## THE APPLICATION OF STEAM TO CANALS.—NO. 4.

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This paper would be incomplete without mention of the experiments of Fairbairn, in 1830 and 1831, as instanced in his "Remarks on Canal Navigation, illustrating the advantages of steam, as a moving power, on canals." The preliminary experiments of light single and double gig boats on the Forth and Clyde canal, moved at a high rate of speed, and variously loaded, as well as the partial success of the steamer *Cyclops*, built under the direction of Mr. Grahame, of Glasgow, with a single stern paddle-wheel, induced Mr. Fairbairn to suggest the construction of a small steamer named the *Lord Dundas*, 68 feet in length by 11 feet 6 inches in depth, provided with a wheel thorough 3 feet 10 inches wide, and a paddle 9 feet in diameter, driven by a ten horse power steam engine; but he also recommends, as an after improvement, a steamer with two narrow paddles, close to the stern, one on each side of the rudder, urging that this plan would remove every impediment to the free access of water to the paddles, and allow an open outlet for the discharge, the paddles to be protected by fenders, sliding down on the outside of the wheels.

Mr. Fairbairn figures the cost of conveyance of a passenger by steamer, between Edinburgh and Glasgow, fifty-six miles, at two pence, or less than a fifteenth of the least possible expense by horses. Though the results given by these boats were not, in practice, so satisfactory as expected, yet Mr. Fairbairn never despaired of a future when steam should be as universal in inland navigation as it at present is in all other of the arts.

Following up the interest which about this period seems to have been excited on canal behalf, we have an influx of applications of machinery to inland water propulsion, many of which are but modified forms of the less elaborate devices we have already mentioned, in which the paramount idea of their authors would seem to be that of advancing the boat without creating a wash damaging to the canal banks, and with arrangements for discharging the water directly aft, or directly down, while some have curved platforms, or "wave quellers," to moderate the swell produced by the propeling machinery.

For actuating vessels on canals, one Henry Pinkus submits a railway constructed alongside, with one rail, on which a suitable carriage traverses. A tube conveys gas along the rail from a stationary engine and reservoir. The gas is brought through a longitudinal valve on the rail tube to a flexible tube from the carriage to a reservoir on board the vessel, and from the pressure here derived machinery is set in motion, which again, by an endless band, turns two horizontal wheels (one on each side of the rail) on shore, and supported on the carriage before mentioned. Finally, these wheels, by revolving, draw the carriage forward, and the carriage, in its turn, tows the vessel. We can imagine that this plan would never depend upon its simplicity for success.

The same inventor offers the plan of a steam engine on a vessel, driving a horizontal wheel, which, by an endless band, turns on shore a pair of horizontal wheels, similar to those described, and these, by revolving, tow along the vessel. The carriage holding these wheels has a curved guard arched over it, formed like the rail on which the carriage runs. This is to enable another carriage meeting it to pass over the first, thus providing for the use of the same rail by boats traveling in opposite directions. In place of the steam engine, the machinery on board may be turned by an electromagnetic engine, actuated by electric currents from on shore. Whether this "leap-frog" arrangement for passing boats could be extended to skipping playfully over the locks is not stated.

A claim, in 1841, proposes a locomotive steam engine on the towing path, to drag itself along a chain fixed at one end, and the boat by a towing line to the engine; while another alternately expands and contracts an elastic sack in a water channel along the bottom of the vessel, by the smoke from a furnace, and thus ejects sufficient water to propel the boat. Later on, there are variations of this. Still another drives an upright shaft in a vessel, which carries a horizontal grooved wheel, on which is an endless rope, moving a drum on a carriage on shore, by which its wheels are turned, so as to advance the carriage, which tows the craft along. The carriage is guided by a wheel in front, directed by a man. Steam is made to issue from a pipe against the air in one, and cogwheels, working into a rack rail on the banks, in another, while a third places an exhausted atmospheric tube at the bottom of the canal, and moves the boat above by a traveling piston. A fourth inventor makes his tubes of wood, and places them upon the banks, or on piles driven along the canal. In fact, "about this time," as the almanacs say, the numbers that considered themselves each the sole possessor of the idea of working canals by atmospheric pressure is amusing.

In 1847, we have flexible tubes placed under water on each side of a boat. They are alternately filled with steam and allowed to collapse. The boat is supposed to advance by the action on the water of the protuberant parts of each tube. There is certainly no needless complication of details about this. In this year we find proposed the towing of canal boats by compressed air contained in portable reservoirs, and an arrangement added to heat the air, in order to restore the caloric lost by its expansion.

The next year, a patent is granted for a tube laid along a canal, and water forced through it under pressure enters nozzle pipes fixed at certain intervals along the tube. Connected to the boat to be propeled is a receiver, with a series of open cells, and as these pass under the end of a nozzle pipe, a valve is opened, which allows the water to impinge on the cells successively, and thus force on the boat and receiver, until they set the next nozzle pipe in action, and close the valve of that which is passed. Still, notwithstanding the ingenuity of this scheme, one would desire much solicitation to invest in its success. Next, we have a shaft extending the entire length of the vessel, with propellers on its projections, working one at the bow and one at the stern. The advantages of this novel feature are not mentioned.

The last of 1851, a patent for fastening iron rails upon walings, supported on piles, and extending the entire length of the canal, on both sides, was issued. Wheels on each side of the boat, and driven by a steam engine, are rotated on these rails, and pull the boat. Instead of locks, the boat moves up inclined planes, gear wheels engaging in racks on the walings, while rollers at the bottom support part of the weight. Unless compensated for all variations of water level, we might expect to find occasional lines "high and dry."

In 1856, a provisional is filed for propelling boats by discharging a stream of fire from an inflammable composition in a tube into the water at the stern; but, from want of faith, or of means, the scheme was abandoned. At a later date, John Bourne patents an arrangement of propellers at the bow, or paddle wheels at the side, to work on the bottom in shallow water, "and thus clear it away," and propel the vessel.

With their usual ingenuity and perseverance, American inventors have explored this branch of engineering practice; but, like their trans-Atlantic brethren, have taken the question of more propulsion as the desired end, attaching thereto some device to still the agitation of the water; and very similar schemes in this field to those already touched upon, have been the result of their labors. The question is not that of a motive power alone, but simple application of the motor that will prevent waves at the bow, suction and settling at the stern, and afford a mean speed of from three to four miles per hour, when fully loaded, with a minimum quantity of fuel. The propeling machinery must be simple and compact, that it may be managed by men not especially educated for the purpose, and to economize both space and expense. These are the requisites, and a boat fulfilling the conditions will be sure of success.

Some twenty-five years ago, Captain Ericsson launched a boat with a screw propeller at each side of the bow, for the Champlain canal. There was no difficulty in the propeling force, but it did not carry sufficient cargo to be profitable. Henry R. Worthington, five years later, ran a steam canal boat from New York to Oswego, during one season. This vessel had a skew paddle wheel on each side of the bow, and a fighting crew, to overcome any prejudices which the opposition boatmen should venture to express. Notwithstanding the extreme force of the arguments employed, the enterprise was abandoned with the season, there not being sufficient capacity for a paying freight.

A boat was fitted with feathering side paddles, some sixteen years ago, by John Baird, for the purpose of towing barges on the Erie canal; but, not carrying cargo itself, and depending on the tunnage fees from the old boats, failed to be a pecuniary success.

In 1860, there was a line of sharp propellers built in Buffalo, N.Y., which, with an expenditure of from three to four tuns of coal per day, averaged six and seven miles per hour. The annoyances caused by the opposition of the horse boats, and the heavy expenses of fuel and engineers, caused their removal to a lake route. Wire rope traction and submerged chains have been frequently tried as well, and found wanting, the canal locks and numerous bends having so far proved insurmountable obstacles.

As late as last year, the duck foot, or expanding propeller, so many times tried in England, was attempted in Albany, N.Y., by Mr. Cornelius T. Smith, and also at Cumberland, Ind., by Mr. Marshall, without satisfactory results; while a Cincinnati doctor, abandoning his pills, conceived that he had hit upon the correct thing by the similar device of a reciprocating hinged shutter. The result made more noise and waves for the canal than greenbacks for his pocket, and our worthy disciple of Esculapius returned to his surgery.

At Lockport, N. Y., a wheel with spokes on the surface, made so as to rise and fall in a recess in the boat, and rolling along the bottom of the canal, was lately tried. It was driven by a chain, and so propelled the vessel. No provision for deep water or soft mud being made, the enterprise came to grief. A scheme now being tried consists of a canal tugboat provided with an endless band or chain on each side of the boat, carrying paddles, which, dipping in the water to propel the vessel, return through the air in a manner akin to similar plans which have been tried here and abandoned. There has been a large sum of money expended, and a frightful noise is produced, still, otherwise it is not considered a success.

## PROFESSOR TYNDALL ON "SOUND."

In his fourth lecture on "Sound," at the Royal Institution, London, Professor Tyndall began by calling attention to the experiments of Saveur, in which musical vibrations were communicated from one body to another, when both bodies had the power of emitting the same note. The lecturer exhibited two wires of the same length and thickness, stretched to the same tension by means of screws, so that the two wires when made to vibrate by means of a violin bow, emitted the same note. He then placed a V-shaped rider of cardboard astride one of the wires, and on causing the other wire to emit a musical note, the second wire took up the vibrations and unhorsed the rider. He recommended the listeners to make similar experiments for themselves, and said that if they would sing into a piano, they would find that the wire which emitted the particular note sang by the voice, would be thrown into a state of vibration, and if a little rider were placed upon the wire, it would be violently agitated.

He next exhibited Savart's experiment, wherein a musical sound is produced by means of a descending jet of water issuing from a circular orifice in a brass plate fixed at the end of a glass tube; the sound vibrations consist of the intermittent flow of the water through the orifice. He pointed out that a jet of water issuing through a small orifice, forms a vein for a short distance from the place of exit, and then breaks into drops, caused by the rhythmic action of the water through the orifice. In his next experiment Professor Tyndall permitted a vein of water to fall vertically from an orifice; then he darkened the theatre, and illuminated the vein by means of a thin beam of light sent down through it from the electric lamp. The vein of water then looked like a luminous spear, about twelve inches long, and below this the water broke into drops, and speedily lost its luminosity. These drops could be made visible by illuminating the falling jet of water from without, by means of a series of electric flashes. The lecturer sounded a syren, and when the musical note reached a sufficiently high pitch, the luminous vein of water began to respond to the sound, and the spear shortened itself to four or five inches, resuming its original length when the sound ceased. Musical beats, produced by means of two organ pipes, caused the luminous spear to lengthen and shorten itself. The lecturer then passed from a vertical to a horizontal jet of water, and made the latter plainly visible by illuminating it with the electric light, so that its shadow was thrown upon a white screen. At a certain distance from the orifice the stream of water broke into drops as before; the syren was then sounded, and when it reached the proper pitch the drops were drawn together, and the jet of water appeared as an unbroken cylinder of liquid from end to end.

Professor Tyndall next exhibited the action of sound upon jets of air, and mentioned the exceeding delicacy required in the manipulations, in consequence of the extreme sensibility of air jets. He was obliged to protect the jet from air currents by surrounding it with a tall glass jar, and he supported the apparatus on layers of flannel to protect it from vibratory motions connected with the building, as a passing cab would otherwise have caused much disturbance. He then, by means of pressure, urged some air, from a bag, through two bottles, one of which contained ammonia, and the other hydrochloric acid; a white smoke, consisting of chloride of ammonium was thus formed, and the jet of air was made visible to the whole audience, in consequence of its being charged with smoke. The jet of smoke laden air thus formed issued into the glass jar in a long, slender stream. An organ was then sounded, and the jet shortened itself at once from about fourteen to about four inches, and at the same became curiously forked, and did not lose this form all the time the sound continued, but resumed its original shape when the sound ceased. This jet responded at once to a slight tap upon the floor.

Next, the lecturer exhibited the action of sound upon naked gas flame. This action of sound upon flame was first noticed by Professor Lecomte, and was brought to its present state of experimental perfection in the laboratory of the Royal Institution. In the first experiment the lecturer caused a straight bushy flame to spread out, by whistling to it with his mouth, and pointed out that a smaller flame of the same kind would do the same thing, but required a higher note. A fish tail flame was also shown to be sensitive to sound, but required a higher note, and greater pressure of gas; in fact, in all these experiments the pressure of the gas must be very carefully regulated, and so adjusted that each flame is very nearly, but not quite, on the point of flaring instead of burning steadily. The most sensitive burner yet obtained by Professor Tyndall is one made of steatite; it requires a very heavy pressure of gas to bring the flame to the sensitive point, and it then gives a flame two feet long. The orifice is circular, and the jet a vertical one. A slight hiss from any part of the theatre of the Institution, made this flame shorten itself to seven inches, and the jingling noise made by shaking a bunch of keys threw the flame into wild commotion. A small bell sounded thirty feet off, in the gallery of the theater, knocked down the flame by the noise of every stroke, and a chirrup always brought it to its lowest point. Speaking irritated it especially words containing many S's, for it was especially sensitive to hissing sounds. The rustling of paper, the rubbing of hands, or the brushing of clothes, all made it shorter.

Notes of high pitch acted most powerfully on the flame. When a tuning fork was gently sounded, so as to give its fundamental note, no effect was produced; but when the fork was violently rubbed with the fiddle bow, so that it gave off overtones, the flame shortened itself, and began to flare. This tuning fork was one with a fundamental note of rather a high pitch. Finally, a musical box, playing an air from the opera of "Faust," was set to work; the high notes caused the flame to fall, while those of low pitch had no influence of the same kind.

The lecture was concluded with a few experiments on resonance, and the introduction of organ pipes. The lecturer observed that when a tuning fork was held over the open mouth of a glass cylinder containing air, when the column of air was of the right length to vibrate in unison with the fork it did so, and then, as the column of air and the fork both sang or vibrated together, a great increase in the volume of the sound produced was the result. When the column of air was made too long or too short for any particular fork, by pouring a certain quantity of water into the cylinder, or taking a certain quantity out, the sound was considerably enfeebled. In one of his experiments Professor Tyndall lengthened and the column of air by admitting