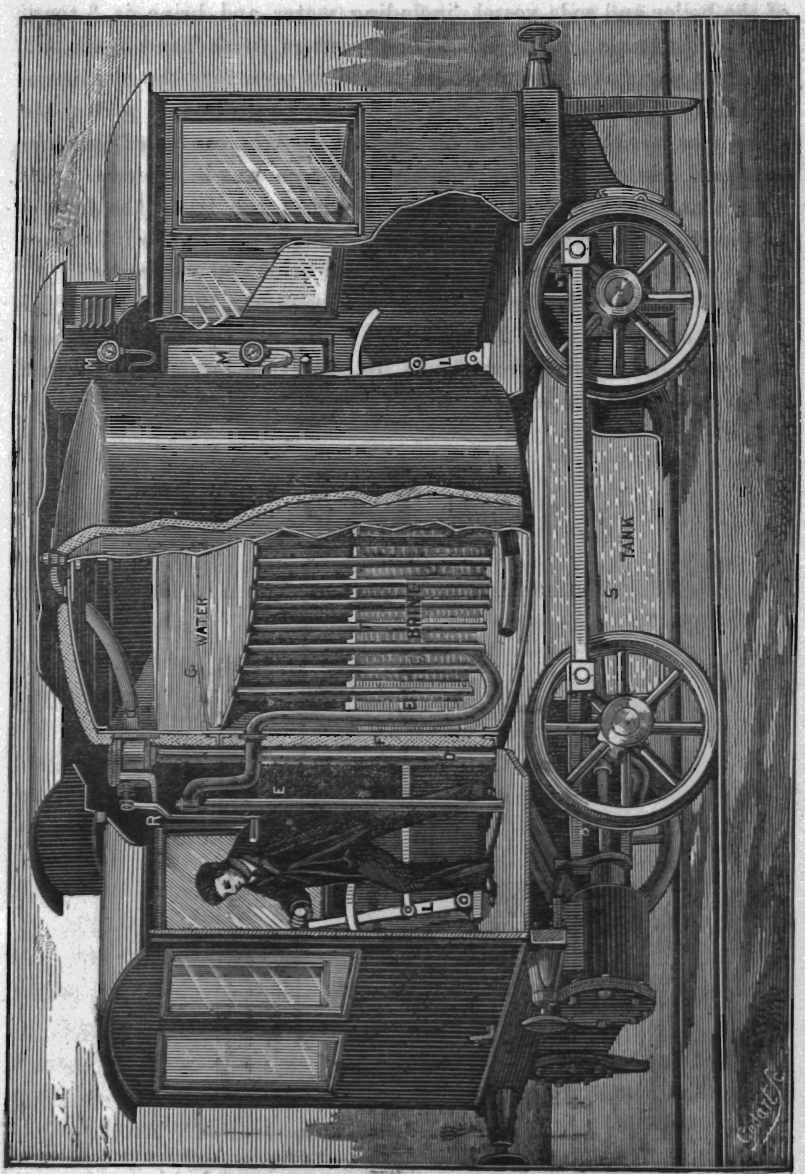

FIG. 11.

This superior steam-making capability renders the soda boiler especially fit for engines which require a sudden increase of quantity or pressure of steam, and has been one of the reasons why it is now in use at the St. Gothard Tunnel.

One of the first boilers Mr. Honigmann constructed for tramway locomotives is shown in Fig. 1. The boiler (A) and the soda vessel (B) are of iron, as the intended pressure was 4 atm. only. The waste steam entered the brine through the pipe (C), which ends in a perforated coil (C), whereby the steam is equally distributed through the brine.

Honigmann's improved engines at present in use on the tramways at Aix-la-Chapelle are shown in Fig. 2. The iron boiler (C) has a strong copper bottom, and 125 field tubes made of brass inserted in it. The steam passes through the pipe (D) and a regulating valve (R) into the cylinders of the engine. The waste steam returns through the pipe (E) into the brine. Boiler and soda vessel are coated with a non-conductor (F), and (S) is a tank for feeding water, (L) the usual reversing gear, and (MM) are pressure gauges. The principal dimensions are as follows, viz. :—

No. of horse-power	15
Diameter of cylinders (two)	7·87 inch.
Stroke	8·65 ,,
Diameter of wheels	19·68 ,,
Diameter of vertical boiler	47·25 ,,
Height ,, ,, ...	20 ,,
Diameter of brine vessel	47·25 ,,
Height ,, ,, ...	55 ,,
No. of field tubes of 1·6 inch diameter ...	120 ,,
Heated surface—	
When starting	58·8 sq. ft.
At the end of the operation	107·4 ,,
Cubical content of boiler	19 cb. ft.
,, ,, brine vessel	52·28 ,,
Space for feeding water	17·65 ,,
Steam pressure	3 to 5 atm.
Quantity of water which can be converted into steam by one charge of brine ...	28·25 cb. ft.
One charge of brine lasts	6 to 7 hours
Hauling force	1,012 lbs.
Weight of boiler and soda vessel, including water and brine	3 tons
Weight of engine	6 ,,
Weight of carriage	2½ to 3 tons

The tramway between Aix-la-Chapelle and Burtscheit has a length of 3,280 ft. without any level parts, the gradients are—

1312	feet	1 : 30
820	,,	1 : 43
1148	,,	1 : 72
3280	feet.	

There are 4 curves of 65 feet radius.

Cost of plant and daily expenses are as follows, viz. :—

CAPITAL.

4 engines each, M 9000	M 36,000	
Concentrating station	M 5,000	
	M 41,000	£2,050

DAILY EXPENSES.

10 per cent. on M, 41,000, interest and wear and tear	M 11·30
Wages for 4 engine-drivers at M 3·50...	M 14·00
,, 1 fireman	M 3·00
,, 1 workman	M 2·60
Lubricating oil, grease, &c.	M 3·00
2400 lbs. coal at M0·40	M 9·60
Repairs	M 4·50
	M 48.00

Or per engine (only 3 engines are running) M 18·00, and as such engine is making 62 miles daily the expenses per mile are M 0·29, or about 3½d.

A large locomotive engine is running daily since October, 1884, a passenger train on the *railway* from Aix-la-Chapelle to Tulich and back (33¾ miles). It has the following dimensions, viz. :—

Diameter of cylinders	23·6 inch
Stroke	24·4 ,,
Diameter of wheels (3 pairs coupled)	47 ,,
Diameter of soda vessel	6 ft. 6 in.
Length of soda vessel	19 ft. 8 in.
Weight of engine	45 tons.

The locomotive superintendent of the Aix-la-Chapelle Railway Company certifies that at a trial made in 1884, this engine hauled a goods train over the line in regular time as per time table. The train consisted of 22 carriages, its total weight was 191·7 tons, whilst the maximum weight allowed on this line for fired locomotives of 45 tons weight is 180 tons. Generally, he says, it is proved that the capability of the soda locomotive is *at leust* equal to that of a fired locomotive of same weight.

Two other engines of the same construction are now in use at the St. Gothard Tunnel.

The practical usefulness of Honigmann's boiler must be acknowledged in face of the facts: That locomotive engines fitted with them are in regular service since two years in Aix-la-Chapelle (railway and tramway); that, in consideration of the highly satisfactory results obtained therewith, the municipalities of Leipzig and Halle have adopted Honigmann's system for their tramways (see *Illustrated Leipzig News* of 23rd January, 1886, and Sydney *Evening News* of 22nd March, 1886); and that two engines which were imported from Germany, and tried on the tramways in Chicago, have given fullest satisfaction to the Directors of the Chicago Tramway Company (see *Railroad Gazette* of 5th February, 1886).

The soda-boiler has passed the experimental stage, and local circumstances (as high wages, expensive fuel and water) can only favor its introduction. No doubt other cities will soon follow the example of Aix-la-Chapelle, Leipzig, Halle, and Chicago, by adopting it for their tramways, especially those which are condemned to see their main thoroughfares like blacksmiths' workshops, filled with smoke, steam, and dirt by the fired steam motors, and the property adjoining such thoroughfares considerably reduced in value. A true expropriation without compensation! The nuisance with this kind of tramways is too well known here to enter more fully into its description; but it may be of some interest to observe the influence of an adoption of Honigmann's boilers on the weakest point of the present system—*i.e.*, its financial results.

The *Sydney Morning Herald* of the 24th March, 1886, states, on official authority, that the weekly expenses for one Baldwin motor, *ex*cluding interest and wear and tear, amount to £31 1s. 7d. This sum includes the following items, viz.:—

Wages for firemen (fourteen shifts)	£5	12	0
Coke	6	7	9
Water	1	3	7

In consideration that with soda-boilers no fireman is required, that 40 per cent. of fuel and nearly all water is saved, but that about one-tenth of a fireman's wages (for the concentrating station) must be added, the weekly savings per motor must amount to £8, or, for 50 motors, per annum, £20,800.

This financial result will be more favorable still if the heavy Baldwin motors, with their elephant-shaped cars, are replaced by a greater number of *light* Rowan cars, with soda-boilers and light engines (total weight, 9 to 10 tons against 33 tons of the present trains), carrying about 50 passengers and running in short intervals. This would meet the wants of the public better; and there is no reason why the services of the conductors should not be dispensed with, provided the cars being properly constructed. If an omnibus-driver is smart enough to attend to his horses, and at the same time to control the door and the fare-box, and to give exchange whilst driving in streets crowded with vehicles and foot-passengers, it would be an insult to doubt the capability of engine-drivers to superintend, *at the stopping-places*, the door, and the fare-box, which can be placed near the engine compartment. To avoid the collection of additional fares at the end of the sections, control-tickets could be issued. Passengers on the suburban railways do not complain of being compelled to buy tickets to keep them during the voyage, and to deliver them when leaving the train, even if the distance is ever so short. Why could not the same be done by tramway passengers? An absolute control would be exercised if each passenger would be obliged to put his fare for the *whole* trip intended into the fare-box when entering the car, and to receive a control-ticket (thin brass-plate), which he had to put into a second fixed box when leaving the car. It needs only to issue, on lines with two or three sections, control-tickets of two or three colours respectively, and with the numbers 1, 2, or 3 punched out, to ascertain at any place of the line whether a passenger has paid the correct fare or not. Moreover would this arrangement offer the best means for obtaining exact returns as to the number of passengers who have been travelling on the various sections of the lines. The traffic department could make use of such statistics for regulating the number of cars to be placed on the various lines in conformity with the real demand. The soda-boiler simplifies the duties of the engine-driver so much that he finds sufficient time for collecting fares and issuing control-tickets, without leaving his place in the engine compartment, whilst the tram stops. The wages of 150 conductors (for 75 cars) would thereby be saved,—viz., more than £23,000 per annum.

These savings on wages for firemen and conductors, on fuel and water will, with those made under the heading "repairs of roads" and "repairs of rolling-stock," doubtless turn the present balance of the tramway accounts from the wrong to the right side without increasing the fares, and without an expenditure of £200,000 for heavier rails which otherwise must be taken into consideration very soon.

Not only for tramways, underground railways, mines (especially coal mines) the soda boiler is of prominent importance, but also for stationary establishments where large quantities of steam are used. The savings of 40 per cent. of fuel represents during one or two years such large figures that even in establishments of medium size the first outlay for the concentrating station with vacuum-pumps will soon be repaid.

There is also another large field for the use of Honigmann's process still, viz., that of steam-drying and over-heating, the latter process being extensively used now in many industries for drying purposes, and would be used more still if, with the present appliances, it were not connected with danger. For drying or over-heating steam a coil of the steam-pipe is placed into a brine vessel containing concentrated soda brine, and a small portion of waste steam is introduced into the brine, which is to be renewed from time to time. No danger is attached to this process, as the temperature of the brine is only a few degrees higher than that of the steam, and as there is no pressure in the brine vessel. Besides the over-heating can be done with the greatest accuracy, the regulation being done by simply regulating the quantity of steam introduced into the brine.

Sometimes it is desirable to combine the apparatus for concentrating brine with the soda boiler. This arrangement is made on various locomotives, and also on a "steam-buggy" Mr. Honigmann built. The brine vessel in this case is used alternatively as concentrator and for heating the boiler. For instance, at the steam-buggy a small fire-box is attached to the bottom of the brine vessel, and before starting the soda brine is (in a place where the smoke does not inconvenience the public) heated until the safety valve of the boiler blows off (at 8 atm.) More water is now injected into the boiler, and thereby the pressure lowered to 4 atm. The buggy is then ready for a trip of 15 to 18 miles, at the end of which the pressure in the boiler is 4 atm. still, that in the soda vessel about 1 atm.

For men-of-war, and especially for torpedo boats, where high speed and absence of smoke for a certain time are of greatest value, the above combination cannot be surpassed. The diluted brine is concentrated in the brine vessel under 3 to 4 atm. pressure. The steam generated thereby is used for driving the ship's engine at low speed, and in case steam of high pressure is suddenly required, water is injected into the boiler proper. Steam of very high pressure is generated therein at once, whilst the pressure in the soda boiler disappears in consequence of the brine being cooled. The engines can now work under high pressure, and without fire and smoke. This mode is very saving as the steam is used twice. That a speed can be obtained which it is impossible to attain by any fired boiler is proved by those experiments (already referred to) which were made to show the superior steam-making capability, and whereby it was stated that a soda boiler is able to generate for a certain time three to four times the quantity a good boiler of same heated surface is able to produce.

Professor Riedler (University at Munich) says at the end of his paper read in 1883 before the Society of German Engineers :—"In consideration of the favourable results obtained by Honigmann's process, it must be acknowledged that it contains so many qualities of practical value that its application will be extended over a very large field, the limits of which cannot be exactly estimated at present. In ships, for small motors (used in dwelling-houses), for heating purposes it will come in use, but in the first instance the soda boilers will soon be used exclusively for tramways, underground railways, in mining and tunnelling, where the present means for transmitting power are suffering from so many deficiencies that none of them could come into general use."