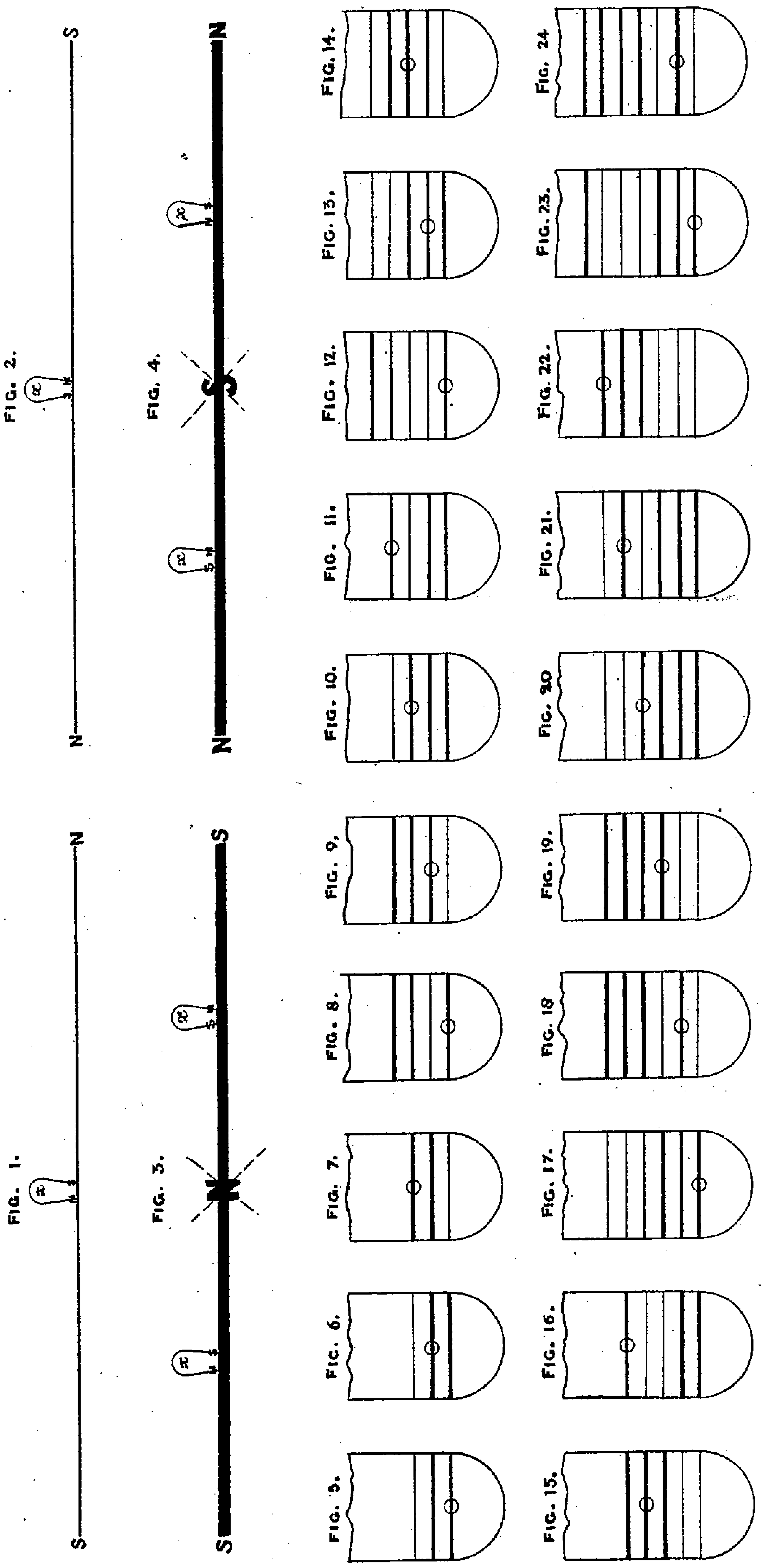
2 Sheets—Sheet 1.

J. W. GIRDLESTONE.

Ship's Compass.

No. 108,585. Patented Oct. 25, 1870.



Witnesses—, Geo: Pitt }
Redd. Carpmael } 24 Southampton Buildings London

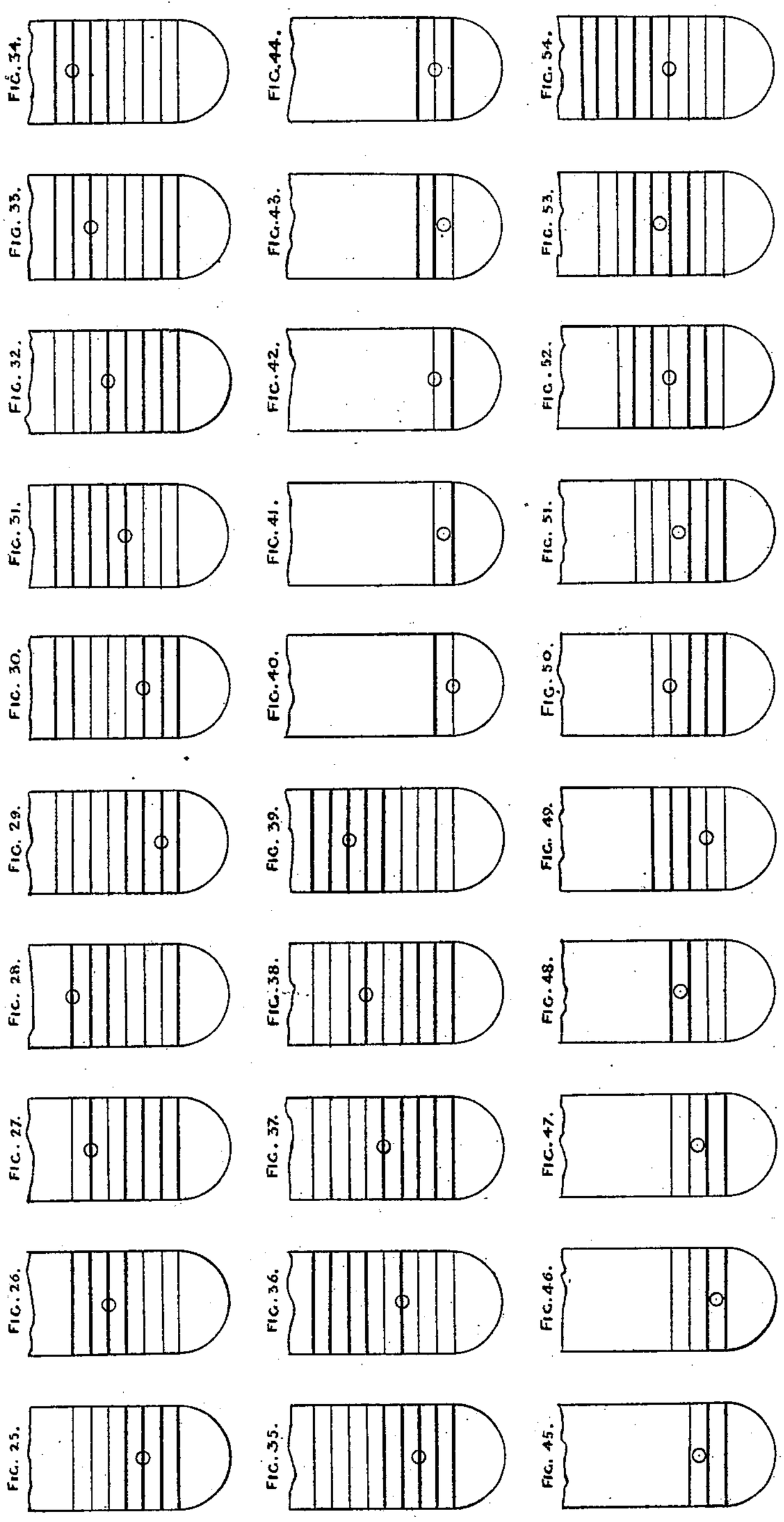
John Ward Girdlestone

2 Sheets—Sheet 2.

J. W. GIRDLESTONE.

Ship's Compass.

No 108,585. Patented Oct. 25, 1870.



Witnesses Geo: Pitt
Richd Carpmael

24 Southampton Buildings
London

John Ward Girdlestone

United States Patent Office.

JOHN WARD GIRDLESTONE, NO. 37 NORFOLK STREET, STRAND, ENGLAND.

Letters Patent No. 108,585, dated October 25, 1870.

IMPROVEMENT IN PREVENTING THE DEVIATION OF SHIPS' COMPASSES.

The Schedule referred to in these Letters Patent and making part of the same

To all to whom it may concern:

Be it known that I, JOHN WARD GIRDLESTONE, of No. 37 Norfolk Street, Strand, in the county of Middlesex, England, a subject of the Queen of Great Britain, have invented or discovered new and useful Improvements in Treating Ships and Vessels, to Correct and Prevent Compass Deviations; and I, the said JOHN WARD GIRDLESTONE, do hereby declare the nature of the said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof; that is to say—

This invention relates to a novel method of correcting and preventing compass deviations in iron, steel, or composite ships or vessels, by polarizing, on the regulated system hereinafter specified, such parts of the ships or vessels as may be requisite, and by the simultaneous employment, in some cases, of "soft" iron.

With a view to explaining the principle of my invention, I will notice briefly the cause and nature of compass deviations.

It is generally understood—

First, that the deviations of the compass from the magnetic meridian are due to the magnetism of the ship.

Second, that the deviations, observable by the aid of a horizontal needle when the ship is on an even keel, consist of two principal parts, termed "semicircular" and "quadrantal," with the addition, in some cases, of a small part, termed "constant."

Third, that the semicircular deviation consists of two parts, one arising from vertical induction, (which, in a well-placed compass, is, in general, but small,) the other arising from the permanent magnetism of the ship, and varying in character with the position of the ship when on the building-slip.

Third*, that the semicircular deviation is caused by a force acting in a particular direction in the ship, which force may, in general, be conveniently resolved into two forces, one acting in the fore-and-aft line of the ship, and the other acting athwart ship.

Fourth, that the quadrantal deviation is caused by horizontal induction.

Fifth, that the constant deviation arises mainly from two causes, namely, *a*, horizontal induction in soft iron unsymmetrically arranged, and, *b*, instrumental error.

Sixth, that, besides the deviations observable by the aid of a horizontal needle when the ship is on an even keel, there are likewise the errors that arise when the ship heels over, termed, respectively, semicircular heeling, quadrantal heeling, and constant heeling.

Seventh, that the semicircular-heeling error is caused, as to the greater part, by the vertical force of the ship, (*i. e.*, by vertical permanent magnetism, and by vertical induction in vertical iron,) and, as to the lesser part, by vertical induction in transverse iron.

Eighth, that the quadrantal-heeling error and the constant-heeling error are, (in the case of a well-placed compass,) in general, so small as to be disregarded with safety in the navigation of a ship.

According to my invention, I correct the semicircular deviation, and, in some cases, the semicircular-heeling error, by polarizing (either in whole or in part, as may be advisable) either one or more of the deck-beams, or the hull, or the stringers, or the ribs, or the stern-post, or any or each of these parts of the ship or vessel, or any other parts thereof, as may be requisite or advisable; also, I correct (when advisable) the quadrantal deviation, and, in part, both the semicircular deviation and the heeling error, by means of soft iron.

It may be well to remark that, although it may, in some cases, be convenient to polarize, (either in whole or in part,) for the purposes hereinbefore named, any, each, or either of the above referred to parts of the ship or vessel; yet, as a rule, it is more convenient to polarize, for the same purposes, deck-beams only. I, therefore, hereinafter more particularly specify my mode of proceeding when polarizing deck-beams only, and by the aid of this specification any competent person will be readily enabled, in any case, (if requisite or advisable,) to polarize, in accordance with my invention, any, each, or either of the other above referred to parts of the ship or vessel.

With a view to explaining the practical details of my invention, I will presently describe a process (to which process, as a separate part of my invention, I make no claim,) whereby bars of hard iron or steel (including the deck-beams of a ship) may be converted into magnets of two classes, which may be conveniently termed simple and compound.

By a simple magnet I here mean, first, that which has two poles only, namely, either at or toward its ends, or, at points equidistant from its center, poles of opposite names; and, second, that which (as regards its practical effect on the ship's compass) is equivalent to first, and has more than two poles, of which those situated nearest to and at either side of its center are of opposite names.

By a compound magnet I here mean, first, that which has three poles only, namely, a central pole of one name, and, either at or toward its ends, or at points equidistant from its center, poles of the opposite name; and, second, that which (as regards its practical effect on the ship's compass) is equivalent to first, has more than three poles, has no central pole,

and whose poles situated nearest to and at either side of its center, are equidistant therefrom, and are of the same name.

Simple magnets may, for the sake of convenience, be divided into two classes: first, those whose poles, situated nearest to and at the right-hand (or starboard) side of their centers, are north; second, those whose similarly-situated poles are south.

Compound magnets may be likewise divided into two classes: first, those whose central poles, or (in the case of magnets that have no central poles) whose poles situated nearest to and at either side of their centers, are north; second, those whose similarly-situated poles are south.

I would have it understood that, when I employ the term center, I intend by this term to indicate (in the case of a deck-beam of a ship) that part of the beam which would be intersected by a line passing through the middle of the compass, and running along or parallel to the midship line of the vessel.

I will now describe a mode of producing what are, as a rule, both the simplest and the most convenient forms of both simple and compound magnets, and by the aid of the following description any competent person will be readily enabled to produce, if needful, any other equivalent forms of these magnets.

I first describe a mode of producing a simple magnet of the first class.

Let the thin horizontal line, Figure 1, represent the bar proposed to be polarized. Place thereon, at or toward either of its ends, the horseshoe-magnet *x*, so that its poles may be parallel to the longitudinal axis of the bar, its south pole being turned toward the intended north pole of the bar. Then pass the magnet *x* from end to end of the bar, when at or toward that end of the bar toward which the south pole of the horseshoe-magnet was turned there will be a north pole, and at or toward the other end of the bar there will be a south pole. By repeating this operation, and by regulating the strength of the horseshoe-magnet, the strength of the bar-magnet thus produced may be regulated; and, if, from any cause, the requisite strength should be exceeded, then, by very carefully reversing the operation, the strength of the bar-magnet may be reduced.

A simple magnet of the second class may be produced by reversing the operation above described for the production of a simple magnet of the first class.

Figure 2 is drawn in illustration of a mode of producing a simple magnet of the second class.

I next describe a mode of producing a compound magnet of the first class.

Let the thick horizontal line, fig. 3, represent the bar proposed to be polarized. Place thereon, between the center (shown by the intersection of two dotted lines) and one of the ends of the bar, and near either, to the end, or to the center of the bar, the horseshoe-magnet *x*, so that its poles may be parallel to the longitudinal axis of the bar, its south pole being turned toward the intended central north pole of the bar. Then pass the magnet *x* between the end and the center of the bar. Next, remove the horseshoe-magnet from the half of the bar thus treated, and place it on the other half of the bar, so that its poles may be parallel to the longitudinal axis of the bar, its south pole being turned toward the intended central north pole of the bar. Then pass the magnet *x* between the end and the center of the bar, when at the center of the bar there will be a north pole and at or toward the ends thereof there will be south poles.

The strength of the bar-magnet thus produced may be regulated on the same principle as that described with reference to the regulation of the strength of a simple magnet of the first class.

A compound magnet of the second class may be produced by reversing the operations above described, for the production of a compound magnet of the first class.

Figure 4 is drawn in illustration of a mode of producing a compound magnet of the second class

I would have it understood that when hereinafter I employ either of the terms "simple magnet of the first class," "simple magnet of the second class," "compound magnet of the first class," or "compound magnet of the second class," I intend, under each of these terms to include any magnet that shall, when produced under the conditions hereinafter specified, and in accordance with the six rules hereinafter laid down, give a practical result equivalent to that which may be arrived at on producing, as above directed, under the same conditions and in accordance with the same rules, the magnet of the same term.

When polarizing a bar of iron or steel or a deck-beam of a ship, I usually employ either a permanent magnet or an electro-magnet, and I usually place the magnet with which I operate in contact with the bar; but, if from any cause I find this course either impracticable or inexpedient, I place the magnet as near to the bar as may be practicable or expedient, and proceed with the operation as if the magnet were in contact with the bar; I therefore, when polarizing a deck-beam of a ship, either bring the magnet with which I operate into contact with the beam, or I mark or chalk out on the deck, immediately above the said deck-beam, the exact position of the beam, and pass the magnet along the line thus indicated, as if along the beam itself.

In the case of a ship whose deck-beams are constructed of any material other than hard iron or steel, it may be found convenient, for the purpose of correcting and preventing compass deviations, to introduce beneath the deck, and near to the compass, two or more bars or beams of hard iron or steel.

In reference to my diagrams or figures numbered 5 to 54 inclusive, which figures are drawn in illustration of some convenient modes of correcting under different conditions referred to hereafter as leading and secondary, the deviations of any compass, I would remark that in each diagram or figure a circle represents the compass; and, further, that in each diagram or figure each thin horizontal line represents a deck-beam of either iron or steel, which I convert into a simple magnet of the first or second class, and each thick horizontal line represents a deck-beam of either iron or steel, which I convert into a compound magnet of the first or second class, according as it may be necessary to effect the conversion, in order to correct the deviations of the compass, as and in the manner hereinafter described.

The leading conditions under which my invention may be carried out are the following:

First, when the ship's head is placed successively on two of the four cardinal points, namely, at north or south and at east or west;

Second, when the ship's head is placed on one only of the four cardinal points; and

Third, when the ship's head is placed on any bearing other than either of the four cardinal points.

In proceeding to carry out my invention under the first leading condition above stated, I place the ship's head in the first instance, by preference, east or west, correct magnetic.

The vertical force of the ship causing the greater part of the semicircular heeling error may be then observed by comparing, in a plane at right angles to the meridian, the times of a given number of vibrations of a dipping-needle on board ship and on shore, placing the dipping needle on board ship over the centre of a deck-beam in a position suitable for the ship's compass, a mode of observation to which I make no claim, as forming a separate part of my in-

vention; also, I in some cases correct, either in whole or in part, the semicircular heeling error by correctly proportioning the times of the vibrations on board ship and on shore through the application of Rules I and II, which rules, with the others below referred to, are hereinafter set forth; also, I correct that part of the semicircular deviation which is caused by a force acting in the fore-and-aft line of the ship, through the application of Rules III and IV. I next place the ship's head north or south, correct magnetic, and, through the application of Rules V and VI, correct that part of the semicircular deviation which is caused by a force acting athwart ship.

If, from any cause, the operations have to be commenced when the ship's head is placed either north or south, correct magnetic, the force causing the heeling error may be observed by the aid of a dipping-needle, and, should the error be such as to need correcting, I place the compass over the center of a deck-beam, and through the application of Rules V and VI, correct that part of the semicircular deviation, which is caused by a force acting athwart ship, reserving, as a rule, the correction of the heeling error until the ship's head is placed east or west, correct magnetic, at which bearing, through the application of Rules III and IV, I likewise correct that part of the semicircular deviation which is caused by a force acting in the fore-and-aft line of the ship.

In proceeding to carry out my invention under the second leading condition above stated, I place the ship's head, by preference, east or west, correct magnetic; also, through the application of Rules I and II, I correct, either in whole or in part, the semicircular heeling error as already directed; also, through the application of Rules III and IV, I correct that part of the semicircular deviation which is caused by a force acting in the fore-and-aft line of the ship.

The force, acting athwart ship, and causing the other part of the semicircular deviation, may be observed by comparing the times of a given number of vibrations of a horizontal needle on board ship and on shore, (a mode of observation to which I make no claim, as forming a separate part of my invention,) and I correct the deviation by correctly proportioning the times of the vibrations on board ship and on shore, and, when the ship's head is east, and the time of the vibrations on board is too great, as compared with the time of the vibrations on shore, or when the ship's head is west, and the time of the vibrations on board is too small as compared with the time of the vibrations on shore, it is inferable that, with the ship's head north, there would be an easterly deviation, and with the ship's head south, there would be a westerly deviation, and I then effect the correction through the application of Rule V; and when the ship's head is east, and the time of the vibrations on board is too small as compared with the time of the vibrations on shore, or when the ship's head is west, and the time of the vibrations on board is too great as compared with the time of the vibrations on shore, it is inferable that, with the ship's head north, there would be a westerly deviation, and that, with the ship's head south, there would be an easterly deviation; and I then effect the correction through the application of Rule VI.

If, from any cause, the operations have to be carried out when the ship's head is placed either north or south, (correct magnetic,) I, in some cases, correct (either in whole or in part) the heeling error through the application of Rules I and II, placing the compass, for this purpose, over the center of a deck-beam; also, I correct, through the application of Rules V and VI, that part of the semicircular deviation which is caused by a force acting athwart ship.

The force, acting in the fore-and-aft line of the ship, and causing the other part of the semicircular deviation, may be observed by comparing the times of a given number of vibrations of a horizontal needle on board ship and on shore, and I correct the deviation by correctly proportioning the times of the vibrations on board ship and on shore, and, when the ship's head is north, and the time of the vibrations on board is too small as compared with the time of the vibrations on shore, or when the ship's head is south, and the time of vibrations on board is too great as compared with the time of the vibrations on shore, it is inferable that, with the ship's head east, there would be an easterly deviation, and that, with the ship's head west, there would be a westerly deviation; and I then effect the correction through the application of Rule III; and, when the ship's head is north, and the time of the vibrations on board is too great as compared with the time of the vibrations on shore, or when the ship's head is south, and the time of the vibrations on board is too small as compared with the time of the vibrations on shore, it is inferable that with the ship's head east there would be a westerly deviation, and that, with the ship's head west, there would be an easterly deviation; and I then effect the correction through the application of Rule IV.

In proceeding to carry out my invention under the third leading condition, above stated, I correct, when desirable, the heeling error (either in whole or in part) by the aid of a dipping-needle, and through the application of Rules I and II; also, I observe, calculate, or otherwise ascertain what would be, *a*, the directly observable deviation, and, *b*, the horizontal force (at the bearing at which the vessel lies during the operations) under the four circumstances following, namely:

First, if the semicircular deviation were in no part corrected;

Second, if that part only of the semicircular deviation caused by a force acting in the fore-and-aft line of the ship were corrected;

Third, if that part only of the semicircular deviation caused by a force acting athwart ship were corrected; and

Fourth, if the entire semicircular deviation were corrected.

Also, I either correct that part of the semicircular deviation caused by a force acting in the fore-and-aft line of the ship, by reducing or increasing (as may be requisite) both the directly-observable deviation and the horizontal force, until they equal the deviation and the force previously ascertained to exist when this part of the semicircular deviation shall have been corrected, and when it is inferable that, with the ship's head east there would be an easterly deviation, and that with the ship's head west, there would be a westerly deviation, I effect the correction through the application of Rule III; and when it is inferable that with the ship's head east there would be a westerly deviation, and that with the ship's head west there would be an easterly deviation, I effect the correction through the application of Rule IV; or I correct that part of the semicircular deviation caused by a force acting athwart ship, by reducing or increasing (as may be requisite) both the directly-observable deviation and the horizontal force, until they equal the deviation and the force previously ascertained to exist when this part of the semicircular deviation shall have been corrected, and when it is inferable that with the ship's head north there would be an easterly deviation, and that with the ship's head south there would be a westerly deviation, I effect the correction

through the application of Rule V; and when it is inferable that with the ship's head north there would be a westerly deviation, and that with the ship's head south there would be an easterly deviation, I effect the correction through the application of Rule VI; also, I correct the remaining part of the semicircular deviation by reducing or increasing, as may be requisite, (through the application, as inference may direct, of Rules III and IV, if the deviation to be corrected be that caused by a force acting in the fore-and-aft line of the ship, and through the application, as inference may direct, of Rules V and VI, if the deviation to be corrected be that caused by a force acting athwart ship,) both the remainder of the directly-observable deviation and the horizontal force, until they equal the deviation and the force previously ascertained to exist when the entire semicircular deviation shall have been corrected.

Before giving my six rules, to which I have made reference, I would remark—

First, that of my fifty-four diagrams of figures, those only that are numbered 5 to 39 inclusive, may be employed, in conjunction with Rules I and II, while those numbered 5 to 54 inclusive, may be employed in conjunction with Rules III, IV, V, and VI.

Second, that my six rules are so drawn up as to be serviceable, if needful, apart from my figures.

Rules.

I. When the time of the vibrations on board ship is too small, as compared with the time of the vibrations on shore, convert the deck-beam beneath the compass into a compound magnet of the first class.

II. When the time of the vibrations on board ship is too great, as compared with the time of the vibrations on shore, convert the deck-beam beneath the compass into a compound magnet of the second class.

III. When the ship's head is east, and the deviation east, or when the ship's head is west, and the deviation west, convert either, *a*, one or more deck-beams, lying, either wholly or in part, within a radius of about twenty feet of the compass, or *b*, every deck-beam represented on any figure by a thick line, into a compound magnet of the first class, if ahead of the compass, and into a compound magnet of the second class if astern of the compass.

IV. When the ship's head is east, and the deviation west, or when the ship's head is west, and the deviation east, convert either, *a*, one or more deck-beams, lying, either wholly or in part, within a radius of about twenty feet of the compass, or, *b*, every deck-beam represented on any figure by a thick line, into a compound magnet of the second class, if ahead of the compass, and into a compound magnet of the first class, if astern of the compass.

V. When the ship's head is north, and the deviation east, or when the ship's head is south, and the deviation west, convert either, *a*, one or more deck-beams, lying, either wholly or in part, within a radius of about twenty feet of the compass, whether ahead or astern thereof, or, except where the heeling error is, or is to be corrected, beneath the same, or, *b*, every deck represented on any figure by a thin line, whether ahead, beneath, or astern of the compass, into a simple magnet of the first class.

VI. When the ship's head is north, and the deviation west, or when the ship's head is south, and the deviation east, convert either, *a*, one or more deck-beams, lying, either wholly or in part, within a radius of about twenty feet of the compass, whether ahead or astern thereof, or, except where the heeling error is, or is to be corrected, beneath the same, or, *b*, every deck-beam represented on any figure by a thin line, whether ahead, beneath, or astern of the compass, into a simple magnet of the second part.

The secondary conditions under which my invention may have to be carried out will be fully understood, and my invention will be readily adapted to them by any competent person conversant with the subject, and acquainted with the details of this specification.

It will be perceived that the deck-beams shown on my diagrams vary in number, and that the compass is represented in various positions with regard to these beams.

In some cases, owing in part to the number of available deck-beams being limited, and in part to their position relative to the compass being, from different circumstances, immutably fixed, there will be found practically little or no room for the exercise of choice as to which, if any, of the different arrangements herein referred to, it may be best to adopt, and in these cases, those beams that are accessible to the operator must be dealt with as experience may direct; and in any case it will be well to bear in mind the two rules following, namely:

First, that it is of more importance to have a considerable number of deck-beams on which to operate when the deviations of a compass are great than when they are small; and

Second, that according as that part of the semicircular deviation caused by a force acting athwart ship is great or small, in comparison with that part caused by a force acting in the fore-and-aft line of the ship, the beams available for conversion into simple magnets should, as compared with those available for conversion into compound magnets have, (1), the advantage, or (2), the disadvantage either, *a*, in number, or, *b*, in proximity to the compass.

If, on preliminary observation, I find the deck-beam or beams, which I purpose polarizing, with a view to the correction of that part of the semicircular deviation which I correct second, so strongly magnetized as to affect the compass; or if, in cases when I correct the heeling error, after the correction of either or each part of the semicircular deviation has been effected, I find the deck-beam, which I purpose polarizing, with a view to the correction of the heeling error so strongly magnetized as to affect the compass, I, in some cases, before proceeding to correct the deviations of the compass, so far temporarily depolarize these said beams, adopting the same principle as that involved in the depolarization of a polarized bar, as to destroy temporarily their effect on the compass.

I would here remark that, after carrying out my invention under either of the three leading conditions above stated, the ship's head may, when advisable, be placed on the bearing, or on either of, or on each of the bearings on which it may have been previously placed, or it may be placed on any fresh bearing or bearings, and the operations in the first instance carried out may be checked; and by the aid of this specification any competent person will be readily enabled, if requisite, to carry out my invention, either in whole or in part, as may be requisite, at the fresh bearing or bearings on which the ship's head may be placed.

A vertical column or pillar of soft iron may, when advisable, be employed for the purpose of correcting that part of the semicircular deviation which is caused by vertical induction, and soft-iron rods, cylinders, or chains may, when advisable, be employed for the purpose of correcting, *a*, the quadrantal deviation, and *b*, the semicircular heeling error. But I make no claim to use either of such vertical columns or pillars of soft iron, or of such soft iron-rods, cylin-

ders or chains, as forming a separate part of my invention.

Having now described my system of correcting and preventing compass deviations, I would have it understood that

I claim as my invention—

1. The process of treating iron, steel, or composite ships or vessels to correct and prevent compass deviations by polarizing on the regulated system herein specified, such parts of the ships or vessels as may be requisite.

2. The employment of soft iron, in conjunction with my system of polarization, for the purpose of correcting compass deviations.

JOHN WARD GIRDLESTONE.

Witnesses:

G. F. WARREN, } *No.* 17 *Gracechurch Street,*
THOS. BROWN. } *London.*