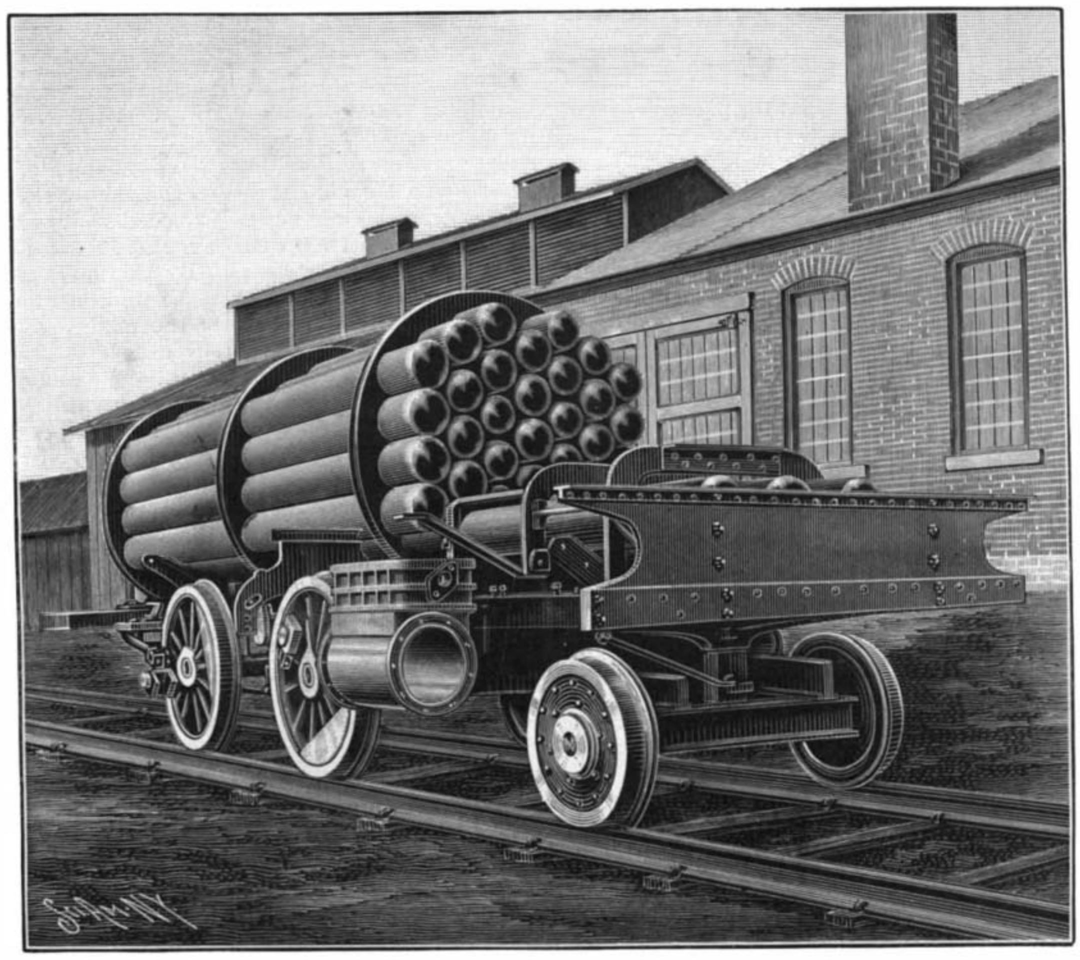
COMPRESSED AIR MOTOR ON THE ELEVATED RAILROADS, NEW YORK.

Compressed air, considered as a motive power, affords a striking evidence of the pertinacity with which a prejudice, which has been engendered by early failures in any line of experimentation, will cling to it in subsequent attempts. At least so it would seem, if one should judge by the ever recurring predictions of failure which greet the arrival of a new design of compressed air motor. These predictions are usually prefaced with the statement that the defects of compressed air are inherent in the application of the principles upon which it works, certain physical laws rendering it impossible that a high efficiency can be achieved.

That the early attempts were doomed to failure because of an extravagant loss of power between the compressor and the motor cannot be denied; but that the defect should be set down as permanent and without remedy is to cast discredit upon the resources of science and mechanics. So far from the course of invention in this particular field being of the blind and uninstructed kind, it has been carried out on scientific lines and marked by an intelligent investigation which will compare favorably with that in any other field of experiment.

In the early and faulty use of the system, air was compressed and stored in a receiver, from which it was drawn for use in the cylinders of the motor. It was found that the mean pressure available behind the piston of the motor was very much less than the mean pressure at the air piston of the compressor. So great was the loss that in some of the plants it is acknowledged to have amounted to between fifty and sixty per cent. The difficulty was due to a natural law governing the contraction and expansion of air, according to which its sudden compression is marked by a sudden rise in temperature, and its sudden expansion being followed by a corresponding fall. If a given volume of free air be compressed to one-half, its temperature will be raised 116 degrees; on the other hand, if a given volume of free air be expanded to twice its original volume, its temperature will fall 116 degrees. If air be compressed in unjacketed cylinders, the attendant heat will be communicated to the walls of the cylinders and lost by radiation, and what heat is not lost in this way will escape by radiation from the storage tanks, as its temperature falls to that of the surrounding atmosphere. Again, the expansion of the air in the motor cylinders will be attended with a corresponding fall of temperature, which, according to law, will be accompanied by a decrease in volume and, therefore, in pressure, this decrease in pressure being additional to that which results from the expansion of the air due to the travel of the piston. There will thus be a loss at both ends—that at the compressor due to the generation of heat and that at the motor due to its dissipation. There will also be the mechanical disadvantage that, the temperature of the exhaust being considerably below the freezing point, the passages are liable to be clogged with ice.

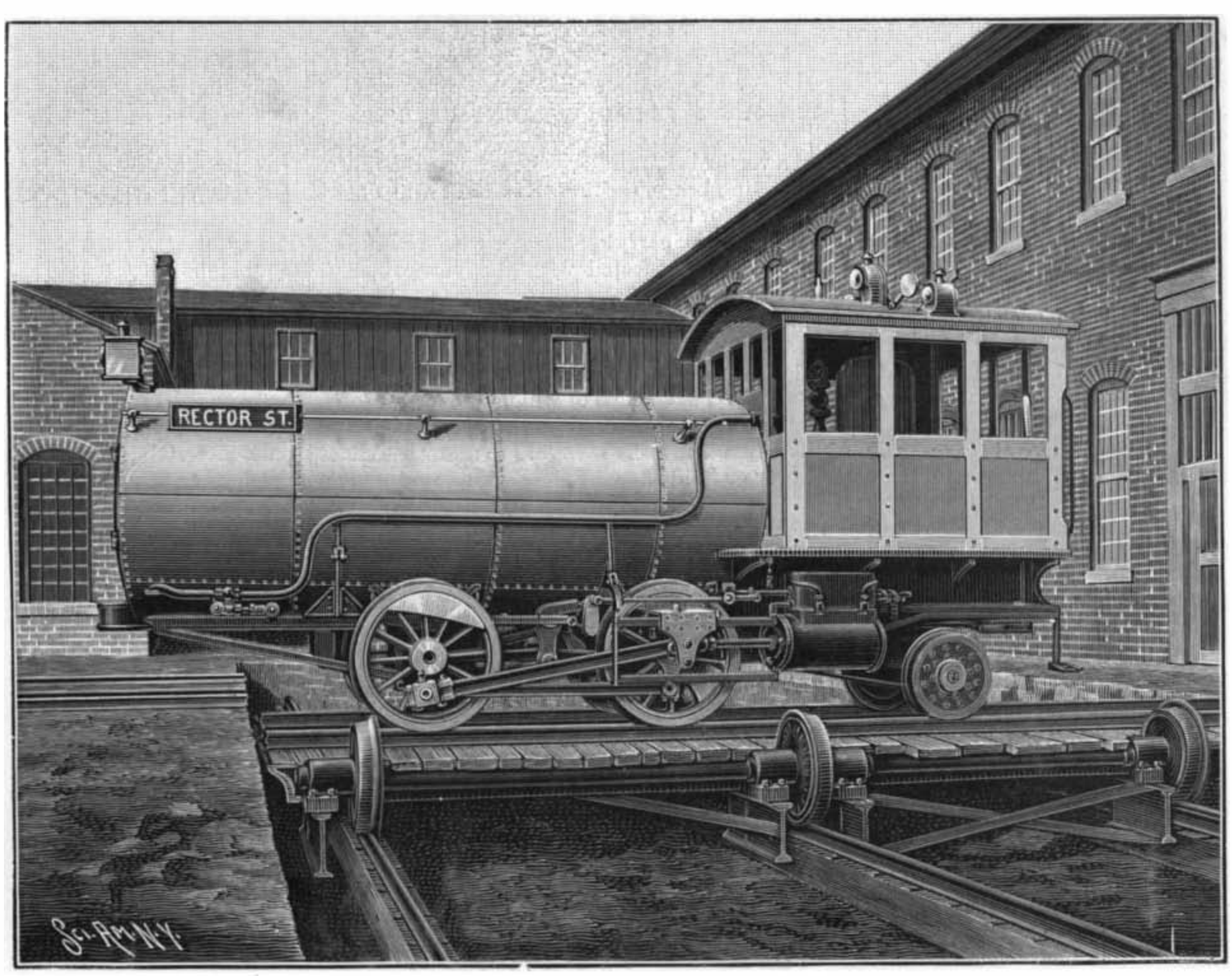
These are the fundamental difficulties which threw discredit upon the first attempts to use compressed air as a motive power, and led to the sweeping assertion that it was inherently and essentially uneconomical. Subsequent experiments in Europe and America have shown, however, that by the application of heat to the air on its way from compressor to motor, its efficiency may be largely increased, and in the various street car motors now running in both countries this reheating is invariably carried out. The system adopted by the builders of the motor which forms the subject of the accompanying illustrations consists in passing the compressed air through a tank of hot water before it is used in the cylinders. There are certain other economies attending the compression at the power station and the utilization of the exhaust steam which altogether render the plant of the Hardie motor of special scientific and technical interest. One of the most marked advances over the old systems is seen in the extremely high pressure (2,000 pounds to the square inch) at which the air is stored in the tanks. This has been adopted because of the valuable and opportune property of air that under high pressures a certain increase of pressure calls for less power and produces less heat than under low pressures. It has been found that to compress 1 cubic foot of free air to 500 pounds pressure per minute requires 0·316 horse power, whereas to compress the same amount of free air to 2,000 pounds pressure requires only 0·400 horse power, though it is deemed advisable to allow 0·45 horse power in practice. The heat of compression is saved by compressing the air in three stages, and passing the heated air through tubes around which cold water is circulating. The air-cooling water is fed to the boilers, and the heat which it has withdrawn from the compressed air is thus recovered. The compressed air is stored in a nest of rolled steel flasks at the normal temperature of the atmosphere, and from them is supplied to a similar nest of flasks carried on the motor.



VIEW OF MOTOR IN COURSE OF CONSTRUCTION, SHOWING BATTERY OF COMPRESSED AIR STORAGE FLASKS.

The reheating of the air is accomplished by passing it at the working pressure of 150 pounds to the square inch—to which it is brought down by a reducing valve—through a tank of water heated to 350 degrees, which is carried on the motor and recharged at the end of each trip. In its passage through the hot water, the air is not only expanded by the increase of temperature by fifty per cent of its original volume, but it absorbs and carries over to the cylinders an amount of water, in the shape of steam, equivalent to half its own original volume. Thus each fifty cubic feet of air admitted from the storage flasks takes up half its own volume of steam, or twenty-six cubic feet —an increase of over fifty per cent; and as it also receives an increase of volume of fifty per cent due to increase of temperature, there is a total gain of volume, as the air and steam pass from the heater, of 100 per cent. The condensation of the steam in the cylinders and pipes liberates the latent heat and maintains the temperature well above the freezing point, besides acting as a lubricant in the cylinders.

The experimental motor which will shortly be running on the elevated roads differs materially in appearance from the steam locomotives now employed. The boiler of the latter will be replaced by a stack of 36 tanks or flasks, 9 inches diameter by 15½ feet long, inclosed in a sheet iron casing. The familiar steam dome and smokestack are wanting; the sand box being placed as at present below on the frame There are four coupled driving wheels, and the cylinders, which are 13½ inches in diameter by 20 inches stroke, are placed directly beneath the cab. These, it will be seen, are considerably larger than those of the present locomotives, which are 12 inches diameter by 16 inches stroke. Altogether the new motor will be a much more powerful machine.



COMPRESSED AIR MOTOR FOR THE ELEVATED RAILROADS NEW YORK CITY.

On a line with such frequent stops as the elevated road, rapidity in starting is a consideration of the first importance. In addition to its increased cylinder power, the motor is provided with a by-pass, by which air may be admitted to the cylinders independently of the slide valve. The motor is thus provided with a reserve of tractive effort which will save several seconds each time the train is started and will result in a saving of several minutes on the round trip.

From the above description our readers will be able to secure a general idea of the principles and construction of the new motor, which is about to contest the supremacy of the steam locomotive under conditions which will provide "a fair field and no favor." Judging from the results obtained with the Hardie motors which are running on the lines of the Third Avenue company in this city, it is reasonable to expect that the new motor will not suffer in the comparison. The first two of these cars, which were put in service on August 3, 1896, have now run about 20,000 miles and carried 125,000 passengers. During the heaviest snow storm of this winter they ran 153 miles on time, their service comparing favorably with that of the cable cars.

How far the same efficiency can be shown by the heavier motors, and how far they can show superior economy to the steam locomotive, will now be determined by a lengthy and careful test.

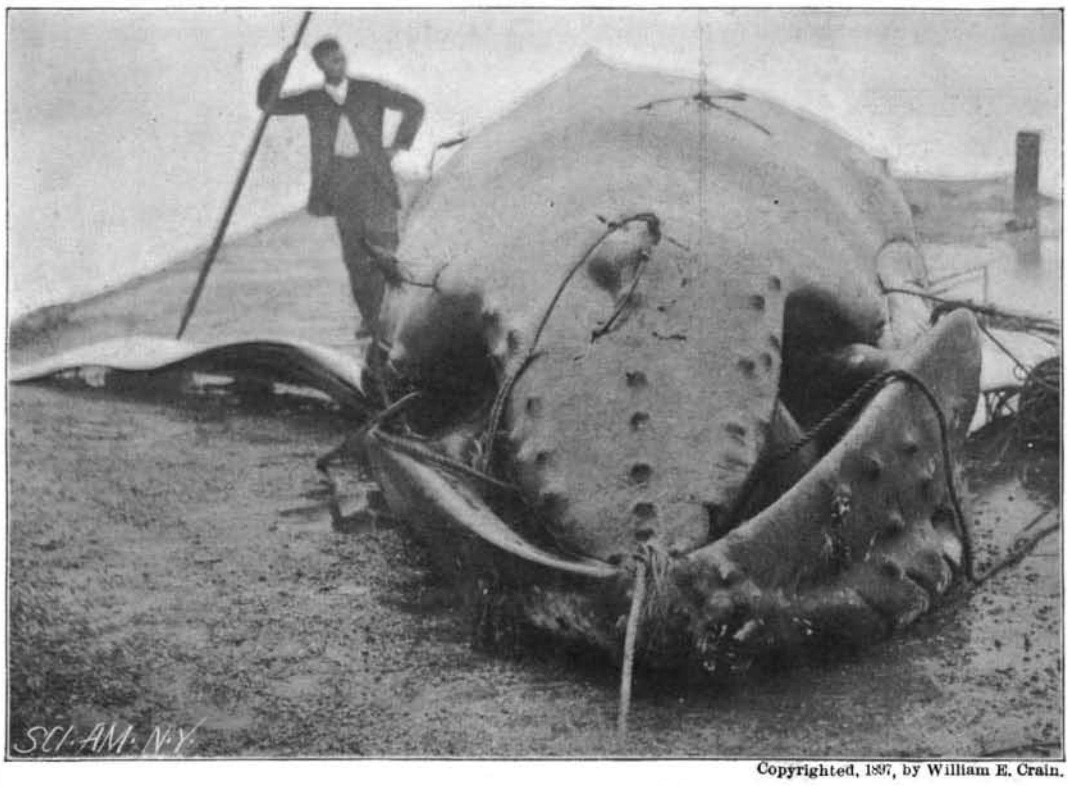
The Niger Exploring Expedition.

After an absence of three years, the expedition under Lieut. Hourst has safely returned to Europe from the Niger, says Nature. The party ascended the Senegal River, and then carried the section of an aluminum boat overland to the upper part of the Niger. On reaching this river the pieces of the boat were put together, and two native boats purchased. In these the expedition sailed down the Niger to Timbuctoo, where a stay of ten months was made. The voyage from Timbuctoo to Lokoja, at the confluence of the Niger and Benue, seems to have been arduous, but from that point the expedition was towed by a launch belonging to the Royal Niger Company to the coast at Wari. How much fresh topographical information Lieut. Hourst's party has obtained is not yet stated; this will depend on the highest point reached on the Niger. Reuter's message states that the expedition "first met the river Niger at Kayes;" but that town is on the Senegal River. There can be no doubt, however, that much valuable scientific information was obtained, for the expedition traveled slowly and was admirably equipped. One novelty was the use of a phonograph for reporting the native war songs. The expedition kept peace with the natives throughout the journey, in which it differs greatly from some of those previously conducted by French explorers in that region.

Raising a Drawbridge by Wedges.

A novel piece of engineering was done in Chicago on October 25, says the Railway Review, which was watched with much interest by civil and railroad engineers. The bridge over Clark Street was raised for the purpose of inserting new casters in the place of the old ones, which were so much worn down as to be at least two inches too small. Assistant City Engineer Roemheld, who had the work in charge, used a series of wedges in place of raising the structure by means of jack screws. The experiment proved an entire success. There were eighty of the old casters to be removed. The old system would have required that the bridge be lifted on jackscrews, so that all the casters could be taken out at the same time and the new ones put in their places. By the new method the work was greatly simplified and shortened.

The casters were so close together that it was impossible to place wedges between them which would be long enough to reach the required height at their thicker ends, unless the angle of the incline should be too great for the power of the bridge engine. To overcome this difficulty, applying the principle of inclined plane, Mr. Roemheld made his wedges in sections. Those used recently were in four parts, each about eighteen inches in length. The thinner sections of wedges were placed first in front of six of the old casters, separated at such intervals as to distribute the weight of the structure in the right proportion. Then the bridge was made to revolve, the six casters rose on the wedges and lifted the bridge free from the remainder of the old casters. When these had been taken away, there was room for laying the remaining sections of the wedges one after another, until the elevation of the bridge was sufficient to allow the placing of the new casters. When all the new casters had been placed for which there was room, the next move was to lower the bridge so that its weight would rest on the new rollers, relieving the six old ones that had done extra service, so that they might be removed. A crew of twenty men, under the supervision of Mr. Roemheld, worked through the daylight hours in changing the casters. Under the old system of work, it is estimated that the change could not have been effected in less than three days, and it would have required the erection of timber false work to accomplish it. In the work as done, not a stick of timber was used.



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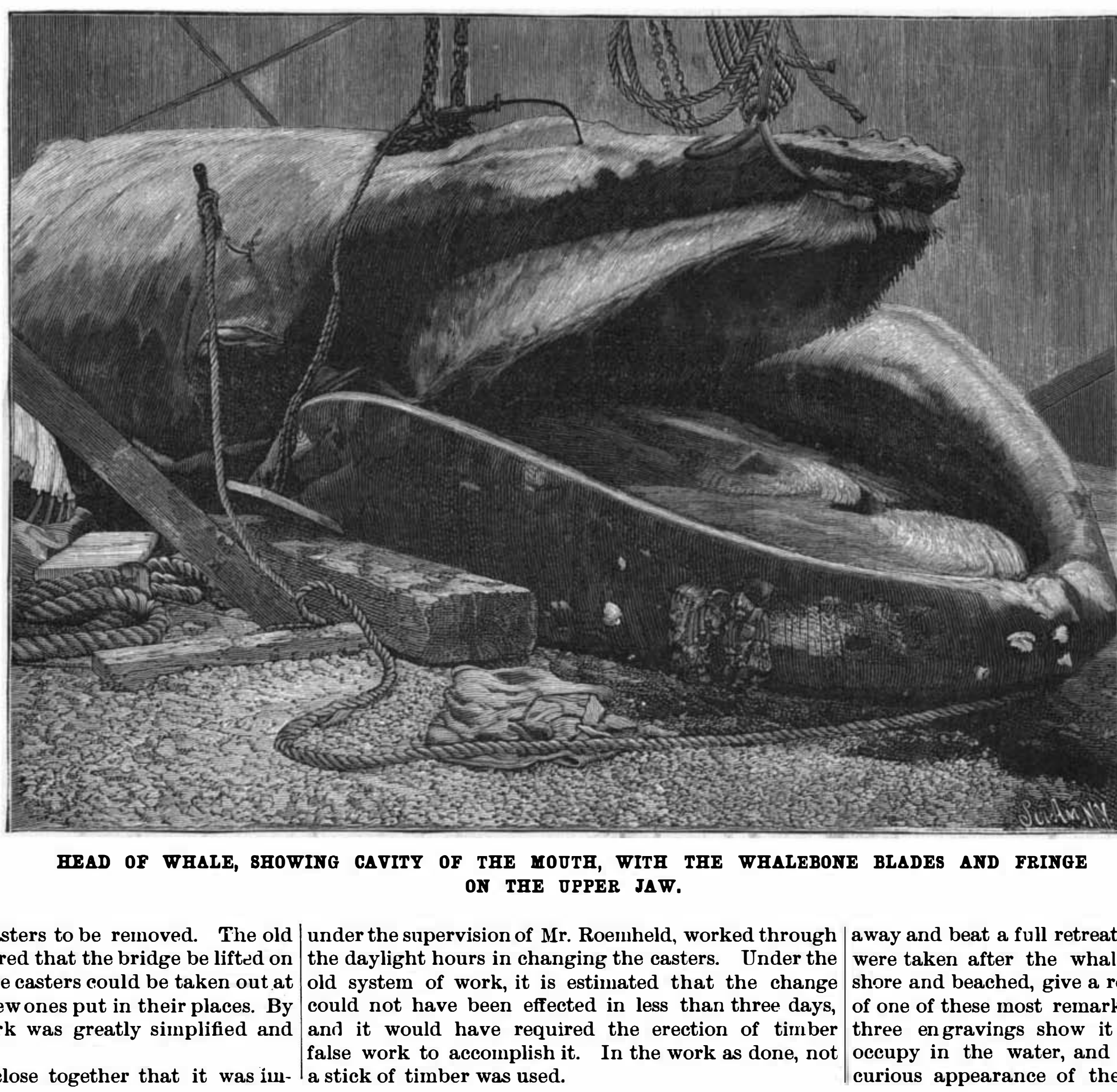
FRONT VIEW OF FIFTY FOOT WHALE CAPTURED IN PUGET SOUND, WASHINGTON, SHOWING THE FORMATION OF UPPER AND LOWER JAWS.

CAPTURE OF A FIFTY FOOT WHALE IN PUGET SOUND, WASHINGTON.

Despite the multiplied number of subjects which are being gathered day by day within the field of the photographer's industrious and ever ready camera, there are some which even the omnipresent "Kodak" and its kind have failed to secure except on rare occasions. Of such an exceptional sort, surely, are the photographs of a newly captured whale from which the engravings which accompany the present article have been made. They were taken and forwarded to this office by Mr. William E. Crain, of Tacoma, Washington, shortly after the whale had been towed ashore, and it is probable that the engraving, which shows the huge mammal with its mouth opened, revealing the long hairlike fringe of the baleen or whalebone blades, is the first of its kind ever produced.

Not without much toil and frequent misgiving was the monster captured, for the hunters were inexperienced and the weapons inadequate, at least so it would appear from the local accounts of the hunt, which seems to have occupied, from the time the first assault was made to the hour at which the whale was finally moored in the harbor, just one week. The capture was mainly due to the efforts of four men in two small boats, who drove the first harpoon near the dorsal fin—not a fatal nor even a dangerous spot, as may be judged by the fact that they were towed for hours without the mammal being sensibly affected. They implanted other harpoons with little effect, and were subsequently joined by a small screw steamer which had rigged up a cannon on its bows for firing the harpoon. With this weapon a fatal shot was fired, the harpoon entering near the heart. It was estimated by the first captors that their boat was towed in all fully two hundred miles, and as the whale appears to have been moving constantly up and down the waters of Puget Sound for a whole week, the estimate is probably not exaggerated. The final effort in which the boats closed in on the whale is thus described by one of the hunters: "His only object seemed to be to evade his pursuers. This evasive work alone made the fight hazardous to us. With a mighty spout of water he would fluke and dive beneath the steamer, and rise upon the opposite side. We were in constant fear lest he might scratch his back on the hull and demolish the craft. When charged upon the starboard side of the boat, he would sound lightly and bob up serenely on the port side. Once in a while he would remain down a few minutes as if playing hide-and-seek, and then saucily show his dorsal fin astern, or ahead, and send up a rainbow of water as though waving a flag of defiance. The boats were not once attacked, and he would always maneuver to find a way to come up in open space, although he manifested no disposition to run straight away and beat a full retreat." The photographs, which were taken after the whale had been towed to the shore and beached, give a remarkably clear impression of one of these most remarkable of all creatures. All three engravings show it in the position it would occupy in the water, and not upon its back, as the curious appearance of the mouth might suggest to



HEAD OF WHALE, SHOWING CAVITY OF THE MOUTH, WITH THE WHALEBONE BLADES AND FRINGE ON THE UPPER JAW.