**Steel-Plate Steam Fan.** — It is always desirable that the means of propulsion for a fan should be as independent as possible of any other source of power; in other words, the motor adopted should be devoted solely to the driving of the fan. In the smaller sizes of fans of the pressure and "Monogram" types, the speed of rotation to produce the required pressure is such that a motor in the form of a steam engine directly connected to the fan shaft would be obliged to operate at too high a speed to remain durable; hence the belted arrangements which have already been shown. In the larger sizes of fans, however, particularly those of steel plate, the speed is such as to make direct connection practicable. A common form of this arrangement is that illustrated in Fig. 23. The fan itself is an exhauster, being identical in form and construction with that shown in Fig. 22, with the exception that the shape of the support is changed and that an engine is substituted for the journal boxes and pulley. This form of engine, which has its cylinder above the shaft, is of the same construction as the regular automatic upright engines built by this Company. The valve is of the balanced piston type, the cylinder is thoroughly lagged, the crank is accurately counter-balanced, and the crank pin is oiled from a stationary sight-feed oiler, attached to the frame of the engine. Large-cylindered low-pressure engines can be furnished in this type. Evidently this construction readily lends itself to application for mechanical draft, particularly under the induced system; for the wheel is overhung upon the end of the shaft and the inner journal may be water cooled.

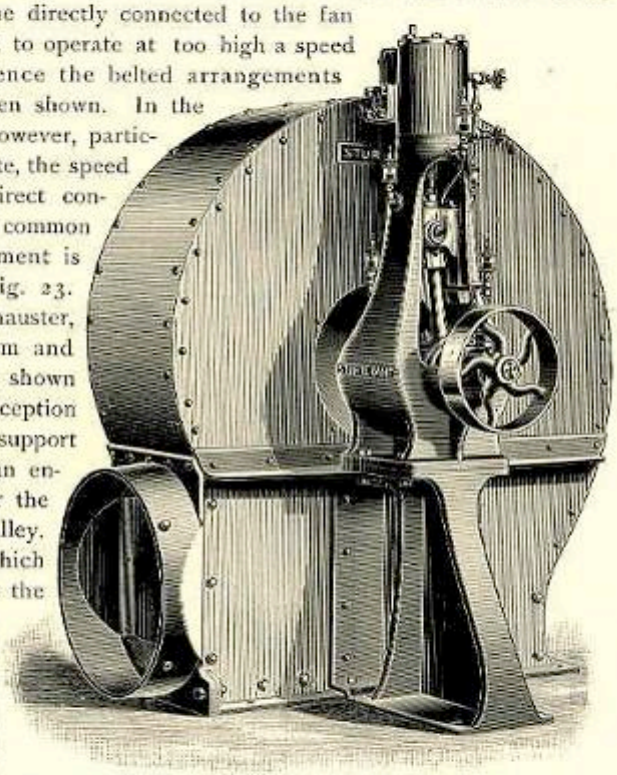


FIG. 23. STEEL-PLATE STEAM FAN WITH ENGINE HAVING CYLINDER ABOVE THE SHAFT.

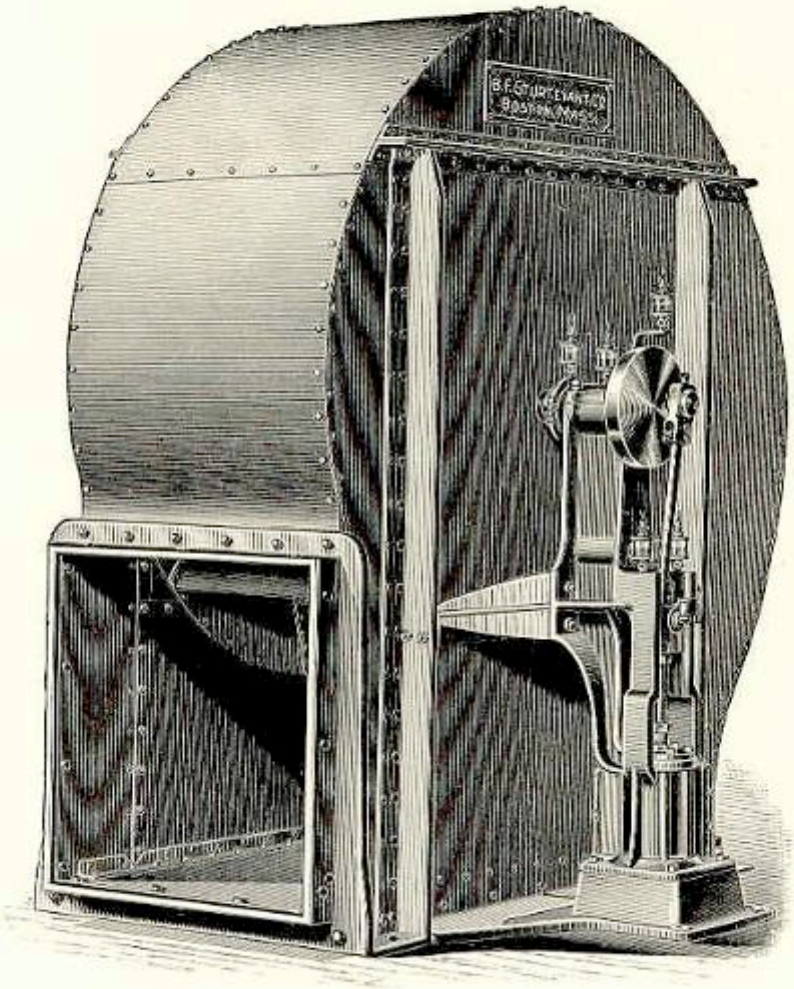



FIG. 24. STEEL-PLATE STEAM FAN WITH ENGINE HAVING CYLINDER BENEATH THE SHAFT.

The form of steam fan illustrated in Fig. 24 is that employed in the larger sizes of full-housing steel-plate steam fans. As is evident, it is specially constructed for this particular use, its cylinder is beneath the shaft, and it possesses but a single bearing, the other bearing for the shaft being regularly placed upon a truss in the inlet upon the opposite side of the fan. When applied for induced draft, the shaft may be extended so that its supporting journal box can be placed outside the inlet connection. Both this bearing and that upon the engine may be chambered and kept cool by a constant circulation of water. The space which in the usual construction is left between the engine and the shell obviates any further trouble from direct transmission to the engine. Various applications of this and the previously illustrated form of steam fan will appear in the succeeding chapter. Both forms lend themselves to control by automatic draft regulators, which may be so arranged that as the steam pressure falls the engine speed and consequently the draft pressure and rate of combustion rise and more steam is at once generated.

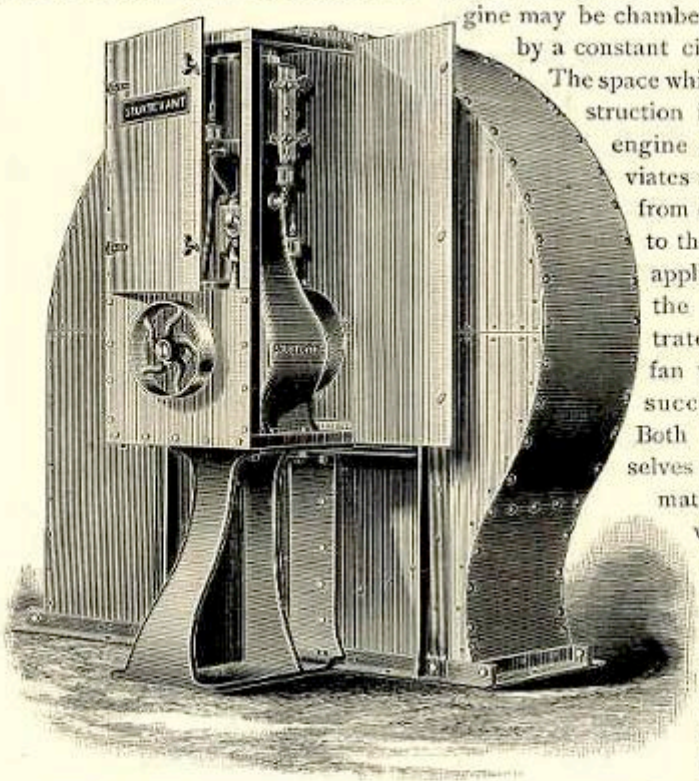


FIG. 25. STEEL-PLATE STEAM FAN WITH ENGINE ENCLOSED.

**Steel-Plate Steam Fan with Engine Enclosed.**— The objection to the presence of an engine in some boiler rooms is usually that of liability to damage from the fine dust which is floating in the atmosphere and constantly tends to work into the bearings with disastrous effect. This objection may be removed by entirely enclosing the engine in a steel-plate casing as shown in Fig. 25. A regular form of double enclosed engine is shown in subsequent cuts.

**Steel-Plate Exhauster with Inlet Connection.** — When an exhaust fan is to be employed for induced draft it is frequently desirable to construct, in connection with and in fact as a part of the fan, an inlet connection in the manner indicated in Fig. 26. As there shown, with the shaft extended through the connection and supported by an outside journal box, the arrangement is particularly adaptable to any type of fan, whether steam or pulley, such as is shown in Figs. 19 and 24, in both of which the shaft is ordinarily supported by a bearing in the inlet. Naturally the external bearings would be provided with cooling devices if hot air or gas is to be handled, and therefore thereby rendered perfectly serviceable even under these somewhat trying conditions.

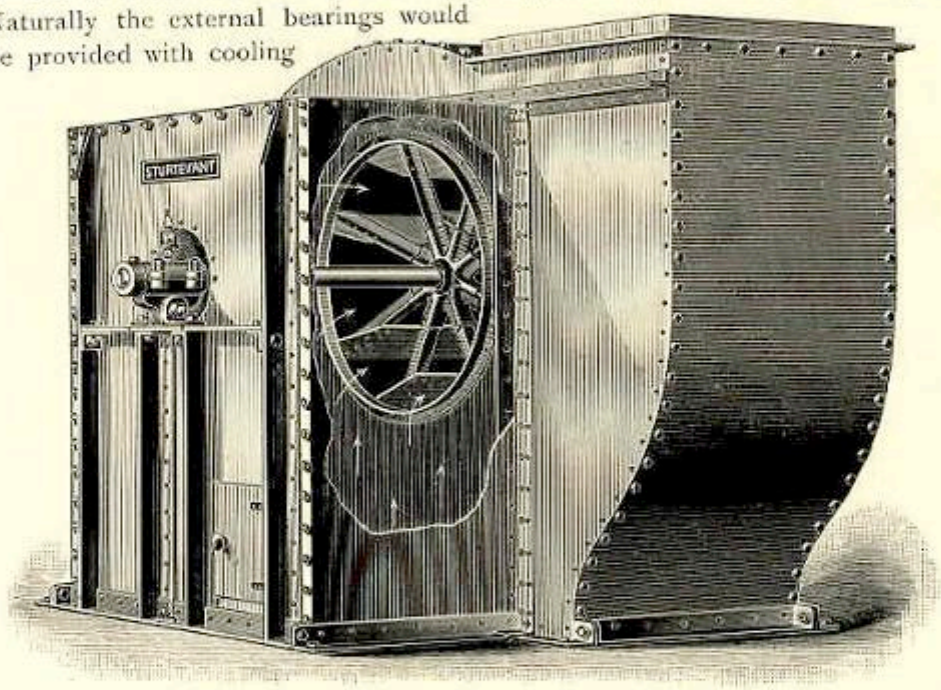



FIG. 26. STEEL-PLATE EXHAUSTER WITH INLET CONNECTION.

As here represented the inlet connection is of steel plate, with angle-iron corner frames and additional bracing of heavy angle iron. It is provided with a door to permit of access to the interior of the connection and of the fan for the removal of soot and dust. Although shown with open bottom for the admission of air or gas, it may as readily be constructed so that the supply can be taken from above or through either side. The bottom connection is especially desirable if the fan is to be placed above the boilers and the gas taken from a flue beneath.

**Special Steel-Plate Steam Fans.**— The types of independent fans which have thus far been presented are those of regular form. But, in the adaptation of fans for mechanical draft, many special forms are required, particularly for application on shipboard. These are generally provided with independent engines, in each case directly connected to the fan shaft. Great variety in the character, form and proportions of these engines is necessary to make them readily adaptable; as a consequence, the differences between most of the fans, the illustrations of which here follow, lie fully as much in the engines, by means of which they are driven, as in the fans themselves.

The smallest and simplest of this class manufactured by this Company is shown in Fig. 27. The general construction of the shell is the same as that of the regular steel-plate exhausters. The engine is self contained, carries the fan wheel upon its extended shaft, and is designed for operation at high speed. It is provided with sight-feed oilers and is adjustable in all important bearings. This size and type is serviceable for forced-draft production on small steam yachts where the grate service is limited in area, being used for the creation of under-grate pressure. Another type, also extensively employed for yacht and general marine work, is represented in Fig. 28. Here the foundation of the fan and engine consists of channel beams extending from the shell of the vessel to an interior support, thus bringing the top of the fan casing close up to the deck. Owing to the limited space in the steam yacht Sapphire, for which this was designed, the outlet was formed in the side of the casing, the air being deflected thereto by a curved plate within the casing. From this outlet a pipe leads to the boiler ashpit. Evidently this arrangement occupies the minimum of space. The engine is of the double-cylindered type subsequently illustrated in Fig. 32. It is particularly adapted for this location because of its compactness, its perfect balance, its ability to run at high speed for a long period and its enclosure from dust and dirt.

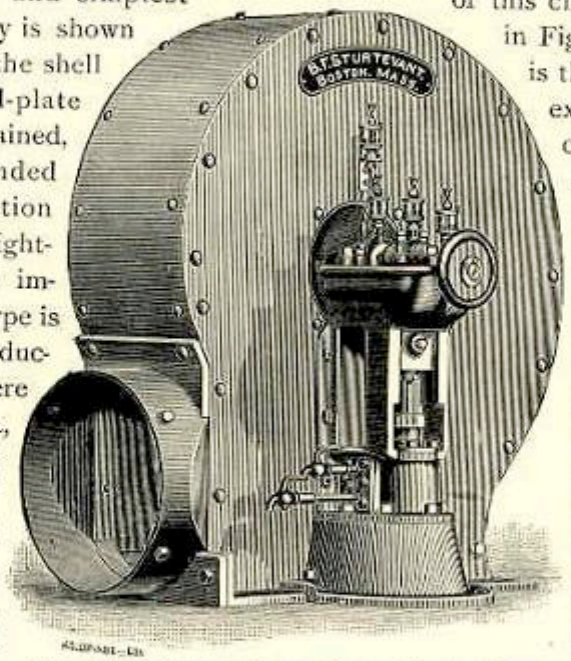



FIG. 27. SPECIAL STEEL-PLATE STEAM FAN, WITH SINGLE ENGINE.

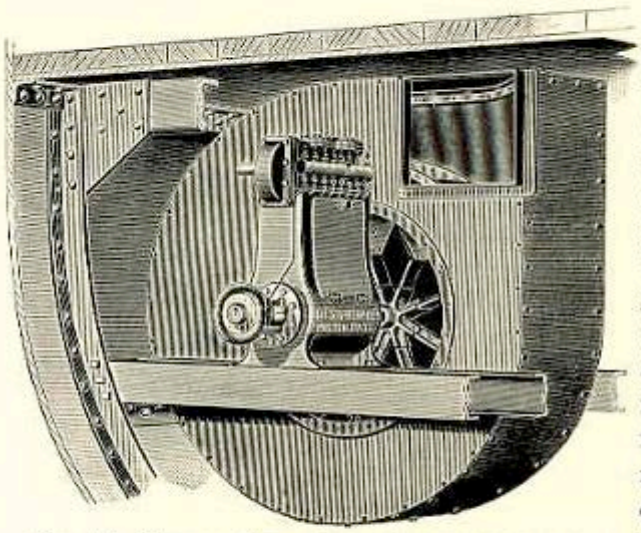


FIG. 28. SPECIAL STEEL-PLATE STEAM FAN WITH DOUBLE ENCLOSED ENGINE.

It is sometimes the case that an upright engine of the type just described will, if of adequate power, require a greater height than the conditions will admit. This difficulty may in some cases be avoided by using an engine of the same type with the cylinders below the shaft, as shown in a succeeding illustration; but when neither form is admissible resort must be had to a special type of horizontal engine. This was the condition which held in the design of the special fan shown in Fig. 29, which represents one of several fans constructed for U. S. S. Monadnock.

The engine is self-contained, having two bearings; and the fan wheel is supported on the end of the shaft. The crank and connecting mechanism are entirely enclosed, preventing the throwing of oil and the admission of dust. By the combined effect of the cast-iron bracket and the angle-iron sling, the engine is held rigidly in its place. Being carried close up to the deck, the fan being in fact fitted in between the deck beams, the least possible head room is occupied. Evidently such a fan can be arranged to deliver in any given direction or entirely around the circumference, as might be desirable in a closed fire room. Other forms for use in marine work are presented in the next chapter.

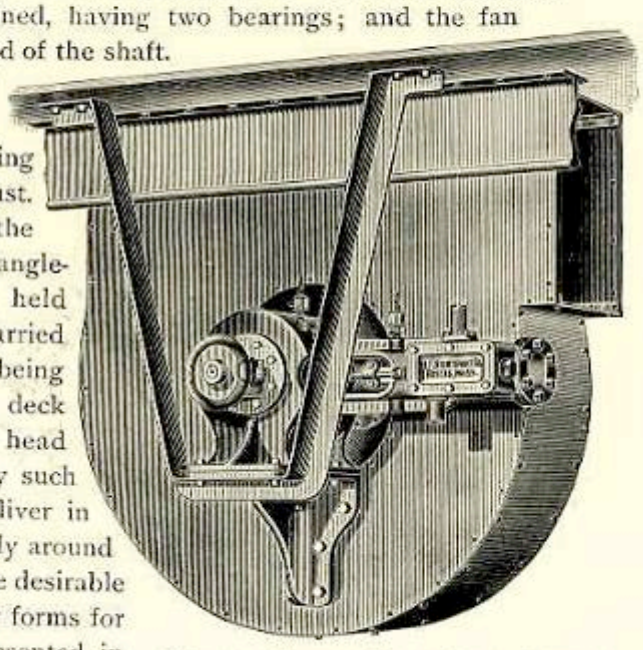


FIG. 29. SPECIAL STEEL-PLATE STEAM FAN WITH HORIZONTAL ENGINE.

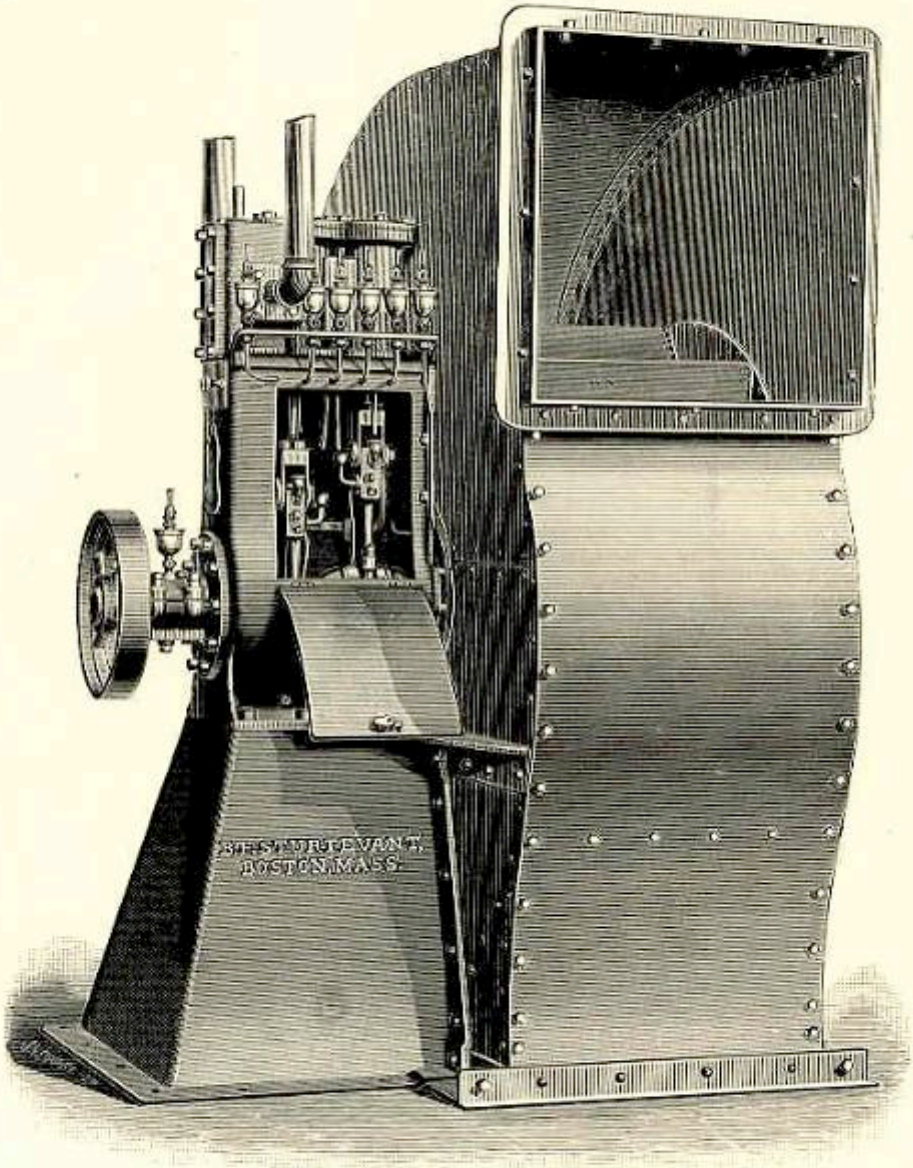



FIG. 30. SPECIAL STEEL-PLATE STEAM FAN WITH DOUBLE ENCLOSED ENGINE.

Still another form of the steel-plate steam fan with a double enclosed upright engine is shown in Fig. 30. This has a top horizontal discharge, and is applicable for either forced or induced draft. The engine is supported upon a substantial cast-iron base and carries the fan wheel upon its extended shaft. The hand wheel upon the outer end of the shaft is provided for starting the engine off the centre, when necessary. Large numbers of fans of this general type, but with the point of discharge to suit the conditions, have been furnished for the production of draft.

A pair of down-discharge fans is shown in Fig. 31, the combination with the engine forming a duplex steam fan, in which both fans are operated in unison by the same engine. A wheel is carried on each

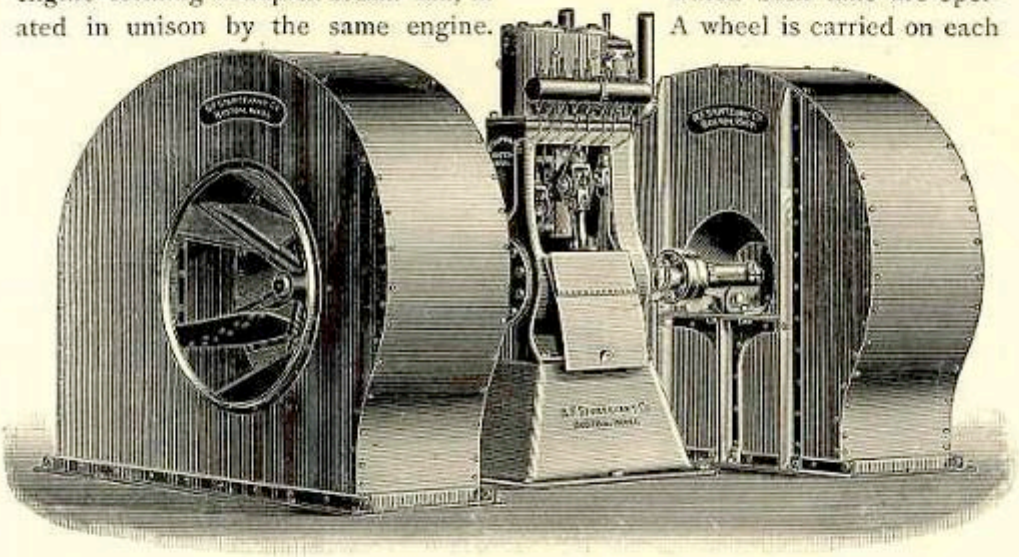
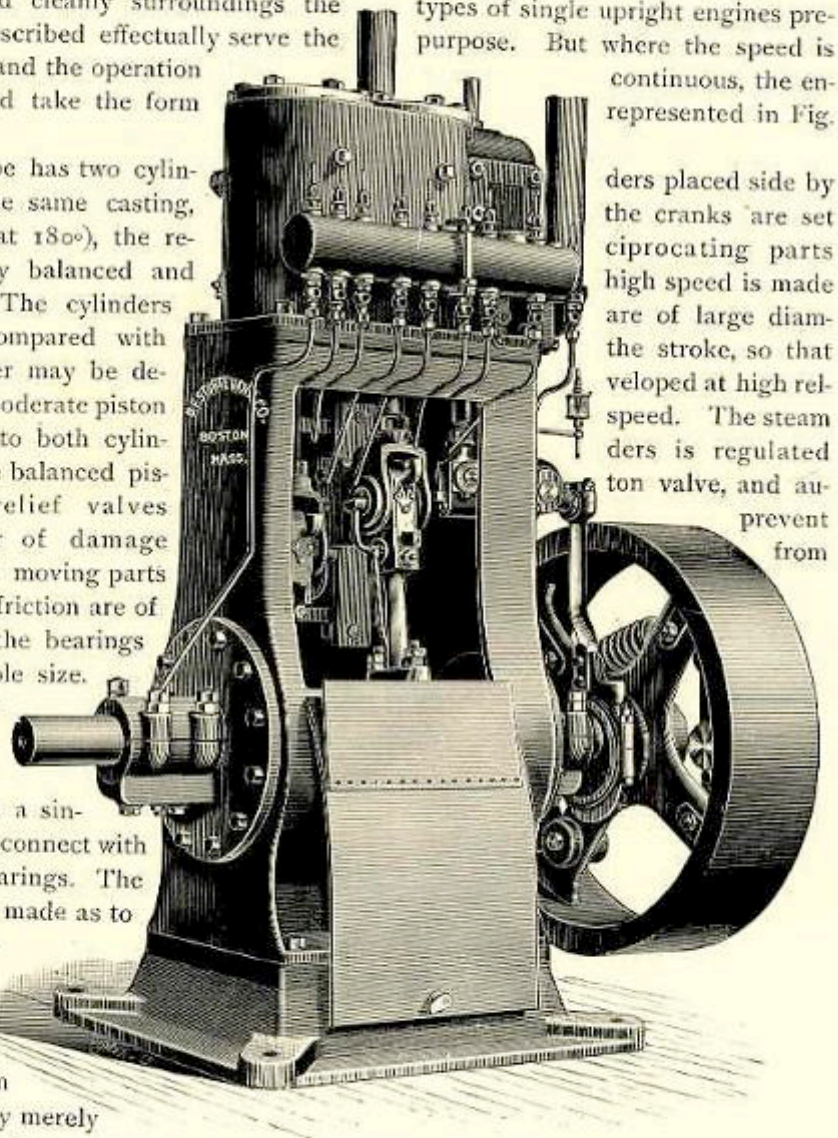


FIG. 31. SPECIAL DUPLEX STEEL-PLATE STEAM FAN WITH DOUBLE ENCLOSED ENGINE.

end of the shaft, which is provided with couplings between the engine bearings and those upon the fans, so that the engine can be entirely removed without disturbing the fans. By the arrangement for down discharge these fans may be placed above the boilers and the air delivered directly downward to them. If it be a stationary plant, a duct would connect each outlet to the boiler ashpits, but if used in the marine service either the closed ashpit or closed fire-room system of supply could be adopted. In the latter case the air would simply be delivered through openings in the deck corresponding to the outlets of the fans and thence discharged directly downward into the boiler rooms. The duplex feature reduces the height which it would be necessary to provide for a single fan of the same capacity.

**Double Upright Enclosed Engine.** — One of the first requisites of an engine for fan propulsion is the ability to operate continuously at high speed. The dependence which is placed upon the fan when it is utilized for mechanical draft is such that perfection in the engine is an important requisite. For moderate speeds and cleanly surroundings the types of single upright engines previously described effectually serve the purpose. But where the speed is excessive and the operation continuous, the engine should take the form represented in Fig. 32.




This type has two cylinders placed side by side in the same casting, the cranks are set opposite (at 180°), the reciprocating parts are thereby balanced and high speed is made possible. The cylinders are of large diameter as compared with the stroke, so that great power may be developed at high relative but moderate piston speed. The steam admission to both cylinders is regulated by a single balanced piston valve, and automatic relief valves prevent all danger of damage from water. All moving parts subject to friction are of steel, and the bearings are of ample size. Complete sight-oiling arrangements from a single oil tank connect with all of the bearings. The frame is so made as to entirely enclose all running parts, still leaving them accessible by merely opening the door.

FIG. 32. DOUBLE UPRIGHT ENCLOSED ENGINE.