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

400 pounds more than is necessary to balance the revolving weights at the crank pin, that is, so far as vertical effects are concerned, the wheel is 400 pounds out of balance.

Wires which have passed under the wheel at speeds below 30 miles do not vary greatly in thickness. At a speed of 59 miles (333 rev.) however, a very short section of the wire is left entirely round, showing clearly that at this speed there is an instant in the revolution of the wheel when it exerts absolutely no pressure upon the rail, and making it fair to assume that there is another instant when it exerts double the pressure it transmits when at rest. In other words, in half a revolution, occupying less than a fifth of a second, the wheel pressure varies from nothing to 14 tons. The increment of the pressure is really more rapid than this, for it is found that the maximum lift occurs after the counterbalance has passed the vertical by a considerable angle. During the upward action the wheel lags and during the downward action there is a corresponding acceleration.

For speeds above 59 miles the undamaged portion of the wire is longer. Thus for 65 miles it is about 45 inches, showing the wheel to be off the rail for almost a quarter of a revolution, and its return to the rail is correspondingly rapid. The destructive effect of such a blow is enormous.

Complete wires are shown, also a diagram of a typical wire taken at 65 miles in which the vertical scale is greatly increased and the horizontal scale is diminished as compared with the actual dimensions of the wire. This diagram shows, as do all the wires, the lagging of the wheel in its upward motion and the rapidity of its return to the rail.

In addition to the immediate results yielded, this experimental investigation may serve as a means to a more complete mathematical analysis of the subject. This latter phase of the work is now being very skillfully developed by Mr. Daniel Royse, M. M. E., Junior member of the A. S. of M. E., to whom, also, I am indebted for numerical results derived from a study of many wires.

THE COLUMBIAN MUSEUM. By JOHN M. COULTER.

[ABSTRACT.]

An explanation of the organization of the Columbian Museum and its scientific possibilities.