required for evaporation will be 5 lbs. for every 31 gallons of water to be evaporated, and the steam boiler must have one horse’s power for every 6 gallons to be evaporated in an hour.

(3.) A third method is the invention of Mr Goodlet of Leith. The substance to be evaporated is forced by means of a pump into a long copper pipe, which enters a close steam boiler, and after winding through it so frequently as to expose a sufficient surface for a sufficient length of time to acquire the necessary supply of heat from the boiler, again passes out from the boiler and discharges its heated contents into an appropriate reservoir, again, if necessary, to be passed once more through the same process by the force pump. In this case the substance is brought to the steam boiler for evaporation instead of having the steam brought to it, and thus any loss of heat during the transit of the steam is prevented.

A steam kiln for drying grain has been used with great success by the same person. The grain is spread out on the iron floor of a large room—this floor is perfo rated with a mιdtitude of small openings, or formed of a very fine grating ; immediately under the floor steam pipes of 6 inches diameter lie parallel to each other at small intervals apart, and radiate heat directly to the floor and the grain, and also to the surrounding air, which in this hot state ascends through the grain ; numerous large ventilators being provided for the escape of the vapour thus impregnated with moisture, after it has ascended through the grain. This method has been found effectual, and 13 attended with less risk of injury than the ordinary one.

In the processes of drying and printing cloths and fabrics of various kinds, rapid and complete drying is of much importance. This is effected principally in what is called a drying frame : this consists of a dozen of tin cylinders, a foot in diameter and 6 or 8 feet long ; these cylinders are closed completely by two hemispherical ends, and are placed upon an axis in a frame, so as to revolve in contact with each other. Steam is conducted into all these cylinders by a pipe passing through the axis, which is hollow, and the joint is made steam-tight by a stuffing box similar to that of the cover of a steam-engine cylinder. A piece of cloth dripping from the dye-vat is passed through the frame once and is then perfectly dry. Of course, the quantity of steam required for this process is proportional to the number of pounds of water to be evaporated from each piece, that is, to the difference between the weight *of a* piece when wet and when dry. The number of lbs. being ascertained, the fuel and power of the boiler are found from article 66.

In the manufacture of paper the process of drying by steam is beautifully exhibited. The wet pulp, laid out on the web of wire cloth, is gradually strained as it approaches the large hollow cylinders, around which it winds for half a minute and then comes off perfectly dry finished paper, ready for use. This process is minutely described in the article “ Paper ” of this Encyclopedia.

4. *Warming Baths, Boiling Liquids, Distilling by Steam.*

69∙ To heat water rapidly, and in considerable quantity, by means of a fire placed at some distance, is a problem frequently proposed ; and steam for such a case is an excellent vehicle for the heat. Let there be placed in a steam boiler 10 gallons of water, and heated into steam ; these 10 gallons conveyed to a reservoir or bath of water at a distance, by a small lead pipe, will heat nearly 55 gallons of water from 32° to the boiling point, or 165 gallons from 40° to 100°, the usual temperature of a warm bath. A bath of the ordinary construction will require about 160 gallons, and the said 10 gallons will require 18 lbs.

of coal, value sixpence. Besides this, the sides of the bath, if made hollow, may be warmed by the introduction of steam between the lining and the outside, at the same time that the water is warmed ; and the apartment may further be heated with steam pipes from the same appa­ratus.

The most effectual method of communicating the heat of steam to water is to pass the open end of the steam pipe from the boiler directly into the water to be heated, so as at once to mix with it. The mouth of the pipe, properly regulated by a stopcock, should enter at the bottom, and be directed from one end of the bath along one side towards the other, and thus the impetus of the steam on entering will communicate to the water a circulation highly conductive toan equable distribution of heat.

A very simple apparatus of this kind may be placed in the same apartment with the bath itself. A boiler 4 feet long and 2 feet deep, with a fire covering a square of 18 inches, will heat such a bath in three quarters of an hour. A copper boiler will be most effective, and the steam pipe should first be matted with bandages of flannel, and then stitched with canvass painted, from the boiler to where it enters the bath.

In establishments where there are many baths, a reser voir at the top of the building may be kept constantly filled with water ready to descend into the baths, the reservoir being supplied with heat from the steam pipe of a boiler placed in the outer buildings, or some other suitable place. It is to be recollected that the boiler used must be what is called a one, two, or three horse power boiler, according as one hundred, two hundred, or three hundred gallons per hour are wanted ; and so on for every additional hundred gallons of water at 100° of temperature—one horse power of boiler for one hundred gallons.

The same process may be used for heating and even for boiling a liquid or solution, in which no injury will result from adding the steam of this condensed water to the liquid. In a dye-work, or other work where much boiling and many solutions are used, steam boiling in this manner is a process of great convenience and value. The vessels containing dyes of various kinds, including leys and solutions of various substances, in which cloths, yarns, wools, and various materials are to be boiled, are ranged around a spacious apartment. Around this apartment, attached to the wall, circulates a steam pipe of two inches diameter, from which smaller branch pipes go off to each of the boilers from the nearest point, and pass down to the bottom of their respective vessels. The exit of the steam is governed by a stopcock under the hand of the operator; and by this means he can easily, by allowing a smaller or greater supply of steam to enter the liquid, produce a uniform and gentle simmer or excite an instantaneous and tumultuous ebullition. Two great advantages give this method much superiority over the common mode of boiling by the direct action of the fire. The condensed steam supplies to the solution exactly as much water as is lost by evaporation, so that it remains of the same strength through a protracted process, and there is no injury sustained by. allowing the substances immersed to settle down and rest at the bottom.

Where it is not aIlowable for the caloriferous steam to be condensed in contact with the liquid to be warmed or boiled, we must resort to the method of heating by sur face ; that is to say, the steam must be conveyed through the mass of liquid **by** a pipe, or other conductor best fitted to give out the heat or retain the water. A very thin pipe of the purest soft copper is best for this purpose ; 2 inches in diameter and 1/20 to 1/40 of an inch in thickness will be found good dimensions, and a square foot of surface for every 10 gallons of water to be boiled per hour will be required. For some purposes, it will be enough to wind the pipe in a spiral