as to cause the lever to balance exactly about the fulcrum; when such is the case the weight of the lever may be neglected in estimating the pressure on the valve." When the small weight is placed on the end of safety valve lever outside of fulcrum the weight is all on the top of the fulcrum pin. As soon as the regular weight is placed on the lever the pressure is transferred to the underside of the pin, the conditions being quite different; the only effect the small weight would then have would be to take its own weight from the underside of the pin and transfer it to the valve, in no degree taking the weight off the lever of the valve.

I am quite satisfied that Mr. Blackgrove will see the error in this matter, as others have done before. It was a common thing many years ago to see these weights on safety valve levers, but they were soon done away with. In a future number I will, if all is well, show your readers a remarkably simple and absolutely correct way of allowing for the weight of levers on safety valves.

J. H. KILLEY.

Hamilton, Ont., May 30, 1895.

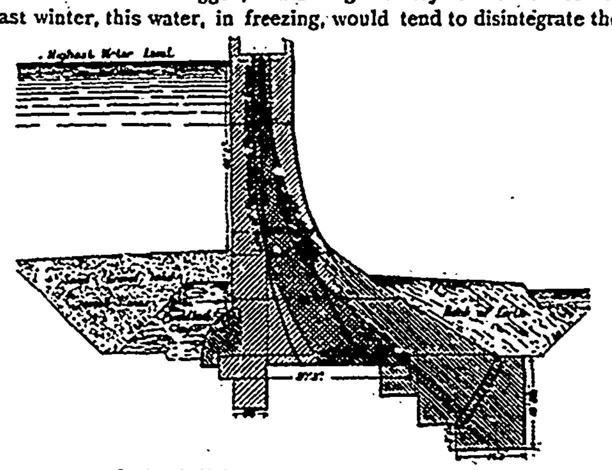
THE R. & O. FLEET.

The following is a list of the captains and chief engineers of the Richelieu & Ontario Navigation Company's fleet of steamers for the season of 1895:

Steamer.	Captain.	Engineer.
1. Quebec	Nelson	F. Gendron.
2. Montreal	Roy	F. X. Hamelin.
3. Berthier	Boucher	E. Arcand.
4. Cultivateur	Paul	M. Dion.
5. Longueuil	Jodoin	N. Braudet.
6. Boucherville	Renaud	X Mathieu.
7. Island Queen	Labelle	J. Matte.
8. Hochelaga	Mandeville	F. Chapelaine.
9. Laprairie	Coursel	Chas. Gendron.
10. Terrebonne	Laforce	M. Sheridan.
11. River du-Loup	Faubert	P. Elingburg.
12. Spartan	Grange	C. J. Taylor.
13. Columbian	Murray	———
14. Hamilton	Vaughan	T. O'Reilly.
15. Algerian	Dunlop	John Matte.
16. Passport	Craig	H. Noel.
17. Corsican	Esford	C. McWilliams.
18. Carolina	Riverin	M. Latulippe.
19. Saugenay	St. Louis	W. Lacroix.
20. Three Rivers	St. Louis	A. Lafleche.
21. Canada	Baker	E. Denis.
22. Chambly	Tranchemontagne	P. Birard.
23 Sorel	Gouin	G. Gendron.
24 Mouche-a-Feu	Crepon	P. Boucher.
25. Hosanna	Paul	———

FAILURE OF THE BOUZEY DAM.

The news that on the 27th April a masonry dam of recent design had given way with disastrous results on the headworks of the Eastern Canal of France, was received with something like consternation by hydraulic engineers, particularly as the reputation of the profession in France for works of this class stands at a high level. The failure of an earthen embankment is always intelligible, and most of the old dams in India have been swept away one after the other, owing to bye-washes insufficiently large to pass exceptional floods. A full investigation into the circumstances of the Bouzey disaster, however, tends to allay the first feelings of alarm, as the structure in question is one for which English engineers would hardly care to be responsible. The dam was intended for supplying water to the summit level of the Eastern Canal, and was situated near Epinal, in the valley of the Avrière. When it gave way the impounded water, amounting to 7,100,000 tons, rushed down the valley, destroying everything on its path as far as Chatel, some ten miles to the north. From the contours, it would seem that the Avrière valley is very narrow, though at intervals it widens out somewhat, closing in again later on. The fall in the ten miles between the bottom of the reservoir and the River Moselle at Chatel is about 430 feet. Hence there was a fall of over 40 feet per mile, which is, of course, excessive for such a body of water as that set free by the failure of the dam. This latter was built of dressed stone laid in lime mortar, the material being a sandstone conglomerate having a crushing strength of from 295 to 550 tons per square foot in different specimens. The tensile strength was, however, comparatively low, amounting to only eleven tons per square foot. The specific gravity of the materials used is stated to be about 2.0. The profile of the structure, as originally built, is shown by the dotted line outline in cut. In plan the structure is quite straight, and is 1,705 feet long. It was founded on the same conglomerate rock as that used for building it. The upper layers of this rock were, however, greatly fissured, and to save expense it was determined not to carry the foundation down to impermeable material, but instead of this a "guard wall" was sunk below the dam, as shown in the figure, the bottom of this wall being 3 feet below the top of the sound rock. On attempting to fill the dam, however, serious disturbances took place, the structure bending horizontally for a length of 440 feet, the deflection at the centre being 1·22 feet, and the dam also sheared off from the guard wall; in short, it slid down the valley several inches. It was thereupon determined to empty the reservoir and strengthen the structure. The alterations made are well shown in the figure. The lower portion of the dam was increased in width from 37.5 ft. to 57.3 ft., and abutted on a heavy bressummer sunk down to solid rock. The thickening, however, was not carried up to sufficient height to avoid the objectionable tension on the up-stream face. As the figure shows, the line of resistance lies considerably outside the middle third of the section. There would thus be a tension on the up-stream face tending to open the joints there, and to admit water to the middle of the masonry. The mortar used was apparently not very hydraulic, as to make the dam water-tight the whole of its up-stream face had been rendered with a layer of Portland cement 1⅜ in. thick. This rendering must have been considerably cracked during the shifting of the dam; but apart from this, the tension already referred to would also tend to crack it. In all probability, therefore, the structure was water-logged, and during the very severe frost of the past winter, this water, in freezing, would tend to disintegrate the



structure, rendering it liable to fail on the first opportunity. An examination of the débris would show whether this view of the matter is well based.

French engineers are not great believers in the theory that the line of pressure of a dam should lie within the middle third of its cross-section. It is perfectly true that existing masonry arches are standing perfectly well, although this line falls well without the middle third, and in the case of the Furens dam there is also some tension on the masonry, but only, if we remember aright, when the dam is empty, the tension being on the down-stream side. It certainly seems advisable, however, to avoid tension on the up-stream face of a dam, as any tendency to the opening of joints there is to be avoided, the more particularly when the cement used is non-hydraulic. When good Portland cement is used, the matter is no doubt less important, but the precaution is at any rate a reasonable one, and we have yet to learn of a failure of a dam in which the line of resistance has been confined to the middle third of the section in accordance with this view of the matter. The safety of a large reservoir dam should not be compromised by the omission of any reasonable precaution, as repeated experience has shown how disastrous such accidents may be. There is also much to be said in favor of curving a dam in plan. It is true that no great advantage can be shown to exist from a theoretical point of view, and the stability of the famous Bear Valley dam has never been quite satisfactorily accounted for. Nevertheless, quite apart from the support derived from any arch action, the curved plan has an advantage in the fact that there is then no tendency for fissures to form on the down-stream side. When the structure is straight in plan matters are different, and though experience shows that with suitable material very little trouble may be expected from cracks of this nature, the tendency to form them is there, and may just as well be avoided. The difference in the quantity of material in the case of a straight dam and curved dam of the same section is insignificant in practice, as the arc and chord subtending an angle of 30 deg., say, only differ by 4·6 per cent., and this increase might without danger be avoided by slightly reducing the area of cross-section in the case of the curved dam.—*Engineering*, London, Eng.