ented April 25, 1871, by William Young, of Easton, Pa. For further information address either the patentee, as above, or the Tuttle & Bailey Manufacturing Company, 74 Beekman street, New York.

## THE APPLICATION OF STEAM TO CANALS.---NO. 2.

BY GEORGE EDWARD HARDING, ESQ., C.E.

In 1472, long before canals, attempts had been made to substitute for the manual labor of oars, the propulsion of boats by wheels moved by oxen; while, on the 17th of June, 1543, with a precision of date which throws much doubt on the probability, the Spaniards claim the construction of a steam-moved vessel. Mention of galleys driven by side wheels are found in the years 1578 and 1587; while, in 1618, David Ramsay obtained a patent from the Crown to apply engines "to make boates for the carriage of burthens and passengers runne upon the water as swift in calms, and more saff in storms, than boats full sayled in great windes;" and again, in 1630, was issued to him a second patent, for a similar purpose.

The many schemes for propelling boats which have been carried to a further or less degree of experiment or practical use since Ramsay's day, are too curious not to be classified, and, at the risk of tediousness, the manner and means for obtaining power of various kinds are enumerated:—From wind, by sails, kites, balloons, and windmills, on deck; from oars, worked by men, animals, and steam; from paddle wheels and screw propellers, placed in every possible part of a vessel, and variously constructed and driven; from the vessel's motion, and from the motion of mercury: from the current-operating machinery on board; from springs and from weights, differently operated; from the explosion of gunpowder, and from gases, either generated

the discharge of steam, compressed air, and from falling water. Electricity is to afford the motive power in six instances; while an endless chain, lying upon the bottom of the canal, and passing over various parts of the machinery, has strong advocates. Some haul the craft along by a rope fixed on shore, and some again by a smooth or rack rail on the banks, with which wheels driven from the boats engage. Thirteen sanguine inventors claim that a locomotive moving along the canal, and towing after the manner employed by horse boats, is the only solution of the vexed question, while nearly as many believe that an atmospheric railway is the only system suitable. The larger number of workers in this field have affected the direct discharge of water at the stern as the greatest good; a less number, by the discharge of air in various ways. One by discharging fire under water is peculiar, though hardly so curious as Congreve's device of sponges for propelling a vessel by capillary attraction. Several of the earlier motors were to achieve their end by thrusting poles against the bottom of the canal; two by water in a tube on the shore, suitably connected with the boat. Bourne and others advise either wheels rolling on the bottom, or the adoption of screws so working, which seem to have many disadvantages; but the action of reciprocating rods, armed with fixed floats or valved pistons, shaped as wedges, cones, or as hollow vessels, and worked at the sides, or under the bottom of the boats, either in or out of channels, has always been a favorite plan, opposed again by a numerous class, who allow the reciprocating motion, but insist that movable floats only can succeed. Variations of this last consist in hinged boards and collapsing propellers, operated in divers ways, while some, in their search for novelty, call all the others wrong, and place the floats at once upon an endless chain, by which they hope to use less power and gain more speed. Water or steam, acting in flexible tubes, ends the list. Among all our counsellers, whom shall we select

Some of these devices are deserving of more than such wholesale notice, and we will particularize a few of the more prominent.

Passing over one hundred and fifty years, during which time we have the invention of the steam engine, and the early labors of such men as Papin, Savory, Jonathan Hulls, James Watt, and Symington, we reach the invention of Patrick Miller, who, in 1787, especially claimed an application of machinery for the purpose of inland navigation. His invention comprised either double or triple vessels, having two or three separate hulls, with one deck over all, with paddle wheels, of any required number, placed in the space between the hulls, so as to be submerged to an advantageous depth. Originally designed to be operated by a capstan, worked by a windmill or manual power, the arguments of Symington, who applied the steam engine, changed the original idea of motive power, and successful experiments were made, in the summer of 1788 and the winter of 1789, upon the Forth and Clyde canal, where a speed of nearly seven miles an hour was obtained Notwithstanding this success, it seems that Mr. Miller did not consider the invention as practical, since, in 1796, we find Miller again applying for a patent for the construction of vessels propelled by wheels worked by capstans, as in the original scheme.

In 1788, John Fitch, an American, obtained a patent from the States of Pennsylvania, New York, New Jersey, and Delaware, for the application of steam to navigation, and also opposed the application of James Rumsey, for a similar patent, the same year. Fitch succeeded in driving his steamboat eighty miles in one day, by means of six oars, or paddles, working perpendicularly on each side of the boat, similar to the strokes of the paddles of a canoe; but his invention came to no practical use.

Rumsey, who had been refused a patent in his native country, came to England, and, in November, 1788, obtained letters patent of Great Britain, for propelling boats on rivers and canals, by alternately moving a valved box backward and forward under the keel of a vessel, by means of his steam engine. The box opened toward the stern, was provided with a valve at the forward end, which, opening as the box moved forward, allowed the water to pass freely, but, closing with the opposite movement, propelled the boat ahead. A second part of his specification describes an arrangement for drawing water at the bow into a hollow, longitudinal trunk, parallel with the keel, and discharging the same at the stern, by the reciprocating strokes of a large pump. Rumsey also devised two wheels, projecting from the bow of a canal boat, which carried an endless chain with floats. The current was supposed to actuate this mechanism, which, by operating a series of poles for pushing against the bottom of the channel, propelled the boat. The similitude of the plan with that of a man lifting himself over a fence by the straps of his boots, is obvious. The death of Rumsey, in 1792, prevented any practical application of his inventions, though his associates, in the spring of 1793, obtained a speed of four miles per hour on the Thames, from a boat arranged upon his pump system, as described, which boat Rumsey had nearly completed at the time of his death.

Next in order, in the year 1801, Mr. Symington was employed by Lord Dundas to experiment, with the view of substituting steam for the horse boats on the Forth and Clyde canal. After two years experimenting, and at an expense of over £7,000, the *Charlotte Dundas* was completed, and launched on the canal in March, 1803. In this boat were first combined all the principal features of our modern paddle wheel steamers, namely, the double reciprocating engine, with connecting rod, and the crank on the axis of the rotary paddle wheel. The paddle wheel—for there was but one—was placed near the stern, in the center of the boat. This seems to have proved a perfect success in regard to self propulsion and towing of other boats; but, though the efficacy of the system was proved, the opinion of the canal proprietors, that the waves it created would damage the banks, prevented its adoption. Notwithstanding the decision of the Forth and Clyde managers, the Duke of Bridgewater, after a careful investigation of the advantages and the supposed drawbacks, gave Mr. Symington an order to build eight boats similar to the *Charlotte Dundas*, to ply on his canal; but the death of the Duke, soon after, prevented the execution of the scheme, and poor Symington and his canal navigation were neglected together.

The ingenious experiments of Stevens, Evans, and Fulton, in America, about this time, being applied for purposes other than canal propulsion, do not particularly concern this narrative; for although, in 1796, Fulton published in London a treatise on canal navigation, wherein he advocates raising and lowering boats by steam inclined planes, yet he makes no mention of steam boats therein; though in January, 1803, he described some experiments with paddle wheels, as more advantageous than the system of chaplets, or endless bands of floats for propeling a system of boats, which were designed to be formed with bows and sterns convex and concave, so that several would form a line with almost continuous sides. Yet he does not seem, even after his practical success on the North river, in 1807, to have again advocated steam for canal uses. In later years, this arrangement of boats has been revived again and again.

Richard Trevethick and Robert Dickinson took out a patent in 1809 for moving an oar, provided with valves, forward and backward in a channel under a boat; and two years later, one Rose received a patent for constructing a canal boat, with water courses open to the water below and at each end, with two or more paddle wheels and cranks acting on the water. No drawings of these plans are known to be in existence. In the same year were also granted two patents for propeling boats by discharging water at the stern by means of a steam pump, similar to Rumsey's principle, but no experiments are noted.

In 1812, but one patent was issued for improvements in canal navigation, where endless bands traverse over wheels at the end or sides of a vessel, and carrying hinged floats to act on the water when propeling the boat, but caused to lie flat on the reverse stroke, in a manner not plainly described.

In the following year, we find an invention by Thomas Mead, who proposes a double endless chain, moving around two wheels, above and below two parallel tubes; on the chain belt are series of pistons, packed so as to pass steam tight through the tubes. Steam from the boiler forces the pistons continuously along one tube, at the end of which they are successively detained and released by catches, and pushed forward a small distance by eccentrics. The steam escapes by a hole in one of the tubes, which is uncovered at proper times, as the pistons require.

In 1815, Richard Trevethick patented a screw propeller, consisting of a worm or screw, or a number of leaves placed obliquely round an axis, which revolves, preferably within a cylinder, at the head, sides, or stern of a vessel. In some cases the screw is to be made buoyant, and works in a universal joint, the advantage of which construction is hard to perceive.

John Millington, during February of the year 1816, lays claim to a propeller more modern in its features than any preceding. He also claims forcing air into tubes, which operated against the water at the stern to propel the boat. In the same year, we have an arrangement with several cranks on the side of a vessel, connected with each other by horizontal connecting rods, upon which are placed vertical vanes of a curved shape, so as to act upon the water by the revolution of the cranks one way (but carried forward above the surface); and in the next, a method of propulsion by operating oars, held vertically at each side of the boat, in a similar manner to Fitch's earlier experiments, except that, by means of cog wheels, the oar blades were feathered, to pass edgeways through the water during the return stroke.

About the same date, Niece proposes propeling a boat by the pressure, on the water, of the gas and rarefied air produced by the inflammation of the essential oil of resin, injected at intervals into an air reservoir and then ignited. The gases pass through tubes, provided with valves, into a well, from which they expel the water with force along a tube opening below water mark at the stern of the boat. By the use of two receivers, and by spiral blowers, refilling the air reservoirs, the propulsion is effected more evenly.

## MANUFACTURE OF VARNISH IN ENGLAND.

[Condensed from the English Mechanic.]

The varnish we shall more particularly describe is that made by intimately mixing gum copal with linseed oil and diluting the mixture with turpentine—the preparation of which requires no small amount of care and attention, and attention, and was formerly attended with no little danger from fire. Copal is a resin found exuding from the *Rhus copallinum*, a tree growing in several parts of America, and from the *Elæocarpus copallifer*, a tree found in the East Indies; it is also imported from the coasts of Guinea. The two latter kinds are generally allowed to be the best, and are commonly known as African.

The object to be obtained in the preparation of varnish is to impart to it a quick-drying property, retaining at the same time transparency and elasticity. To secure these characteristics great care is necessary, in melting the gum, in boiling that and the oil together for the requisite time and at the proper degree of heat, and in the complete solution of the resinous matter employed. To achieve these results a pure and limpid sample of oil is generally chosen, which is placed in a copper pan holding from 80 to 100 gallons, and heat gradually applied till the scum rises, after removing which the oil is allowed to boil for about two hours, when it is dosed with calcined magnesia in the proportion of an ounce to every four gallons of oil, but added by degrees and with occasional stirrings. This being completed, the oil is again boiled briskly for about an hour, and then, the furnace being drawn allowed to cool. When the temperature is sufficiently reduced, it is removed to leaden cisterns, where it is stored till fit for use.

Under the old system of making varnish, the gum pot and oil pot were open to the atmosphere of the shop in which the operation is performed; but the vapors arising during the process are now either taken into the furnace shaft, or condensed into liquid by suitable refrigerators. The *modus operandi* is somewhat as follows. The oil being placed in its boiler and approaching the requisite degree of temperature —namely, that at which the gum melts, the copal is placed in its copper, about 10lb. being the usual quantity fused at a time. In a few minutes it begins to melt, and gives off unpleasant vapors. When thoroughly melted and clear, a portion of the oil is added, and the mixture boiled and stirred till of the proper consistency; it is then taken and emptied into the boiling pot, from which the requisite quantity of oil for the following charges of gum has been previously withdrawn. The gum pot being thoroughly cleansed, another portion of the gum is placed in it and melted in a similar manner to the first, and so on, till sufficient gum has been fused for the quantity of oil prepared. The whole is then placed on the furnace and boiled till a scum rises and spreads gradually over the whole surface, which then froths up rapidly in the same way as boiling milk, and must be instantly removed, when the scum being stirred down, the dryers are added, a little at a time, and the boiling continued till the mixture feels stringy to the fingers. The boiling pot is then removed from the fire, and when sufficiently cool, turpentine is added till the desired consistency is attained, when the varnish may be placed in the storing tanks. Formerly a great waste of turpentine took place by evaporation through mixing it while the varnish was still too hot; but of late years a vast improvement has been adopted in this respect, and it has been practically demonstrated that not only is there no necessity for "boiling" the oil and gum after incorporation but that the produce is equally good if the turpentine be added just before the mixture becomes too cold to permit of a perfect amalgamation. In fact, it is now acknowledged that the oil need not be raised to a higher temperature than that at which the gum employed fuses, and that when the two are mixed the lowest possible degree of heat which will insure their incorporation, is sufficient to secure all the results desired. By this method a large quantity of the turpentine formerly lost in evaporation, is saved and there is, moreover, less risk of fire. It is indeed a moot point whether it is absolutely necessary to add turpentine in quantity at all, as even when the loss during the preparation of the varnish is reduced to a minimum, a still further reduction occurs whilst the varnish is ageing and clearing in the storing tanks, and it is sometimes found necessary to thin it before it can be used.

To prevent the workmen being distressed by the pungent odors of the melting gum, in modern varnish factories the boiling and gum pots are placed close together, and by means of caps and heads (provided with openings to facilitate stirring,) the pots are connected with chimneys which carry off all vapors into the smoke shaft, or to the condensing tanks. A close fitting cover is also provided for the boiling pot to extinguish the flames in case the oil should take fire—a great improvement on the old fashioned carpet, which an assistant stood ready to throw over in case of accident; while tramways are laid down so that the boiling mixtures can be rapidly conveyed into the open air in the event of firing, and for the purpose of cooling before the addition of the turpentine.