

*An*  
**ENGINEERING  
DISCUSSION**

*by*

**COL. J. G. VINCENT**

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## INTRODUCTION

Of course, every Packard salesman has read Mr. Macauley's letter to Packard stockholders, in which he says:

*"The Packard Six has been on the market four years, during which time it has been so far refined and perfected that we believe the appearance and fundamentals of the car will be unchanged for a considerable time; that is to say, the car has been standardized. And while doubtless we shall from time to time make minor and detail improvements, we do not anticipate any necessity for substantial structural changes for a long time to come . . . ."*

While Mr. Macauley had no occasion to make mention of the Packard Eight in his letter, the statements concerning the Six apply equally to the Eight except, of course, as to the years the Eight has been on the market. It would take something more than an engineering prophet to look forward into the future and then design a car upon which it would never be necessary to make any changes. You men who have been with the company over a period of years recognize in the Packard Six of today the original Packard Six with certain changes, principally refinements and additions that have been made.

First came the demand for a Six of larger capacity which called for longer wheelbase lengths and, of course, additional power. Then public opinion suddenly crystallized into a four-wheel brake demand, occasioned no doubt by generally larger motor car production with resulting crowded traffic conditions. Packard, as you all know, recognized this at once, and was the first American maker of prominence to announce four wheel brakes as standard upon its cars. Today, we find the public insistent upon the comfort and other advantages of low pressure tires.

Such tires necessitate a steering mechanism entirely different from that which has been satisfactory for high pressure tire use. Packard, we believe, is the first to have solved the steering problems incident to the use of low pressure tires. So sure are we of this, that we have adopted low pressure tires as standard equipment on both the Six and the Eight. You and your prospective customers will be interested in the chapter which follows, covering the problems of correct steering.

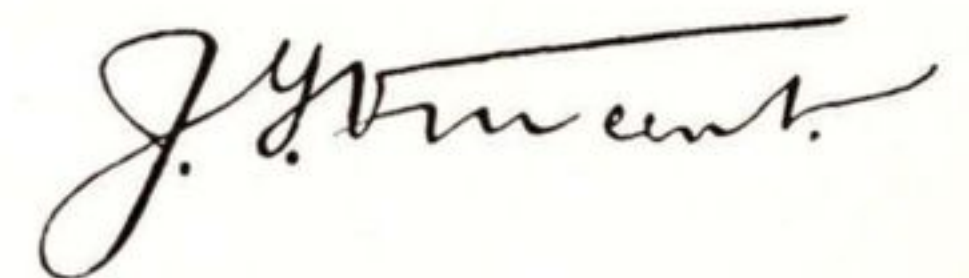
Having designed well, built well and offered its cars on the sound basis of long life, it has remained for Packard to make it easier for the owner to get this long life out of his car. Simple as lubrication problems may look to the uninitiated, it has taken years of study to evolve the combination now found on Packard cars—the chassis pressure lubricator and the motor oil rectifier. These absolutely remove the drudgery and uncertainty from motor car lubrication. Virtually, the lazy owner, the procrastinating owner, or the all-too-busy owner, now is protected against his own indifference to giving lubrication its proper attention.

Two principal factors have made necessary the solving of lubrication problems. First, in the early days motor fuel was so good that crank case dilution was unheard of. Second, those were also the days when the motor car was a novelty and the owner took pleasure in spending almost unlimited time caring for his car. Today, things are different. Fuel is not nearly so volatile. And the owner, long since recognizing his car as something more than a novelty—a vital part of the average man's equipment for everyday life, both business and social—seldom takes pleasure in the routine care of his car. All too often, he finds it even a hardship to give it up for attention at the hands of someone else.

Then another thing: we are about to welcome into the Packard family thousands and thousands of men and women who have never had any previous experience with the better class of cars. They have followed the expensive habit of buying a lower-priced car every year or two, turning it in on new models designed to catch their attention. They have in many cases paid little or no attention to the lubrication of their cars because of the thought that they would not be keeping them very long. While it will be a part of every Packard man's duty to see that such owners appreciate the value of lubrication, the chassis pressure lubricator and oil rectifier have to a great extent lessened the work which must be done.

Please let us remember that nothing of a mechanical nature can ever rebuild itself from within. Not a single one-thousandth of an inch can be added, by itself, to a worn spring bolt. In the life of an automobile nothing is more true than the old saying of "an ounce of prevention is worth a pound of cure," and "a stitch in time saves nine." Therefore, we believe that in offering the combination of chassis lubricator and oil rectifier, Packard has taken a step far, far in advance of anything now found upon other cars.

Let me emphasize that neither the lubricator nor rectifier are mere attachments. Both have been thoroughly engineered into the Packard motor and chassis and are found, either singly or in combination as they are on Packard, on no other car. In conclusion, may I ask that you read, and then study over and over again, the following short chapters in which I have tried to give you a complete understanding of the things we have done to make Packard cars even better cars.



CHAPTER I  
LUBRICATING FORTY-FIVE POINTS  
IN ONE SECOND

**T**HERE is an old, natural law which engineers regard with the same deep respect with which the American Indian worshipped the rising sun. This immutable law is that any metallic surface rubbing on another metallic surface must be lubricated if wear and tear of the surface is to be avoided or deferred over a long period of time.

Most of us would not neglect intentionally to see that the engine is well supplied with oil, for we would be certain of a damaged engine, possibly an expensive tow to a service station and a liberal repair bill to return the car into service. We would, of course, not neglect to lubricate the engine, no matter how inconvenient or disagreeable the process, because we would be so sure of the consequences.

The chassis parts should receive the same careful attention. How often is a broken chassis-spring credited to a rusted spring-bolt or shackle; how often have faulty brakes and accidents been the result of a seized brake-shaft; faulty steering and ditched cars due to dry steering-system joints? Troubles such as these are by no means rare, although seldom traced to their source.

But we are sure of rapid depreciation of the chassis when lubrication is neglected or inefficient; squeaks, rattles, hard riding and possibility of broken springs or spring bolts result.

Engineers always have appreciated the importance of lubricating the chassis parts and always have provided means for doing so, adequate always *if* attended with painstaking regularity and care, but often disregarded by the occupied business or professional owner.

Much of this neglect of chassis lubrication is not wilful neglect but rather the result of a duty put off from time to time for more urgent matters of business or professional importance. Even the so-called high-pressure lubricating systems that may require but a short time for each service do not avail against procrastination. The business or professional man who drives his car has little time and inclination to bother with such details and usually depends upon the service station for such work. But under the pressing matters of every-day life, when the thought does strike that "my car needs greasing but I'm too busy now—I'll just let it go until tonight," he simply puts off the job, waiting until the thought occurs again, and usually with similar results the next time.

Contrast with this, the Packard chassis lubricating system. A business man on a hurry call traveling along at high speed, perhaps, reflects "my car needs oiling," and he reaches forward and lightly pulls a plunger knob. The job is done, all the forty-five friction points in the chassis are oiled for another hundred miles!

What could be easier, more convenient and require so little time yet be fully dependable, infinitely more so than other ways? Packard engineers have long considered this very question. Convenience, simplicity and dependability were demanded; and here, as always, simplicity and dependability go hand-in-hand.

The Packard chassis lubricating system is composed practically of no moving parts. It has a central tank under the hood which holds about five pints of oil. A simple spring-operated plunger feeds the oil to the distributing lines and thence to the points where lubrication is required. The action of the device is ex-

tremely simple. To lubricate the chassis, the action of pulling the plunger knob against pressure of the spring fills the oil pump cylinder with oil which is forced into the distributing system by the spring-operated plunger, when the knob is released. To give some idea of what is accomplished by this single operation, all the points which are lubricated are listed.

<i>Name of Part Lubricated</i>	<i>No. of Points</i>
Front axle brake equalizer lever shaft.....	4
Front axle brake operating shaft.....	8
Front spring bolts.....	6
Hand brake intermediate lever shaft.....	2
Hand brake operating shaft.....	4
Hand brake lever shaft.....	1
Rear axle brake equalizer lever shaft.....	3
Rear axle brake operating shaft.....	4
Rear axle spring bolts.....	6
Rear axle torque arm rear end.....	2
Steering connecting rod ball joint.....	2
Steering sector shaft.....	1
Steering cross tube ball joint.....	2
Total.....	45

That is to say, a total of 45 points are completely and effectively lubricated in one second—far less than the time needed to tell about it. Such an important addition will have its strongest appeal to the lovers of what is fine in transportation. Absence of squeaks and rattles, stability of riding comfort, assurance of safety, easy handling of a car and absence of insidious and costly depreciation are assured. Packard engineers long have realized this and always have labored to

make lubricating the car as easy of accomplishment as possible. This improvement is epoch-making. The daintiest lady in white kid gloves can do it all easily and have no stain on her gloves to show for it. Both Packard Six and Eight have this wonderful feature.

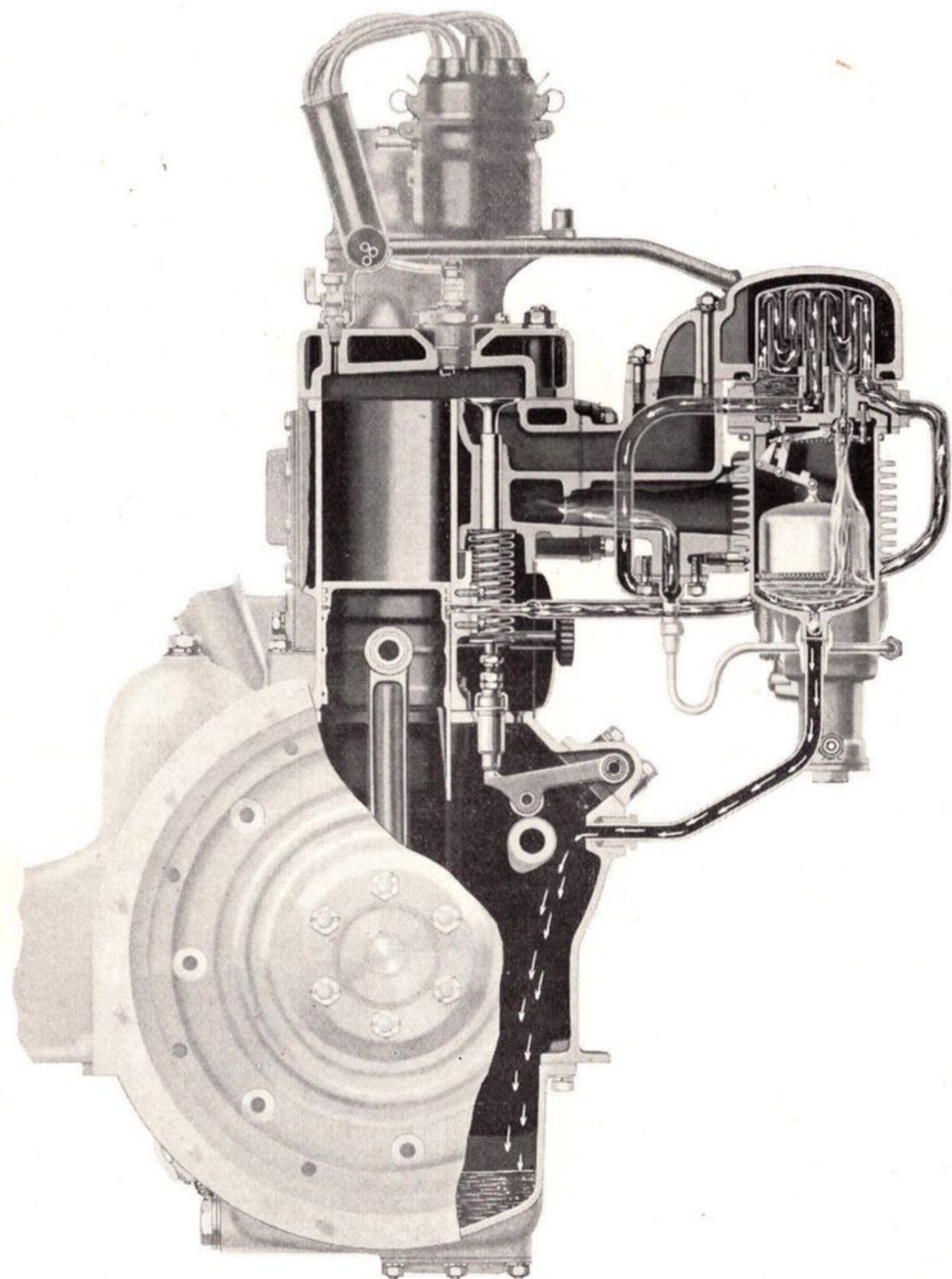
## CHAPTER II

### THE PACKARD MOTORS

**T**HE volatility of gasoline gradually has been getting worse, and while it is true that this condition has been forced to some extent by competition among oil refiners, it is, for the most part, the result of a national endeavor to utilize petroleum resources with the least possible waste. Although the motor-ing-public as a whole and the automotive industry itself have been benefitted greatly by low gasoline prices, the car-owner feels a certain justification in complaining about some of the difficulties of motor operation which have been brought about by the changing fuel. Such things as hard starting, poor gasoline economy, crankcase oil dilution, premature wear of the engine parts, along with increased expense and general irritation are common experiences to all motorists.

At first, difficulties of carburetion and distribution presented a problem which was in itself a big one and not only was its solution imperative, but exceedingly difficult, for no sooner was the industry adapted to the use of one grade of fuel than the volatility again decreased, often making it necessary to start all over again. Carburetion obviously was the major problem, for the motorist demanded that his car run smoothly and pull well, even if to attain these qualities required more frequent attention or involved more rapid cylinder wear. And since carburetion was the major problem, Packard concentrated all efforts upon it until recently, when we developed a most satisfactory solution in the "fuelizer."

But premature wear, the result of contamination of the engine oil with gasoline, is not so much a detriment to actual power development of the engine as it is to



THE OIL RECTIFIER

quiet and long-continued smooth-running operation which, because of the present high standards of educa-

tion and taste among discriminating motorists, is demanded more and more. Accordingly, Packard engineers have devoted themselves to a painstaking study and to a thorough examination of all methods for eliminating this contamination evil.

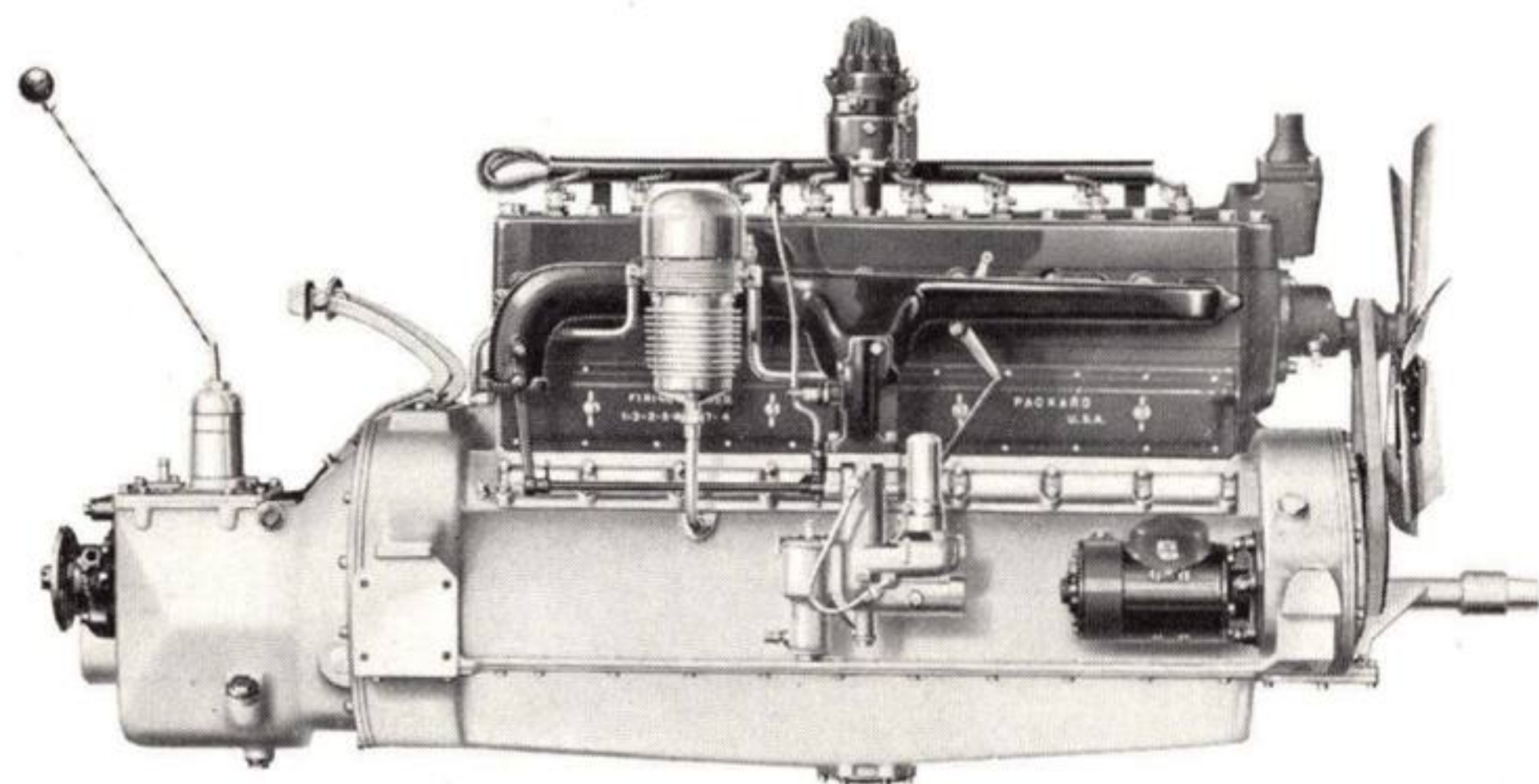
The aluminum oil-rectifier which has been incorporated in Packard motors consists of a retort heated by exhaust gases. The general arrangement of the rectifier is clearly shown in the view on page 14, the intake to the rectifier from the cylinders being attached to the right hand side of the retort; the outlet to the manifold is on the left hand side; and the outlet to the crankcase is connected to the bottom of the rectifier chamber. The intake to the rectifier extends to a point on the cylinder walls where it registers with a slot in the piston, running as high as the third ring from the top. Constant suction therefore is present at this point. Unburned fuel, water vapor and sulphuric acid formed during combustion, which start to pass the pistons, are drawn into the retort by the suction. Lubricating oil that starts to pass up from the crankcase into the combustion chamber likewise is trapped and drawn off.

This mixture after reaching the retort is subjected to sufficient heat to distil it. Unburned fuel, water and sulphuric acid, as vapor, then passes back into the intake manifold to be burned in the cylinders. Vaporization is assisted by the partial vacuum in the retort. The lubricating oil is too heavy to vaporize at the heat present and hence accumulates in the lower part of the retort until it reaches a level high enough for it to trip a float and it then pours back into the crankcase.

The use of the rectifier maintains the body of the oil at sufficient viscosity to prevent bearings burning out.

It lengthens many times the interval after which it is advisable to drain the crankcase, consumes fuel that otherwise would be wasted, and prevents oil pumping, thereby increasing oil mileage materially.

Results of exhaustive tests indicate it is perfectly safe to state that the oil rectifier, as developed and built into Packard motors, accomplishes one of the most important advances ever made in motor operation. This is because it has three very distinct advantages:



VALVE SIDE OF MOTOR

Note the oil rectifier contained in the neat aluminum casting attached at the rear end of the exhaust pipe. The piping in connection with this device is simple and direct and the unit is placed sufficiently high so as not to interfere with the accessibility of the valve compartment or other important parts of the engine.

First, it materially increases oil mileage; second, by keeping the motor oil in practically new viscous condition, it gives a very material increase to the life of parts of the motor, such as pistons, cylinders, wrist pins, connecting rods and crankshaft bearings, insuring continual smooth, powerful operation; and third, by removing the water and resulting sulphuric acid

from the crankcase, it eliminates the corrosion and etching of parts inside of the motor. But such precautions are not sufficient in themselves to insure quiet, smooth, powerful operation unless the design is fundamentally correct and developed to the highest possible degree.

**Counterbalanced Crankshafts.** In order to maintain smooth motor operation throughout the useful life of a car it is necessary, of course, that the design be fundamentally and inherently correct in the first place. It is common knowledge that Packard has been foremost in bringing about new standards of freedom from vibration. Most motor-wise folk will still remember the furore brought about by Packard's accomplishment along these lines in the famous Twin-Six, a result so smooth in comparison with anything else then available as to deserve to be called revolutionary. There was, of course, no question but that given adequate time Packard could still further improve on its own efforts. The Packard Six and Packard Eight each represent an important step in advance in this direction. Now, however, even these advances have been overshadowed by the reward of unflagging, persevering engineering effort concentrated on a single objective, namely, to retain Packard's



THE NEW COUNTERBALANCED CRANKSHAFT FOR THE PACKARD EIGHT

Notice the two counterweights next to the center bearing and the two at the ends of the crankshaft. The Packard Six crankshaft is similarly counterbalanced.

supremacy among the world's finest motor cars.

In Packard cars a seemingly effortless application of power has been achieved by two important improvements; first, a new system of crankshaft balancing; and second, detailed revisions in the valve gear operating mechanism. There have been broadcasted of late so many and varied claims on different methods of crankshaft balance as would lead to an interminable discussion if each of these were reviewed in detail. The subject is of an extremely complex nature and it is believed that the matter can be disposed of in a far more convincing manner by a demonstration of either the Packard Six or Eight operating over the entire range of speed from the lowest to the highest, with a remarkable degree of smoothness.

*Valving.* Coming now to a description of the improvements in the valve gear, it may be first stated that one of the most annoying elements in motor operation arises from noisy valves or tappets; and of all mechanical elements which constitute an automobile the valve gear is a mechanism requiring not only extreme refinement of detail but careful, accurate workmanship in the manufacture of the component parts. Consider a small mass moving in a twenty-thousandth part of a second through a distance of only one one-hundredth of an inch, or at a velocity of 50 miles an hour. Conceive, then, of a small body striking another body traveling at the rate of 50 miles an hour. Conceive, if you can, the disturbance of such an impact, and then realize this is actually what happens in a motor each time the valve rocker arm is lifted and strikes the tappet. In the first place, the camshaft itself is subjected to large forces during the opening of the valve, particularly the exhaust valves, which are

backed up by a considerable pressure in the cylinder. These forces tend to deflect the camshaft out of its normal position and if the shaft is not sufficiently rigid or is not adequately supported by bearings, this deflection may be serious.

In Packard cars the camshafts have been made larger and at the same time more bearings have been provided to support it, resulting in an enormous increase in the rigidity of the mechanism.

In addition, other improvements have been made in the valve mechanism. The rocker lever, the design of which has been a distinctive feature of Packard motors for a number of years, and which has the important function of relieving the tappet of side-slap, has been improved so as to make the valve action more nearly perfect. This rocker lever is provided with a generous size roller which is placed almost directly under the tappet contact. It permits the lifting action of the cam to be more directly transmitted to the tappet and relieves the rocker lever of powerful bending stresses further increasing the rigidity of the valve mechanism. The shape of the cam itself has been subjected to a very careful study and analysis and this highly important part has been given a form which more nearly approaches the ideal movement in its action than was heretofore thought possible. The shape of the cam, particularly at that portion which takes up the clearance between the tappet, is now made so that the rocker lever is brought in contact with the tappet at the slowest possible velocity and hence, when contact does take place, the lift is smooth and free from appreciable shock.

The size of the cam and the cam roller have also come in for much consideration. With the use of

large cams and cam rollers, the non-lifting forces in the cam action are reduced, thus subjecting the entire valve gear to less work than previously.

All of these things promote to a remarkable degree smooth, quiet operation of the valves; first, because of the great rigidity of the mechanism which reduces shock from deflection of the parts; second, the rocker design which promotes more direct lifting of the valve; third, the large cam and the use of the cam roller which reduces the forces on the valve gear, reduces the loads on the bearings and other valve gear parts; fourth, the cam design which promotes smoother action when taking up the clearance.

When the Packard Eight was brought out about two years ago, many an automobile critic expressed the view that a new standard in motor-car transportation had been established. The Packard Eight in many respects even surpassed the optimistic hopes of Packard engineers and manufacturing executives. This result had been accomplished primarily through the achievement reached in the design of the Packard Six, which has been imitated in appearance by others with a boldness unashamed. As our experience has widened, we have made progress in the science of building automobiles and just as the Packard Six proved advanced ideas in engineering, the Packard Eight has established them on a yet firmer foundation.

To bring the performance of the Packard Six more nearly in keeping with the performance of the Packard Eight, the Six motor has been enlarged, the bore having been increased from  $3\frac{3}{8}$  inches to  $3\frac{1}{2}$  inches. At the same time, to maintain or even to improve on the already velvety smoothness of the Six, the dimensions of the crankshaft have been increased. In the Six

motor the main crankshaft journals are  $2\frac{3}{8}$  inches in diameter and the crank-pin journals are  $2\frac{1}{8}$  inches. The direct effect is such a completely smooth performance as to make it stand practically alone. The combination of seven main bearings with a perfectly balanced crankshaft of these proportions is translated into a human experience at once pleasing and sufficient—complete lack of motor vibration.

Packard's time-honored policy of definitely proving out refinements well in advance of production was never more thoroughly demonstrated. Ten cars, five of each type, were equipped with the proposed improvements, and each of these cars was subjected to a different kind of extreme driving condition. Some were maintained in typical city and suburban service. Others were driven cross-country at high speed. Two cars were driven wide open for long periods on the Indianapolis Speedway and finally, one of each of the cars was given a 25,000 mile road test of a special character developed through years of testing experience. A condensed summary of these tests is given below.

SUMMARY OF 25,000 MILE TESTS OF SIX AND EIGHT CYLINDER CARS

	<i>Six Cyl.</i>	<i>Eight Cyl.</i>
Distance traveled—miles.....	25,000	25,000
No. of hours on road.....	836	806
Average speed (M. P. H).....	29.9	31
Gasoline consumption—gallons.....	1692	2279.5
Gasoline—miles per gallon.....	14.8	10.95
Oil consumption—gallons.....	14.8	15.5
Oil—miles per gallon.....	1688	1610
Crankcase dilution at end of run—percent.....	3.5	2.0

Major repairs during run.....	None	None
Man hours required to put cars in perfect operating condition at end of 25,000 mile run.....	7	9

**Notes:**

Crankcase oil was not changed during entire test.

Entire 25,000 miles was completed on one set of five tires for each car and at end of test the tires were all in good condition.

These tests consisted of a continuous day and night run with picked crews over routes selected to give every conceivable kind of driving conditions. This included stretches of famous Michigan concrete roads where continuous high speed is permissible; unimproved roads of the worst character where the lugging ability of the car is tested to the utmost; steep grades and sharp curves subjecting brakes and steering gear to strains rarely met in average service; and finally, the narrow winding, sandy trails through the dense forests of Northern Michigan. A careful daily record was kept covering every conceivable angle of the car operation and these reports were amplified by large graphical charts posted in the Chief Engineer's office. In six weeks to a day, each of these 25,000 mile test trips was completed! Forty times as much mileage as the average user would cover in the same time, or, expressed another way, three years of average service compressed into six weeks—that is one of Packard's methods of safeguarding the buyer of a Packard car!

CHAPTER III  
UNIVERSAL JOINTS

**I**N order to carry out further the Packard ideal of enduring service, both the Packard Eight and the Packard Six are equipped with improved universal joints. The universal joints perform that highly important function of transmitting power to the rear axle in such a way that every movement of the axle is accommodated as the car moves over the irregularities of the road. As the universal joint is composed of mechanical elements which move relatively to one another, lubrication is highly essential. If through neglect or through accident these joints are not adequately lubricated, the surfaces wear excessively out of shape, or the wearing surfaces become serrated with deep scratches. When this happens, the mechanical action is no longer smooth and even, but instead jerky and rough. Often this imperfect action sets up vibrations which are transmitted either to the rear axle or forward to the transmission. These vibrations often cause disagreeable axle or transmission noises and sometimes have detrimental effects more severe. Fortunately enough, this seldom happens in Packard cars, but Packard engineers saw an opportunity to improve where it might be thought improvement is not necessary.

Therefore, Packard engineering standards decreed that the lubrication of the universal joints should receive important attention. The outcome has been the adoption of universal joints lubricated by oil instead of grease, first, because oil is the more efficient lubricant since it can pass with greater ease between the intimate working surfaces; and second, because changes in temperature do not seriously affect its lubricating efficiency.

But the very ability of oil to go through very small spaces, which makes it efficient as a lubricant, also makes it difficult to retain in a universal joint. In Packard cars the universal joint design very effectively overcomes this difficulty and turns it into an advantage. The natural forces of rotation of the universal joint shaft are made use of to retain the oil in the housing of the joint, and at the same time to aid the lubricant in doing its work.

Further improvements are the natural outcome when diligence is concentrated on effecting improvements. For instance, the new joints have somewhat larger bearing surfaces and these are more advantageously disposed, resulting in a double effect of reducing the forces acting on these bearings and hence greatly increasing the life of perfect action.

In addition, the Packard specification for carefully balancing each universal joint shaft assembly assures a unit in Packard cars which will operate perfectly for long periods without any attention on the part of the user.

## SOLVING A HARD PROBLEM IN STEERING

**T**HE problem of easy steering has been a difficult one ever since the first steering system was built, and engineers never quite had fulfilled the insistent demand for easy steering under all sorts of road conditions until the advent of the Packard Eight.

When the Packard Eight was put on the market two years ago, the motoring public was pleasantly surprised, even amazed, that such a large car could be handled so easily. In this car, for the first time, even a woman could drive through the dense traffic of a city, making continual turns to the right or left without that tired-out, nervous feeling afterward. This was accomplished by painstaking study and expensive experimentation. In this design, the innovation of complete ball-bearing mounting for the steering pivot was incorporated, so that the friction here is reduced to so small an amount as to be negligible. For the same purpose of reducing friction a special construction was devised for the ball joints on the steering arms. But a new element recently has been introduced to challenge the whole automobile industry anew on the problems of steering.

The motoring public has served notice that it wants a car which will steer with the hitherto unknown ease that came into being with the advent of the improved Packard system of steering. At the same time the public has served notice that it wants the extra riding comfort obtained with low pressure tires. But with the advent of low pressure tires there was introduced to the automobile industry an entirely new thing—"wheel wobble." The entire industry went to work on the new problem. It was found that this "wobble" of the front wheels could be somewhat nullified by

making steering gears tighter and over-inflating the low pressure tires. Packard, however, is the first with the solution that ends this wobble rather than just compromises with it, and at the same time maintains the steering ease which the motoring public, through the Packard Six and Packard Eight, learned is possible. In accomplishing this, too, Packard has recognized the demand of those who desire the added riding ease of low pressure tires and has built a steering mechanism which does not make it necessary to defeat the purpose for which low pressure tires were created. It is not necessary to compromise with "wheel-wobble" now by inflating low pressure tires to a point where they give no greater ease than high pressure tires; nor is it any longer necessary, except at extreme high speeds, to over-inflate them to make possible steering without great effort.

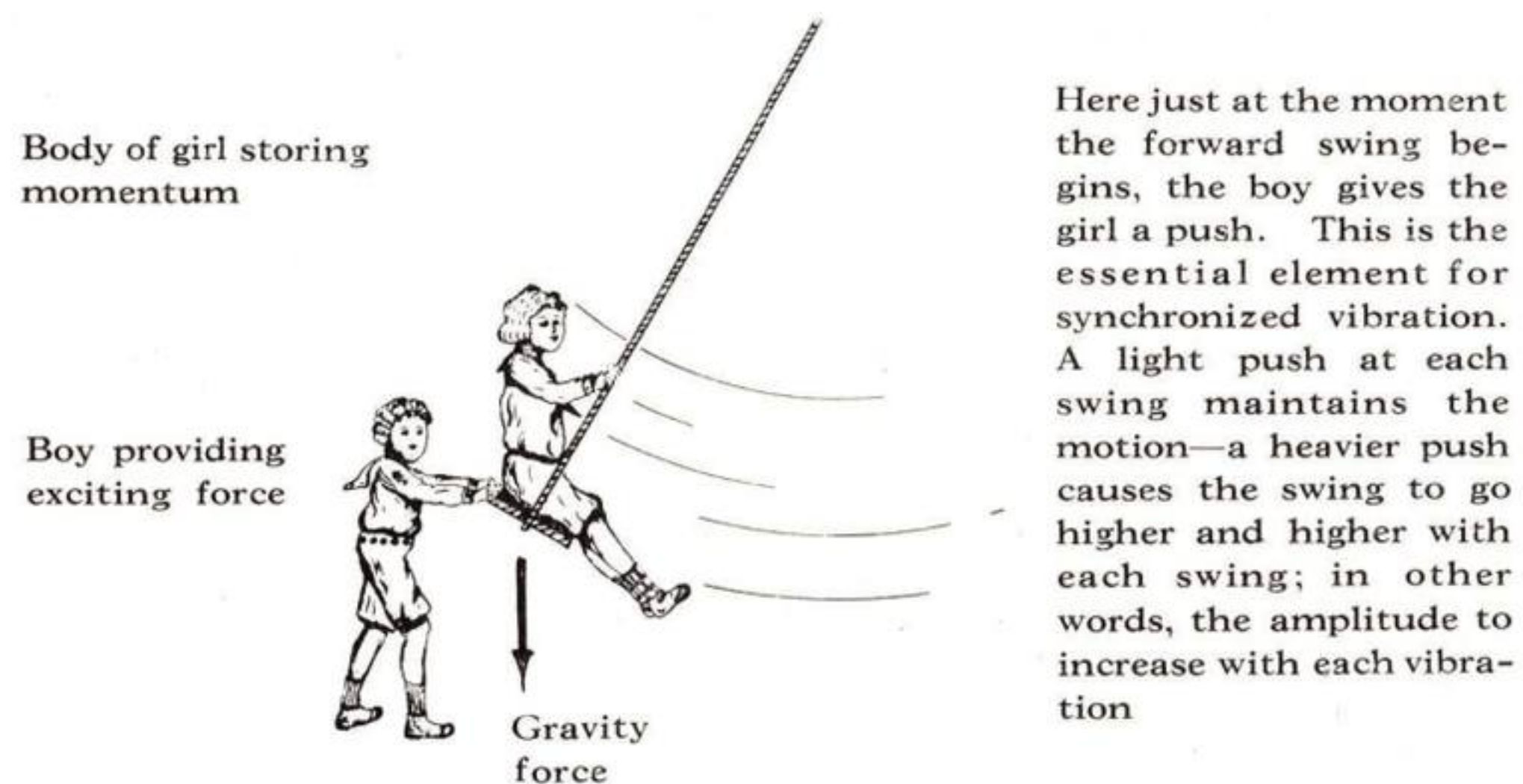
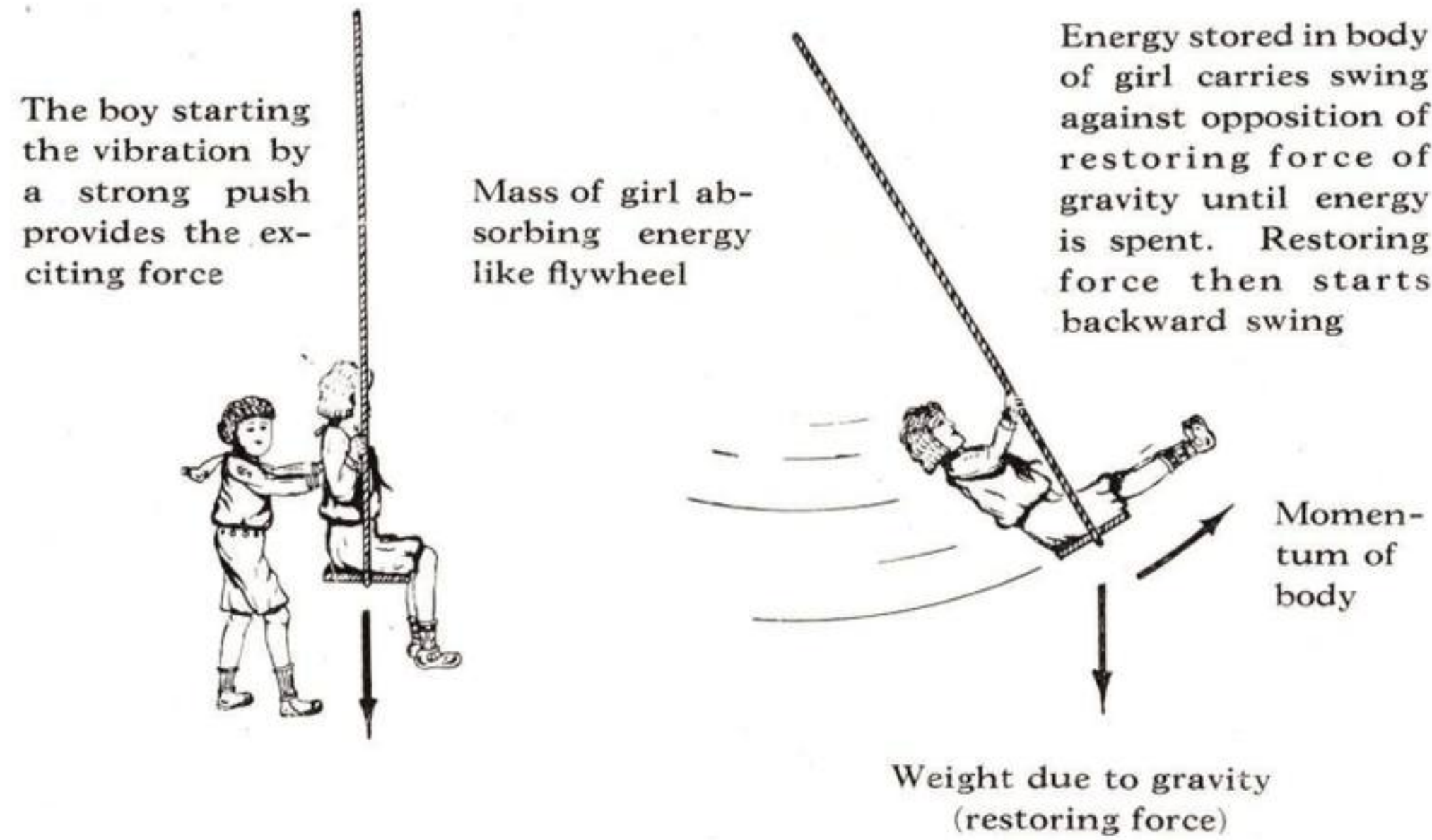
The wheel-wobble is of itself not necessarily dangerous. It may lead to dangerous consequence if the driver becomes frightened and loses control, and therefore it presents some dangerous aspects. But even if the danger were not great, a period of wheel-wobble is generally most uncomfortable for the driver and the passengers of the car. Often the maximum speed of the car is limited to the speed at which wheel-wobble becomes severe—a speed which may be less than that of which the car may otherwise be capable. For this reason, the seriousness of the problem demanded that every practicable effort be made to eliminate such an annoying, if not dangerous, condition.

So Packard engineers set out on an intensive study. For several months, cars were driven about stripped of front fenders so that the actions of the front wheels

could be studied easily. Standard cars were taken out on the road and then one element at a time was changed in order to determine its effect. At first the ball seat springs in the steering connecting rod were adjusted to different tensions. It was found that these had a considerable influence and that invariably when the tension was low, wheel-wobble occurred more easily and at lower car speeds; while with greater tension wheel-wobble was less. Other things were tried, such as changing the stabilator settings; the air pressure in the tires; balance of the front wheels and tires; steering gear ratios; different kinds of road surfaces, and a number of other factors. However, it seemed that regardless of the changes, no definite improvement could be made without defeating to some extent the real purpose of low pressure tires.

For instance, it was found that the speed at which wheel-wobble occurred was entirely independent of the kind of road surface. It seemed to occur just as easily on a new concrete road as on gravel or other surfaces. What seemed to have the greatest effect was inflation of the tires. As the tires were inflated to higher pressures, the speeds consistently went higher and higher before wheel-wobble started, until no wobble could be obtained within the driving range of the car. This seemed to be the only important clue to the solution and pointed to the possibilities of analyzing the various factors responsible.

The fact that air pressure had such an important influence and that it also controls the elasticity of the tire shows that somehow this elasticity was one of the controlling factors, if not the determining factor itself. Further study indicated that the dynamics of wheel-



wobble are exactly the same as that for any resonant vibrating system. This is more simple to understand than it sounds. A simple vibration is composed of three principal elements. First, the exciting force which causes a movement or displacement of a body, such as a push against a pendulum, causing it to swing. The second element is the restoring force which tends to bring the body back to its original position, such as the force of gravity which seeks to return the pendulum to its natural position of rest. The third element is the mass of the body which stores up energy of these forces tending to maintain the motion caused by either one of the forces mentioned. As, for instance, a pendulum given a thrust does not stop immediately when the push is relieved but keeps on going until the energy is spent.

When the exciting force is timed exactly with the restoring force, and the amount of energy in each force is practically equal, then we have a condition of resonance. A boy pumping a swing has created a resonant vibrating system and this is illustrated for the benefit of the non-technical reader in the diagrams on page 26. Conventional steering systems are subject to exactly similar vibration effects, and the exciting forces in this case might be a series of road shocks, unbalance of the tires, the peculiar action taking place between the tire and the road surface; while the restoring forces may be the action of gravity or the elastic stress in the front springs and tires and other parts of the steering system. In any case, if both of these two groups are timed together, a period of resonance occurs.

Evidently, then, the problem of eliminating or reducing wheel-wobble resolves itself into doing one of several things; for instance, if the exciting forces could

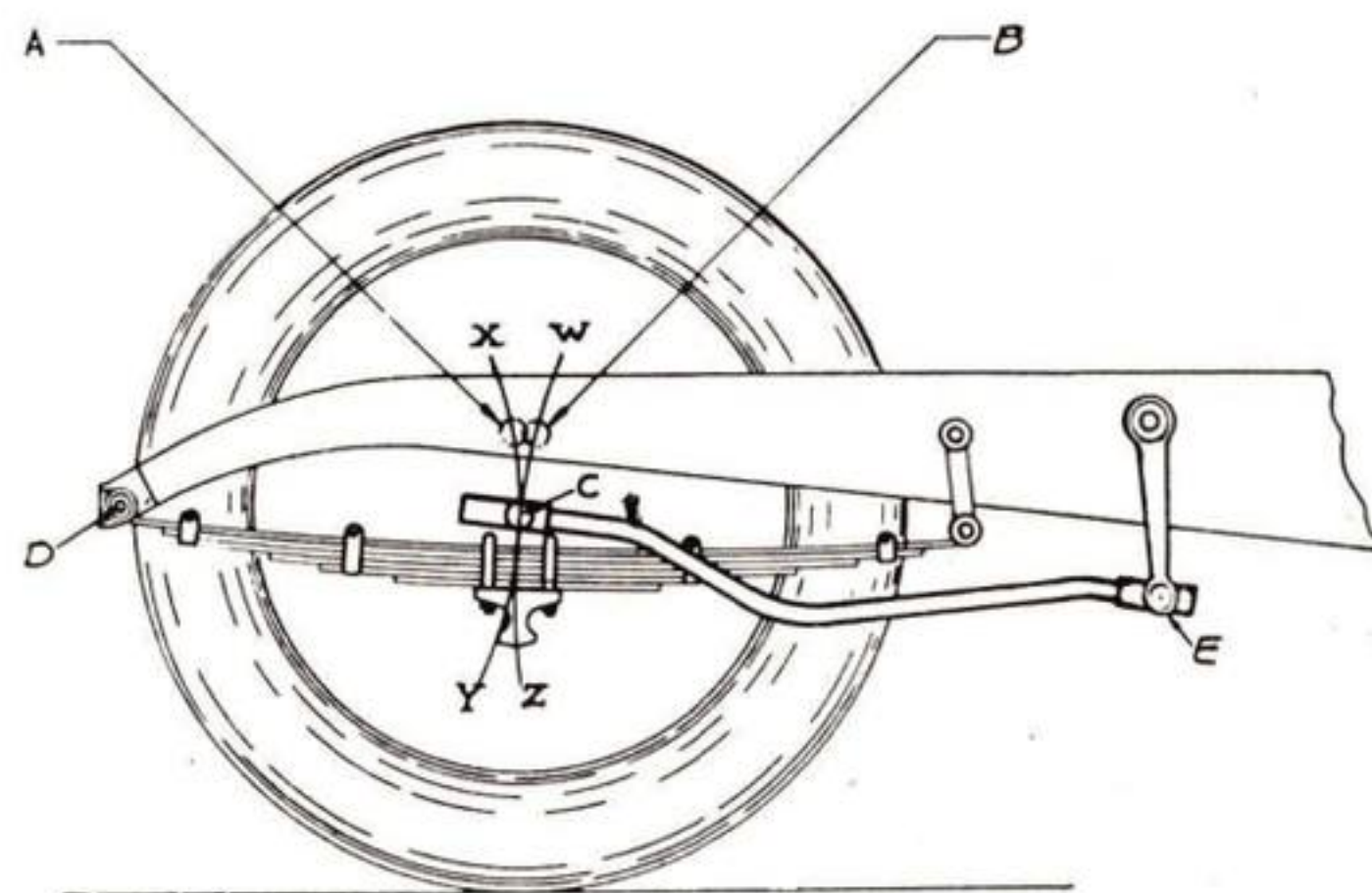


Figure 1.—Conventional front end suspension and steering—showing how the arcs X-Y and W-Z diverge, which means the same thing that if perfect steering were to obtain, the ball C would have to move on both arcs at the same time, which is, of course, physically impossible. Hence, exciting forces tend to deflect the wheel sideways whenever the front spring is flexed and cause wheel-wobble

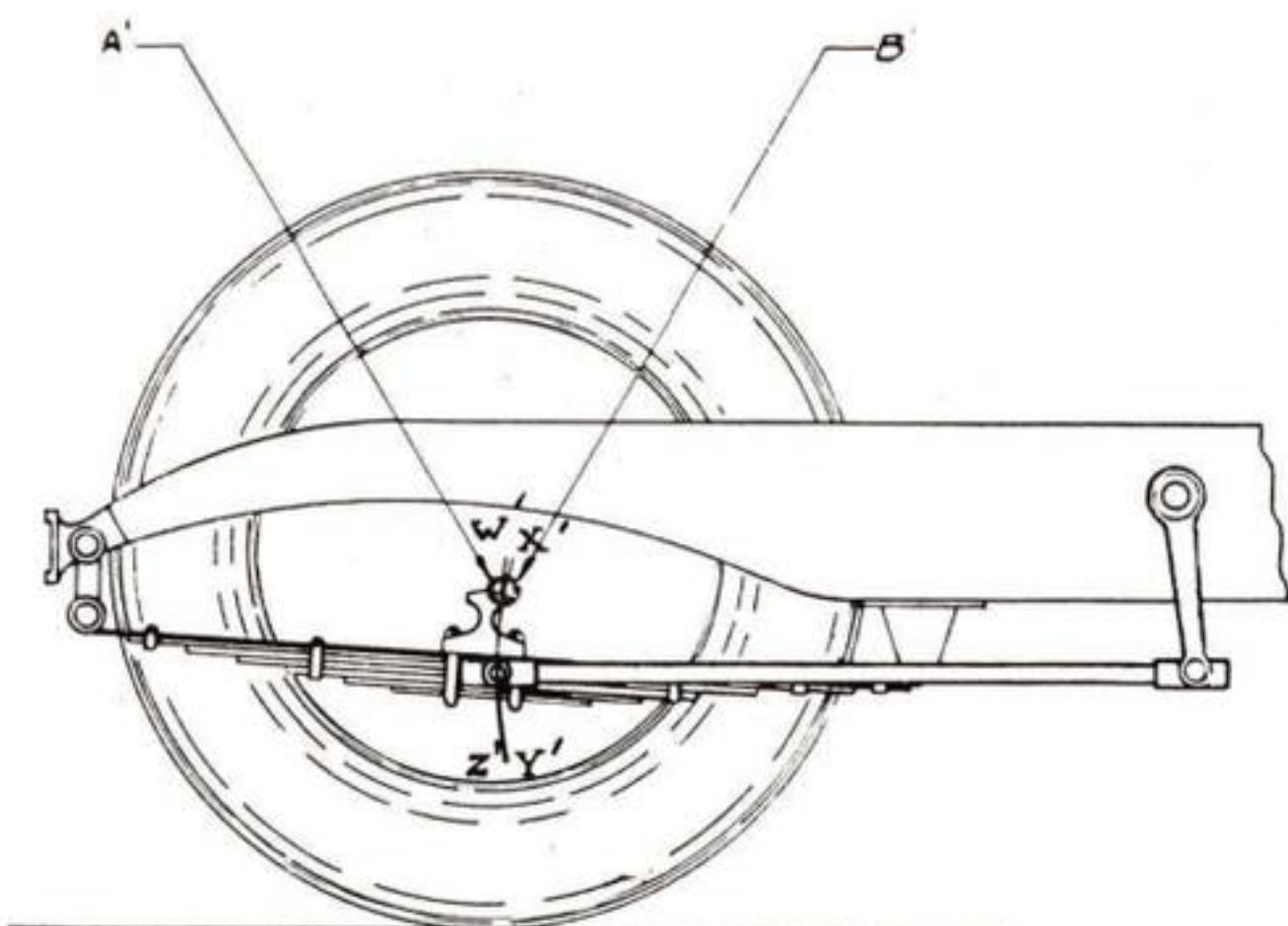


Figure 2.—Showing improved Packard underslung suspension and steering layout. Here the arcs X'-Y' and W'-Z' very nearly coincide with one another. Obviously the steering is more nearly perfect and the exciting forces causing wobble are practically eliminated

be eliminated, it is apparent that the period of resonance could not be established.

An analysis of a conventional front axle steering construction shows that an exciting force of an immense magnitude is caused by virtue of the steering geometry whenever the front wheel is displaced vertically; that is, when the wheel receives an upward shock due to some road obstruction. This may be more clearly explained by reference to figure 1 on page 30. It is seen that the front spring is hinged at the point *D* at the front end of the frame. At *C* is shown the neutral position of the steering arm ball. When the spring is deflected upward due to an upward shock, the path of this ball, if the wheels are to remain in the straight-ahead position, should be approximately a circle whose center is at *D* and the new position of the ball should be at *A*. However, the link which transmits the motion of the ball *C* from the steering gear is hinged at *E* and hence, for any given position of the steering wheel, the movement of the ball *C* can only be an arc described about the hinge point *E* and thus, for a spring deflection, as before, the actual path of the ball will be to some point *B* as determined by the movement of the connecting link. The distance from *A* to *B* then represents the movement of the ball from the straight-ahead position and hence, instead of the wheels facing straight ahead, they are turned out to the right as shown in figure 3, page 32.

The front wheels, having a considerable mass, store up energy in this movement which is arrested by the elasticity of the linkage. The outward swing of the wheel brings into play a very large force known as a gyroscopic couple arising from the flywheel action of

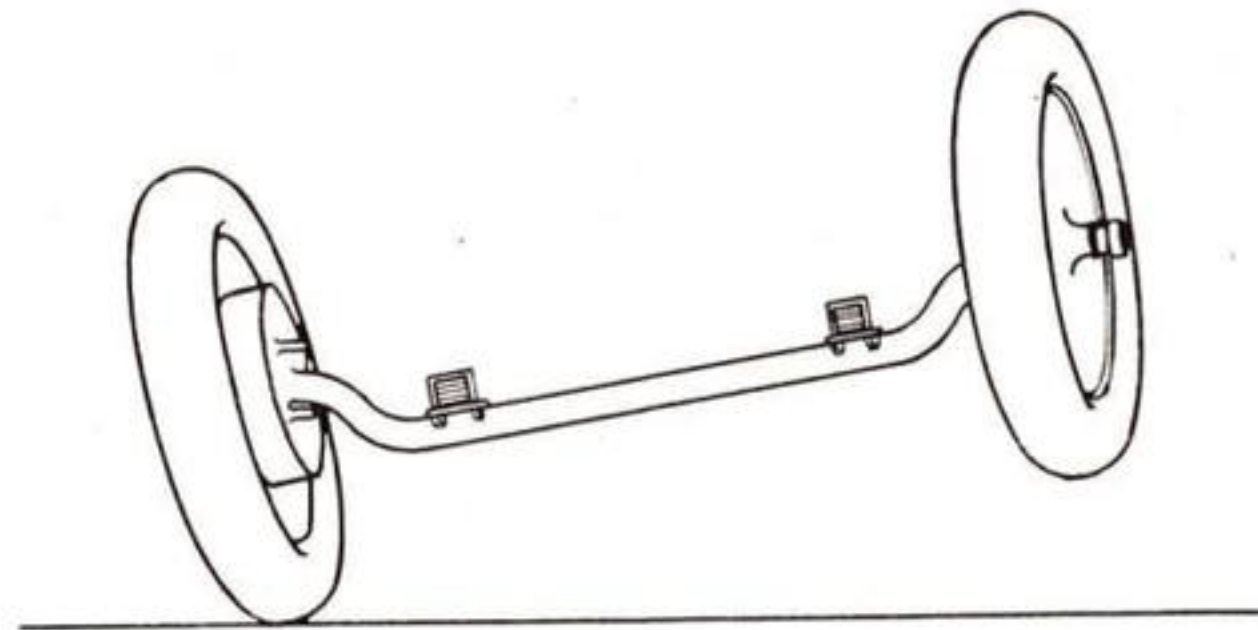


Figure 3. Showing how wheels are turned sideways when springs are deflected in conventional construction

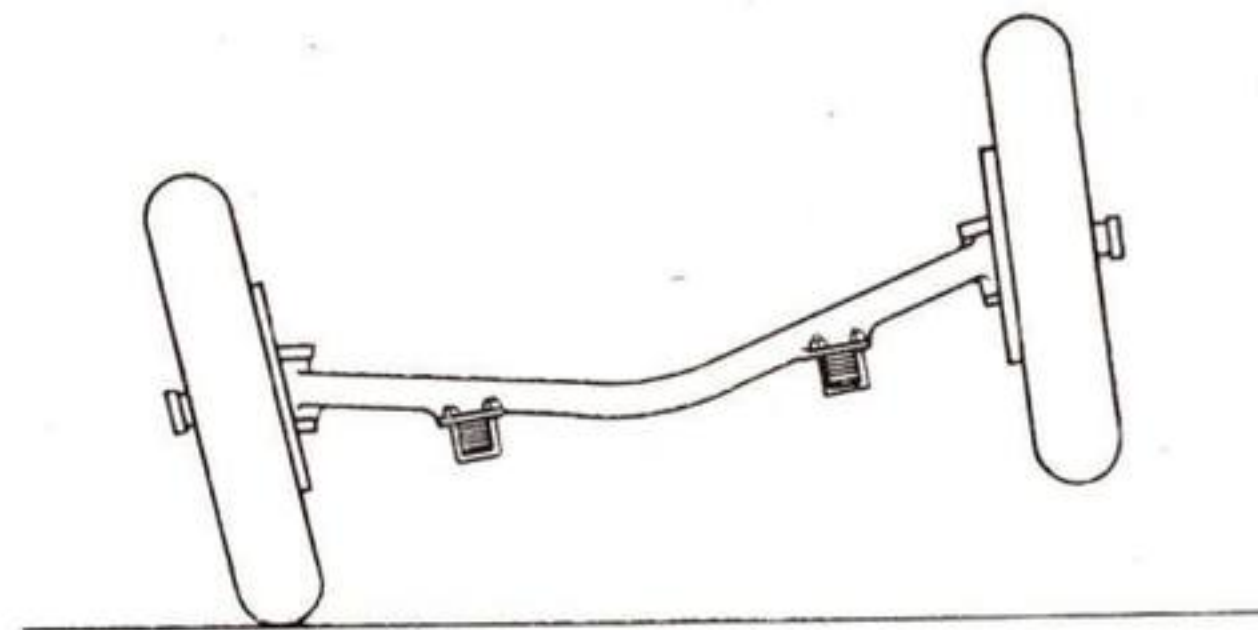


Figure 4. Showing wheels straight ahead in Packard suspension when springs are deflected

the wheel and tire. This couple tends to press one wheel down against the road and lift the opposite wheel in the air when the wheels are swinging in one direction, and reverse when the wheels swing back in the opposite direction. This action of the forces causes the front axle to teeter or rock and, acting through the springs, the frame and body are given a rocking motion in opposition to the front axle. When all these forces are timed just right with the natural vibrations of the springs and masses, the vibrations grow to great proportions—sometimes uncontrollable proportions.

Figure 2 shows clearly the construction of the advanced Packard steering system. The front spring is hinged at the rear end and shackled at the front end. The required path of the steering-arm ball is an arc struck from the rear spring eye. The connecting link, however, also pivots on the steering arm and the actual path of the ball is on an arc struck from this pivot. As seen in the diagram, these two arcs nearly coincide, the greatest departure from the proper path being the distance  $A'-B'$  which occurs only with the largest spring deflections. The principal exciting force is, by this means, reduced to the smallest possible value. It is not necessary to eliminate this force entirely because there is considerable friction between the tire and road which acts in the manner of a brake against wheel-wobble and when the exciting forces are less than this friction, wheel-wobble cannot take place.

This type of axle construction under test gave excellent results; high speeds were reached without the slightest indication of wheel-wobble, and this with standard air pressures for low pressure tires.

Other important advantages occur in this construction. With the underslung spring, the fastening of the spring to the front axle is superior to other methods, because the top leaf which takes all the braking strains is fastened directly to the axle, giving a more direct line of action for the braking forces and subjecting the other parts of the spring to a much better distribution of stresses. The braking reactions are taken through the rear end of the spring by the frame; this point takes all the braking strain off the front extensions of the frame. In addition, when the wheels receive a shock due to passing over some unevenness of the road, the steering linkage is not subjected to the great shocks sometimes transmitted right up to the driver's hands in other systems. This is an important advantage because the steering linkage and the steering gear are relieved of these high stresses, an advantage leading to less wear and eliminating adjustments.

The advantages accruing from this steering and front axle mounting may be summarized as follows: For the first time the direction of the front wheels of a car has been brought entirely under the control of the driver, since road obstacles can have practically no influence on the steering. The least possible effort is required at the steering wheel to guide the car and the severest shocks encountered by the front wheels will not affect the course set by the driver nor necessitate a firmer grasp on the steering wheel. And, finally, all of these results embodied in Packard cars are practically essential for the completely satisfactory use of low pressure tires.

## CHAPTER V COMFORT AND APPEARANCE

COMFORT and appearance are considered together in this chapter because they are two properties which are closely inter-related in their appeal. The term comfort may be restricted to cover physical comfort, whereas appearance may be interpreted as implying mental comfort when the appearance is such as to satisfy our sense of beauty.

And therefore, since comfort and appearance are complementary to each other, they have been built into Packard cars with the utmost harmony which masters of this kind of creation have been able to accomplish, and it is only when this harmony prevails that we can speak separately of those features which promote comfort and appearance.

*Physical Comfort.* As to those features which promote physical comfort, Packard bodies are replete with them. First, perhaps roominess is the principal essential to physical comfort in motor car body design.

This feature of roominess is one leading to the greatest enjoyment of the owner or his companions in travel. How often is it necessary to press the car to its maximum passenger capacity? It is on these occasions that the owner feels his just pride in the possession of a correctly designed and appointed automobile to accommodate its full passenger capacity with genuine comfort. How enjoyable and carefree it is to be able to call for a host of guests at the railway station, fill every seat in the car and travel miles to the suburban home without that guiltiest of feelings that the guest of honor or some dear friend is uneasily wedged in between his younger companions, or that the auxiliary seats are too small, the leg space too short, or the seat back at an uncomfortable angle!

To permit this very maximum of comfort, Packard engineers have given the same critical study to body engineering as to chassis design. Almost innumerable mechanical details must be given the most serious attention, not only to obtain these features of comfort when the car is new, but also to insure lasting qualities.

The springs in the seat cushions, for instance, are important. In the construction, the materials and the various treatment necessary to insure long life without any alteration in their springiness or change of form, comfort finds a most helpful ally.

Therefore, in order to insure the maximum of seating comfort, Packard engineers specify cushions made up of many small springs each individually sewed in a fabric container and each carefully made of the finest material and heat-treated scientifically to the best spring properties.

But this is only one of the details of seat construction. Over the springs the heavy duck-cloth foundation of the cushion is laid. On top of this is a thick layer of curled hair padding, then a layer of cotton wadding, then the final coverings of upholstery trimming is put on. Each of these is of great importance. The foundation of heavy cotton duck must be strong yet flexible. The hair must be of long, strong fibers of great resilience. If short fibers are used, the hair pad separates into patches during use and the seat becomes uneven or lumpy and stiff or board-like with use. The cotton wadding likewise must be soft, even and have considerable resilience. These details and materials the car owner perhaps never sees. As in all things of intrinsic worth they prove themselves after hard usage; like pure platinum which will remain un-

touched by flame and acids that would consume every imitation.

And so even to these unseen details, Packard ideals of quality are exacted jealously with a craftsmanship no less skillful than the master watch-maker setting the hidden jewels in a precision time-piece—in order that the Packard owner shall receive his full measure of comfort.

Many, many other details could be described and explained but here only a few can be mentioned.

For the convenience and comfort of men, cigar lighters are furnished on all models. For the lady, vanity cases of quality and beauty are at hand in all enclosed models. Then there are the smooth, easy-acting door locks, the convenient bar-type robe rails and the correctly-placed foot rests.

To provide for all the various changes of weather and at the same time provide correct and adequate ventilation, detailed study has been given to the window regulators used on the enclosed models, and the cowl ventilator installed on all models. The easy-acting window regulators permit any degree of window opening by the simple operation of a fraction of a turn or several turns of a conveniently placed handle. And the cowl ventilator, which is not simply a gate to allow the inrush of air, but instead, a scientifically designed ventilator which deflects the air to eliminate drafts, is so built that water is collected and drained off so it cannot enter the body. Yet the degree of ventilation in all weather is controlled at will by a convenient handle beneath the instrument board.

The automatic windshield cleaner is not only a convenience and comfort to the driver in rainy or snowy

weather or during storms when the driver must concentrate his energies to the safe control of his car, but is also a source of comfort and security to the other passengers, for they know that the driver need not remove his hand from the wheel to turn a hand operated cleaner, and they need not ride in the blasts from an open windshield to give the driver unobstructed vision.

For those who prefer the open body styles, every thought and effort to comfort in stormy weather has been given. The construction and quality of the top to withstand the ravages of sun and rain and cold, to hold its shape accurately and protect always, are results of careful study. The easily attached, close fitting curtains that permit adequate protection in storms, with open body enjoyment in fine weather are but another Packard detail.

Space does not permit of a discussion of the multitude of other refinements considered essential to meet Packard's exacting standards of comfort demands. As a matter of fact, it is impossible to express in mere words the lasting impressions of luxurious and restful transportation to be gained only by actual travel in either the Packard Six or Packard Eight.

*Appearance.* What is appearance?

Shape? Indeed!

And this can be measured in so many inches from point to point.

Color? Yes!

And this could be expressed in the cold terms of the scientists as so many millionths of an inch of wavelength.

Size? Undoubtedly! The cubic contents of the space occupied measures this. And thus, by the aid of cold drawings, color charts and specifications, we could completely describe it.

But, when we view an object and say: "Beautiful!" we have told all about its appearance—our own particular inner feeling, that glow of warm friendliness, the urge to possess it—that kind of elation of the heart and mind only is of importance. Length, breadth, wave-lengths, cubical dimensions are irrelevant.

But are these details irrelevant? A painting poor in perspective is noticeably at a disadvantage to one of good perspective, and perspective is largely a matter of the dimensional relation of lines.

And in the study of the artistry in motor-car design, these lines are of utmost importance. Packard engineers believe that automobile design as to the aspects of appearance is a fine art like interior decorating or architecture. So believing, they strive to give their best to this art, to the study of lines, color, harmony and grace in order to attain genuine beauty.

We might consider for a moment the procedure in the study of Packard lines. First of all, let it be said that Packard never strives to produce that spontaneous appeal like love at first sight. Packard art must wear well. It must be enduring. It must be more—it must make a growing, stronger, fuller appeal with time. Like the melodies of Chopin, always there must be the desire for more. And after an endurable art is created, if the spontaneous appeal remains, all has been done. To attain this end, Packard designs are never hurried and every consideration is given to detail. It is common for Packard to spend months just in the design of

a fender. For instance, the present design of fender, which has been copied so widely, was the outcome of months of study. The first models were made of clay. Days were spent in getting just the right effect from the single detail of the front or visor portion of the front fender. The clay model was reshaped and reworked, taking off a fraction of an inch here, and adding a fraction there. Then the remainder of the fender went through many changes. A line here was straightened a trifle more; a crown adjusted to obtain more harmony; the roll of edge reduced to give more grace—and so the model was worked and reworked until a design was procured which, in the seasoned judgment of competent critics, was complete in harmony.

But Packard endeavors to be its own severest critic, never satisfied; progress and development in art is inevitable. In Packard cars is reflected the work of two years of painstaking study and expensive development. Lines alone have not been the objective. The real objective has been to get the utmost in harmony, grace and individuality. In fact, these all combine into a beauty distinctively Packard. To do this, body lines, fenders, interior arrangement, body fittings, headlamps, radiator, upholstery, texture of materials, the tints and shades of coloring in the trimming materials, the color of the paint and the arrangement of the striping—all these and many other details were studied carefully.

But since mere words are inadequate to express that which only can be felt, we must be content to tell what Packard engineers have done in the endeavor to attain their ever-raising ideal.

After clay models of these improvements were worked and reworked, actual cars embodying them

were built and further studies made. Slight changes were made here and there. Numerous types of headlamps were fitted, various painting and striping schemes carried out. The interior trimming of various tints and patterns was studied; even a complete line of body metal-ware, such as pull-to handles on the door, window regulator handles, interior lights and light switches, was developed distinctively of Packard pattern.

In the closed bodies, such touches as silk curtains to match upholstery cloth, the absence of mechanical connections due to concealed door checks, and a neat clean-cut treatment of the entire interior is at once apparent. To break the monotony of the door trimming the lower body sides and doors are trimmed in carpet to match the floor covering.

Words but merely suggest the feeling that all this detail work and study is intended to create, just as words fail to express the song in one's heart in happy mood. And who could not respond to the grace of the Packard lines, the graceful transition between the hood and cowl; the harmony of the nicked radiator and headlamps, with the lines and color schemes of the various Packard bodies; the gentle, luxuriant touch of the interior appointments with fine texture of material, and good taste expressed in the metal-ware? All these combined with the utmost that makes for genuine physical comfort, produces a rare combination that readily can be appreciated.

And thus Packard engineers have labored over single details, like the great Wagner who labored over a single measure in his great operas, to give Packard owners all within their power, of comfort, style and beauty in their Packard creations.



