CHAPTER VII.

THE FAN-FURNACE COMBINATION SYSTEM.

ADVANTAGES.

The combination of a fan with furnaces has been successfully applied in numerous instances, especially in the heating and ventilation of churches and school buildings. The use of the fan renders this system capable of supplying a nearly constant volume of air under all conditions of wind and weather. Reversals of the air current in the flues, due to changes in the direction of the wind, which sometimes occur in the simple furnace system, are prevented.

APPLICATION OF THE SYSTEM.

The fan-furnace combination may be applied not only to churches and schools, but to hospitals, public and other buildings where a large and continuous supply of fresh air is required. In comparison with other mechanical systems this one is less expensive and simpler in its make up.

When arranged to rotate the air it is capable of warming the rooms very quickly. The system is, therefore, well adapted to buildings used intermittently. For buildings of good size, which must be kept warm night and day, this method of heating must give way to some form of steam apparatus. With the latter the cost of power for driving the fan will be less than for gas, electricity or water, and the boiler fires may be handled more easily than a number of furnaces.

LOCATION OF THE FAN.

The fan should be placed between the furnace and the fresh air inlet to the building (see Figs. 47 and 48). The air will then be forced, instead of drawn, through the furnace, as would be the case with the fan placed beyond them.

The "blow through" arrangement has several advantages over the other. At a given speed the fan will handle a greater weight of cold than of warm air; hence, to deliver a stated volume, the fan, when so arranged, may be run at a lower speed than when handling air at a higher temperature, as in the "draw through" arrangement. The lower the speed the less the noise and vibration. The air being under pressure, any leakage of gas or dust from the furnaces is prevented. Branch pipes may be taken from the main cold air duct before reaching the furnaces and be carried to the mixing dampers placed at the base of the flues.

With the "draw through" arrangement this would be impossible, as only warm air is handled by the fan.

LOCATION OF DRIVING APPARATUS.

The engine or motor and fan must be located where they will be least likely to cause trouble from noise. The best location is

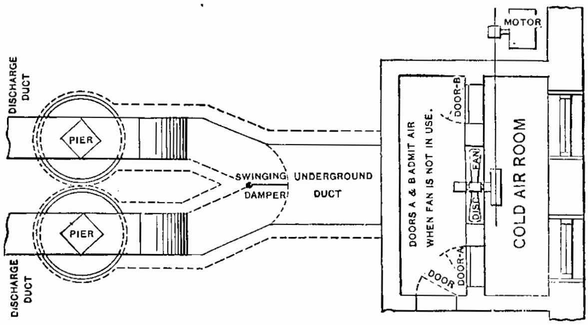

Fig. 47.—Plan of Fan-Furnace Combination.

just outside the walls of the building in a room provided for the purpose. If the apparatus must be located in the basement, the fan and engine or motor must be placed away from piers, which are likely to transmit vibration. To prevent sounds being carried along galvanized iron ducts the following expedient is sometimes resorted to. A section of the pipe about 4 inches long is cut away and a sleeve of light canvas is slipped over the ends and fastened by means of wires drawn up tightly, thus forming a flexible air tight connection.

SIZE OF FURNACES.

The size of furnaces for schools, churches and public buildings is determined as explained in the chapters under those headings. Having calculated the grate areas, bear in mind that small furnaces have more heating surface proportionally than large ones. Hence they may be used to better advantage than a single large furnace having their combined grate area.

KIND OF FURNACES.

The furnaces must be of the best materials and construction to withstand the severe strain often accompanying intermittent use. The ratio of heating to grate surface must be large. Extended surface in the form of pins and ribs may be used to advantage to break up the air current. To secure the best distribution of air around the furnace a pit should be used.

AREA OF AIR PASSAGES IN FURNACES.

When the furnaces are intended to be run, at times, independent of the fan the space for the passage of air through them should

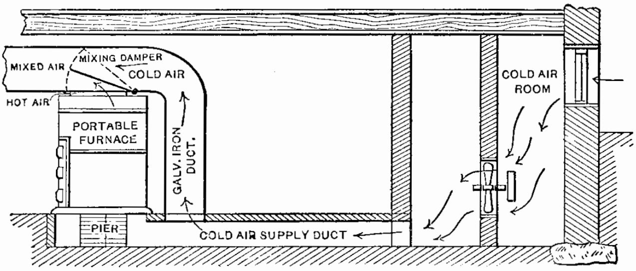

Fig. 48.—Sectional Elevation of Fan-Furnace Combination.

be about equal to the combined capacity of the ducts supplied, or sufficient to permit the required volume of air to pass at a velocity of about 300 feet per minute. A higher velocity, say 600-800 feet per minute, may be allowed in furnaces which are always used in connection with the fan. If the space is too great the air will be likely to be unequally heated, a portion passing through the furnaces without being brought into close contact with the heating surface.

SETTING.

The furnaces may be set either in brick or galvanized iron, the relative merits of which have been previously discussed. The joints must be tight, to prevent the leakage of air. It is well to cover galvanized iron casings with plastic non-conducting material.

The furnaces may be placed side by side, in battery, so-called, or they may be set separately and connected with the fan by ducts. The battery arrangement facilitates firing and attendance in general, but furnaces so placed cannot be run as well independently as those located near the rooms which they heat. With either ar-

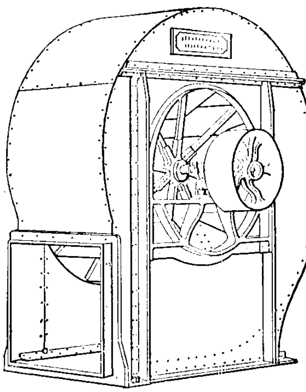

Fig. 49.—Blower Type of Fan.

rangement, provision should be made for returning air from the building when unoccupied.

TYPES OF FANS.

Two types of fans are used, the blower type, Fig. 49, like a paddle wheel, where the air leaves the fan in a direction perpendicular to the shaft, and the disk fan, Fig. 50, like a propeller, where the air leaves the fan in a direction parallel to the shaft.

When the ducts are of considerable length the blower is preferable to the disk fan, for with the former the air may be handled against resistance without excessive expenditure of power. The disk fan is adapted only to short lengths of pipe of large area.

If the resistance be increased by closing registers or dampers, the volume of air delivered will be diminished, but the power consumed by a disk fan will be greater. On the other hand, with fans of the blower type, if the resistance be similarly increased the lessened delivery of air will be accompanied by a corresponding reduction in power.

SPEED OF FANS.

It has been found in practice that fans of the blower type having curved floats operate quietly and give good results when run at a speed corresponding to ½ ounce pressure—*i e.,* a speed at

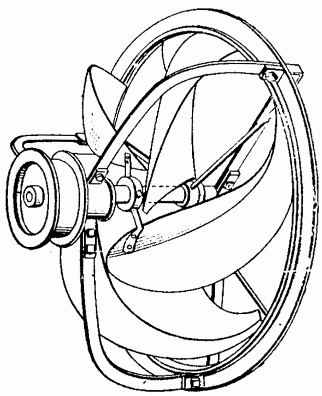

Fig. 50.—Disk Type of Fan.

the circumference of the wheels of about 3600 feet per minute. Higher speeds are accompanied with a greater expenditure of power and are likely to produce a roaring noise or cause vibration. A much lower speed does not provide sufficient pressure to give proper control of the distribution during strong winds.

FAN CAPACITIES.

The capacities and powers given in fan manufacturers' catalogues are not, as a rule, attainable in practice, the tables being based on other than practical working conditions. They should therefore be used with caution.

The following tables, XVIII and XIX, are intended as a guide in the selection of fans and motors, the former to be used where the ducts are of considerable length, the latter where they are short and of large area with easy turns:

Table XVIII.—Air Delivery per Minute and the Appropriate Size of Motor for Fans of the Blower Type.

Nominal size of fan. Hight of housing. Inches.	Diameter fan. wheel.	Width of fan housing.	Ordinary speed ½-ounce pressure.	Cubic feet of air delivered per minute.	For belted motor use horse-power.
40	24	12	580	1,600	1
50	30	15	465	2,600	1
60	36	18	390	4,500	2
70	42	21	333	6,000	3
80	48	24	293	8,000	3
90	54	28	260	11,000	5
100	60	32	233	12,500	5

Table XIX.—Air Delivery per Minute Against Slight Resistance and the Appropriate Size of Motor for Fans of the Disk Type.

Disk fan wheel. Inches.	Speed.	Cubic feet of air delivered per minute.	For belted motor use horse-power.
12	1,000	600	¼
18	800	1,500	½
24	500	2,300	1
30	410	3,500	1
36	380	5,700	1½
42	330	7,800	2
48	280	9,900	3
54	250	12,500	3
60	230	16,000	5

THE MOTIVE POWER.

The driving apparatus generally consists of an electric motor, gas engine or water motor. The gas engine is the most expensive in first cost, then the electric and water motors, in the order named.

The cost per hourly horse-power where the amount is less than 5 horse-power per hour would be on an average about 5 cents for the gas engine, 10 cents for the electric motor and 30 cents for the water motor. The electric motor is the most convenient machine to use. It may be easily controlled by a switch and starting box or speed regulator. The latter should have an automatic device to cut out the resistance coils whenever the current is interrupted from any cause. The motor may be connected directly to the fan shaft or it may be belted. Independent motors should be slow speed and should rest on an adjustable base for convenience in tightening the belt. Motors are generally wound for 110 or 220 volts. An extra charge is commonly made for 500-volt machines. In ordering always state the voltage.

The gas engine is the least quiet of the three machines, the noise of the exhaust being difficult to overcome. This may be done, however, by leading the exhaust pipe first into a cast iron pot or equalizing chamber, thence into a pit or dry well of large capacity with a suitable outlet. A water supply for cooling the cylinder is necessary, and in some locations of the engine this involves danger of damage from freezing in case of neglect.

The water motor is simple, quiet and convenient, but the cost of running one at city water rates is generally prohibitive.

AREA OF DUCTS AND FLUES.

With the blower type of fan the size of the main ducts may be based on a velocity of 1200 to 1500 feet per minute, the branches on a velocity of 1000 to 1200 feet per minute, and as low as 600 to 800 feet when the pipes are small. With the disk type of fan the size of the ducts should be based on a velocity per minute not greater than 1000 feet, preferably less, in order to keep the resistance low.

Flue velocities of 500 to 700 feet per minute are permissible with the fan combination, though it is better, when possible, to keep the velocity as low as 400 feet. When the furnaces are placed separately and are intended to be run independent of the fan at times, the warm air flues should be based on a velocity of about 300 feet per minute.

The size of registers may be based on about the same velocity as last stated, adding 10 to 25 per cent. to offset the additional resistance to the passage of air through them.