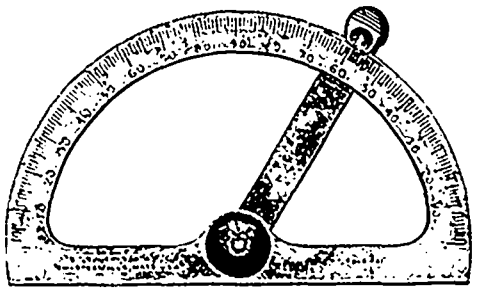
ANGLE INDICATOR.



(FAY'S PATENT).

This tool is what its name implies. It is to be used in connection with a universal bevel for transferring any given angles. It will produce a given degree as accurately as any micrometer protractor, but not the minutes. It is nicely graduated from 0 to 90 deg., reading from both ends, and it is finished in the Stevens Arms & Tool Co.'s usual superior manner. We cannot emphasize too strongly its great usefulness. It is stated that it should be in the hands of every machinist, tool-maker, draughtsman and metal sheet worker, in fact, any person who desires a handy angle indicator.

CONCRETE RAILWAY STRUCTURES.*

BY F. G. JONAH, M. CAN. SOC., C.E.

That concrete possesses many great advantages in the construction of railway structures is being more generally appreciated from year to year, and with the increasing interest in this class of work the writer feels warranted in presenting to the members of this society some designs of concrete culverts and bridge piers. These structures are particularly well adapted for use in the construction of new lines of railway, owing to the comparative ease with which the material for making concrete can be transported, as against heavy stone-work. The use of derricks for loading and unloading material and specially constructed wagons for heavy hauling are not necessary in concrete work, and, as it can be made with cheap, unskilled labor, a great saving in the wages of the force employed is thus effected. These culverts have a decided advantage over cast iron pipes on new works, owing to the great cost of transporting the pipe, but for renewals on old roads, cast iron pipe, up to five feet in diameter, is excellent. They will be much safer from washouts, however, if the ends are protected by wings, for which nothing is better than the concrete ends shown on the culvert plans. The plans submitted ranged in size from an 8 inch sewer pipe, with concrete ends, up to a five foot arch culvert. In 1894 the writer built upwards of thirty culverts after these plans, and up to the present time there has not been a failure of any kind about them.

The arches were turned with hard brick; in a larger culvert they could be made entirely of concrete, but for a small semi-circular arch there would be difficulty in holding the fresh concrete in place. In the construction of these culverts, wooden forms are necessary for the work above the bottom or pavement line. The forms are practically moulds into which the concrete is dumped. They should be made of lumber not less than 1½ inch thick, dressed on the side next to the concrete. They should be well made and held together with clamps, to facilitate putting up and taking apart rapidly. If carefully used, one set of forms will serve for a great many culverts. For that portion of the culvert which is in the ground, including the back of side walls, the earth should be carefully excavated to the exact form of the culvert, any irregularities or holes beyond the figured dimensions will represent a waste of concrete. In putting the concrete in place, great care must be exercised in tamping it thoroughly, to insure a close contact with the forms. If this is not done, the work will present a honeycomb appearance when the forms are removed. Forms should be left standing in place until the concrete has partially set. It was found in this work that to make one cubic yard of concrete required 1.17 barrels Portland cement, 24.5 cubic feet of broken stone and 9.3 cubic feet of sand. To make a cubic yard of brickwork required 400 ordinary size brick and .93 barrels natural cement. The material was hauled an average distance of three miles, and cost on cars as follows:

Portland cement, per bbl.	$2 90
Louisville cement, per bbl.	90
Machine crushed macadam, per cubic yard	2 10
Sand per cubic yard	80
Brick, per M.	8 00

The following rate of wages was paid:	Per day.
Teamster, man and team	$2 50
Bricklayers	2 50
Concrete gang:	
Foreman	2 00
One laborer	1 50
Six laborers at	1 25

The average cost on all culverts was:	
Earth excavation in foundations	$ 35
Concrete per cubic yard	6 80
Brick-work per cubic yard	7 70

*From a paper read before the Canadian Society of Civil Engineers.

TORONTO WATER WORKS CONDUIT.

The first or north section is that across the harbor from the pumping station to Hanlan's crib. It consists of two pipes nearly parallel, the westerly pipe 3 feet in diameter, of cast iron, with each joint flexible, laid in 1874; the easterly pipe of steel, 4 feet in diameter, laid in 1889 and 1890; the length of this section is 4,660 feet. The second or central section is that through Blockhouse Bay and across the Island from Hanlan's crib to the shore crib. It consists of two parallel pipes, the southwesterly one of wood, 4 feet in diameter, laid in 1873, 1874, 1875 and 1876, but abandoned on the completion of the second pipe, which was laid in 1889 and 1890. The northwesterly and new conduit is of steel, 5 feet in diameter. The length of this section is 6,027 feet. The third or south section is that in Lake Ontario, from the shore crib to the intake. A wooden pipe 6 feet in diameter for a distance of 2,357 feet, laid in 1881 and 1882. This section was extended a distance of 365 feet in 1890 and 1891. This extension is of steel 6 feet in diameter, making the total length of this section 2,722 feet. The manholes are of iron, with a trap-door at the top of each, not air tight.

(For profile of conduit see City Engineer's Report, 1893, pp. 3 and 4. This shows the depths to top of conduit, the filling over it, the points where pipe broke, etc.).

In the latter part of 1893 after the conduit had been fully repaired, the friction head was measured and found as follows: "While by D'Arcy's formula the head consumed on the 6-foot pipe was sufficient to deliver 32,000,000, on the 5-foot pipe 28,000,000, and on the 4 and 3 foot pipes, 20,000,000 per 24 hours, or expressing it in friction head, the total measured head was 6.5 feet to deliver 22,500,000, against a calculated head of 3.91 feet, showing a loss of 2.59 feet, the water in the lake being 1 foot 0 inches above zero." (See pp. 31 and 32 City Engineer's Report, 1893). The actual head in each section is given in this Report, but it is evident that the 6-foot section was not carrying the water it should. In examining it since the last accident, sand was found in it to a depth of 2 feet in places. Making an approximate calculation for the obstruction in the 6-foot pipe, and taking a higher coefficient for roughness the theoretical head in each section necessary to deliver 22,500,000 of gallons per 24 hours would be as follows:

	Head.
North Section—4 foot and 3 foot pipes combined. 4,660 feet long	3.09 feet.
Central Section—5 feet diameter, 6,027 feet long	2.65 feet.
South Section—6 feet diameter, 2,722½ feet long	0.85 feet.
Actual head	6.50 feet

With the lake 18 inches below zero it will be found that the hydraulic grade line when delivering 22,500,000 gallons at pump well, will touch the top of the 4-foot conduit at one point only, that is, 125 feet north of Hanlan's crib, at which point the conduit rose in 1892, and again in 1895. On the profile of 1893 it is shown as uncovered with sand. In the second section the top of conduit is above the hydraulic grade line for nearly half its length, at one point being half the diameter of the pipe