Moved by 4 jacks of 50 tons, 200 tons.
Approx. co-efficient of friction, say ½ to 0.5 about.
Moved by 2 jacks of 100 tons and 1 of 50 tons, 250 tons.
Approx. co-efficient of friction 0.65.

Taking co-efficient of friction at ½, the thrust of the ice was about $\frac{648,000}{2}$ or 166 tons, or about 11 tons per square foot considering the ice three feet thick and striking the pier obliquely on a width of 5 feet.

THE STORAGE BATTERY FOR RAILWAY TRACTION.

As early as 1880, experiments in connection with storage battery traction were made in London, Paris, Brussels, Birmingham, Hamburg, New York, New Orleans, Washington and Dubuque. The short life of the batteries and the enormous expense of renewing the positive plates, resulted in failure, the battery quickly deteriorating under the care of the ordinary railway employees. In theory, as the Street Railway Review remarks, the storage battery did present many ideal conditions. "It provided a self-contained motor car with no outside accessories, as trolley lines, feeders, bonds for the transmission of the current. The electric current could be generated in a station free from overloads and troublesome peaks, at certain times of the day, and thus the station need only be of minimum capacity for the work required."

In Europe.

E. A. Ziffer, C.E., of Vienna, Austria, president of a local street railway, in an address before the International Street Railway Association, which met in Geneva last summer, reviewed all the present systems of mechanical traction, and sums up his conclusions in reference to the storage battery system in these words: "Accumulator traction, which might be considered the ideal, is still in the experimental stage, in spite of the good results already obtained. It continues to be a subject of great interest, and has a hopeful future." The weight of the batteries has always been a detriment to the working of the storage battery system of traction. Mr. Ziffer gives the weight of the battery, with all accessories, capable of operating a double truck car, weighing 12½ tons, English, for a distance of 9½ to 12½ miles, as 1.2 tons, English. The Ribbe Accumulator, which has been tested on one of the lines in Berlin, is lighter than the usual type, the weight for a capacity of 300 amperes-hours at a pressure of 260 volts, being 3.4 English tons. Even this is very much heavier than the batteries which are being made in Canada, which were mentioned and illustrated in our October number; but notwithstanding the enormous weights of the European and American batteries, very satisfactory progress has been made on both continents. The Wurtemburg State railways are making an important test of the value of storage batteries for traction purposes, and have put in operation near Stuttgart, on a line 14½ miles long, a storage battery car seating 48 passengers, the battery having 188 cells, weight, 5.8 tons (weights are stated in English tons), and giving a capacity of 16,000 watt hours. In a test made in September, 1897, with this car, which weighed, with passengers, 28.75 tons, the current consumption was from 29.34 to 30.45 watt hours per ton mile, at an average speed of 19 miles per hour—a very satisfactory result. Similar experiments are being carried on in Belgium on the Brussels-Liege line. In Paris, 35 storage battery cars are in use, the batteries alone weighing 3.5 tons out of a total of 14 tons per car, loaded with 52 passengers. The time of charging the batteries is from 8 to 12 minutes. The battery contains 54 ampere-hours. The Ostend Tramway is operated by accumulators.

Since March, 1896, two accumulator cars have been in use on the narrow gauge lines near Darmstadt. The cars carry 32 passengers, and weigh, without passengers, 8.1 tons, of which the battery weighs 2.3 tons. The plates are of the Plante type, and have a capacity of 30 ampere-hours, with 4.20 volts, average E.M.F. From April, 1896, to August, 1898, these cars made an average of 62.14 miles per day, and the consumption of current has been 645 watts per car mile. Up to the spring of 1897, no trouble had been experienced with these cars, therefore the Railway Commissioners decided to install some larger cars, which will soon be in operation. In May, 1897, two 24.4 ton motor cars were put in operation on the Ludwigshafen, Neustadt & Worms lines, having a total length of 32.3 miles. Each car weighs 11 tons, battery, 9.3 tons; motor and accessories, 4.1 tons. A single charge of the battery makes the round trip at an average speed of 15½ miles per hour. Each car carries 36 passengers, and draws one trailer carrying 50 passengers. The cost of operation, including wages of conductor and motorman, fuel, oil and waste, is 28.65 cents per train mile. On the Frankfort-on-Main tramway, the battery weighs 2 tons, and the empty car, excluding the battery, weighs 6 tons The battery is stored in 4 or 5 minutes, and this charge lasts for short round trip of half an hour. In Munich, where the overhead trolley is not allowed, a storage battery locomotive is about to be put in operation, to draw a trail car. On the Berlin-Charlottenburg line the battery consists of 180 cells of 260 ampere hour capacity. The car body and truck weigh 19,316 lbs., battery, 15,048 lbs.; 2 motors, with gears, 3,300 lbs.; total, 37,664 lbs. When loaded with 42 passengers, total weight is 43,000 lbs. With the battery on this car it makes ten round trips a day, covering 90 miles a day, at an average speed of 9.3 miles an hour, but 14.25 miles per hour is the best performance.

While the overhead trolley system is the one most generally adopted in Europe and America, and in the opinion of Mr. Ziffer is the most simple, the most economical, and the one which has given in practice the best results up to the present time, he concedes that "It is a very difficult thing to say which among all the mechanical systems of traction is the most desirable from an engineering and economical standpoint. It is necessary to take up each condition individually, and weigh carefully all the relative circumstances in construction and operation."

The list of systems is now rather extensive, and may be grouped as follows: Steam—Rowan, Serpollet, Clark systems; Stored Steam Locomotives—Lamm-Francq & Dodd systems; Compressed Air—Merkarski, Popp-Conti, and American Air Power Company's system; Gas Benzine and Petroleum Motors—Lubrig, Daimler and Diesel systems. There are, also, the cable system, the overhead trolley, the electric conduit, the surface contact, the third rail, and the mixed electric systems—combination of accumulators, and overhead,