Special Steel-Plate Steam Fan, Double Enclosed Engine, Cylinders beneath the Shaft. — Insufficient height above the centre of the fan shaft frequently compels the substitution of an engine with cylinders beneath the shaft for one having its cylinders above the shaft. The same general type of engine is employed, however, the enclosed feature being retained, and the working parts, which are the same as those in the other type, being made readily accessible. This form of construction is clearly shown in Fig. 33. A single oil tank supplies all bearings through connecting tubes or wipers. The entire top, including the door and oil tank, may be easily removed if necessary. The automatic cylinder relief valves, which are plainly shown in the cut, form an important feature of this engine. The fan, which, like those previously described, is of steel plate, is designed to discharge directly downward through an outlet in the base at the end nearest the observer. Such an arrangement is particularly convenient for application under many of the conditions which exists in mechanical draft plants, where the air is to be forced into the ashpits.

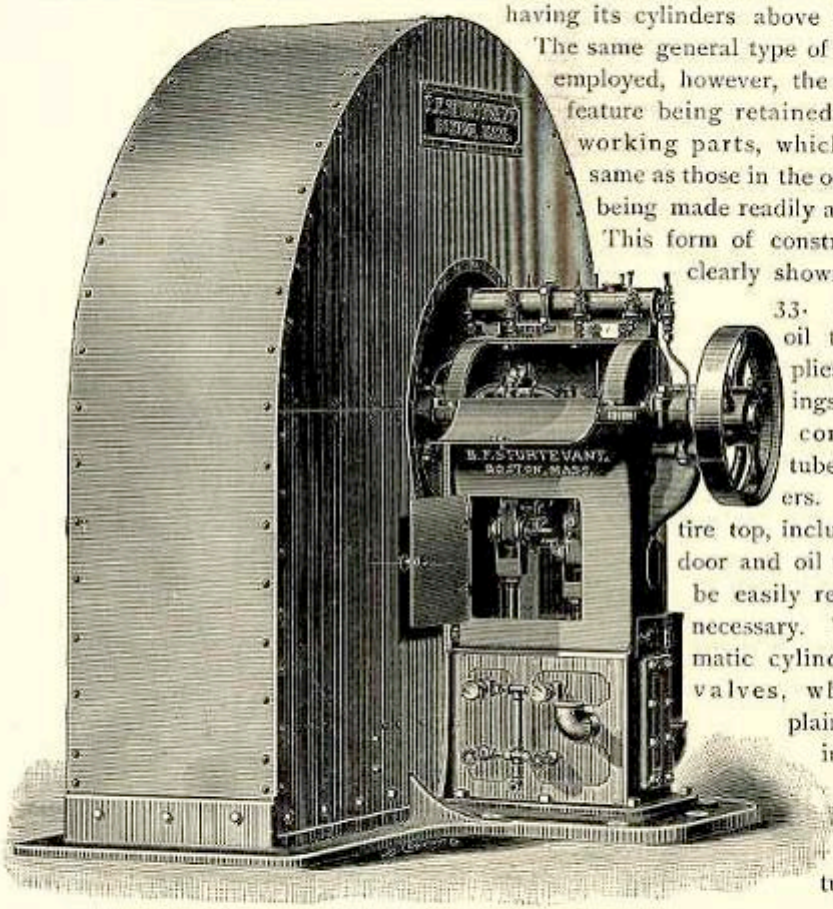

FIG. 33. SPECIAL STEEL-PLATE STEAM FAN WITH DOUBLE ENCLOSED ENGINE, CYLINDERS BENEATH THE SHAFT.

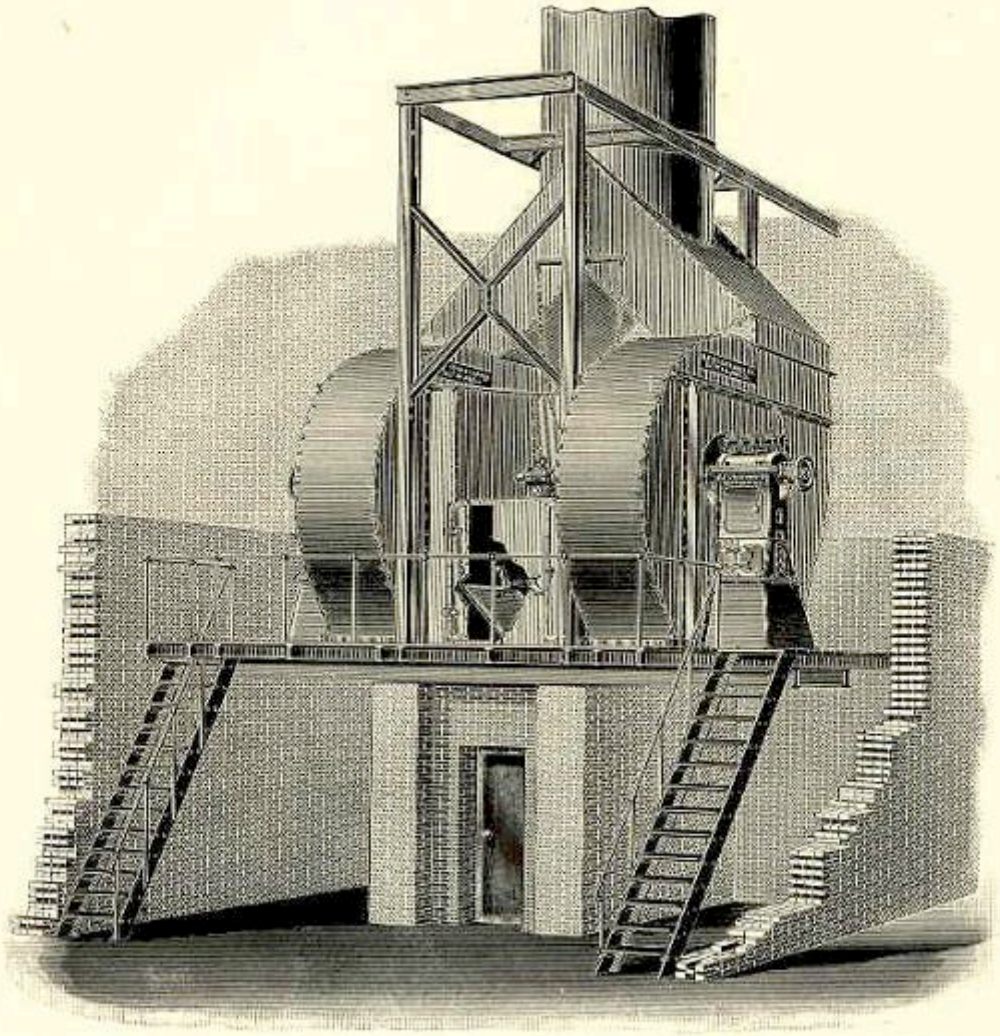

FIG. 34. SPECIAL DUPLEX STEEL-PLATE STEAM FAN APPLIED FOR INDUCED DRAFT.

Special Duplex Steel-Plate Steam Fan. — Two fans provided with engines of the type just described and set up in proper manner to form a duplex fan are shown in Fig. 34, which represents the arrangement designed for and installed at the Holyoke Street Railway Co.'s power house at Holyoke, Mass., for the production of draft by the induced system. The flue gases enter the brick chamber beneath the fans and thence pass to the sheet-iron connection between them. Here is located, as shown, a swinging damper, by means of which the gases may be made to enter either fan. Another damper, in the connection above the fans, likewise operates so that when one fan is in use the other is entirely shut off and is accessible for cleaning or other purposes. Either fan is capable of producing the maximum draft that is required by the entire plant. One fan may thus serve as a relay.

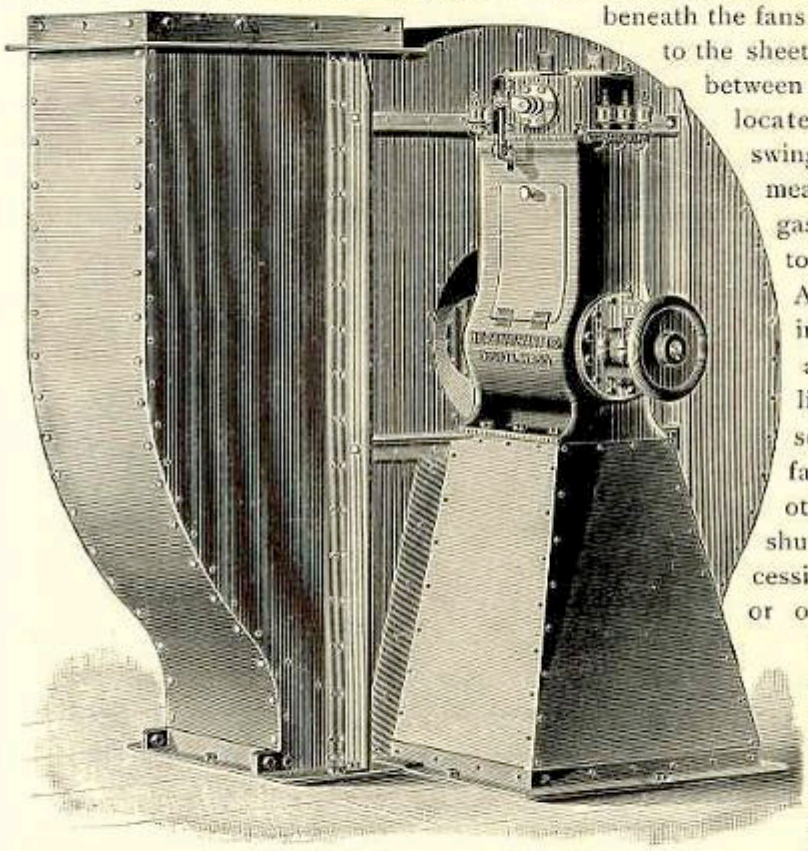

FIG. 35. SPECIAL STEEL-PLATE STEAM FAN WITH UPRIGHT COMPOUND ENGINE.

Special Steel-Plate Steam Fan with Upright Compound Engine. — The fan illustrated in Fig. 35 differs from those previously shown, in that it is provided with a special type of compound engine. This engine, because of its simplicity and economical performance, is of value where the exhaust steam cannot be utilized and high efficiency is important. A single oscillating valve performs the functions of the two valves necessary in the ordinary types, and with half the complication of moving parts.

Special Steel-Plate Steam Fan with Double Open-Type Engine. — Another type of double upright engine, not enclosed, and therefore suitable only for cleanly locations, is illustrated in Fig. 36. The relative size of this steam fan can be judged by the fact that the engine cylinders are 9 inches in diameter by 5½ inches stroke. For absolute rigidity, the engine was, in the plant from which this illustration was taken, set upon a special brick foundation. This renders its support entirely independent of the fan and removes all strain therefrom. The wheel, as in previous fans described, is overhung upon the end of the engine shaft, which is of large diameter and supported in three bearings within the base of the engine. The greatest care has been given to the continuous and effectual oiling of this engine, with the result that in numerous installations on transatlantic steamers it makes the passage without a stop. It is extremely compact, requiring the minimum of floor space for a given output, and is, therefore, especially valuable for use where but little space is available.

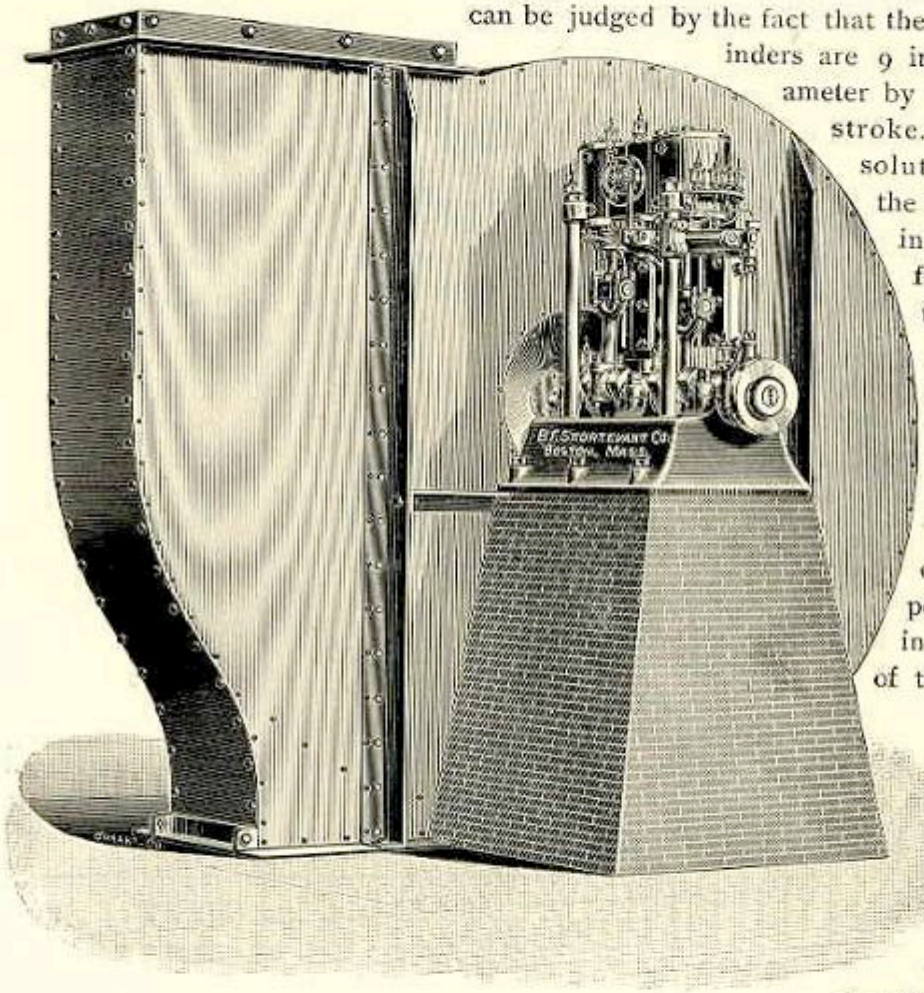

FIG. 36. SPECIAL STEEL-PLATE STEAM FAN WITH DOUBLE OPEN-TYPE ENGINE.

Special Cast-Iron Steam Fan with Double Horizontal Engine. — A somewhat unique form is presented in Fig. 37, which is from a photograph of one of the fans furnished for the U. S. S. Puritan. The side pieces of the shell are of cast iron, the rim being of heavy steel plate and the entire bottom of the casing being open for the delivery of the air directly downward. Supported upon projecting brackets cast on to one side of the shell is a double horizontal engine with its cranks set opposite so that the reciprocating parts

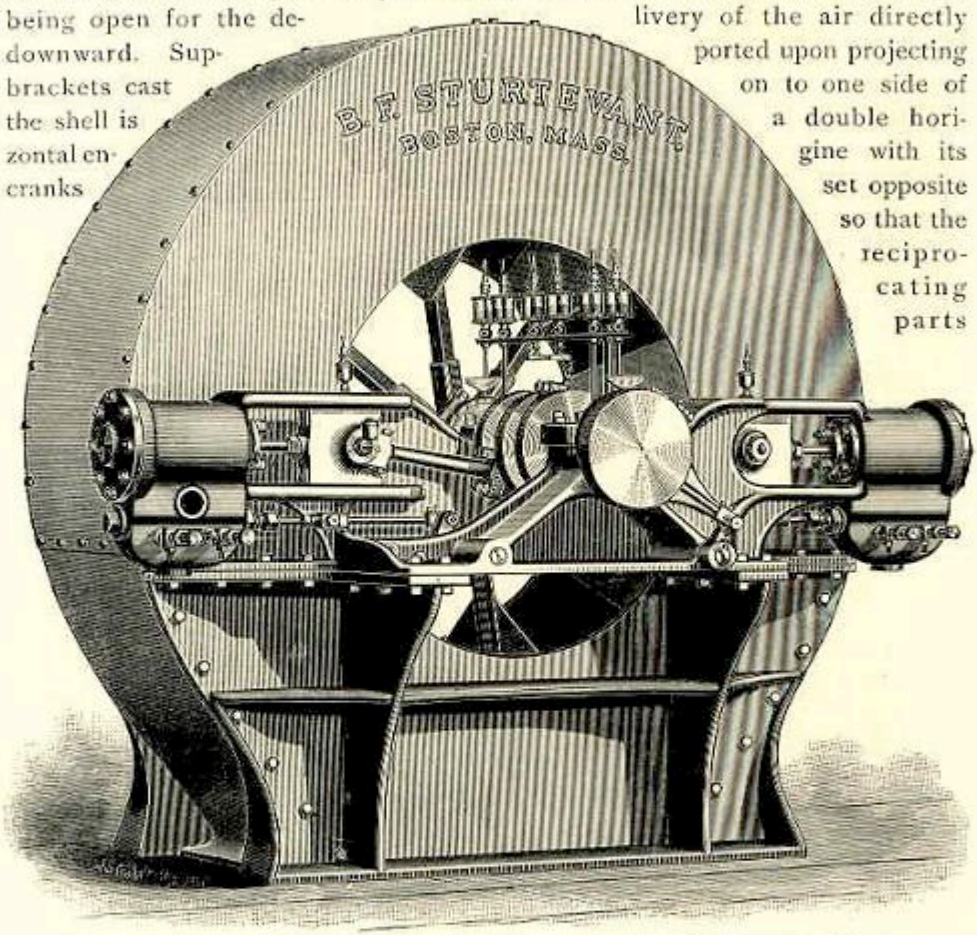

FIG. 37. SPECIAL CAST-IRON STEAM FAN WITH DOUBLE HORIZONTAL ENGINE.

are balanced. High rotative speed is thus made possible without objectionable vibration of the engine. The engine, in fact, consists of two engines, so constructed that either may be removed without disturbing the other. The valves, which are of the piston type, are actuated by eccentrics, transmitting the motion by means of rockers. A thorough system of sight-feed oilers, wipers and catch cups is provided, as is clearly shown.

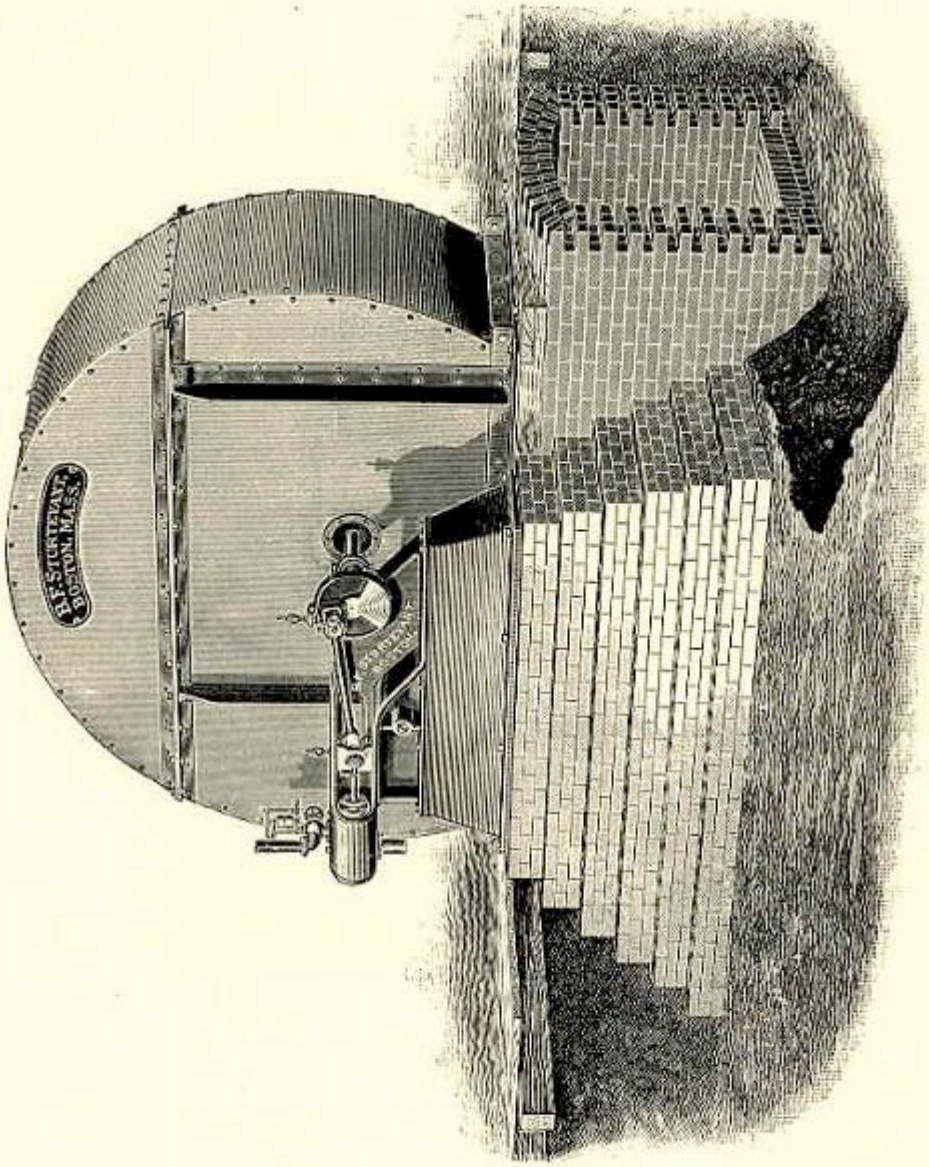

FIG. 38. STEEL-PLATE STEAM FAN WITH THREE-QUARTER HOUSING AND HORIZONTAL ENGINE.

Steel-Plate Steam Fan with Three-Quarter Housing. — All the fans previously described have been of the full-housing type. Under certain conditions, such as a lack of available height or the desire to discharge into an underground duct, a fan having a portion of its scroll constructed in the brick foundation is both economical and convenient. The standard type of three-quarter-housing fan, as this form is called, is presented in Fig. 38, where it is shown as driven by a direct-connected horizontal engine, and arranged to deliver the air into an underground duct. Such an arrangement is of especial convenience for a large forced-draft plant, where the air is forced into the ashpits from a duct beneath or in front of them. For an induced-draft plant the arrangement shown in Fig. 39 is well adapted. The curve of the fan scroll is continued within the brick foundation and the air or gas is discharged horizontally at the top, whence it may be readily conducted to a chimney. The engine is of the single upright variety already illustrated in connection with the full-housing fans. It carries the fan wheel upon its extended shaft, and is rigidly supported on a substantial brick foundation bonded into the fan foundation. The absence of a bearing in the inlet leaves it entirely unobstructed for the passage of air or gases, the condition desirable for induced draft adoption.

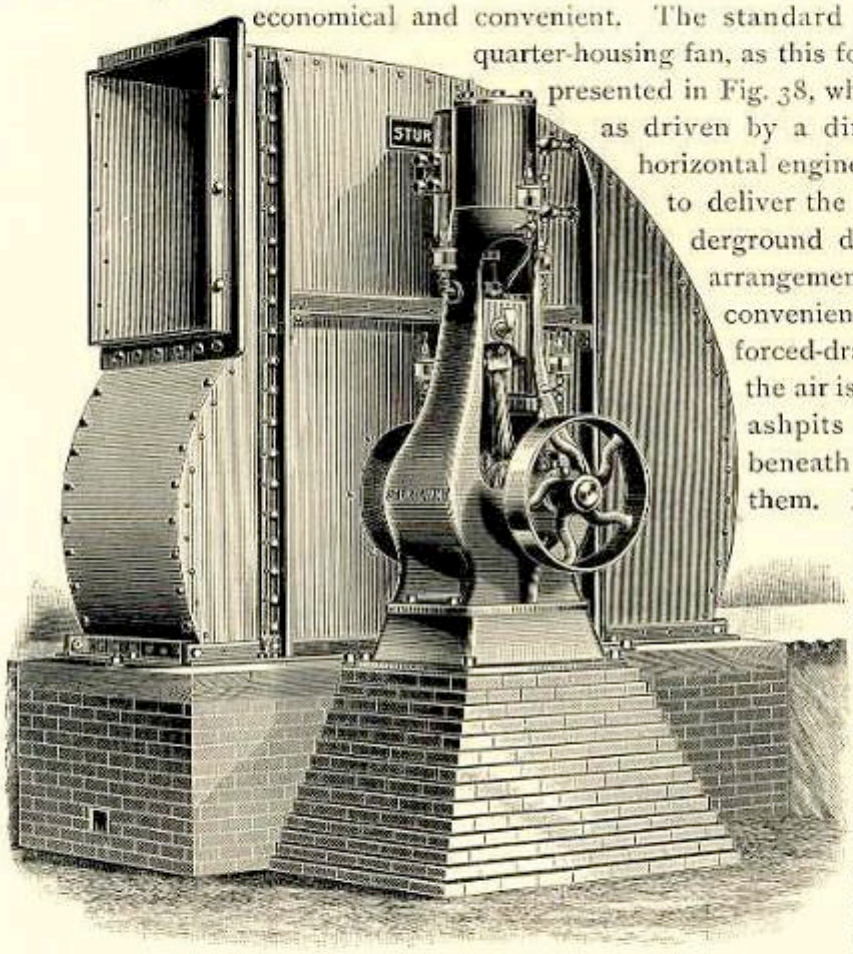

FIG. 39. STEEL-PLATE STEAM FAN WITH THREE-QUARTER HOUSING AND SINGLE UPRIGHT ENGINE.

Steel-Plate Steam Fan with Three-Quarter Housing and Double Upright Engine.—One of the most important features desirable in a steam fan applied for induced draft is an engine capable of sustained operation at high speed. The high speed is necessary because of the greater tip velocity which a fan must have in order to produce a given pressure or vacuum when it handles hot gases, while the necessity of continuous operation is evident from the fact that an entire establishment may be dependent for its power upon the draft thus produced. Both of these features are provided in the type of fan illustrated in Fig. 40. The engine is of the double variety, which has been already illustrated in Fig. 32, and there fully described. The large diameter of its cylinders, their short stroke and the cranks set at 180° are all conducive to the development of the maximum power for a given space, and the maintenance of a high relative speed. The wide spacing of the journals on the engine insures the stable overhanging of the wheel, even if of considerable width. Although here shown discharging into an underground duct, a fan of this type can evidently be as readily arranged to discharge in any given direction. When arranged to discharge the air or gas directly upward, it becomes, with its unobstructed inlet, especially adapted for induced draft; for the outlet may be prolonged into a short stack which will be supported by the fan. Any of these fans can be fitted with pulleys instead of engines, and arranged to be driven by belt from any desirable source of power.

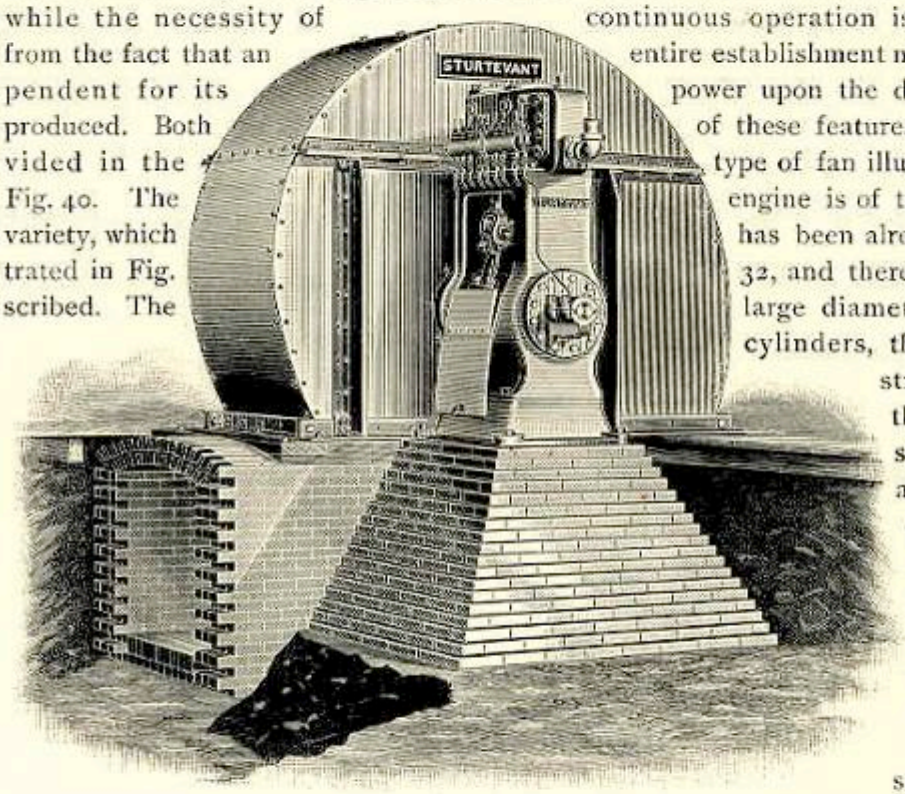

FIG. 40. STEEL-PLATE STEAM FAN WITH THREE-QUARTER HOUSING AND DOUBLE UPRIGHT ENGINE.

Steel-Plate Steam Fan, Three-Quarter-Housing Type, with Steel-Plate Bottom. — The condition frequently presents itself in induced draft practice where the fan is to be set above the ground floor, and yet it is desired that it be of the three-quarter-housing type. It then becomes necessary to construct the bottom of steel plate in place of masonry. Such an arrangement is shown in Fig. 41. As shown, the I beams of the regular floor construction are so disposed as to furnish the proper support for the fan and its engine, while permitting of the downward projection of the lower part of the housing. By a variety in the heights of the beds for different-sized engines it is possible to locate the centre of such a fan at almost any desired distance above the floor. A complete duplex induced draft plant, with fans of this general type, is presented in Fig. 42. Here the engines are horizontal and the shafts extend through the fan wheels to a central chamber which is kept open to the atmosphere and where they are supported in water-cooled boxes. The fan outlets are angular so as to permit of more ready connection to the stack above. The space between the fans and towards the observer forms a chamber to which the gases are conducted from the boiler. Here the adjustable damper serves to admit them to either fan at will, while the dampers in the connections above operate to open or close the corresponding outlets. As each fan is capable of producing all the draft required for the entire plant, either may be stopped when desired, the dampers so adjusted that no gases will pass through, and the interior thus rendered accessible. The stack is supported on the special steel-beam construction which is practically independent of the fans.

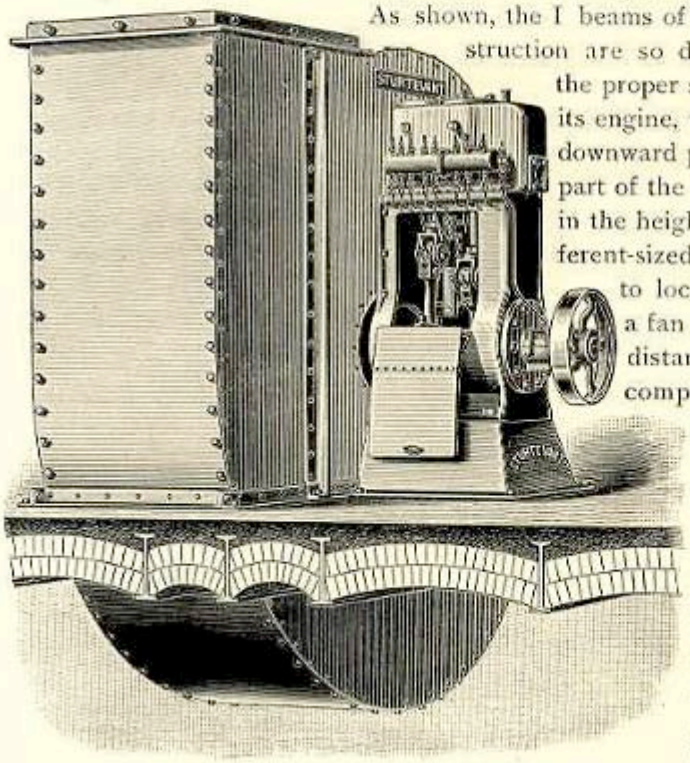

FIG. 41. STEEL-PLATE STEAM FAN, THREE-QUARTER-HOUSING TYPE, WITH STEEL-PLATE BOTTOM.

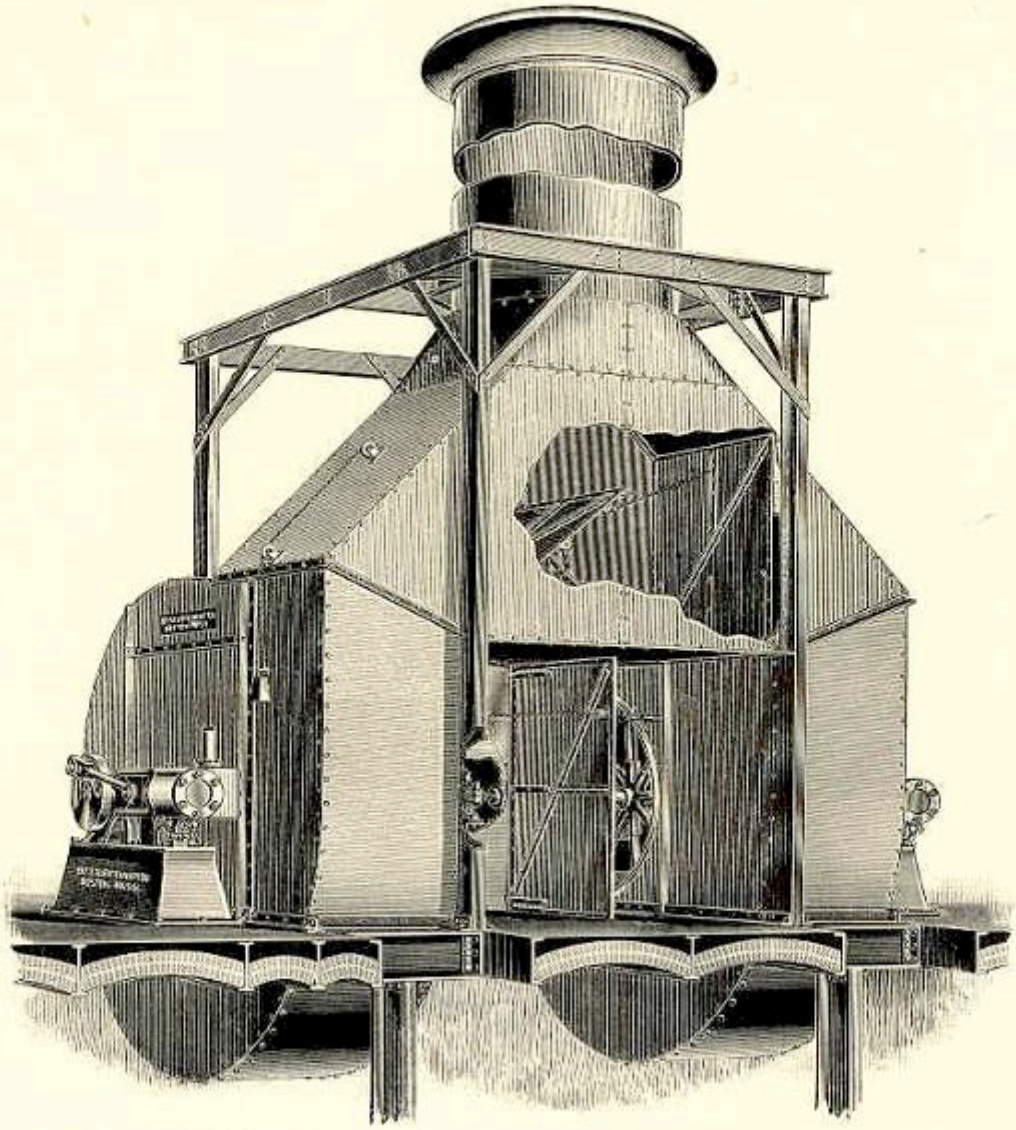

FIG. 42. SPECIAL DUPLEX STEEL-PLATE STEAM FAN, THREE-QUARTER-HOUSING TYPE, WITH STEEL-PLATE BOTTOM AND HORIZONTAL ENGINES.

Electric Fan, "Monogram" Pattern. — Conditions may arise in boiler practice in which an electric fan will prove of especial value for draft production. Such a condition frequently exists where the boilers are devoted solely to producing steam of low pressure for heating purposes, but where the draft is insufficient. Manifestly the low pressure makes it practically impossible to introduce a steam fan to assist in the draft production, unless the engine have a cylinder of extraordinary size. An electric fan, however, if installed where a power circuit is constantly available, becomes practically independent of the boiler itself and may be as readily operated when starting the fires as when steam is up. In small plants, with possibly only a single boiler, the purchase of a steam fan, even if the steam pressure is sufficient, is almost out of the question; for if made small enough to do only the work required of it, it becomes almost impracticable. But an electric fan may be furnished at a reasonable cost and of acceptable efficiency, in comparatively small size. Such a fan is that illustrated in Fig. 43. The shell is of cast iron, and of the Monogram type already illustrated in Fig. 16. It furnishes a very rigid structure, to which the motor is attached. This is of the bi-polar type, substantially contained within the heavy wrought-iron circular fieldpiece. The shaft runs in two ring-oiler bearings, and throughout the machine is the product of the most careful design and construction. Its form permits of the fan being placed in any position desired, with the feet uppermost, for instance, or attached to a vertical wall, so that the air may be discharged directly upward or downward, according as the fan may be set. The application of such a fan may save almost the entire cost of an additional boiler when a sufficiently high rate of combustion to accomplish the desired results in the generation of steam is impossible under existing conditions.

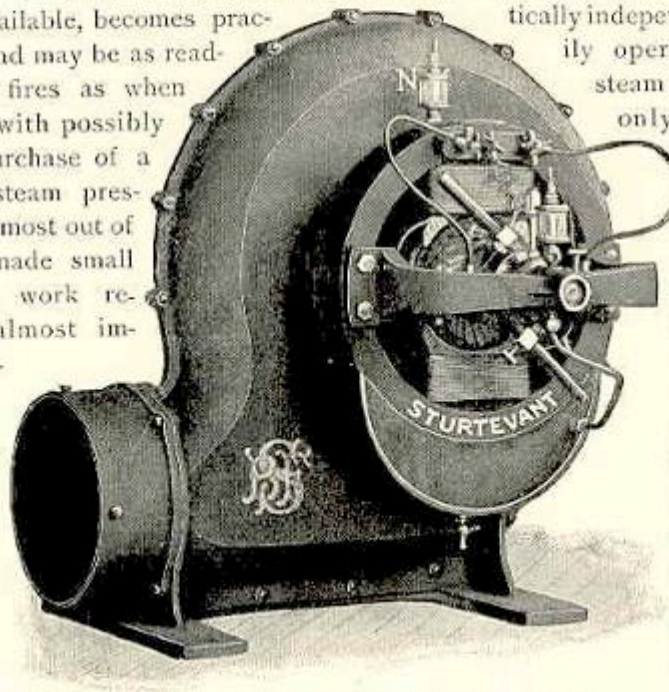

FIG. 43. ELECTRIC FAN, "MONOGRAM" PATTERN.