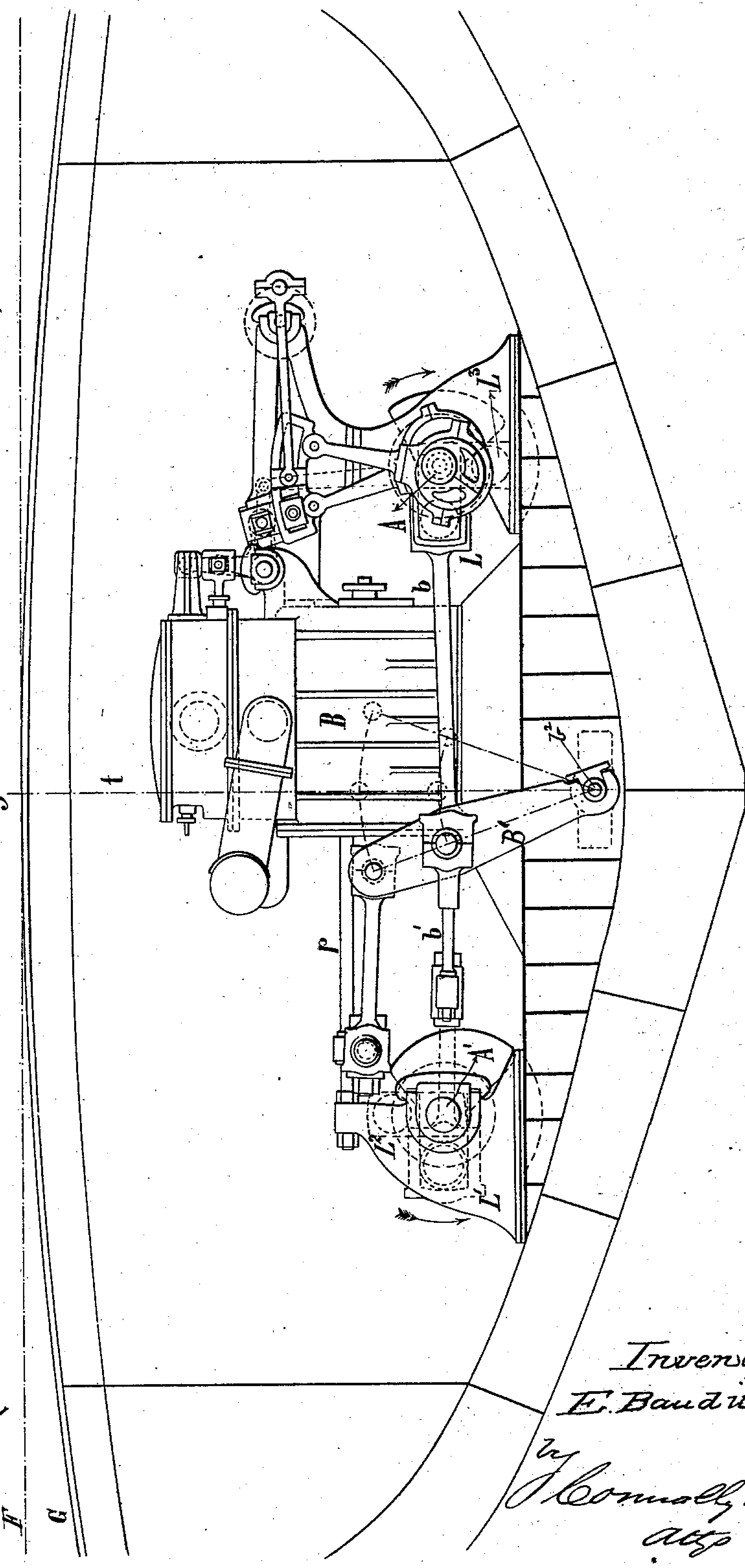
(No Model.) 4 Sheets—Sheet 1.

E. BAUDUIN.

ENGINE FOR TWIN SCREW VESSELS.

No. 315,381. Patented Apr. 7, 1885.

Fig. 1



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4 Sheets—Sheet 2.

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ENGINE FOR TWIN SCREW VESSELS.

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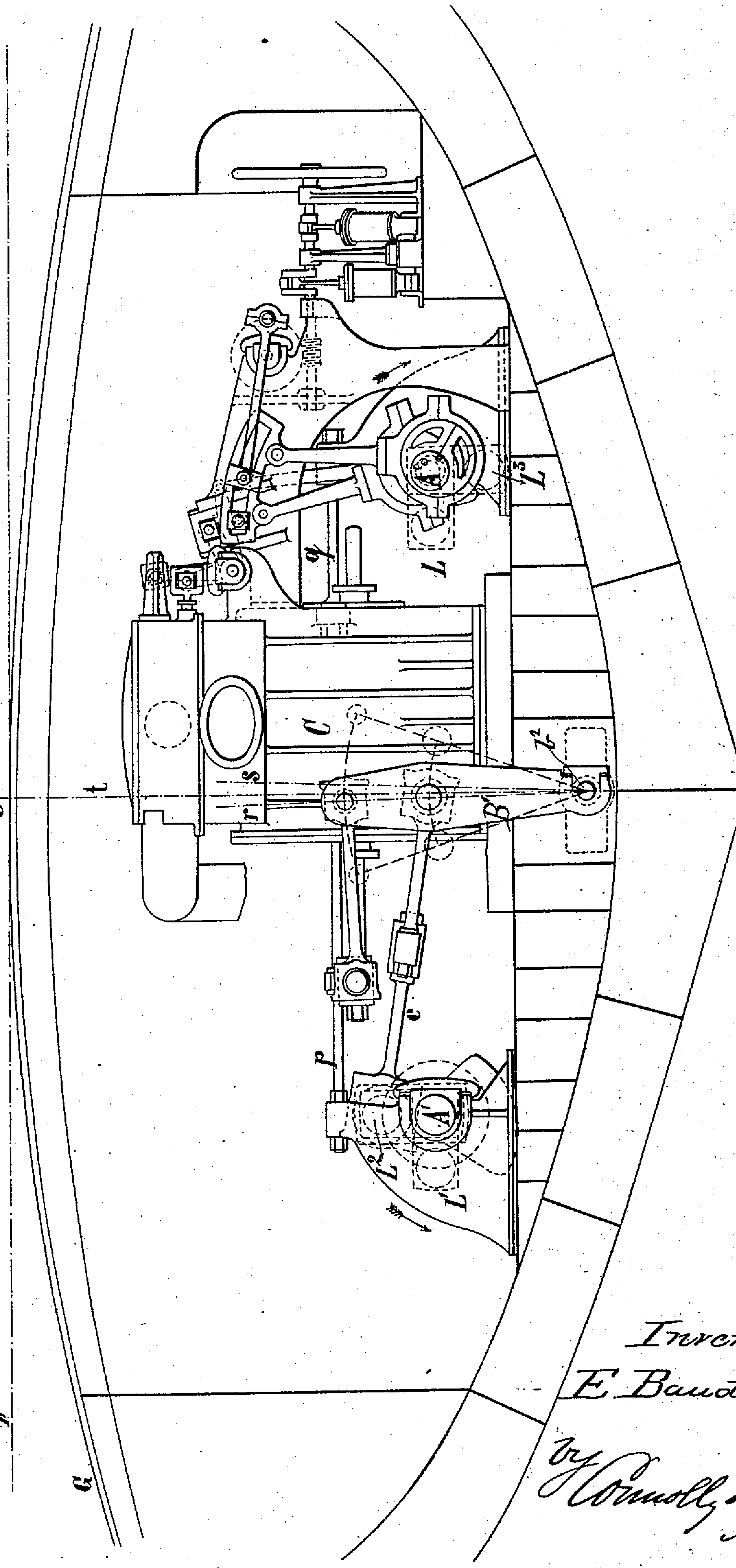
Fig. 2



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ENGINE FOR TWIN SCREW VESSELS.

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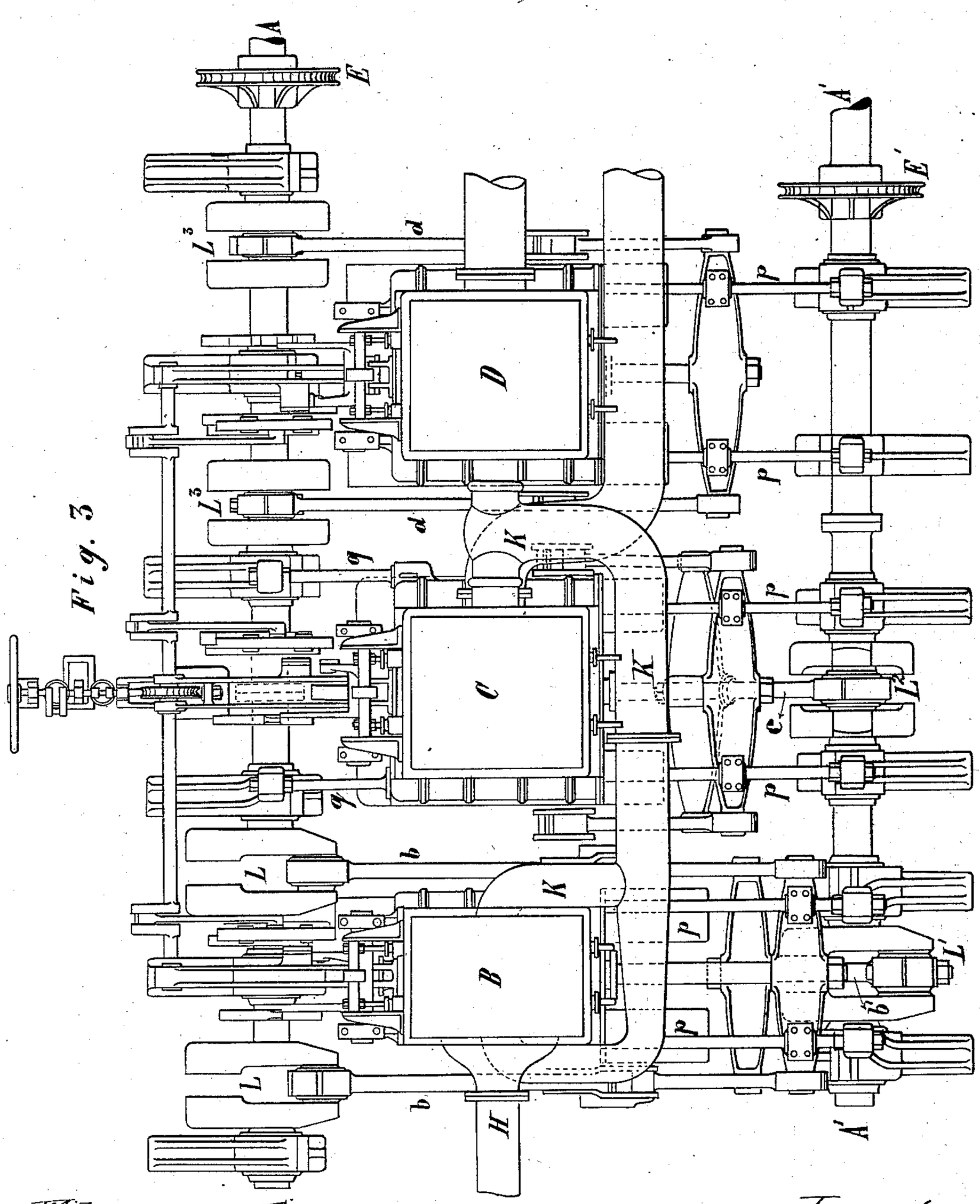

Fig. 3.

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ENGINE FOR TWIN SCREW VESSELS.

No. 315,381. Patented Apr. 7, 1885.

Fig. 4

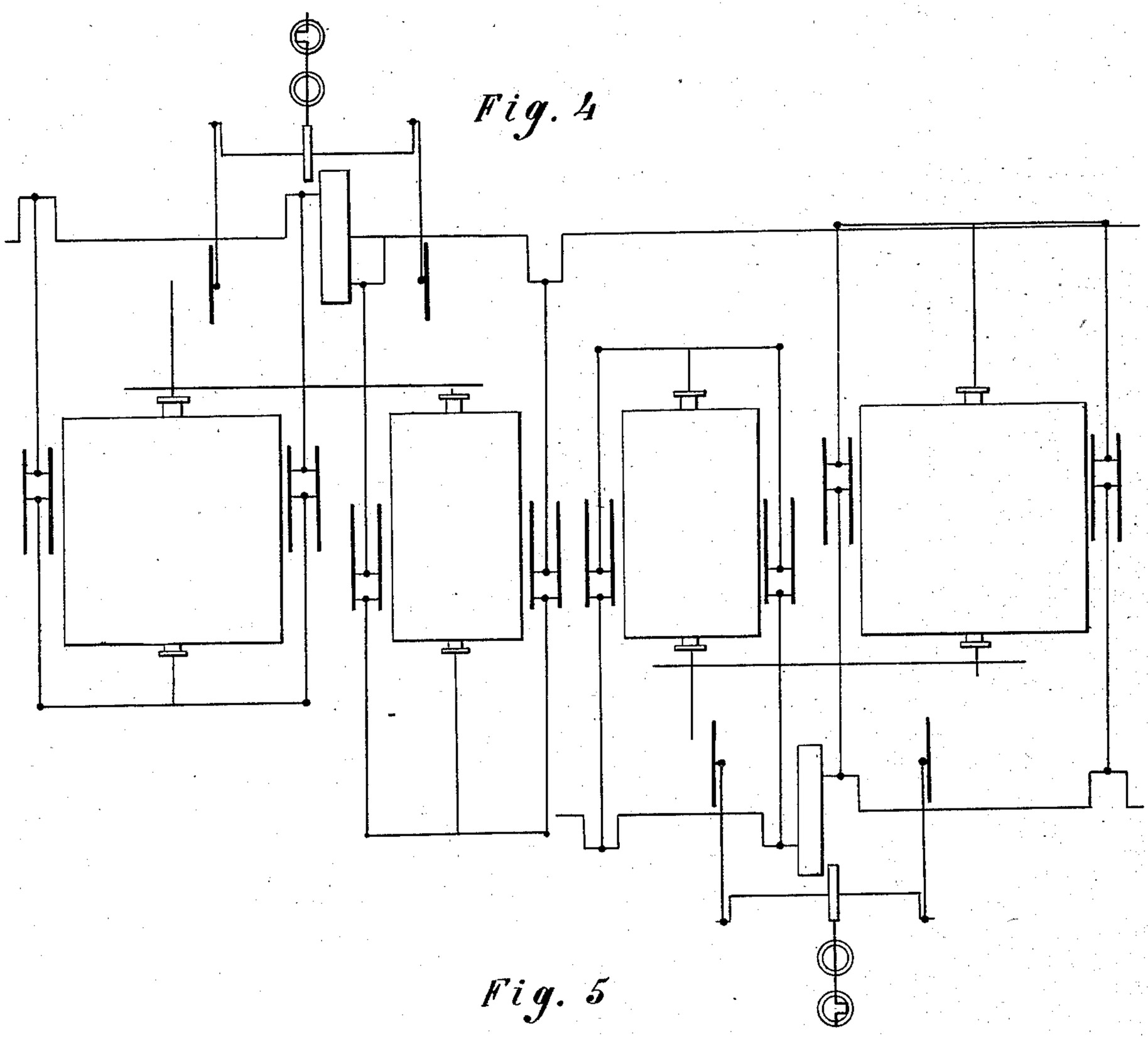
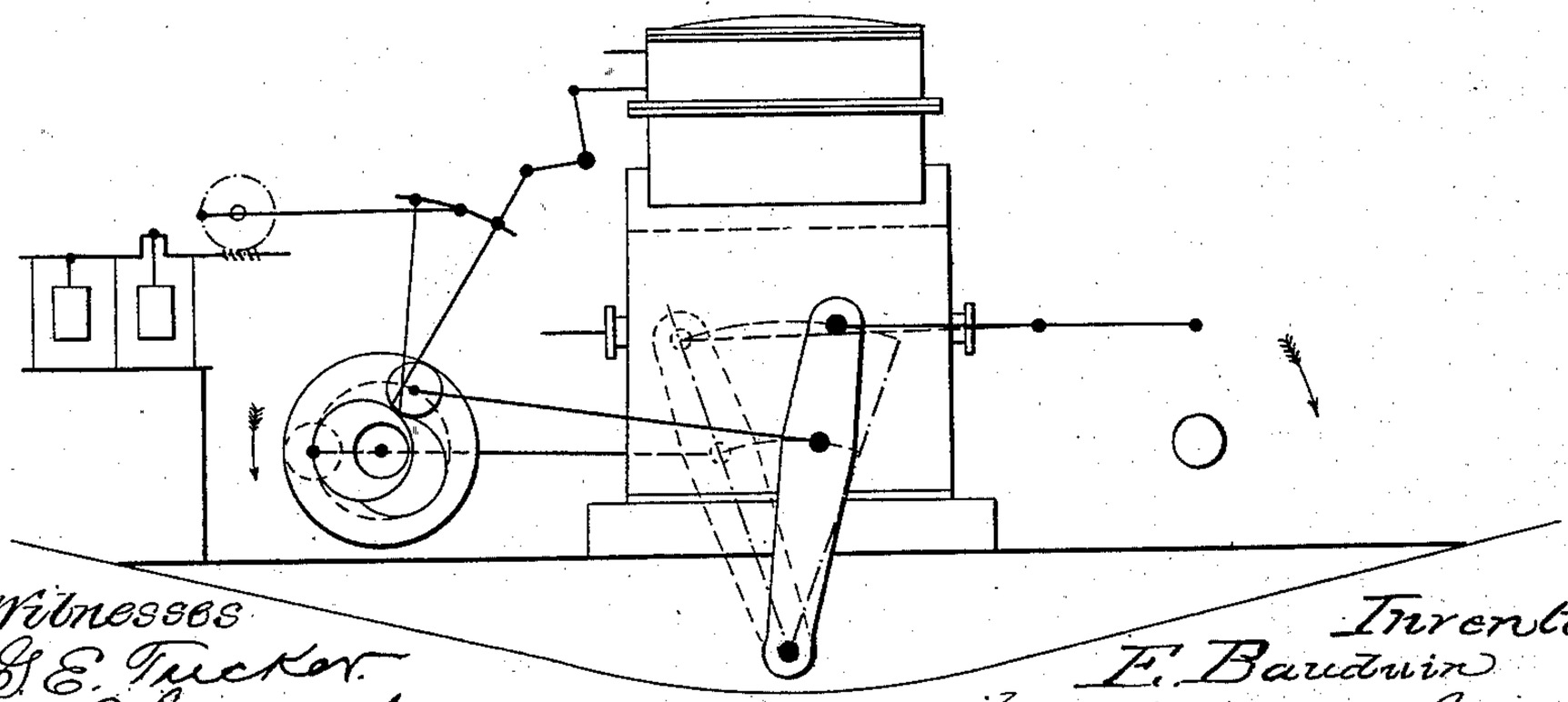


Fig. 5



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UNITED STATES PATENT OFFICE.

EDWARD BAUDUIN, OF POLA, AUSTRIA-HUNGARY.

ENGINE FOR TWIN-SCREW VESSELS.

SPECIFICATION forming part of Letters Patent No. 315,381, dated April 7, 1885.

Application filed October 23, 1884. (No model.) Patented in England July 19, 1884, No. 10,372.

To all whom it may concern:

Be it known that I, EDWARD BAUDUIN, a subject of the Emperor of Austria, and a resident of the city of Pola, in the Empire of Austria-Hungary, have invented certain new and useful Improvements in Engines for Twin-Screw Vessels, of which the following is a specification.

This invention relates to the coupling and driving of the shafts of twin-screw vessels.

The object of the present improvements is the coupling and driving of the shafts of twin-screw vessels with only one set of engines without wheel-gearing or additional rods or levers for coupling, the main feature of this part of the invention being that of three (or five) cylinders one cylinder acts on both shafts, whereas each of the other cylinders acts only on one shaft, and the arrangement of a horizontal side-lever type of engine particularly suited for twin-screw vessels.

For coupling and for driving the shafts of twin-screw vessels according to the present invention three cylinders, at least, are necessary; but, if desired, more than three might be employed. The said cylinders are placed horizontally athwartship and one alongside of the other, although not necessarily in a line, nor exactly in the middle between the two shafts. The high-pressure cylinder can be placed at the end or between the low-pressure cylinders, as desired.

In the accompanying drawings, Figures 1 and 2, respectively, are side elevations of the first and second cylinder of a three-cylinder compound engine constructed according to this invention, and Fig. 3 is a plan of the same. Figs. 4 and 5 are diagrams showing a modified arrangement.

Figs. 1, 2, and 3 show the application of the said invention to an engine of the horizontal side-lever form (the cylinder horizontal, the lever swinging vertically on a fulcrum below the cylinder, close to the inner skin of ship) of about six thousand indicated horse-power, having one high-pressure cylinder of sixty-five inches and two low-pressure cylinders of eighty-five inches diameter and sixty-three inches stroke of piston, with cranks of twenty-one inches in length, being equal in cylinder volume to two sets of compound vertical hammer engines, each of them having one high-pressure cylinder of fifty-four inches and one low-pressure cylinder of one hundred inches diameter by forty-five inches stroke of piston.

The high-pressure cylinder B, which I will call the "leading cylinder," is provided with two connecting-rods, *b b'*. The double connecting-rod *b* actuates two pairs of cranks on the starboard shaft A. The other rod, *b'*, which is single, actuates one pair of cranks on the port crank-shaft A'.

The low-pressure cylinders C and D are provided with connecting-rods *c* and *d d*, respectively. The double rod *d* of the cylinder D actuates two pairs of cranks of the starboard crank-shaft, A, while the single rod *c* actuates one pair of cranks of the port shaft A'.

The arrangements of cranks and connecting-rods admit of many variations, for we have single, double, and built-up connecting-rods, the main feature of the system for coupling the shafts remaining, as said before—that of three or five cylinders one works on both shafts, whereas each of the other cylinders works on one shaft only. On each shaft the set of cranks belonging to one cylinder stands here at an angle of ninety degrees to the set of cranks belonging to the second cylinder; but this angle might be greater, if desired; thus, for instance, it might amount to one hundred and thirty-five degrees, which appears to be recommendable for a uniform motion of the engine. The three piston-rods are, at the port side, each provided with a cross-head carrying two side rods, which take hold of the uppermost gudgeons of the side levers. These latter carry at about one-third of their length the connecting-rods.

The position of the engine chosen for the drawings is that in which the greatest difference takes place in the relative positions of the pistons of the two low-pressure cylinders, their cranks standing vertically—the port one on the upper, the starboard one in the lower, position. The pistons, instead of standing at half-stroke, stand, by the well-known influence of the length of connecting-rod, somewhat nearer to the respective shafts, as can be observed at Fig. 2 by the position of the central lines of the side levers, that of the middle engine (marked *r*) being inclined to the left, and that of the aft engine (indicated by the dotted

line *s*) inclined to the right, of the vertical central line *t* of ship. This circumstance is the cause why the two shafts can by no means be coupled with merely two cylinders having connecting-rods at both ends, whereas by the before-described arrangement, the pistons of the two low-pressure cylinders being, independently of each other, at liberty to accommodate themselves to the position of the cranks given to them by the leading cylinder, it is clear that there is no obstacle to the free motion of the shafts A and A′ in both directions of ahead and astern, and that by means of the connecting-rods of the leading cylinder, in conjunction with the steam-pressure on the pistons of the two low-pressure cylinders, the shafts A A′ are coupled effectually and in a most simple manner. The pistons of the two low-pressure cylinders work nearly always in the same direction, so that in small engines the slide-valves of both can be worked by one pair of eccentrics. The direction of the forward motion is marked by the arrows, and can be reversed to astern; but the capability of working the screws independently of each other had to be sacrificed. However, in case of damages to the engines or screws, the voyage can, after disconnecting, be continued either with three, two, or one cylinder, when the necessary steam valves and pipes are fitted with both or with one screw, as the case may be, so long as the shafting carrying the eccentric disks remains intact. As long as the engine is under pressure there is no possibility of one of the shafts taking a wrong direction; but on turning the engines by hand-gear care is to be had to prevent this from occurring, for which purpose both wheels E E′ are to be used while the cranks actuated by the leading cylinder are passing the dead-centers.

In Figs. 1 and 2 the position of the engine is shown in the section of a large war-ship, F being the water-line, and G the armor-plated deck, which, as will be observed, can be laid still considerably lower, if required, especially at the sides. In Fig. 1 the dotted lines L^2 L^3 show the position of the cranks actuated by the low-pressure cylinders, and in Fig. 2 the dotted lines L, L′, and L^3 show the position of the cranks actuated by the leading cylinder B and by the aft low-pressure cylinder D.

H indicates the main steam-pipe; K K, the pipes leading the steam from the high-pressure cylinder B to the low-pressure cylinder C D. *p p p p p p* are guide-rods for the piston cross-heads, serving, also, as stays between the cylinders and frames, as well as the rods *q q* of the cylinder C.

Condensers and pumps, which of late were often fitted separately in convenient positions, as well as other details not forming new features of the present invention, are not shown in the drawings, the operation of eccentrics, slide-valves, and their gearing needing no explanations, and as their construction can be of various forms the description of the drawings has also been restricted to the new features of the invention.

The method of coupling and driving the shafts of twin-screw vessels can also be applied to direct-acting and various other forms of engines, to simple engines, compound and triple expansion compound engines; but as the shafts of the latest twin-screw vessels since the more general introduction of the vertical hammer engine for twin-screw vessels are placed comparatively close together and low down in the ships, the horizontal side-lever form of engine shown in the drawings appears to be the most suitable type of engine to satisfy both these conditions, requiring of all horizontal forms of engine by far the shortest distance between the shaft-centers, and allowing of laying the shafts as low down in the ship as with the vertical hammer engine, giving more than sufficient length of crank and very long connecting-rods. At the same time it allows of a more favorable proportioning of cylinders, while by the intervention of the side levers the diameter of cylinders becomes reduced and their length increased without requiring to exceed the reasonable limits to the speed of piston.

In the drawings, B′ designates the side levers of the horizontal type of engine specially referred to. These levers are shown as being fulcrumed at b^2 below the horizontal cylinders and near the inner skin of the ship, the arrangement of the connecting-rods and other connections being as already explained. The side levers are arranged as shown and specified in order to adapt them and their connections to horizontal engines applied to vessels in which the twin shafts are placed quite low down in the vessel and comparatively close together.

The number of revolutions is of necessity the same for both propellers. The engine is under perfect control, and can be handled by one starting-engine only. The pressure per square inch of crank-bearings of the high-pressure cylinder is, notwithstanding the larger diameter of the only high-pressure cylinder, less than that on the crank-bearings of two separate sets of engines of the same power collectively, since there are three bearings to take up that pressure, whereas that on the crank-bearings of the low-pressure cylinders remains the same. Since, as a rule, the power of an engine is obtained more efficiently by one cylinder than by two, and by application of the described system one cylinder only takes the steam directly from the boilers, (compound engine,) it may be reasonably expected that the ten to fifteen per cent. of economy of power resulting from the use of twin screws against single screws will be considerably increased, as the observations made in this respect have of necessity been taken from twin-screw vessels having two separate sets of engines.

For very powerful engines—say twelve

thousand to thirteen thousand indicated horse-power—it will be difficult to absorb the effect of such enormous power with a single screw, since, on account of the draft of ship and of the great velocity of and friction at the outer parts of screws, twenty-four feet of diameter of screws may be considered as a limit. The object may, for example, be attained more satisfactorily with two screws of from twenty to twenty-two feet diameter. During the last year three or four large steamships were disabled by the rupture of shafts or propellers. When such vessels are fitted with the described arrangement of twin screws driven by one compound engine, they will offer greater security, since in case of a breakdown they will be able to continue their voyage with the remaining shaft or screw, uniting the economical working of one compound engine with the advantages and greater security connected with twin screws. The power of the engine being divided on two shaftings, the latter are less endangered, as the strain is naturally much reduced, and they can be made of moderate dimensions.

For ships of war this form of engine appears to be unrivaled, since the highest part of the machinery, situated midships, or nearly so, is still considerably (four to five feet) below the water-line, allowing the adoption of armor-plated decks of the most efficient curves and in the best possible positions.

When greater importance is laid on having two separate sets of engines than on the economy of power or increased speed of vessel, and other advantages connected with the described method of coupling and driving both shafts of twin-screw vessels by only one set of engines, these horizontal side-lever engines can also be arranged separately, as shown in Figs. 4 and 5, in which case each set can have two or three cylinders, as desired, and be erected in the manner usual with horizontal engines in twin-screw vessels. In this case and remaining by the fore-cited example, the high-pressure cylinder would have forty-five and five-eighths inches diameter, the low-pressure cylinder eighty-five inches for two-cylinder, or sixty inches for three-cylinder, engines. They will then still offer the same advantages in respect to armor-plated decks and present nearly the same side elevation as in Figs. 1 and 2. By giving every cylinder two straight connecting-rods (which for two-cylinder engines makes eight connecting-rods, or two more than the English steamship Alexandra) opposite to the piston crank-rods, which were to be situated on the port side for the foremost and on the starboard side for the aft engine, or vice versa, a longer crank than necessary can be obtained, or the shafts be brought considerably nearer to each other, the shaft of the foremost engine passing underneath of the piston-rods of the aft engine. As a matter of course the slide-valve motion is to be effected from the shaft belonging to the respective set of engines and double starting-gear to be fitted. This arrangement would, for instance, in the space of twenty-one feet between the shaft-centers allow of the superfluous length of crank of thirty inches and of ninety inches stroke of pistons by connecting-rods of four times the length of crank, which certainly would require nine hundred feet speed of piston at sixty revolutions per minute. Thus this form of engine admits of cranks as long as those of the highest vertical hammer engines, and does not even reach to the water-line, and when their pistons are made of steel provided with floating rings and their weight properly supported they may become great favorites for war-ships, the more so as the two sets may be separated by a water-tight bulk-head athwartship.

I claim—

In an engine for twin-screw vessels, the combination, with the two propeller-shafts, of a single set of engines comprising three or more cylinders, one of which carries connecting-rods at each end, each of which rods is connected to one of the said shafts, the remaining cylinders carrying connecting-rods at one end only, and being each connected to but one of said propeller-shafts, substantially as and for the purpose described.

The foregoing specification of my improvement in engines for twin-screw vessels signed by me this 30th day of September, 1884.

EDWARD BAUDUIN.

Witnesses:
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