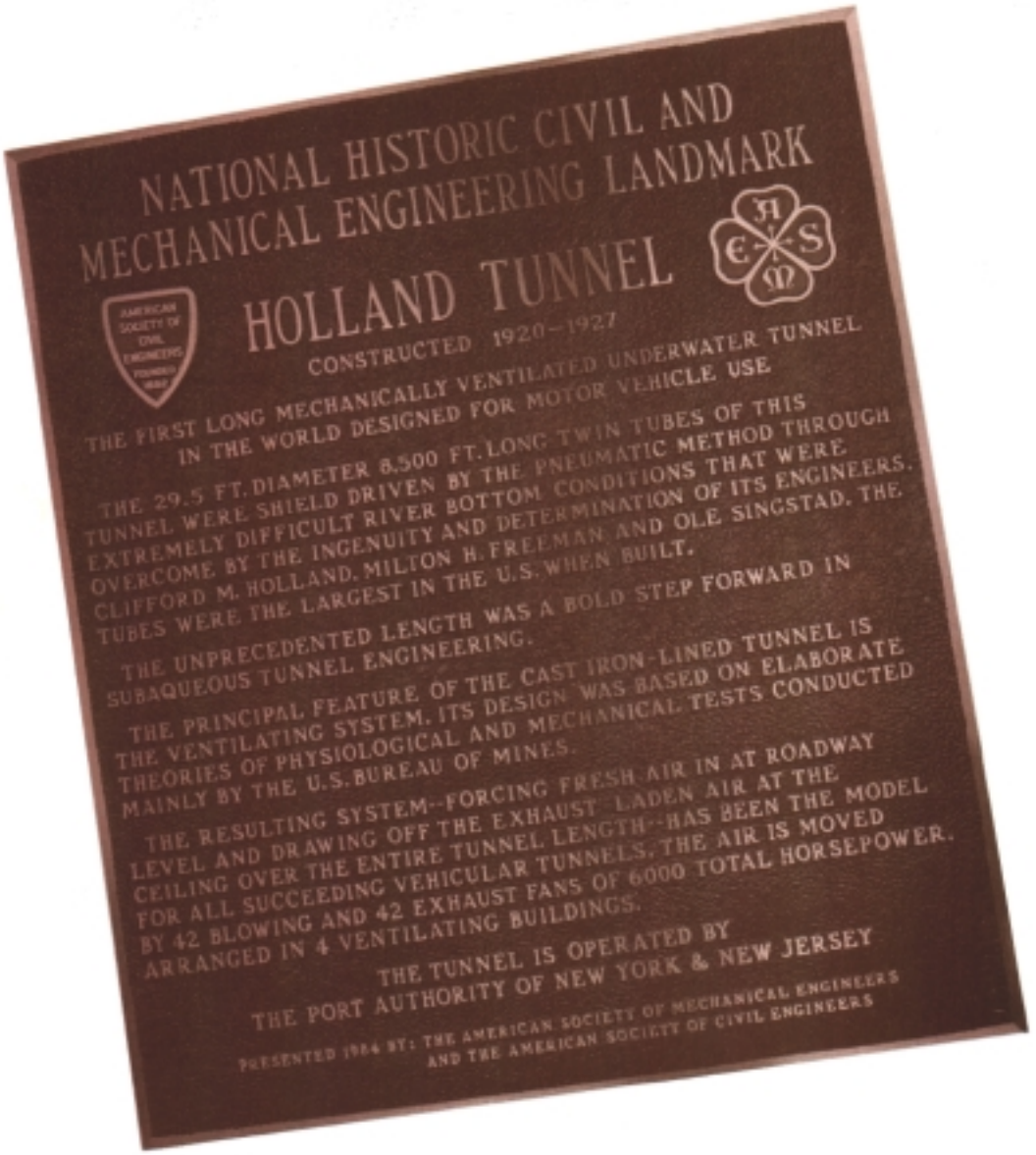

NATIONAL HISTORIC CIVIL AND
MECHANICAL ENGINEERING LANDMARK
HOLLAND TUNNEL
CONSTRUCTED 1920–1927
THE FIRST LONG MECHANICALLY VENTILATED UNDERWATER TUNNEL
IN THE WORLD DESIGNED FOR MOTOR VEHICLE USE
THE 29.5 FT. DIAMETER 8,500 FT. LONG TWIN TUBES OF THIS
TUNNEL WERE SHIELD DRIVEN BY THE PNEUMATIC METHOD THROUGH
EXTREMELY DIFFICULT RIVER BOTTOM CONDITIONS THAT WERE
OVERCOME BY THE INGENUITY AND DETERMINATION OF ITS ENGINEERS.
CLIFFORD M. HOLLAND, MILTON H. FREEMAN AND OLE SINGSTAD. THE
TUBES WERE THE LARGEST IN THE U.S. WHEN BUILT.
THE UNPRECEDENTED LENGTH WAS A BOLD STEP FORWARD IN
SUBAQUEOUS TUNNEL ENGINEERING.
THE PRINCIPAL FEATURE OF THE CAST IRON-LINED TUNNEL IS
THE VENTILATING SYSTEM. ITS DESIGN WAS BASED ON ELABORATE
THEORIES OF PHYSIOLOGICAL AND MECHANICAL TESTS CONDUCTED
MAINLY BY THE U.S. BUREAU OF MINES.
THE RESULTING SYSTEM--FORCING FRESH AIR IN AT ROADWAY
LEVEL AND DRAWING OFF THE EXHAUST LADEN AIR AT THE
CEILING OVER THE ENTIRE TUNNEL LENGTH--HAS BEEN THE MODEL
FOR ALL SUCCEEDING VEHICULAR TUNNELS. THE AIR IS MOVED
BY 42 BLOWING AND 42 EXHAUST FANS OF 6000 TOTAL HORSEPOWER.
ARRANGED IN 4 VENTILATING BUILDINGS.
THE TUNNEL IS OPERATED BY
THE PORT AUTHORITY OF NEW YORK & NEW JERSEY
PRESENTED 1984 BY: THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AND THE AMERICAN SOCIETY OF CIVIL ENGINEERS

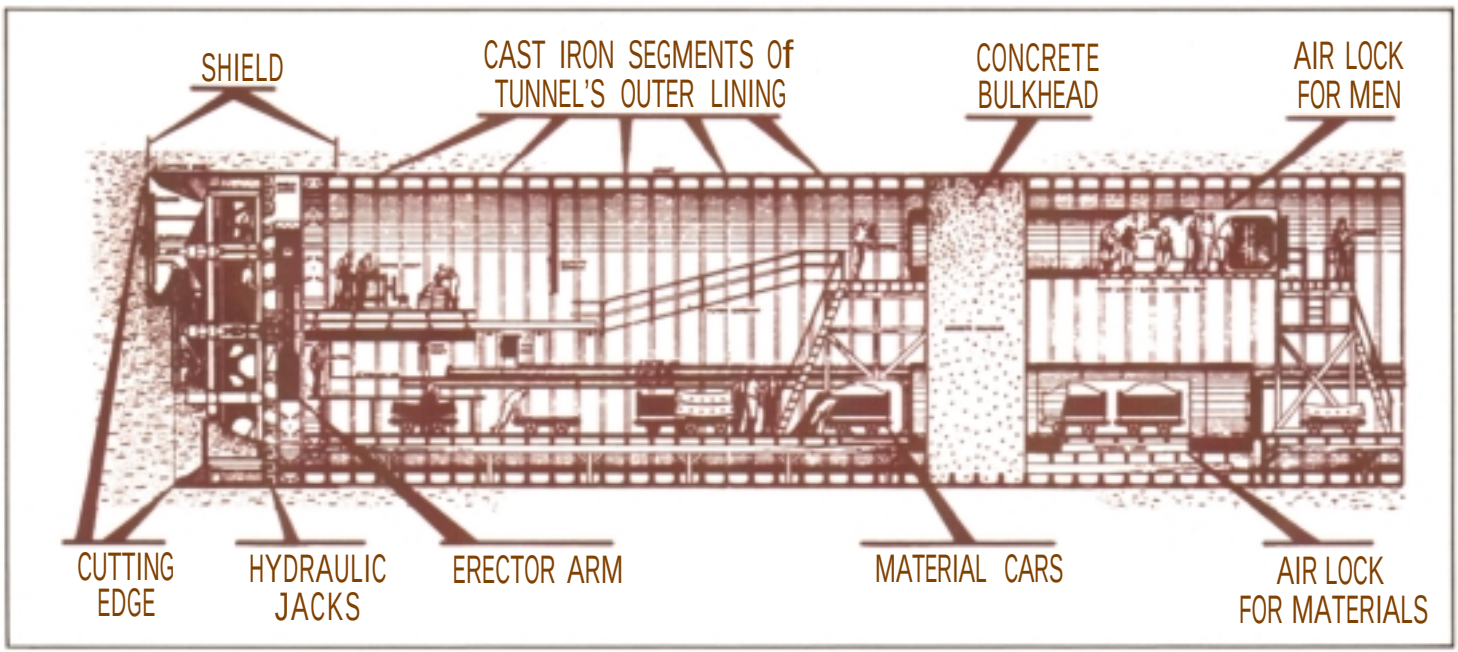
THE HISTORY OF A UNIQUE ENGINEERING ACHIEVEMENT - THE HOLLAND TUNNEL

The 1.6 mile-long (2.6 km) Holland Tunnel was the first tunnel under the Hudson River for motor vehicles and, at the time of its opening, the longest underwater, mechanically ventilated tunnel in the world.

tunnel's best location for traffic and street systems, to determine the tunnel dimensions, and to plan its plazas. A novel idea then was to separate the entrance and exit plazas to minimize street congestion. The twin 29'6" (9 m)

gases, had to be solved.

Different construction possibilities—trench, caisson, and shield—were analyzed in depth. The great volume of river traffic on the Hudson River and the soft silty condition of the river bottom were



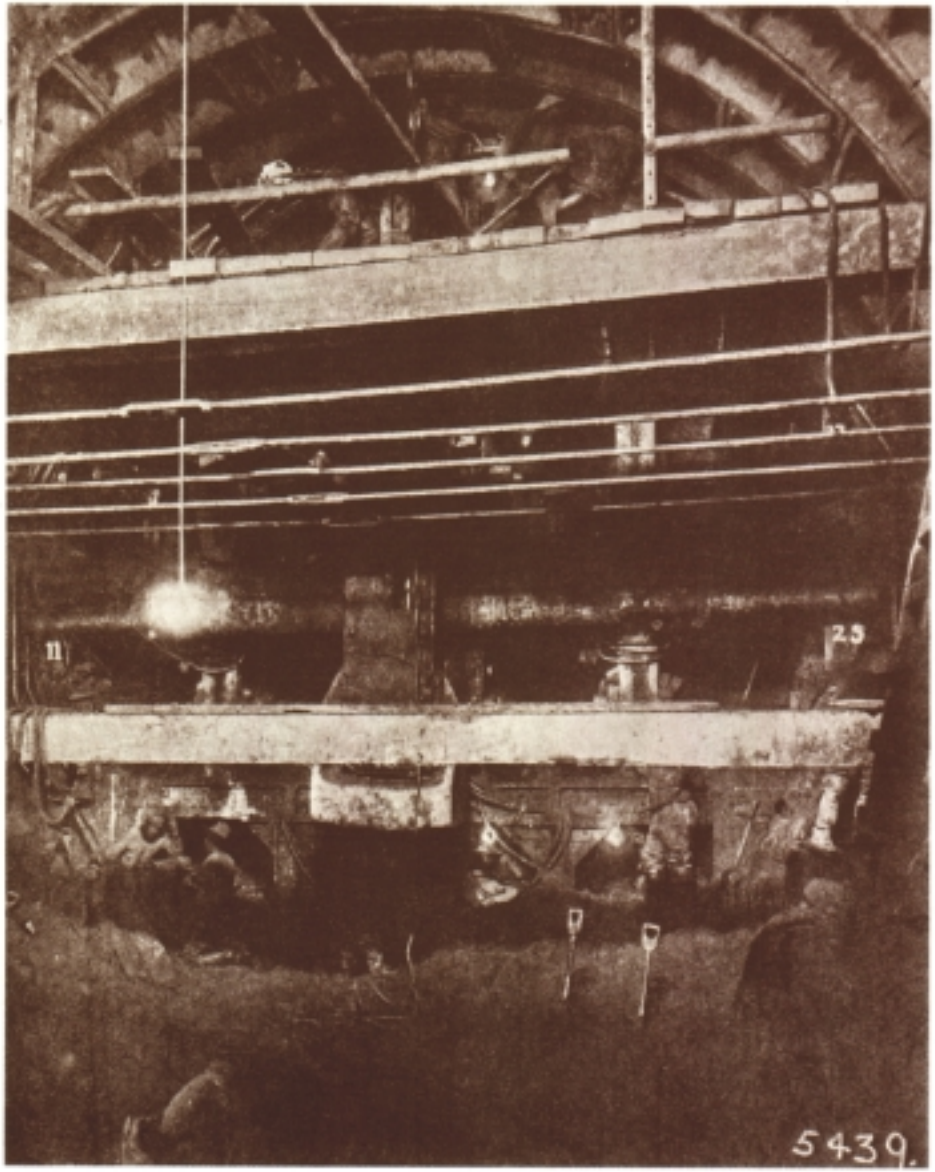
LONGITUDINAL SECTION THROUGH TUNNEL HEADING SHOWING CONSTRUCTION IN RIVER SILT

The tunnel was a technological achievement that pioneered the solution to the many civil and mechanical engineering problems involved in its design and construction.

Some first-of-their-kind traffic engineering studies were instituted to select the

diameter, shield-driven, cast iron-lined tunnels, nearly twice the diameter of earlier rapid transit tunnels, enormously compounded construction problems. A brand-new problem, that of designing a ventilation system to clear the tunnel of noxious automobile and truck exhaust

decisive factors in adopting the shield method. Numerous tunnel cross sections and roadway widths were evaluated before making the final choice of two-lane circular tubes, each with a roadway 20'0" (6.1 m) wide. Though narrow by today's standards, it was generous at the time.



REAR VIEW OF SHIELD AND PART OF COMPLETED TUNNEL DURING CONSTRUCTION.

The shield method of construction was invented and first used by Marc Isambard Brunel for excavating a tunnel under the River Thames at London in 1825.

The modern tunnel shield is a steel cylinder whose forward end acts as a cutting edge. A divided partition at the front face prevents the river bottom from entering the shield, except as permitted through suitable openings for removal of spoil material. The rear section overlaps the previously placed lining of cast iron rings.

Inside the shield, hydraulic jacks bear against the completed tunnel lining, pushing the shield ahead when pressure is applied. After the shield has been shoved forward the distance of one lining ring, segments of the next cast iron ring are erected and bolted together to extend the lining under the protection of the rear section. In subaqueous tunneling, compressed air is introduced into the forward heading of the tunnel to counterbalance the pressure of the water and to prevent water from entering the tunnel.

Construction of the Holland Tunnel began on October 12, 1920. The first shield was erected in the Canal Street shaft on the New York side.

VIEW TAKEN DURING A SHOVE IN THE SOUTH TUNNEL EAST, JERSEY CITY, SHOWING SILT FLOWING INTO THE TUNNEL THROUGH SECOND LEVEL POCKETS.

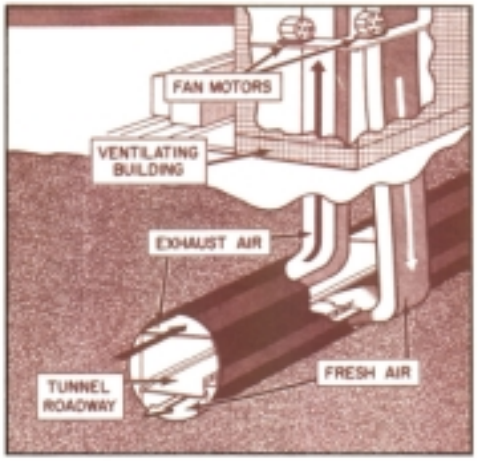
On October 26, 1922 compressed air was introduced into the shield chamber, and actual tunneling was begun. The shields were typically 30'2" (9.2 m) in outside diameter and 16'4" (5 m) long. The upper half was equipped with a hood projecting 2'6" (.76 m) ahead of the shield proper. Each shield was equipped with thirty 10" (.25 m) jacks with a combined thrust of 6,000 tons (5,450 t), and a hydraulic erector used to lift the lining segments into place to form a complete ring.

The weight of a shield, with all equipment, was about 400 tons (363 t), 30'2" (9.2m) in diameter and 16'4"(5m) long.

REAR OF SHIELD-
ERECTION OF CAST IRON
TUNNEL RINGS

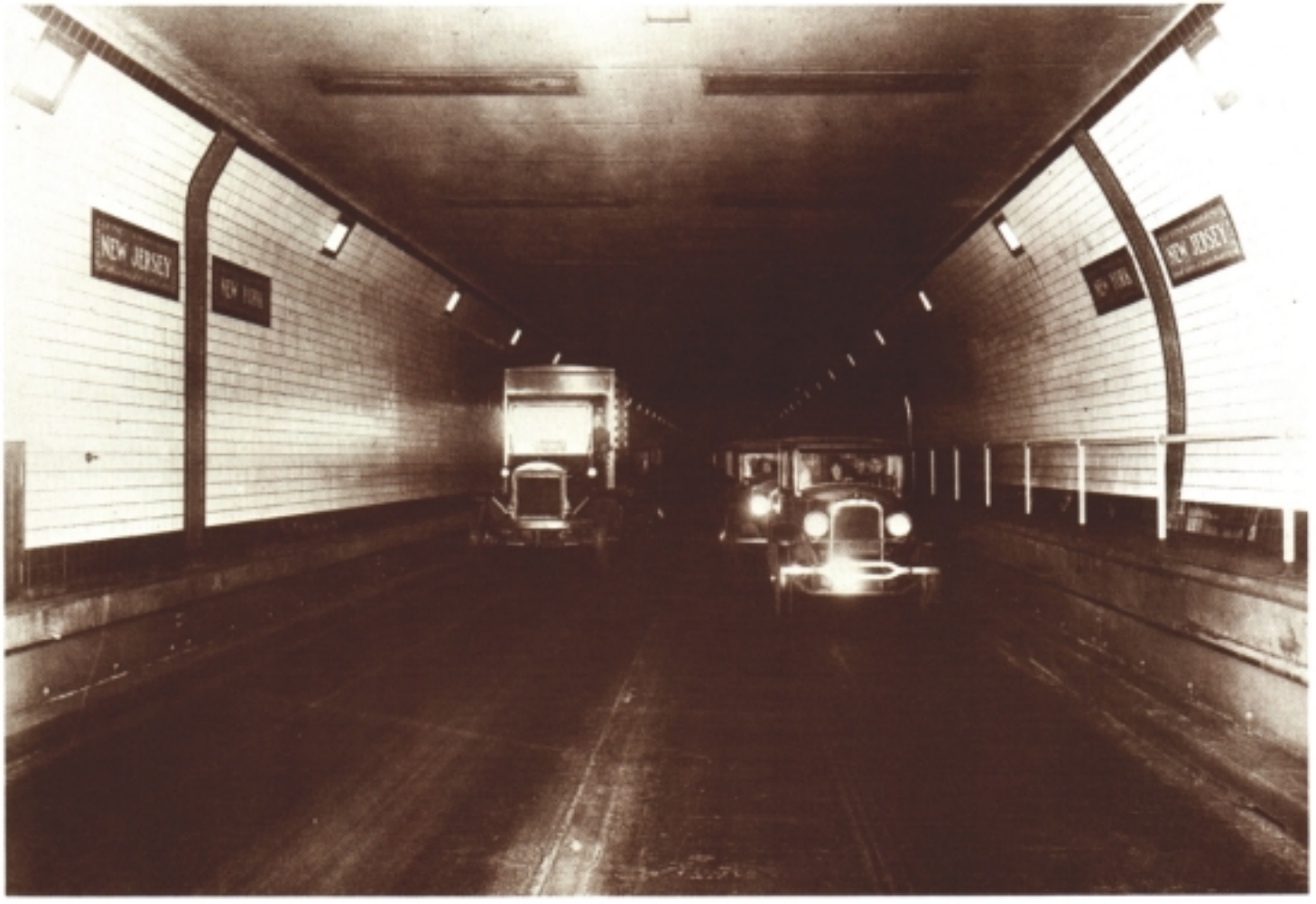
The paramount challenge was to design a ventilation system for an underwater tunnel specifically intended for internal combustion powered vehicles. The combined scientific knowledge of Yale University, the University of Illinois and the United States Bureau of Mines, augmented by the ideas and experience of individuals and engineers, was put to the goal of having the air in the tunnel as safe as the air in the open. After a long and thorough investigation, a system of ventilation, generally called the Transverse-Flow Type, was adopted.

CLOSER RING AT JUNCTION OF SHIELDS, NORTH TUNNEL.

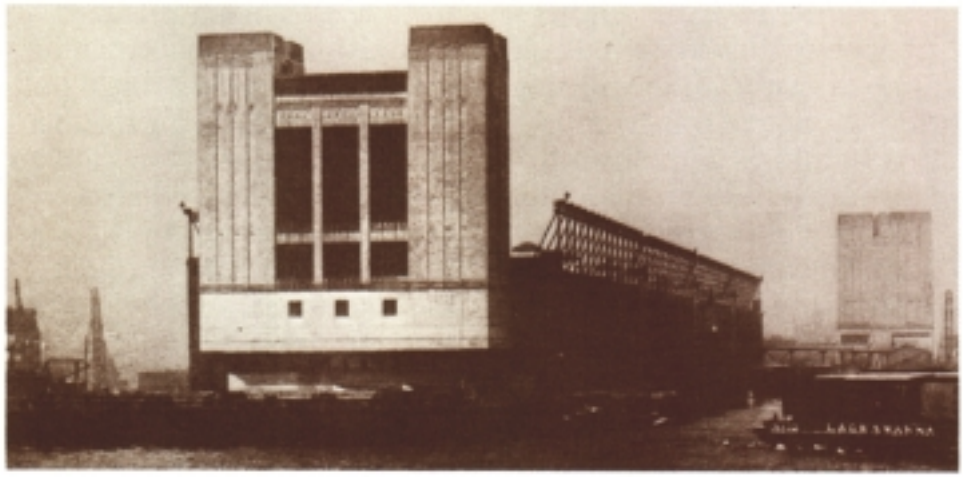


In the Holland Tunnel's transverse-flow system, fresh air is drawn from the outside through one of four ventilation buildings and blown by fans into a fresh air duct located under each tunnel roadway. The air enters the tunnel proper through narrow slots just above the curb, spaced 10 to 15 feet (3 to 4.5 m) apart. Exhaust fans (also located in the ventilation buildings) pull the exhaust-laden air through openings in the ceiling into an exhaust duct located above the ceiling slab, and discharges it into the open air through the roof of one of the ventilation buildings.

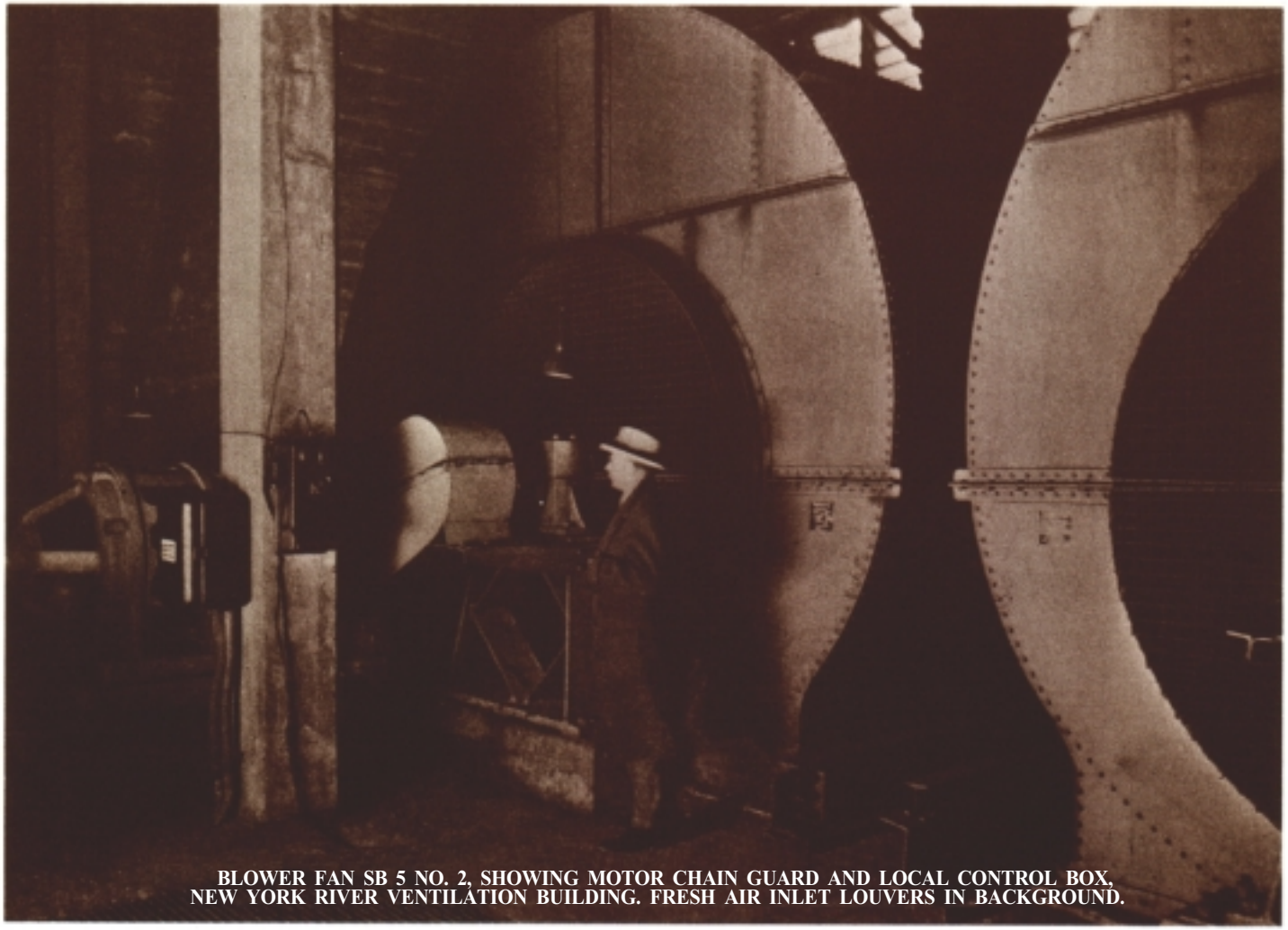
SCHEMATIC OF TRANSVERSE-FLOW TYPE OF VENTILATION.



VIEW OF INTERIOR OF NORTH TUNNEL SHOWING TILED MARKERS AT THE NEW YORK AND NEW JERSEY STATE LINE.



GENERAL VIEW OF NEW JERSEY RIVER VENTILATION BUILDING. NEW JERSEY LAND VENTILATION BUILDING IN RIGHT BACKGROUND.



BLOWER FAN SB 5 NO. 2, SHOWING MOTOR CHAIN GUARD AND LOCAL CONTROL BOX, NEW YORK RIVER VENTILATION BUILDING. FRESH AIR INLET LOUVERS IN BACKGROUND.

The four ventilation buildings (two in New Jersey and two in New York) house a total of 84 fans, of which 42 are blower units, and 42 are exhaust units. They are capable, at full speed, of completely changing the tunnel air every 90 seconds.

Air samples taken continously from each of the exhaust ducts in the seven ventilation sections of the tunnel are passed through analyzers recording the amount of carbon monoxide generated by tunnel traffic. Constant monitoring of the analyzers dictates when changes in the speed of ventilation are needed.

A central control board, located in the Supervisory Control Room and manned 24 hours a day, provides unbroken surveillance of all ventilating equipment and tunnel lighting. A system of indicator lights enables the supervisor to locate immediately any interruption or variation in the operation of tunnel equipment.

The Holland Tunnel, between Canal Street in Manhattan and 12th and 14th Streets in Jersey City, opened to traffic on November 13, 1927, has strengthened the unity and economy of the New York - New Jersey Metropolitan Region and its port. Today commercial traffic crosses the Hudson River in minutes, a trip that often took hours by ferry.

American Society of Civil Engineers
American Institute of Mining and Metallurgical Engineers
American Society of Mechanical Engineers
American Institute of Electrical Engineers

New York
November 16th, 1927.

Appreciating the Tributes paid to the Skill and Devoted Service of

Clifford M. Holland
Milton H. Freeman
and Ole Singstad

Chief Engineers of the Holland Vehicular Tunnel,
and to their engineering assistants,

upon the occasion of the formal opening of the Tunnel on November twelfth, nineteen hundred and twenty-seven, and especially appreciating the naming of the Tunnel after Mr. Holland and the East Plaza after Mr. Freeman, the Executive Officers of the above named National Engineering Societies, in behalf of the membership of these societies, some fifty-seven thousand in number, hereby express in turn their appreciation to the members of

The New York State Bridge and Tunnel Commission
and
The New Jersey Interstate Bridge and Tunnel Commission

of the recognition accorded the Engineering Profession in this enterprise, so significant in its technical phases and in its economic and social aspects.

John F. Stevens — President, American Society of Civil Engineers — George T. Seabury — Secretary
President — H. Foster Bain — Secretary, American Institute of Mining and Metallurgical Engineers
President — Calvin W. Rice — Secretary, American Society of Mechanical Engineers
President — F. L. Hutchinson — Secretary, American Institute of Electrical Engineers

ENGROSSED AND ILLUMINED RESOLUTIONS PRESENTED TO THE COMMISSIONS BY THE FOUR NATIONAL ENGINEERING SOCIETIES.

The Holland Tunnel is a tribute to its engineers: Clifford M. Holland, whose death resulted from his untiring efforts to complete it, and Milton H. Freeman and Ole Singstad.

The Holland Tunnel is one of the few engineering works named after the engi-

CLIFFORD MILBURN HOLLAND 1883-1924
FIRST CHIEF ENGINEER OF THE HOLLAND TUNNEL

neer who built it. Its design and construction became the model for the Lincoln, Queens Midtown, Brooklyn-Battery and many other tunnels throughout the world.

The Holland Tunnel is operated by The Port Authority of New York and New Jersey.

The plaque designating the Holland Tunnel a National Historic Civil and Mechanical Engineering Landmark by the American Society of Civil Engineers and the American Society of Mechanical Engineers was presented in 1984.