pendicular pipes, where they were united to the elbow, the same. The faces of these collars were made smooth, so as to fit close to, and at the same time turn on each other; loose flanches on the pipes were bolted to others on the elbow, and thus drew the collars together so as to prevent water from leaking through. Now it will be seen that although the joint which unites the elbow to the perpendicular pipe would allow the jet pipe to be turned in a lateral or horizontal direction, there appears no provision to raise or lower it, and no apparent use at all for the joint. We were at first at a loss to divine how the stream could be directed up and down as occasion might require, for Belidor has not explained it; but on examining more closely the figure in his work, we found that the jet pipe itself was not straight, but bent near its junction with the elbow. This solved the mystery, for it was then obvious that by twisting this pipe round in its joint, its smaller orifice could be inclined up or down at pleasure.

The pumps of the engine at Ypres are substantially the same as those of the last, but the piston rods are moved by a short vibrating beam placed directly over the cylinders. The axle of the beam is continued through both sides of the wooden case, and to its squared ends two iron rods are fitted, like crank handles on the axles of grindstones. To the lower ends of these rods are attached, by bolts, two horizontal bars of wood, on the outside of which a number of long pins are inserted. When the engine was in use men laid hold of these pins, one man to each, and pushed and pulled the bars to and fro, somewhat as in the act of rowing, and thus imparted the requisite movement to the pistons, a mode of working fire engines that might, we think, be adopted with advantage in modern ones, for the vigorous working of these is so exhausting that the strongest man can hardly endure it over a minute at a time. The jet pipe of this engine is connected to the other by coupling screws or "union joints," the most useful and ingenious device for joining tubes that ever was invented; and one which, from its extensive application in practical hydraulics, in gas or steam works, and also in philosophical apparatus, has become indispensable. I notice it here on account of its having been erroneously attributed to a modern engineer; whereas it was not new when introduced into Ypres fire engines above a hundred years ago. In closing allow me to say Canada has done as much as any other country in the world to invent and improve fire engines, the credit for which is largely due to the Perry family, and I have the honor to be one of them.

For THE CANADIAN ENGINEER.

THE BOUZEY DAM FAILURE AND THE QUEBEC LANDSLIDE.

BY C. BAILLAIRGE, C.E., QUEBEC.

The failure of the Bouzey dam in France, following on that of Johnstown and so many others of a significantly fatal nature, must afford food for reflection as to whether we do not rely too much on theory and mathematics, and too little on common sense considerations.

This dam was 1,400 and odd feet in length at bottom, and over 1,700 feet at top, 40 feet high above bottom of reservoir, and its thickness equal to half its height. The specific gravity of its components of construction was 2.0, or 125 lbs. per cubic foot.

Uncomplimentary though it be to my French confreres in the profession, I must say that the cross section of the dam, as given in *Engineering*, London, Eng., and reproduced in THE CANADIAN ENGINEER, has a very unscientific and inadequate looking profile, with far too much masonry below the bottom of the reservoir, and far too little of it at the centre of pressure.

The fact is that with dam walls, as with ordinary earth-retaining walls, the mortar or other cementing material cannot be relied on to persist in its pristine qualities of adhesiveness, in its efficiency to bind the masonry for all time to come, or even for such a comparatively small period as 30 to 50 years.

Now since a dam or other retaining wall will and does become, so to say, water-logged or saturated with moisture to the extent of—under the effects of frost and chemical decomposition—disintegrating the mortar and reducing it to sand, as observed in hundreds of cases under similar circumstances; since it must and will come to be in 20, in 50 or in 100 years that the cementing material will have lost its binding qualities and the masonry become reduced to the state of a dry stone wall; since this is inevitable, for a dam must or should be supposed to endure for all time or for centuries, like the pyramids, like the Roman aqueduct, etc.—therefore must it be contended and admitted that, while doing the best we can in the way of enduring cementing material, the dam or retaining wall should be built of such thickness that the binding matrix need not be relied on, and the mere dead weight of the masonry, as if a dry stone wall, made sufficient to stand the thrust of the pushing water or back filling, whatever it may be.

The writer has advocated this years ago in alluding to the failure of the Montreal harbor wall along Commissioners street, which, though hardly 50 years old, has been long giving way, as has also almost every wall built by the Federal and Local Governments, and the old Government of "United Canada" during its last forty years. The Louise embankment walls, now less than ten years old, are all bulging out on their way to ruin.

Canadian engineers are becoming fully alive to this, and retaining walls, as those erected by the C.P.R., are made to approximate more in thickness to the full height of the material to be supported or retained, or of which the thrust is to be efficiently counteracted; as witness, also, the Baker dam of the New York aqueduct, and others of recent construction.

The Bouzey dam failed, such is the generally received opinion—see New York *Engineering Record*, etc.—from the dam becoming buoyant by infiltration from below, or due to the probably cracked state of the up-stream cement coating, thereby losing so much of its weight (as does a stone in water), that what remained of such weight was insufficient to stand the pressure.

The dam gave way at a point below its centre of pressure, by sliding on its base, or over, or along the underlying masonry, and no wonder it did, since the co-efficient of friction of dry stone is but ·5, while the specific gravity of the dam was but 2·0, leaving not only absolutely nothing as a margin or factor of safety, but showing the wall to be only half the thickness or weight required, even if not water-logged or buoyant to stand the pressure, or resist the tendency to slide forward; and if water-logged or saturated, and the joints thus lubricated with water, this co-efficient of ·5 must have been considerably reduced, and in a way to overcome the supposed co-efficient ·7 of repose (static), that of motion (kinetic) reducing to ·5.

What, then, should the thickness of the dam have