STEAM & HOT WATER BOILERS
1840-1930

Steam Boilers

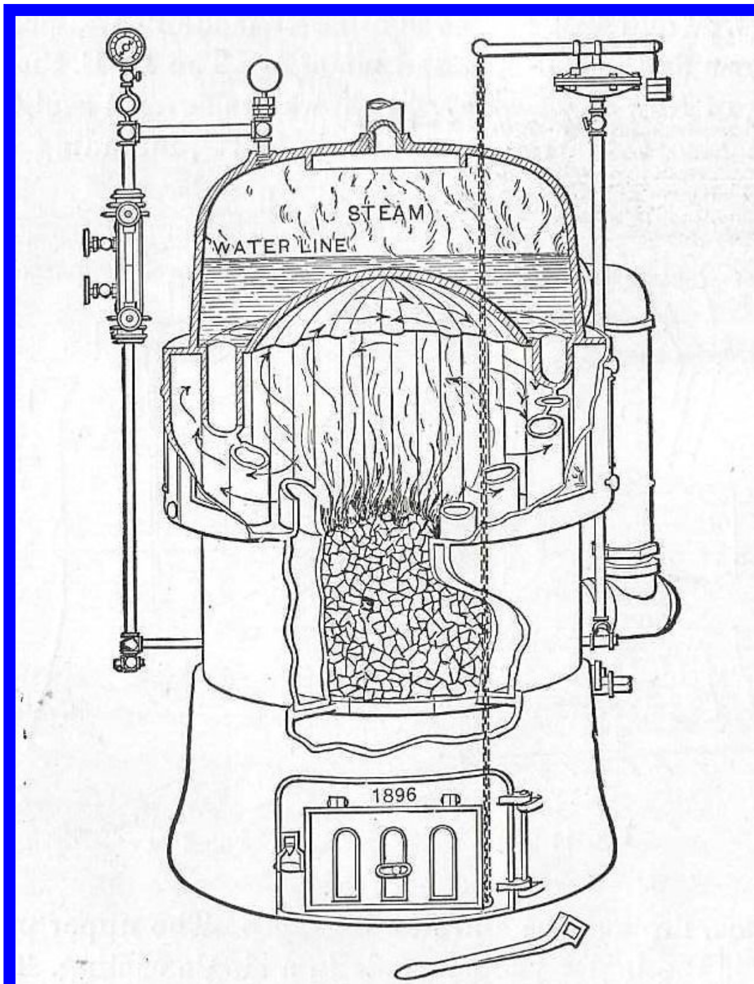

Fig. 45.—(The Doric.)

FROM AMERICAN TEXTBOOK BY WILLIAM J BALDWIN 1905

BALDWIN ON HEATING;

OR,

STEAM HEATING FOR BUILDINGS REVISED.

BEING A

DESCRIPTION OF STEAM HEATING APPARATUS FOR WARMING AND VENTILATING LARGE BUILDINGS AND PRIVATE HOUSES, WITH REMARKS ON STEAM, WATER, AND AIR, IN THEIR RELATION TO HEATING; TO WHICH ARE ADDED USEFUL MISCELLANEOUS TABLES.

BY

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CHAPTER VI.

FORMS OF BOILERS USED IN HEATING.

THE conditions required for heating boilers, which are of such proportions that they may be fitted up to work automatically, are simplicity of construction, durability of parts, and ordinary economy in firing.

A source of danger to the success of the young steam-fitter and to others inexperienced in steam-fitting, is their endeavor to construct ideal boilers, which usually prove to be failures. It is far better to use boilers proved successful by others, and improve their weak points from experience with them. Success lies in that which will give *least trouble*, and will not wear out rapidly—the burning of a few tons of coal more or less in a year is not a proper test; as the conditions of management, the size of the house, the amount of ventilation, the number of hours the apparatus is operated in the year, and last, though not least, the comfort and satisfaction—all must be taken into consideration to prove economy.

Fig. 34 shows probably the simplest form of upright boiler used for heating, excepting, perhaps, one with a flat crown sheet. The grate is drawn in at the bottom, by a slanting annular dead plate, as shown; the center part of the grate only has openings. The brick-work is very simple, and is built around the boiler, leaving about a three-inch space for a flue, and the smoke pipe is taken out at the bottom. It does not rate very high in point of economy of fuel; but it is very easily kept clean, and lasts a long time. They are now seldom seen.

Fig 35 shows an upright boiler (multi-tubular), which is drawn in at the fire-box, to the size for the grate. This dispenses with the annular dead plate, and makes a very permanent piece of work. This boiler is set to carry the heat, when it leaves the tubes down one side of the boiler, and up the other, passing under a septum of iron, or a division wall, which may be run very near the boiler, but so as not to press against it. When the tubes of this boiler are not smaller than two and a half inches, or longer than three feet, and nothing but hard coal is used, it will require cleaning but once a year, provided there is no leak in the fire-box, or about the ends of the tubes.* To clean the boiler,—remove the cover

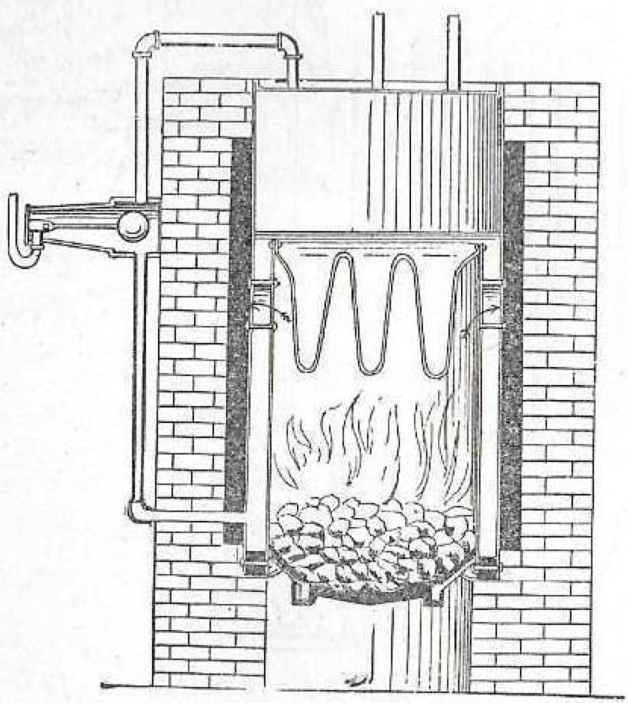


Fig. 34.

* Much moisture causes the fine white ash, which comes from hard coal, to bake on the heating surfaces, and should be prevented.

a′, and use a steel wire tube brush. The cover *a*′ is covered with abestos or magnesia on the top, and in the space *c*, around the top, to prevent radiation, or danger from fire. It will be noticed, this boiler is set on a cast-iron plate, to give it stability. This plate is more satisfactorily made in *two* parts, and bolted together, which will prevent the heat of the

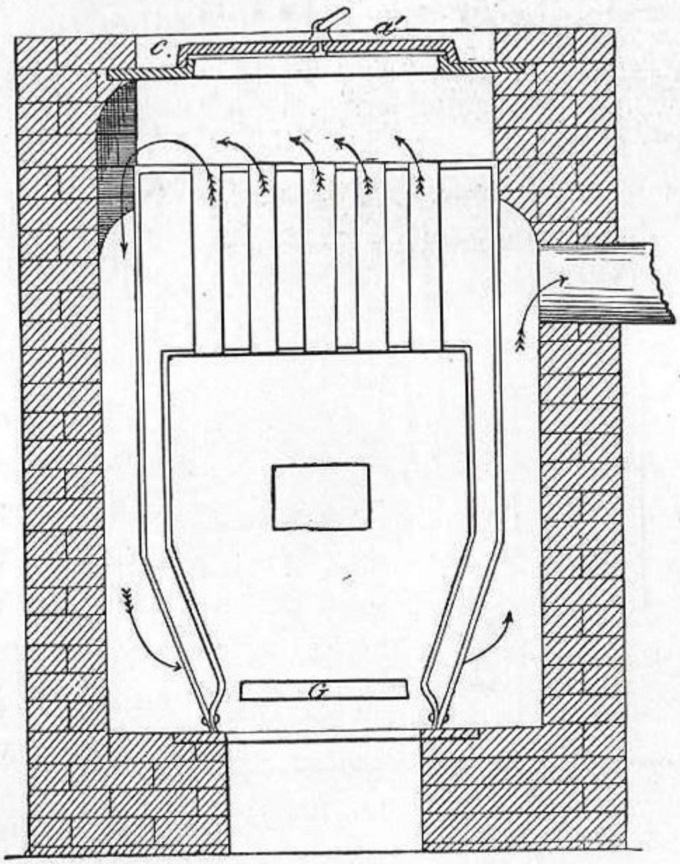


Fig 35.

fire from cracking it, after it is set. The grate is here shown, a little higher than it is usually set; but it would be well to keep it as high as the rivets.

Fig 36 shows the ordinary upright boiler, set for heating. It has a peculiar steam dome, as shown, which prevents an excessive heat on top, and it is claimed slightly superheats the steam. It also has an ash-sifting grate below the regular grate which saves much dust in the manipulating of ashes, and prevents the grate proper from burning out rapidly.

The form of dome shown here prevents the cleaning of the boiler tubes except with a steam blower. The

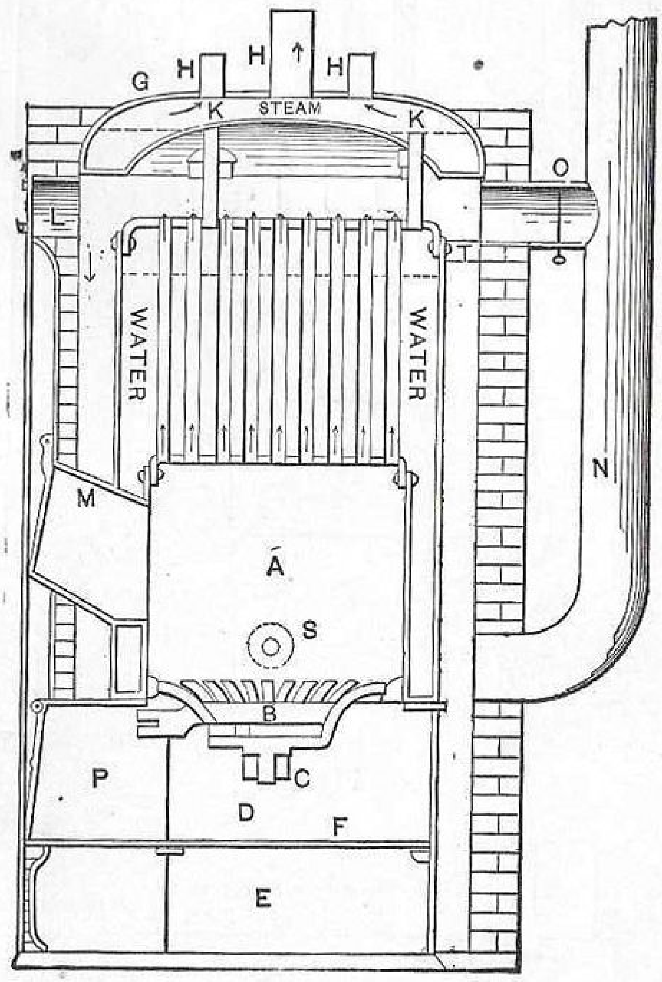


Fig. 36.

connections between boiler and dome have also to be of very large diameter, and circulating pipes—not shown—are necessary to take the condensation or water carried into the dome back to the boiler. When they are omitted the water carried into the dome is carried over into the heating pipes, and much noise in the apparatus is the result.

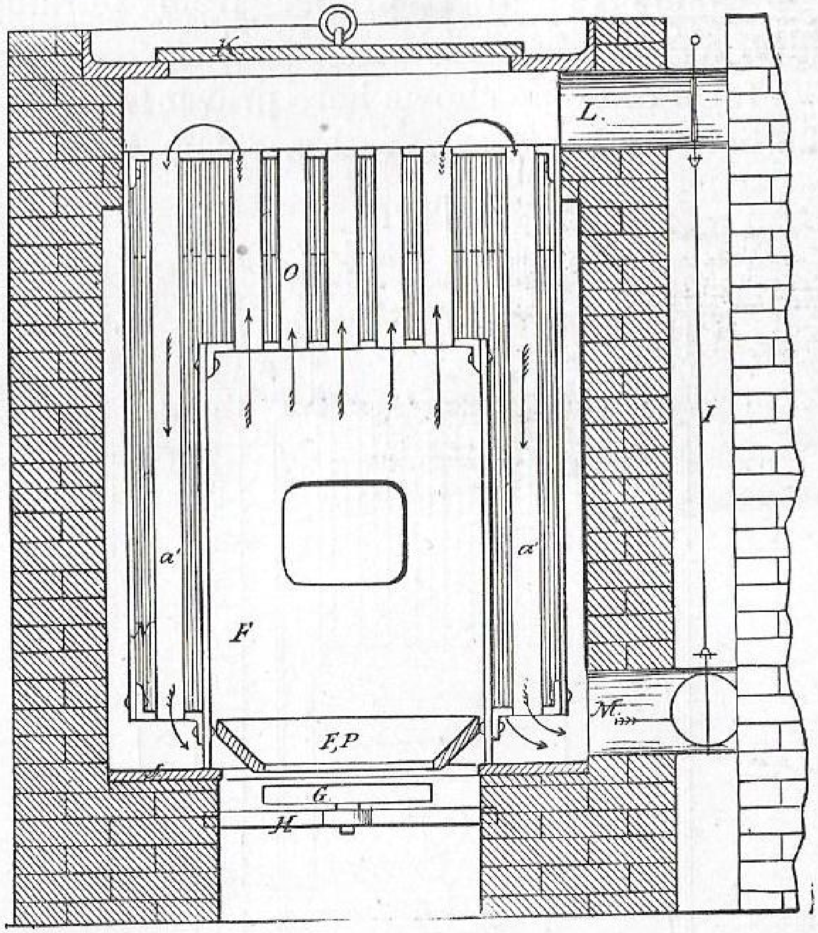


Fig. 37.

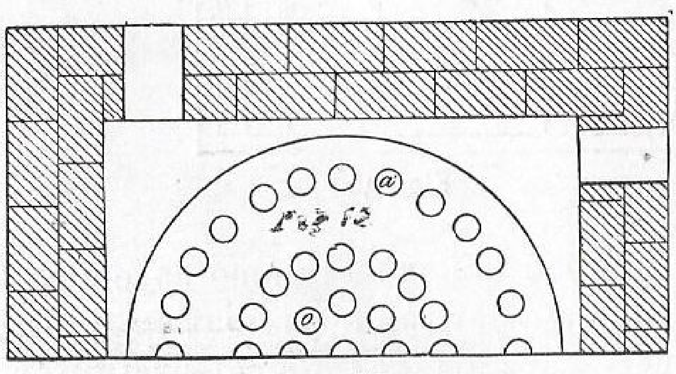


Fig. 38.

Figs. 37 and 38 show an *upright multi-tubular reverberatory tube boiler*. Fig. 37 is a vertical section on a center line, and Fig. 38 a half cross-section, to show the walls and tubes. In Fig. 37, *F P* is the fire-pot, or dead plate; *F*, the fire-box or furnace; *G*, the grate; *H*, a bar set in the brickwork of the ash-pit in such a way it may be removed to put in a new grate, and into which the grate is pivoted, a certain distance below the edge of the fire-pot, to admit of shaking and cleaning from the bottom. The amount of opening is regulated by washers on the pivot of the grate, to suit the size of coal used; *O*, the direct tubes; *a'*, the reverberatory tubes; *J*, the bottom plate; *K*, the cover; *L*, the direct chimney flue; *M*, the bottom or drop chimney flue.

In point of economy of fuel, probably there is no house-heating boiler stands higher than this, if properly proportioned, and in permanency it is fully equal to any wrought-iron boiler used; besides, it is not difficult to clean. It will be seen that all the flues are internal, and if the gases of combustion cannot impart any heat *to* the boiler, after cooling to a certain degree, they cannot abstract any *from* it, as happens in external flues, when the gases cool to the temperature of the steam or below it, by an admixture of air through the brickwork before reaching the chimney.

It is also an excellent boiler where light power is desired, in which case the tubes may be of smaller diameter than would be used for heating, and longer, to suit a higher rate of combustion.

When upright boilers are enclosed in brickwork, the outside is usually built square, to suit the door castings, and for appearance; but the inside is generally built *round*, three or four inches from the boiler, to make a flue or an air space, which will be the same distance from the boiler at every part. A wall so built generally cracks in the thinnest part, which makes it necessary to build the wall square inside and outside, as shown with cleaning doors at

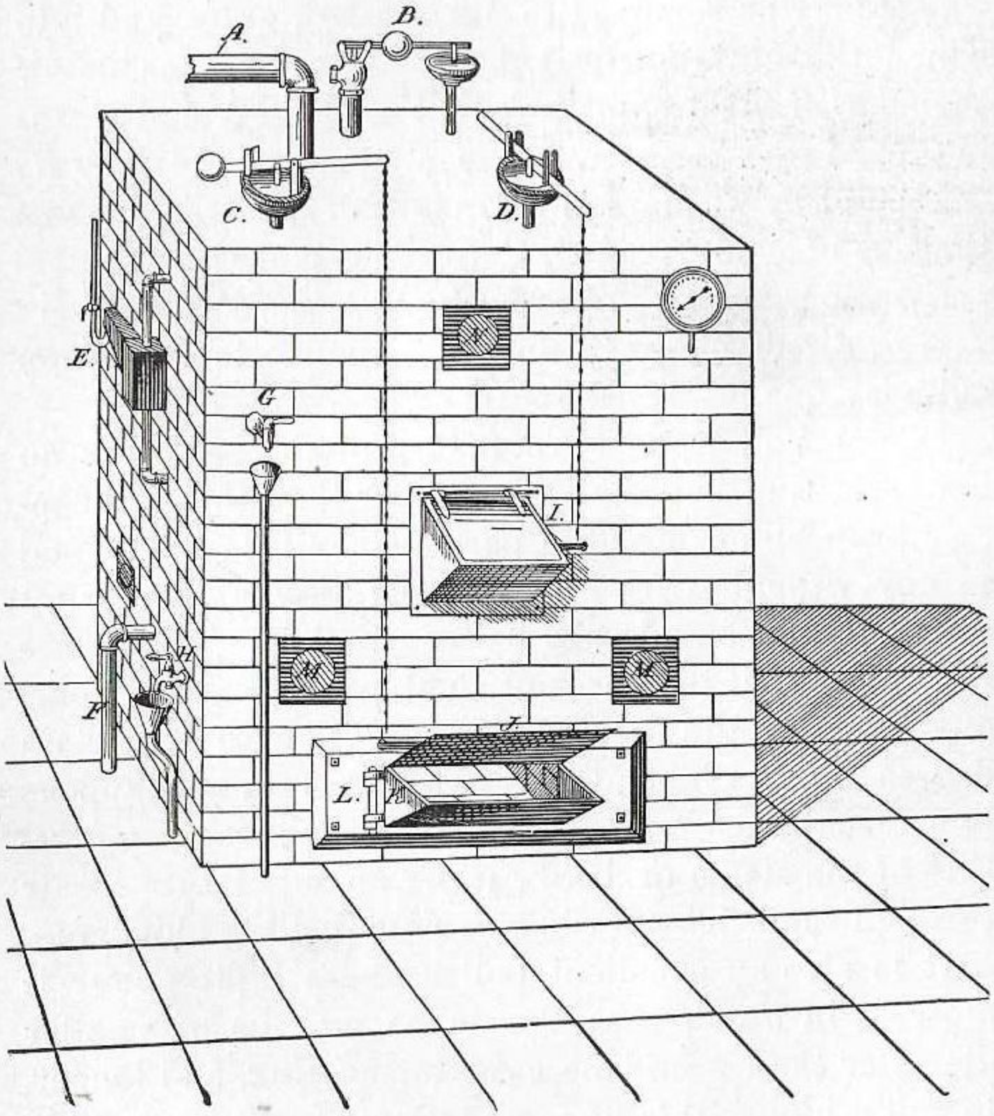


Fig. 39.

corners. The infilteration of air through the walls of brick-set boilers is a great source of loss.

When wrought-iron boilers are constructed for low-pressure heating, have them built just the same as if they were intended to carry high steam, taking care the leg, the part formed by the side of the fire-box, and the shell, is properly stayed with socket-bolts, or stay-bolts, as boiler-makers often show a disposition to leave the legs unstayed, when they know the boiler is for very low pressure.

Fig. 39 represents this boiler when set and fully fitted with the necessary self-acting appurtenances. *A* is the main steam pipe, which must be run for no other purpose but to distribute steam to the heaters; *B*, the safety valve, with its auxiliary diaphragm; *C*, the draft-door regulator (the pipe carried up inside the brickwork); *D*, the fire-door regulator, which is not absolutely necessary; but it is well to have, in case anything should prevent the draft-door from closing; *E*, the automatic water regulator, whose connections should not be a branch, from any other pipe —nor should they be branched for any purpose; *F*, the main return pipe, which should have no valves in it, unless there are valves in the main steam pipe to correspond. When there is but one boiler, it is generally better to dispense with valves in steam and return pipes at the boiler. *G*, the gauge cock, which for cleanliness may have a drip-pan under it, connected with the ash-pan; *H*, the blow-off cock, which in a heating apparatus *should never be connected directly with the sewer or drain*, but should be a lever handle cock over a tunnel, as shown, to prevent the *possibility* of water passing out of the boiler without the knowledge of the person in charge. The tunnel can be removed when not in use. *I*, the fire-door, on a good slant, so as to form a shute for the coal, and to close without a latch; *J*, the draft-door, an attachment to the ash-door; *K*, the ash-door, which is hinged to the frame *L*, and will open without interfering with the draft-door; the chain and the bolt having nearly the same *common axis*; *L*, the ash-door frame, which is bolted to a skeleton frame, built into the brick work, that can be removed to put in a new grate; *M M*, are hand holes, to clean the space at the bottom of the drop tubes; *N*, a hand hole, to clean the upper tube

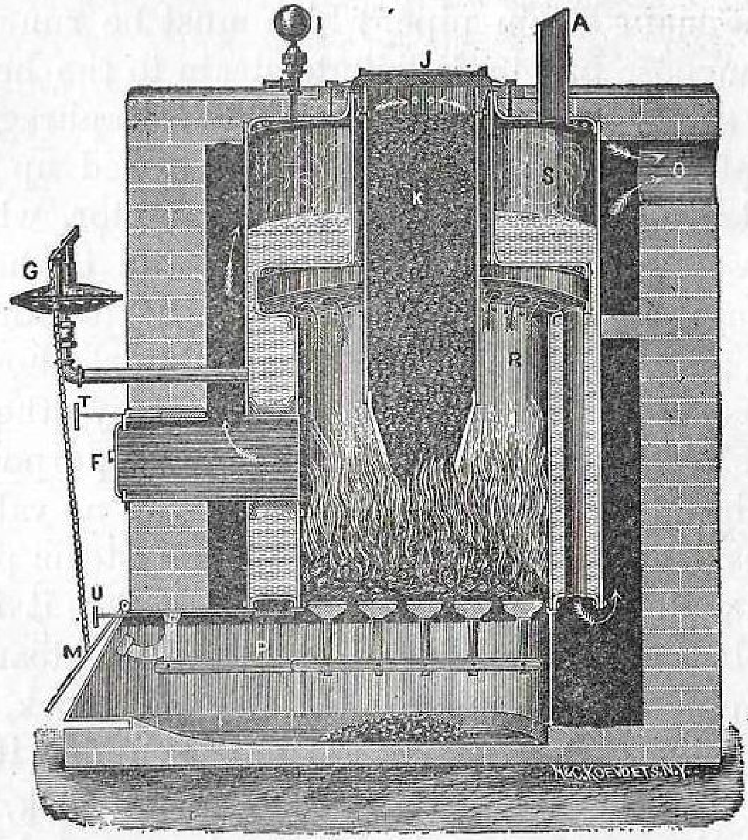


Fig. 40.

sheet, and through which a steam tube cleaner may be used, if desired.

Fig. 40 represents a wrought-iron boiler, which came into public notice about twenty years ago, and has given good satisfaction.*

* It was patented by Mr. Wm. B. Dunning, of Geneva, N. Y.

It is a reverberatory *tube* boiler, with a *coal magazine*, similar to the base burning stoves, and is entirely constructed of wrought iron, except the cast-iron magazine. When set, according to the manufacturer's instructions, every part of the boiler is exposed as heating surface; the heat passes between the magazine and the fire-box, and thence down the drop tubes, *D*, and up and around the shell. The magazine is made to pull out, and care should be taken when setting them, to have sufficient room overhead to accomplish this.

The heating boilers I have so far shown are all of wrought iron types. Since first writing this book, however, many cast iron house heating boilers have appeared in the market.

Presumably the first cast iron sectional boiler to make any appreciable headway and to remain permanently in the market is the "Mills" Boiler, made by The H. B. Smith Co., of New York. It consists of a number of cast iron sections A A, such as shown in Fig. 41, joined to a steam drum B, and to two water headers B′ and B′ by locknut nipples. The sections A A are practically upright tubular units, two of which when put together in the manner shown, form what is called a section, their depth being about six inches. A number of these sections are added together to form the boiler. The sides of the ash pit P may be formed of masonry so as to form flues F F with the outside brickwork C. The sections are then built together on plates covering these flues, which form a foundation. The grate line is at G. The direction of the fire, therefore, is backwards and upwards from the grate, returning to the front

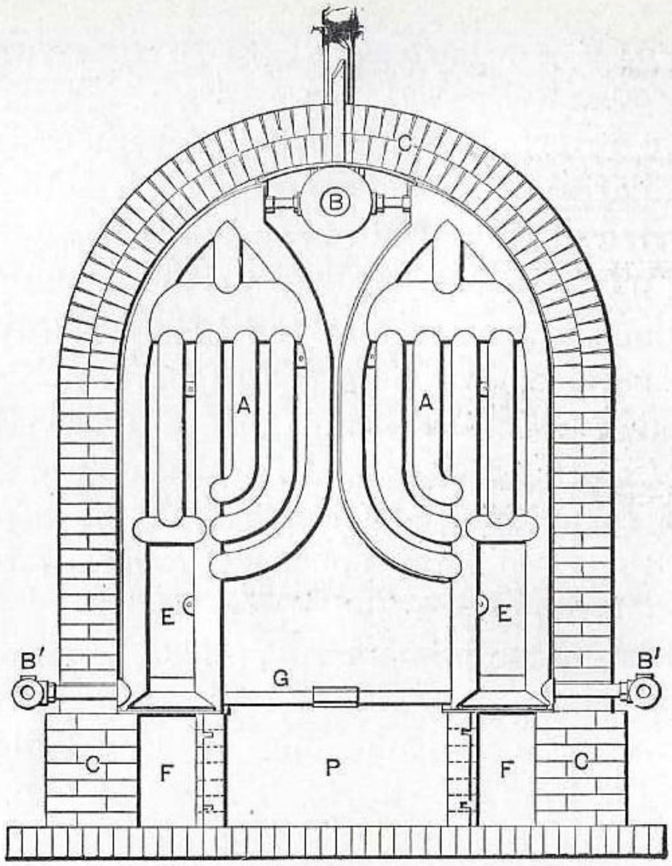


Fig. 41.

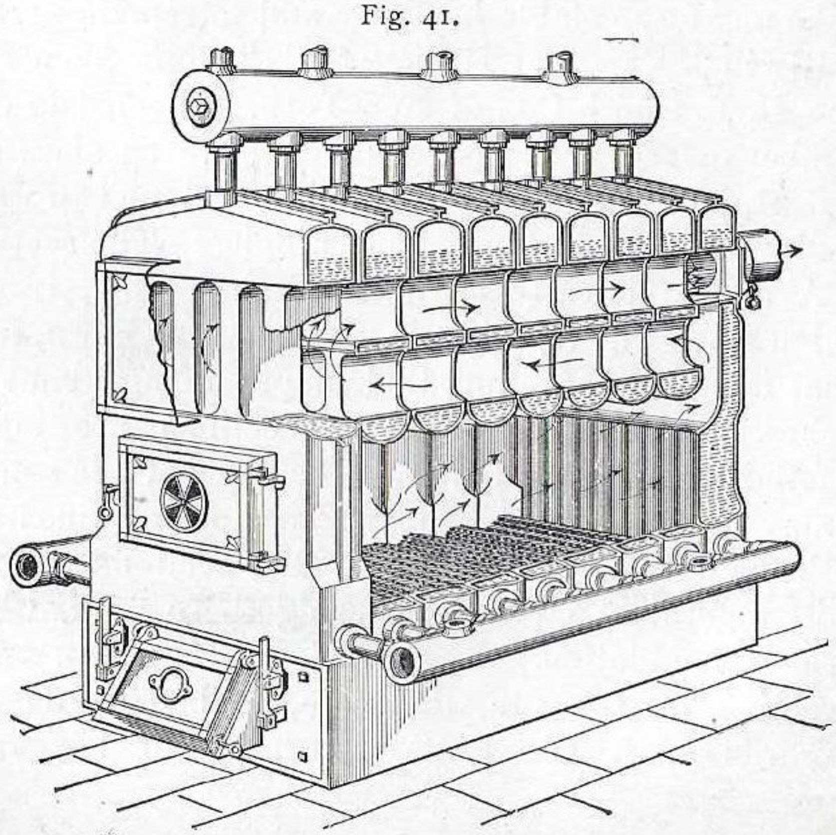


Fig. 42.

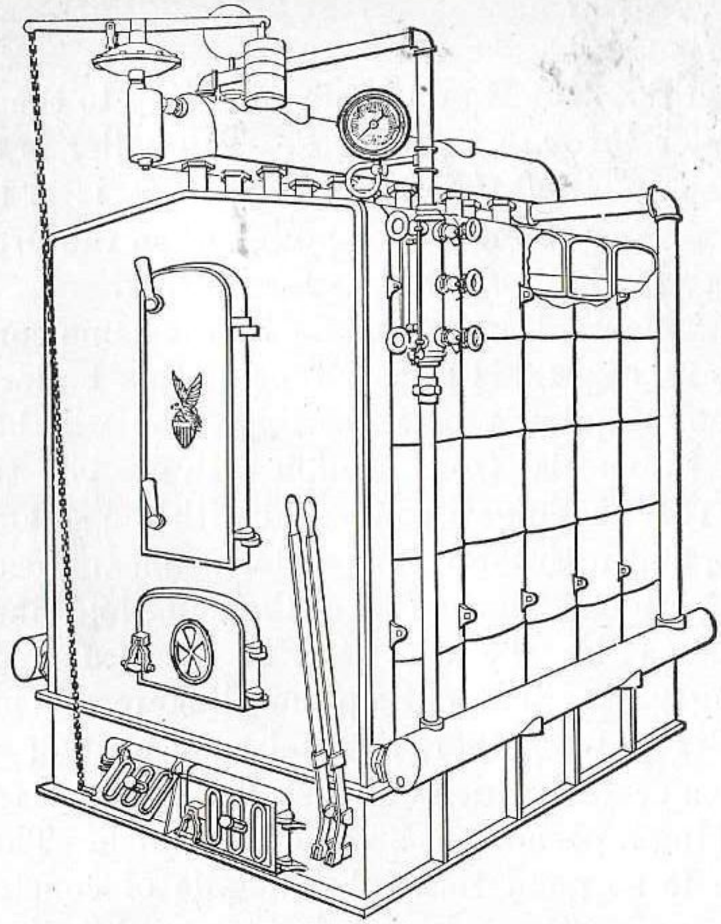
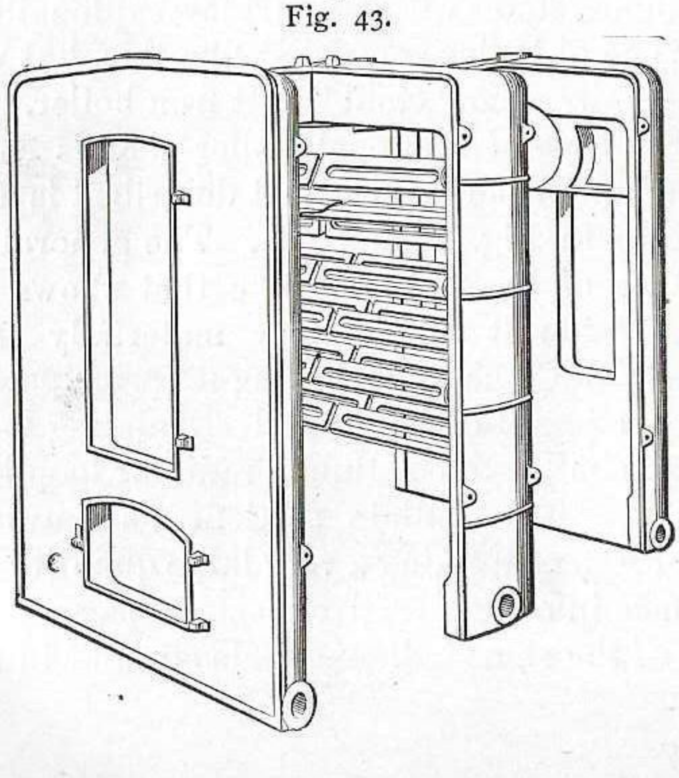


Fig. 43.



through the flues E and again returning to the rear of the boiler through the flues F. The boiler is usually enclosed in brickwork as shown. It is a type of boiler that can be used for power when the pressures are not very high, as well as for heating.

The "Mercer" boiler, made by the same company, shown in Fig. 42, is a later type of this boiler which does not require a brick setting. As will be seen, there is a special front section with fire box sections and a rear section all connected with the steam drum on top, and with the return water drums on each side of the bottom. The course of the flame and flue gases are shown by the arrows. It is furnished with shaking grates that cut up the clinkers. When the boiler is put together, it receives a coat of plastic asbestos cement which clinches between the tee bars T, making a permanent and smooth finish. The illustration is so good that other details of construction can be understood without further explanation. An earlier type of boiler somewhat like this, but which is not shown, was the "Gold" cast iron boiler.

Another type of sectional boiler that is connected with headers in the manner just described is the Gurney, shown in Fig. 43 and 43a. The general outside appearance of the boiler is like that shown in Fig. 42, but inside it differs very materially from all other cast iron boilers by having its principal heating surface composed of horizontal circulating loops. A loop very similar to the Bundy radiator loop is screwed into the intermediate sections, as shown in the centre of Fig. 43a, giving a very large quantity of heating surface in a comparatively small space. A modification of the same boiler is made circular in two sections. They are made by the Gurney Heater Mfg. Co., of Boston.

As an illustration of what may be done in a single casting or almost a single casting, we show the boilers, Figs. 44 and 45. Fig. 44 is a boiler made in two parts, known as the Cottage, and made by The H. B. Smith Co., of New York. Fig. 44 shows the several sections and also the arrangement of the parts, including the

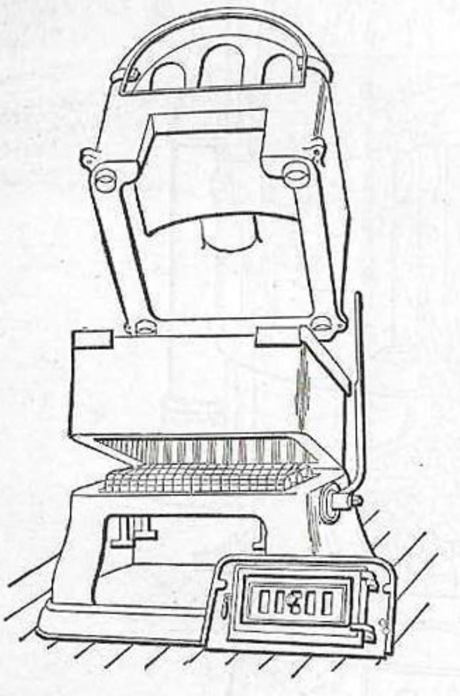


Fig. 44.

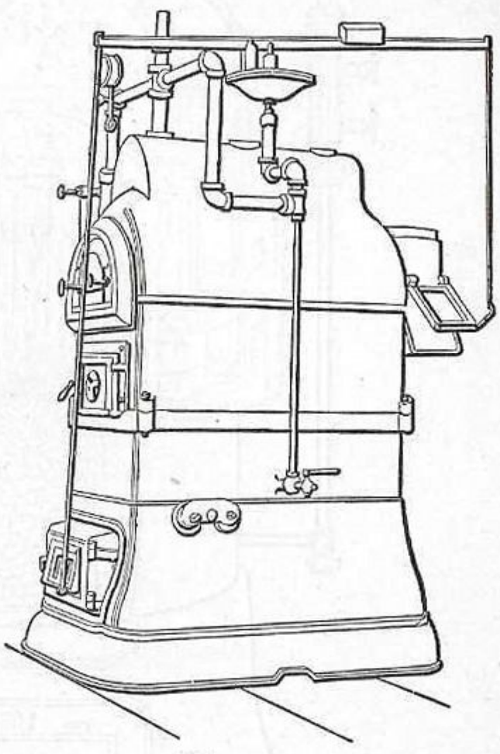


Fig. 44a.

grates, fire surface and flue passages. The upper part forms the boiler proper made in a single casting. The flue gases pass backwards and upwards and forward through the two side flues, and return to the rear again through the centre flue. The mid-section shown in the illustration, forms a water leg about the fire, and the boiler proper and the water leg are joined together by slip nipples. Fig. 44a shows the general appearance of the boiler when set up and used for steam.

Fig. 45 shows a vertical water tube boiler made by the Gurney Heater Mfg. Co., of Boston, which may be

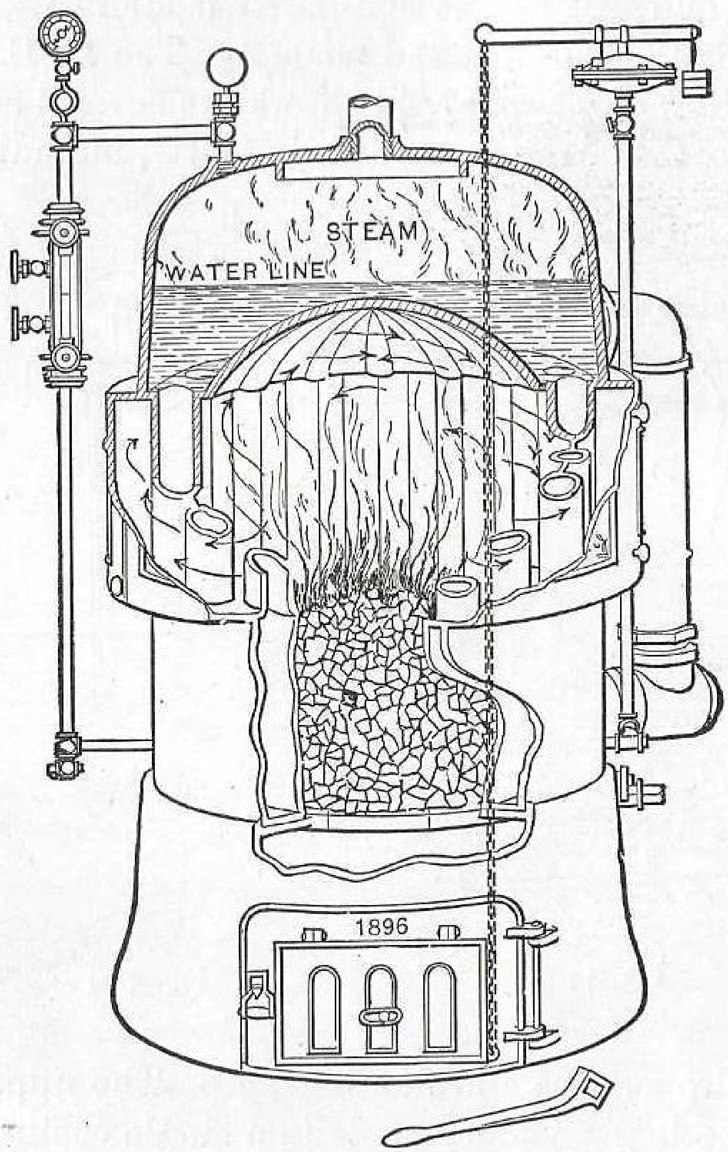


Fig. 45.—(The Doric.)

said to be made entirely of a single casting, and is so made so far as the water and steam parts of the boiler are concerned. The illustration shows the arrangement of the boiler so thoroughly that comment is unnecessary. The Cottage and the Doric boilers, of course, are made for comparatively small heating apparatus, while the other types of cast iron boilers run up to very large sizes and can be used in batteries for the very largest description of work.

Fig. 46 shows a recent type of cast iron sectional boiler put on the market by the A. A. Griffing Iron Co., of New York. Its general difference from other

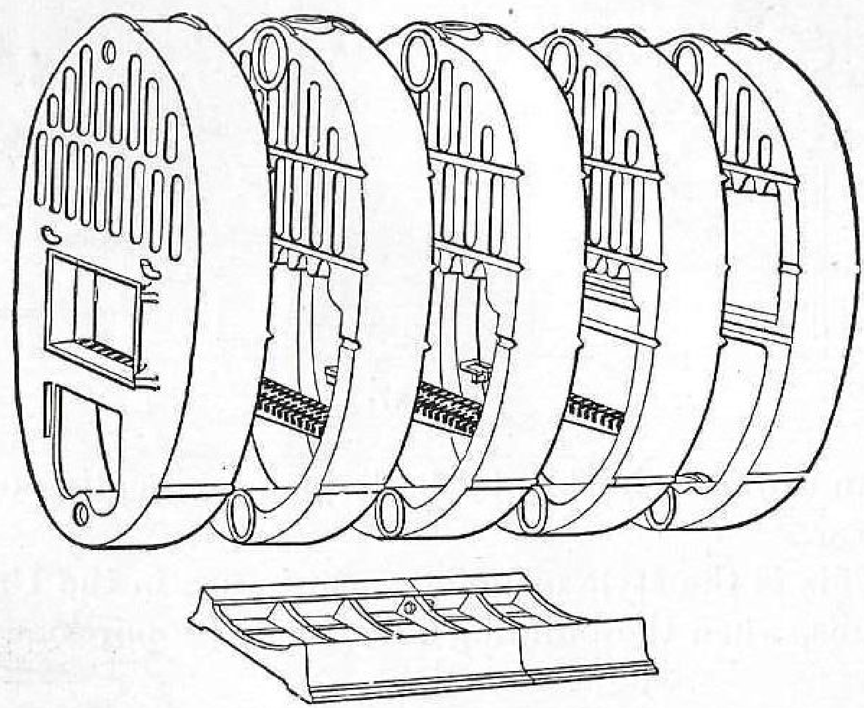


Fig. 46.

boilers of its class lies in the fact that it is put together entirely by slip nipples, the ash pit being formed by the lower part of the section proper; the sections themselves simply setting in an iron cradle on the foundation. The crown sheet of he firebox is corrugated. The gases of combustion pass forward and backward through the tubes, the upper row being superheaters. These boilers, I am informed, are being used for both heating and power. They are called the "Bundy."

THE HORIZONTAL MULTI-TUBULAR BOILER.

Figs. 47, 48 and 49 show longitudinal section half front elevation and half-cross section, and plan,

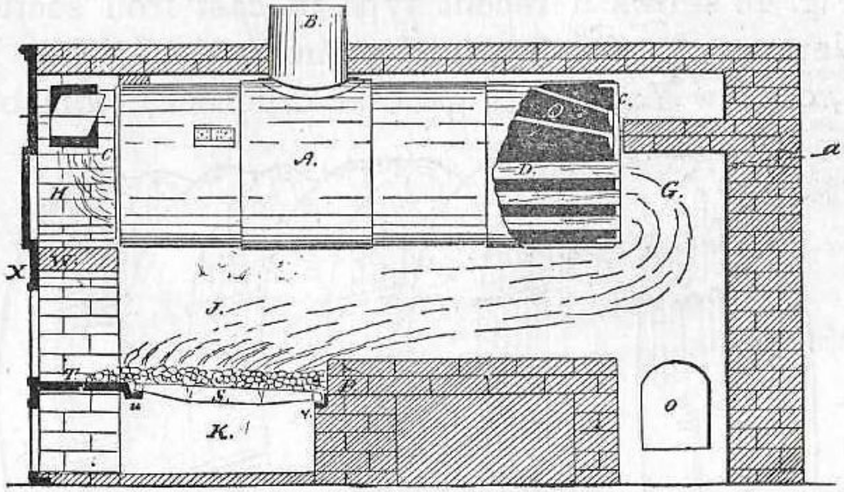


Fig. 47.

of an ordinary horizontal boiler, set for heating or for power.

This is the style of boiler most in use in the United States, when the building is of such proportions that

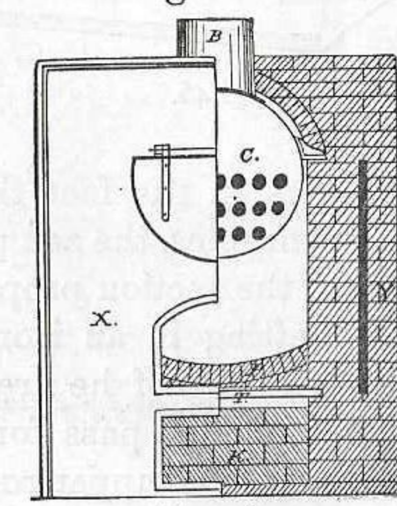


Fig. 48.

it requires power, and considerable notice will be given to it—its method of construction, setting and so forth, as it is the typical American boiler. They are sometimes fitted with automatic appurtenances, but where two or more of them are in a building, automatic draft regulators are all that should be used; and a careful engineer or fireman should do the rest.

When used for power where the water contains mud, as in some western cities, they should be fitted with a mud pipe, as shown in Fig. 50, or if used for heat-

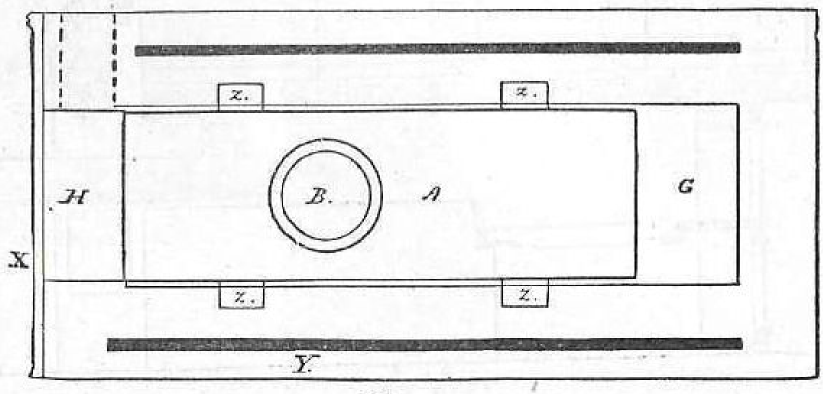


Fig. 49.

ing when the water is wasted; but this is scarcely necessary in a gravity apparatus.

Fig. 50 shows a horizontal boiler where the front end of the shell is supported by resting in the cast-iron front; with the front connection formed by what is known as *breeching;* this is sometimes made of light iron and bolted on; but it is better to form it by an extension of the boiler shell, as shown. This dispenses with the division *W*, as shown in Fig. 47.

There seems to be a dislike to this front, for no better reason than because it is not considered ornamental. It is certainly a substantial front, if made in sections and bolted about the doors, where all fronts are liable to crack, and if set as shown with deep dead-plate and two courses of firebrick lining, it will seldom require repairs; but if the front bearer is bolted to the cast front, and the front is lined with a single course of fire-bricks, held in their place around the door by a cast-iron frame, the frame will burn off, the

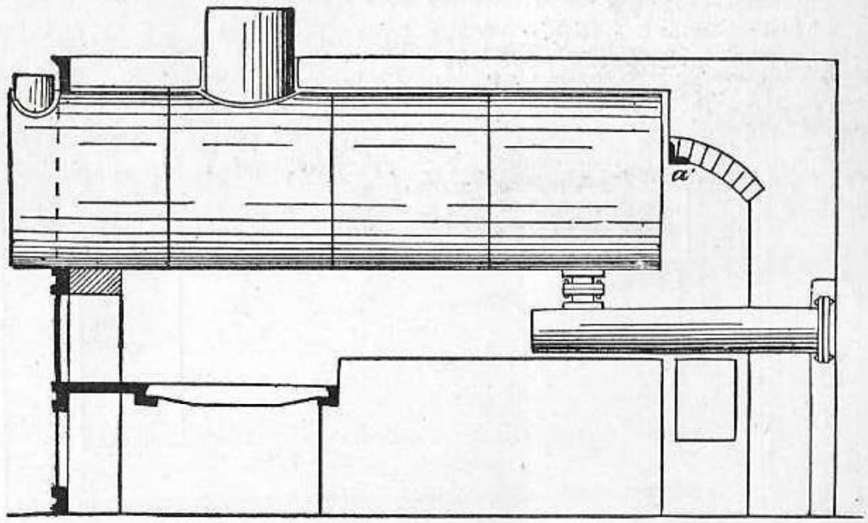


Fig. 50.

lining fall down, and the front become heated and cracked. With a straight or "flush" front, a dead plate is always used, to keep the fire away from the front connection *W*, Fig. 47. The thickness of the wall necessary to form the front connection forms a lining for the front, which *must* be kept in repair, or *W* will fall, and as *W* cannot be dispensed with in a boiler set, as in Fig. 47, the front is thus preserved. If the dead plate is used and made sufficiently deep, whether *W* is used or not, the front will last!

This front and setting also obviates the necessity for the projection, shown in Fig. 47, which is spoken of elsewhere.

PLATE 2.

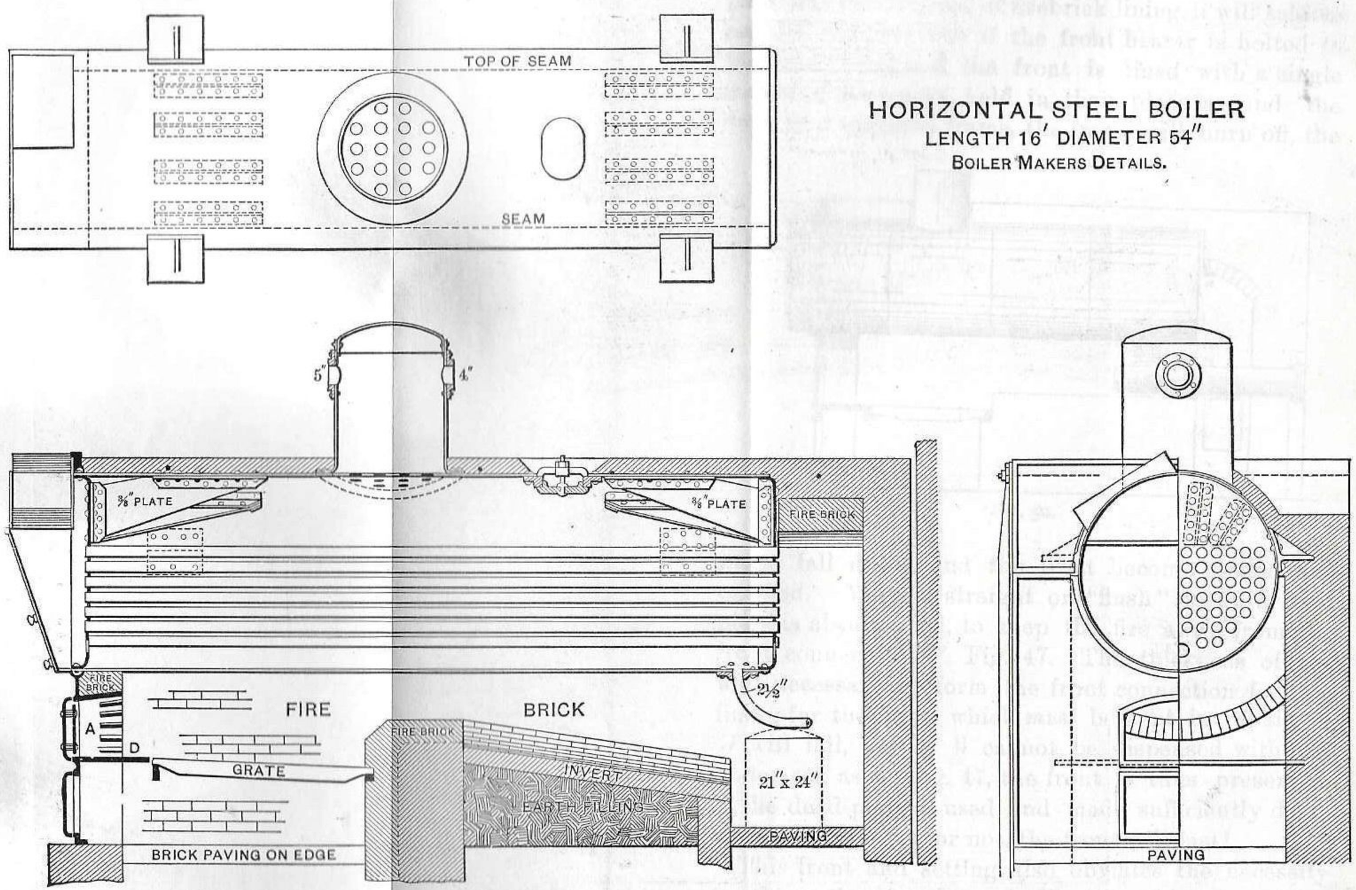

HORIZONTAL STEEL BOILER
LENGTH 16′ DIAMETER 54″
BOILER MAKERS DETAILS.
TOP OF SEAM
SEAM
5″
4″
3/8″ PLATE
3/8″ PLATE
FIRE BRICK
FIRE BRICK
2½″
FIRE
BRICK
A
D
GRATE
FIRE BRICK
INVERT
21″ x 24″
EARTH FILLING
PAVING
BRICK PAVING ON EDGE
PAVING

Plate 2 shows a horizontal multi-tubular boiler, similar to the boiler shown in Fig. 47, but with the *improved cast-iron fire-door arch A;* with the man-hole on the shell, domed steam drum, flat gusset braces, and other details of a modern steel boiler.

It was usual to make the shells of No. 1 charcoal hammered iron—though nearly all are now made of a fine grade of boiler steel. When steel is used, shells up to 42 inches should be made of $\frac{1}{4}$ inch plate; from 42″ to 48″ of $\frac{5}{16}$ thick plate, and from 48″ to 60″ of $\frac{3}{8}$ to $\frac{7}{16}$ thick plate; with head sheets of $\frac{3}{8}$ to $\frac{7}{16}$ and $\frac{1}{2}$ respectively, shells and heads being constructed of best flange steel.

The domes of these boilers are usually made one-half the diameter of the shells, and about the same height; but the limited height of cellars often reduces the height of the dome, and in some cases renders it necessary to dispense with them altogether.

The height for the setting of a 48-inch shell should not be less than 11 feet, and as much more as can be conveniently had. This will allow 2 feet from the paving of the ash-pit to the grate, and 2 feet more from the grate to the boiler, 4 feet for the boiler and 2 feet for the dome, leaving 1 foot from top of dome to underside of sidewalk or floor beams. For each additional foot of diameter of boiler 16 inches should be allowed.

Low cellars are a detriment to a heating apparatus in another and very important respect—they bring the main steam pipe too near the water line of the boiler, and make the use of mechanical devices necessary in work which otherwise could be made more perfect as a gravity apparatus.

When the man-hole of a boiler is in the top of the dome, a hole in the shell underneath the dome, large enough to easily admit a man from the dome into the shell is required. This is bad practice, as this large hole weakens the boiler materially; which fact engineers generally pay no attention to. The shell of a boiler underneath the dome should not be cut out unless it is reinforced in some proper manner; but should be perforated with a number of small holes—say 2 inches in diameter—until their aggregate area is four or six times that of the steam pipes.

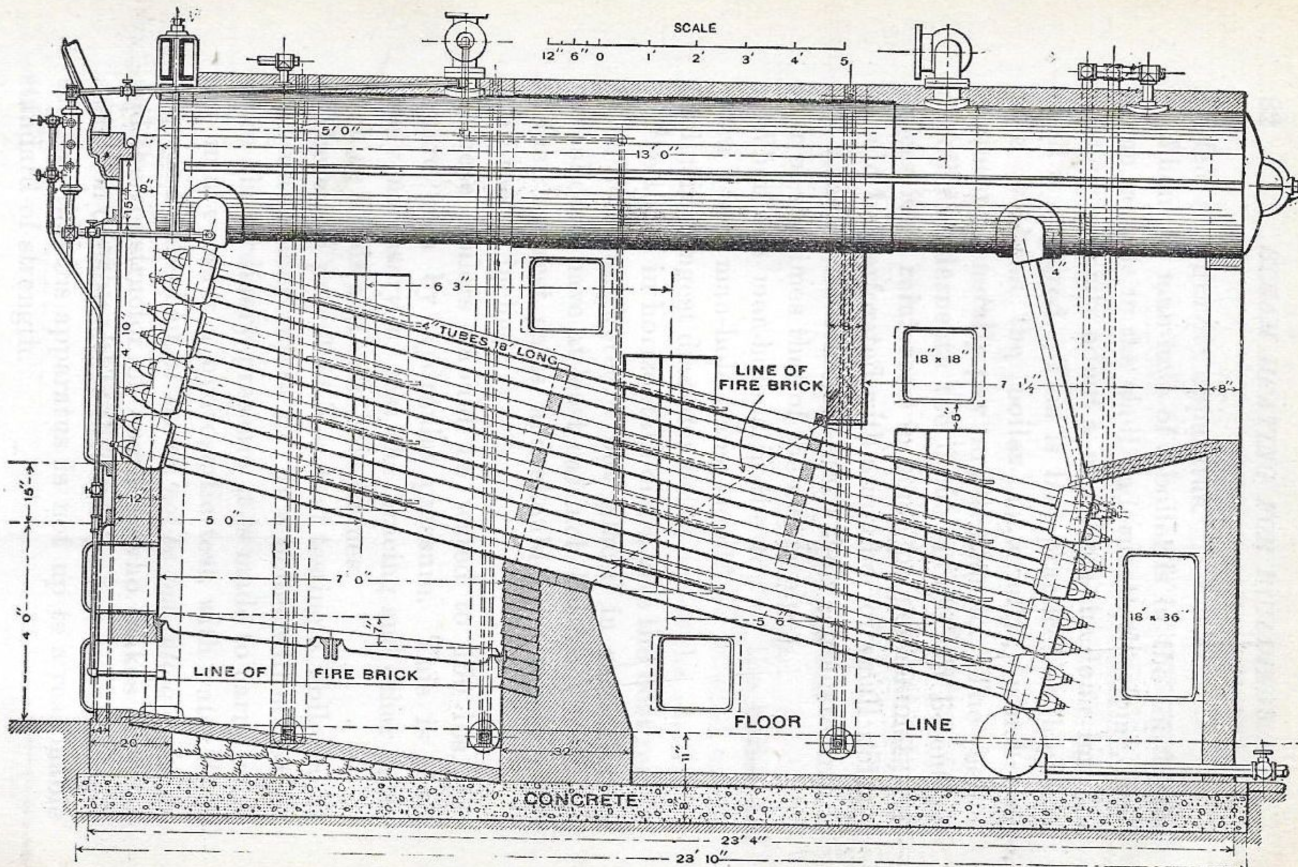
When the man-hole is in the top of the boiler an extra heavy man-hole frame should be riveted to the shell; its longest diameter being *across* the shell.

The tubes in horizontal boilers give the best results when not "staggered," but placed in vertical rows and should have at least *one* inch between the tubes at their nearest parts, and should be not nearer the shell than 3 inches.

These boilers should be tested to 150 lbs. per square inch by hydraulic pressure. This is absolutely necessary to test the bracing and other parts, such as heads and man-hole frames.

There is a prevalent idea that testing a boiler with cold water may injure it. If a boiler will not stand twice the ordinary pressure it is made to carry without injury under a hydrostatic test, with water at 40 degrees Fahrenheit, *it should not be put into a building*, and the constructor or engineer who makes such an assertion does so either through ignorance or through the fear that his apparatus is not up to a reasonable standard of strength.

PLATE 3



THE CALDWELL WATER-TUBE BOILER.

Plate 3 shows a water-tube boiler. It is of a class that may be used for either heating or power. It is known as the Caldwell boiler, made by James Beggs & Co., of New York, and represents an improved form of the Babcock & Wilcox type. This boiler differs from the regular Babcock & Wilcox in the formation of its headers. In the latter the headers are of one piece from top to bottom of each section, while in the Caldwell the headers are made up of four or five short elements, each element having but four tubes expanded into it. Several of the elements are then put together, forming a section of the boiler. The hand-hole plates in the Caldwell boiler are also on the inside of the headers, so the pressure does not come on the bolts, but on the gaskets. The heights of these boilers usually prevented their use in basements or cellars with a gravity apparatus, but with a modern pump-governor apparatus they are fast coming into general use, principally on account of their comparative safety. Now modified forms are being made, called "architects' boilers," which are lower, that are intended to overcome this difficulty.

Fig. 51 shows a Root water-tube boiler, manufactured by the Abendroth & Root Mfg. Co. of New York. It is a very early type of the water-tube boiler, and from its earliest form the Babcock & Wilcox type was probably developed. Its present form is made up of a number of two-pipe elements, the elements being arranged in vertical staggered rows, and connected back and front with special bends and a peculiar form of joint. Each vertical row connects into a steam- and water-drum, so that five, more or less, of these rows or larger elements make up a boiler, the drum of each large element connecting with the steam-drum. Circulating pipes connect between the small drums and the back headers of the boilers so as to give the water a circulation through the smaller drums. The large cross or steam drum is also connected to the rear cross headers by a dry-pipe, so that any water carried over by the force of ebullition or otherwise is returned to the lower part of the boiler from the upper or steam drum.

The method of setting and the other general form of parts is plainly shown in the illustration.

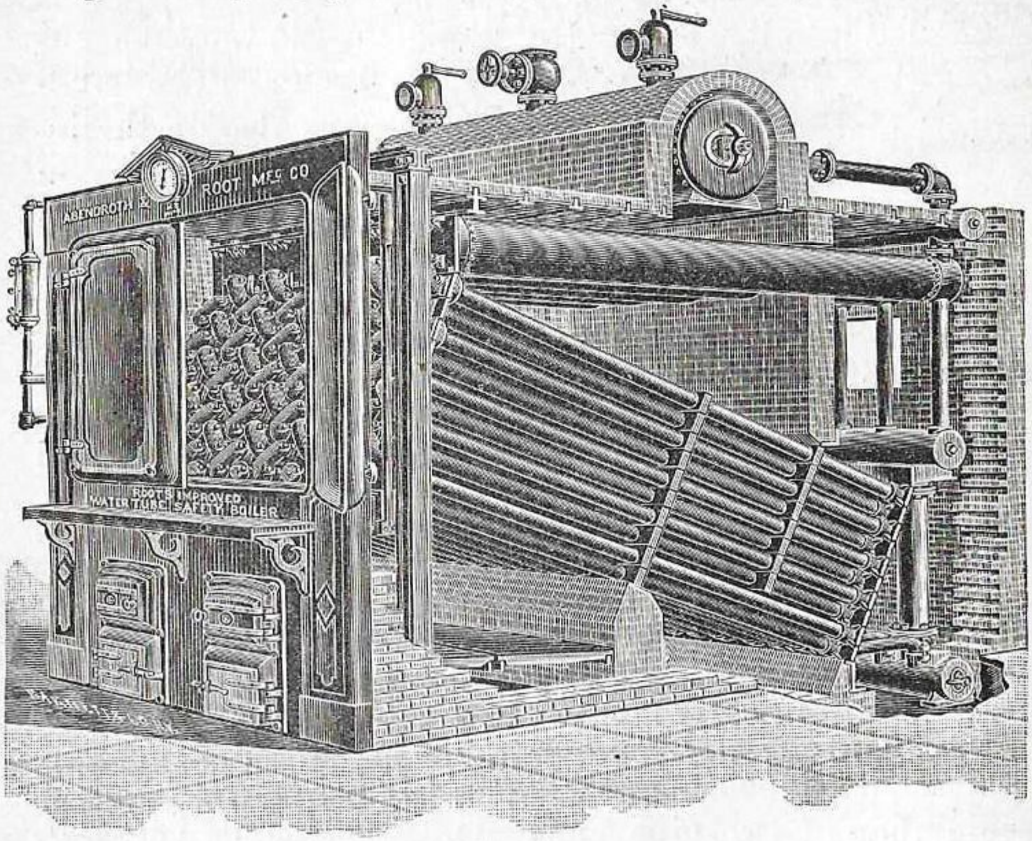


Fig. 51.

A point in the favor of water-tube boilers is their greater safety when compared with the shell boiler. Eleven feet in these boilers is rated as a horse-power, while fifteen is the usual rate in the multi-tubular shell.