round the inside of the vessel to be heated ; but if the vessel be large, numerous pipes must pass through the liquid. For boiling 1000 gallons per hour, 200 feet of copper pipe 2 inches in diameter are required.

In distillation by steam, the same method of communicating heat to the liquid to be distilled is employed as al ready described in boiling. But the vapours of other liquids, having less specific caloric than water, a smaller quantity of steam from the boiler will be required to evaporate than to evaporate an equal quantity of water; thus the heat of one gallon of water will evaporate and cause to be distilled 2 gallons of alcohol, 3 of sulphuric ether, and 4 of turpentine. It is a curious phenomenon, of which distillers should avail themselves in carrying off the vapour in distillation, that although alcohol floats on water, and ether on alcohol, nevertheless the vapour of water floats above vapour of alcohol, and vapour of alcohol above vapour of ether.

The densities of water, alcohol, and ether being 10. 8. 7∙

and the densities

of their vapours 6. 16. 25.

in round numbers.

5. *Preparation of Food by Steam.*

70. The last of the applications of steam which we shall here examine is that which was historically the first, its application to cooking and other domestic uses. This invention makes its appearance in the following record of the Royal Society of London.

At a meeting of the Council of the Royal Society,

December 8, 1680.

Ordered, that a book intituled A New Digestor, or Engine for softening Bones, &c., written by Denys Papin, Doctor of Physick, and Fellow of this Society, be printed and published. Chr. When.

This work on the New Digester was accordingly published in 1681 ; “ Containing the description of its make and use in these particulars, viz., Cookery, Voyages at Sea, Confectionary, Making of Drinks, Chymistry and Dyeing, with an Account of the Price a good big Engine will cost, and of the profit it will afford.”

The following list will show the extent to which the learned doctor had proceeded in applying steam to the improvement of the dietetic art. It is copied from the Index to the work. “ (1.) How to know the quantity of pressure in the Digestor. (2.) How to know the degree of heat. (3.) How meat may be kept upon the fire three times as long as is necessary to make it ready, and yet it will not be spoiled. (4.) The same experiment made upon bones. (5.) How to boil mutton. (6.) How to boil beef. (7.) How to boil lamb. (8.) How to boil rabbits. (9∙) How to boil pigeons. (10.) How to boil fish. (11.) How to boil pulse. (12.) How to make jelly, very cheap. (13.) Glue for glasses. (14.) Hartshorn turned like Parmesan cheese. (15.) A macquerel kept without salt. (16.) Salt water as good for nourishment as fresh water. (17∙) To make sweetmeats at a cheap rate, and of a new taste. (18.) To make two sorts of drink with the same fruit. (19.) To make a new sort of wine. (20.) Tinctures drawn in the hundredth part of the time usually required for them. (21.) New ways for distilling. (22.) How to hatch chickens (23.) How to save the labour of grinding cochenille. (24.) To dye with thick juices. (25.) To make horn and tortoiseshell soft for a great while.”

This catalogue of uses of steam we shall shortly run over, as the modern uses of steam for cookery are principally applications of Dr Papin’s methods, and as valuable economization in the preparation of food on a large scale has resulted from them, especially in the extraction of

highly nutritious food from bones. A digester on the principle of Dr Papin is used in every modern kitchen.

“ Description of the Digester and how to use it safely.”

“ A A is a brass (or copper) cylinder, hollow within, shut at the bottom and open at the top. B is another cy­linder inverted upon it. C C are two appendices or ears cast to the cylinder A A, as the trunnions of a piece of ordnance. D D are two pieces of iron put upon the appendices at one end, and the iron bar E E at the other. F F are two screws, which serve to press both the cylinders A A, B B, against one another. G is another hollow cylinder, made of glass, pewter, or some other materials, fitted to receive those things that are to be included in the cylinders A A, and B B, with water all round it.

“To use this engine with convenience and ease, it ought to be fitted in a furnace built on purpose for it, and should go on ns far as the appendices C C ; so the fire being underneath, and the screws well fastened, and a piece of moistened paper laid between the cylinders at the joint *i* *i* to make it steam tight, you may boil your meat as long as you please without danger of wasting it by the ex halation of the volatile parts.

“ To know the quantity of the inward pressure, you must have a little pipe open at both ends as H H : this being soldered to a hole in the cover B B, is to be stopped at the top with a little valve P, exactly ground to it. This must be kept down with an iron rod I M, one end of which must be put. into an iron staple M, fastened to the bar E E, and the other end kept down by a weight N to be hung upon it nearer or further from the valve according as you would keep it less or more strong, after the manner of an ordinary Roman balance, or steelyard.

“ To know the degree of heat, I hang a weight to a thread about 3 feet long, and I let fall a drop of water into a little cavity made for that purpose at the top of it, and I tell how many times the hanging weight will move to and fro before the drop of water is quite evaporated.

*“ Experiment.* Having filled my pot with a piece of a breast of mutton, and weighed five ounces of coals, I lighted my fire, and by blowing gave such a heat that a drop of water would evaporate in 4 seconds, the inward pressure being about 10 times stronger than the atmosphere : I let the fire go out of itself, and then the mutton was very well done, *the bones soft* and the juice a strong jelly. So that, having had occasion to boil mutton several times since, I have always observed the same rule, and never have missed to have it in the same condition, which I take to be best of all.’’

Beef required 7 ounces of coal and the same heat, and the beef was very well boiled, although there were more parts of the bones not quite softened. Lamb, rabbits, and pigeons, mackerel, pike, and eel, were subjected to the same process; whence the doctor infers that the bones of young beasts require almost as much fire as those of old ones to be boiled, that rabbit bones are harder than those of mutton, that tough old rabbits may be made as good as tender young ones by this means, that pigeons may be best boiled with a heat that ovapo rates a drop of water in 5 seconds, that mackerel was