

# “Air Power Economy in a Granite Quarry”

(Rockport Granite Company, Bayview, Massachusetts)

## *Mine and Quarry*

Sullivan Machinery Company, Chicago, Illinois

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The article begins:

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“This company owns 500 acres at the extremity of Cape Ann, about three miles from Gloucester. It has ten openings or pits in operation, at Rockport, Pigeon Cove and Bay View, and large finishing sheds at Rockport, and at Bay View there is also a large quarry at Jonesport, Me, from which a handsome red granite is shipped to Rockport for finishing....”

This article, which begins on the next page,  
is presented on the Stone Quarries and Beyond web site.

<http://quarriesandbeyond.org/>

Peggy B. Perazzo  
Email: [pbperazzo@comcast.net](mailto:pbperazzo@comcast.net)  
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# MINE AND QVARRY

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LOCKING THROUGH THE ST. MARY'S FALLS CANAL



IMPROVEMENTS IN THE  
ST. MARY'S RIVER

DIAMOND DRILL COSTS

AIR POWER IN A GRANITE  
QUARRY



PUBLISHED  
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SULLIVAN MACHINERY CO.

RAILWAY EXCHANGE  
BUILDING, CHICAGO.



Finishing plant and docks of the Rockport Granite Co., Bay View, Mass.

#### AIR POWER ECONOMY IN A GRANITE QUARRY.

The Rockport Granite Company, at Rockport, Mass., one of the oldest and largest granite firms in the country, has been a user of air power in its quarries and sheds for a number of years, and presents one of the best examples to be found, of intelligent planning and efficient management in its methods and equipment.

This company owns 500 acres at the extremity of Cape Ann, about three miles from Gloucester. It has ten openings or pits in operation, at Rockport, Pigeon Cove and Bay View, and large finishing sheds at Rockport, and at Bay View. There is also a large quarry at Jonesport, Me., from which a handsome red granite is shipped to Rockport for finishing. The company employs over 500 men. Air power has been used for several years at the Rockport quarries and sheds, being furnished by a 1300-foot compressor at the main opening and by two 550-foot compressors at the newer "Farms" quarry.

#### BAY VIEW QUARRIES.

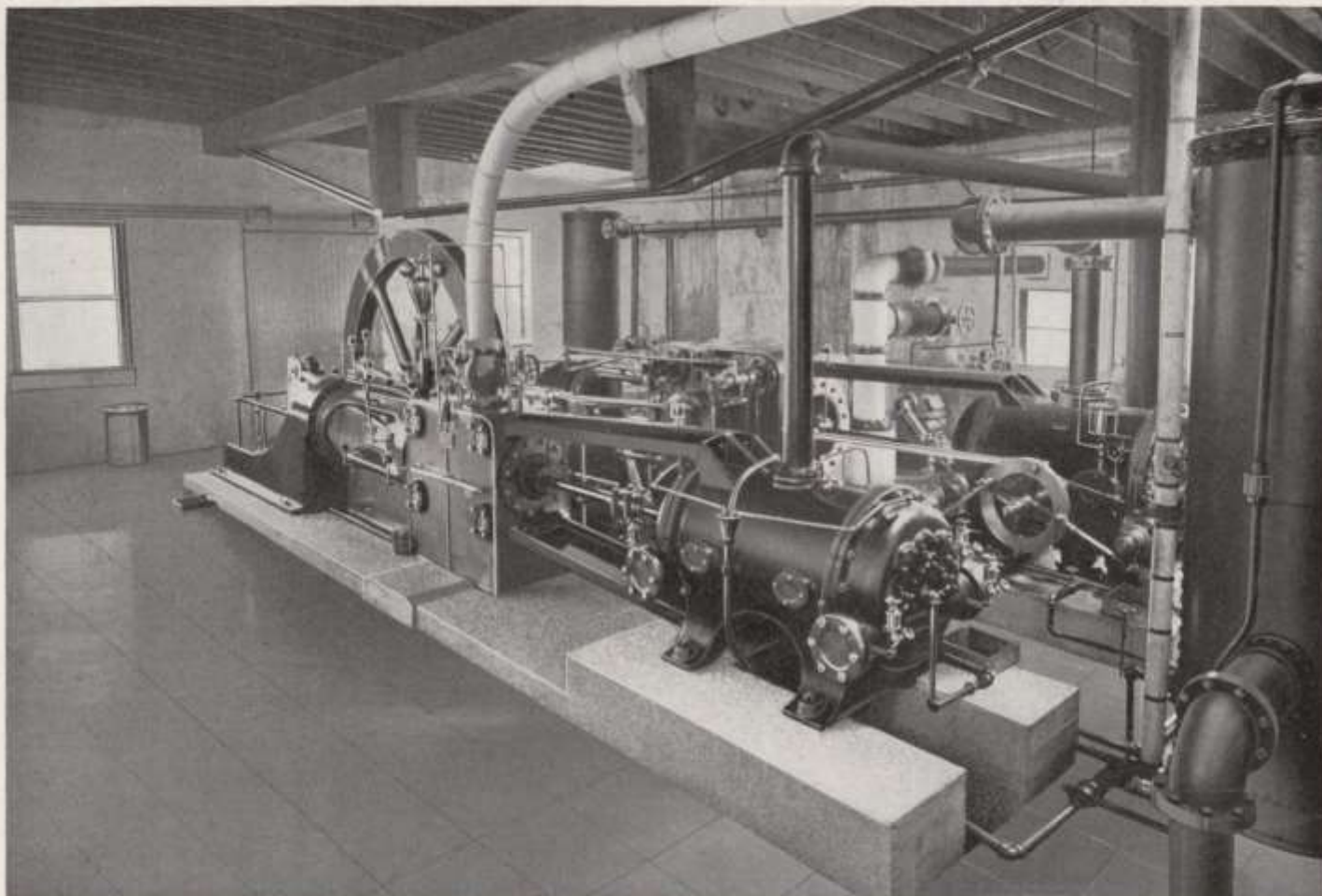
At Bay View, three miles west of Rockport, on the other side of the cape, there are four quarry pits, and the main finish-

ing plant of the company. This plant includes a mill 150 feet long, containing polishing machines, a surfacing machine, a gang saw and a large lathe; and a cutting shed, the enclosed part of which is 240 by 65 feet. This shed is immediately on the water front, adjoining the shipping dock. The stone is handled from the quarry cars to the shed and from the shed to the dock by a locomotive crane.

#### POWER PLANT.

The company, about a year ago, installed one of the largest air plants in New England, to operate the machinery in these quarries and sheds. It consists of a Sullivan-Corliss cross compound two stage air compressor of 1600 cubic feet capacity. This machine is illustrated on pages 214 and 218. It is installed on a solid concrete foundation, in a granite power house, shown on page 218.

This plant supplies air to the four quarries and the cutting sheds. It operates six hoisting engines, averaging 7x10 inches in size, a small stationary engine, between 30 and 40 Sullivan "plug" drills several large rock drills, and five pumps in the quarries, and two surfacers, five Sullivan "plug" drills and about a dozen



Sullivan Class "WX" Corliss Air Compressor at the Bay View quarries of the Rockport Granite Co.

(photo caption) "Sullivan Class 'WX' Corliss Air Compressor at the Bay View quarries of the Rockport Granite Co."

hand tools in the shed. The air is distributed from the compressor in a five-inch main 3600 feet long and a four-inch main 1200 feet long. Branch mains of three and  $2\frac{1}{2}$  inch diameter aggregate 3734 feet. There are also 1300 feet of  $1\frac{1}{2}$  inch supply pipe, 2000 feet of  $1\frac{1}{4}$  inch, and 1700 feet of one-inch lines.

To secure the greatest possible efficiency from the air, nine reheaters are installed, at various points in the quarries, and one in the shed. Five of these were made by the Rockport Granite Co., in their own machine shops, and five by the Sullivan Machinery Co. They are rated at a capacity of 250 feet of air cubic per minute each.

In equipping this plant, the company spared no pains to establish a working equipment which would permit the production of stone upon the most economical basis possible. Their attention was addressed particularly to the power plant, and the boilers, air compressor and auxiliaries are all of the most efficient type which they could procure. In order to determine the degree of success which they had attained in this object, a test was made, on January 9th and 10th, 1908, to ascertain the commercial economy and efficiency of the air plant. This test was conducted by engineers of the Sullivan Machinery Co., assisted by representatives of the Rockport Granite Co., and of the manufacturer whose instruments were employed in making the test.

#### THE COMPRESSOR.

The air compressor consists of a Sullivan Corliss Cross Compound condensing steam engine, with two-stage air cylinders. The low pressure air cylinder is placed tandem with the low pressure steam, and the high pressure air cylinder tandem with the high pressure steam cylinder. Its general dimensions are as follows:

High Pressure Steam Cyl. . . . .	13 in. diam.
Low Pressure Steam Cyl. . . . .	26 in. diam.
Low Pressure Air Cyl. . . . .	24 in. diam.
High Pressure Steam Cyl. . . . .	15 in. diam.
Length of stroke . . . . .	36 inches.

Displacement capacity, 1617 cubic feet of free air per minute, at 86 R. P. M., against 100 pounds terminal air pressure. The steam valve motion for both the steam cylinders is of the full Corliss pattern, the automatic cut-off being actuated by dash-pots. The engine is governed by a weighted fly-ball governor, whose effect is to hold the engine speed constant as the air pressure varies. It works in unison with an automatic air pressure regulator, which reduces the speed of the compressor as any desired limit in the pressure is approached. Both the governors operate by lengthening or shortening the cut-off of the compressor.

A steam receiver is situated between the high and low pressure steam cylinders, for reheating and drying the steam in its passage from one to the other. The compressor is operated condensing, a jet condenser and air pump giving the vacuum. The air pump takes its steam from the reheater coil.

Air is admitted to both air cylinders by means of positively operated semi-rotary valves, and discharged through automatic poppet valves in the cylinder heads. Both the cylinder bodies and heads are supplied with water-jackets, to remove the heat of compression. Further cooling is secured by a large receiver inter-cooler, placed between the low and high pressure cylinders, and by a receiver after cooler through which the air passes on leaving the high pressure cylinder. Drains are provided at the foot of each cooling tank, so that practically all water vapor is removed from the air before it enters the pipe line. This obviates the danger of freezing at the exhaust ports of the drills and other air-driven machinery. The steel cooler shells or bodies contain groups of copper tubes for the circulating water, and baffle plates cause all the air to cross the tubes in thin sheets during its passage.



A general view of one of the quarries.



Sullivan "D-15" Hammer Drills in the Bay View Quarries.

The boiler is of the return tubular type, fitted with an arch protector and a damper regulator. The auxiliaries consist of a duplex outside plunger pot valve steam pump for boiler feed; two duplex steam pumps for the water circulation, through the compressor cylinder jackets, intercooler and aftercooler; a simple steam pump for removing the condensed steam and cooling water from the condenser, and for maintaining the vacuum, and two feed water heaters.

The boiler feed water is drawn from a concrete cistern, which takes its supply from a small brook near the power plant, dammed up to form a permanent reservoir. The feed water passes first through a heater placed between the low pressure steam cylinder of the compressor and the condenser, and then through an auxiliary heater of the same pattern, receiving the exhaust steam from the pumps. A part of the cooling water from the aftercooler and from the intercooler was used as feed water for the boiler in the first and second day's test, respectively.

#### CONDITIONS OF TEST.

Two separate tests were run, the first on January 9th, and the second on January 10th. During the first day's test, the regular service conditions of speed, pressure and air consumption were observed, while on the second day, a nearly constant speed was maintained. When the compressor was delivering more air than could be used, the surplus was allowed to escape into the atmosphere. The tests were run continuously from 8:30 a. m. until 4:00 p. m. on the first day and from 8:10 a. m. until 4:10 p. m. on the second day. On the second day the speed of the air pump was reduced, as it was found that more cooling water than necessary was being used. This, together with the higher steam pressure and constant speed, accounts for the lower steam consumption on that day.

#### METHODS EMPLOYED.

All steam and water piping, glands and valves were inspected and made tight before the test, to prevent leakage. The steam pressure on the first day was held nearly constant at 140 pounds, and on the second day at 145 pounds per square inch. Care was used to keep the fires clean and even at all times. Bituminous "run of mine" coal from Cambria County, Pa., was used. Its analysis shows a fuel value of 15,000 British thermal units per pound. All gages, thermometers, calorimeters, indicator springs and other instruments were carefully tested and standardized for this test, and found to be without appreciable error. Eight indicators were used in taking readings, one at each end of each cylinder of the compressor. Revolution counters were attached to the compressor and each of the pumps. Cards were taken every ten minutes, and readings were made from the counters, steam and air pressure gauges, and of the temperatures of the air at all stages of its passage through the compressor, and also of that of the cooling water and feed water.

The compressor ran at an average speed of 77.21 revolutions per minute on the first day, and of 78.04 on the second, the piston speed being 463.26 feet and 468.24 respectively. Air was compressed to an average pressure of 92.47 pounds per square inch in the first test and of 100.05 in the second.

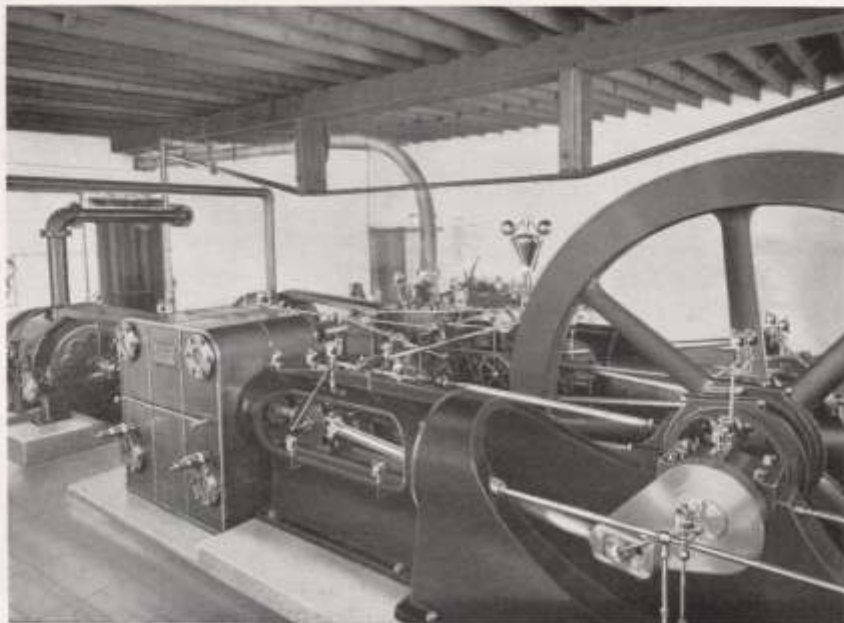
#### RESULTS.

The results of the tests were as follows:

	Jan. 9	Jan. 10
Steam consumption for compressor, per indicated H. P. per hour, pounds.....	14.56	14.25
Steam consumption for entire plant.....	18.75	17.95
Coal consumption for entire plant per indicated H. P. per hour, pounds	1.881	1.844



Bay View powerhouse and finishing plant of the Rockport Granite Co.



Low-pressure side of the Sullivan Air Compressor.

Indicated H. P. required to compress 1000 cubic feet of standard free air per hour from atmospheric pressure to 100 pounds gauge pressure per square inch . . . . .	3.124
Mechanical efficiency of compressor per cent. . . . .	88.4    89.3

The mechanical efficiency of the compressor was, probably decreased three or four per cent, owing to the fact that an improper lubricating oil was used in the steam cylinders, so that the automatic sight feed oilers could not be used. A careful test of the boiler plant showed an evaporation of water per pound of coal actually used, of 10.21 pounds on the first day and 10.03 on the second. The thermal efficiency of the boiler was 66.7 per cent. and 65.8 per cent. on the two days.

#### COST OF COMPRESSING AIR.

From these tests, the cost of compressing 1000 cubic feet of standard free air, from atmospheric pressure to 100 pounds per square inch (gauge) was calculated to be \$.011065. This is based on the total coal consumption and includes the cost of operating the auxiliaries. Lubricating oil and labor are not included in these figures.

#### PRODUCT.

The stone produced by the company is very hard and holds its color well.

It is free from iron, and has a crushing strength of about 23,000 pounds to the inch. It is principally used for buildings, bridges and heavy granite construction of all kinds. More paving blocks are made here than anywhere else in New England. The Jonesport Red Granite was employed in the Real Estate Trust Co.'s building, the Siegel-Cooper Building, New York, the Suffolk County Court House, Boston, and the American Baptist Publication Building, Philadelphia. "Bay View Gray" may be seen in the Boston and Baltimore Post Offices, in the eight

towers of the Cambridge bridge at Boston, and the Registry of Deeds of Essex County, at Salem, Mass. "Bay View Green" has been effectively used in the columns of the Madison Avenue Presbyterian Church, in New York, and in the Logan Monument, in Chicago. The company is now supplying stone for the Manhattan Anchorage of the Williamsburg Bridge, for the National City Bank building at New York City, and for a large sea wall at the Kittery, Me., Navy Yard. The waste rock is sold as crushed stone.

#### ROCKPORT QUARRIES.

The main office of the company is in an ivy-covered granite building, at Rockport, on the brow of a hill overlooking to the East, the stone yard where the paving blocks are cut, the finishing shed, and the shipping docks, along the water's edge. The large quarry (see page 216) is about 300 yards to the west. At the Farms quarry, a mile further out on the cape, many improvements are being made. The stone here lies in sheets, permitting blocks of any dimensions to be gotten out very economically.

#### QUARRY FACILITIES.

Nearly all the product from the quarries is shipped by vessel from the company's three private docks, which have a capacity of 1200 tons each, per day. Ten vessels are owned by the company and a number of others chartered for their exclusive use. The quarries, stone sheds and yards and docks, are connected by about six miles of railroad track, also the property of the company, together with locomotives, cars and locomotive cranes for handling the granite.

The officers of the Rockport Granite Co., are C. Harry Rogers, President, Rockport, Mass., and Chas. S. Rogers, Treasurer and General Manager. The company maintains branch offices at 31 State street, Boston; and 21 Park Row, New York. It is capitalized for \$300,000 and was organized in 1864.



Finishing plant and docks of the Rockport Granite Co., Bay View, Mass.

(photo caption) "Finishing plant and docks of the Rockport Granite Company, Bay View, Massachusetts."



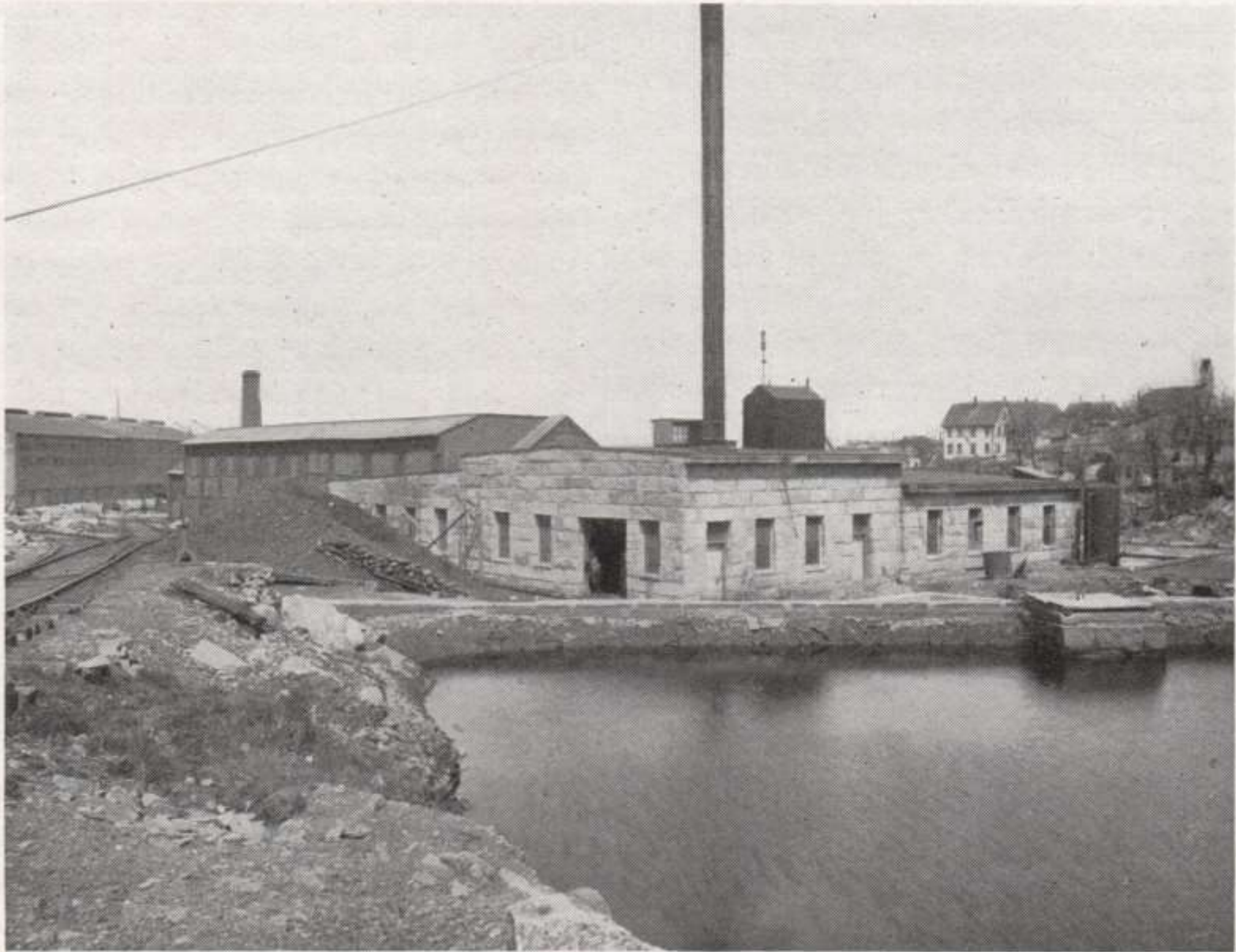
**A general view of one of the quarries.**

(photo caption) "A general view of one of the (Rockport Granite Company) quarres."



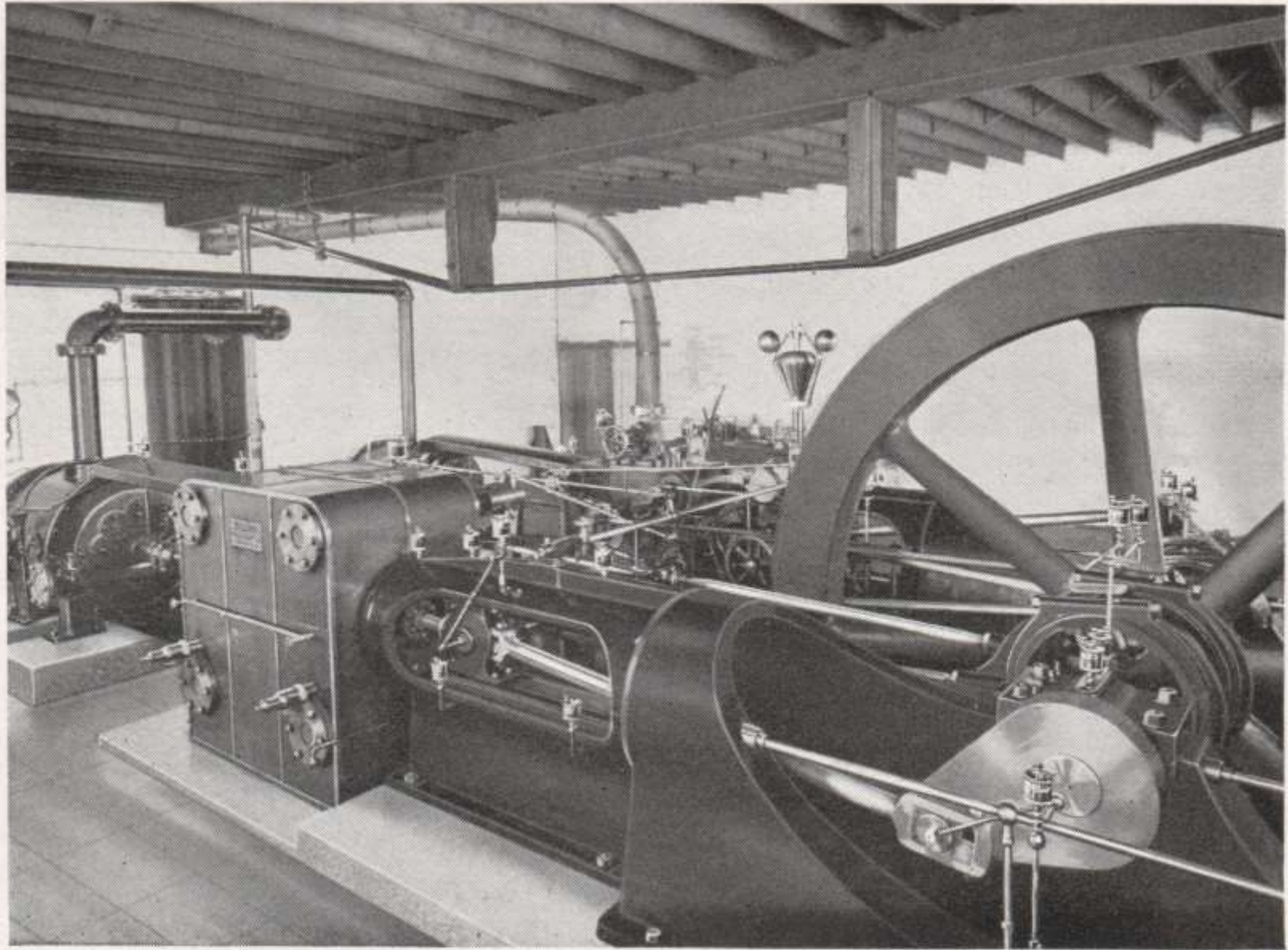
Sullivan "D-15" Hammer Drills in the Bay View Quarries.

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Bay View powerhouse and finishing plant of the Rockport Granite Co.

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**Low-pressure side of the Sullivan Air Compressor.**

(photo caption) "Low-pressure side of the Sulllivan Air Compressor."