THE VALUE OF THE STEAM PIPE WITHIN THE SMOKE BOX OF A LOCOMOTIVE, AS A MEANS OF SUPERHEATING. By WM. F. M. GOSS.

The pipe connection, by which steam is conveyed from the boiler to the engines of an American locomotive, begins at the throttle valve within the dome of the boiler, and extends forward along the inside of the boiler until it finally passes out through forward head into the smoke box. Here it receives a fitting known as the "T-head," from which branch pipes leading to the cylinders on either side of the machine. The T-head and the two branch pipes are exposed to the temperature of the smoke box, which, when the engine is in action, is several hundred degrees higher than the temperature of the steam within the pipes, and it is therefore evident that the latter must receive some heat from the smoke box in its passage through these pipes. The amount of heat thus transmitted, however, has always been a matter of speculation.

Designers of compound locomotives have often arranged an enlarged pipe within the smoke box to serve in the double capacity of receiver and re-heater, the expectation being that the steam exhausted from the high pressure cylinder would be dried, or even superheated, by its passage through this pipe in its course to the lower pressure cylinder. To throw some light on the extent of the drying or superheating effect, as well as to settle another question at issue, the following experiment was made upon the Purdue experimental locomotive:

A thermometer having been inserted in the T-head, another in the middle of one branch of the steam pipe, and a third in the saddle close to the valve-box, the locomotive was run with the throttle partially open, the drop in pressure from the boiler to the pipe being sufficient to superheat all of the steam at the lower pressure. It is evident that a change in the quality of the steam as it passed from one thermometer to another in its course to the cylinders would be at once detected by a change of temperature.

The conditions of the test were maintained for half an hour or more before observations were taken, after which time the thermometers were read and other observations taken simultaneously at five minute intervals for a second half hour. The following is a summary of results:

Smoke box temperature	700. ° F
Increase of smoke box temperature over temperature of steam in the boiler	345. ° F
Temperature in T-head	335.30° F

Temperature in middle of steam pipe . . . . . 339.65° F
Temperature in saddle . . . . . 327.87° F
Pressure in dry pipe by gauge . . . . . 70 lbs
Temperature of saturated steam at pressure in dry pipe . . . . 315.68° F
Approximate time occupied by the steam in passing the steam pipe . . . . . 0.1 seconds

It will be seen that the temperature of the steam was increased 4.4° F in passing half the length of the branch pipe, which is equivalent to a gain of 8.8° F in its passage through the whole length of the branch pipe. The transfer of a quantity of heat represented by this increase of temperature would affect moist steam by increasing its dryness about 0.5 of 1 per cent., an amount too small to affect the efficiency of the whole machine to any measureable extent.

The thermometer in the saddle indicated a temperature of 9.4° F lower than the temperature in the T-head, and 18.2° lower than the presumable temperature at the end of the steam pipe, so that, from the T-head to the cylinder, there is no gain, but an actual loss of heat by the steam. This effect is to be accounted for in the fact that the mean temperature within the cylinders is much lower than the temperature of the incoming steam, which, combined with the effect of radiation from the saddle, operates to lower the temperature of the iron which surrounds the steam in its passage through the saddle. It is certainly clear that the cooling effect of the saddle more than offsets the gain in heating effect secured from the smoke box.

The conditions were varied and all of the work repeated several times with the same general results. The figures given represent the test giving the greatest heating effect.

Enlarging the pipes within the smoke box would have a beneficial effect in increasing the action herein considered, since it would add to the extent of heating surface and lengthen the time occupied by the steam in passing the same, but, as a practical matter, a limit to such enlargement is soon reached.

As affecting the reliability of results, it may be said that the thermometers used have a range of from 100 C to 200 C and read to $\frac{1}{5}$ of a degree. They were inserted in long tubes, and at the T-head and at the middle of the steam pipe these tubes were protected by allowing steam to flow past them under pressure into the atmosphere. Before being used the thermometers were carefully compared when in the identical tubes used upon

the locomotive by subjecting them to saturated steam of about the same temperature as that recorded in the experiment. The reading of one was accepted as standard, and the errors of the other two determined.

AN EXPERIMENTAL STUDY OF THE ACTION OF THE COUNTERBALANCE IN LOCOMOTIVE DRIVE-WHEELS. By WM. F. M. GOSS.

In the mechanism of the locomotive, the mass of the reciprocating parts (piston, piston rods, crosshead, etc.) is balanced to a greater or less extent, by the addition of masses to the drivers, known as counterbalances. But the counterbalances move in circular paths, so that it is only the horizontal component of the radical force derived from them that serves to neutralize the effect of the reciprocating parts; while the vertical component of these counterbalances is an unbalanced force causing the pressure of the drivers on the rails to vary with every revolution. The extent of the disturbing effects of this unbalanced vertical component has long been a question of serious concern to the locomotive designer; but in this country, at least, they have found but little light to guide them. It has been difficult to ascertain enough of the conditions existing at any phase of the wheel's motion to serve as a basis for satisfactory mathematical work, and no solution has as yet been presented which will enable the designers to anticipate effects which are incident to the action of the completed machine. Practical demonstrations, however, are not wanting. Bridges are shaken until they fall, and rails are actually crooked under the stresses brought upon them by locomotives passing at high speed.

It occurred to the writer that in the case of the Purdue experimental locomotive a study could be made of the extent of this changing pressure of the wheel upon the rail, by feeding a wire under the wheel and by making use of the resulting variations in its thickness. This was first accomplished last spring, but the most satisfactory results have been obtained during the term just closed. A light mark made with a cold chisel across the face of the wheel leaves its impression in the wire and furnishes the desired reference point, by means of which particular effects may be connected with their appropriate wheel positions.

The following, concerning one of the rear drivers, may be of interest:

The pressure which this wheel exerts upon the rail when at rest is 7 tons, and its counterbalance, reduced to the radius of the crank pin, weighs