COLLEGE NOTES

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The Automotive Laboratory

By Professor W. E. Lay

A DISCUSSION OF THE RELATIVE VALUE OF THE INDUSTRIAL AND THE TECHNICAL SCHOOL LABORATORY AND THEIR METHODS AND LIMITATIONS. REASONS WHY MICHIGAN SHOULD HAVE AN AUTOMOTIVE LABORATORY. DESCRIPTION OF THE NEW LABORATORY AND ITS FACILITIES

During the war research and scientific investigation of everything having a possible relation to the great conflict were conducted on a scale never before attempted. The war has been called the war of engineers and scientists. It might well be called the war of the automobile industries, for certainly no other industry played a more important part and development work was particularly intense. Now that the big problem has apparently been solved there is no less a need for continued work of this nature. It is true, of course, that in the reconstruction period the most rigid economy is necessary. But research work carried on with the full utilization of all present facilities will ultimately be an economy. It always has been an economy ultimately.

From time immemorial the seat of learning, the school, has been also the center of research. Gradually through the painstaking efforts of men at educational centers has the complex mass of known facts been gathered, arranged and classified to form the body of what we call the sciences. It is necessary for every modern scientific school or college to maintain laboratories where work can be done by the student, which proves how certain principles and theories hold true and also shows him their limitations in practical application. There is in the United States a large quantity of such equipment available for accurate scientific investigation and in most cases it is now being used in that way. There have also grown up in various industries large and very completely equipped laboratories. In the case of the automotive industry their work has been a very important factor in the phenomenally rapid development of the automobile.

Industrial and Technical School Research

There seems to be a fundamental difference betewen industrial and technical school laboratory work. The reason for this can be traced back to the incentive behind the endeavor. The work done in an industrial research laboratory is carried on with the idea of immediate improvement of the product or the development of new products. At the college laboratory the incentive is often purely a desire to explore, which finds expression more or less in the work of any human being. Too often this work has been done without taking into consideration whether it would have an immediate practical application or indeed ever prove of value to mankind. However, it will be admitted that in general the work is done in a thorough and conclusive manner. The university, at which every one is searching for knowledge, has an atmosphere conducive to the complete solution of problems in all their details. The work is carried on in a manner at once painstaking and accurate without serious interference or time limit and should give results conclusive beyond question.

In the industrial experimental laboratory real research is carried on but there is always a tendency to side-track it to give way for makeshifts which will temporarily satisfy the demands of the public or the sales force and return a satisfactory profit.

Seldom indeed can the engineer attack a problem, carry out his investigation until all possibilities

State	Automobile Builders Number	Rank in United States	Truck Builders Number	Rank in United States
Michigan	34	1	53	1
Ohio	25	2	32	3
Illinois	16	4	40	2
Indiana	20	3	13	6
Total for group	95		138	
Total for United States	167		300	
Percentage of group	57		46	
Percentage in Michigan	20		18	

have been exhausted, and bring the work to a successful conclusion. There are some types of work which can best be done in an industrial laboratory and probably will always be done there. On the other hand, some research work can very properly be done at the laboratories of our universities and technical colleges.

There are general investigations which can be taken up by the industry as a whole and it is perhaps this kind of subject that can be handled best in a laboratory of a State university or technical college. The University of Michigan by virtue of its location in the center of the automobile industry should be among those considered for work along these lines. The accompanying statistics taken from Automotive Industries on the distribution of automobile and truck builders will help make this clear. In the same magazine, the daily production of cars by the leading motor-car builders in August, 1919, was reported. Twenty-six of the 34 listed were located in Michigan and had a total daily production of 5,574 cars or approximately 1,670,000 for the year. As the year's production for the whole United States was under 2,000,000, Michigan produced more than three-fourths of the automobiles built in the United States for the year 1919.

Automobile Laboratory at University of Michigan

There has been at the University a gradual development of laboratories and equipment for use in teaching engineering science with particular reference to its application to problems met in the design and operation of automotive vehicles. Among these is the automobile division of the mechanical laboratory. This section quickly outgrew the space allowed in the main laboratory and this year moved into one of the cantonment type of buildings used for training army mechanics during the war, occupying a floor-space 60 x 120 ft. This laboratory is divided into three sections, a class-room, a general laboratory for routine testing and demonstration and a research room where accurate mechanical testing and investigations can be carried out. The classroom is supplied with tables, charts and data books needed in computing the results of experimental tests.

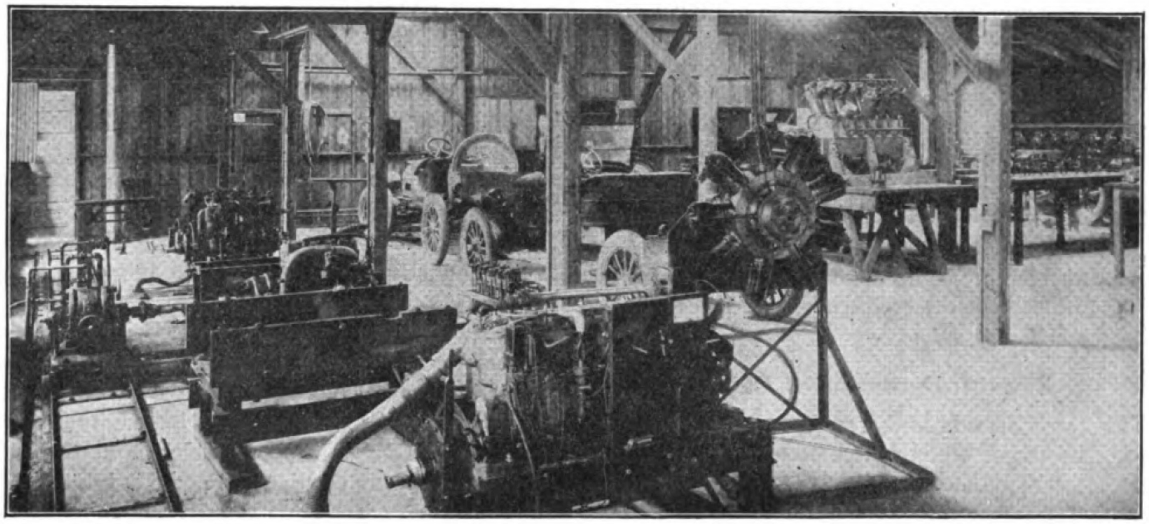

FIG. 1. GENERAL AUTOMOBILE TESTING LABORATORY

General Laboratory

The second section is equipped with seven engine testing-stands and three water-dynamometers of from 20 to 60-hp. capacity and one calibrated fan-brake. The water-dynamometers are mounted on a track so that they can be easily moved to position at the rear of any engine where they are fastened in approximate alignment by two holding-down tee-bolts. The dynamometer is connected to the engine by a drive-shaft with two metal universal-joints. The shaft is splined at both ends. Both engines and dynamometers are fitted with the same universal-joint unit which is fitted to receive the splined ends of the shaft. To disconnect the dynamometer from the engine it is necessary to loosen the holding-down bolts and move the dynamometer down the track until one universal-joint slides free from the shaft. Then the shaft can be removed entirely and held ready to go into place as the dynamometer is aligned with the next engine. Water for cooling the engines and the dynamometers is furnished through two pipes on the wall, one supplying cold water and the other water at any desired temperature from cold to near the boiling-point. If the engine is aircooled conditions similar to those in operation on the road are obtained by use of a portable Sirocco blower driven by a direct-connected electric motor. Fuel is supplied from 10-gal. tanks mounted on light stands supplied with large casters so that they can be rolled to the gasoline pumps for refilling when necessary.

There are available for demonstration and tests over 20 engines varying in size from the Ford to the Liberty aviation engine. Two chassis are used for car-performance tests including hill-climbing, acceleration and economy of fuel over the driving range. In addition, there is mounted on demonstrating racks considerable equipment, including carburetors, ignition systems, governors, clutches, transmissions and rear axles.

Research Dynamometer Room

The third section, the research room, includes among its larger equipment a 100-hp. and a 60-hp. electric dynamometer, a set of chassis testing drums, a drawbar pull dynamometer and a motor-generator set. The dynamometers are fully equipped with switchboards, load resistances, control rheostats, beam-scales, tachometers and electrically operated revolution-counters to be used in conjunction with the pull measuring apparatus. The important feature of this room is the layout of the dynamometers and testing-floor to use the dynamometers to their full capacity. It had been found in previous years that when a complicated set-up had been built up for special work the dynamometer could not be used for any other work without tearing down the set-up and making a new one. So when the new laboratory was laid out the pedestals of the dynamometer were mounted in a flat circular bedplate or base with a circular groove on its under surface. A similar base was set in the concrete with a corresponding groove in its upper surface. These grooves are filled with ¾-inch steel balls and form a bearing upon which the dynamometer can be turned to align its shaft with any one of the four testing-bases or the countershaft driven by the chassis drums. The dynamometer is located exactly by two dowel pins directly under its shaft. The relative position of the dynamometer and engine bases is illustrated in Fig. 3.

Metal universal-joints and a drive-shaft splined at both ends are used here as well as on the water-brakes. As the dynamometer is rotated on its base, the distance between the universal-joint on the dynamometer and that on the engine is increased until one splined end of the shaft comes free from its universal-joint. The shaft can then be readily removed and placed in position on another engine so that it goes into place as the dynamometer is brought into alignment with it. Thus the dynamometer can be

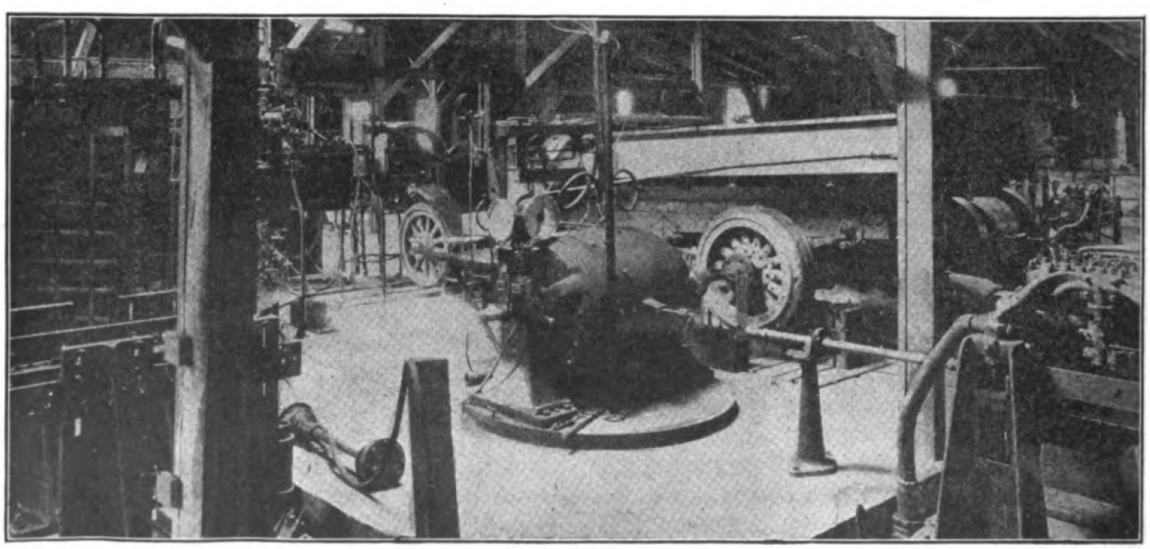

FIG. 2. DETERMINING THE EFFICIENCY OF THE TRANSMISSION SYSTEM IN THE DYNAMOMETER ROOM

disconnected from one engine and connected to another in 5 or 10 minutes.

The chassis-testing outfit consists essentially of two drums, having a wood surface 6 feet in diameter and 18 inches wide, which are mounted on large shafts at the proper distance apart to correspond with the track of an automobile. The outer end of each shaft is splined and will fit the axle drive-gears of a 5-ton truck differential carrier assembly in place of an axle-shaft. This in turn will drive a heavy gearset which drives the dynamometer through silent chains as outlined in Fig. 4. The dynamometers can thus be driven at the same speed as the dynamometer and engine set-up shown in Fig. 3. In front of the scale-beam is a table supported by the dynamometer base. The field-rheostats or load and speed controls have been placed under this with the control-wheels above. A throttle and spark-control quadrant is located on the post just above the table and the large tachometer is only 2 feet from the eyes of the operator. This brings all controls within easy reach and with the dynamometer in any of its positions the switchboard is never more than two steps from the operators' position at the control table.

The engine bases are built up of four slotted rails

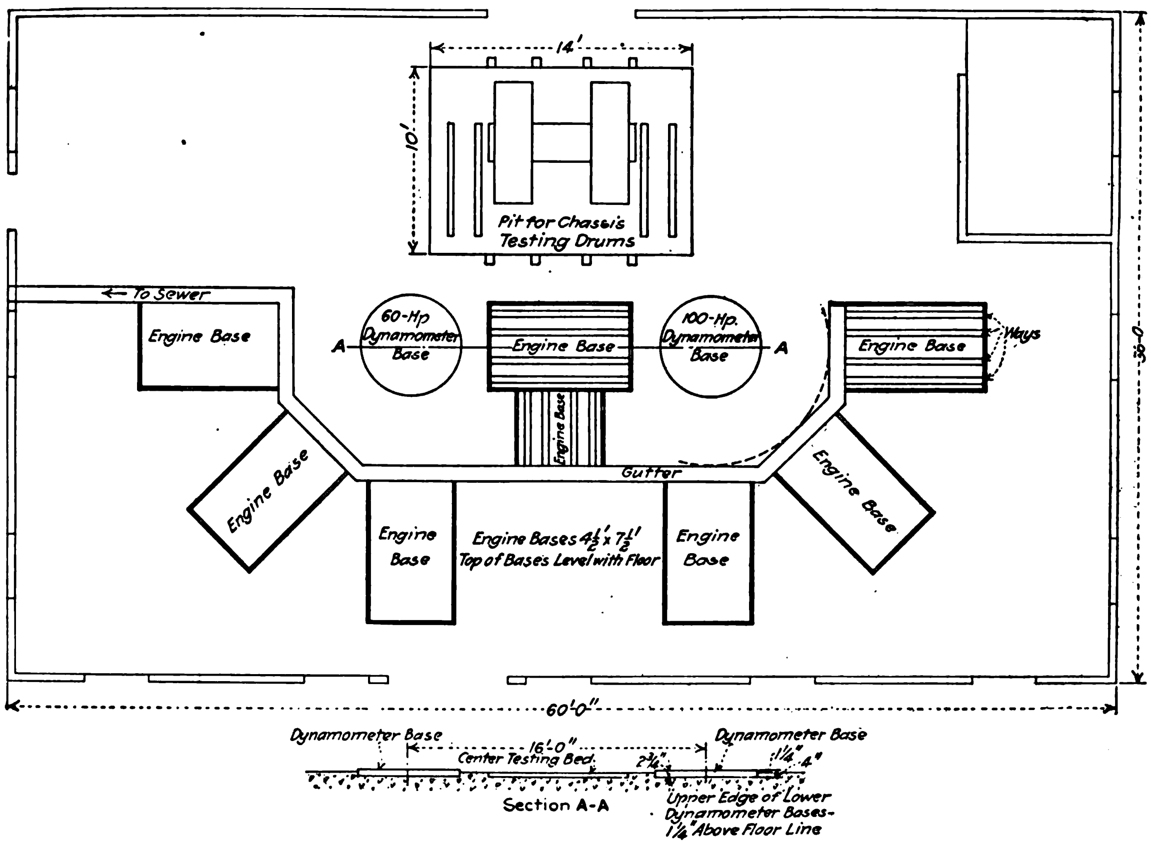

FIG. 3. LAYOUT OF APPARATUS IN THE DYNAMOMETER ROOM

engine and easily absorb the output. The net power-output of a chassis can be determined by measuring the pull of the car with a drawbar dynamometer and determining the peripheral speed of the drums.

The motor-generator set is used to furnish direct current to operate the electric dynamometers. The motor, being of the synchronous type, is not affected by variations of voltage and will maintain a constant speed of the electric generator and a constant voltage at the dynamometer switchboard.

Among the more interesting details might be mentioned the arrangement of the controls of the bolted rigidly to 2-inch angle-iron and the whole embedded in a concrete slab separated from the rest of the floor by planks. If the engine being tested develops excessive vibration, it is not communicated through the floor to the dynamometer or any of the weighing apparatus. The gutter shown between the engine and dynamometer bases carries off the water and contains the main exhaust and hot and cold water pipes. By a suitable arrangement of valves water is delivered from the outlet through garden-hose to the engine jacket, the radiator or cooling tank at any desired temperature.

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With this arrangement the dynamometer is made to serve a variety of purposes without building new parts for each test or disarranging it to such an extent that it cannot be made to handle a different kind of work in a short time. In other words, it has been made somewhat universal. There is space between the dynamometers for mounting a transmission so that one dynamometer can drive the transmission and the other absorb the output, thus measuring both the input and the output and determin-

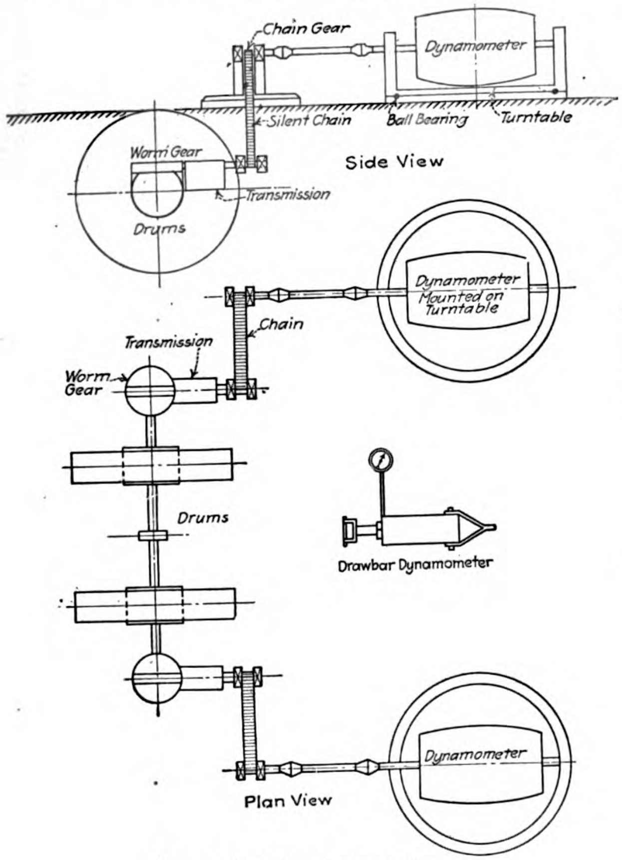

FIG. 4. CHASSIS TESTING OUTFIT

ing the mechanical efficiency. A rear-axle can be mounted between them and driven by an engine on a reaction dynamometer so that the efficiency of the final-drive and the action of the differential can be determined. In Fig. 3 a truck is shown jacked-up with each rear-axle jackshaft connected to a dynamometer. Here the efficiency of the transmission system, including the universal-joint shafts, transmissions, final-drive, and the bearings in the differential-carrier, is being determined. There is room for six engines to be mounted at the same time. This arrangement will allow one engine to be set up while tests are being made on another if necessary.

There is available for use in connection with the above-mentioned equipment special fuel-measuring devices with electrically operated revolution-counters and stop-watches, meters for measuring air and water, pyrometers, gas-analysis apparatus, a monograph, indicators and complete accessories necessary for doing accurate research work.

This laboratory is undoubtedly the most complete of its kind in the country and its facilities afford a most excellent opportunity for research work on the many and varied problems which obstruct the progress of automotive vehicle design.

Research Work on Automobile Headlights

Dr. Sawyer, of the physics department, is conducting experiments for a Detroit firm upon a new form of automobile headlight. By means of a special arrangement of lenses and reflectors it is hoped to perfect a new lamp which will give a maximum amount of light without the glare, and so conform with police regulations. Patents have already been secured by the Detroit firm, although the development has not reached a stage which would warrant manufacture of the lamps, as their cost would be considerably higher than the present type.

The Honorary Societies

The second semester elections, 1921, of the honorary societies were:

The Tau Beta Pi

H. S. Simpson	T. R. Halman
R. E. Swart	R. M. Hazen
P. C. Ackerman	F. D. Johnson
W. E. Brandemer	A. J. Maslin
B. L. Beckwith	A. L. May
R. C. Bergvall	G. W. McCordic
R. N. DuBois	H. B. Seely
G. F. Emery	S. B. Smith
Wm. Fink	A. D. Stauffer
M. A. Goetz	E. B. Tucker

Triangles

F. A. Camp	C. M. Kindel
F. L. Cappon	T. J. Lynch
F. A Horn	R. G. Reason
J. E. Johns	R. H. Rowland
P. G. Goebel	R. C. Sterns

Web and Flange

W. E. Bandemer	W. P. Lyons
H. R. Carpenter	R. A. McCordic
J. D. Cruise	J. A. Riggs
C. S. Finkbeiner	H. S. Simpson
M. A. Goetz	C. S. Warner