W. S. RUSH.

MOTION INDICATOR.

APPLICATION FILED APR. 29, 1907.

900,427.

Patented Oct. 6, 1908.

2 SHEETS—SHEET 1.

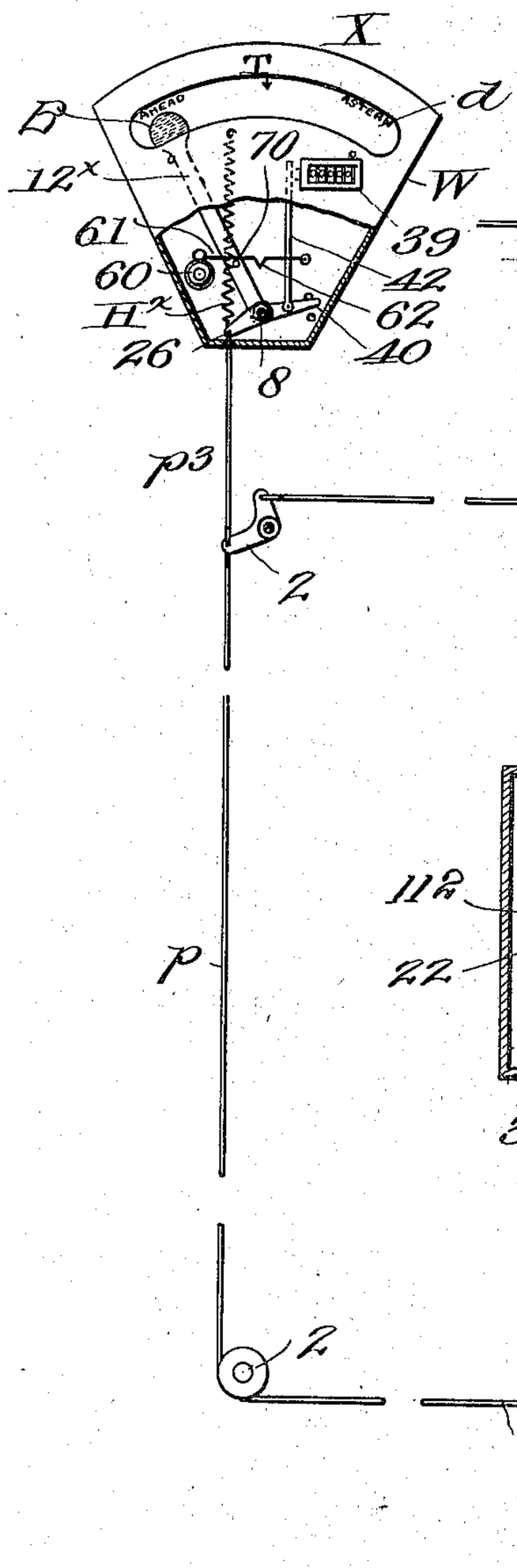
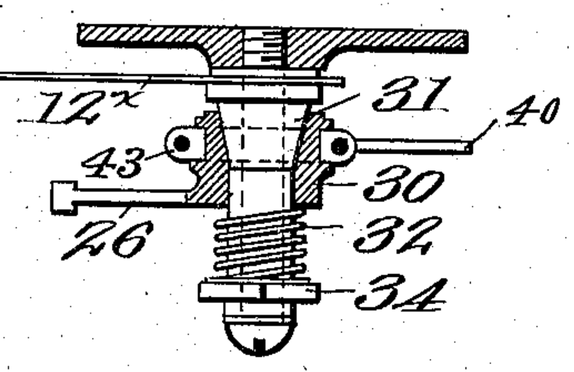


Fig. 6.



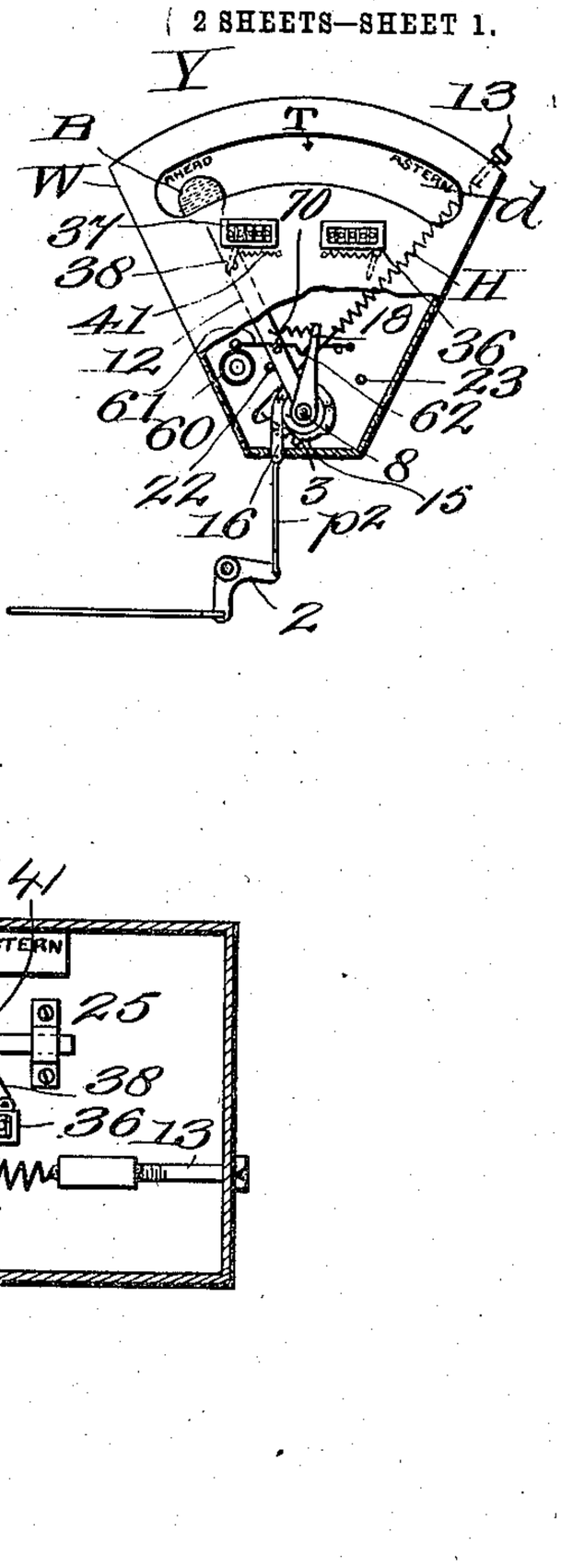
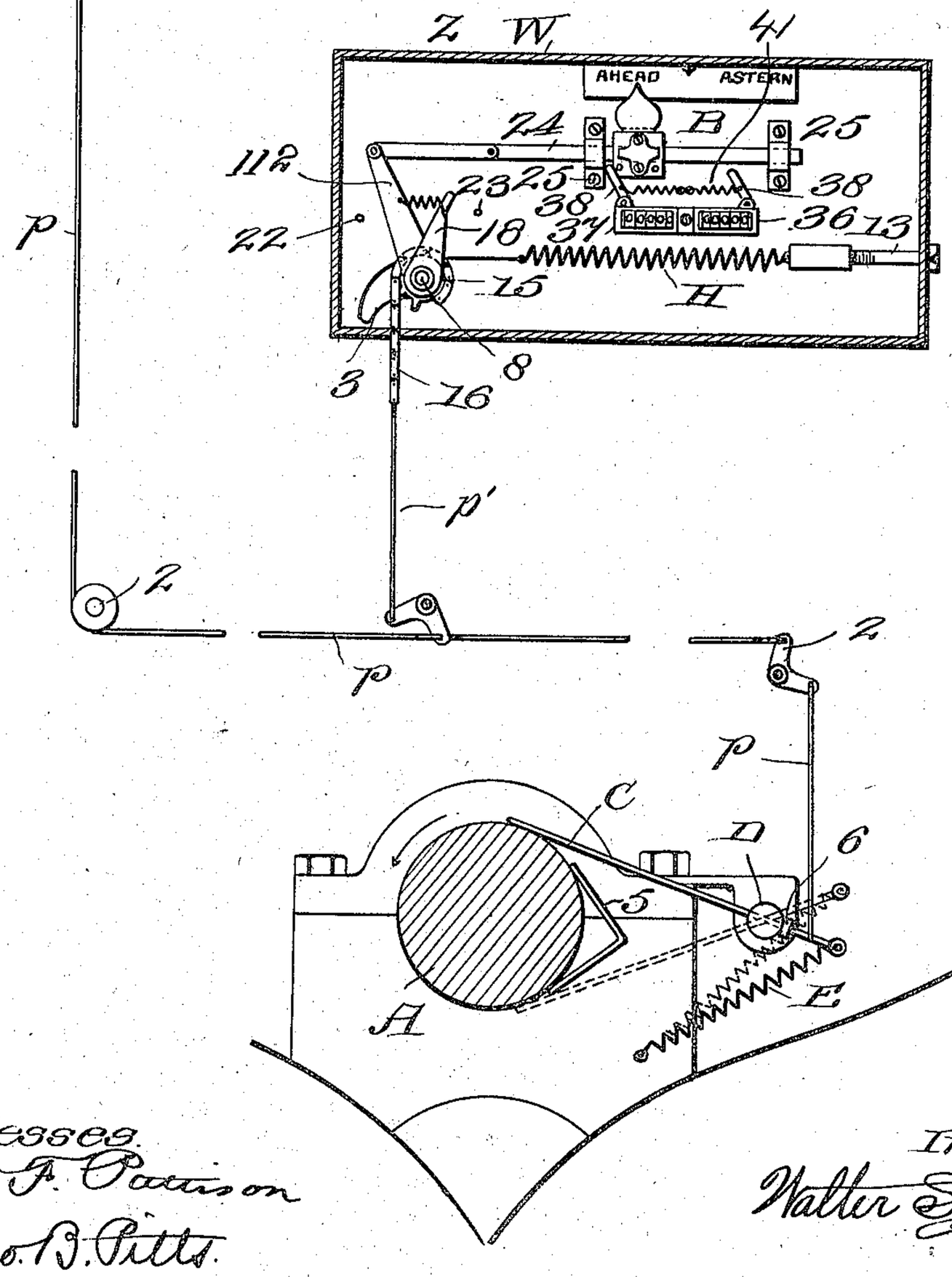


Fig. 7.



Witnesses.

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Geo. B. Pitts.

Inventor.

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2 SHEETS—SHEET 2.

Fig. 4.

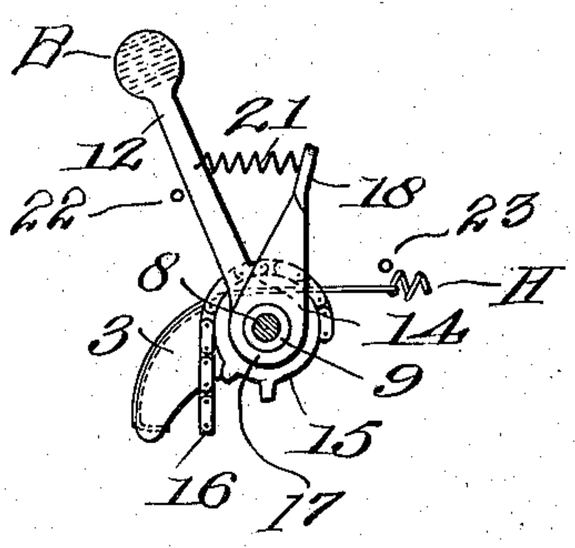
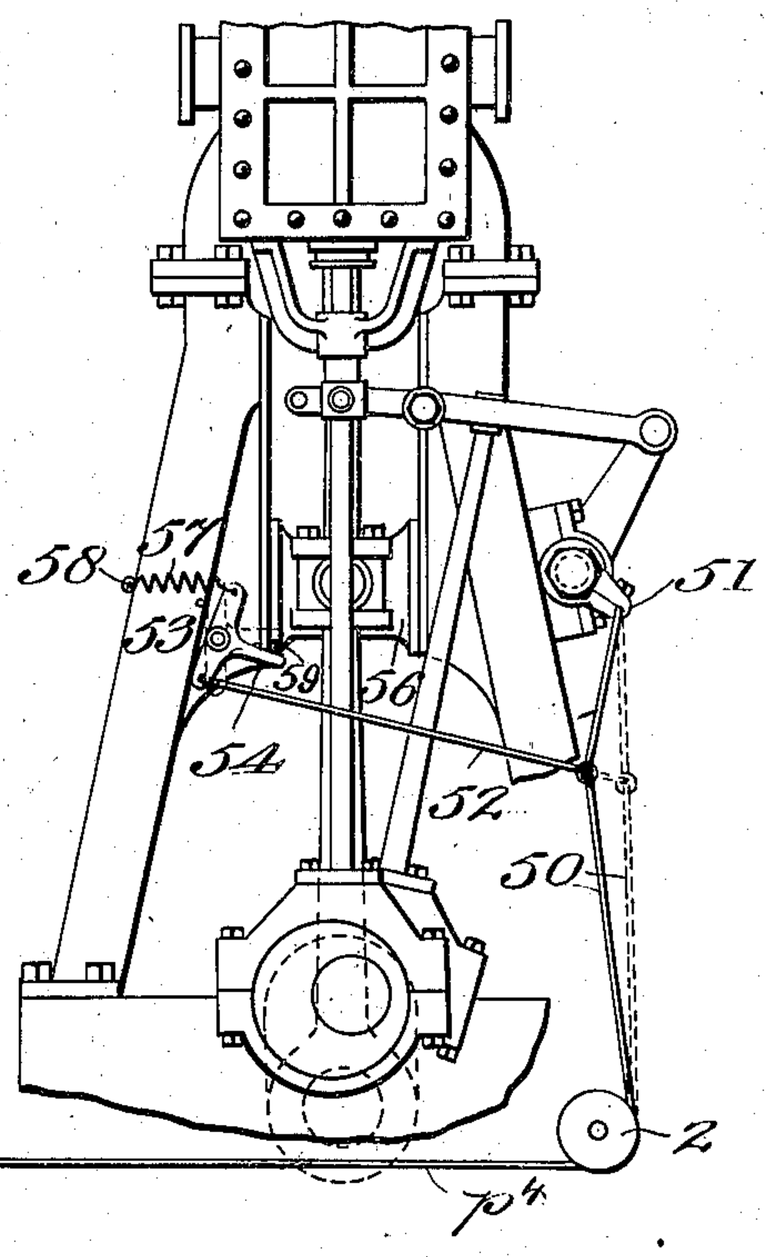


Fig. 3.



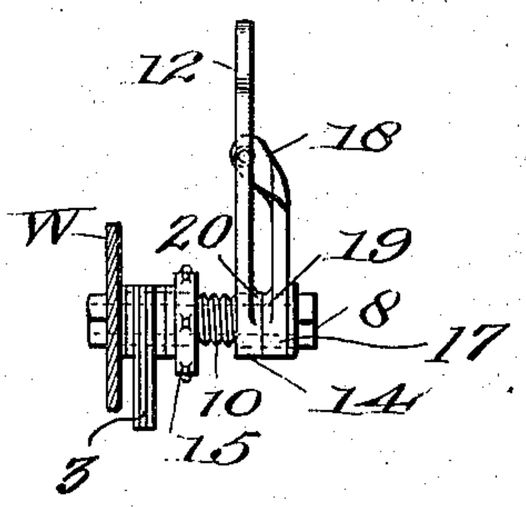
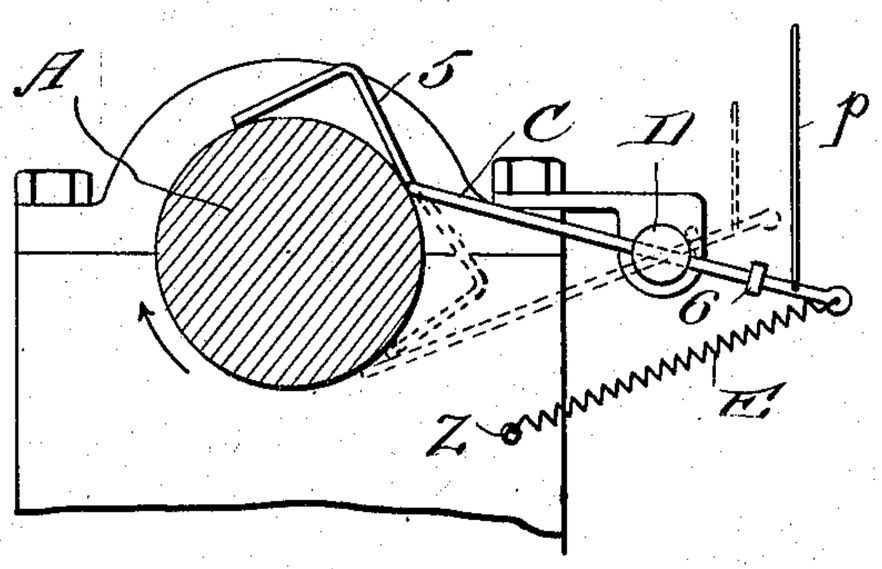


Fig. 5.

Fig. R.



Witnesses.

J. F. Dennison

Geo B. Pitts.

Inventor.

Walter S. Rush

UNITED STATES PATENT OFFICE.

WALTER S. RUSH, OF SAN FRANCISCO, CALIFORNIA.

MOTION-INDICATOR.

No. 900,427. Specification of Letters Patent. Patented Oct. 6, 1908.

Application filed April 29, 1907. Serial No. 370,874.

To all whom it may concern:

Be it known that I, WALTER S. RUSH, a citizen of the United States of America, and a resident of the city and county of San Francisco and State of California, have invented new and useful Improvements in Motion-Indicators, of which the following is a specification.

This invention relates to improvements made in devices for indicating the movements of a rotating shaft, or other part that derives its movements from an engine, or motor.

The invention has for its object, chiefly, to provide a means or device that will indicate in one place, or in several different places or stations in a ship, the rotation of the main shaft, or another part deriving its motion from the engine; showing by its movement the speed at which the shaft is being driven, and also the direction in which it is rotating, and the changes in the direction of the motion, as the same take place.

A motion-indicator of my invention consists of the various parts and combination of parts as hereinafter described, and it embraces a novel means of operating an indicating-device in harmony with the revolutions of the engine-driven part; a novel means of registering the number of revolutions in a forward direction, and the number in the reverse direction, or backward, separately of each other; an indicating device of novel construction, and means for operating by or from the indicating device an audible signal, all hereinafter set forth in the following description and pointed out in its claims at the end of this specification.

The accompanying drawing to which reference is made herein illustrates a complete motion-indicator of my invention, and also the manner in which I arrange or combine two or more motion-indicators for operation with, or from, the same actuating-mechanism.

Figure 1 is a view, partly in elevation and partly in vertical section, of an apparatus embodying my invention, and representing the motion-imparting devices, three distinct and separate sets of indicating devices, supposed to be located at different points, and connecting mechanism between the indicating and the motion-giving devices. Fig. 2 is a view, partly in elevation and partly in vertical section, of the devices for operating the apparatus, that is, the devices or mechanism from which the indicators are operated. Fig. 3 illustrates a construction of actuating-mechanism by which the movements of the indicating-hand are produced mechanically from the movements of the cross-head and reversing mechanism in a reciprocating engine. Fig. 4 is a detail front-view, and Fig. 5 a side-view partly in section, both on an enlarged scale, of the friction-clutch and connected parts of the mechanism that vibrates and shifts the indicating-hand. Fig. 6 is a horizontal sectional view in detail, on an enlarged scale, of the friction-joint seen in casing X, Fig. 1; the same being a modification of the construction represented in Figs. 4 and 5.

A novel feature of this invention consists in a motion-indicating device having a hand or indicating-part capable of vibratory movement at a sight-opening in an inclosing case, and in mechanism for imparting movement to the hand in unison with the revolutions of a shaft, such as the engine-driven shaft in a ship; the said mechanism being adapted also to change the working position of the vibrating-hand from one side of the center of the sight-opening to the opposite side thereof, as often as a change in the direction of rotation of the shaft takes place.

In a system embodying my invention there may be employed one or more indicating devices located at more or less widely separated points, and I have in Fig. 1, illustrated three indicating devices, each differing from the others in details of construction; and these are designated, as entireties, by the reference characters X, Y and Z, respectively. The hand or index constituting the visible portion of the indicator and the parts directly connected therewith are inclosed for protection within cases W, each having a sight opening *d* through which the index or hand is exposed to view and by which its working position and its movements, whether to one side or the other of the center of such opening may be observed.

The mechanism through which the motion-indicating hand B is caused to vibrate from and in harmony with the revolutions of the engine-driven shaft, operates also to change the working-position of the hand from one side of the center T of the sight-opening to the opposite side, as often as a change in the direction of the motion of the shaft takes place. This part of the invention termed the vibrating-mechanism has the additional

function, therefore, of shifting or changing the position of the indicating-hand automatically by or from every reversal of the motion of the shaft.

The mechanism by which the vibrating movements and the changes in the working-position of the indicating-hand are produced directly from a revolving shaft, will be described with reference to Figs. 1 and 2 of the drawing.

The bar C sets across the shaft A, and is movable in an arc on a center consisting of a rocker-bearing D, in which the bar C is also fitted to slip, or move longitudinally, to a limited extent. The longer arm or member of the bar C that is on one side of the bearing D lies upon or against the shaft A, and also in the path of an angular abutment 5 that projects or stands out from the peripheral surface of the shaft. To the shorter arm or member of the bar C on the opposite side of the center D the motion-indicating hand B is connected either by a single wire, when it can be carried directly therefrom to the actuating-mechanism; or, in situations where it becomes necessary to turn and carry the wires in different directions, the connection is made by a line of wires p^1— p^2 p^3—, and bell-cranks, pulleys or other direction-turning devices, 2. Through these connections the bar C being alternately lifted and dropped by the abutment 5 in the revolutions of the shaft, imparts to the hand of the indicator, short vibratory movements in harmony with the revolutions of the shaft. The indicating-hand thus shows by its movements the relative speed of the shaft, and the fact that the shaft is in motion, or is at rest. Instead of being rigidly fixed in the bearing D, however, the bar C has a limited movement longitudinally in the hole or socket in the shaft through which it passes; the extent of such movement in one direction being limited by a fixed collar 6, and in the opposite direction by the coiled spring E. One end of the spring E is attached to the end of the bar C, and the other end to a fixed point on the shaft-bearing below the center of movement D of the bar C, and under its tension the bar C is so retained in normal working position with respect to the abutment 5, that while the shaft A continues to revolve in a forward direction, as indicated by the arrow in Fig. 1, the bar lying over the shaft will be lifted and dropped as the abutment 5 passes under it. On the other hand, when a reverse motion of the shaft A takes place and it is revolved in the direction of the arrow in Fig. 2, the abutment 5 will be carried against the end of the bar C, and, striking that end, it will push the bar longitudinally through the bearing D as the shaft continues to turn backward, with the effect to carry the bar C from its position over the shaft to the position under it, indicated by dotted lines in Fig. 2. Changing the position of the longer member of the bar C from above the shaft to such position below it, and correspondingly changing the position of the shorter member on the opposite side of the bearing D, in the manner described, has the effect to move the indicating-hand from one side of the center of the sight-opening to a working position on the opposite side; for the reason that the point of attachment of the connecting wires p with the bar C is set above the axis D a sufficient extent to allow the hand B of the indicator to be drawn over to the opposite side of the center T, by the spring H (or $H^{\times}$), thereby changing the working position of the hand from the left to the right side of the sight-opening. With the longer member of the bar C lying against the lower side of the shaft A, therefore, the indicating-hand is maintained in working position to the right of the center T, and while retaining that position it will be vibrated by the bar C during the revolutions of the shaft A. On the other hand, on the instant that the motion of the shaft A is reversed the bar C will be brought to the position over the shaft A, and the indicating-hand will be drawn over to the left of the center T by the increased strain thrown on the wires.

It will be seen that the function of the spring E is to hold the bar C against the lower side of the shaft when occupying the position indicated by the dotted lines in Fig. 1, as well as to maintain the bar in position with the collar 6 against the bearing D; whereas the effect of the spring H (or $H^{\times}$) upon the connecting wires is to keep them under proper tension in both working positions of the bar C, and to hold that part also in the path of the projection 5 when the bar is lying over the shaft. The two springs E—H, thus maintain the required degree of tension upon the line of connecting wires, and so control the vibrating hand that, under all variations in the length of the wires due to stretching, or to expansion and contraction of the metal, the relative position of the indicating-hand in either of its two adjustments to one side or the other of the center T will remain the same. Provision is made for regulating the tension of the spring H by attaching one end to a nut and screw 13.

In the form or style of indicator illustrated at Y in Fig. 1 the indicating-hand B is mounted on, or is a part of, an arm 12 that is movable in an arc on a stud 8, behind the curved sight-opening d in the front of the case W, and the connection between the arm 12 and the actuating-mechanism at the shaft A is made through wires p—p^2, and bell-cranks 2. In the indicator illustrated at X Fig. 1, the wire p^3 is connected to the arm 26 of the friction-device employed in that indicator, which is represented in detail in Fig. 6.

In the form of indicator illustrated at Z

Fig. 1, the indicator-hand B moves in right lines and is fixed on a slide-bar 24, movable in guides 25, and attached by one end to the oscillating-arm 112, that is arranged to move in a vertical arc from a center 8. A sprocket-wheel 15, also mounted on the same stud 8 that carries the arm 112, is connected with the rocking-bar C at the shaft A through the medium of the wires p—p', and a sprocket-chain 16. This connecting means has the effect to cause the arm 112 to vibrate on the stud 8 in harmony with the revolutions of the shaft A. As often as the bar C changes its angular position from one side to the other of the shaft, also, the indicating-hand B is moved over the center T to a working-position on the opposite side, as before described. A vibrating-mechanism of this construction has the advantage of imparting the vibratory movements to the indicating-hand, and also of changing the working-position of the hand in unison with the engine-driven shaft A directly from and in harmony with the movement of the shaft, through a single line of connecting wire.

A novel feature in this part of the mechanism in the several forms of the indicator consists in compensating connections preferably in the form of a friction-joint or coupling between the vibrating-arm 12 (or $12^{\times}$ or 112) and the part to which is connected the wire leading to the vibrating-mechanism. The object of this part of the invention is to prevent the indicator-hand from being thrown out of its normal working position on one side or the other of the center T, by variations in the length of the connecting wires, such as may be due to the expansion or contraction of the metal, stretching of the wires or from other causes.

As illustrated in Figs. 4 and 5 the arm 12 has a hub 14 screw-threaded to fit on the thread 10 of a sleeve 9, which is fixed to or formed in one piece with the sprocket-wheel 15. The sleeve is fitted loosely on the stud 8, and is also joined or attached to a cam 3 on the same stud, to which is attached one end of the coiled spring H. The tension of the spring is thus constantly applied to the sleeve in opposition to the strain of the chain on the sprocket-wheel, and the sleeve 9 receives rotative motion on the stud, first in one direction and then in the opposite direction, as the vibrating mechanism draws on the wire. A lock-nut 17 on the threaded-portion of the sleeve in front of the arm 12, provided with an arm 18, bears against the hub 14 of the arm 12 when the arm 18 is pressed outward by the spring 21, with the effect to bring the two faces 19—20 in contact and set up sufficient friction to lock the arm 12 on the screw-threaded sleeve. The arm 12 is thus locked on the sleeve when the two arms 12—18 are pressed and held apart by the spring 21, as in the position illustrated in Fig. 4, and under such condition the arm 12 will be locked on the sleeve and will vibrate with it. On the other hand, the arm 12 will be loosened on the sleeve, and will adjust itself to its proper working position in the sight-opening whenever one of the arms (12 or 18) is pressed towards the other by coming in contact with the stops 22—23, whether by moving the arm 12 towards the arm 18, or the last-mentioned arm towards the arm 12. Under such conditions, the sleeve will be free to turn on the stud 8 without affecting the arm 12, and any required extent of movement of the sleeve may take place in either direction according as the coiled spring H may take up any additional lengthening of the connecting wires arising from expansion or stretching, or any reduction in the length of the wires may cause them to act upon the sprocket-wheel in opposition to the tension of the spring. The angular movement of the arm 12 towards the arm 18 is produced by the fixed stop 22, and the similar movement of the arm 18 towards the arm 12, by the fixed stop 23, which is situated on the opposite side of the center of movement 8. The location of these stops is such that under normal conditions of adjustment the arms 12—18 will not come in contact with the stops, and will be held apart by the coiled-spring 21 placed between them. But should the vibratory movement of the arm 12 towards the left be increased beyond its normal length when the indicator occupies a working-position on the left of the center T, the arm 12 will strike the stop 22, whereupon it will be pressed towards the opposite arm 18, and its movement in that direction bringing the two arms towards each other, will act to reduce the degree of frictional contact between the parts 14—17 necessary to lock the arm 12, thereby loosening that part on the sleeve, and allowing the sleeve to turn separately of the arm. In like manner, an increase in the length of angular movement of the arm 12 toward the right when the indicator B has its working-position on the right of the center T, will have the effect to bring the arm 18 against the stop 23, and the arm 12 will be loosened on the sleeve the same as before.

In that modification of the compensating or friction-joint which is illustrated in Fig. 6, the wire p is connected with the indicating-arm $12^{\times}$ by a short arm or lever 26 fixed to, or formed as a part of, a sleeve or tubular piece 30 that forms the female-member of a friction-clutch, composed of a hub or tubular part 31 on the end of the indicator-arm $12^{\times}$ constituting the male-member. That portion of the member 31 over which is fitted the member 30 is preferably of conical shape to secure the necessary friction, and the parts are pressed together by the coiled spring 32 placed between the member 30 and a threaded-nut 34 on the cylindrical portion

of the member. In the event of a change taking place in the angular position of the arm 26, such as would take place under variations in the length of the connecting-wires, whereby the arm $12^{\times}$ will be brought against and arrested by one or the other of the fixed stops 22—23 in the case, the member 31 to which is attached the arm $12^{\times}$ will move in the part 30 of the coupling, and allow the arm to assume a different angular position. By this means the relative working-position of the indicating-hand in the sight-opening is kept always the same, whether it be set to vibrate on the left, or on the right, of the center T.

At casing Y, Fig. 1, I have illustrated one way in which I operate two separate counters, or registering-devices 36—37, directly by or from the vibratory movements of the indicating-hand, and thus provide a registration of the revolutions when the shaft is traveling forward, and a separate register of the revolutions made by the shaft when traveling backward. By this means the register 37 gives the total revolutions forward, and the register 36 the total revolutions backward. The registering-devices employed are of any well-known construction. They are situated in the case in close relation to the arm 12 or to the bar 24 when the indicating devices are of the character indicated at Z, are separately operated by a lever 38 connected at the fulcrum-end with the units-wheel of the counter by any well-known means, such as a pawl and ratchet-wheel, the lever 38 being set to stand in the path of the movable indicator, so as to be struck and moved by that part in its throw. The return-throw of the lever 38 is produced by a coiled-spring 41. Two such registering-devices, having their respective levers 38 oppositely set in this manner are separately operated by the arm 12 to register the forward and the backward revolutions of the shaft from which the indicator is operated. In the case X there is shown but one register which is arranged to show the total number of revolutions, both forward and backward, and is connected with and operated from the sleeve 30 of the compensating joint through a train of connecting parts consisting of a friction band 43 encircling the sleeve, an arm 40 connected therewith and a link 42 between this arm and an arm connected with the units member of the counter or register.

Fig. 3 illustrates the manner in which the vibrations of the indicating-hand and the changes in its working-position from one side to the other side of the center of the sight-opening can be produced from the movements of the cross-head in a reciprocating marine engine. The wire p^4 from the indicating-device is connected by the wire 50 with or into some part of the shaft-driving mechanism that changes its position with each change taking place in the direction of rotation of the shaft, such as the lever 51 of reversing mechanism. From the wire 50 a wire 52 is carried to a lever 53 pivotally mounted on the engine-frame, and having an arm 54 extending in the path of a stop or projection 59 carried by the engine cross-head 56. The wire 52 is attached to the end of one member of the lever 53, and to the opposite end a coiled spring 57, which is also attached to a fixed point 58 on the engine-frame, so as to maintain the lever 53 in proper working position. As the member 5 of the lever is struck by the projection on the cross-head, it produces a vibratory movement in the wire 50, which is transmitted to the indicator-hand through the connecting-wires, thus causing the indicator to vibrate in harmony with the reciprocations of the engine.

Combined with each indicator, illustrated at X and Y, Fig. 1 is a means for producing an audible signal every time the indicating-hand changes its working-position that is, each time it is shifted from one side to the other side of the sight-opening but arranged so that no signal is given when the indicator is merely vibrated; the same comprising a bell 60, and a striker-carrying spring 61, having an angular offset 62 so arranged in the path of a pin 70 on the indicating-hand 12 (or $12^{\times}$) that the spring will throw the striker against the bell and give a signal every time the indicating-hand is set over from one side to the other of the center T. The signal thus given by the bell makes known to the pilot the change in the direction of the travel, at the instant it takes place, without requiring him to ascertain the change by looking at the indicator-hand. This signal-bell is a useful auxiliary to the indicating-hand; particularly in relieving the pilot from the necessity of remaining at all times in a position at the wheel where the indicating-hand will be in sight. Every change in the movement of the engine from "ahead" to "astern", or in the opposite direction to which it was previously traveling is thus made known to the pilot by the bell at the moment of the change, without the necessity of watching for the movement of the indicating-hand.

The mechanism to which my invention relates is, as described, adapted to indicate the movements of a piece of machinery, and, merely for the purpose of illustrating the invention, I have, in this case, as for instance in Fig. 1, chosen to illustrate an apparatus in which there is a visual indicator B, an audible indicator 60 and recording indicators 36, 37. Therefore, when I herein refer, without words of limitation, to an indicator, I desire to be understood as applying that term in a broad sense, intending it to include as well, devices that indicate by means of a more or

less permanent record, such as a register, as those whose indicators are of a more transitory character, such as the audible or visual indicators represented.

In Fig. 3 hereof, I have illustrated an embodiment of my invention having the motion-transmitting devices connected directly with the parts of an upright reciprocating marine engine. This specific form of motion-transmitting connection I have made the subject matter of my application No. 328,970, filed August 2, 1906.

It will be seen that the connections described impart to the indicator two sets of movements; first, shift movements, or changes in the working position of the indicator, these consisting of relatively long movements that serve to indicate changes in the direction of motion, or in the setting of the parts of the apparatus to cause changes in the direction of motion, as indicated in the arrangement shown in Fig. 3; and, secondly, vibrations or relatively short movements that are entirely independent of the shift movements, and which serve to indicate revolutions, reciprocations or other movements by which the speed of the mechanism is indicated. These two sets of movements given to the indicator, may be either on curved lines, as indicated at X and Y, Fig. 1, or on right lines, as indicated at Z in said figure. The connections between the indicator and the part of mechanism whose movements are being represented are direct, that it to say, are such that the indicator gives a direct record of the work of the shaft or other part to which connection is made. For many reasons it is most desirable to make the connections above referred to of the mechanical sort; and I prefer to arrange them so that they tend to impart to the indicator, in making the shifts above described, movements that are abnormally long. This tendency to impart abnormally long shift movements is either constant and regular at each shift movement, or irregular in occurrence, as for instance when the connections are either unduly loose or taut. But while the connections are of such nature as to tend to impart these abnormal movements to the indicator, the latter is restrained and maintained in proper working position, this result being secured by reason of the yielding joint or connection between the indicator and the motion-transmitting wires or connections, and the positioning stops 22, 23 which arrest the indicator after it has been shifted to the desired, normal, extent.

Where, in this specification, I speak of shifting the indicator, I refer to the relatively long movements that are imparted thereto to indicate motion direction, and where I speak of vibrating it, I refer to the relatively short movements that are imparted thereto to indicate revolutions, reciprocations or such like movements indicative of speed.

It will be understood that my invention is not limited in its useful applications to apparatus for indicating the movements of a rotating shaft, as is clear from a consideration of the embodiment thereof indicated in Fig. 3. Therefore, when I herein refer to the indicator as being used in connection with, and adapted to show the movements of a revolving shaft, I wish it to be understood that such expressions are not used for the purpose of limiting the invention to a particular use or application, but rather for convenience of expression.

Having thus described my invention what I claim is:—

1. The combination with an engine-driven shaft, of an indicator for showing the movements thereof comprising a member having a to and fro movement and shiftable as to its working position from one side of a central point to the other side, and capable of vibratory motion in either of said positions, the said member by its working position serving to indicate the direction in which the shaft is being turned and by its vibrations the speed at which it is being driven, and means actuated directly from the said shaft and controlled by its revolutions, operating at every reversal of the motion thereof to shift the working position of the said member from one side of the center to the other, and to vibrate it in either position in harmony with the movements of the driven shaft, substantially as set forth.

2. The combination with an engine-driven shaft, of means for showing the movements thereof comprising a case having a sight opening and an indicator having a to and fro movement at the sight opening, and capable of being shifted as to its working position and of being vibrated in either of its working positions, and mechanical connections actuated directly from the shaft and controlled by its revolutions, and operating to vibrate the indicator in whatever position it may occupy in consonance with the rotations of the shaft, and arranged to shift the working position of the said indicator at each reversal of the direction of rotation of the shaft, substantially as set forth.

3. In a motion-indicator for an engine-driven shaft, the combination of an indicator mounted for vibratory movement at a sight-opening, and shiftable as to working-position from one side of the sight-opening to the opposite side, means operating to vibrate the said indicator in harmony with the revolutions of the engine-driven shaft and to shift the working-position of said indicator in every reversal of the said shaft, and a registering-device connected with the said vibrating means and operated in unison with the vibrations of the said indicator.

4. In a motion-indicator for an engine-driven shaft, the combination with a shaft, and a hand having vibratory motion at a sight-opening, and adapted by its vibrations to indicate the motion of the engine-driven shaft, and by its working-position with relation to the center of the sight-opening to indicate by its position the direction in which the said shaft is being driven; of means for vibrating the hand and for changing its working-position from one side of the center to the opposite side in every reversal of the engine, comprising a bar movable in an arc on a pivot-bearing, and also movable longitudinally through the said bearing, means connecting the indicator-hand with the member of the said bar on one side of its bearing, for moving the hand in harmony with the said bar, a projection on the shaft adapted to engage the said bar on the opposite side of said bearing and to lift and drop the bar in the revolutions of the shaft and by contact with the end of the said bar in a reverse movement of the shaft to change the working-position of the bar with relation to the shaft, and a spring acting on the bar in opposition to the projection carried by the shaft.

5. In a motion-indicator for an engine-driven shaft, the combination with a shaft, of a hand, a pivot on which the hand is mounted for vibratory motion behind a sight-opening, means for changing the working-position of the hand from one side of such center to the opposite side in every change made in the direction of travel of the shaft, and for imparting vibratory motion to the hand in either working-position; comprising a rocking-bar, a projection on the shaft adapted to lift and drop the said bar in the revolutions of the shaft and by engaging the end of said bar to change the working position of the bar as often as the direction of rotation of the shaft is changed, an arm movable angularly above on the pivot of the hand, a friction-clutch connecting said arm with the hand, and means connecting the said arm with the rocking-bar.

6. In a motion indicator for an engine-driven shaft, the combination of a hand, a support on which the hand is mounted for vibratory motion at a sight-opening and also changeable from a working-position on one side of the center of said opening to a corresponding position on the opposite side of such center, an arm on the pivot of the hand movable angularly around the pivot, means for vibrating said arm from the revolutions of the engine-driven shaft, said means operating also to change the working position of said hand in every reversal of the motion of the engine-driven shaft, means connecting the said arm with said vibrating means, a friction-clutch connecting the hand with said vibrating-arm, and means for regulating the friction between the parts of said clutch.

7. In a motion-indicator for an engine-driven shaft the combination of a hand pivotally mounted for vibratory motion behind a sight-opening and changeable as to working-position from one part to another of said sight-opening, an arm movable angularly about the pivot of the hand, and a friction-coupling between said arm and the hand, comprising a conical hub on the hand movable on the pivot, a sleeve surrounding the conical hub and to which the arm is secured, means for regulating the frictional contact between the hub and the sleeve, comprising an adjustable nut on the hub and a spring placed between the hub and the nut, and means for imparting vibratory motion to the said arm from the revolutions of the engine-driven shaft.

8. In a motion-indicator for an engine-driven shaft the combination, of an indicator having a to and fro motion; a spring for moving the indicator in one direction; means connecting the indicator with a moving part of the engine for moving it in opposition to the force of the spring and in harmony with the motion of the engine, means operating to change the working-position of the indicator in every change made in the direction of motion of the engine and a compensating connection between the indicator and the said connecting means.

9. In a device for indicating the work of a driven shaft, the combination with a shaft, of an indicator, a direct mechanical connection from the shaft to the indicator through which the movements of the shaft are transmitted to the indicator, and having a part bearing upon the shaft, and a spring for maintaining engagement of the said part with the shaft, the spring being located at the end of the connections distant from the shaft, substantially as set forth.

10. In a device for indicating the work of a ship's shaft, the combination with the shaft, having a contact projection, of an indicator, a direct, flexible, mechanical connection between the shaft and the indicator having a part bearing upon the shaft in the path of the said contact projection, and a spring situated adjacent to the indicator for holding the connections in engagement with the shaft and maintaining them under tension.

11. In an apparatus for indicating the movements of a ship's shaft, the combination with a shaft carrying a contact device, of an indicator, mechanical connections extending from the indicator to the shaft and including a reversible device resting upon the shaft and adapted to be engaged by the contact device of the shaft, and arranged to be reversed thereby whenever the direction of rotation of the shaft is changed and maintained in such reversed position until the direction of rotation of the shaft is next changed.

12. In an apparatus for indicating the movements of machinery, the combination with the mechanism whose movements are to be indicated, of an indicator adapted to be shifted from one position to another to indicate changes in direction of movement, mechanical connections between the indicator and the mechanism whose movement it shows, means for putting the connections under tension, and means for changing the tension of the connections when the direction of movement of the mechanism is changed to cause a shift of the indicator.

13. In an apparatus for indicating the movements of machinery, the combination with the machinery whose movements are to be indicated, of an indicator adapted to be shifted from one position to another to indicate direction of movement, connections including a yielding joint between the indicator and a moving part of such machinery adapted to shift the indicator to agree with the direction of movement of the machinery, the connections being arranged to impart to the indicator an abnormally long movement, means for arresting the indicator and maintaining it in position when it has been shifted to the proper extent, the said joint allowing movements of parts of the connections after the indicator has been stopped.

14. The combination with a shaft having a projection 5, of a bar adapted to rest on the periphery of the shaft in the path of the projection, a rocking shaft in which the bar is mounted, the bar being free to slide in its bearing therein to a limited extent, an indicator, connections between the indicator and the bar, and means for holding the bar in engagement with the shaft, substantially as set forth.

15. In a device for indicating the revolutions of a shaft, the combination with the shaft, of an indicator, a single line of direct mechanical connections between the shaft and the indicator, means for imparting to the indicator through the said single line of connections vibratory movements in one path when the shaft is rotated in one direction and in a different path when the shaft is rotated in the opposite direction and a contact bar to which the said line of connections is secured arranged to bear upon one side of the shaft when the latter turns in one direction and on the opposite side of the shaft when it turns in the other direction whereby the change of the position of the said bar from one side of the shaft to the other operates to shift the entire line of connections, substantially as set forth.

16. In an indicating apparatus for a piece of machinery, the combination of a reciprocating indicator, a single line of reciprocating connections through which the movements to the indicator are communicated, means for giving to the said reciprocating connections a movement in one direction when the mechanism is running forward and for imparting a reciprocation in the other direction when it is running backward, means for imparting relatively short reciprocations to the connecting devices to indicate the speed of the mechanism, and means for maintaining the said single line of connections under proper tension, substantially as set forth.

17. In an apparatus for indicating the movements of a shaft, the combination with the shaft provided with a projection, of a reciprocating indicator, reciprocating connections for giving motion to the indicator, and a contact-piece operated upon by the projection on the shaft and connected with the said reciprocating connections, and arranged to be set in one position or another, and through the said reciprocating connections to set the indicator in one position or another, accordingly as the shaft turns in one direction or the other, and arranged to be reciprocated by the engagement of the projection on the shaft with the said contact-piece as the shaft rotates, substantially as set forth.

18. In an apparatus for indicating the movements of machinery, the combination of an indicator adapted to be shifted from one position to another, connections through which the movements of the machinery are communicated to the indicator, and a compensating joint or connection between the said connections and the indicator, substantially as set forth.

19. In an apparatus for indicating the direction of rotation of a shaft, the combination with the shaft, of an indicator, connections through which motion is imparted to the indicator to shift it from one position to another, a bar to which the said connections are united, a spring for holding the bar in contact with the shaft when inclined in one direction, another spring for holding the bar in contact with the shaft when inclined in a different direction, and means operated by the shaft for shifting the bar from one inclined position to the other accordingly as the shaft is turned, substantially as set forth.

WALTER S. RUSH.

Witnesses:
EDWARD E. OSBORN,
L. M. FRANK.