THE IOWA ENGINEER

The Master Engineer

Distribution of Loads on Highway Bridges With Wooden Floors

Locomotive Testing at Iowa State College

The State Lake Bed Survey

Bond in Reinforced Concrete

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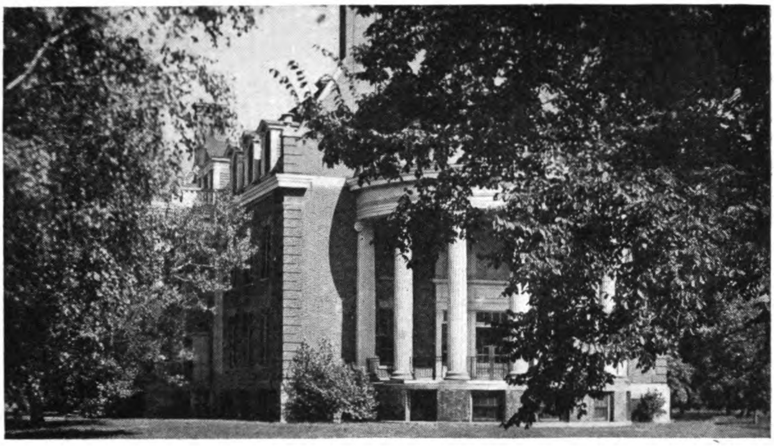

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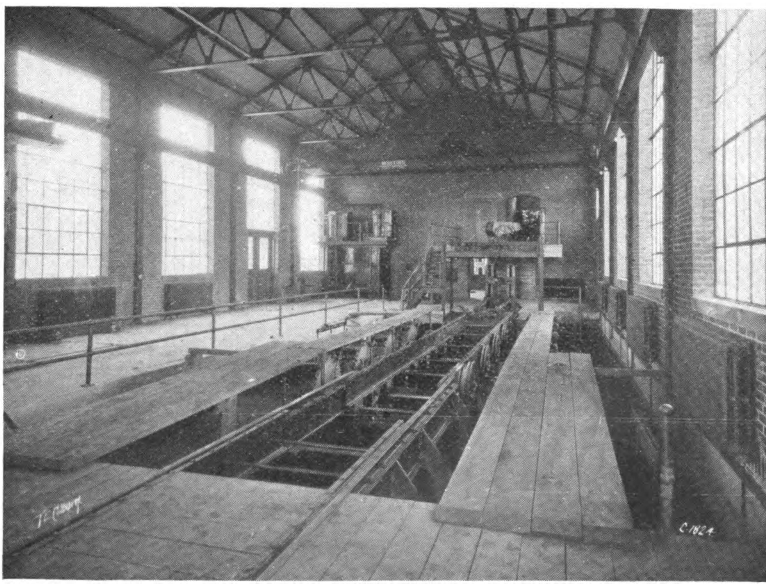
Locomotive Testing at Iowa State College

R. A. NORMAN*

A description of the Locomotive Laboratory building, showing its floor plan and the trackage for bringing locomotives into the building, was given in an earlier issue of this magazine. Since then all of the machinery necessary for making complete locomotive tests has been installed, with the exception of the draw bar weighing apparatus and a satisfactory means of taking care of the smoke.



The Testing Plant ready for Mounting the Locomotive

A temporary scheme is made use of for getting the draw bar pull, which is measuring the pull on each brake wheel, by means of a 6,000 pound capacity dynamometer, and when the brake arm length is carefully determined, the radius of the support wheel measured, and a careful estimate made as to the friction of the support wheel bearings, the draw bar pull can be closely approximated.

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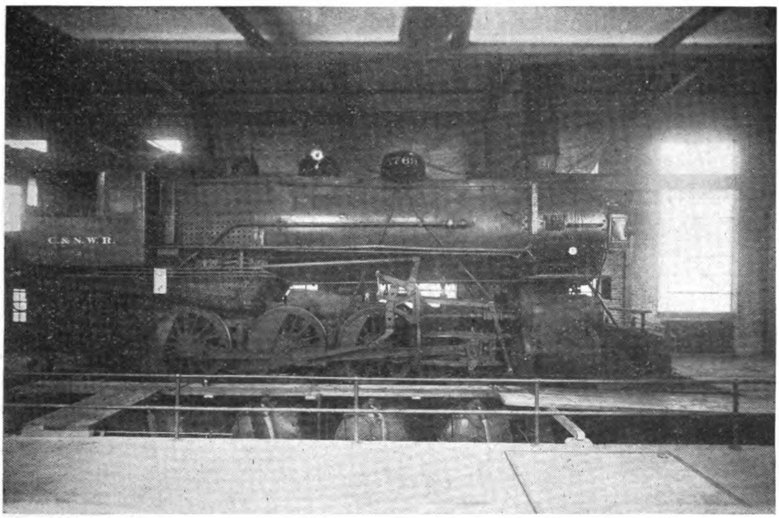
In the latter part of May the C. & N. W. Ry. Co. loaned the college one of their consolidation locomotives, No. 1769, for the purpose of limbering up the laboratory machinery and for making a preliminary test on the locomotive. The engine was brought out to the college over the Ames and College electric line, brought to the building and run into place and anchored to the dynamometer post by means of heavy bars fitted with turnbuckles, after which the removable track was dropped, the smoke jack connected up and everything was ready for firing up.



Engine number 1769 ready for test

The preparing of a locomotive for an efficiency test and the testing of it requires attention to many details. The following is a general outline of what may be considered the most important items in such a preparation and test. Road engines require a great deal of work done in fitting up sampling tubes, indicator rigging, putting in thermometer wells, etc., and in the doing of this work and the application of the instruments great care should be taken both for the convenience of the observer and the securing of readings that will represent true conditions. Before starting the test, this data should be taken.

Circumference of all driving wheels.

Diameter of cylinders.

Stroke of piston.
Clearance of volume, head and crank ends, both sides.
Piston rod diameter.
Size and type of valve.
Greatest valve travel.
Steam lap.
Exhaust lap.
Type of valve gear.
Type of boiler.
Size and number of tubes.
Total heating surface.
Type of superheater.
Size and number of superheating tubes.
Superheating surface.
Size of fire box.
Style of grates.
Air inlets into fire box.
Type and size of exhaust nozzle.

The above items are of special importance when comparative tests of different locomotives are made.

When the test is under way, it is very important to keep the steam pressure, quantity of coal fired at each firing, the thickness of fire and other firing operations as uniform as possible.

The rate of supplying feed water should be as uniform as possible throughout the test and the water level (about second gage cock) should be maintained from start to finish.

The duration of the test depends upon the character of the fuel used, the rate of combustion and the working limitations of the revolving parts. The test should preferably be continued until at least 25 pounds equivalent evaporation of water per square foot of heating surface have been obtained. The maximum limit will be three hours, when the coal and water performances are uniform.

In starting the test, the locomotive should be run at the speed of the test a sufficient length of time to build up a level fire and it should be maintained throughout the test as nearly as possible. The ash pan should be cleaned at the starting signal and when the test is completed the collected ash should be dumped immediately. The same should be done with the front end cinders if there are any.

In a laboratory test it is desirable to have observers enough to take all the important readings simultaneously. The following arrangement would take care of this.

Foreman of test	1
Data	1
Brake wheel operator	1
Dynamometer observer	1
Cab and coal observer	1
Temperature and pressures	1
Speed, boiler pressure, drafts and pyrometers	1
Water observer	2
Indicator observer	2
Gas sampler	1
Oilers	2
Engine operator	1
Fireman	1
Coal passers	2
Total number of men	18

There should, in addition to this, be a chemist to make analysis of coal and ash.

The following observed data should be taken:

Duration of test.
R. P. M. of engine.
R. P. M. of support wheels.
Position of throttle lever.
Position of reverse lever.
Temperature in smoke box.
Temperature in fire box.
Temperature steam in branch pipe.
Temperature steam in exhaust passage.
Temperature of feed water.
Pressure in boiler.
Pressure in branch pipe.
Pressure in exhaust passage.
Draft in smoke box, front of diaphragm.
Draft in smoke box, back of diaphragm.

Draft in fire box.
Draft in ash pan.
Injectors, time in action.
Quality of steam in dome.
Quality of steam in branch pipe.
Kind of coal fired.
Pounds of coal fired.
Pounds of ash.
Pounds of cinders collected in smoke box.
Analysis of smoke box gases.
Pounds of water delivered to injectors.
Pounds of water delivered to boiler.
Dynamometer pull in pounds.
Indicator cards.

The following is a summary of average results:

Duration of test, hours.
Number of revolutions per minute.
Speed in miles per hour.
Throttle opening.
Reverse lever position.
Boiler pressure.
Superheat in branch pipe.
Draft in smoke box, inches water.
Draft in fire box, inches water.
Draft in ash pan, inches water.
Calorific value of fuel.
Dry fuel fired per hour.
Dry fuel fired per hour for sq. ft. of grate.
Water delivered to boiler, pounds per hour.
Equivalent evaporation from and at 212°, pounds per hour.
Equivalent evaporation, lbs. per hour per sq. ft. of total fire heating surface.
Equivalent evaporation in lbs. per pound of dry fuel.
Boiler horse power.
Efficiency of boiler, based on fuel.
Dry steam to engine lbs. per hour.
Indicated horse power.
Dry fuel per I. H. P. hour, lbs.
Dry steam per I. H. P. hour, lbs.

Draw bar pull in pounds.

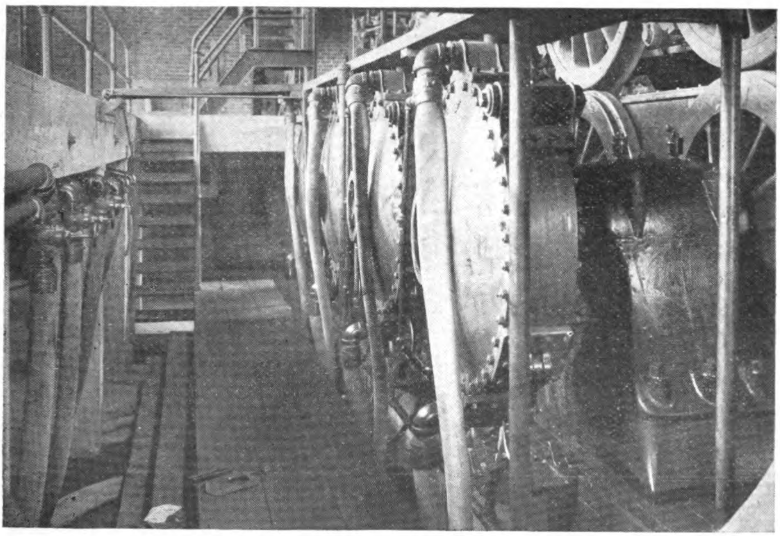
Draw bar horse power.

Dry fuel per D. H. P. hour, lbs.

Machine efficiency of locomotive, per cent.

Thermal efficiency of locomotive based on fuel, per cent.

Having made the observations suggested in the preceding and calculated the results, there will be information available which will give a clear and definite idea as to just what the locomotive is doing.



View showing the support wheels and water brakes

The testing laboratory may be made useful to railroad companies in many ways. It not only gives them means of knowing the efficiency of the locomotive as a whole, but may be used to test out different locomotive appliances, such as superheaters, brick arches, grates, etc., under conditions that are constant, which is impossible in road service.

In a comparative test of fuels, a laboratory test would be a cheaper means of securing results than road tests, because only a small number of tests need be made to get the results sought.

It is hoped that the locomotive testing plant of the Iowa State College may prove useful in many ways to the railroads of Iowa.