Specification of William Johnson : method of heating fluids.

A.D. 1809 . . . . . N° 3236.

SPECIFICATION

OF

WILLIAM JOHNSON.

METHOD OF HEATING FLUIDS.

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JOHNSON'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, WILLIAM JOHNSON, of Blackheath, in the County of Kent, Gentleman, send greeting.

WHEREAS His most Excellent Majesty King George the Third, by His Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the Fifteenth day of May, in the forty-ninth year of His reign, did, for Himself, His heirs and successors, give and grant unto me, the said William Johnson, His especial licence that I, the said William Johnson, my exors, admiors, and assigns, or such others as I, should said William Johnson, my exors, admiors, or assigns, shoud at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, shoud and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick-upon-Tweed, and in all His Majesty's Colonies and Plantations abroad, my Invention of "**A NEW OR IMPROV'D PROCESS FOR HEATING FLUIDS FOR THE PURPOSES OF ART AND MANUFACTURES**;" in which said Letters Patent there is contain'd a proviso, obliging me, the said William Johnson, by an instrument in writing under my hand and seal, particularly to describe and ascertain the nature of my said Invention, and in what manner the same is to be performed, and to cause the same to be inrolled in His Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

NOW KNOW YE, that in compliance with the said proviso, I, the said William Johnson, do hereby declare that the nature of my said Invention and the manner in which the same is to be performed is described and ascertained in the following explanation thereof, that is to say:—

That my Invention is for heating fluids and saving fuel; and is particularly adapted for the improvement of the steam engine for boiling and evaporation in the making of sugar and salt and spirits from corn or molasses, or rectification; and for brewing and dyeing, and every purpose where steam heat can be used as a substitute for the direct action of fire, and is not at present adopted by this exact form of process. As it may render the process more intelligible and satisfactory to many persons by stating the theory on which it is founded, the following previous explanation will be useful:—It is suppos'd that fire burning freely constantly acts on the bottom of a boiler with 1000 or 1200 degrees of heat; yet, notwithstanding this great heat, it is found that when it is employed to evaporate water by common or open boiling, never to raise the temperature of the water higher than 212° of Farenheat; consequently, all the heat which acts in perpendicular direction from the fire beyond what is sufficient to keep the water rapidly boiling at 212° must pass away useless through the water in chemical combination with the steam in a latent state; or otherwise, the temperature of the water wou'd be found, when more or less rapidly boiling, at different temperatures; this it has been discovered to do by Dr. Black, and proved by Mr. Watt and others, by various experiments; and therefore when the steam is confin'd from freely passing away, it is found that its heat may be rais'd to any temperature requir'd, approaching the heat reflected from the fire, and when convey'd at high temperature into a proper receptacle, necessarily possessing according to its degree of heat all the properties and convenience of flame of fire for heating fluids; from these considerations it has been concluded, that as the rapid action and power of the heat from fire is sufficient to maintain a constant evaporation at the highest temperature for any purpose requir'd, that steam at moderate high temperature produc'd from a boiler of a given size, would, when confined to act in a proper manner in a close receptacle underneath a fluid, have power to boil it at a lower temperature, and evaporate it when contained in a vessel of double or four times its own dimensions (the exact proportion not yet ascertain'd) as rapidly as cou'd be effected at that temperature by the direct action of fire. This theory having been satisfactorily proved to be correct, the following statements will explain and describe the vessels and the process by which it may be carried into effect, for the use of the steam engine and manufactures mention'd:—Let the boiler on the

fire to supply steam, represented by A, be made of sufficient strength to bear a high pressure of steam, on which let there be a safety valve, to be loaded according to the heat of steam requir'd, as shewn at C; to which boiler let a main pipe be fix'd, as represented by D, having smaller pipes as E, E, to convey the steam to the different receptacles, on which pipes and on the main must be fix'd cocks or valves, as F, F, F, to be regulated by a weight, to govern the direction and quantity and temperature of the steam to be discharg'd; let another boiler, as represented by B, be form'd (open or close at the top, according to the purpose for which it may be intended,) of dimensions requir'd, suppose double the dimensions or superficial content of that on the fire, for the use of the steam engine or manufacturing purposes, and having a close receptacle of a few inches depth, form'd as represented at G (or any other form) at the bottom of the vessel, for receiving the steam from A by the pipe E, and that, if were requir'd, that the water or other fluid in the larger vessel B shou'd be made to boil, and evaporated at the heat of 212 degrees or common boiling; let the temperature of the steam in A be rais'd to about 248° (as near as is at present ascertain'd), which when discharg'd at that temperature into the receptacle G will boil and evaporate the fluid contain'd above it in the vessel B as rapidly as can be affected at the same temperature by the direct action of fire; consequently, if the temperature of the steam discharg'd from A was always preserv'd at about 278 or 280 degrees, it appears by the tables of the ascertain'd power of heated steam, that when it is rais'd to that temperature that it will be of double the power of 248°, or be sufficient to evaporate double the surface with equal rapidity; and therefore, if it were requir'd by this process to evaporate water as rapidly (as by the direct action of fire) from the boilers at present in use for the condensing steam engine at a temperature of 225 degrees by the same proportion'd vessels, that this will be effected by the same process, and raising the temperature in A to the proportionate heat required. It will be understood, that whilst communicating by steam so rapid a heat to a larger vessel, that about the same quantity of steam will evaporate from the small boiler A as will in the same time be evaporated from B. To provide for this rapid evaporation from A, it will be necessary either to have that vessel much deeper than B, which for some purposes will be prefer'd, or to supply it again by a forcing pump with the water from the receptacle G, produced by the condens'd steam from A. This must be convey'd by a separate main and communicating pipes distinct from the steam main; the returning the water at an inferior heat to the boiler is in practice with the condensing steam engine where the supply water is return'd at about 100 deg^{s} temperature, whilst the water in

the boiler is at the temperature of about 225 deg°, which is at 125 degrees of difference; there will consequently be no inconvenience in returning the water from G to A, which wou'd be return'd always at the same temperature nearly as when discharg'd. From what has been stated and described, which will be sufficient for almost every purpose where this process for heating fluids can be employ'd, it will be obvious, that if the high temperature of the steam from the boiler A will be sufficient to maintain the heat in B, when of four times its own dimensions, at the lower temperature requir'd, that as the breadth of A, expos'd to the action of fire, wou'd be but one-fourth that of B, it coud not consume more than one-fourth the fuel that woud be requir'd to evaporate B, supposing it was evaporated at the same temperature by the direct action of fire; and it appears also certain, that in bringing any quantity of liquid to boil (where in considerable factorys the steam boiler wou'd always be kept in readiness), that it will be conveniently effected in much less time than it is possible to be done on the present plan, when the fire is to be made up, and perhaps at any time, as it was found to require not more than 15 degrees difference of temperature to evaporate from B by steam the same quantity of water as from A in an equal time by the more direct action of fire; and when the boiling has commenc'd, the rapid action of the steam heat may be continued to expedite the work, when the direct action of fire coud not be allowed without danger, or of certain injury.

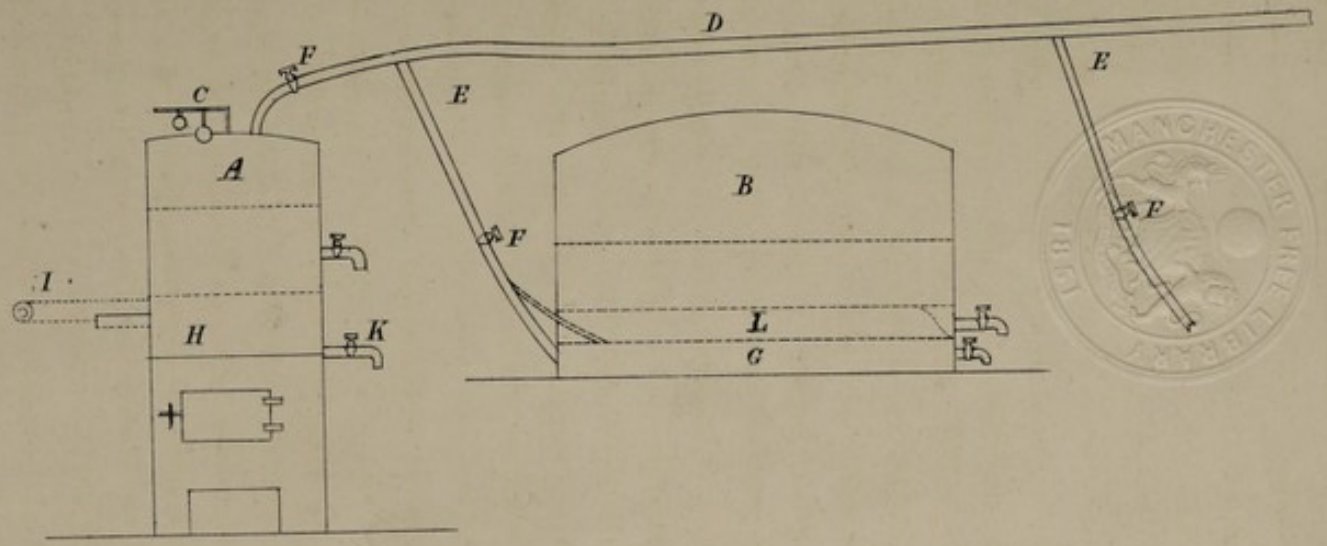
The mode of process and form of work described will be sufficient for the steam engine employing the heat of steam to the boiler as the substitute for fire; and will in general be sufficient for distilleries and breweries, and for evaporation in the making of sugar, which is effected by the burning the refuse of the sugar cane, which produces an extensive flame that passes under the whole length of several distinct vessels, that vessel which is nearest to the first action of the fire finishing the sugar. It will consequently be necessary for this process, and also for making salt or any other manufacture, where one steam boiler is design'd to provide steam for every vessel employ'd, to have the range of main pipe with smaller pipes communicating to the close vessels G or L at the bottom of each boiler or pan, and the forcing pump and apparatus, first stated. In the apparatus with which I have made experiments, I adopted a division in the boiler A (for occasional use), as represented by the space H under the dotted line, forming two boilers in one vessel, one above the other, with distinct quantities and surfaces of water, (the lower vessel H having a discharge pipe and safety valve as I, K,) which was adopted for the purpose of ascertaining the action and quantity and apparent power

of steam from two surfaces at the same instant, and for protecting (by the evaporation being prevented) the bottom of the boiler in contact with the fire from injury. That one principle of this process for evaporating fluids, by employing close receptacles for the steam to be conveniently condens'd and supply return'd (when requir'd) back to the boiler, I propose adopting by this form of apparatus, when prefer'd by the employer, evaporating from two surfaces of the steam boiler at the same time, or employing two and evaporating only from the upper one. The advantage and convenience of steam to convey heat for many purposes has been long known; it has been a considerable time adopted by a different process by dyers and others, who employ one common boiler to distribute the heat by steam to the different vessels of the manufactory, but in all of them with little variation in the form. The steam is convey'd through a pipe laid round the bottom of the fluid to be heated, with small holes in the pipe, to allow the steam to pass directly into the fluid and mixing with it, by which mode no material, if any, saving of fuel can arise than what results from the difference of waste by one considerable fire, in preference to the waste which wou'd arise from several fires being employ'd. This difference is found to be very considerable, which advantage, added to the avoiding the great inconvenience and charge for attendance and repairs requir'd by several fires, is a sufficient inducement to them to adopt boiling by steam in the manner stated; and as heat convey'd by steam is already much adopted, every improvement that may conduce to its being introduced into other manufactorys cannot be too much explain'd; and to induce confidence in adopting the exact process here propos'd, it is proper to make a few observations on two modes of employing steam that are most known and commonly adopted, which are by conveying the steam directly to the vessel to be boil'd; the other, by steam or heated water from the direct action of fire upon an outer vessel surrounding the vessel containing the liquid to be boil'd. First, on the employment of steam convey'd from a boiler by a pipe to the vessel to be boiled, the great imperfection of this plan is, that it cannot save any material quantity of fuel but what arises from avoiding the waste occasion'd by a number of fires, as before stated; because, immediately that the steam enters the fluid in the vessel to be boiled, every excess of heat above the temperature of 212° passes off useless, in the same manner as first stated respecting the direct action of fire, notwithstanding a pipe is used with small holes to check its waste and spread the heat; and the steam produced from a boiler of ten feet surface convey'd in this manner could but make another of ten feet surface boil, and with somewhat less rapidity, if the tem-

perature was attempted to be raised above 212 degrees; but when it is not raised higher than just boiling, at 212°, it is found by the dyers (and others) that one large boiler of 100 feet surface, providing steam at considerably raised temperature (at about 230), will keep several large vessels boiling, whose aggregate surface is 2 or 300 feet or more, although the heat which boils them is convey'd into the water to be boiled; which effect is produced in consequence of the density and depth of the water, assisted by a circular pipe with small holes, (as it was found on trials, that when the steam was allowed to enter the liquid directly from the orifice of a large pipe, and not as stated, it chiefly evaporated immediately, without communicating much heat,) and the motion of the cloth during the process of dying also assisting it to spread before it can evaporate, obtains a sufficient boiling heat; (this effect from one boiler on several vessels of its own dimensions in the clearest manner proves the advantage that will result from conveying the steam at high temperature into a vessel as propos'd to extend its heat in proper manner, and from which receptacle a supply of water at high temperature can be return'd to the boiler, which cannot be done on the plan now in practice;) but if the steam from 100 feet boiler was convey'd into the water of another boiler of 100 feet surface employed to work a steam engine, it is obvious that the engine could not possibly work so rapidly as if the same fire was employed to act directly under its boiler, and therefore no fuel wou'd be saved. The great difference, therefore, is evident from this process, which proposes to employ the steam from the 100 feet boiler, raised to high temperature and rapidly discharged under a steam engine boiler of double or treble its dimensions into a close receptacle, by which to preserve a sufficient heat for working the steam engine at a lower temperature; and again, if steam is convey'd into stills for the purposes of distillation or rectification, the mixing so large a body of water with the wash of the malt distiller, or in rectification where flavour is to be preserved, (as more than an equal quantity of water must be condens'd in the liquid to be distilled to evaporate the quantity required,) is an imperfection that renders this mode of evaporation improper to be adopted for such purposes. The other mode propos'd is the principle of the well-known Balnenon, to have water inclosed within an outer case round the still or other vessel, the fire acting under the outer case. This mode avoids every injury that may arise from mixing the condens'd steam with the fluid to be heated, or that may arise from the direct action of fire on the vessel containing the liquid; but by this mode no fuel can be saved; on the contrary, it will require more fuel, for the following reason:— Suppose a fire of one foot surface acting under a boiler of four feet surface

(1 SHEET)

A.D. 1809. MAY 15. Nº 3,236.
JOHNSON'S SPECIFICATION.



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against an outer case, the water in the outer case and liquid in the boiler will gradually heat together, and when the liquid in the inclosed vessel boils, it will immediately in a particular form carry off in steam the heat afterward received, as the caloric so received from the action of a small fire will (from its natural tendency to ascend) then pass off in a current or vein of steam, rising in perpendicular direction in quantity exactly according to the breadth of the fire, forcing its way to the opening of discharge; because, although the fire will heat to the boiling degree all the water contained in the surrounding case, the vein of hotter steam mentioned will keep back the steam of inferior heat from passing off; consequently every additional foot of fire placed under the outer case would increase the evaporation in exact proportion to the power of the first. It is therefore evident that no saving of fuel can arise from this plan compared with employing the fire to act direct on the vessel containing the liquid to be evaporated, but must increase the consumption; and except avoiding injury from the direct action of fire on the liquid, evaporating would be attended with almost every inconvenience and defect.

These comparative statements of the different modes of conveying heat to fluids do not properly form part of a Specification; they are inserted for the purpose of explaining the difference and advantages of the process proposed compared with others, to assist them who are unacquainted with such subjects to decide more correctly, who at present employ the steam engine, or who are engaged in manufactures, to excite enquiry and to forward into their service a substitute for the expensive direct action of fire, where the convenience and advantage from conveying heat by steam has never yet been properly considered or in any manner adopted; and this process will without inconvenience be adapted for many purposes to the present vessels, by introducing a seperate hollow vessel (within the boiler) to receive the steam, made of shallow depth, as shewn by the dotted Figure L, of proper dimensions, to cover the whole bottom of the inside of the boiler or pan; the pipes conveying the steam and for discharging it when condensed passing through the sides of the boiler into it, by which means the steam from the boiler A will be communicated without material expence.

I have stated, that when prefer'd by the employer I adopt as part of the improved process a double vessel on the fire, of equal breadth with its surface in the lower vessel in contact with the fire. I propose to employ linseed or other oil (which requires a temperature of about 600 degrees before they volatilize), to prevent injury from outward pressure by the outward vessel, as no temperature of water in the inner vessel would be required to such a degree

of heat as would allow the oil to volatilize. By adopting this mode of communicating sufficient heat, I propose that the inner vessel should be made of wood (which at present is adopted for the steam engine) braced with iron, with metal bottom; or that it should be made of copper (or other metal), the joints of which may be laid together and fastened with bolts, as any cement required would be secure from the action of the fire. What may be the inconveniences or incorrectness of this part of my design I have not had time perfectly to ascertain.

In witness whereof, I, the said William Johnson, have hereunto set my hand and seal, this Fifteenth day of November, One thousand eight hundred and nine.

WILLIAM JOHNSON. (L.S.)

AND BE IT REMEMBERED, that on the Fifteenth day of November, in the year of our Lord 1809, the aforesaid William Johnson came before our said Lord the King in His Chancery, and acknowledged the Specification aforesaid, and all and everything therein contained and specified, in form above written. And also the Specification aforesaid was stampt according to the tenor of the Statute made for that purpose.

STANLEY.

Inrolled the Fifteenth day of November, in the year of our Lord One thousand eight hundred and nine.

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