ever, if the work was done quite as thoroughly as the specifications demanded; the frequency of breaches of the canal banks seem to indicate a disregard of some of the requirements.

WATER SUPPLY.

Next to maintaining the integrity of the canal banks came the question of water; how to get enough, and how to guard against too much. The Connecticut canal was fortunate in the relation of the Farmington River. A dam just below Unionville, and three miles of a feeder canal—which, incidentally, would have been a part of the New Hartford canal, had that "side cut" as it was termed, been built—delivered what was supposed would be an abundance of water to what was almost the highest level. Losses through the soil, particularly that of the Hamden Plains, as well as evaporation, however, necessitated additional supplies, and all along the line such brooks as were at the proper elevation were led into the canal, while from time to time spillways were built to take off any excess due to rain. Failure to realize the amount of water which would have to be so wasted led to some bad washouts, the over-full canal spilling over its banks, until the necessary additional spillways and waste gates were provided.

The short summit level at the Connecticut-Massachusetts boundary was first fed from the Congamond Ponds, but the possibilities of this supply had been over-estimated, and there was trouble over water rights, eventually leading to a feeder from the upper water of Salmon Brook.

In Massachusetts, the Congamond Ponds fed the flight of locks leading down into the Westfield Valley; the valley level itself had a feeder from Little River; while a large feeder from Westfield River, taken off from above the falls at Woronoco, and carried six miles across country, fed the summit north of Westfield and the levels from there down to the Connecticut River.

STRUCTURES

The canal was taken over such brooks as were too low to be led into it. In Connecticut, with the exception of the Farmington River and Mill River crossings, this was done by stone arch culverts, a number of which exist today in various conditions. All are of the same general type; except where on a rock foundation there is a plank floor which extends under and carries the side walls, and which, unless the engineer deemed it unnecessary, is "protected" by piling at each end. The side walls, which are about two feet high regardless of span, and the semi-cylindrical barrel are of rubble, usually laid in "water lime," or natural cement, as are also the headwalls, the ends of which are curved. The ring stones are cut, but are frequently of varying sizes in the same ring, and in some instances there not only is no key stone, but the nearest stone to that position is one side of it.

These culverts range in span from four feet up to the beautiful forty-

FIG. 5. TYPICAL STONE CULVERT UNDER CANAL.

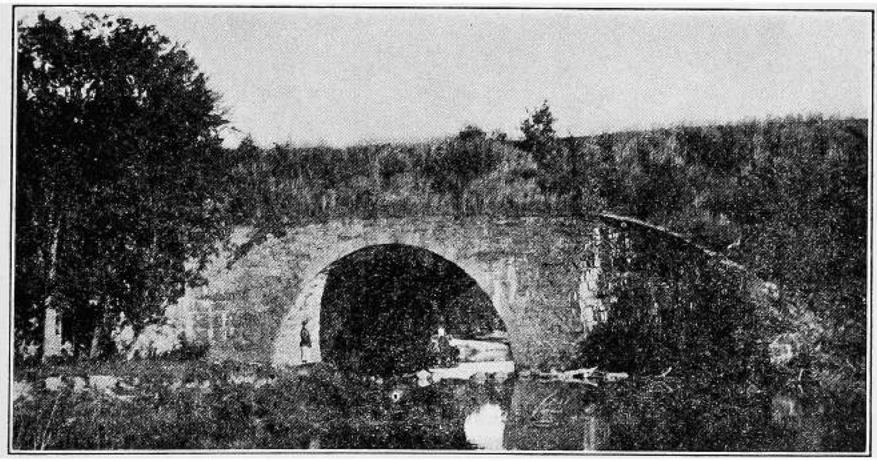

FIG. 6. ARCH CARRYING CANAL OVER SALMON BROOK, GRANBY, CONNECTICUT.

feet span arch over Salmon Brook at Granby, particularly interesting as being the third attempt to span this brook, the two first ones having been washed away by floods. No information has been found as to the first other than it was wrecked before August 31, 1826, for on that date the Superintendent and the Engineer were instructed to determine whether to rebuild or to substitute an aqueduct. The bids for rebuilding were asked for on September 16; the culvert was to be of forty feet span, of stone laid in water lime, and the price per perch (24¾ cubic feet) of masonry was to include laying "and securing" the foundation, which was to be of stone or timber at the option of the Engineer.

Whatever was done, the culvert went out again in the flood of September 4, 1828, but presumably on October 3, 1829, it was reported completed. The third time evidently was "the charm" for it is today carrying the tracks of the Northampton branch of the New York, New Haven and Hartford Railroad.

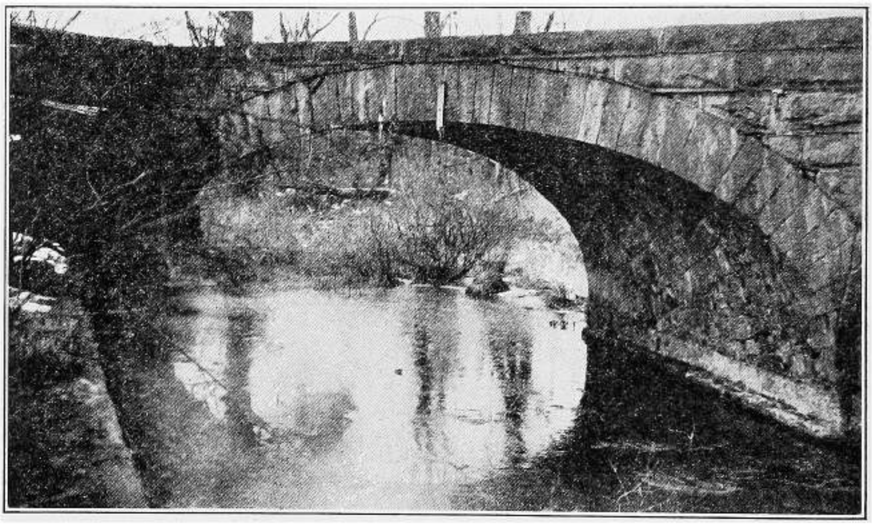

FIG. 7. SKEW ARCH CARRYING RAILROAD OVER CANAL NEAR BROOKSVALE, CONN.

In Massachusetts the majority of the culverts are gone, a very short section of what was a very long twelve-foot span arch culvert which carried the upper level feeder from Westfield River over Moose Meadow Brook, near Woronoco, being the only example of arch culvert remaining. Near Northampton, there are several box culverts under the Northampton branch at points where the latter now occupies the site of the canal, but while it is probable these were built for the canal, this is open to question.

There is in Connecticut an arch culvert which, while not built as a part of the canal, was constructed to permit the canal to operate while the railroad operated over it. Located near Brooksvale—it is Bridge 13.00, that is, 13 miles from New Haven station, on the Northampton branch —it is a multicentered helicoidal skew arch. The arch consists of a tangent 2 feet long on each side, next 6 feet of a 6 feet radius circle each side, and finally a central arc 12 feet long of 12 feet radius. The normal span is 18 feet, but the heavy skew angle gives an opening at the face of 28 feet. Its particularly interesting feature however is in the development of barrel beds to be approximately normal to the theoretical pressure lines, these beds starting horizontally and then curving down to make an angle of approximately 30° with the horizontal.

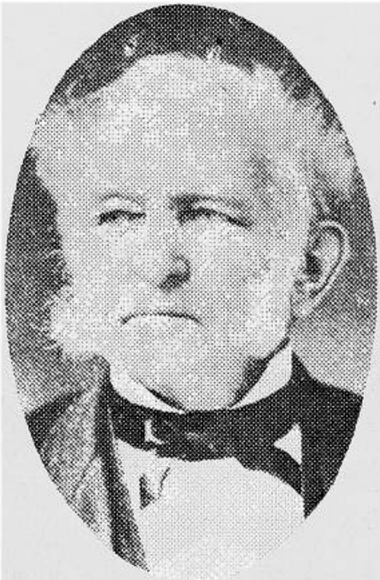

FIG. 8. HENRY FARNAM, ASSISTANT AND LATER CHIEF ENGINEER.

This was the work of Henry Farnam, who succeeded Davis Hurd as Chief Engineer about 1828. Another farm-boy, Henry Farnam was born at Scipio, New York on November 9, 1803 and had much the same type of education as Benjamin Wright and Davis Hurd, the latter being a relative by marriage. In 1821, through Davis Hurd's assistance, he was taken on the surveying party of David Thomas, then Chief Engineer of the Erie Canal west of Rochester. Starting in as cook, the only position vacant, he soon had opportunity to show his ability and was rapidly advanced. Davis Hurd brought him to the Farmington Canal as his second assistant, at the princely salary of one dollar a day and expenses, Hurd as Chief Engineer receiving at that time $2000 a year and expenses.

Just when Henry Farnam became Chief Engineer is not clear. Davis Hurd was Chief Engineer of both companies as of September 30, 1826, for the contracts for the construction of the Hampshire and Hampden Canal, of that date, say:

> "And it is further agreed by the parties that Davis Hurd Esquire shall be the chief engineer on said canal etc. etc."

His resignation, "at least until the next spring" was accepted November 19, 1829, and Wm. H. Butler was temporarily employed in his place. Farnam's biographies say he became Chief Engineer of the

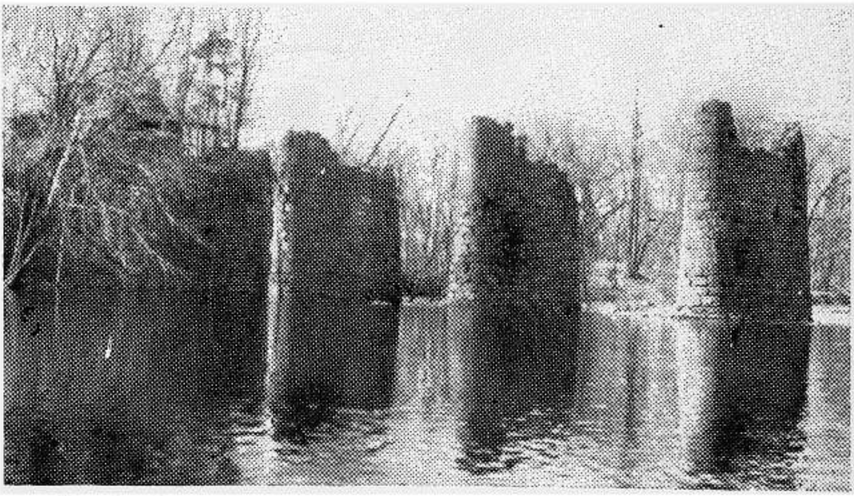

Fig. 9. Abutment and three piers of Farmington River Aqueduct.

Farmington Company in 1827, but while the minutes of that company from 1826 record increasing responsibilities rested on him, and refer repeatedly to the "Chief Engineer", there is nothing to show who the latter was, and some of the 1828 references are of a character to at least make it a question if it was Farnam. In any event, soon after Davis Hurd's resignation from the Hampshire and Hampden Company Henry Farnam became Chief Engineer, first of both companies, and then of the successor company, the New Haven and Northampton Company, from which he resigned in 1850, at which time the Directors, in resolutions of appreciation, said:

> "For the uniform fidelity with which Mr. Farnam has performed all the duties devolving upon him; for the unimpeachable integrity with which the many thousand dollars, which have passed through his hands, have been expended; for the unshaken confidence with which he carried forward