CHAPTER 7

Conversion: Coal to Oil

Some types of cast iron boilers designed to burn coal are not suited to burn oil. Aside from adapting the furnace for oil burning, changes must be made in the passages formed by the heating surface.

Extra large flue passages are **not suited** *to the high temperature flue gases encountered with oil.*

In these boilers having the large flue passages, baffling must be resorted to in order to slow down the high velocities of the extra hot gases, otherwise unburned particles of oil may lodge on the heating surface, resulting in carbon. Since carbon is an excellent insulator, the efficiency of the heating surface is lowered whenever it collects.

Preliminary to Conversion.—Before constructing a combustion chamber and installing a burner, the heating system should be carefully checked for defects and cleanliness. A boiler which is inadequate for the job (most of them are inadequate) or is in need of repairs will not give satisfactory results after the burner is installed.

All flue passages should be cleaned so that the maximum amount of heat generated is absorbed by the boiler.

Soot or ash are good insulators and both are always undesirable.

All doors should fit tightly and all other openings or cracks should be tightly cemented shut. The stack from the furnace to the chimney should have tight joints. Dampers should not close the stack more than 80% of the cross sectional area of the stack. Inspect stack for leaks and obstructions of any kind.

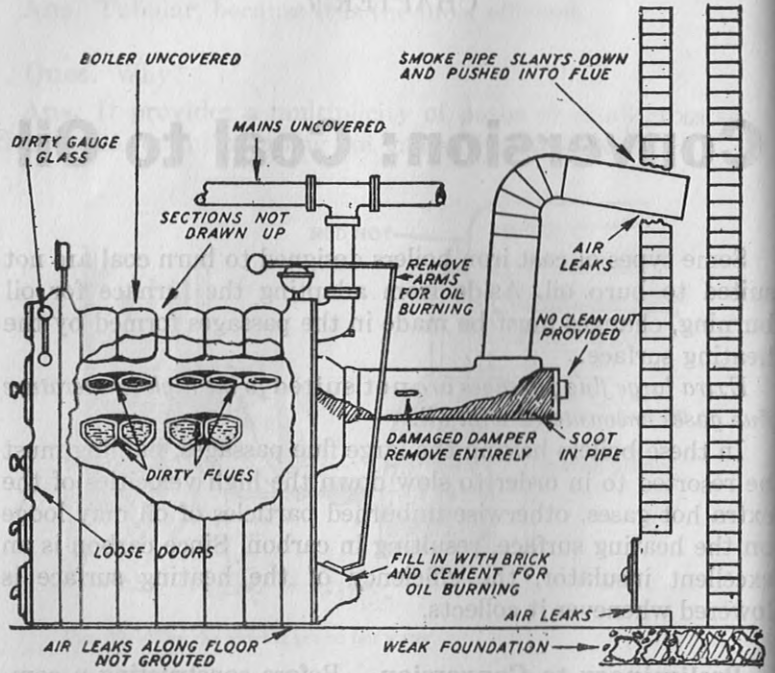


FIG. 1—Boiler troubles to be remedied before converting and installing an oil burner.

The best burner on the market cannot correct the faults of a boiler that is no good.

The owner should get rid of such junk and install a boiler with adequate heating surface to economically take care of the load.

Ques. What is the important requirement for combustion chambers and why?

Ans. The flame must be in the presence of refractory material so that it will not come in contact with any of the relatively cold heating surface of the boiler.

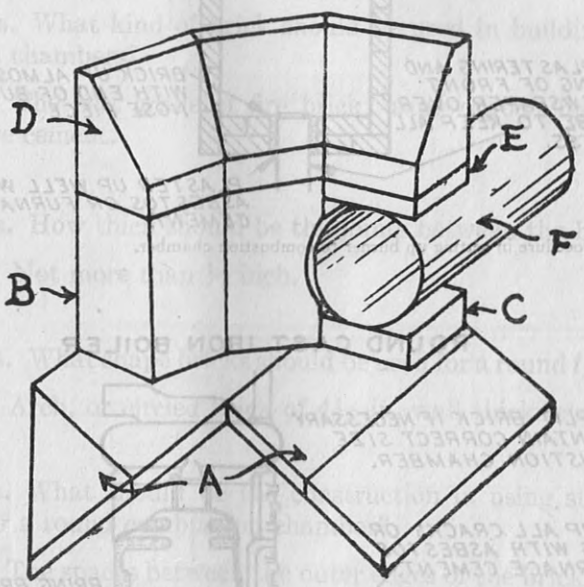


FIG. 2—Custom built combustion chambers. Instructions: 1. Place split brick A, on ash pit floor to form combustion chamber. 2. Mix refractory brick binder to consistency of heavy cream in shallow pan. 3. Dip bottom and sides of brick B, in binder and place in circular position on construction chamber floor, start at back and work front. 4. Tighten finished tier with bands furnished. 5. Fill behind first tier with asbestos or rock wool. 6. Install top tier D, in same manner, tighten with one band. 7. Cap chamber with mixture of 3 parts asbestos and 1 part fire clay and trowel smooth. 8. Place metal sleeve F, in opening and cement tightly in place. 9. Insert draught tube tin metal sleeve and pack with asbestos rope or rock wool.

When the flame is burned in suspension in a combustion chamber of refractory material, the refractory wall reflects the heat back into the flame and thereby increases the flame temperature.

Ques. What is the effect of the increase in flame temperature from reflected heat?

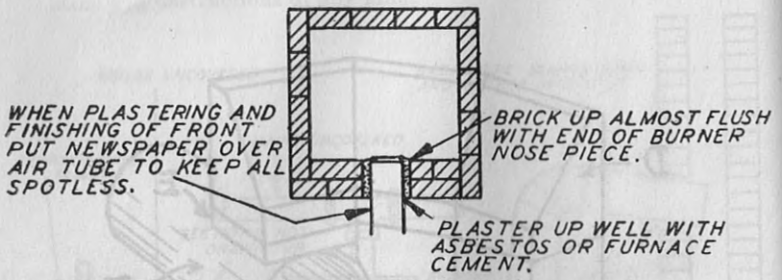


Fig. 3—Procedure in setting up burner to combustion chamber.

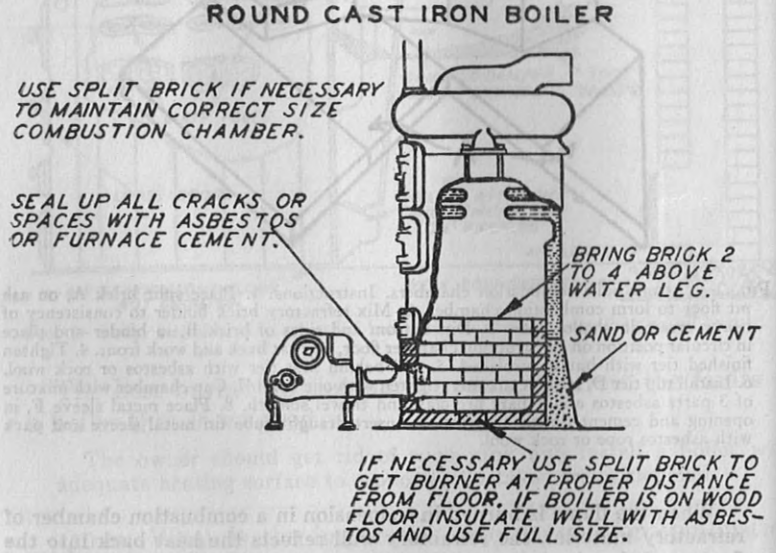


Fig. 4—Combustion chamber for round cast iron boiler.

Ans. It greatly increases the rapidity of combustion and thereby makes possible the burning of every particle of oil within the zone of combustion.

Ques. What kind of brick should be used in building combustion chambers?

Ans. The best grade of fire brick, using a good high temperature cement.

Ques. How thick should be the joints between the brick?

Ans. Not more than ⅛ inch.

Ques. What shape bricks should be used for a round furnace?

Ans. Arch, or circled brick of 4½ in. wall thickness.

Ques. What should be the construction in using standard brick for a round combustion chamber?

Ans. The spaces between the outer edges of the brick should be filled with high temperature cement and small pieces of fire brick to obtain firm construction and prevent infiltration of oil vapors through the wall.

Ques. How should the opening for draught pipe be constructed?

Ans. It should be 1½ to 2 ins. larger than the pipe using as a lining a piece of sheet metal slightly cone shaped with the larger end at the outside.

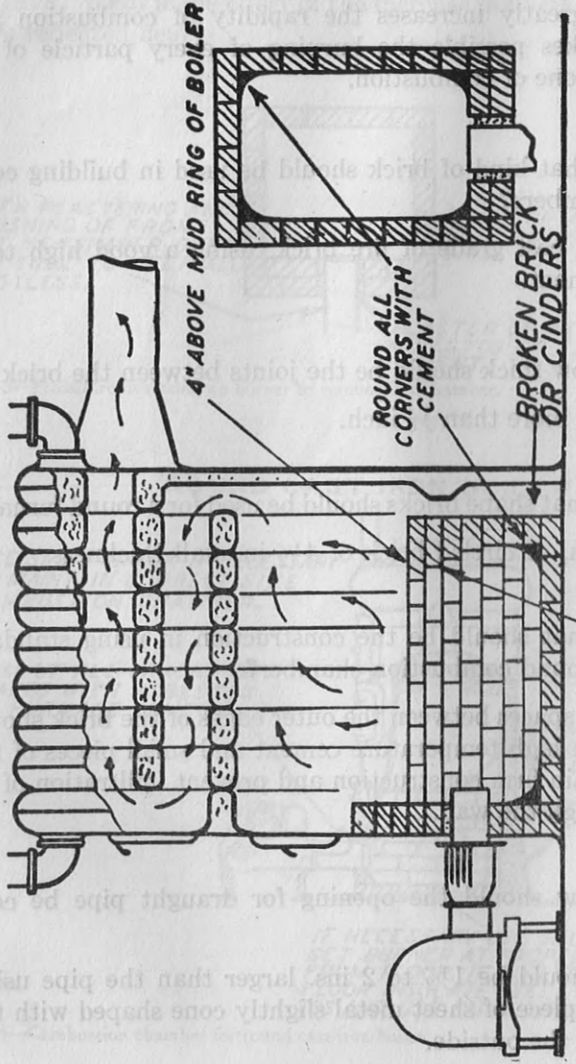


Fig. 5—Combustion chamber for horizontal cast iron boiler.

Ques. How should the draught pipe joint be made?

Ans. Asbestos pipe covering should be wedged between the pipe and the lining in the combustion chamber wall.

Ques. Why?

Ans. This affords an air tight seal and at the same time the resilience of the packing prevents vibration of the burner being transmitted to the furnace.

Distance Bottom of Draught Pipe to Floor

Narrow Flame Nozzles:	
1 gal. per hr.	3"
2 gal. per hr.	3½"
3 gal. per hr.	4"
Medium Flame Nozzles:	
1 gal. per hr.	3½"
2 gal. per hr.	4"
3 gal. per hr.	4¼"
Wide Flame Nozzles:	
1 gal. per hr.	4"
2 gal. per hr.	4½"
3 gal. per hr.	5"

Ques. What height should be allowed between draught pipe and bottom of floor of combustion chamber?

Ans. It depends upon the quantity of oil being burned and the size and shape of the combustion chamber as given in the accompanying table.

Ques. How should the draught pipe be installed?

Ans. At an angle of 1½° inclined toward combustion chamber.

Ques. What should be the height of the combustion chamber walls?

Ans. It should be high enough so that the flame will not come in contact with the relatively cool walls of the boiler. At the burner end, the refractory need not be higher than the grate line of the boiler.

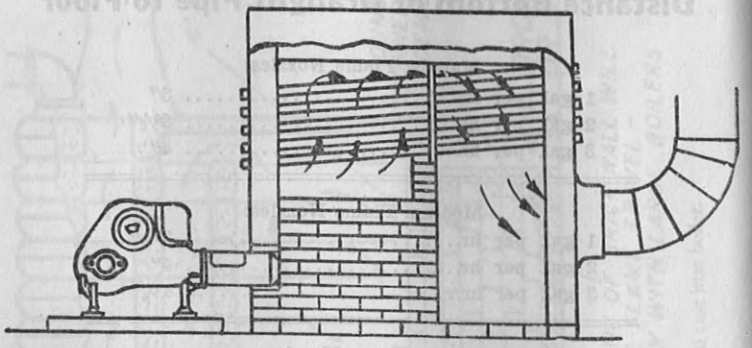


Fig. 6—Combustion chamber for a water tube boiler.

Ques. What should be the length for warm air furnaces?

Ans. The combustion chamber should be built up to the level of the bottom of the fire door. The wall opposite should be higher to prevent the sprayed oil coming in contact with the metal walls of the furnace.

Ques. How should the combustion chamber be sealed to the furnace walls?

Ans. With a high temperature cement and in case of large ceiling space fill in at the top with small pieces of fire brick and seal over with the high temperature cement.

Ques. What is accomplished by this construction?

Ans. It prevents air leaks around the bottom of the furnace and supports the walls.

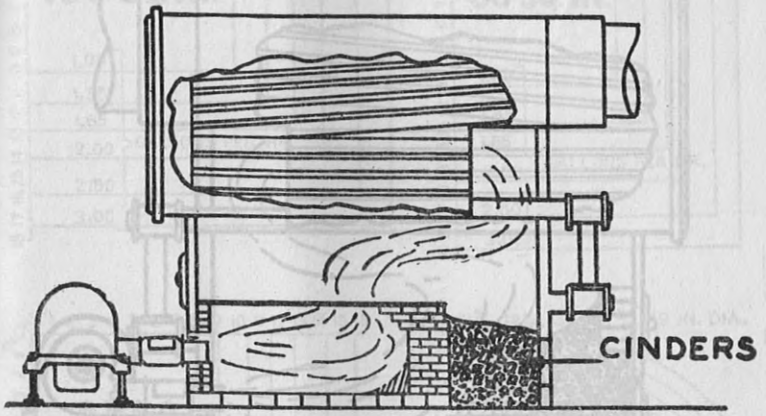


Fig. 7—Front firing a boiler.

Seal combustion chamber walls to furnace around ash pit door to prevent infiltration of air. Any air leakage lowers efficiency of burner. Seal openings with furnace cement.

Ques. What construction is sometimes made where the installation of fire brick is difficult or where a thin wall is necessary to obtain sufficient floor area?

Ans. For one gallon burners (one gallon per hour) the combustion chamber may be made by applying 1 or 1½ ins. of plastic refractory, such as Plibrico or equal, directly to the

walls of the furnace or boiler. This construction is of the makeshift order and should be avoided if possible.

Ques. What is a corbel?

Ans. A form of baffling or step out arrangement of the brick work of the rear wall, forming a target wall which the flame strikes and is curled back to prevent short circuiting.

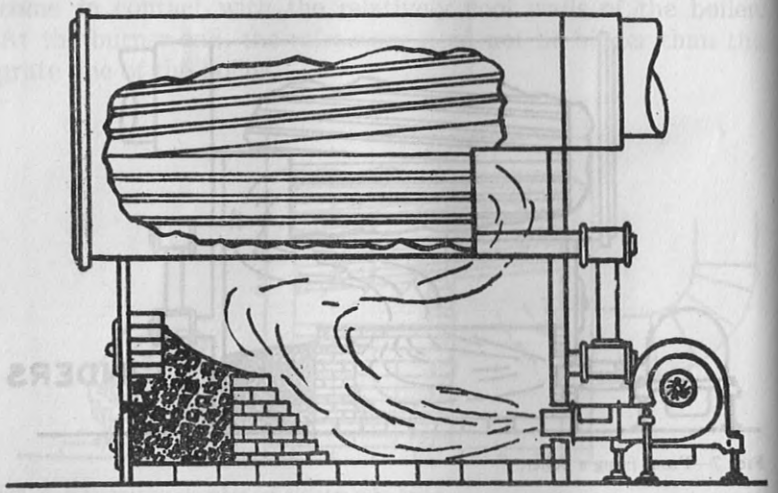
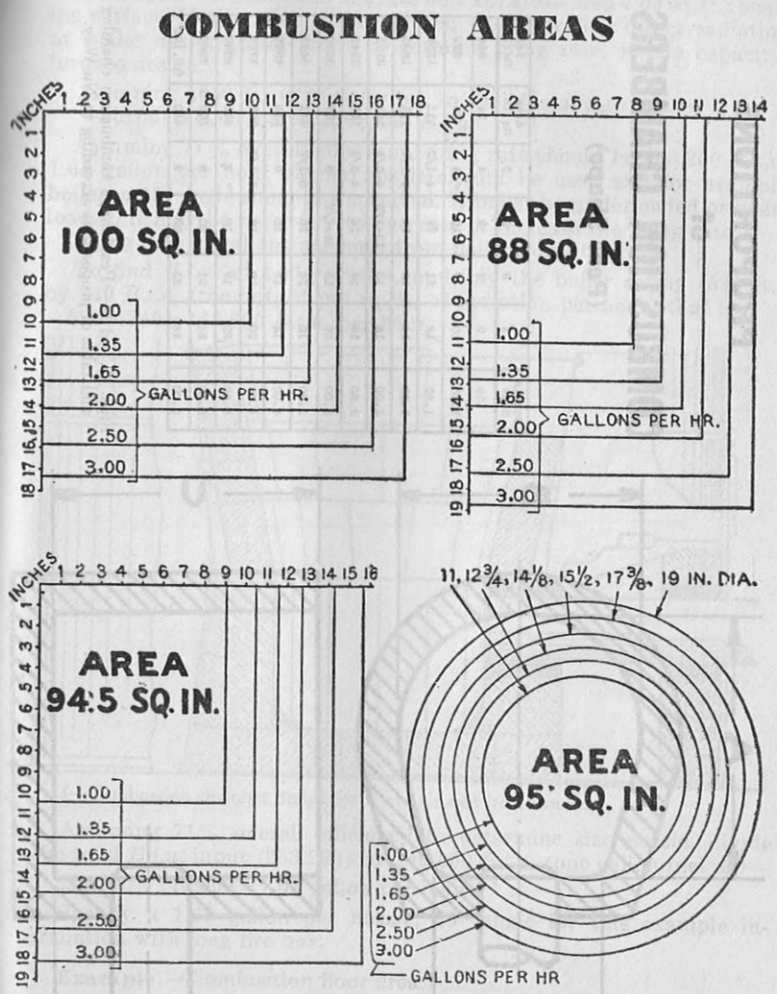


Fig. 8—Back firing a boiler.

Ques. Give a general rule for combustion area of combustion chambers.

Ans. Allow 100 sq. ins. of floor space per gallon of oil. See diagrams figs. 9 to 12.

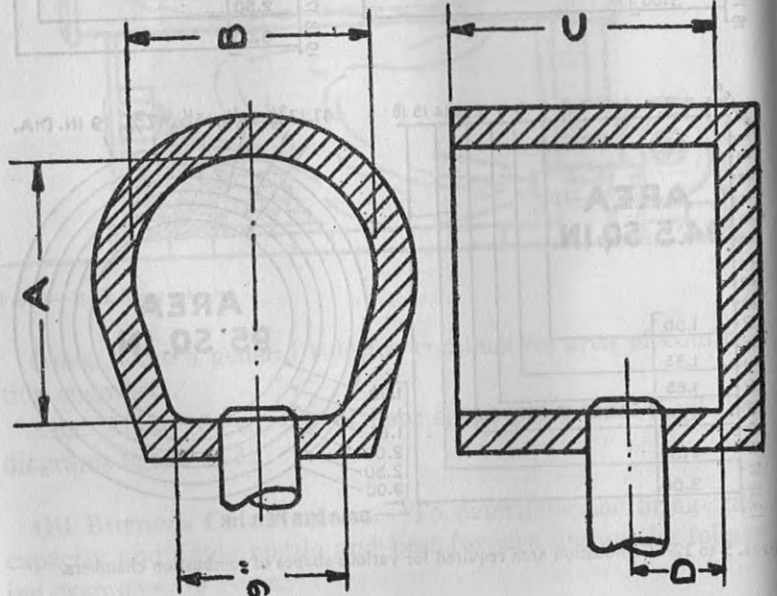
Oil Burners Calculations.—To determine the firing rate capacity and angle nozzle and best furnace design the following examples are given:



Figs. 9 to 12—Combustion area required for various shapes of combustion chambers.

PROPORTIONS of COMBUSTION CHAMBERS (Pear Shape)

Nozzle Size	A	B	C	D	Area Sq. In.	Vol. Cu. In.
.76	9	9	9	4	74	666
1.00	10	9	10	4	82	820
1.35	12	11	12	4-1/2	111	1332
1.65	14	12	13	4-1/2	141	1833
2.00	16	13	13-1/2	4-3/4	161	2173
2.50	16	14	14	4-3/4	192	2546
3.00	17	15	14-1/2	5	207	3000
3.50	18	16	15	5-1/2	231	3465
4.00	14	17	16	6	256	4096
4.50	20	18	17	6-1/2	282	4794
5.00	22	19	18	7	325	5850
6.50	24	21	20	8	392	7800
8.00	26	23	22	9	460	10,120



FIGS. 13 and 14—Pear shape combustion chamber and table of proportions according to Nu-Way.

Example.—Dimensions of grate 36 x 16; grate area 4.09 sq. ft.; heating surface 41.4 sq. ft.; rating 690 sq. ft. equivalent direct radiation at boiler outlet (total load). Determine firing rate, nozzle capacity, furnace design.

Assuming 4000 *B.t.u.* transfer per sq. ft. of heating surface, output = 4000 × 41.4 = 165,600 *B.t.u.*

Assuming 71% overall efficiency, firing rate should be 233,200 B.t.u. 1.65 gallon per hour burner nozzle should be used and for example boiler, a 45° angle should be specified. If boiler be underloaded or overloaded, it may be necessary to decrease or increase the firing rate.

Firing rate in gallons per hour from boiler output rating:

To find *B.t.u.* at boiler outlet, multiply the boiler rating (690 ft.) by 240 *B.t.u.* (the output per sq. ft. of radiation per hour) that is:

690 × 240 = 165,600 *B.t.u.* per hour.

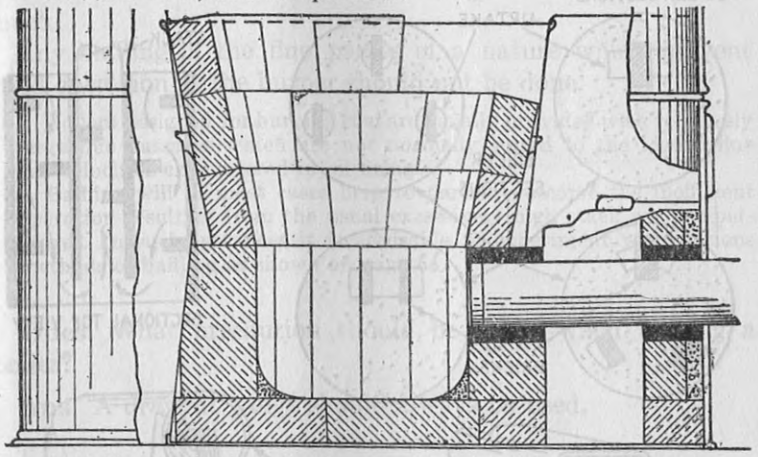


FIG. 15—Combustion chamber design for warm air cast iron furnace.

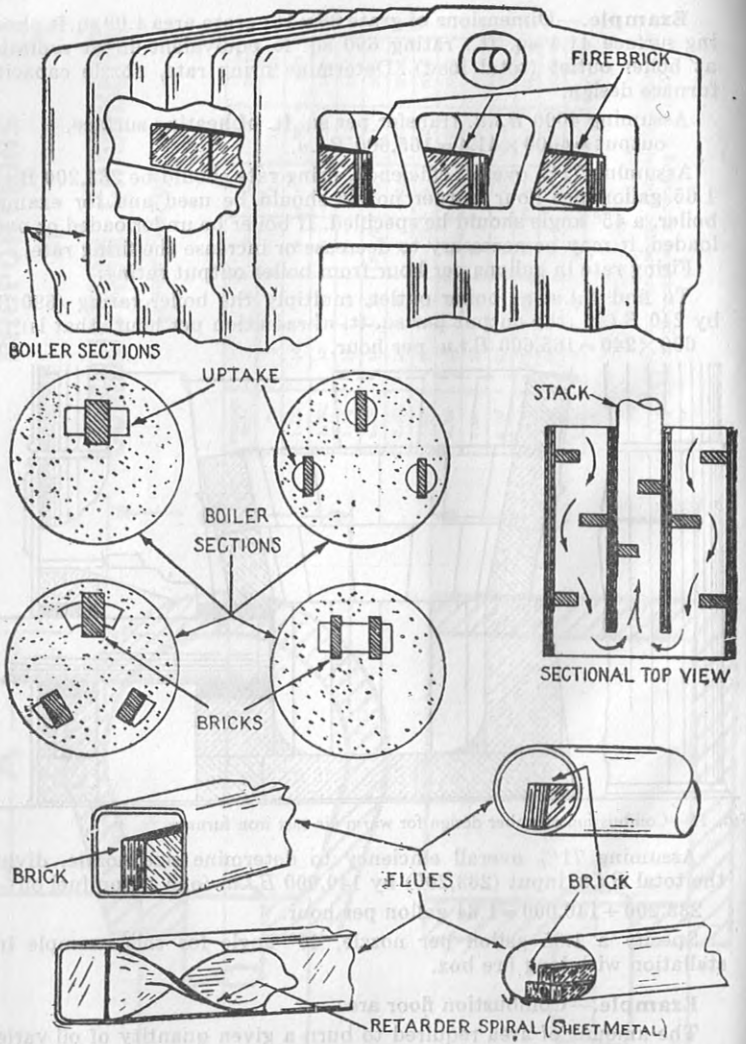
Assuming 71% overall efficiency to determine size nozzle, divide the total *B.t.u.* input (233,200) by 140,000 *B.t.u.* (one gallon fuel oil)—

233.200 ÷ 140,000 = 1.64 gallon per hour.

Specify a 1.65 gallon per nozzle, 45° angle for this example installation with long fire box.

Example.—Combustion floor area.

The amount of area required to burn a given quantity of oil varies according to the shape of the combustion chamber.



FIGS. 16 to 25—Various methods of baffling for sectional cast iron boilers.

According to the diagrams (figs. 9 to 12) in a square combustion chamber more area is required to burn a gallon of oil than in one of rectangular dimensions.

Baffling of Boilers.—Round boilers and some furnaces are sometimes so constructed that the flue passes are almost direct from the fire box. To cope with such ridiculous construction there are on the market canopies which can be hung in the boiler to baffle the flow of gases from the fire box to the flue passes and which in some instances improve matters somewhat, but the losses due to such stupid designs cannot be reduced much.

Any baffling of the flue passes of a nature which prevent good operation of the burner should not be done.

Boilers designed for burning coal are usually provided with relatively large flue passages which are not normally suited to the higher flue gas velocities encountered in oil firing.

Baffling will in most cases help to partly overcome the inefficient operation resulting from the usual excessively high stack gas temperatures. In such instances it is advisable to experiment with various methods of baffling as shown on page 54.

Ques. What precaution should be taken when baffling a boiler?

Ans. A draught gauge should always be used.

Ques. What should be the minimum draught?

Ans. A minimum draught of .03 ins. should be maintained over the fire with the lowest anticipated stack draught.

Unsatisfactory for Conversion.—Some coal boilers and furnaces simply are unfit for oil firing, notably the (ridiculous) four section round type of boiler and its brother, in the form of

the ridiculous "up and out" furnace. According to Adam "wise dealers steer a wide path around such boilers and furnaces."

The owner of such junk should learn something about adequate *heating surface* and resulting **low** *stack temperature.*

The prime object of a boiler is to transmit heat from the burning fuel to the water, not to dump it outdoors via the stack and chimney.