet connection opens. Water is now circulated through the whole cooling system, the intake manifold, the cylinder heals, the cylinder block, and the radiator. In all three stages, the major portion of the coolant is circulated through the cylinder heads for greatest scrubbing action at the point of highest heat generation. (See Fig. 7.)

Transmission

With the introduction of the dual-range transmission, the Edsel driver will enjoy greater flexibility of control along with the advantages of greater performance, better fuel economy, and smoother shifting.

The new transmission allows the option of starting in first or second gear and provides for smoother shifts into high gear automatically at speeds which are dictated by throttle opening. The forced downshift feature, the hill-braking ability in low range, and the usual neutral, reverse, and park ranges are retained.

The advantages of first-gear starting are evident. The transmission is automatically in first gear and performance at wide-open throttle is thus better than in previous model transmissions where the throttle had to be depressed past the detent for a downshift to first gear. In city driving, the same acceleration is achieved at a lower throttle opening, providing better fuel economy and the comforting feeling of power in reserve in the form of unused accelerator pedal travel. Also, the high break-away torque, available in first gear through the transmission, allows the use of lower ratio axle and, consequently, improved fuel economy at cruising speeds.

The transmission is basically a 3-element torque converter in combination with a Ravegnaux (compound) planetary gear set that will provide three speeds forward and one speed reverse. The major innovation is the substitution of a sprag-type one-way clutch to be the reaction member of the planetary gear set in the first gear. The shift from first to second gear can be made smoothly since a shift off a one-way clutch is basically smoother than one in which two bands are involved. With the one-way clutch, the timing problem of two bands disappears. A further aid to smooth 1-2 shifting is the addition of a hydraulic accumulator to the front servo that assists in smooth application of the front band. (See Fig. 8.)

Air Suspension

Why an air suspension? It is more complex and costly than conventional types. It requires a staggering expenditure of time, talent, and money for development. Is there, apart from competitive pressure, a compulsive reason for offering it to Edsel customers? Briefly, yes: it offers, for the first time, a practical means of attaining the full ride benefit of very soft springing.

To design or manufacture conventional springs with very low rates, is not at all difficult. To apply them to a car, however, is quite another matter. In leaf springs, for example, torque windup becomes a prohibitive consideration. Leaf springs lost out in front suspensions for this reason many years ago. In coil springs and torsion bars, the problem is space—with lower rates, they become larger; more significantly their operating space (wheel travel) requirements increase. More and more wheel travel is wasted in providing for load changes. Unloaded cars begin to look ridiculously high while heavily loaded cars practically ride on the compression bumpers; net jounce travel approaches zero. Moreover, mechanical springs are essentially constant-rate devices and adequate cushioning at the jounce and rebound stops becomes increasingly difficult with softer springing.

It is in these respects that the use of air as a spring medium has three important advantages: (1) a very low-rate air spring can be fitted in the space vacated by a normal-rate coil spring; (2) air systems necessarily incorporate automatic leveling and a car can have a pleasingly low curbside appearance yet at maximum load, full-jounce travel remains available; (3) the rate pattern of an air spring can be precisely tailored to make the best

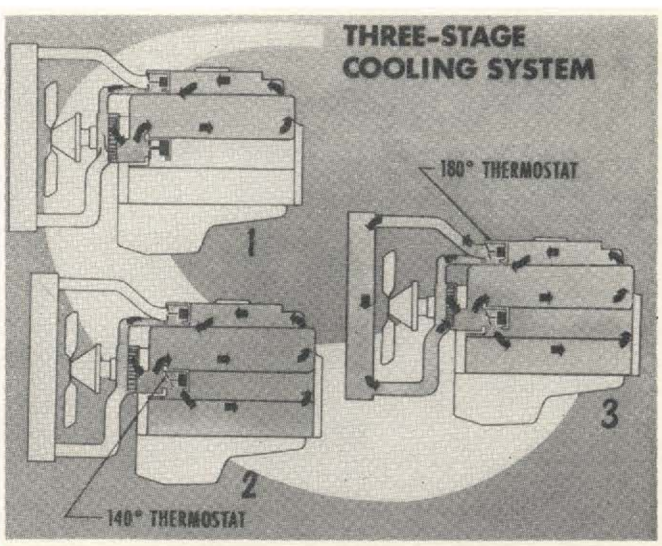

Fig. 7—Three-stage cooling system

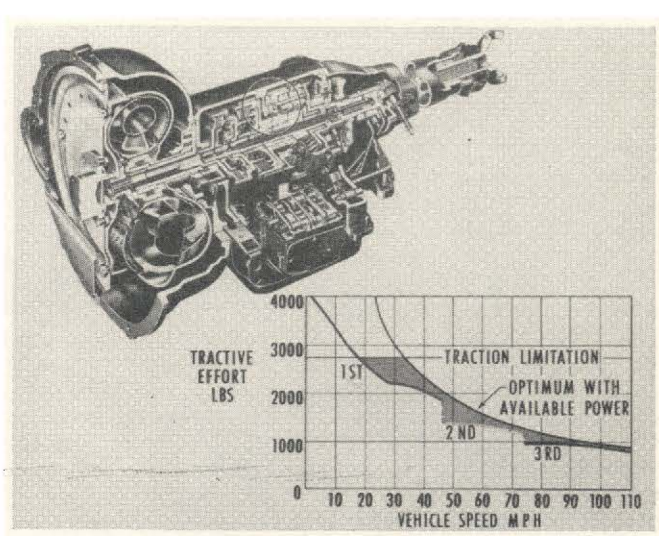

Fig. 8—Dual-range transmission

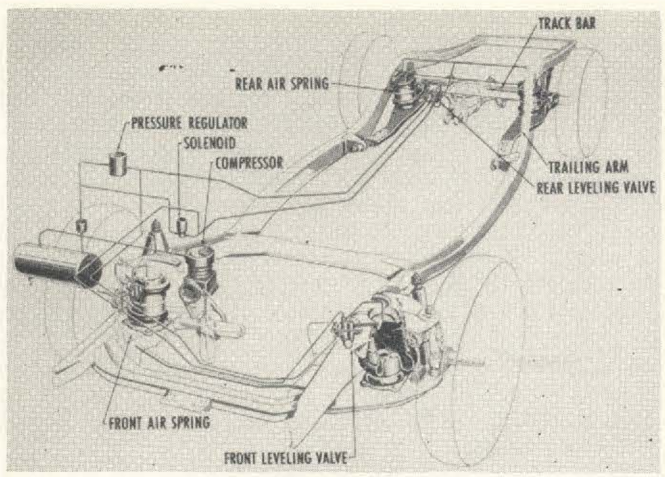

Fig. 9—Air suspension

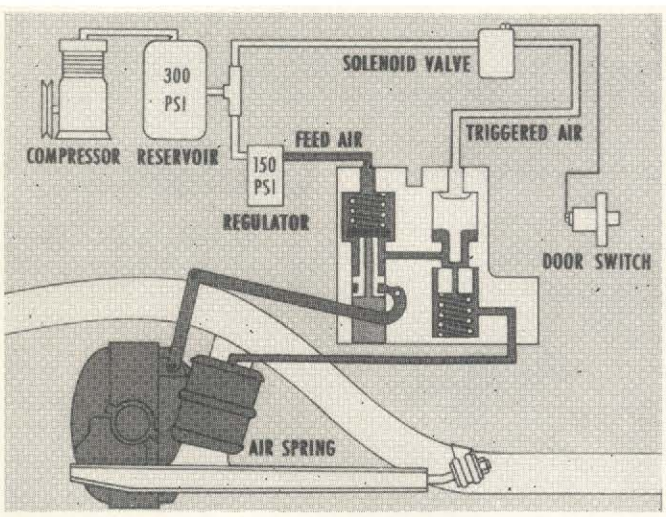

Fig. 10—Leveling operation

possible use of available wheel travel.

Three principal air level ride features are: the air springs, leveling valves, and trailing arm rear suspension. Briefly, the system works as follows (Fig. 9): Compressed air, used both as the spring medium and as the means of height control, is supplied by a specially developed compressor. This is a single-cylinder unit belt driven at approximately engine speed and lubricated by engine oil. Its piston displacement is 2.71 cu in. Balance pressure is approximately 300 psi, maximum power requirement approximately 1 bhp. It is a quiet and smooth running device with adequate capacity. The compressor delivers air through a flexible hose and a check valve to a 400 cu in. reserve tank mounted in the right fender just aft of the headlamp. A manual drain valve, for removal of any accumulated moisture, is installed at the low point of the tank and a filter is placed in the outlet line.

From the reservoir, which is normally at 300 psi (balance pressure of the compressor), air is used for two distinct purposes. Most of it is consumed in supplying the springs; air for this function proceeds through a copper line to a regulator valve, thence at reduced pressure (150–160 psi), to the three leveling valves (two front, one rear), and from these to the springs. Air at reservoir pressure is also supplied for a control, or "triggering" function; in this case, it is fed to a door-controlled solenoid valve and from there by nylon lines to fast-action mechanisms in the three leveling valves.

This arrangement brings about a dual, or "slow-fast" continuous height control. When the car is being driven (or is standing still with the doors closed) and a height adjustment is required, air is directed to or from the springs through highly restricted passages in the leveling valves so that height changes take place slowly. But as passengers enter or leave the car and a door is opened, the solenoid valve is actuated; this pneumatically opens a relatively unrestricted bypass in each leveling valve, through which springs are filled or exhausted. Thus, the leveling process is quite rapid as long as any door remains open. (See Fig. 10.)

The system includes several minor components which require a few words of explanation. The T-check valves between the springs and the leveling valves are low-limit devices which prevent the springs from exhausting below a set minimum pressure. They inhibit extreme leveling action, which could cause difficulties in jacking.

The pressure regulator or reducer valve maintains an approximate balance between the system-to-spring (fill) differential pressure and the spring-to-atmosphere (exhaust) differential pressure. This balance is required in rough road operation where the leveling valve is working continually. If the system were operated at the 300 psi reservoir pressure, for example, there would be perhaps a 220 psi differential to fill the rear springs and an 80 psi differential to exhaust them. On a long stretch of rough road, especially washboard, far more air would be admitted during jounce motions than could be exhausted during rebound motions. Even though the slow leveling passages were in use, the car would soon be riding high against the rebound stops. Pressure regulation at 150–160 psi keeps the car in trim regardless of road conditions.

A restrictor valve is used in the Ranger and Pacer models and is located between the right rear spring and the rear leveling valve. This valve contains a very small orifice, together with a bypass triggered by the solenoid valve in the same manner as the bypasses in the leveling valves. Thus, the orifice is effective only in the slow leveling mode. The reasons for using this restrictor will be made apparent in the discussion dealing with the rear suspension.

The leveling valve might be called the "brain" of the system. Its operation is fairly straightforward. Flow of air to and from the air springs is governed by a small rubber-covered seal disc. Each of the three valves in the system is mounted on the chassis frame; its actuating lever is linked to the unsprung mass, so that when the car riding height at that point deviates from normal, the lever shaft is rotated, and a cam on the shaft causes the plunger to move—up if the car is too low, down if it is too high. An upward movement of the plunger lifts the seal disc off its peripheral seat, admitting air at 150 psi to the passage. If at this time the car doors remain closed (slow leveling cycle), the air passes through the restricted orifice to the appropriate air spring or springs. Similarly, if the car is too high, the plunger moves downward away from the seal disc and exhausts air from the spring via the orifice and passage and then through the vertical hole in the middle of the plunger to the atmosphere.

The fast leveling fill and exhaust cycles differ from the slow cycles only in that air flows around the circumference of the nylon piston instead of through the orifice. This is accomplished by high-pressure (triggering) air from the solenoid valve which opens whenever a door is opened. The triggering air depresses the plunger and unseats the nylon piston, thus opening the comparatively unrestricted circumferential bypass around the latter.

An interesting feature of the valve is that the orifice, although severely restricted, is not actually very small in diameter. A fine wire passing through the orifice greatly reduces its effective area, and at the same time acts as a cleansing means. Another feature is the small amount of lever movement required to bring about leveling—the valve has a very narrow "null" band. The entire mechanism is compact, simple, and durable.

The heart of any suspension system is its springs; they are probably the most important of all the factors which influence a vehicle's ride and, to a lesser degree, its handling. The Edsel air springs were chosen and developed in line with a major design objective: to take advantage of the ride potential of ultra-soft springing without sacrificing good handling qualities.

The air-spring design, which can be described as a girdled rubber cell with a variable area piston, was selected for two reasons. It requires minimum air volume and installation space to provide exceedingly low rates in the normal ride range, and it permits maximum flexibility in attaining any desired rate pattern.

The production front and rear air spring units consist of four basic parts: the rubber air cell, the retainer band or girdle, the piston or pedestal, and the upper seat. In addition, the rear units include clamps at both upper and lower seals to prevent unseating if the shock absorbers are removed or disconnected while the car is on a hoist.

It is evident that as the piston travels up and down within the cell, its effective area varies considerably. The character of this area variation depends primarily upon the shape of the piston. Since area is a factor in the rate equation, the shape of load-deflection and rate curves can be controlled by piston design. This can be seen on a typical static load-deflection curve having the characteristic pattern which was sought and achieved; also, a corresponding dynamic load-deflection curve for the same spring, obtained electronically at approximately sprung mass resonant frequency. A comparison shows that static and dynamic curves bear a strong general resemblance to each other, but dynamic rates in the neutral ride range are very much higher than static rates. In a vehicle, the dynamic wheel rate may be 4 or 5 times the static wheel rate.

This points out one of the major pitfalls to be avoided in the development of low-volume air springs. In an effort to minimize dynamic rates, it is all too easy to arrive at a suspension with a strong negative rate at normal ride height. A very mild negative rate for the spring itself may be permissible (provided the effect of suspension bushings or other spring elements cumulates in a positive overall suspension rate) but a negative wheel rate is not tolerable. Among other antics which it performs, a vehicle with a negative wheel rate is likely to cycle slowly between full-jounce and full-rebound while standing at the curb.

In the Edsel cars, dynamic rates in normal ride are sufficiently low to provide bounce and pitch frequencies in the neighborhood of 50 and 55 cpm, respectively. This, of course, is a major factor in the attainment of luxurious riding qualities. Static wheel rates are sufficiently positive to provide good stability at the curb, in approaching and emerging from curves, in braking, in accelerating, and other maneuvers. The smooth but strong rate buildup characteristics in both jounce and rebound, combined with automatic leveling, allow maximum utilization of the space available for suspension travel and result in excellent rough-road behavior. In addition, the rate buildup contributes toward good cornering and general handling.

Over and above the springing, first-class suspension geometry is requisite to good handling. In adapting air springs to the Edsel cars, it was possible to retain the standard coil spring front suspension geometrically intact. It was only necessary to move the shock absorbers aft of the control arms. But, of course, a different rear suspension was required and finally adopted. It is a trailing arm type with several rather unusual features. One is the forward attachment of the trailing arm to the frame; instead of the usual transversely mounted rubber journal bushing, it uses a large spike-end rubber mount similar to those often found in shock absorber ends. This particular design serves several purposes. It almost eliminates torsional loading in the trailing arm. It permits rather large axial, but only small radial deflections; this contributes very greatly to harshness reduction without adversely affecting rear end steering.

The trailing arm rear mounting is also interesting; each arm is attached to the axle by means of a pair of transverse rubber bushings whose axes are spaced some 5 in. apart. This arrangement gives effective isolation yet it ties the axle and trailing arms together in such a way that they constitute a roll stabilizing unit, with the axle housing acting as the torsion member. A considerable amount of rear end roll resistance is obtained in this manner.

Because of frame differences, the Corsair and Citation rear end geometry varies slightly from that of Ranger and Pacer models; in the former, the trailing arms run almost straight fore-and-aft; in the latter, the forward pivots of the trailing arms are somewhat further inboard. This reduces the twisting effect on the rear axle housing during roll; consequently, the Ranger and Pacer cars require rear roll resistance, which is provided by the restrictor valve mentioned previously. Normally, with a single rear leveling valve, the two rear springs are interconnected by a common air supply line; during roll, unrestricted air transfer takes place between them and they contribute no roll resistance. However, since Ranger and Pacer cars incorporate restriction in the supply line to the right rear spring, airflow between the two springs is severely inhibited in normal running with the doors closed, so that the individual springs act to increase roll resistance.

Combined with the geometrically conventional front end, the Edsel rear air suspension provides very satisfactory cornering and general handling qualities. There is, of course, a transient "feel" which differs slightly but not objectionably from that of Hotchkiss drive vehicles; driver consciousness of it quickly disappears.

Braking

Full braking reserve is very important, especially with today's high-speed vehicles. The automatic brake adjuster, designed for this Duo-Servo brake assembly, maintains approximately 0.010-in. clearance at all times by adjusting the brakes whenever lining wear exceeds 0.005 in. All adjustments are made on reverse braking to eliminate the possibility of overadjustment that could be caused by drum distortion on panic stops in forward braking.

The installation consists, mainly, of a control cable fastened to the anchor pin at one end, and to the adjusting lever at the other end. This cable is routed over a guide, which is attached to the shoe web, so that any shoe movement, beyond the predetermined brake adjustment, will lift the adjusting lever. When lining wear exceeds 0.005 in. the shoe movement will raise the adjusting lever until the next tooth is engaged on the adjusting sprocket. After releasing the brakes, the adjusting spring will rotate the screw resulting in the brake adjustment. (See Fig. 11).

An additional advantage of the automatic brake adjuster, aside from eliminating conventional periodic brake adjustments, is to allow the lowering of the brake pedal to a closer relation with the accelerator pedal.

Test Program

In the initial stages of planning, it was decided that as much time as possible would be allowed for testing. The actual test program had its start in the early part of 1955 when several Mercury and Lincoln automobiles were modified to incorporate contemplated Edsel components. These first test cars enabled us to answer preliminary questions regarding package, suspension geometry, and brakes.

Cars were assigned for specific test purposes and the engineers equipped them with latest design components for severe and extensive road tests throughout the country. The test trips were so numerous and the locales so widespread that our test progress boards began to resemble arrival and departure schedules of a busy bus terminal.

Test engineers assigned to brake development piled up miles on the hills and mountains in the vicinity of Jennerstown, Pa., where we have garage and test facilities. Tests were conducted on brakes and related components; master cylinders, wheel cylinders, hydraulic lines, and brake drums were checked and rechecked. Brake lining wear was measured and carefully recorded to cover thousands of durability miles.

Chassis engineers had taken their cars and were headed south on ride, handling, and evaluation trips through Kentucky, Tennessee, and Georgia. Testing procedures and techniques were combined and modified to provide data such as highway fuel and oil economy.

Air conditioning engineers headed into Florida and Texas for their phase of testing. Vero Beach may be a prominent playground but to the test engineers, it was a proving ground. Condensers, evaporators, and compressors were installed and compared.

Other crews were at work testing in various areas from Dearborn to San Francisco: carburetion, vapor lock, fuel handling, and percolation tests were conducted at Pikes Peak, our proving ground in Arizona, Death Valley, and even on San Francisco's Telegraph Hill. The induction engineers tested until they were certain the carburetor that functioned so beautifully on the plains of Kansas served equally as well on Pikes Peak. In many areas, main highways were bypassed and the rough, deep-rutted, cross-country trails were used to get frame durability data.

Inclement weather was no deterrent to our program; in fact, it was made a part of the program. Test cars were driven up into the severe cold of northern Michigan and Minnesota where cold starting, automatic choke, and heater evaluation tests were conducted in sub-zero weather. Heaters were called upon to thaw out semifrozen engineers in -30 F weather.

The Edsel test program was one of the most extensive conducted; well over a million and a half test miles have been driven. Tests at the Dearborn Test Area alone accounted for 779,000 of those miles. The Dearborn test area is our 360-acre backyard with 14 miles of road, including multisurface roads, high-speed track, and a test hill with 17 and 30% grades. Having these facilities so close at hand was a tremendous asset in our development tests. Many times preliminary test data was made available in a day or two. The conference room—where the decision to try a component was made; the machine shop—where the component was fabricated; the garage—where the component was installed; and the test track—where the preliminary tests were conducted—were conveniently located in one compact area. 480,200 test miles were driven at our 3880-acre Michigan proving ground, where we have 30 miles of test roads, hills with grades varying from 7 to 60%, and one of the finest high-speed tracks in the country.

The first Edsel frames were tested at our Arizona proving ground, where the test vehicles were driven over the rough terrain, through dried out river beds, over desert trails, and across arroyos testing frame welds and body mounts. The continuous +90 F temperatures also made this an ideal place to conduct engine cooling and other tests requiring high ambient air temperatures. Tests conducted at this proving ground accounted for an additional 265,800 test miles.

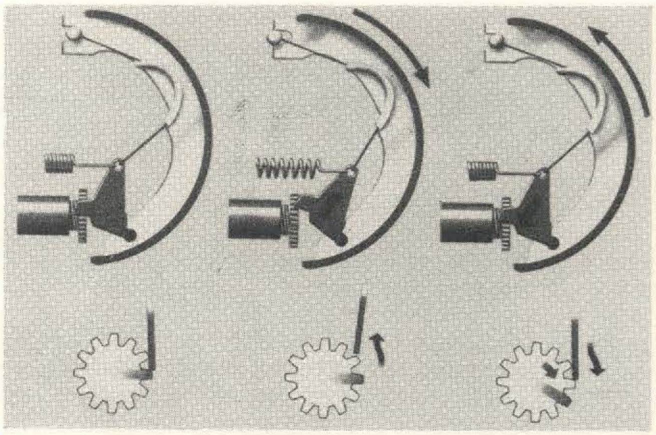

Fig. 11—Automatic brake adjuster operation