

and in some instances a temperature of 580 deg. Fahr., was slightly exceeded. The Vaughan-Horsey superheater in freight service showed a temperature in the steam chest of 500 deg. Fahr., averaging from 480 deg. Fahr., to 520 deg. Fahr., according to the working of the engine. Experiments that have been made appeared to show that with this style of superheater a rather higher degree of superheat is obtained with a corresponding number of superheater tubes than with the Schmidt superheater, probably due to the form and arrangement of the headers, but it has been found that no increase in the temperature of the superheated steam is obtained when four superheater pipes are included in one element, or in other words, when the steam is caused to travel through four superheater pipes in its passage from the superheated steam header to the saturated steam header. With the Schmidt superheater, this increase takes place and the superheat obtained is practically the same as with the Vaughan-Horsey arrangement.

Fourteen administrations in the U.S. have experimented with engines using superheated steam, the number of engines reported being 70 in all. The majority of these are equipped with the Vauclain superheater which is somewhat similar to the Schmidt smokebox superheater, with the exception that the large flue used in the latter design by which a high temperature is obtained in the superheater is not used. Information is not available as to the actual result obtained by this superheater, but the tests reported would indicate that the temperature of the steam in the steam chest is from 25 deg. to 40 deg. Fahr.; above that corresponding to the pressure of the steam in the boiler. This test also showed a saving in coal consumption of 11% as compared to a corresponding simple engine. Results reported by other administrations using superheaters of the Schmidt or Cole return bend type are universally favorable to a more extensive use of this device.

Accurate figures are not obtainable but the saving reported in fuel varies from 10 to 28% as compared to corresponding simple engines. Neglecting the extreme figures given it would appear that the experience on these roads very well confirms the average results reported for the C.P.R.

An extensive series of tests was conducted at Purdue University by Prof. Goss for the Carnegie Institute, Washington, D.C., the results of which were presented by him in a paper read before the American Railway Master Mechanics Association in 1909. The economy in fuel obtained with a temperature of the superheated steam of about 150 deg. Fahr., above that corresponding to saturated steam at the boiler pressure averaged from 10 to 15%, and deductions were drawn to show that with a boiler pressure of 180 lbs. per square inch and steam superheated 200 deg. a saving of 19% should be anticipated. This report was criticised at the convention as possibly under-estimating the saving that could be obtained. In the first place, on account of the boiler of the engine on the testing plant being comparatively small, the application of a smoke tube type of superheater reduced the amount of evaporating surface to a greater extent than is the case when the same apparatus is applied to a larger boiler. In the second place the comparisons at high pressures were made against the saturated steam engine under testing plant conditions in which steam leaks of every description were as far as possible eliminated thus obtaining better results on the high pressure saturated steam engine than would be possible in actual service. The results obtained on the testing plant, were also compared upon the basis of equal rates of evaporation,

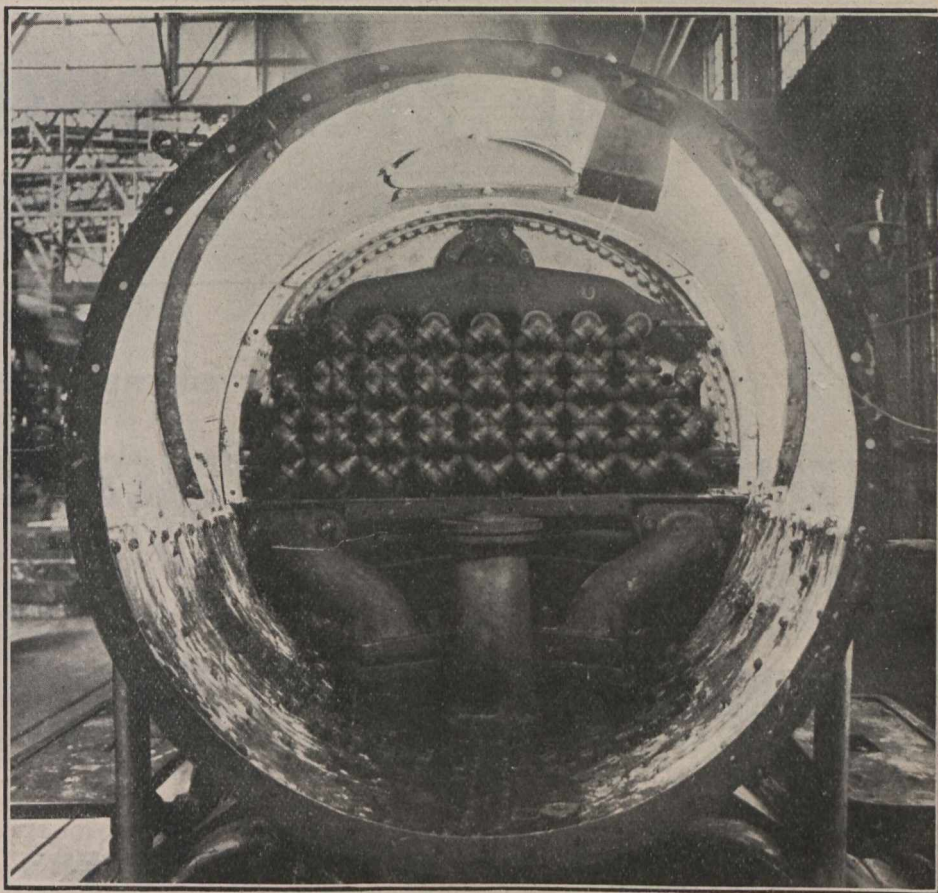


Fig. 41.

while under service conditions, in which an engine using superheated steam is worked in comparison with one using saturated, the comparisons are actually referred to equal amounts of power developed. This leads to two possible explanations of the greater economy reported in road service than that obtained in a testing plant. The first is that whereas with the smoke tube type of superheater, in which steam of a greater thermal value is delivered to the engine, and a portion of the products of combustion are ejected at the front end of the boiler at a higher temperature than would be the case in an engine using saturated steam, it would be expected that the economy in water consumption would be greater than that in fuel, it is universally reported that actual experience shows the reverse. This would at first appear contradictory but consideration will show that as the efficiency of the boiler varies with the rate at which it is worked, any saving in the steam consumption will lead not only to a corresponding saving in fuel consumption, but to a greater saving, in proportion to the decrease in the rate of combustion. Thus, assuming a decrease in the steam consumption when an engine is exerting a given amount of power of 20% and neglecting the difference in the evaporative efficiency of a boiler delivering superheated steam from one delivering saturated steam, a decrease of 20% in the steam evaporated will lead to a decrease in the coal consumed of from 25 to 30%, on account of the lower rate of combustion and the more efficient transfer of the heat from the products of combustion to the water in the boiler. This increase in efficiency is evidently more than sufficient to balance the decreased efficiency of the superheated steam boiler as compared to the ordinary boiler, and the anomaly of the greater saving in coal than in water is thus explained. In the second place any cause

leading to a reduction in the demand on the fireman enables him to fire more carefully and by doing so obtain better results than when his energies are over-taxed. On a test plant this condition does not exist as the firing is uniformly performed with the greatest care in order to obtain comparative results, but in road service the reduced consumption of steam of a superheater engine may lead to a greater economy than anticipated owing to more economical firing.

The general experience in Canada and the U.S. therefore with regard to the use of superheated steam may be summarized by the statement that a substantial economy in coal has been effected, that on account of conditions this economy is not as great in freight service as in passenger service, and in the latter a considerable benefit is obtained from the increase in the capacity of the engine. As against this advantage there are two possible disadvantages, viz., an increase either in the cost of maintenance or in the number of failures or breakdowns on engines when hauling trains.

With reference to the cost of maintenance no figures are available except on the C.P.R. and on this road comparisons are made difficult, by the fact that for some years previous to the introduction of the simple engine using superheated steam, the engines constructed had been of the two cylinder compound type which have proved exceedingly expensive to maintain. It is therefore impossible to present accurate figures comparing an ordinary simple engine with those of a corresponding type using superheated steam, but it may be stated, that a careful study of the cost of repairs on this road shows that the cost of maintenance of superheaters is little, if any greater than that which would be expected from an ordinary engine. The addition of any de-