PROVING GROUND

"PROVE ALL THINGS; HOLD FAST THAT WHICH IS GOOD"

General Motors' PROVING GROUND

Forty miles from Detroit, birthplace of the motor car industry, at Milford, Michigan, is an isolated community of engineers and scientists devoted to one purpose: Measuring the motor car.

SINCE the invariable question asked of any car is, "What does it do on the road?", the General Motors engineers early decided that what was needed was a *road that provided every type of surface and conditions likely to be met.* The Proving Ground, opened in 1924, was the result.

On 28 miles of specially constructed winding roads and straightaways of many grades and surfaces, and in a dozen workshops and laboratories, the "fact-finders" of General Motors Proving Ground ever since have been working to determine why to-day's cars are better than yesterday's, and how the car of to-morrow can surpass that of to-day.

The road, or rather the series of roads at the Proving Ground, provides the toughest and most searching series of tests that could be devised for a motor vehicle — gruelling hills, long speedways, stretches of gravel and mud, a "water course," brutal cobblestones and modern concrete highway. One mile of the durability run is considered equal to four miles of average driving.

Cars are driven incessantly day and night, often 25,000 miles and more, for GM engineers to find facts that may result eventually in a better car.

Laboratory Precision Sets Standards

When you think of a modern laboratory test, you think of the utmost precision that science can furnish. Well, the Proving Ground not only applies laboratory tests but it demands strict laboratory precision of its road tests, and many of the testing instruments are designed to be taken out and installed in the car on the road.

• *A stop-and-start test on a grade rising 27 feet in 100.*

The Proving Ground might be called a Bureau of Standards. More than 100 cars yearly are bought from independent dealers to make sure they are representative products and not "doctored up" for the research by a manufacturer, and the results of the tests — tests for running economy, efficiency, durability and comfort — help set the standards that GM's new models must first attain and then surpass.

A Road for Every Test

Shown here are some of the routine tests that hundreds of cars each year, since 1924, have been undergoing at the Proving Ground — and they're not only General Motors cars, but also the cars of its competitors, of all makes and all nations.

The conditions, good or bad, provide the equivalent of roads anywhere in the world. Here a 1946 Cadillac makes a stop-and-start test on a formidable hill rising 27 feet in 100 — a 27% grade. Other tests may include grades from 1 to 60%, although the lastnamed is so severe it is reserved for military vehicles.

Why should rain or hitting a puddle cause the ignition to falter? Distributors, coils and wiring should be able to defy a drenching, said GM engineers, and so they devised the quarter-mile "bath tub."

Another portion of the Proving Ground, a dirt road, when flooded by a sprinkling system (which can also furnish a drenching rain storm), becomes a sea of mud.

"It's twice as hard to make a rough road as a smooth one," explained one engineer and, travelling over the Proving Ground, it's not difficult to see why.

One stretch, for example, is laid intentionally with alternating bumps to pitch the car from side to side. A masterpiece of curves and hair-pin turns, it makes the tyres shriek at high speeds.

Below, right, we see one of the world's roughest roads —the granite paving stones of a highway of "Belgian Block." A hundred miles of this is considered much worse than a thousand average miles and some experts condemn it as excessively severe. However, GM heavy-duty trucks and buses regularly use it for a "work-out."

WHY All This Testing?

From all this two chief functions emerge. The *first* is:

The Proving Ground is to serve as a testing laboratory for all car divisions, offering its facilities to any and all GM engineering departments for the development of new models and other experimental work.

All major GM divisions, for instance, maintain their own garages, permanent testing crews and drivers always at the Proving Ground.

• *A Buick successfully negotiates the ¼-mile "bath tub".*

Its *second* function is:

To test ALL cars, impartially and thoroughly, so that car divisions will know how their products compare with all others and with those of competitors. Incidentally, every new car is broken-in for 2,000 miles at steadily increasing speeds by Proving Ground drivers before it begins the standard road tests.

Any new mechanical development, however perfect it may seem in the blueprint stage, may develop minor flaws when put into operation, and the Proving Ground exists to remove any possible weakness before the vehicle reaches the public highways.

To a large extent, each GM division works competitively, which leads to the development of new ideas and new models.

If one car division develops, say, a new bearing which is proved successful, then this information is available to other GM divisions through the Central Office at Detroit. That doesn't mean, however, that there are no secrets at the Proving Ground. There are plenty. Each garage keeps its own performances well guarded — up to a point. Pontiac, for example, jealous of Chevrolet's increasing reputation, may preserve some special feature until the time is ripe for all "cars of to-morrow" to share the new triumph.

AND the result of all this is PROGRESS. Why, in only ten years, one representative low-price car increased its maximum speed by 26%, its hill-climbing ability by 69% and improved its fuel economy by 15% — and yet increased in price by only 9% in cost per pound of weight, as weight has increased to meet the demands for roominess, style and riding comfort.

Consider some specific changes since 1924, when the first car at the Proving Ground drove its first measured mile:

Brakes have gone from two wheels to four — Cylinders have been changed from four to sixteen and back to eight — Helical gears have supplanted spur gears in the transmission — Synchro-mesh transmission, gear shifts on the steering column, and, now, automatic transmission have been developed;

and other striking improvements have been:

All-steel bodies; new alloys and lighter metals; better fuels and lubricants with greater engine longevity; new contours, new styling and new finishes.

Hailed as revolutionary changes, they are more correctly *evolutionary*, and a vast number of them have evolved directly from the work of the Proving Ground researchers.

Back in 1925 a car was worn out at an average age of 6½ years, or after 25,750 miles. Now, with the advances in automotive design and engineering, after that mileage the car is "just nicely broken in."

• *One of the world's roughest rides, the "Belgian Block" road of heavy granite blocks laid unevenly.*

AS cars drive in they are classified in one of four groups — Engineering, Durability, Distribution or Special — and their testing routine is set accordingly.

Engineering cars are tested for performance, economy and handling, and are usually run for 10,000 miles.

In Durability testing, cars may be driven 25,000 and more miles, tested at regular intervals and then taken down for examination.

The Distribution group is so named because, after having been broken in for a few thousand miles, units are taken down and the parts weighed and distributed by components and groups for specification data.

TAKE a drive through the Proving Ground with a test driver on his assignment and examine some of the instruments carried.

Many of the vehicles have a fifth wheel attached — a remarkable instrument devised by GM engineers to be the most accurate speedometer known. Correct to within one-half of one per cent., it registers miles in terms of volts which in turn are calibrated by sensitive meters in m.p.h. readings. It checks on the other four wheels since it gives exact speeds without errors due to wheel-slip, varying tyre pressures or other factors.

A car, with a "Brake Test" sign on the back, roars down a straightaway, and comes to a sudden stop in a matter of seconds, the brakes being applied by an automatic mechanical "foot" installed as part of the testing equipment, since human reactions, even those of a test driver, vary too greatly for the exact checking demanded.

A brake machine powered by compressed air is set to depress the pedal at any desired pressure up to 200 pounds, and this pressure and the time taken are recorded automatically on waxed tape. Since there may be 250 stops at varying speeds in the day's routine, exact data on safer braking are collected.

Tyre marks are too crude a measure of braking efficiency, and, mounted on the fifth wheel, a little black box holds another GM invention, which accurately records the distance required to bring a car to a standstill from the split second the brake is applied. From such instruments comes information that is playing a great part in road safety.

• *A fifth wheel checks the other four. This fifth wheel, a GM invention, is the most accurate speedometer yet devised.*

• *A test driver discusses a 25,000-mile driving assignment with one of the supervisory staff.*

Since the momentum of a 4,000-lb. car travelling at around 80 m.p.h. and braking rapidly is such that brake linings may absorb enough energy, in the form of heat, to raise the car 200 feet in the air, the brakes and brake linings must be good to stand such punishment. Tests such as those outlined provide some of the facts for the development of stronger components.

THERE are long speedways — but test driving is not for setting speed records. Test driving is durability driving, and speedway tests give more than a check on miles per hour, they give valuable data on fuel economy, durability and safety — all vital reasons for testing.

Testing for economy, cars are driven over the carefully measured straightaways while precise instruments measure the consumption of oil and petrol at various speeds. . . One car strains up a steep grade from a standing start . . . Another is timed as it moves from a start in first gear over a marked distance.

On a wide, circular concrete "skid pad" another car is being driven endlessly around, while an observer checks its lean or "roll." Another observer studies instruments measuring the steering effort required and the stress on each road wheel.

But why establish such a vast set-up?

Of course, for safety's sake, testing is better done on private roads free from other traffic. Some secrecy also may be necessary, but, above all, there must be every facility for carefully controlling each run. Every mile and every minute of running time, the car is being tested to a strict schedule — so many turns, so many stops, so many *exact* miles at *exact* speeds.

• *Mounted behind the fifth wheel speedometer, the little black box precisely measures the stopping distances in the hundreds of braking tests. Right:—The chronometer (on the seat) times the brake machine (rear) powered by compressed air as it depresses the brake pedal exactly at the pressure desired. The recorder (right) marks on tape deceleration time, pedal pressure and pedal travel required to stop the car.*

On the speedway, a section of which is shown below, separate lanes for various speeds, in the miles of straightaways and banked turns, assist in providing valuable data on fuel economy and general toughness.

According to its orders, a car may run in any lane from "Low Speed" to "60" or "Wide Open." The braking apron, seen on the right, is used for brake tests at whatever speeds are assigned.

Since gravel roads are found throughout the world there is intensive testing over the five miles of that surface. This steeply sloping section shown below (right), with its switchback humps, enables traction on the loose surface and spring action to be studied.

The test car shuttles between road and laboratory. The average car has 17,000 individual parts and the Proving Ground Laboratories may analyse nearly all of them collectively as assemblies in the course of 150 or more investigations.

While the Proving Ground has its numerous laboratories, most car divisions — Chevrolet, Buick, Pontiac, GMC Truck, etc. — also have their own laboratories, in addition to the great General Motors Research Laboratories in Detroit.

Taking the Road Indoors

Testing for durability and economy are the main concern of the "fact-finders" in the laboratories also. The "bench" or "rig" tests, so-called because separate components or assemblies of the car are taken out for analysis on a laboratory test bench or by a "rig-up" of equipment, have been devised to obtain as closely as possible the conditions of actual road testing. They can, however, be even more severe. For example, a machine that continually engages and disengages the clutch up to a million cycles, or one that whips and twists brake hoses, may in a few days give vastly more wear and tear than is possible in the life of any car.

A car is moving on a pendulum electrically timed to find its centre of gravity, so important for safety and ease of steering . . . Instruments similar to those used by surveyors precisely measure a car's dimensions, both inside and outside, and from those dimensions come improvements in designing for comfort . . . In a darkened room illumination and black shadows are cast on a curved wall marked like graph paper. The pattern of light and dark comes from two pinpoints of light, "electric eyes," within the car, representing the driver's eyes — and thus are charted his range of vision and consequent margins of safety . . . The compression ratio of each cylinder is measured by a compressed air device . . . Heavy weights are tossed up and down on a seat, and windows are wound up and down for thousands of cycles to test the probable life under wear and tear on those parts . . . . Those are but a few of the laboratory tests.

• *This straightaway has separate lanes from "Low Speed" to "Wide Open", for economy and durability testing.*

• *Switchback slopes in the five miles of gravel road provide facts on springing, traction and tyres.*

A car's performance may vary with the weather—temperature, humidity or wind may affect it. It would be absurd to quote one car's fuel consumption in sub-zero weather against that of another in mid-summer, so a full-scale official U.S. weather bureau notes all wind and weather statistics for purposes of comparison. That study of weather, and its influence on a car's performance, is just another valuable research tool.

If rain or mud are required, GM engineers can remedy any deficiency, as was mentioned earlier.

The search for *silent* power is one of the never-ending quests, both on the road and in the laboratory. On the road, "Elmer, the electric ear," an electric listening device, is installed in the car to pick up noises—body noises, engine noises, vibrations, rattles, squeaks—and to register them as decibels, units of noise, that must be eliminated to bring about both greater driving comfort and mechanical efficiency.

In the Sound Laboratories, tests may be conducted in "quiet" rooms, which are rooms within rooms.

Since noises reflected from neighbouring walls interfere with the delicate operation of detecting squeaks, rattles or vibration, cars are sometimes transported to the roof (below right) for undisturbed examination.

To study gear noises, Gear Laboratory engineers (below left) use a stethoscope and a strobotac which "stops" gear motion for examination and photography.

In other tests, too, photography is bringing to engineers microscopic precision in studying moving parts. One high-speed motion picture camera can take up to 8,000 frames a second.

• ***An ear to the mechanism. These GM fact-finders actually photograph gears in motion with a strobotac, while one "listens in" with a stethoscope.***

From the atoms of metal in the connecting rod to the molecules in the fuel, nothing escapes the team of testers.

Science Finds Stronger Metals

More than 80 per cent. of a car's weight is iron and steel, as are most of the individual parts, so, to eliminate any weak link, all metals have to be proved durable enough for their respective tasks.

What type of cast-iron wears best in cylinder walls and piston rings? How can an even stronger steel be developed for gears? These are problems that Proving Ground research is solving. On the opposite page (lower) the structure and constituents of metal are shown being examined by a combination of special high magnification metallurgical microscope and camera. The X-ray eye of the spectrograph (right) makes visible the heart of the metal. The ultimate breakdown by chemical analysis takes place through the emission spectrograph whereby each element in a metal can be quantitatively determined and identified by its particular wave-length seen in the spectrum.

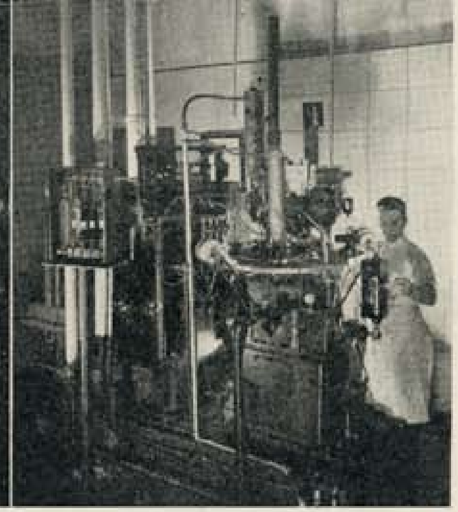
Pursuing "Inside Engine" Facts

In spite of the improvements that are heralded in each year's new models, the vehicle is only as good as the fuel available for it, and this fact has not been overlooked by the Proving Ground fact-finders. Research to cure engine knock, headed by GM's former vice-president, Dr. C. F. Kettering, resulted in ethyl gasoline. Dr. Kettering is seen (opposite page, top left) at the infra-red spectrophotometer used for identifying certain molecules. From such studies into the re-arrangement of the atoms in the various molecules of petrol may result a new fuel structure with a higher octane rating.

What actually happens inside the engine combustion chamber? Quartz windows in the combustion chamber (top, centre and right illustrations) have disclosed many "inside engine" secrets. The beam of light (bottom, right) literally throws light on fuel-air mixtures in carburation, for air and fuel flows are made visible by that optical system.

A glimpse of a dynamometer engineer (bottom, left) studying the machine's findings gives no indication of the special building with its rooms housing elaborate equip-

• ***There are fewer outside noises up on the roof, so this Oldsmobile will run there on rollers while Sound Laboratory engineers with microphones measure each part, seeking more silent running.***



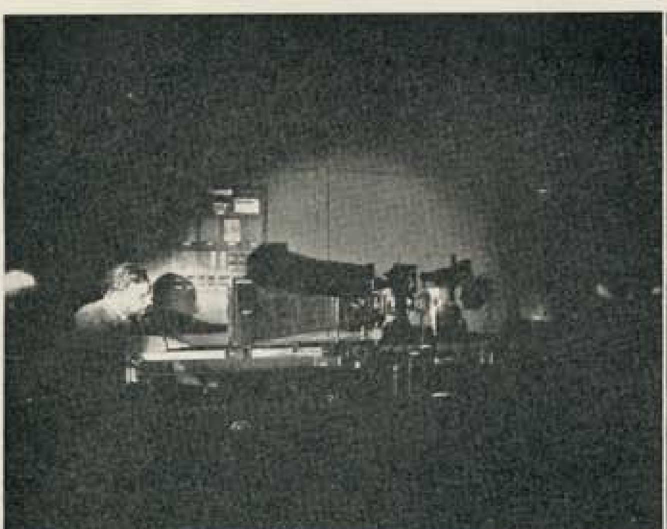
ment. One of the dynamometers — "power measurers" — is in its specially constructed room on the left. There, an engine's performance in horse-power at varying revs. per minute, fuel consumption, engine temperature, and much more, may be observed from the instrument panel.

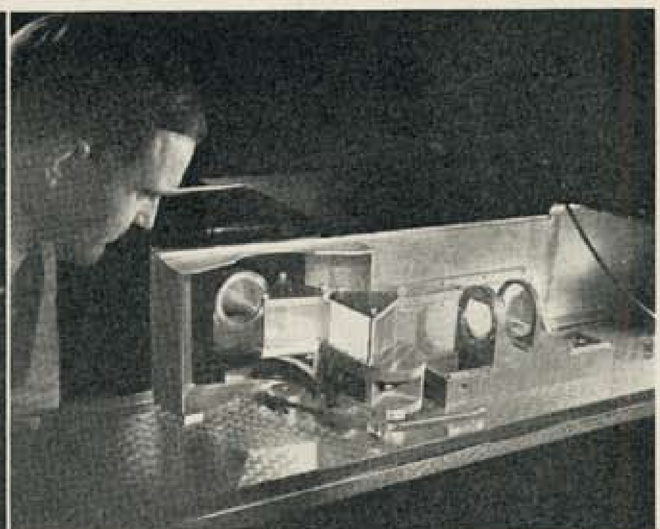
On one type an engine is given a straight-out run for a predetermined number of hours at a set speed or speeds. For example, it may be tested for 100 hours at 4,600 revolutions per minute, before being torn down and measured for wear. Or the differences in its performance under various conditions may be compared. From such intensive "life checks" have resulted the improvements in economy, power gains, and fuel distribution that mark the modern car.

Still another, a chassis dynamometer, may provide a harsh test for a complete car. The car rests on large rollers which may either impart power to the wheels or measure the power from the wheels. By affixing cleats or "bumps" to the rollers a lifetime of jolting and jarring can be concentrated into a few hours.

Those are a few of the tests adding to the essential "know-how" of GM engineers, and setting the pace for automotive progress.

The advice of St. Paul to the Thessalonians (1: 5: 21): "Prove all things; hold fast that which is good," has guided the men of the Proving Ground for almost a quarter of a century, in finding facts that may help General Motors build still better vehicles.






DANGEROUS
USE ONLY
WHEN DRY
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