Find from Chart No. 1—

a = 3,504 feet per second.

h = 331 feet.

Critical time $T_o = \frac{2L}{a}$ = 5.7 seconds.

Commencing on the right-hand side of the chart, we find on the scale for "diameter of pipe in inches, D," the value 36. From this value of 36 pass a line through value, ½ inch on the scale of "thickness of pipe walls, in inches, d," and produce line to cut scale for "ratio of $\frac{D}{d}$," which gives the value 72 for $\frac{D}{d}$. From this value of 72 on the scale for "ratio of $\frac{D}{d}$," draw a line through the value of 4,000,000,000 on the scale for "modulus of elasticity of pipe material in tension, in pds. per square foot, E," and produce to cut the scale for "velocity of vibration along pipe in feet per second," which gives the value 3,504 for a. Now go to the left-hand side of the chart, and on the scale for "velocity of vibration along the pipe, in feet per second, a," find the value 3,504, and from this point draw a line passing through the value 3 on the scale for "velocity of water in pipe before gate closure, in feet per second, V," and produce line to cut the scale for "excess head, in feet, due to water hammer, h," which gives the value of 331 feet. This is the maximum excess pressure over and above the static pressure that can be obtained if the time of gate closure is less than $\frac{2L}{a}$, or 5.7 seconds.

Problem 2—Chart No. 2.—Find the probable pressure rise in a penstock 240 feet long, 72-inch diameter, made of ½-inch plate, carrying water at a velocity of 10 feet per second, when the time of gate closure is 3 seconds, and static head 150 feet. For ordinary water hammer or pressure rise, the time of gate closure, T, must be greater than $\frac{2L}{a}$ and for this case Chart No. 2, for Allievi's formula, must be used. In order to check the value of T one must resort to the use of Chart No. 1, to obtain the probable value for a. This problem will be worked out in detail similarly to the previous problem.

Given: L = 240 feet.

D = 72 inches.

d = ½ inch.

H = 150 feet.

$\frac{L}{H}$ = 1.6.

V = 10 feet per second.

E = 4,000,000,000 pds. per square foot.

Material = steel plate.

Find—

h, from Chart No. 2, = 28 feet.

a, from Chart No. 1, = 2,950 feet per second.

T_o, critical time, = 0.163 seconds.

Commencing on the right-hand side of the chart, join the value of 3 on the scale for "time of gate closing or opening in seconds, T," with the value of 1.6 on the scale for "ratio of length of pipe to static head, $\frac{L}{H}$," and mark the point of intersection of this line with the "support." Next, find the value of 10 on the scale for "velocity of water in pipe before gate closure, in feet per second, V." Draw a line through the point of intersection on the "support" of the previous line and produce to cut scale for "percentage of pressure rise in pipe due to gate closing, $\frac{h}{H} \times 100$," and read the value of 18.5. Now go to the left-hand side of the chart, and from the value of 150 on the scale for "normal static head, in feet, H," draw a line passing through the value of 18.5 on the scale for "percentage of pressure rise or drop in pipe, $\frac{h}{H} \times 100$," to intersect the scale for "excess head, in feet, due to water hammer, h," and read the value 28 feet for h.

Chart No. 2 will be found useful for solving many problems in hydro-electric work. For instance, Mr. Wm. F. Uhl in his paper on "Speed Regulation in Hydro-Electric Plants," published in the proceedings American Society of Mechanical Engineers, 1912, uses the value of $\frac{h}{H} \times 100$ (percentage of pressure rise or drop), in his formulæ for speed variation. The above chart is therefore applicable to the formulæ found in this paper.

The value for pressure drop obtained from Chart No. 2 may be used for checking up pipe lines with long, flat gradients at the upper end, in order to see that the head necessary for accelerating the water for various times of gate opening is kept less than the static head on the pipe at every point. This will avoid any chance of inward pressure which might cause the pipe to collapse.

In dealing with pressure rise in wood-stave pipes the correct value for E (modulus of elasticity of pipe material, in pds. per square foot), to use in obtaining the value of a (velocity of vibration along the pipe, in feet per second), would logically appear to be that for steel, as the steel bands alone resist the water pressure. In order to figure the value of a, it would seem consistent to assume in place of the wood-stave pipe a steel pipe made of plate, of such thickness as to have an equivalent area of steel per lineal foot as that contained in the steel bands.

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RAILROAD EARNINGS.

The following are the weekly earnings of Canada's transcontinental lines during November:—

Canadian Pacific Railway.

	1916.	1915.	Increase.
November 7	$3,036,000	$3,015,000	+ $ 21,000
November 14	3,051,000	3,035,000	+ 16,000
November 21	2,984,000	2,960,000	+ 24,000

Grand Trunk Railway.

November 7	$1,244,959	$ 986,765	+ $258,194
November 14	1,283,901	971,715	+ 312,186
November 21	1,202,291	935,884	+ 266,407

Canadian Northern Railway.

November 7	$ 885,000	$ 806,500	+ $ 78,500
November 14	825,100	820,800	+ 4,300