

PUTTING PROGRESS
THROUGH ITS PACES

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THE STORY OF THE GENERAL MOTORS
PROVING GROUND

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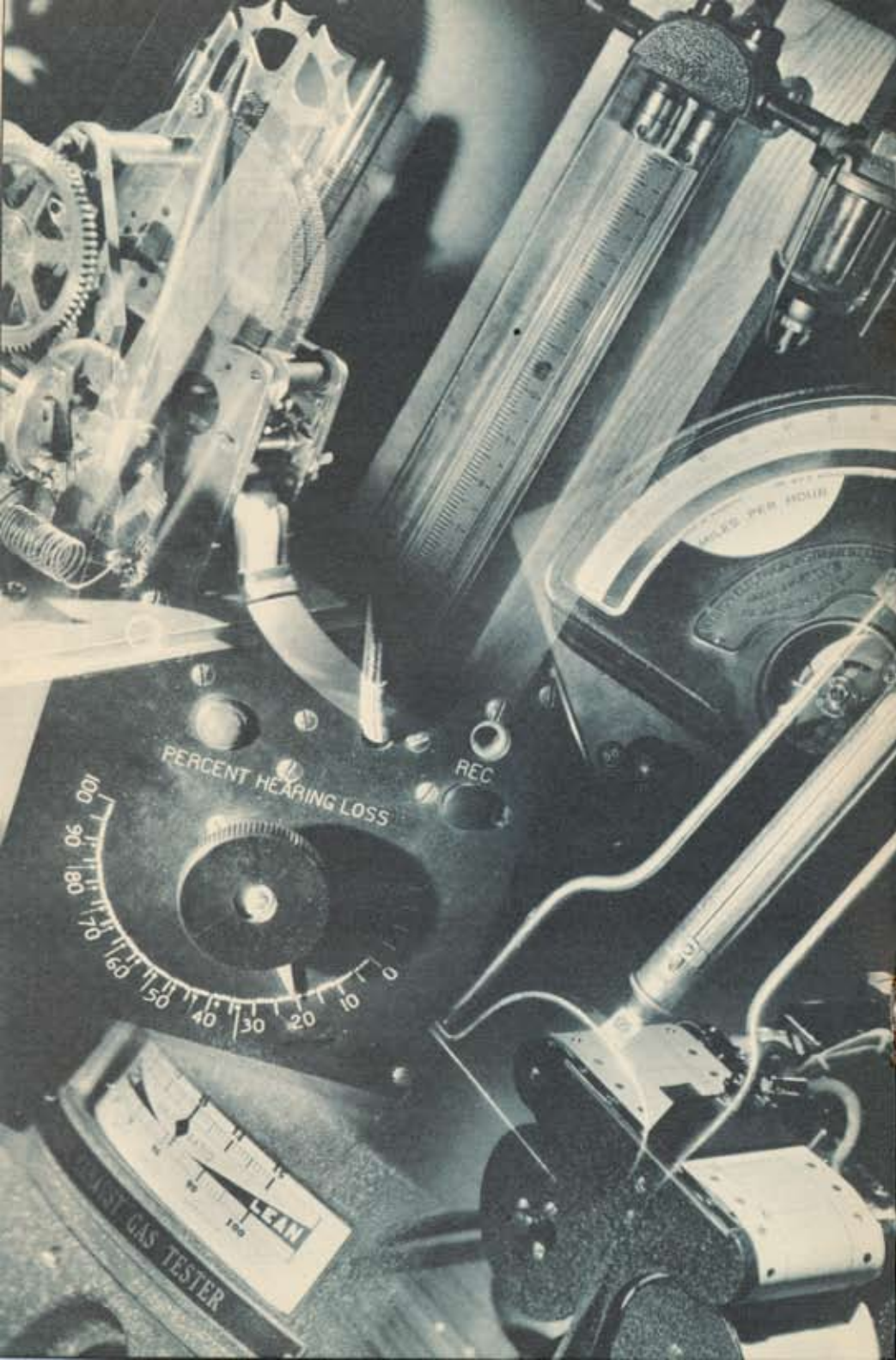


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PROVE all things—Hold
fast to that which is good.”

I. THESSALONIANS.



WHY?

AN infinitesimal speck in the blue sky—eighteen thousand feet straight up. The speck noses over and drops like a plummet, motor roaring. Looking upward, a group of men in uniform anxiously watch a new army combat plane undergoing its acid test.

Naval architects, sailors, crowded docks.—Somewhere a bell clangs. There is a symphony of shouted orders, rattling chains, wheezing winches. Puffing tugs nose a giant ship out to sea. A new leviathan of the deep begins its trial cruise.

Los Angeles, Central Station.—A mob of curious people, photographers, reporters, and railroad officials. A hand is waved. "All aboard!" The streamlined train M-10001 begins its time-annihilating run across the United States.

Milford, Michigan.—A group of engineers with a collection of carefully calibrated instruments. A sleek sedan speeds across a rough road of Belgian block, and rushes into a water bath, throwing up a ten-foot spray. It speeds around an oval speed loop at 25, 40, 60, 80 miles per hour. A General Motors car is being put through its paces.

"Why," we ask, "in these days of superior steel, rubber and gasoline—fact-finding research, and production methods where the limits are held to tenths of a thousandth of an inch, why is it necessary to test cars in this manner?"

General Motors does its testing for the same reason that the United States Army tests its airplanes and its sixteen-inch guns; for the same reason that a great steamship line tests its liners and the Union Pacific its new trains. A defective ignition system is seldom found on a drafting board, night visibility cannot be discovered on a blueprint, and endurance cannot be calculated with a soft pencil and a pad of paper. These are the things that can be determined by only one method—*thorough testing*.

Every year General Motors manufactures hundreds of thousands of cars. We cannot afford to speculate. It is better for us to search for our mistakes and endeavor to correct them than to have someone else do it. So in 1924 a Proving Ground was established covering 1268 acres with miles of every known type of road.

There is no mysticism and no partiality at the Proving Ground. It is there for just two specific purposes. The first is to aid in the inception and development of new ideas and new models by having a small, isolated world where the Division engineers, unhindered by countless traffic regulations and without danger to the general public, can perform any tests they desire under all driving conditions.

Experimental garages are maintained at the Proving Ground by each of the General Motors Divisions: Cadillac, LaSalle, Buick, Oldsmobile, Pontiac, Chevrolet, Fisher Body and GMC

Truck. These experimental garages are operated independently of one another and are under the supervision of the Division engineers.

The second reason for our having a proving ground is to enable us to establish indisputable facts about automobiles in general. In other words, it is necessary to provide facilities for the comparison of all cars; a place where we can evaluate General Motors cars against all other products.

In order to do all this repair shops had to be built. A weather bureau, living quarters, and resident engineering offices were incorporated into a self-contained community devoted to establishing motor car facts. And to be sure the cars themselves were representative, we put ourselves in the position of the average purchaser and bought standard models in the open market, both in this country and abroad. Vital statistics on car operation and performance began to accumulate—statistics of a basic nature that, at all times, are available to the engineers of the General Motors car divisions. This information is, of course, in addition to that obtained by each Division on its own product. There seems to be no better way of assuring ourselves that our product will be the best we know how to build.

On the following pages are described a few of the hundreds of tests employed at the Proving Ground. From these brief descriptions may be gained a little insight into General Motors' system for finding facts and our sincerity in our efforts to build better cars.



$$s = \frac{16 Pr}{\pi d^3} \left[\frac{(4c-1)}{(4c-4)} + \frac{.615}{c} \right]$$

YOU probably didn't know you got this when you bought your car. It is the theoretical formula for the maximum allowable stress in a coiled spring such as is used in knee action. Elaborate calculations at the Research Laboratories show this type of spring to be ideal for its purpose. Computations show that by substituting certain figures for the variables in the formula, a certain spring is best suited for a certain car. But is this true?

The composite scene on the left illustrates a few of the roads over which the test cars must travel. Among them is a picture of a stretch of Belgian block pavement, a duplicate of a section of the road between Antwerp and Brussels. It is a road built of irregularly laid granite blocks and is one of the roughest types of road in modern usage. It serves to test, in an actual car, the merits of a rather complex formula. But it is only one of ten different types of road that this formula must travel over.

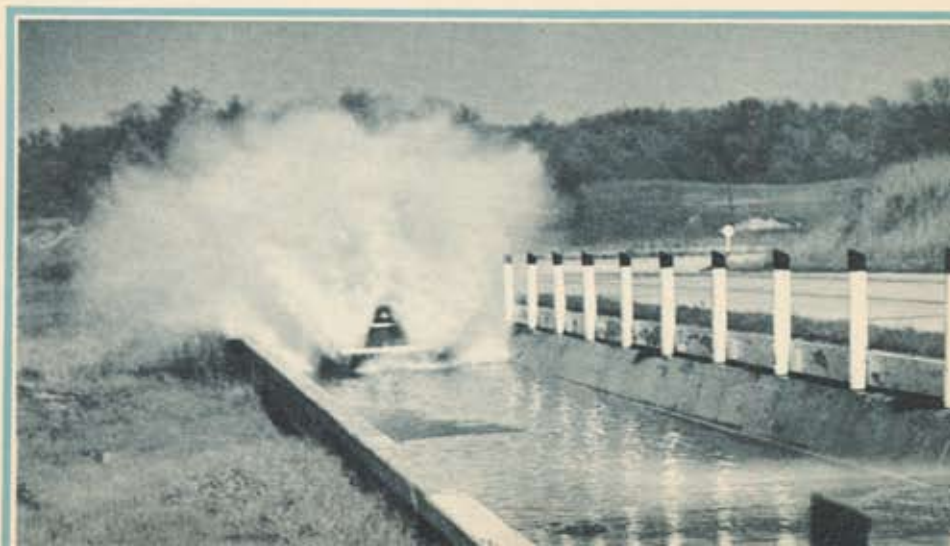


AN EAR TO THE MOTOR

THERE are many metaphors about noise of cars. Comparisons are made to the smooth texture of velvet, to silk, to gliding on ice, to Indian tom-toms, to coffee grinders and to threshing machines. But metaphors are poor substitutes for facts. Engineers at the Proving Ground have accurate methods of detecting and measuring noises. As the engineer "listens in," he is able to make an unqualified determination of noise intensity over the full speed range of the car. With his *audiometer*, he can search out annoying sounds and trace them to their place of origin. Improved mufflers, intake silencers, silent transmissions, and quieter bodies—these are the results of his efforts. But the engineers feel that this is just a beginning in their battle against noise.

THE BATH TUB

SWISS-S-S-SH! A car driving at thirty miles an hour thru a concrete bath tub! This artificial lake is, in reality, a depressed section of concrete pavement with retaining walls which can be filled with water to any desired level. Here the waterproof qualities of cars are tested. We find out if the windows, doors, and floor boards are properly sealed, and whether or not the brakes will operate after a ducking. Carburetors and ignition systems are studied after a penetrating deluge. A record is obtained of performance after baptism.



THE FIFTH WHEEL

Problem: An automobile leaves a certain town with the speedometer set at 1023. When the speedometer reads 1215, the driver discovers that he has used exactly twelve gallons of gasoline. How many miles did he average per gallon?

Answer: Somewhere between fifteen and seventeen, depending on the accuracy of the speedometer.

It is not uncommon to hear about cars that deliver twenty-five miles to the gallon, cars that accelerate at some phenomenal rate, and speeds approaching a hundred miles per hour—but one could never be sure whether they were actual or speedometer miles.

At the Proving Ground, it would be very embarrassing to be testing a car at forty-one miles an hour, and be passed by a car that was supposed to be going forty. The speedometer couldn't be blamed for all the trouble; tire pressures have to be held to a fraction of a pound to make any speedometer read accurately. So we set to work to design a device that would tell us the truth. The result is something the engineers call the fifth wheel. It is accurate in diameter to hundredths of an inch. It is light, and as frictionless as human ingenuity can make it.

Connected to it is a small electric generator. The faster the wheel turns, the stronger the electric current. Miles are read in terms of volts. Suppose an engineer wishes to know the speed; our generator is fastened on the running board and the fifth wheel is allowed to run along the road beside the car. Sensitive meters, inside the car, read the electricity that is being manufactured on the running board. A fifth wheel checks the other four.





EYES THAT CAST SHADOWS

Grotesque shadows on a curved wall—something that looks like a gargoyle or a distorted obelisk on a charted background—weird patterns of light and shade. These are shadows from an automobile. There is no man behind the steering wheel, no face behind the windshield, just two gleaming eyes, two pin points of light. We are in a laboratory for testing vision.

Do you see those black shapes on the wall, those shadow pictures of radiator ornaments and pillars? They are silhouettes caused by parts of the car obstructing the light from the shining eyes—they represent interference with the driver's vision. The smaller the black areas, the more the driver can see, and the greater his safety.

All of us realize that vision is a vital factor in driving a car. When our father climbed from a horse and buggy into a horseless carriage, our problems in vision increased. A very valuable pair of eyes had been sacrificed. No longer could we rely on old Dobbin to help guide the shay—we perform the task ourselves, and because of the inherent nature of our vehicle we see a good deal less of the road than did our faithful horse.

So our engineers started to study vision—to cut the size of those black shadows. A laboratory was built and the problem tackled with eyes by Edison, and a calibrated checkerboard wall.

SEARCHING WITH SUCTION

“SO we bought an enlarged vacuum cleaner, hose and all. After bolting it to the floor we took a car, closed all its windows, pushed the hose thru a dummy rear window, and started pumping the air out.”

This was a Proving Ground engineer speaking. He wanted to know how effectively automobile bodies were sealed against leaks. He had become curious about those small whistling drafts that used to filter into cars near the windows, around the doors, and thru the floor boards.

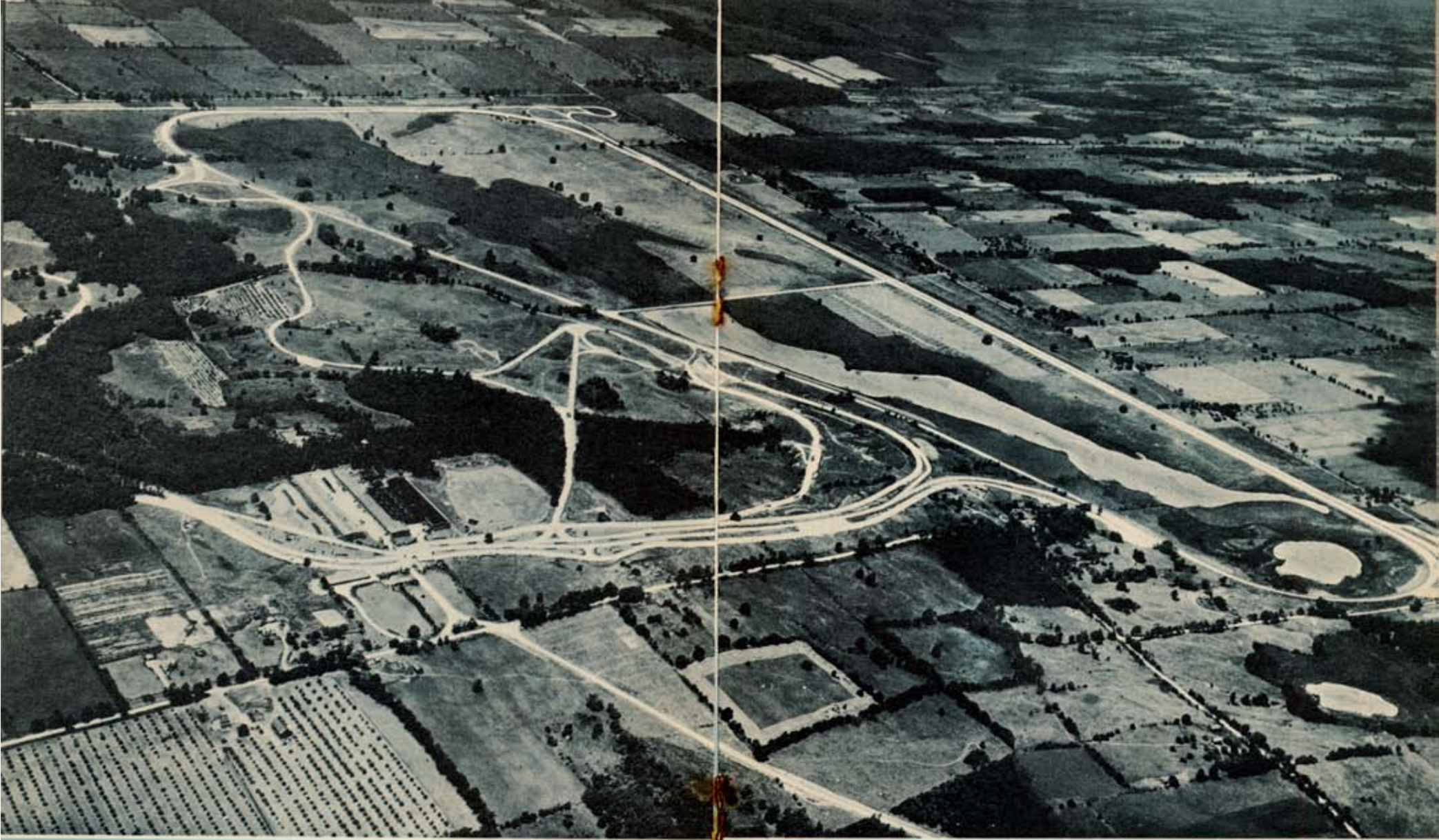
He couldn't tell much with a car in motion, so he used a suction pump on a stationary car. The more the body leaked, the more air he obtained. Then he stuffed some putty in the cracks around the windows, just as he would have caulked a boat. He couldn't get as much air out of the car as before, but he found out exactly how serious an offender the leaks around the windows were. He discovered a number of interesting things with his vacuum cleaner. All of which, when added together, enabled him to materially improve your safety and comfort.



“QU'EST CE QUE L'EFFORT DE TORSION?”

THIS question has been put to us in practically every language of the civilized world. “Wie gross ist die Kraft am Steuerrad?” “Hur stort är styrningsmotståndet?” Or in English, “What is the steering effort?”

So we decided to find out. Our engineers developed an auxiliary wheel which clamps over the regular steering wheel. Between the two, they placed a dial, indicating the efforts in pounds of force that were required to make a given turn. In order to be perfectly fair, all the cars that were being tested were made to drive around the same standard curve painted on a level pavement. Since they all had an identical job to do, we obtained an accurate comparison of the steering qualities and found out why some cars steered more easily than others. The same question, asked in fifteen different languages, gave just one set of answers. But it required two steering wheels to obtain the truth.



**THE GENERAL MOTORS
PROVING GROUND**

**WHERE PROGRESS IS PUT
THROUGH ITS PACES**

A SPLIT SECOND

IT is difficult to be matter of fact about a speedway. Even the hard-boiled testing engineer who practically lives on one, feels the drama—some of the desperate struggles that are necessarily associated with it. You can talk about parabolic cross sections, spiral leads, thirty-four degree super-elevations and thousands of tons of concrete, but you forget them, and remember a single fleeting instant when a projectile of steel on wheels flashed by and droned into the horizon. You are not interested in the pages and pages of elaborate computations made by the engineers or in the difficulties involved in pouring a piece of parabolic pavement wide enough for eight cars to drive abreast. You don't care if the track is 3.8 miles long, if it is the finest speedway of its type in the world. You only retain a composite mental image of a car living its life in a few hours, the smell of the track, the roar of the engine and the scream of the tires—an automobile giving its all in a gruelling, relentless grind—martyrdom, if you please, so that your car and thousands of others might live a little longer.



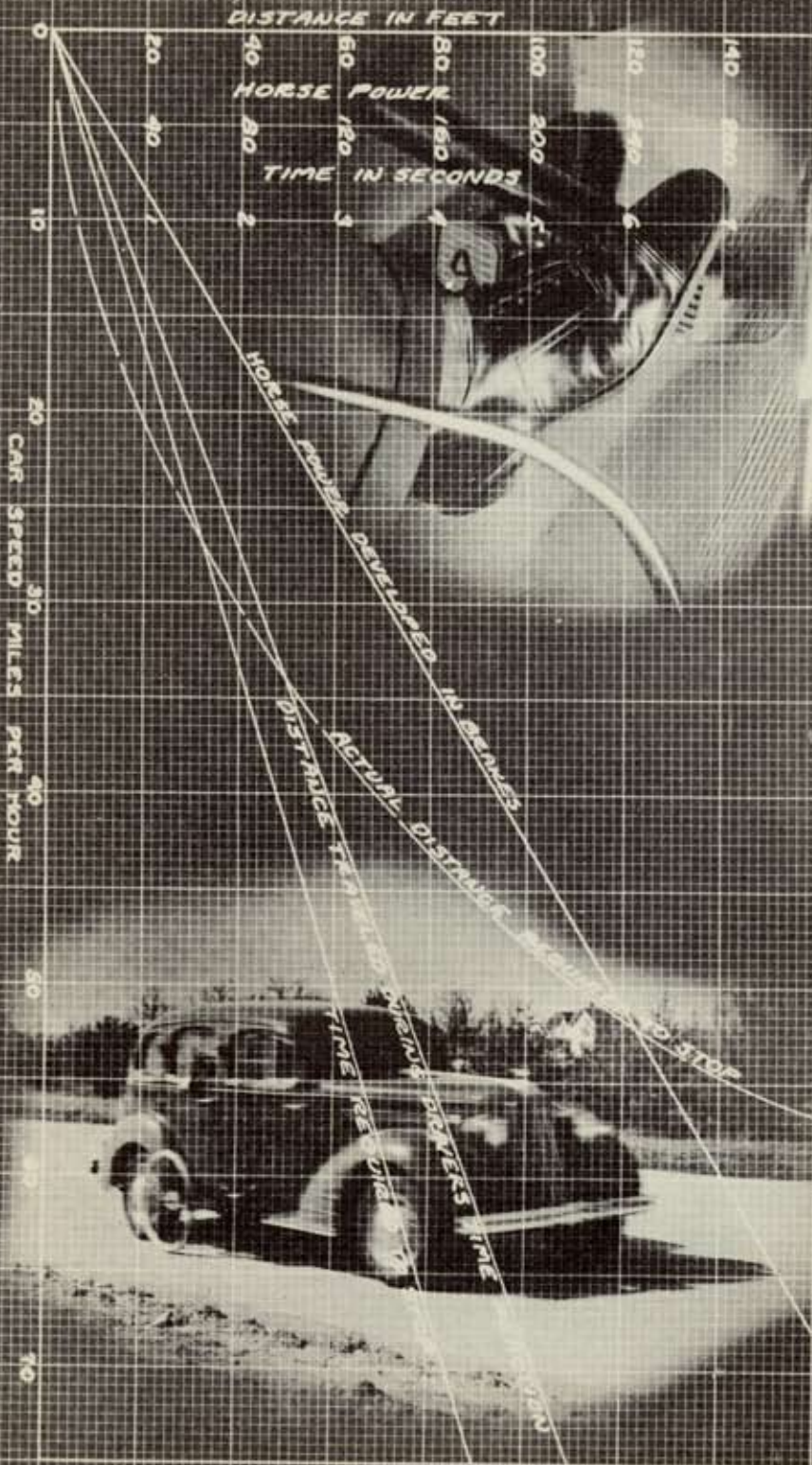
329 HORSEPOWER

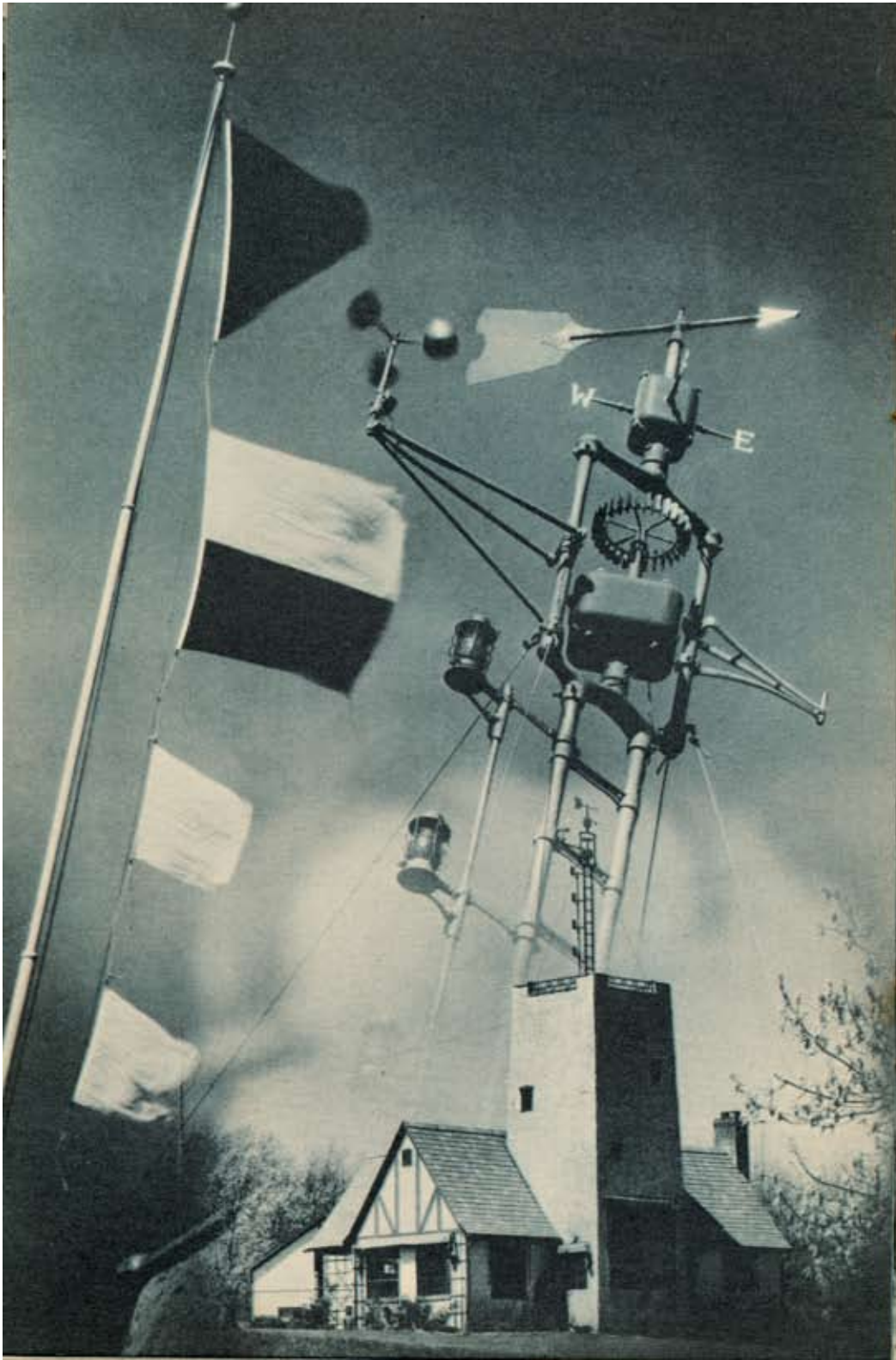
“THE law of conservation of energy stipulates that energy can be transformed from one form to another, but that it cannot be destroyed.” Momentum is one form of energy and heat is another. A car builds up momentum as the speed is increased. When we stop the car, something has to be done with this energy. Since it can't be destroyed, we convert it into heat. That is all the brakes do. *They change momentum into heat.*

Now there's a lot of momentum to a car traveling 70 miles an hour. If we wish to stop a 3500 pound automobile as quickly as we can (which, incidentally, requires 4.2 seconds), we must absorb 329 horsepower in the brakes. That is a lot of power. It would be enough to lift our car 165 feet off the ground. It is easy to see, therefore, that our brakes must do a tremendous amount of work in a day's drive.

So brakes are tested at the Proving Ground. If the 329 horsepower is multiplied by 250 emergency stops, the result is 82,250 horsepower—enough power to raise an average fourteen story building a foot off the ground! That is the power that the test car must develop in its brakes during a single day's driving.

It is a ruthless endurance test. Up to top speed, then, slam! On go the brakes! A dead stop in five seconds! Up to top speed again, slam! Another dead stop!—on and on until brake linings are worn to mere shadows of their former selves. Then back to the repair shops, to elaborate measurements, to tabulations of the driver's effort, to analysis of the linings, to photomicrographs of the drums—to a final check and the establishment of new facts about the expenditure of millions of horsepower—for safety.





Lat. 83° 42' Long. 42° 35' Nor-Norwest

FOUR feet of snow in Montana, a howling wind in Chicago, a blazing sun in the Sahara, rain in the Dutch East Indies. This is weather, variable, unreliable, and constantly changing. A car has been sent to northern Saskatchewan. It is making a desperate effort to start at forty degrees below zero. The motor gasps for breath, coughs, and dies. In Florida, as part of the field work of the Proving Ground, lie endless samples of car parts covered with various paints, lacquers, and metal platings. Some of them deteriorate under the bombardment of a blistering sun and a salty air.

A thirty-mile-an-hour wind sweeps across the level test roads at the Proving Ground. On a slender mast a red pennant jerks and throbs in a boisterous effort to tear itself to shreds. The wind increases; other flags are run up the mast. These are signs of the impending vehemence of nature, and since comparative tests are worthless unless the conditions under which they are conducted are identical—a few cars scurry to the comfortable protection of their garages. The rest of the cars remain to see if they can stand the gaff. Every test must be accompanied by a weather report—the straining pennants on the mast must tell their story in the engineer's log book.

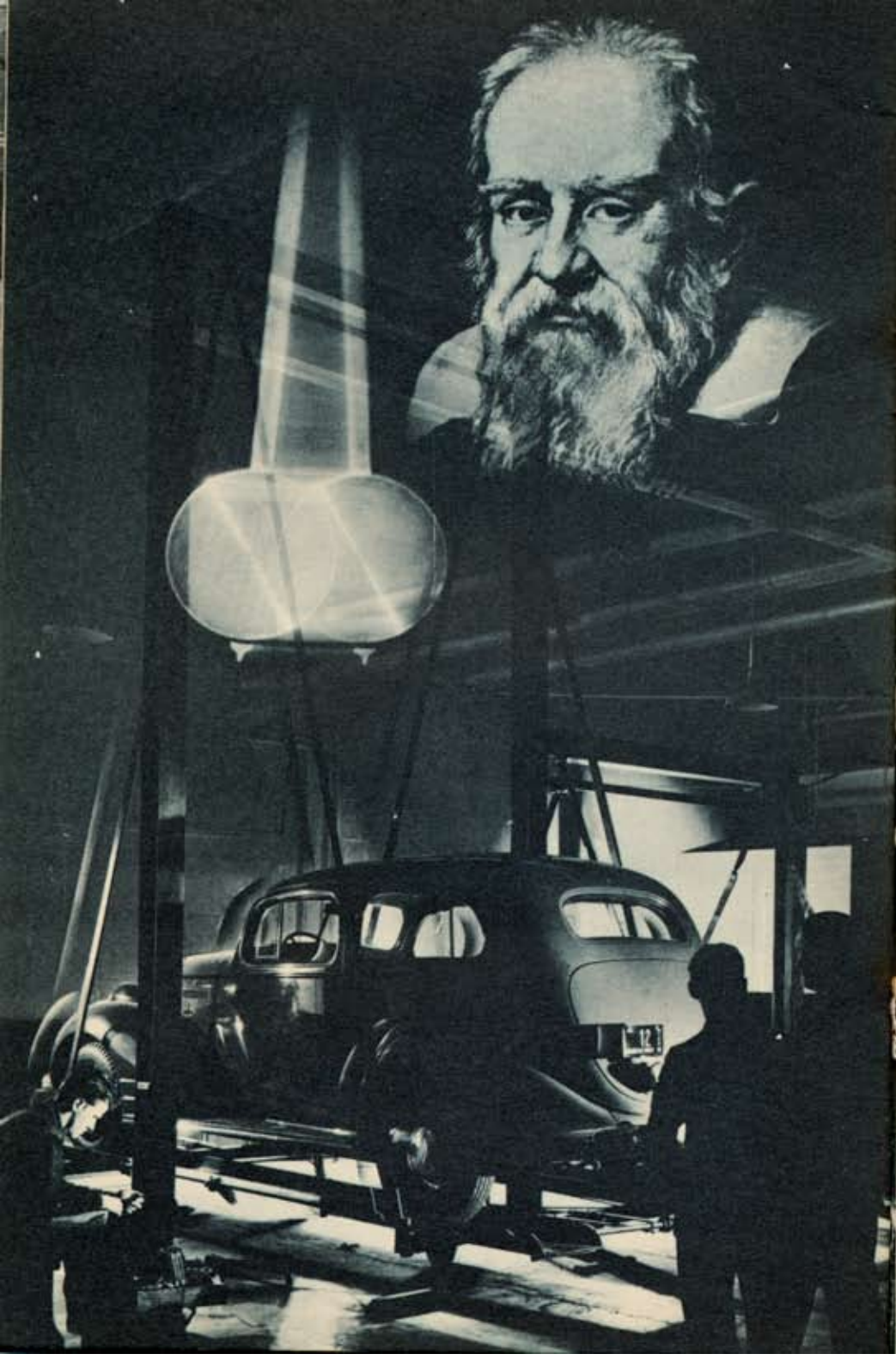
The Proving Ground has the slender masts with its pennants, the delicate instruments giving wind velocities and directions, barometric pressure, the amount of sunlight, the amount of rain or snow, and the temperature. We have the government reports on weather conditions in other parts of the country—in fact, our bureau is an official government station. These implements have been built into a complete weather bureau, into a place where weather is transformed from a hazy variable to a valuable research tool.

FACTS IN FRACTIONS

$85\frac{9}{16}$, $17\frac{1}{8}$, $11\frac{5}{8}$, $67\frac{1}{2}$: Figures with fractions! A new car has arrived at the Proving Ground. It may have come from the other side of the Atlantic or from a factory thirty miles away. It is resting on a level concrete floor and is being measured with microscopic exactness. An engineer stands behind an instrument similar to a surveyor's transit. He slides it along a polished steel rail which is ground to an absolute level. Every now and then he sights thru it, adjusts its exact position, and calls out a number: $59\frac{3}{8}$, $35\frac{15}{16}$, $26\frac{1}{16}$, $113\frac{1}{8}$. These are the horizontal dimensions. They represent the distance from the front wheels to the edge of the steering wheel, the width of the front door, the width of the front window, and the wheelbase—hundreds of dimensions, all of them accurate to a minute fraction of an inch.

The examination is concluded and the tabulations are transferred to drawings of both the inside and outside of the automobile. An accurate picture has been obtained of the physical appearance of the car—a picture which will enable us to judge the quality of its design. Facts have been gathered which will facilitate the improvement of our cars, and which will aid in making a more intelligent interpretation of the trend in design. The past has been measured for the benefit of the future.





GALILEO SWINGS A CAR

GALILEO lived about three hundred years ago, and yet most of us know something of his life. He did some interesting things in physics, he invented the telescope, and he went to church. It was while he was in the Cathedral at Pisa that he became fascinated by a bronze chandelier swinging in front of the altar. He noticed that the lamp always took the same time to complete a swing, regardless of the distance it traveled. So he did a little thinking, and then he wrote one of the basic laws of physics: it is called the law of the pendulum. It seems that there are only a couple of really important considerations in the law: the time that it takes for the pendulum to make a complete swing, and the distance from the pivotal point of the pendulum to the center of gravity of the swinging mass.

Now we can return to the Proving Ground. Engineers had been doing considerable talking about the center of gravity. They knew that if it was too high, a car would roll over rather easily. If it was too far forward, steering was difficult, and if it was too far back, there was trouble on the turns. So it became essential that they know the center of gravity of a given car. But how to find it? Handbooks were consulted. There was much figuring. Then someone thought about Galileo and the law of the pendulum. After that, the problem was easy. The engineers placed the car in a swing, gave it a push and noted the time that is required for it to make a complete oscillation. A few simple computations and they had the distance from the point of support of the pendulum to the center of gravity of the car. Subtracting the height of the swing, they had the position of the center of gravity relative to the road. By adapting a three hundred year old discovery, we answered an important question of today.

WHAT DOES THE PROVING GROUND PROVE?

IT seems only yesterday that the first car drove its first measured mile at the Proving Ground. But in this short time brakes have gone from two wheels to four wheels, cylinders have multiplied from four to sixteen, helical gears have supplanted spur gears in the transmission, celluloid windows have given way to controlled ventilation, Knee Action springs have leveled the bumps in the highway, steel Turret Tops have replaced fabric roofs. A new automobile has been born—not a super-car, produced by some mystic process, but a better car, the result of constant experimentation and testing. It has come from the design boards of the car divisions, from the Research Laboratories, from those who indicated their wants through the Customer Research staff, and from the tests made at the Proving Ground.

During the years of its evolution, hundreds of cars have been analyzed and dissected. The Proving Ground had stock cars from Germany, Italy, France, England, and from the factories thirty miles away. Each of these cars contributed its bit to the general store of basic information . . . perhaps just one point on a chart of performance, or endurance, or safety, or comfort, or economy. Fifty millions of miles have been traveled. Thousands of tests have been made. A host of opinions and vague notions have been eliminated.

In a long room stand row on row of steel cases filled with confidential records. Duplicates may be found in the

engineering files at any of the General Motors car divisions . . . records that are invaluable in designing the car of today and tomorrow.

The work goes on. Progress is put through its paces. The car of a decade hence will probably be different from anything we know today. But that is in the future. While we are *en route*, we must remember that no matter how painstaking the research, how thoroughly the parts are tested before assembly, how accurate the production, there is only one sure way to discover whether or not the product is as it should be . . . take samples of those tens of thousands of cars to be built, and actually test them—*Proving all things and holding fast to that which is good.*

PHOTOGRAPHS BY OTTO LINSTEAD.



GENERAL MOTORS

CHEVROLET

PONTIAC

OLDSMOBILE

B U I C K

L a S A L L E

CADILLAC

GENERAL MOTORS
TRUCK

AN EYE TO THE FUTURE
AN EAR TO THE GROUND