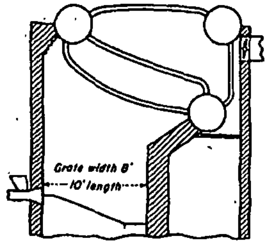
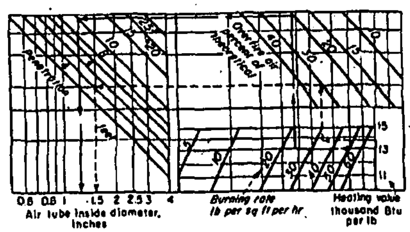
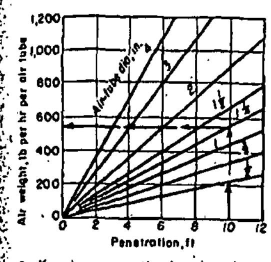
BLOWER JETS: Simplified, Step-by-Step Procedure for Selection and Sizing to Get Efficient Overfire Action in Stoker Furnaces



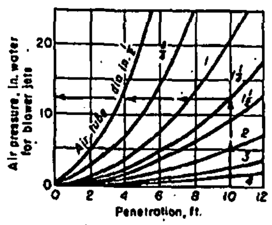
1 Sample stoker-fired boiler, above, will have jets mounted in front wall



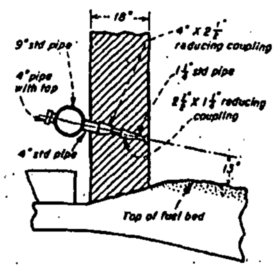
2 Applying the first four factors in Table II to this chart gives air-tube dia required for a blower-supplied jet



3 Knowing penetration length and tube dia get weight of air per tube above



4 Using same factors as Fig. 3 determine required air pressure at tube



5 Locate air tubes on tube spacing above bed; aim 6 in. above on back

How Overfire Jets Can Be Made to Cut Smoke*

Here's an easy-to-follow procedure that gets results in cutting down smoke from old boilers. All the details you need to build a set of workable steam or air jets—diameter spacing, number, capacity of the tubes—are discussed and explained

CLEAN AIR

A JOB FOR THE POWER ENGINEER

By L N ROWLEY, *Managing Editor*, and J C McCABE, *Associate Editor*

▶ A RELATIVELY INEXPENSIVE, quickly available tool for cutting down smoke in an old boiler sounds like magic. Yet Bituminous Coal Research, Inc has been running a series of jet clinics across the country to show combustion engineers where just such a tool has been put to work. This tool is an overfire jet.

Let's first look at the function performed by this jet, and then learn how to make and apply one. Smoke, as distinguished from cinder and flyash, consists of finely divided carbon and soot particles. These particles come into being when decomposed hydrocarbons issuing from the fuel bed fail to burn completely because of (1) insufficient oxygen (2) inadequate turbulence or mixing (3) a combination of 1 and 2. Here is where overfire jets get in their work.

There are two types depending on where they draw their primary force: (1) blowers to give *both* additional air and turbulence (2) steam jets to give turbulence only, or both turbulence and additional air depending upon location of steam nozzle in air tube.

As far as selection of type goes blowers have cheaper operating costs as air movers than do jets. Where a boiler operates with little or no makeup blowers are almost the obvious choice. Steam jets apply where (1) there are no blowers (2) initial cost of blowers *seems prohibitive* (3) *only turbulence* is needed.

As for service, no overfire jet can overcome poor firing practice. They are no cure-all. But as a supplementary tool or a source of auxiliary overfire air they prove most helpful.

General Operation. Bear this in mind. Installing jets is useless unless one of the following conditions applies: (1) reliable automatic jet controls—preferably electronic (2) a situation requiring continuous operation of jets (3) a *convenient indication for acquainting* the fireman with the density of flue gas. No fireman will or could be expected to operate jets only as needed.

Now let's get about the job of choosing a jet-system design for a work[...] boiler, Fig. 1. Tables II and V[...] *the steps but we'll follow throug[...]* need to know (1) maximum bu[...] rate per sq ft of grate area per h[...] percentage of overfire air require[...] distance from walls that jets mus[...] to penetrate smoking areas—[...] length of penetration (4) heating [...] of coal.

Maximum burning *rate come*[...] observing hourly rate of coal con[...] tion under peak load and divid[...] grate area in sq ft. For our exa[...] it is

$$\frac{2000 \text{ lb coal per hr}}{80 \text{ sq ft}}$$

or 25 lb per hr per sq ft.

Second, the percentage of overfire [...] required: Here a guide chart based on experiments comes to aid. It shows the following:

Smoke density	*Estimated percentage overfire air needed*
Light	10
Moderate	20
Heavy	30

Only in cases of extreme smoking is more than 30% overfire air needed. As much as 35% overfire air is not too much if dense but infrequent smoke develops when, for instance, the fuel bed is manually disturbed during cleaning. But the larger the percentage of excess air needed the more important that the jets operate only as long as needed. For our example, we'll assume moderate smoke and 20% overfire air.

Third point—length of penetration usually equals grate length if overfire jets are in the front wall; grate width if in side walls. Our case has them in the front wall of furnace, and length of penetration is 10 ft.

Heating value of coal comes from (1) recent analyses of coal burned (2) typical analyses of coals from the same mine or bed (3) coal suppliers. Our example uses 13,000 Btu per lb coal.

Fig. 2, solid line, employs the four points (Table II, a-d) we have just determined to give air-tube diameter. Table I gives recommended center-line spacing of air tubes.

But how many tubes do we need? This is determined by dividing the inside length of the furnace wall in inches by distance of air-tube spacing and subtracting one. Convert fractions into nearest whole number. Example:

$$\frac{8 \text{ ft} \times 12 \text{ in. per ft}}{13\text{-in. tube spacing}} - 1 = 6 \text{ tubes}$$

Fig. 3 takes into account the length *of penetration and the air-tube dia to* give the lb per hr of air to be delivered by each tube—560 lb per hr. Fig. 4 uses these same factors to determine air pressure required at air-tube entrance, 13 in. of water.

Total air-weight requirements of all tubes must be converted to the same terms by which fan and blower manufacturers rate equipment. By use of a conversion factor .222 in a formula, this can be done. For example: No. of air tubes x weight of air per tube per hr x .222 equals cu ft of air per minute at 70 F, or 746 *cfm in our case.*

The air pressure, 13 in. of water, required at the air-tube entrance may also be used for blower discharge pressure. But duct velocity must not greatly exceed 2000 fpm for this to be true, and there can't be any sharp bends or abrupt area changes in the duct work. Again, an established formula employing a conversion factor of .072 comes to the rescue to give the required cross-sectional area of the duct.

I: Center-Line Spacing of Air Tubes*

Penetration length, ft	Air-tube diameter, in. 0.5	1	1.5	2	3	4
4	5	5	6	7	8	9
6	7	7	8	9	10	11
8	10	10	11	12	13	14
10	12	12	13	14	15	16
12	15	15	16	17	18	19
14	17	17	18	19	20	21
16	19	19	20	21	22	23
18	22	22	23	24	25	26
20	24	24	25	26	27	28

* To nearest inch

II: To Choose Blower Overfire Air Jets

a. Estimate maximum burning rate per sq ft grate area per hr
b. Estimate percentage of overfire air required
c. Estimate length of penetration required
d. Determine heating value of coal burned
e. Determine air-tube diameter
f. Determine air-tube spacing
g. Calculate number of air tubes required
h. Determine weight of air per tube
i. Determine air pressure for blower
j. Calculate total cu ft air per min to inject into furnace
k. Determine cross-sectional area of ductwork needed
l. Don't let any jet impinge on furnace wall or live coal

* Material is developed from Technical [...] VII—"Application of Overfire Jets to Prev[...] from Stationary Plants," by B B Bresd[...] Memorial Institute, and W B Major, Bitum[...] Research, Inc.