

Air Pressure in the Subway

By Frederic Campbell, Sc.D.

ALL who ride in the New York city subways have experienced a strange discomfort in the ear at various times, not always the same, and most pronounced in passing into and through one of the tubes leading under the river. This is due to the compression of the atmosphere produced by the train's motion; and it is felt most in the tubes because they are more confined, there being insufficient outlet for the air's escape. It is said that in the tubes of the Pennsylvania Railroad, passengers manifest particular sensitiveness, as indicated by unusual effort at swallowing; to this they are prompted because of the Eustachian tube, connecting the throat with the inner ear; it is an effort to equalize the pressure on both sides of the eardrum.

The aneroid barometer, so sensitive that it will often move its needle when even carried from the first to the second story, is well fitted to record and measure the variations of air pressure on moving trains in subways; and the writer recently made the experiment with a Tycos instrument. It is easy to believe that, if he had stood at the very front of the train, with the door closed behind him, so that no air could escape through the car, he would have found the needle indicating greatly increased pressure, that is, showing a higher record, as if one had descended to lower levels, where the air is always more dense. And, if he had stood at the extreme rear of the train, with the door closed behind him, so that no air could sweep upon his instrument from the interior of the cars, a much lower record would have been read, as if one had ascended to some lofty hilltop, where the air strata are more rarefied. Directly in front of every swiftly moving train, particularly if confined in a tube of small caliber, the air is being forcibly packed into a condition of great density; while directly behind it, the recession of the train is leaving the air behind, causing a partial vacuum.

But, these facilities not being granted to passengers, experiments can only be carried on within the cars; these, being open at ventilators or windows, afford good opportunities, as one's sense of discomfort in the cars may well assure us. The experiments in going were made in the front car, and in returning in the rear car. The trip going was from Borough Hall, Brooklyn, over the Broadway line to its terminus at 242nd Street. The trip returning was from 177th Street of the Bronx line back to Borough Hall, Brooklyn. As the barometer was found to stand exactly the same at Borough Hall on the return as at the start, it is apparent that weather conditions had not materially changed. The following table shows the readings, as recorded in the inches of the mercurial barometer column; the first column should be read down; the second column should be read up; this arrangement enables one readily to make comparisons.

	Front of first car, Broadway line, going.	Rear of last car, Bronx line, returning.
Borough Hall	29.84	29.84
Entering tube	29.90	29.88
Highest tube pressure	30.05	29.90
Lowest tube pressure		29.84
Bottom of tube		29.87
Bowling Green	29.90	29.88
Wall Street	29.87	
Between Brooklyn Bridge and Fourteenth Street	29.84-29.89	
Fourteenth Street	29.86	29.85
Between Fourteenth Street and Grand Central	29.84-29.87	
Grand Central	29.84	29.83
Between Grand Central and Seventy-second Street	29.80-29.86	
125th Street		29.85
Between 149th Street and 135th Street		29.82-29.87
Third Avenue and 149th Street (subway begins)		29.84
177th Street, elevated platform, open-air		29.78
242nd Street, elevated platform, open-air	29.82	
242nd Street, street level, open- air	29.84	

From the above figures the reader may draw his own conclusions. Looking them over, however, it is manifest that, within the train, there is not the difference in pressure that the ear discomfort seems to indicate. The very highest figures here given are 30.05, and the lowest 29.78, a difference of only 0.27 of an inch on the mercury scale. Every subway traveler knows how quickly the ear discomfort is relieved, even while still closely confined in the tube. It is conceivable, however, that, with the swift rush of the train, barometers in different cars and even in different parts of the same car would read differently at the same instant; with the whirl of the atmosphere, there may easily be dense spots, and also rare spots or "pockets;" and the action of the aneroid barometer is not sufficiently prompt in its response to rapidly changing conditions.

Enough is shown, however, to support the theory that there is condensation at the front and rarefaction at the rear of a subway train, and that this is particularly marked in the close limits of the river tube. The highest pressure was shown in the front car going, while in the tube; and, in the rear car, returning in the same conditions, the instrument recorded 0.21 of an inch less pressure. From this it would seem that relief from ear discomfort might well be expected at the rear of the train, and that this relief may be expected in increasing degree as one selects his seat farther from the train front.

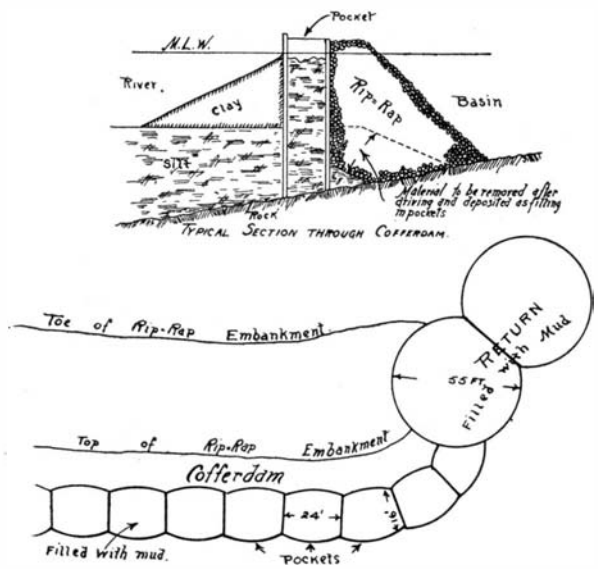
The high reading at bottom of tube is partly due to the low altitude; for there we are below sea level, and not a few feet beneath that of Borough Hall and the subway generally. Some other variations of reading are doubtless also due to variation of level rather than to differences of air pressure caused by the motion of the train. Where two or four tracks spread out across the subway, there is such opportunity for the air to escape that the barometer is not commonly affected; yet in the rush and whirl of swiftly passing trains it sometimes shows considerable uneasiness.

The Great Cofferdam for the Hudson River Piers

By Robert G. Skerrett

VERY notable engineering task is under way on the Hudson River side of New York city preliminary to the building of the 1,050-foot docks for the biggest of ocean liners. The first of the new piers are to be located at the western ends of Forty-fourth and Forty-sixth streets, so as to facilitate the ease with which passengers may go to or from the center of the city with its hotels and railroad terminals.

As the Commissioner of Docks and Ferries, Mr. R. A. C. Smith has pardonably declared: "The construction



Cross-section and plan of the North River cofferdam.

of these piers involves unique engineering problems of very great interest. The site selected is located over a shelving rock ledge 20 feet below mean low water at the inshore end and from 44 to 50 feet below mean low water at a point approximately 220 feet from the present shore line. In order to remove this subaqueous rock it is necessary to uncover it by holding back the waters of the Hudson River by means of a temporary dam and by blasting out the stone when thus exposed. This method in the end will prove considerably cheaper than by the under-water blasting of the rock because it insures a more satisfactory consummation of the task. It is essential for the safety of the ships which are to use the piers that the rock be removed to a uniform depth, and that no jagged points be allowed to remain to menace the hulls of those vessels. This uniformity could be made certain of at a minimum of cost by working upon the rock only when uncovered. Besides, by dry excavation, it is possible to leave solid buttresses of rock to support the pier structures, and thus to provide smooth and uniform walls from the river bed upward."

To carry out the preliminary steps of this unusually large project, the engineers of the Department of Docks had to plan without any comparable precedent to guide them. True, the Federal authorities had done kindred work in the cases of the cofferdams at Black Rock in the Niagara River, and in uncovering the bed of Havana harbor preliminary to the raising of the ill-fated battleship "Maine"; but the task on the shores of the Hudson is a much more difficult one in certain particulars. The cofferdam when finished will have an approximate length of 800 feet, and with a depth of water of 38 feet, plus silt 30 feet deep overlying the ledge, the experts have had to provide against a combined hydrostatic pressure of a head of 68 feet. Therefore, even with the use of modern steel sheet piling, the

stability of the bulkhead had to be assured by flanking support. Accordingly, there will be a bank of rip-rap on the inshore side having a width at the base of something like 70 feet, and rising to a point 6 feet above mean low water. The offshore side of the dam is being steadied by a clay embankment of suitable dimensions.

Between the dam and the shore there is now impounded a body of water amounting to quite 55,000,000 gallons, and the drainage of this will leave the structure to bear unaided the one-sided thrust of the Hudson. The area left dry will be 800 feet long with an average of 300 feet in width, and out of this pocket there will have to be excavated 76,500 cubic yards of solid rock to make the necessary channels for the slips for the first pier and a half. The half pier will be lengthened as occasion requires, and other piers will be developed later. But when the immediate project is completed, there will be a depth of available water at low tide of 44 feet, and room enough to accommodate three of the largest of the transatlantic liners.

The walls of the cofferdam are made up of Lackawanna steel sheet pilings having a width of a trifle over 12 inches between interlocks, and about 70 feet long. The pilings are driven so as to form a series of contiguous pockets with an average length of 24 feet and a breadth of 16 feet, the front and rear faces being slightly arched, and the connecting walls perpendicular to the flow of the stream. The pockets have been filled with the mud dug from the inner face of the cofferdam, preliminary to building the rip-rap up from the bed rock. The pile drivers have encountered a number of difficulties in the neighborhood of some of the old wooden piers, and at times it has taken 170 blows to get the piling home to rock bottom. Otherwise, the work has gone along in a satisfactory manner. The true test will come some months later when the basin is drained. By way of guarding against any show of weakness at that time, the face of the cofferdam has been provided with a couple of good-sized sluices, and it will be possible through them to reflood the area quickly. Again, these same sluices will facilitate letting the water in when the excavating is finished—a necessary advance operation before starting the demolition of the dam.

The cost of building the cofferdam and excavating the rock, as per contract, is to be \$487,812.90. As high as \$708,128.52 was bid, and the city's engineers figured the work could surely be done for \$497,500. This was certainly coming pretty close to the possibilities of the contractor, and it is a very creditable performance on the part of the officials of the department concerned.

The Largest Fore-and-Aft Sailing Yacht

THE spirited picture on our front cover of this issue represents the largest fore-and-aft, three-masted sailing yacht in existence. It was designed by William Gardner, and is now nearing completion at Lawley's yard for Alexander S. Cochrane, the owner of the cup defending yacht "Vantite."

Several notable three-masted fore-and-aft schooners have been built in this country during the past few years, which are thoroughly familiar to that portion of the public which takes a keen interest in yachting. The first of these was the "Atlantic," which, it will be remembered, won the transatlantic race for a cup offered by the German emperor. The second was the "Karina," designed by Theodore B. Wells for Robert E. Tod, and the latest and largest is the yacht which is herewith illustrated. The principal dimensions of these three vessels are as follows:

The Largest Fore-and-aft Schooner Yachts.

	Length on Deck.	Waterline Length.	Beam.
"Atlantic"	184 ft.	135 ft.	29 ft.
"Karina"	198 ft.	148 ft.	33 ft. 8½ in.
New Yacht	210 ft.	150 ft.	33 ft.

The model of the new schooner is particularly handsome, and her form is so sweetly modeled that the expectations of her designer that she will realize from 17 to 18 knots in strong winds, and under the most favorable conditions bid fair to be fully realized. Although she is designed primarily for extended ocean cruising, her vast sail-spread will probably make her more than a match for her competitors when she is sailing under full racing canvas. Her length of 150 feet on the waterline and 210 feet on deck, and her beam of 33 feet and draft of 18 feet, to say nothing of her high freeboard, will render her a particularly commodious and able ocean-going yacht.

For calm weather and for maneuvering in making and leaving harbor, she is provided with a gasoline engine of 300 horse-power, which will be capable of driving her at 10 knots.

The new yacht will be furnished simply throughout in accordance with the taste of her owner, and she will have accommodations for 8 guests and a crew of 35 men. She carries a cold storage ice plant, and is electrically lighted throughout.