Specification of Samuel Hall : steam engines, boilers, furnaces, &c.;

Contributors

Hall, Samuel.

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SPECIFICATION

OF

SAMUEL HALL.

STEAM ENGINES, BOILERS, FURNACES, &c.

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Steam Engines, Boilers, Furnaces, &c.

HALL'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, SAMUEL HALL, late of Basford, in the County of Nottingham, and now of London, Civil Engineer, send greeting.

WHEREAS Her present most Excellent Majesty Queen Victoria, by Her Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the Twentieth day of February, in the eighth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Samuel Hall, Her especial licence, full power, sole privilege and authority, that I, the said Samuel Hall, my exors, admors, and assigns, or such others as I, the said Samuel Hall, my exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick upon Tweed, in the Islands of Jersey, Guernsey, Alderney, Sark, and Man, and also in all Her said Majesty's Colonies and Plantations abroad, my Inventions of "IMPROVEMENTS IN STEAM ENGINES, BOILERS, FURNACES, AND FLUES, IN CONSUMING FUEL, IN PREVENTING SMOKE, AND IN PROPELLING VESSELS;" in which said Letters Patent is contained a proviso that I, the said Samuel Hall, shall cause a particular description of the nature of my said Invention, and in what manner the same is to be performed, to be inrolled in Her said Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in part 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 Samuel Hall, do hereby declare that the nature of my said Inventions, and the manner in which the same are to be performed, are fully described and ascertained in and by the following description thereof, reference being had to the Drawings hereunto annexed, and to the figures and letters marked thereon (that is to say):—

I shall now state the objects and the nature of my several improvements in the order in which they are mentioned in the said Letters Patent.

First, the object and nature of my improvement in steam engines consist in the admission of injection water to all kinds of injection steam engines by means whereby it shall be so measured as to supply a given quantity of it to condense a given quantity of steam at whatever speed the engines may be working, and whereby the water shall be introduced into the condenser more or less frequently, according as the steam pistons are moving at a greater or less speed, and whereby also the injection water shall cease to flow altogether when the engines are brought from any cause whatever to a state of rest, and moreover the whole of the quantity of injection water required to condense a cylinder full of steam is admitted instantly into the condenser at the moment the steam is entering therein from the cylinder, instead of such injection water entering during the whole of the stroke of the steam piston; whereas by the common method of introducing the injection water, videlicet, by means of the uninterrupted pressure of the atmosphere and injection cocks or valves, it enters the condensers with the same velocity whether the engines are going at a quick or at a slow speed, or even when they are stopped, unless the injection cocks are carefully regulated or closed by hand, and the steam moreover enters in a continued stream during the whole of the stroke of the steam piston, instead of its entering in the requisite quantity suddenly at the commencement of each stroke of the steam piston, and none entering during the remainder of the stroke of such piston.

Second, the object and nature of my improvements in boilers consist, first, in an improvement in such boilers as have internal fires, which is intended to supply atmospheric air to such fires for the purpose of consuming the smoke and inflammable gases arising therefrom; second, in a particular arrangement of tubes, whereby so extensive a quantity of metallic surface is presented to the flame and heated gases resulting from the combustion of fuel as shall cause their caloric or heat to be given out to the water or other fluids surrounding them in boilers in a more complete manner than is commonly effected.

Third, the objects and nature of my improvements in furnaces are the increasing of their durability, and their efficiency in consuming the smoke and

inflammable gases arising from the combustion of fuel, being improvements upon my Patent for the "combustion of fuel and smoke," of the Ninth day of May, One thousand eight hundred and forty-two.

Fourth, the object and nature of my improvement in flues is the causing of the heat from the fires of dyers, bleachers, and many other kinds of boilers to be more uniformly distributed all around them, and the rendering of the ebullition of the water or other fluids contained in them more equable, this being a matter of much importance in boilers of the above-mentioned description.

Fifth and sixth, the objects and nature of my improvements in consuming fuel and preventing smoke are, first, the supplying of fuel in an uniform and regular manner to furnaces, and that without having frequently to open the fire doors for that purpose, whereby cold air is injuriously admitted, as is the case when fuel is supplied to furnaces by hand in the usual manner; second, in the forcing or drawing of air into and through furnaces and fire tubes or flues, in the quantity proper to consume correctly the gaseous as well as the solid parts of the fuel, and thereby prevent the nuisance of smoke.

Seventh and last, the object and nature of my improvements in propelling vessels are of two kinds, which I shall explain separately; the object of each of them is the superseding of the use of paddle wheels, screw propellers, and other similar apparatus at present in general use, and the nature of the first is the drawing of water into vessels and the projecting of it out of them into the water in which they are floating in a particular manner, so as to propel such vessels, and in some cases the projecting of air into water in a similar manner for the same purpose; and my second method of propelling consists in the applying of a vibrating plane or planes of a particular kind and in a particular manner, so as to cause them to press against the water in which vessels are floating, and thereby to propel such vessels not only forwards or backwards but sideways, and also to turn them round, and that in a space scarcely exceeding the length of the vessel.

Having stated the objects and nature of my improvements, I will now describe the apparatuses for putting of them in operation, in the same order as that in which they are herein-before enumerated. I shall now therefore describe, first, my improvement in steam engines.

Figure 1, Plate 1, and Figure 2, Plate 2, shew my apparatus for supplying the injection water to steam engines in the manner which I have already pointed out. Figure 1 is a horizontal plan of the apparatus taken from z, z, through Figure 2; and Figure 2 is a vertical section of it. a is a cylinder containing a piston a^1 for measuring and supplying the injection water to the engine. b, b, is an inlet pipe, furnished with two openings b^1 and b^2, and con-

taining two hollow circular slide valves c^1 and c^2, which are fixed upon a rod c^3, to which two tappets d^1 and d^2 are attached. By the ascending and descending of these valves the injection water is admitted into the cylinder a above the piston a^1, and below it alternately. e is another similar pipe, furnished with similar apertures e^1 and e^2, and similar valves f^1 and f^2, fixed on the rod f^3, to which the two tappets g^1 and g^2 are applied. By the working of these two valves the injection water is expelled from below and above the piston a^1 alternately into the condenser through the pipe e^3. The following is the order of the operation of this apparatus:—The arm c on the steam piston rod d having, on the termination of the down stroke of such piston, pressed upon the tappets d^2 and g^2, and having thereby lowered all the valves so as to close the apertures b^1 and e^2, and open the apertures e^1 and b^2, the piston a^1, which works freely through the arm c, is caused to rise by the pressure of the atmosphere, and expel the water in the cylinder above it through the aperture e^1, and through the hollow valves f^1 and f^2 and pipe e^3, into the condenser; after the above operation the steam piston rises, which is the direction in which it is moving, as shewn in Figure 2 by the arrow. On or near the termination of the upward stroke the arm c on the steam piston rod will strike against the tappets d^1 and g^1, and thereby reverse the situation of the valves in pipes b and e, closing the apertures e^1 and b^2, and opening the apertures b^1 and e^2, whereby the injection water underneath the piston a^1 will in its turn be forced through the latter aperture e^3 into the condenser by the pressure of the atmosphere on the piston a^1.

Second, my improvements in boilers are shewn in the same plates, videlicet, I. and 2, and the same Figures, videlicet, 1 and 2. Figure 1 is a horizontal section of them, taken from x to x, through Figure 2. j is a boiler, which contains three sets or systems of fire tubes or flues j^1, j^2, and j^3, a part of the latter projecting into the chimney K. Through these three sets of tubes the flame or heated gases evolved by the combustion of fuel in the furnaces pass successively in the direction shewn by the arrows, that is, first through the tubes j^1, then through the tubes j^2, and lastly through the tubes j^3. In order to cause the flame and heated gases to pass with sufficient velocity through such systems of tubes a stronger draught through them than that produced by a common chimney may be required. I therefore force or draw atmospheric air through them in the manner and by the means hereafter to be described.

Third, my improvements in furnaces are shewn by Figures 1, 2, 3, and 4, in Plate 4. Figure 1 is a vertical and longitudinal section of a stationary boiler and furnace, taken through their centre, to which my improvements are applied. Figure 2 is a longitudinal and horizontal section of the furnace, from

which the boiler is removed, being taken through Figure 1 from *a* to *a*. Figure 3 is a cross section taken through Figure 1 from a^1 to a^1; and Figure 4 is also a cross section taken through Figure I. from a^{11} to a^{11}. A is the furnace; B, the ash pit; and C is a plate at the end of the furnace, on which the scoria and other incombustible matters are deposited; it moves on an axle, and may be occasionally turned down so as to cause the matters deposited thereon to fall down into the ash-pit. D, D, is a main flue at the sides and back of the ash-pit, for the admission of atmospheric air into the furnace, and above the fuel. E, E, are openings on each side of the ash-pit, for the entrance of the air into such flues; and F is one of two sliding doors to admit it, and to regulate its entrance, and indeed to shut it off altogether when required. *h*, *h*, are square fire-bricks, which lay over the flue, resting upon each side of it; and *i*, *i*, are intermediate fire-bricks, of a somewhat triangular form, having communications with the main flue at *j*, *j*, to convey the air from it in jets through the small apertures *k*, *k*; these two bricks may be made in one brick, the triangular part joining to and projecting from the square part, and these I prefer when they can be procured, as they make the furnace sides much more firm and durable. G, G, is an air flue over the front of the furnace, being connected with the main flue D, D; and *l*, *l*, are holes to introduce small jets of air into and over the front of the furnace.

Fourth, my improvement in flues relates to the flues of particular sorts of boilers or pans herein-before mentioned, and consists in the application of two flues instead of one around them, the one causing the flame or heat from the fire to circulate towards the chimney from the right to the left, and the other, which is above it, causing them to circulate from the left to the right.

Figures 1 and 2, Plate 5, shew a boiler of the above description; Figure 2 being a horizontal section of it, taken from *y* to *y* through Figure I., and Figure I. being another section of it, taken from *z* to *z*, through Figure 2. A is the fire-place, and B the ash-pit. *a* is the entrance at the back of the fire-place to the uppermost flue a^1, a^1, viz^t, that which circulates from the right to left, as shewn by the arrows, and terminates in the chimney *b*; and *c* is the entrance to the lower flue c^1, c^1, which runs under flue a^1 from the left to the right, and also terminates below it in the chimney.

Fifth, my improvement in consuming fuel, as applied to furnaces, already described and shewn by Figures 1, 2, 3, and 4, Plate 4, will be explained by the following description:—*c*, *c*, are fire bars, which are stationary, and *d*, *d*, are others which are moveable in a backward and forward direction; there are on all these bars inclined planes *e*, *e*, the raised ends of which are at right

angles with the upper surfaces of the bars; these inclined planes are at about two inches distance from each other, and they are rather narrower than the upper surface of the bars from which they project, this being for the purpose of preventing as much as possible their breaking or grinding the fuel, or even the scoria, on their passage from the back to the front of the furnace, for it is desirable to prevent as much as possible either small particles of fuel, or even scoria, from dropping between the fire bars into the ash-pit, whereby a waste of the former would be caused, and the latter would be prevented from being deposited on plate C, for the purpose of being occasionally removed therefrom. On the front ends of the bars *d*, *d*, are cast or affixed the forks *b*, *b*; within these forks a revolving shaft *f* is placed, on which the excentrics *g* are fixed; by the revolving of this shaft the fire bars *d*, *d*, *d*, are moved backwards and forwards, and their motions are simultaneous, the excentrics being fixed on the shaft in a straight line; the bars may, however, be moved in any other order which may be preferred, by fixing the excentrics on the shaft in the proper positions to effect the movements of the bars in the order required; for instance, they may be placed so as to move half or any other number of them forward while the others are moving backwards, or the excentrics may be so placed as to move the bars alternately or otherwise; the best arrangement will in fact depend upon the kind of fuel that is used, and whether it is small or in large pieces, and a little experience will shew what is the best arrangement of the movements of the bars for each kind of fuel respectively. By means of this apparatus it is evident that the fuel in the furnace will be moved progressively forwards, i. e., from the front of the furnace to the back or bridge thereof, for the vertical ends of the inclined planes of the moveable bars *d*, *d*, will, during their forward motion, push the fuel forwards towards the furnace bridge, and the vertical ends of the inclined planes on the stationary bars *c*, *c*, will prevent it from being drawn backwards by the inclined planes of the moveable bars, for such planes will slide underneath the fuel without moving it, except in a trifling degree backwards. H is a hopper to contain the fuel for the supply of the furnace; g^1 is one end of it. *m* is a plate, which forms its back, and *n* is another plate, which is moveable on an axle, and between these two plates there is a space through which a quantity of air passes into the furnace, which enters through a number of apertures perforated in the upper side of the plate *n*, and passes underneath the plate *m*; this current of air prevents the two plates *m* and *n* from getting too hot, and it is considerably heated previously to its entering into the furnace by passing between them. *o* is another plate, which forms the front of the hopper; it moves on an axle, and may be lowered so as to lie in a horizontal position, and range in a line with the fire bars, or

it may be placed in any other position, and moveable at pleasure, by means of a ratchet wheel fixed on its axle, and a latch to drop into it, or this may be done by any other suitable means.

Figures 7, 8, 9, and 10, are Drawings of a locomotive engine with my machinery for supplying fuel to furnaces applied to it.

Figure 7 is a longitudinal vertical section taken through the middle of the engine.

Figure 8 is a cross section of it taken through Figure 7 from *a* to *a*. Figure 9 is another cross section of it taken from a^1 to a^1; and Figure 10 is a cross section of the furnace taken from a^{11} to a^{11}; the same letters are used to denote the different parts of the feeding machinery of the locomotive engine as are used in describing it as applied to a stationary furnace, A being the furnace; B the ash-pit; *c*, *c*, the fire bars, which are stationary, and *d*, *d*, those which are moveable in a backward and forward direction; and *e*, *e*, being the inclined planes for forwarding the fuel from the front to the back of the furnace. *b*, *b*, are the forks; *f*, the revolving shaft; and *g*, one of the excentrics for moving the fire bars *d*, *d*, backwards and forwards, as herein-before described. Figure 11 shews another kind of fire bar for supplying furnaces with fuel; it is round, with a projecting spiral upon it. b^1, b^1, are two of these bars, with the spiral running from the left to the right; on the ends of each of these bars a pinion is fixed, in which a worm *d* on the shaft *f* revolves; the teeth of these worms and pinions are cut in opposite directions, so as to turn bars b^1, b^1, to the right, and b^{11}, b^{11}, to the left, when the shaft *f* is put in motion, by which means it is evident the spiral will cause the fuel to proceed on the flat bars *a*, *a*, *a*, from the front to the back of the furnace.

Figures 12 and 13 shew a third kind of fire bar for supplying furnaces with fuel; it is round and has inclined planes upon and all around it to effect the same purposes as those already explained as performed by flat fire bars; the inclined planes are here shewn as affixed to the whole lengths of the bars; but there need only be inclined planes at the front ends of the bars, as shewn on the flat bars in Figure I., provided the fuel contain much sulphurous, vitreous, or other matters which adhere to the fire bars and cause them to require frequent cleaning; a little experience will shew how many inclined planes should be applied on the bars to work to the greatest advantage. The last-mentioned description of round bars have not only the backward and forward motions of the flat bars *d*, *d*, given to them, but they are at the same time turned round (as is the case with the spiral bars), this circular movement being intended to keep them from getting too much or unequally heated by the fire; the double movement of the above-mentioned round bars will be obvious by inspecting

the Drawings, Figures 12, and 13; *f* being a revolving shaft fixed in a moveable carriage *h*, with the excentric *g* upon it, causing the backward and forward movements; and the worm *i*, which is also placed on shaft *f* working in the pinions *j*, *j*, on the ends of the bars, gives them the circular motion at the same time that they are moving backwards and forwards.

Sixth, my improvements in preventing smoke consist of the combination of my improvements in furnaces and in consuming fuel.

Seventh, my first improvement in propelling vessels is shewn in Plates I., 2, and 3; the parts of this apparatus which I shall first describe in order to render the further description of this improvement more intelligible are the two chambers p^1 and p^2 formed on the outside and bottom of a vessel, being separated by a stop *q* between them; and each of them has a long narrow aperture r^1 and r^2, the first pointing towards the stern, and the latter toward the head of the vessel; and the widths of these apertures may be adjusted so as to admit and expel the streams of water into and out of chambers p^1 and p^2 at such velocities as experience may point out to be the best; this is done by moving the plates s^1 and s^2 by the rods t^1 and t^2. This method of propelling consists in drawing water into one of the chambers p^1 and p^2, and forcing it out of the other with great velocity against a column of water, the altitude of which depends upon the depth which those chambers are below the surface of the water in which the vessel is floating; it will be obvious, that when the water is drawn into chamber p^2 through the aperture r^2, which points towards the head of the vessel, and forced out of chamber p^1 through the aperture r^1, which points towards the stern, the vessel will be propelled in a forward direction; and when the entrance of the water into and its exit out of the chambers are reversed the vessel will be propelled astern.

I shall now proceed to describe the apparatus whereby the above operations are performed. C is a steam engine cylinder with a piston working within it, the rod whereof *d* is attached to the cross head D; there are two other cylinders E, E, which are also furnished with pistons working within them, the rods whereof *k*, *k*, are also attached to such cross head; the arrangement of cylinders and the system of valves about to be described are intended to act in the double capacity of a pneumatic and hydraulic apparatus, i. e., not only to pass currents of water through the chambers above mentioned, but also to pass currents of air through the furnaces and flues, and cause such currents of air to perform operations which will hereafter be pointed out.

I shall now describe the other parts of the above pneumatic hydraulic apparatus, and explain the manner in which it acts to effect the processes I have mentioned. The steam cylinder C is provided with steam valves, which may

be of any convenient and well-known description; they are not shewn in the Drawings, as they form no part of the present Invention. It is, however, necessary to describe the system of valves applied to the cylinders E, E, and explain how they act in passing streams or jets of water through the above-mentioned chambers p^1 and p^2 and the manner in which their entrance and exit are reversed; to change the direction in which the vessel is propelled, when required, a box F is connected by pipes u, u, to the lower ends of both of the cylinders E, E; on the sides of this box two cylinders G^1 and G^2 are attached; the box is connected with the cylinder G^1 by an inlet pipe into it leading from box F, furnished with a valve l^1, and an outlet pipe with a valve l^2, and the box F is connected with cylinder G by a similar inlet pipe with a valve m^1, and outlet pipe with valve m^2; within cylinder G^1 is a hollow cylindrical slide valve n^1, and within the other cylinder G^2 is a similar valve n^2; these cylindrical valves are for the purpose of passing streams of water into chamber p^1, and out of chamber p^2, or in the reverse direction, viz^t, into p^2, and out of p^1. In the situations in which these cylindrical valves are shewn in the Drawings the currents of water produced by the working of the pneumatic hydraulic apparatus will be in the latter direction, videlicit, they will enter into chamber p^2, and make their exit through chamber p^1; for the current of water will flow in the following direction; videlicet, first through chamber p^2 and pipes o^4 and o^3; then through the apparatus in the following order, videlicit, first through cylinder G^2, then through valve m^2, box F, valve b^1, cylinder G^1, and then through the circular hollow valve n^1, and pipes o^1 and o^2, into chamber p^1, from whence it will be forced through the passage r^1 into the water in which the vessel is floating. When the hollow circular valves n^1 and n^2 are reversed, viz^t, when the former is raised and the latter is lowered, the current of water will be reversed, for the apertures b^2 and m^1 will be opened, and the apertures b^1 and m^2 will be closed, whereby it is evident that the water will enter at the apertures r^1 into chamber p^1, and find its way through the above-mentioned pipes, cylinders, and box to and through the chamber p^2 and aperture r^2 into the water.

I will now proceed to describe the action of the above-mentioned apparatus, so far as it operates in its pneumatic capacity. In this capacity it is intended to pass currents of atmospheric air through the fires and fire flues, or tubes of my improved furnaces and boilers; this is done in two ways, videlicit, first, by the forcing of such air into closed ash-pits, and through the fires and fire tubes, in the manner shewn in the Drawings; and, second, by drawing it through them, (if I may so express myself,) which is effected by exhausting or drawing away the gases resulting from the combustion of the fuel from the

upper ends of the third or last set of fire tubes, thereby producing in them a partial vacuum. When the forcing process is adopted the air may be drawn by the hydraulic pneumatic apparatus from the top of the engine room (by which it will be ventilated) through pipe *r*, and forced through pipes *s*, *s*, and branch pipes *t*, *t*, into the closed ash-pits B, B, and through the fires, and from thence the gases arising from the combustion of the fuel will be passed through the fire tubes j^1, j^2, j^3, into the chimney K, from whence they may escape into the atmosphere in the usual manner, or they may by shutting the damper *m* be made to pass away through pipe *n* in a horizontal or any other direction, and make their exit at any place that may be preferred. When this process is adopted, and it is required to get access occasionally to the ash-pits to clean them out, or for any other purpose, the currents of air should be stopped off from them and turned into the chimney; for this purpose, there is a valve box *v*, containing two valves v^1 and v^2, shewn by dotted lines, and when they are placed in the situations here shewn, the air is forced into the ash-pit, and through the fires and fire tubes in the manner above described; but when valve v^1 is opened and valve v^2 is closed the air will be forced into the chimney through pipe *w* without passing into the ash-pit, furnace, or fire tubes; but still an ample quantity of air will be drawn through them by the current of air projected into the chimney, in which it causes a considerable draught, so considerable indeed that it may be desirable in some cases to draw the air through the furnaces altogether by this method, in preference to forcing it through them, as herein-before described. But when the above-mentioned method of creating currents of air through the furnaces and flues by exhaustion is adopted, the ash-pits must be opened and the damper *m* must be closed, and the pipe *n*, instead of conveying the gases away from the chimney, must be connected with the inlet pipe *r* to the pneumatic hydraulic apparatus, and the gases drawn in by it may be forced through pipe S into the water or the atmosphere as may be preferred. The way in which the pneumatic hydraulic apparatus acts in its former capacity is as follows: the air and gases, as the case may be, are drawn into and expelled out of the cylinders E, E, above the pistons, in same manner as is done with water below the pistons; for this purpose, each of those cylinders has a valve box H attached to and communicating with it, which box is furnished with an inlet pipe *r* and an inlet valve r^3, and with an outlet pipe *s* and an outlet valve s^3. On the descent of the pistons the air or gases, as above described, are drawn into the cylinders through the pipes *r*, *r*, and the valves r^3, r^3, and on the ascent of the pistons they are expelled through the valves s^3, s^3, and the pipes *s*, *s*, the air being sent into the ash-pits or otherwise, and the gases into chambers at the bottoms of

vessels similar to chambers p^1 and p^2, or such gases may be expelled in any other convenient place.

I will now proceed to describe my second improvement in propelling vessels, which consists in the use of vibrating planes, plates, or floats, which are fixed on an axle or shaft, on which they vibrate backwards and forwards so as to perform such an arc of a circle as experience may shew to be the best. I find that the plates vibrating to the extent of from forty-five degrees to sixty degrees of a circle act very well; the operation of these plates or floats is, that by vibrating on their axle from the right to the left, and vice versâ, alternately they press against the water, and the water in its turn presses against them in a direction forming an acute angle with the line in which the propeller is acting and in which the vessel is proceeding, which angle of pressure is calculated to propel such vessel in a powerful manner. Figures 1, 2, 3, 4, 5, and 6, Plate 6, shew the various parts of my vibrating or universal propellers. I call them universal propellers, because as already stated they will not only propel the vessel ahead and astern, but sideways, and around. A, Figures 1 and 2, shew a vessel to which such propellers are applied. a^1 and a^2 are vibrating planes, plates, or floats attached to the vertical shafts b^1, b^2, which are placed at the two quarters of that vessel, and such shafts are supported by and turn upon suitable bearings; and a^3 and a^4 are similar vibrating planes, being attached to similar shafts b^3 and b^4, the same being placed at the bows of the vessel. c^1, c^2, c^3, and c^4, are arms fixed on and projecting from the shafts above mentioned; and these arms are respectively connected by the rods d^1, d^2, d^3, and d^4, to the cranks e, e; these cranks are fixed to the ends of the shaft f, which is driven by steam or any other suitable power; by this arrangement of machinery the revolving of the cranks imparts a vibrating motion to the planes or plates, whereby the vessel is propelled in any required direction, which will be effected by placing the inclined planes in the requisite positions. When they are placed in the positions (being at one extreme of their vibration) shewn in the Drawing, the vessel will be propelled ahead; and when they are reversed, it will be propelled astern, and, in fact, each vibrating plane propels in the direction of a line bisecting the arc in which it vibrates towards its centre of vibration, from which it will be easily understood in what positions the planes must be placed, not only to propel the vessel ahead or astern, but sideways and around as if turning on a pivot. The methods of placing these vibrating planes in their proper positions, and altering them at pleasure, are shewn by Figures 3, 4, 5, and 6, Plate 6, which are drawn to a larger scale than the other Figures. a is the head of the shaft of the vibrating propeller;

the upper part of this head is square. *b* is an arm by which it is moved; the arm is formed with a horizontal recess or cavity *c*, *c*, in which a spur wheel *d* is fixed, which acts as a ratchet wheel; this wheel has a square eye or hole in its centre, whereby it is fixed on the square part of the head *a* of the shaft, but the eye or hole of the arm is round, so as to allow it to turn round upon the shaft. e^1, e^2, are two palls inserted in the hollow part of the arm, and they act in opposite directions upon the teeth of the ratchet wheel *d*. f^1 is a cam fixed on the spindle *g*, to which a handle *h* is applied; by turning this spindle the cam may be made to act upon either of the palls so as to disengage either of them from the ratchet wheel; when the cam is in the position shewn in the Drawings both of the palls will be pressed upon the ratchet wheel by the springs *i*, *i*, by which means the arm *b* will be firmly fixed upon the shaft of the vibrating planes; when the position of the vibrating planes or plates are required to be altered, that is effected by disengaging one of the palls from off the ratchet wheel by means of the cam f^1, according to the direction in which the planes are required to be moved; for instance, if the vibrating plane be required to be moved from the right to the left, the right-hand pall must be displaced, and, vice versâ, if the plane be required to be moved from the left to the right, the left-hand pall must be removed. *k* is a conical collar fitted upon the square part of the shaft, and serving as a centre or bearing for the upper eye of the arm. *m* is the pin, to which one end of the connecting rod from the driving crank is attached; it is made spherical to allow of the deviation of the rod from a direct line owing to the motion of the crank to which the other end of the connecting rod is connected.

Having fully described the objects and nature of my Inventions, and the apparatus and machinery for putting them into operation, I will now proceed to state the extent of my claims.

First, I claim as my improvement in steam engines the measuring of the injection water to them so as to supply a given quantity of it to condense a given quantity of steam, whether the engines are working at a slow or a rapid speed, and to arrest without manual labor the supply of such water altogether when the engines are brought to a state of rest, and when of course no steam is passing through them to require condensation.

Second, I claim as my improvements in boilers the application of more than one length or set of fire tubes through which the flame or heated gases produced by the combustion of fuel shall successively pass until they have given out their caloric or heat to a satisfactory extent to the water or other fluids by which they are surrounded. And I claim in combination with the use of two

or more successive sets of fire tubes the means of causing by propulsion or exhaustion the passage of a sufficient quantity of atmospheric air through the furnace.

Third, I claim as my improvements in furnaces the use of intermediate fire-bricks between the triangular bricks and jet holes extending across the main air flues, as herein described, to protect the walls which divide the flue from the furnace at each side and end thereof; and I claim the application of jets of air over the front of the furnace in combination with the jets at the sides and back of the furnace, these being improvements, as already stated, in my patent apparatus of May the Ninth, One thousand eight hundred and forty-two.

Fourth, I claim as my improvement in flues the application of two or more flues around boilers, one flue above another, and circulating in contrary directions from the fire to the chimney.

Fifth and sixth, I claim as my improvements in consuming fuel and preventing smoke, first, the use of inclined planes or screws, or other suitable projections on fire bars, for effecting the operations of supplying furnaces with fuel in an uniform and continuous manner, and for conveying away from them the scoria and other incombustible matters, whether such bars revolve or move backwards and forwards, or both, or whether a part of them are stationary while the others are in motion. Second, the method herein described of passing atmospheric air into the furnace between the plate forming the front thereof and the moveable plate at the back of the hopper for supplying fuel, this stream of air being for the double purpose of keeping those plates cool, and of heating such air for the consumption of the smoke and inflammable gases previously to its entering into the furnace and sweeping over the fuel. Third, I claim the application of moveable plates to form the front and back of the hoppers for supplying fuel to furnaces, for the purpose of giving more easy access to the furnaces than would be the case if those plates formed a part of the hopper and were immoveable. Fourth, I claim the method herein described of forcing air through furnaces, in combination with the method of changing its direction and causing it to enter either into the ash-pit or chimney, as required. Fifthly, I claim without such combination, the injection of air into the chimney to produce currents of air through furnaces. Sixthly, I claim the forcing of air into furnaces above the fuel as well as below it, by branches from *w*, connected with a closed chamber around the furnace, and with jet holes around them, similar to those shewn around the locomotive engine furnace in Figures 7, 9, and 10, Plate 4.

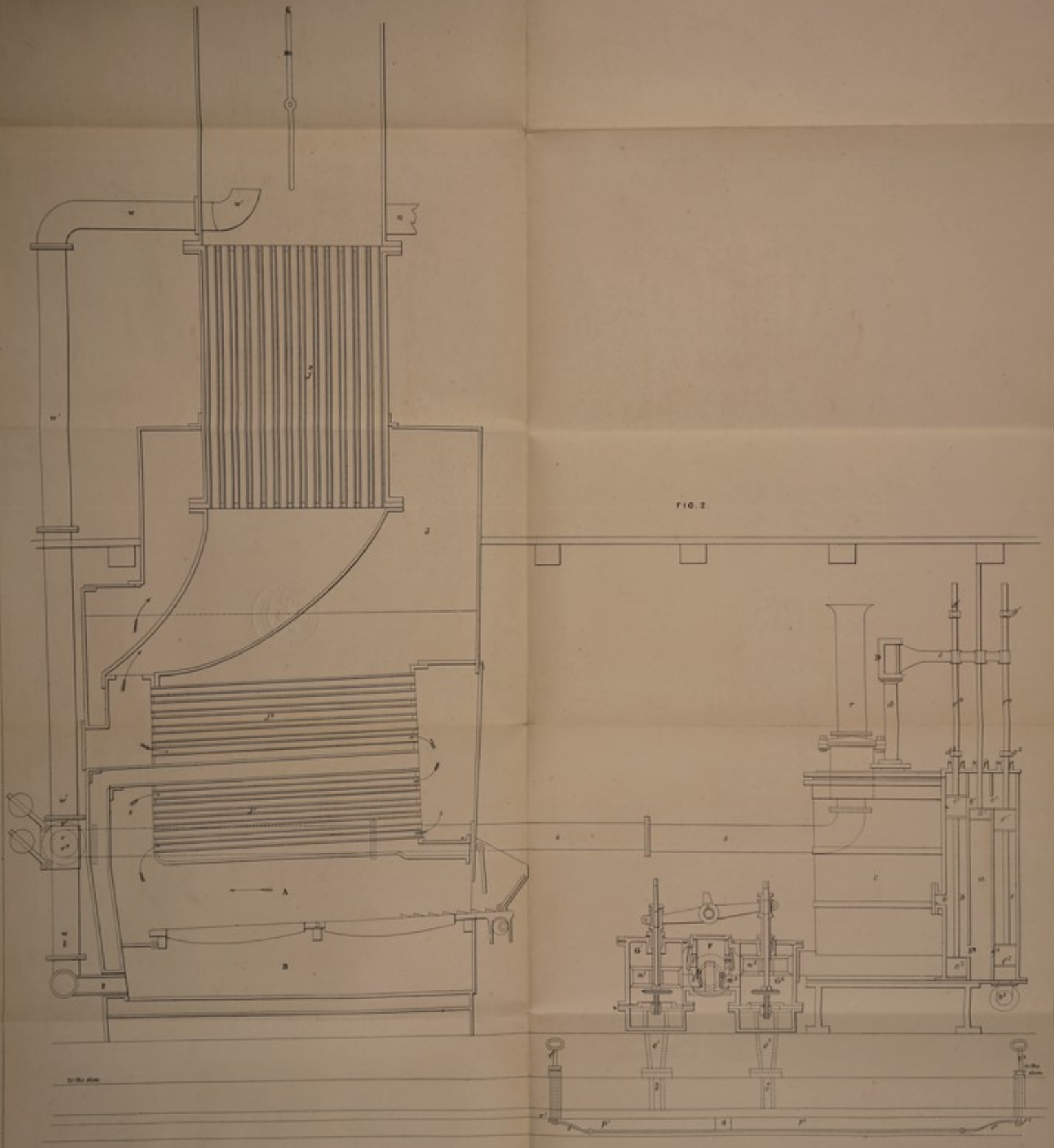
Seventhly, my general claim, as far as relates to my first improved method of propelling vessels, consists of the threefold combination of the projection of a sufficient quantity of water, which is shewn by the relative size of the steam and other cylinders herein described, at a sufficient velocity, videlicet, at about five times the velocity that it is passed through the hydraulic pneumatic cylinders, as stated hereafter, against a sufficiently high column of the water in which the vessels float, to propel them with great speed and advantage. My particular claims relating to the above-mentioned method of propelling vessels consist, first, in the drawing in and forcing out of streams or jets of water through chambers fixed at the bottoms or lowest parts of vessels, and at or near the middle or centre of gravity thereof, as herein described, in order that even when the vessel is violently pitching the column of water shall not be reduced, as would be the case if the propelling water were drawn in and forced out at the stem and stern of the vessel; such streams or jets of water being passed at the rapidity and against a column of water of the altitude contemplated in my above-mentioned general claim, which I shall now more particularly explain. The currents of water through the openings into the two chambers should be at least equal in velocity to that of the periphery of a suitable paddle wheel, or, in other words, the water should pass into and out of those openings into the chambers with at least five times the velocity that it passes through the pneumatic hydraulic cylinders; the aggregate area therefore of the inlet openings as well as that of the outlet openings should be equal to only one fifth part of the united area of both those cylinders. My second particular claim consists in the apparatus I have described for reversing the direction of the streams of water for the purpose of propelling vessels by converting the inlet openings into the outlet openings, and vice versâ, at pleasure, as herein-before described. My third particular claim consists in the forcing of air in some cases against columns of water through chambers similar to those herein described. My fourth particular claim consists in the pneumatic hydraulic apparatus which I have described, in which the same cylinders are used for the double purpose of creating currents of air and currents of water, and whereby any extraneous matters which may enter with the water does not pass the piston, as such water passes through the cylinders below such pistons, and thus injury to the cylinders by such extraneous matters is avoided.

My claims, as far as they relate to my second improved method of propelling, consist, first, in the use of vertical planes vibrating in horizontal arcs for propelling vessels in any required direction, as herein-before described, and I claim them, whether placed at the head, stern, midship, or other part of the vessel.

A.D. 1845. Feb 20. N° 10,531.
HALL'S SPECIFICATION.

PLATE I.

FIG. 2.



The enrolled drawing is partly coloured.

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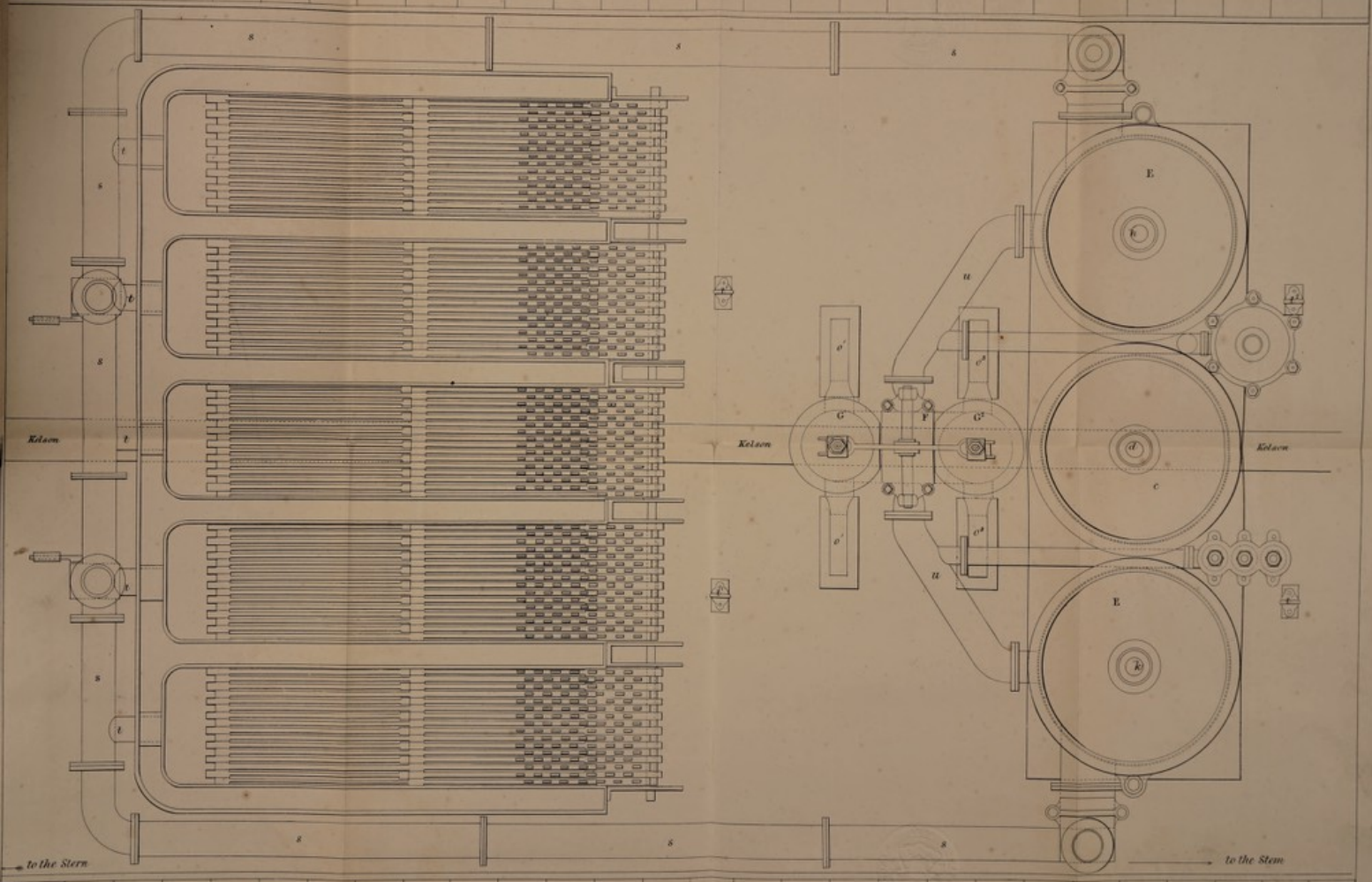
Printers to the Queen's most Excellent Majesty. 1858.

A.D. 1845. Feb 20. N° 10, 531
HALL'S SPECIFICATION.

6 SHEETS
PLATE. 2.

PLATE. 2.



The enrolled drawing is partly colored.

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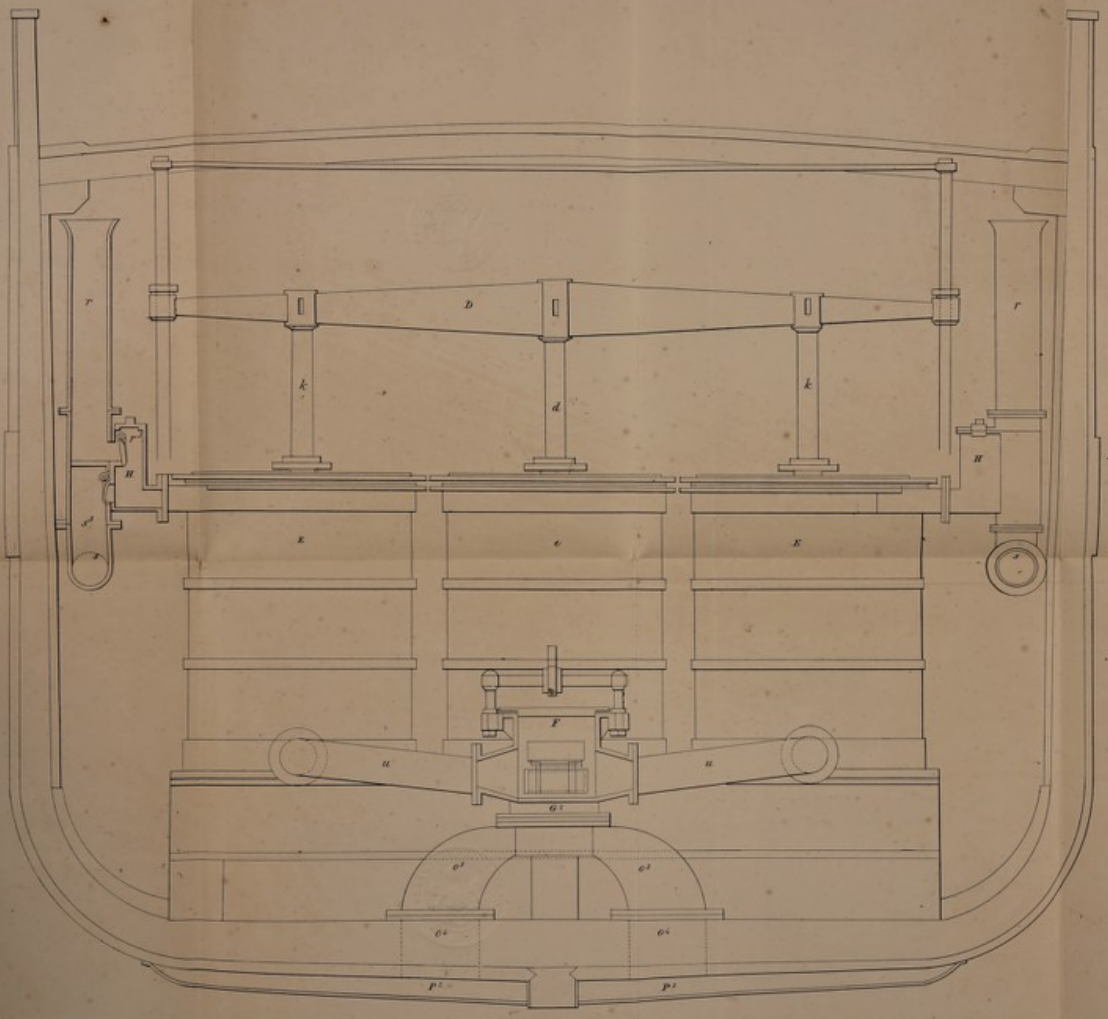
Malby & Sons, lith.

A. D. 1845. February 20. N° 10,531.
HALL'S Specification.

(6 SHEETS)
PLATE 3.



The enrolled drawing is partly colored.

Malby & Sons lith.

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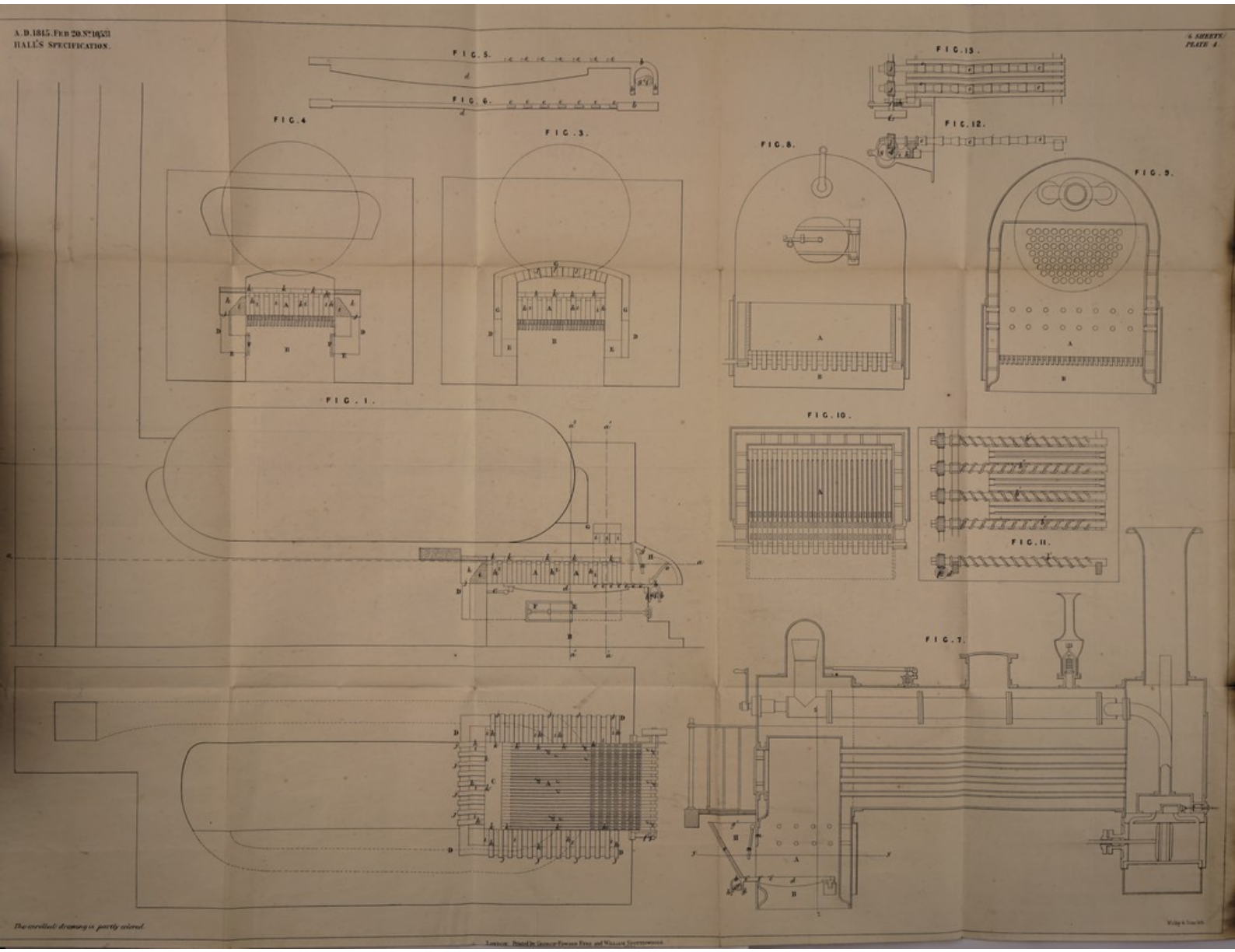
Printers to the Queen's most Excellent Majesty. 1845.

A.D. 1845. Feb 20. N° 10531
HALL'S SPECIFICATION.

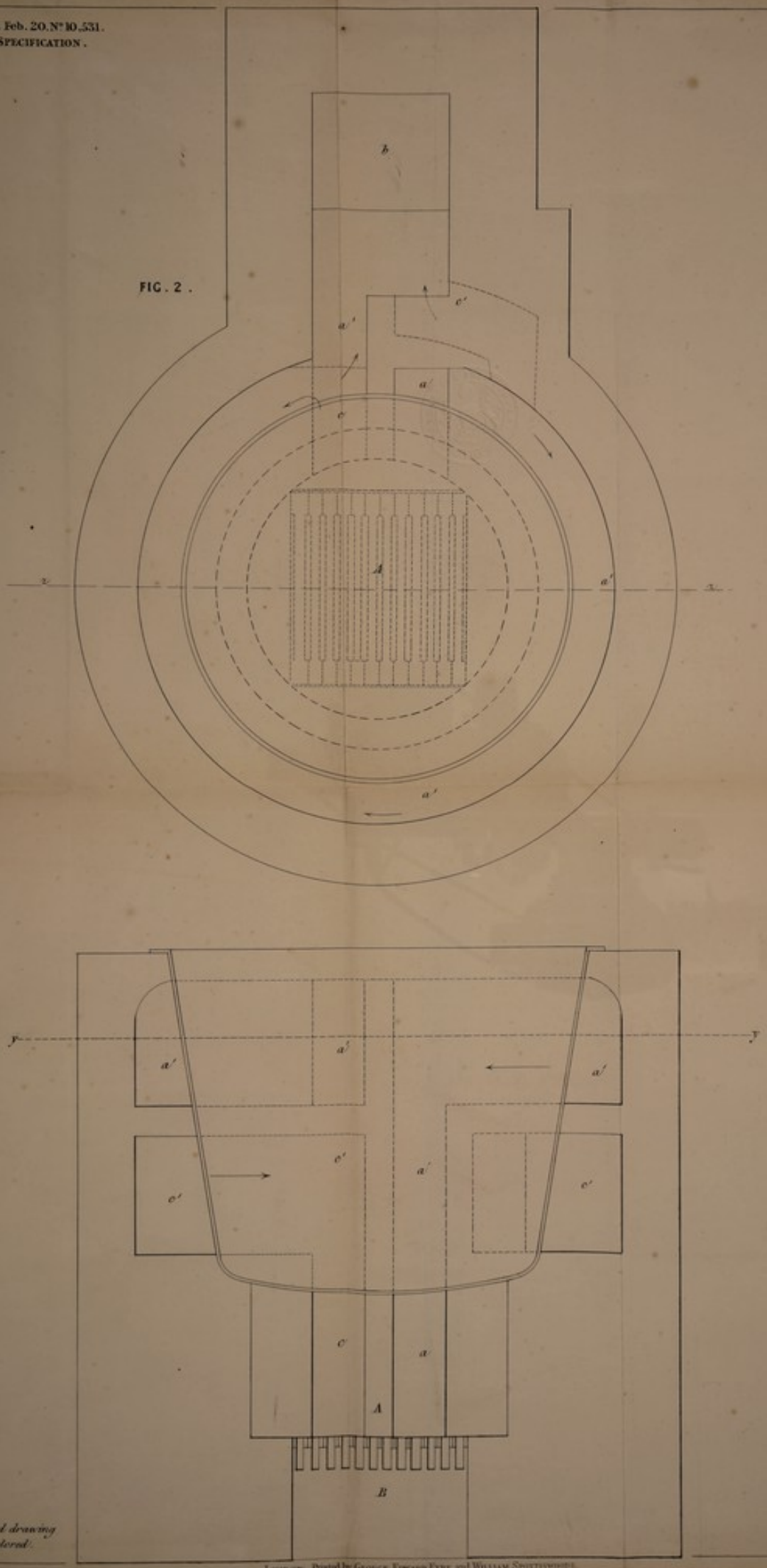
6 SHEETS
PLATE 4.



The enrolled drawing is partly colored.

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE.

FIG. 2.



The enrolled drawing to partly altered.

Malby & Sons, Litho

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A.D. 1845. Feb 20. N° 10,531.
HALL'S Specification.

6 SHEETS
PLATE 6.

FIG. 4.

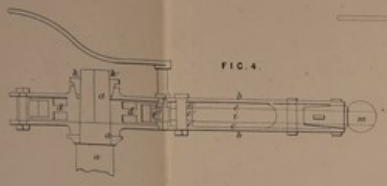


FIG. 5.

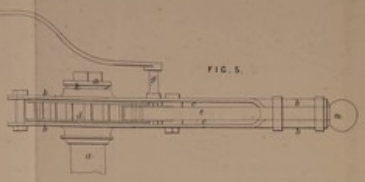


FIG. 3.

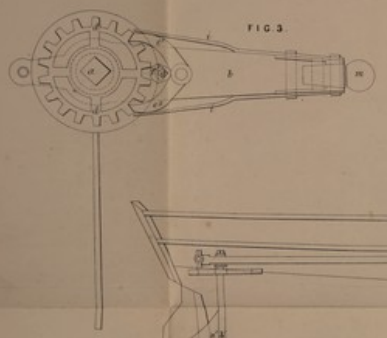


FIG. 6.

FIG. 2.

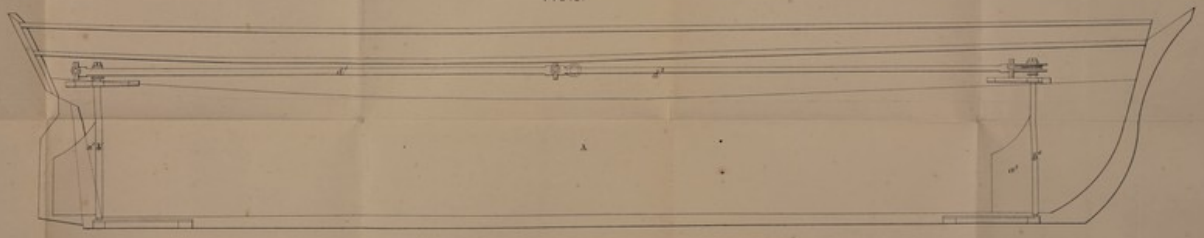
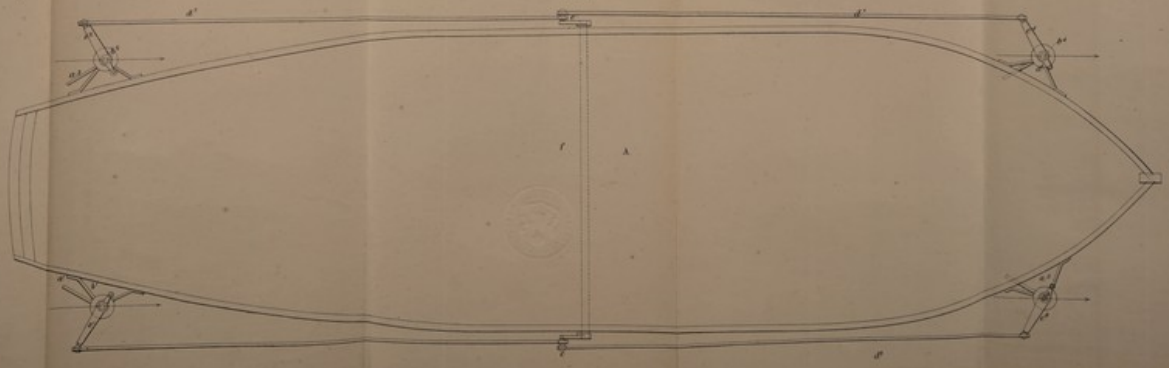


FIG. 1.



The certified drawing is partly colored.

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Second, I claim the method herein described of changing the position of the vibrating planes for the purpose of altering the course of the vessel while the engines are at work and without stopping them.

In witness whereof, I, the said Samuel Hall, have hereunto set my hand and seal, this Twentieth day of August, in the year of our Lord One thousand eight hundred and forty-five.

SAMUEL (L.S.) HALL.

AND BE IT REMEMBERED, that on the Twentieth day of August, in the year of our Lord 1845, the aforesaid Samuel Hall came before our said Lady the Queen in her Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained and specified, in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute made for that purpose.

DREW.

Enrolled the Twentieth day of August, in the year of our Lord One thousand eight hundred and forty-five.

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Printers to the Queen's most Excellent Majesty. 1854.