To all whom it may concern:

Be it known that I, Charles Radiguer, a citizen of the French Republic, residing at St.-Denis, Department of the Seine, in France, have invented certain new and useful Improvements in Belleville-Boiler Elements with Tubes of Increasing Diameter; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The novel arrangement which forms the object of the present invention resides in employing in one and the same element of a Belleville steam generator, tubes whose diameters increase in the upward direction, with the object of diminishing the resistance to circulation at the upper part of the element and thereby render the circulation in the lower tubes more active.

This arrangement is applicable to elements comprising two or three coils as well as to elements with a single coil.

In order to avoid multiplying excessively the different types of tube in one and the same generator, it is preferable not to employ more than three different diameters, such for example as 70, 80 and 100 or 82, 100 and 115 mm.

If the element comprises a single coil and six forks, the two lower forks can be mounted in 82 mm. tubes, the next two forks in 100 mm. tubes and the two upper forks in 115 mm. tubes.

The junction boxes of the tubes should preferably be uniform in diameter, corresponding with the maximum diameter of the tubes employed. Similarly the bore and tapping centers for the reception of the tubes should preferably present the same distance for all diameters of tube. The boxes, which are superposed flat, thus form a facade identical with that of an ordinary element.

The elements thus constituted present the further advantage of increasing the interval between the lower tubes and of permitting of direct radiation from the furnace reaching a larger number of the lower tubes.

If, for example, the single coil element is to comprise nine forks instead of six, three forks of each of the three tube diameters are fitted.

If the element is to comprise eight forks only, three forks of each of the larger diameters can be fitted and two forks only of the smallest tube diameter.

If the element is to comprise only seven forks, the seventh is arranged at the top, that is to say with tubes of the maximum diameter, that is to say there will be two 82 mm. forks, two 100 mm. forks and three 115 mm. forks.

If the element comprises two or three coils, the special lower boxes, front and rear, will be employed in each coil, with the tubes of smallest diameter, but always preferably with the dimensions that correspond with the boxes of largest diameter; then come the ordinary boxes fitted flat.

With two coils and three diameters of tube, a twelve fork element is constituted by arranging in each spiral two 82 mm. forks, two 100 mm. forks and two 115 mm. forks. If it be desired to fit only ten forks altogether, one 115 mm. fork at the top of each spiral is omitted. If only eight forks are required instead of twelve, one 100 mm. fork and one 115 mm. fork is omitted in each coil.

With three coils and three diameters of tube an eighteen fork element is formed in fitting two forks of each of the three diameters. There will be fifteen forks per element if one 115 mm. fork per coil be omitted. There will be twelve forks per element if one 100 mm. fork and one 115 mm. fork be omitted in each coil.

The various fittings in question are illustrated by way of example in the accompanying drawing, in which:

Fig. 1 is a front elevation of three boiler elements constructed in accordance with the invention;

Fig. 2 is a side elevation of the structure shown in Fig. 1;

Fig. 3 is a diagrammatic section taken on the line X-X of Fig. 2;

Fig. 4 is a front elevation of three boiler elements in which connecting boxes of varying sizes are used for the tubes;

Fig. 5 is a side elevation of the structure shown in Fig. 4.
Fig. 6 is a more or less diagrammatic section taken on the line Y—Y of Fig. 5; Fig. 7 is a side elevation of three boiler elements constructed in accordance with the invention and each element comprising two coils; Fig. 8 is a side elevation of the structure shown in Fig. 7; Fig. 9 is a more or less diagrammatic section taken on the line Z—Z of Fig. 8; Fig. 10 is a front elevation of two boiler elements constructed in accordance with the invention, each element being composed of three coils; Fig. 11 is a side elevation of the structure shown in Fig. 10; and Fig. 12 is a more or less diagrammatic section taken on the line T—T of Fig. 11.

Figs. 1, 2, and 3 show three elements with one coil composed of eight forks (16 tubes), three of these forks being in 82 mm. tubes, three in 100 mm. tubes and two in 115 mm. tubes. These elements are mounted with boxes of tubes 115 mm. in diameter.

Figs. 4, 5, and 6 represent three elements mounted with a single coil composed of eight forks, three of which are fitted with 82 mm. tubes, three with 100 mm. tubes and two forks with 115 mm. tubes. These elements are fitted with boxes corresponding with the diameters of the tubes.

In the first six figures, the 82, 100 and 115 mm. tubes are respectively designated by the letters a, b, c, with an index which indicates the row of the tube starting from the tube of the same diameter arranged lowest. The front boxes which carry the 82, 100 and 115 mm. tubes are grouped under the letters A, B, C. The rear boxes are designated by the same letters with an index showing their row. The rear boxes are provided with two tubes of the same diameter; the same applies to the first two front boxes in each diameter but the fourth box in the natural order carries an 82 mm. tube and a 100 mm. tube and the seventh box carries one 100 mm. tube and one 115 mm. tube.

Comparing Figs. 1 and 4, it will be noted that in Fig. 4 the boxes of the adjacent elements do not contact in the lateral direction. Only the 115 mm. tube boxes contact. The vacant spaces existing between the lower boxes of the elements notwithstanding the provision of the baffles and the screens, form chimneys through which the gases ascend along the doors of the tube boxes and reach the chimney of the generator directly without having served to heat the tubes. It is for this reason that the 115 mm. tube boxes are uniformly employed in Figs. 1, 2 and 3 for all the tubes; this arrangement increases the height slightly but the losses of heat referred to are avoided and the convenience is afforded of using but a single type of tube for replacements.

Figs. 7, 8, and 9 represent three two-coil elements each composed of three forks, two forks are fitted with 82 mm. tubes, two with 100 mm. tubes and one fork with 115 mm. tubes. In these three figures the coils are represented by the letters A and B. In order to designate the front boxes, the letter V is added to the box of the coil with an index which indicates the row of the box in the coil. For the rear boxes, the letter R with an index indicating the row is employed.

The tubes are designated by the natural order of the numerals of the first set of ten, in the first coil from 1 to 10; for the second coil the numerals of the second set of ten (11 to 20) are employed.

In each coil in the upward direction the first four tubes are 82 mm. in diameter the following four tubes are 100 mm. in diameter and the two following tubes are 115 mm. in diameter.

With this method of numbering there is no difficulty in following in Figs. 7 and 9 the path of the current which circulates in each coil. The box $AV^1$ carries on the left the last 82 mm. tube which comes from the rear and on the right the first 100 mm. tube which proceeds from front to rear. The front box $BV^2$ carries on the left the last 100 mm. tube which comes from rear to front and on the right the first 115 mm. tube which proceeds from front to rear.

Figs. 10, 11, and 12 represent two elements with coils each mounted with two forks in 82 mm. tubes one fork of 100 mm. tubes and one fork of 115 mm. tubes.

In these three figures the coils are represented by the letters A, B, C with the letter V and an index indicating the row for the front boxes and with the letter R and an index for the row for the rear boxes, the tubes of the first coil are designated by the natural order of the numerals from 1 to 8 for the first coil and from 11 to 18 for the second coil and from 21 to 28 for the third coil, and this applies whatever the diameter of the tubes may be.

In each coil the box $AV^3$ carries on the left the last 82 mm. tube which comes from 115 the rear and on the right the first 100 mm. tube which proceeds from the front to the rear. Similarly the box $BV^4$ carries on the left the last 100 mm. tube which comes from the rear and the first 115 mm. tube which proceeds from the front to the rear.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a boiler, the combination with an upper collector and a lower collector, of a boiler element comprising a plurality of boiler tubes through which the water is circulated from the lower collector to the upper
collector by the rising steam in the tubes, the tubes in the vicinity of the upper collector being greater in diameter than those in the vicinity of the lower collector and the spaces between the tubes decreasing with the increase of the diameter of the tubes.

2. A boiler element comprising a coil adapted to permit water to be circulated upwardly therethrough by rising steam and comprising a plurality of tubes varying in size from relatively small tubes at the bottom of the coil to relatively large tubes at the top of the coil, the spaces between the tubes decreasing with the increase of the diameter of the tubes.

3. In a boiler, the combination with an upper collector and a lower collector, of a boiler element comprising a plurality of boiler tubes through which the water is circulated from the lower collector to the upper collector by the rising steam in the tubes, the tubes in the vicinity of the upper collector being greater in diameter than those in the vicinity of the lower collector, and junction boxes to which the ends of the tubes are connected, the longitudinal axes of the tubes being equal distances apart whereby the spaces between the tubes decrease as the diameters of the tubes increase.

In testimony whereof I affix my signature.

CHARLES RADIGUER.