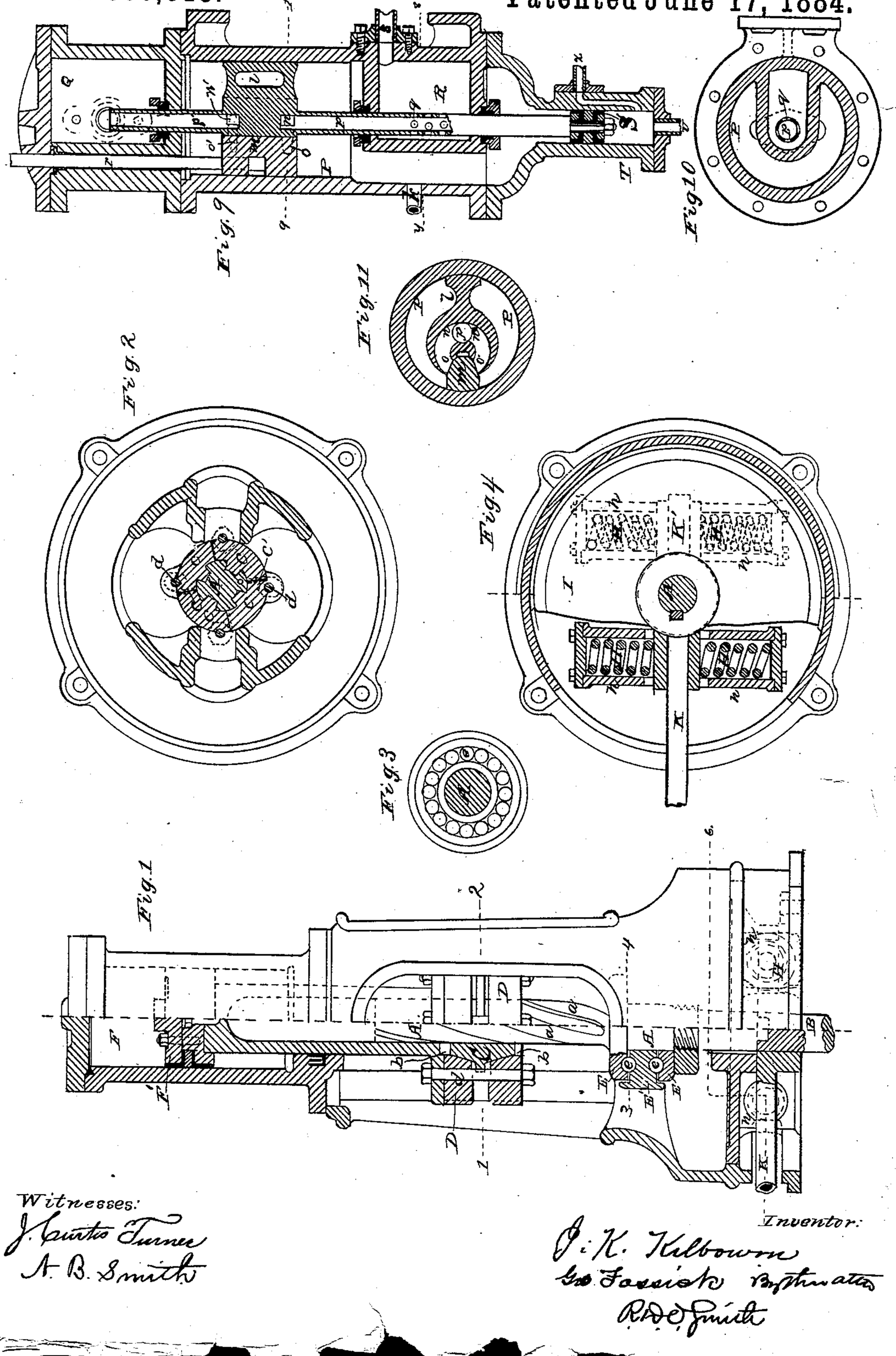
(No Model.)

4 Sheets—Sheet 1.

J. K. KILBOURN & G. FOSSICK.

STEERING GEAR FOR SHIPS.

No. 300,613. Patented June 17, 1884.



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(No Model.) 4 Sheets—Sheet 2.

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STEERING GEAR FOR SHIPS.

No. 300,613. Patented June 17, 1884.

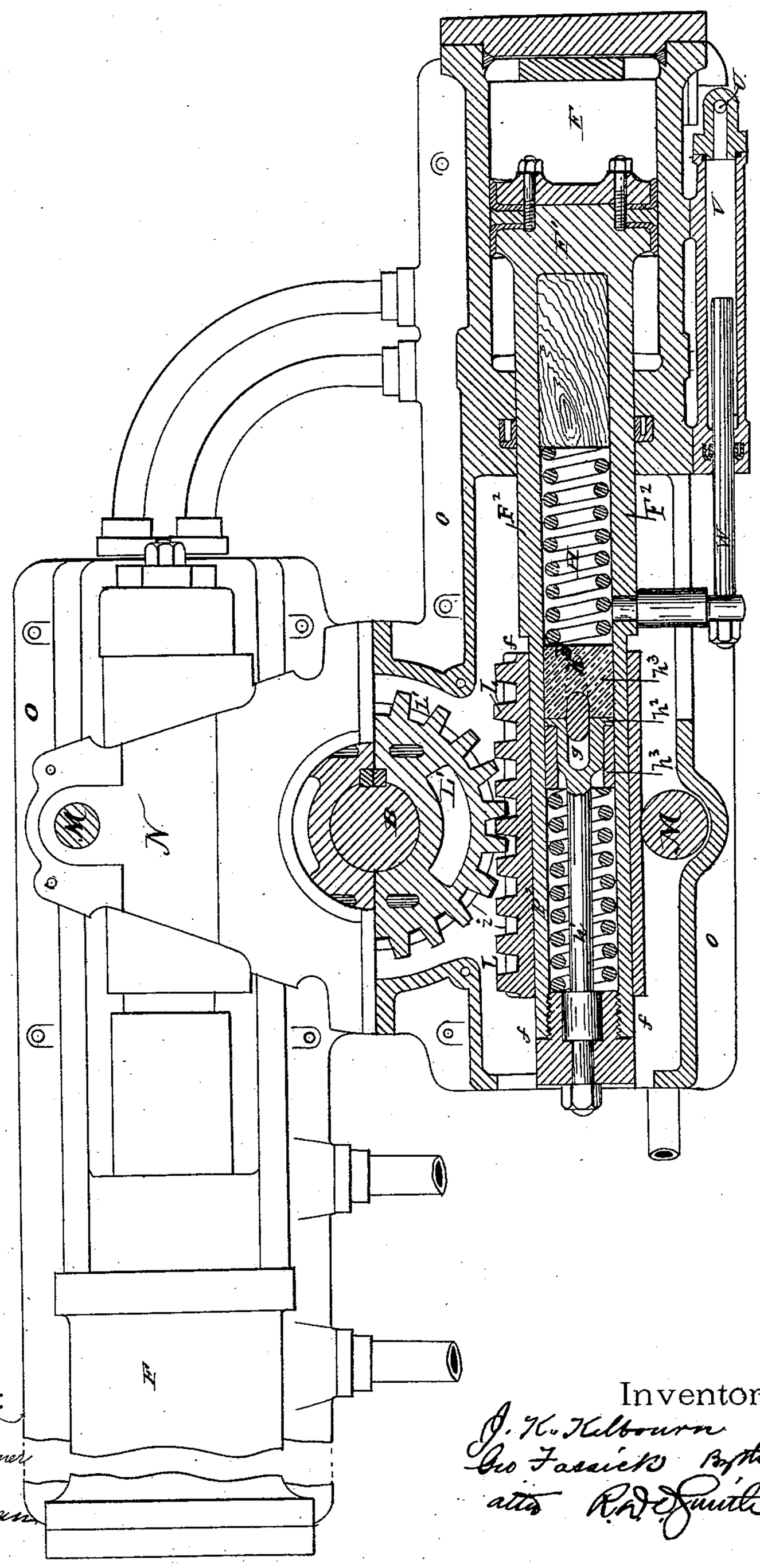

Fig. 5.

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(No Model.) 4 Sheets—Sheet 3.

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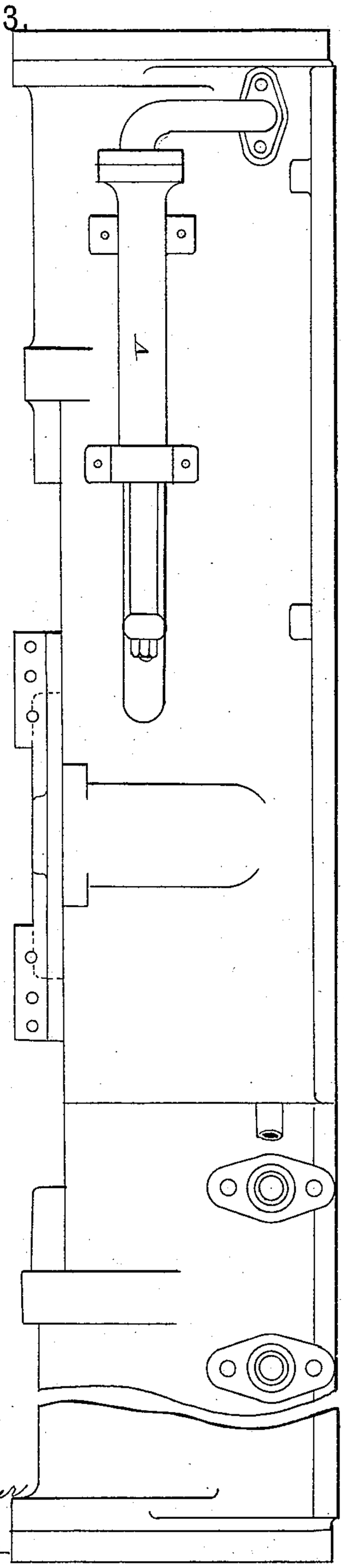
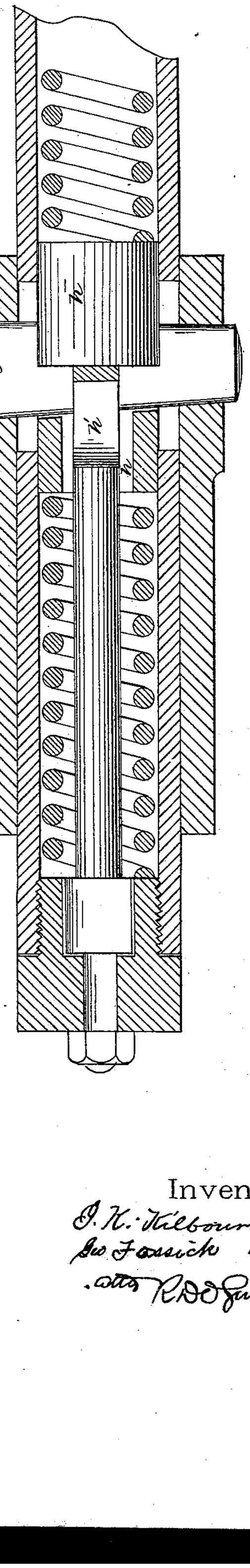


Fig. 6.



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(No Model.) 4 Sheets—Sheet 4.

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Fig. 7

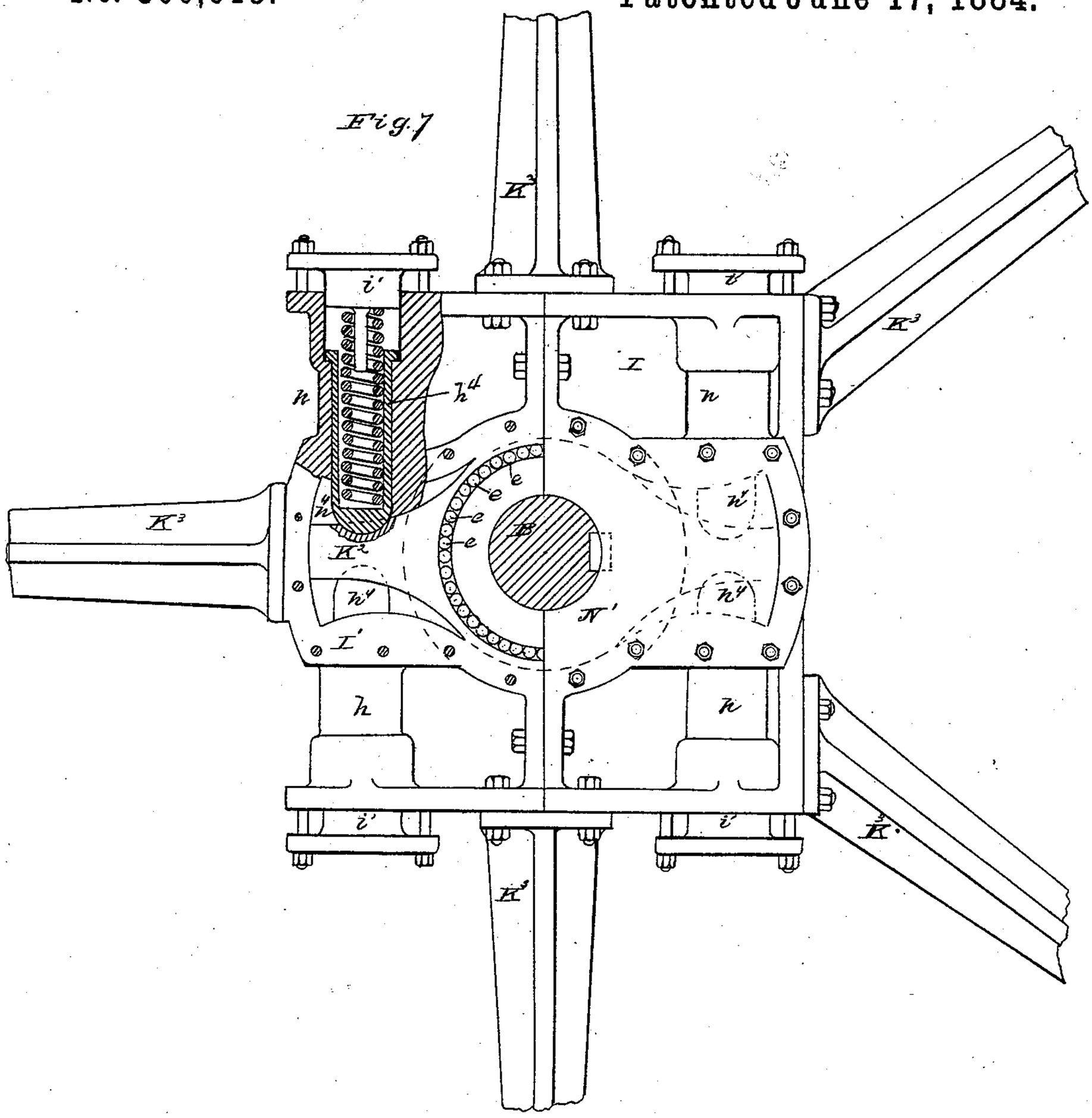

Fig. 8

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UNITED STATES PATENT OFFICE.

JOSEPH KNIGHT KILBOURN, OF BRIXTON, COUNTY OF SURREY, AND GEORGE FOSSICK, OF STOCKTON-ON-TEES, COUNTY OF DURHAM, ENGLAND.

STEERING-GEAR FOR SHIPS.

SPECIFICATION forming part of Letters Patent No. 300,613, dated June 17, 1884.

Application filed July 11, 1883. (No model.) Patented in England January 15, 1881, No. 199, and in France July 15, 1881, No. 143,957.

To all whom it may concern:

Be it known that we, JOSEPH KNIGHT KILBOURN, a citizen of the United States, but now residing in Brixton, county of Surrey, England, and GEORGE FOSSICK, of Stockton-on-Tees, in the county of Durham, England, have invented new and useful Improvements in Steering-Gear, (for which we have obtained a patent in England, dated July 15, 1881, No. 199, and also in France, dated July 15, 1881, No. 143,957, and which, according to our knowledge and belief, has not been in public use in the United States for more than two years from the date of this application,) and of these improvements the following is a specification.

Our said invention relates partly to certain improvements in that class of steering-gear in which the power is transmitted to the rudder-stem by the use of a quick-threaded screw or spiral bolt; also, to improvements in that class of steering-gear in which the tiller is held rigid by an incompressible liquid or by unyielding mechanism; also, to improvements that may be applied to any system of steering-gear wherein it is desirable to have a dual action in the valve-gear controlling the motive power—that is to say, in which one part of this action—namely, the starting motion—is derived from the steering-wheel or its equivalent. The other part—an automatic closing motion—is obtained direct from the mechanism which actuates the rudder.

In order that our said invention may be fully understood, we shall now proceed to describe the same, and for that purpose shall refer to the several figures on the annexed sheets of drawings, the same letters of reference indicating corresponding parts in all the figures.

Figure 1 of the accompanying drawings is a sectional elevation illustrating a mode of carrying out our said invention as applied to that class of steering-gear in which the power is transmitted to the rudder-stem by the use of a quick-threaded screw or spiral bolt. Figs. 2, 3, and 4 are horizontal sections, taken, respectively, along the lines 1 2, 3 4, 5 6, Fig. 1. Fig. 5 is a half-plan and half-horizontal section illustrating the application of relief-springs to a horizontal steering-gear having two cylinders. Fig. 6 is a detail section, drawn to a larger scale, showing the springs and their connections corresponding to the arrangements illustrated in Fig. 5. Figs. 7 and 8 are plan and elevation illustrating the application of relief-springs direct to the rudder-head, and is applicable to steam or hand gear. Figs. 9, 10, and 11 illustrate that part of our said invention which relates to the valve-gear for controlling the power for working the steering mechanism, Fig. 9 being a longitudinal section of the valve-gear, and Figs. 10 and 11 cross-sections of the same, taken, respectively, along the lines 7 8 and 9 10, Fig. 9.

In the class of steering-gear hereinbefore referred to—that is to say, where the power is transmitted by the use of a quick-threaded screw or spiral bolt—the severe labor and great wear come on the nut which turns the screw or spiral bolt, and the excessive friction is on the surfaces of the parts that sustain the end-thrust of the screw or spiral bolt. Heretofore no adequate provision has been made to take up this wear or lessen this friction. Now, this part of our said invention has for its object the obviating of these defects, and this is effected in the following manner, reference being had to Figs. 1 to 4 of the drawings:

A is the screw or spiral bolt for transmitting motion to the rudder-stem B, the screw or spiral bolt receiving its rotary motion by the vertical to and fro movements of a non-rotating nut, C, adapted to the screw. According to this part of our said invention, we make the nut C in segments *c c*, Fig. 2, the number of which correspond to the number of threads *a* in the screw or sides to the spiral bolt. The aggregate of these segments forms a complete circle, the external surfaces being in the form of a double truncated cone, as shown at *b b*. The segments are held together and in position by a double cross-head, D D, bored to fit the surfaces of the cone at *b b*, Fig. 1, and drawn together by strong bolts *d*. In the first fitting of the nut the contact edges of the segments may have left thereon "file-spots" *c'*, which are subsequently reduced, or may have intervening strips of thin metal, which are subsequently removed whenever it is desirable to take up the "lost motion" occasioned by wear, the two parts of the cross-

head D D being brought into closer proximity. The obtaining compensation for wear is an important object of this part of our said invention, and which is thus effected in an economical manner.

In order to reduce excessive friction, we employ two series of metal balls, *e e*, placed between the surfaces E E′ and E of the parts, which sustain the head-thrust in both directions. These balls may be of hardened steel, or of chilled iron or other suitable material of such hardness that the pressure upon them shall not cause abrasion.

It is obvious that in lieu of using balls their equivalents may be employed—as, for example, conical rollers—whereby the same effect is obtained. In the example illustrated the power is applied by means of a hydraulic cylinder, F, ram F′, and cross-head D. This part of our said invention is, however, applicable, whether the power is applied by hydraulic agency or otherwise.

In the case of hydraulic steering-gear as heretofore constructed, adequate provision has not been made to overcome the excessive rigidity with which the rudder is held, or relieve the shock caused by heavy seas against the rudder. According to another part of our said invention, we overcome this difficulty in the following manner: In addition to the well-known "relief-valves," which are usually located at a point more or less remote from the rudder, we employ an arrangement of relief-springs in very close proximity to the tiller, through which all the power is transmitted to the rudder-stem, and which will, in the event of excessive strain, yield to a predetermined extent, and recover again as soon as this excessive strain is removed. The nearness of these springs to the rudder-stem causes them to give instantaneous relief, thereby acting as a cushion to the tiller or its substitute. These relief-springs are especially applicable to two modifications of hydraulic steering-gear, which may be respectively designated "vertical" and "horizontal," as shown in Figs. 1 and 5. They are also applicable to any system of gear where the rudder is rigidly held by chains or other mechanical appliances. One method of such application is shown in Figs. 7 and 8. With the vertical with a single cylinder, the latter is placed directly over the rudder-stem, as shown in Fig. 1. With the vertical with two cylinders, one cylinder is placed on each side of the rudder-stem. As, however, in both cases, the arrangement is otherwise similar, we shall describe the application of this part of our said invention to the vertical apparatus with a single cylinder, reference being had to Figs. 1 and 4 of the drawings.

F is a cylinder, the ram F′ of which works a cross-head, D.

H H are relief-springs, the boxes *h h* of which form part of a disk-plate, I, attached to the screw or spiral bolt A, and turning with it. This plate forms the coupling which connects the screw or spiral bolt A to the rudder-stem B, the tiller K resting between two or more of the relief-springs H H, and closing them whenever there is excessive strain upon the rudder. In the example shown in our drawings two springs H H act upon the tiller K, and the rudder-stem B is also provided with a supplementary tiller, K′, upon which two other springs H H act. Inasmuch as the springs and the boxes that contain them turn with the screw or spiral bolt, the action of the tiller against the springs is always at the same angle. Fig. 5 illustrates the application of this part of our said invention to horizontal steering-gear with two cylinders. The two cylinders form part of or are secured to one and the same bed-plate, O, as shown in Fig. 5. The stems F^2 of the ram F′ are tubular and contain the springs H H. The connections from the rams to the rudder-stem may be made in various ways; but we prefer to make the connection, as shown in the drawings, by means of racks L on the rams, and a pinion, L′, on the rudder-stem B. By this method the power is always applied at right angles to the resistance. The racks are tubular, forming sleeves which surround the ram-stems F^2, and are connected to them by pins *g* in such a manner that the rack-sleeve is allowed a longitudinal play on the ram-stem, as shown at *f f*, Fig. 5, to the extent of the relief motion obtained from the springs, while the pins *g* are caused to act without play upon the blocks h^3, which compress the springs. Under this arrangement any excessive strain or blow upon the rudder is transmitted through the pinion L′ to the racks L, and thence to two of the springs H, (according to the direction from which the strain or blow proceeds,) whereby the said springs are compressed, so as by cushioning the strain or blow to afford the requisite relief, the springs returning to their normal position as soon as the rudder is relieved from the excessive strain. The springs are normally maintained at a uniform neutral point by means of a rod, *h′*, the extremity h^2 of which separates the two blocks *h*.

The arrangement for direct application of the relief-springs to the rudder stem or "head," applicable to every system of steering-gear, is shown at Figs. 7 and 8. It consists of a short double-ended tiller, K^2, firmly secured to the rudder-stem B. A disk-plate, I′, which, for convenience, may be made in two parts, is shown. Four spring-boxes *h h* are formed on this disk-plate. In each spring-box there is a cylindrical tubular piece, h^4, one end of which is open, the other closed, and of hemispherical shape, working in a socket on the teller K^2, of suitable form to receive it.

H H are relief-springs of suitable strength to resist the normal power required for working the rudder, and to yield only against excessive pressure.

N′ is a strong cover over the central opening in the disk-plate I′, to which it is firmly

bolted. This cover is shown as one piece; but it may also be divided at right angles to the division in the disk-plate.

O′ is also a flange covering a portion of the central opening at the bottom of the disk-plate.

e e are a series of metal balls placed in a semicircular groove on the top of the tiller K^2. A corresponding groove is formed in the under side of N′.

i′ i′ are flanges closing the spring-boxes *h h*.

K^3 are arms (shown broken in the drawings) which may be extended to receive a rim for chains or other connections from either hand or power gear.

The disk, arms, and rim constituting a complete wheel is the modern substitute for the old single-ended tiller. The action of this arrangement needs but little explanation. The disk-plate, with its attachments, is supported on the metal balls, and is free to move on the boss of the tiller for about twelve degrees in either direction, but is held in a normal position by the series of springs H H. Assuming, for the sake of illustration, that the rudder was fixed and that power was applied to the chain-wheel, in this case the springs would close, and the wheel might be turned for twelve degrees before putting any strain upon the rudder in excess of the power necessary to close the springs. Reverse this action, and assume that said wheel is held taut and rigid by chains or other appliances. Then a blow against the rudder will cause the springs to close before transmitting excessive strain to the chains or mechanism of the steering-gear.

We do not confine ourselves to the particular arrangement shown, as it will be evident that various modifications of this arrangement may be made without departing from the principles of our invention.

In the description of the horizontal hydraulic arrangement shown in Fig. 5 it should have been stated that to insure greater strength, together with smoothness of action, the racks and pinion are shrouded to the pitch-line *i i*, and with a view to maintain the pinion and racks in gear vertical rollers M are placed against the backs of the racks L, the two being connected by a cap-plate, N.

The different modifications of hydraulic steering-gear hereinbefore described refer to the systems using differential pistons as rams—that is to say, a piston or ram which has one face of equal area to the cylinder, and the other of, say, one-half of the area of the cylinder. In this case the pressure is constant on the smaller face of the ram, while the larger face is alternately subjected to and relieved from pressure. This differential ram is, however, not essential to the application of our said invention, but is preferred, and the description of different parts of the invention hereinbefore described has reference to this particular class.

Another part of our said invention relates to the "valve-gear" which controls the power for working the steering mechanism, and is applicable to steam stearing as well as to hydraulic gear; but, in order to avoid confusion, we shall describe it as applied to a hydraulic arrangement. In all successful systems of steering other than by manual labor the steersman or "man at the wheel" has only to set in motion the mechanism which does the work, and to determine, by the extent of movement he gives to wheel or lever, the exact position to which the rudder is to be set. This mechanism, so started, is stopped by its own action whenever the rudder arrives at the indicated point. In other words, there should always be a fixed relation between the position of the wheel or its substitute and the position of the rudder, and the two parts should be so arranged that the first cannot be moved without causing a corresponding movement of the rudder. This part of our said invention has for its object obtaining such an arrangement of equilibrium-valves as insures easy movement, certainty of action, and great simplicity of construction. This object is effected in the following manner, reference being had chiefly to Figs. 9, 10, and 11 of the drawings, and also partly to Fig. 5 of the drawings.

In a valve-chest, P, Figs. 9, 10, and 11, located on or near the pumps, and connected by a pipe, *k*, to the cylinders F, hereinbefore referred to, at the rudder-head, we provide two valves—one, *l*, which, for convenience, we term the "rudder-valve," the other, *m*, having its seat on the rudder-valve, and which we term the "wheel-valve." Each of these two valves has an entirely independent movement. The rudder-valve *l* has two compartments, *n n′*, from which are ports or passages *o o′*, covered by the wheel-valve *m*. At each end of the rudder-valve *l* is a tubular valve-rod, *p* or *p′*, one end of each opening into one of the before-named compartments *n n′*. One of these valve-rods, *p′*, that extends through the chest P into the chamber Q, is filled with a liquid under constant pressure from the pumps. The other rod, *p*, extends through a supplementary chamber, R, called the "exhaust-chest," with which the tubular rod is in communication by means of openings *q*. On the end of this valve-rod is a piston, S, fitting a small cylinder, T, which surrounds the rod. This cylinder is connected with the rudder mechanism, as hereinafter described. The wheel-valve *m* has one solid rod *r*, extending through the valve-chest, and has a connection by rod or otherwise to the wheel. The wheel-valve in its normal position, as indicated in the drawings, covers both the ports *o o′* in the rudder-valve, the port *o′* being the pressure-port, and the port *o* the exhaust-port. The valve-chest P, the pipe *k*, connecting it to the cylinders F at the rudder-head, and the said cylinders are always filled with liquid. By the act of uncovering the pressure-port *o′* this liquid is placed under the full pressure of the pumps, and the rams F′ in the cylinders F are moved in one direction. When the pressure-port *o′* is closed,

the act of uncovering the exhaust-port *o* causes the rams in the cylinders F to move in the other direction, and discharges the liquid into the exhaust-chamber R, and thence through a pipe, *s*, into the supply-tank. This uncovering of the pressure and exhaust ports, thereby starting the mechanism into action, is the function of the wheel-valve, which receives its motion from the wheel.

With respect to the motion of the rudder-valve *l*, it is absolutely essential that any movement of the rudder should cause a corresponding movement of the rudder-valve. This can be effected by means of a series of metal rods, or by a cylinder containing a piston inserted in the pipe *k*, connecting the valve-chest P and the cylinders F at the rudder-head; but we prefer to employ the arrangement illustrated in the drawings, and next hereinafter described. The small cylinder T at the valve-chest P is connected by a pipe, U, to a small supplementary cylinder, V, Fig. 5, wherein is a plunger, W, carried by the stem F^2 of Fig. 5, or by the cross-head D, Fig. 1, although not shown in the last-mentioned figure.

In first preparing the apparatus for operation the plunger W is withdrawn from the cylinder V to the extent of its stroke, and the piston S is placed at the outer end of the cylinder T. The connecting-pipe U and the cylinder V are then filled with liquid and closed. This liquid thereafter remains without change in quantity except from loss by leakage, which loss must be compensated for by supplying fresh liquid from time to time, for which purpose a pipe, X, is provided. When the plunger W is withdrawn, as before described, the ram F′ in the main cylinder F is at the end of its stroke. Any motion of the ram then causes a corresponding motion to the plunger W, forcing the liquid out of the cylinder V through the pipe U, and against the piston S on the valve-rod P, which in turn moves the valve *l* a corresponding distance. The reverse movement of the ram F′ at the rudder-head again withdraws the plunger W, and the liquid under pressure from the valve-chest P forces the piston S back to the starting-point, and in this manner the piston S on the valve-rod *p* always moves in one direction or the other, corresponding to the movement at the rudder-head.

Having now described and particularly ascertained the nature of our said invention and the manner in which the same is or may be used or carried into effect, we would observe, in conclusion, that what we consider to be novel and original, and therefore claim as our invention, and desire to secure by Letters Patent, is—

1. In a steering-gear in which the power is transmitted to the rudder by means of a screw or spiral bolt, the nut which turns the screw or spiral bolt, constructed in segments, substantially as and for the purpose hereinbefore described.

2. In a steering-gear in which the power is transmitted to the rudder by means of a screw or spiral bolt, the nut which turns the screw or spiral bolt, constructed in segments, with their external surfaces in the form of a double-truncated cone, combined with cross-heads fitted thereto, and clamping-bolts, substantially as and for the purposes hereinbefore described.

3. In a steering-gear in which the power is transmitted to the rudder by means of a rotating screw or spiral bolt, and in combination with said screw, anti-friction balls or their equivalents, arranged as herein set forth, for receiving the end-thrust in both directions, substantially as herein described.

4. In a steering-gear in which the power is transmitted to the rudder through a rotating screw or spiral bolt, one or more relief-springs interposed between said screw and the rudder, and anti-friction balls or their equivalents, upon which to suspend the tiller or its substitute, in order that it may be free to move and sensitive to the action of the said springs, substantially as hereinbefore described.

5. A steering-gear operated by hydraulic or steam pressure applied to rotate a spiral bolt in line with the rudder-head, combined with relief-springs interposed between said rotating spiral bolt and said rudder-head, substantially as and for the purpose hereinbefore described.

6. In a hydraulic or steam steering-gear, the combination and arrangement, with the moving but non-rotating nut, the rotating spiral bolt actuated thereby, and the rudder, of the horizontal relief-springs interposed between the rotating bolt and the rudder-head, substantially as herein shown and described.

7. The steering-gear, rudder-head, and interposed springs H, combined with boxes *h*, to inclose said springs, attached to and moving with said rudder-head, whereby the springs always act against the tiller at the same or nearly the same angle, irrespective of the position of the rudder, substantially as and for the purpose hereinbefore described.

8. In a steering-gear, the rudder-head and actuating-piston F, a rack or racks and pinion, as herein set forth, shrouded to the pitch-line, and in combination therewith rollers or roller M, maintained in contact with the rack and shrouding.

9. In a steering-gear operated by steam or hydraulic pressure, in which the main valve is opened by hand and closed automatically, the combination, with the actuating-piston and cylinder, of the wheel-valve *m*, the rudder or main valve *l*, with its tubular spindles *p p′*, the pressure-chamber Q, the exhaust-chamber R, and a connection with said piston, substantially as hereinbefore described.

10. In a steering-gear operated by steam or hydraulic pressure, in which the main valve is opened by hand and closed automatically, the combination, with the wheel-valve, of the rudder or main valve, with its tubular spindles, the pressure and exhaust chambers, ar-

ranged as herein set forth, the piston S, connected to the rudder or main valve and working in the cylinder T, which is capable of being placed at one end in communication with the pressure and exhaust passages, and at its other end in communication by a pipe containing liquid with the cylinder V, and the plunger W, connected to the main ram, the whole of the parts being constructed, arranged, and combined together so as to operate substantially as hereinbefore described, and illustrated in the accompanying drawings.

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