(No Model.)

# A. FRANKE.

## ASTATIC GALVANOMETER.

No. 582,120. Patented May 4, 1897.

*Fig. 3.*

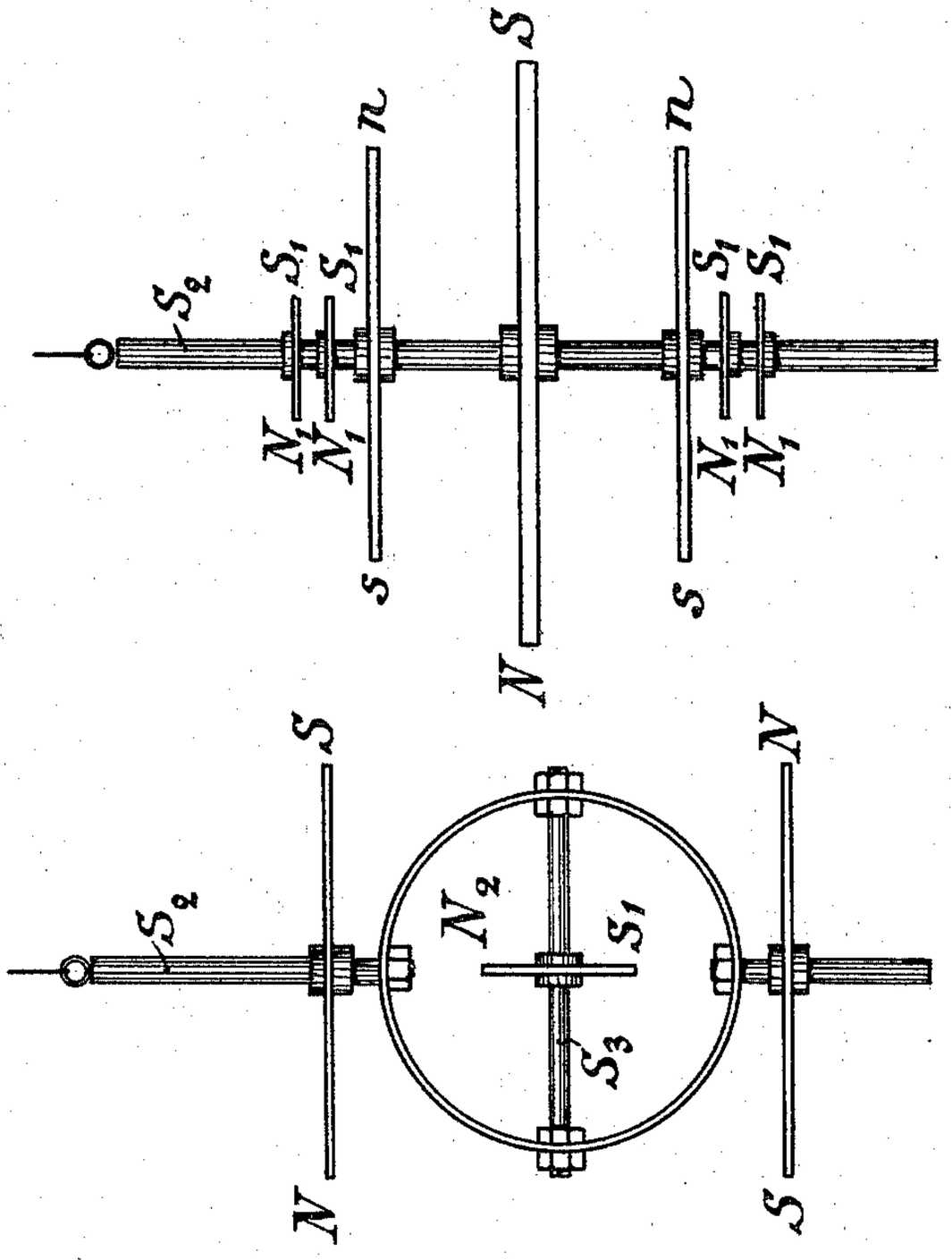
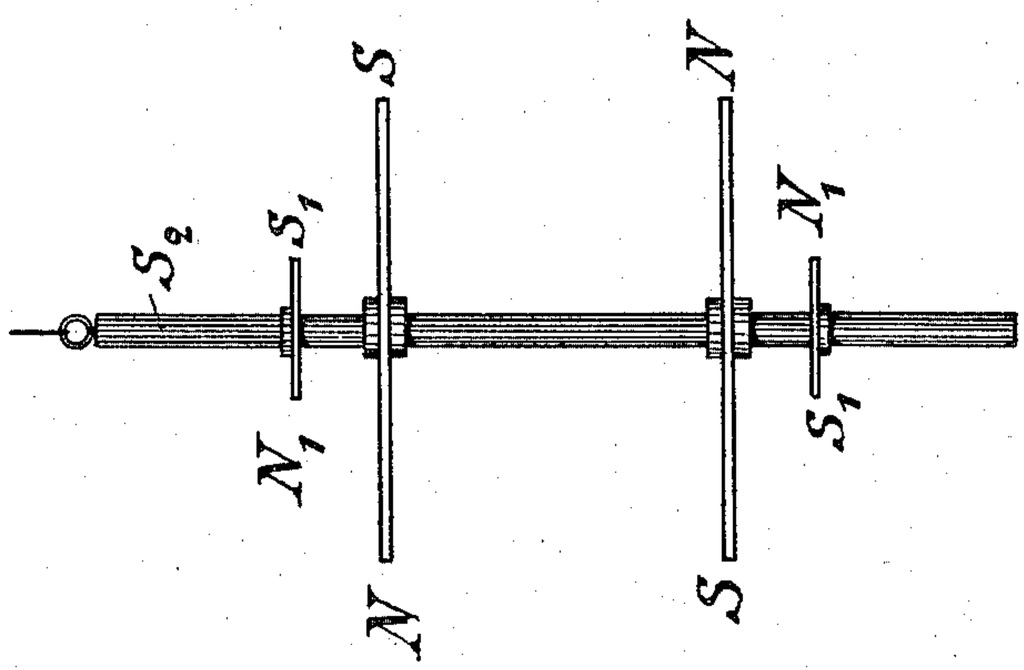



*Fig. 2.*




*Fig. 1.*

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# UNITED STATES PATENT OFFICE.

ADOLF FRANKE, OF BERLIN, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, OF SAME PLACE.

## ASTATIC GALVANOMETER.

SPECIFICATION forming part of Letters Patent No. 582,120, dated May 4, 1897.

Application filed September 29, 1896. Serial No. 607,359. (No model.)

*To all whom it may concern:*

Be it known that I, ADOLF FRANKE, a subject of the German Emperor, residing at Berlin, in the German Empire, have invented certain new and useful Improvements in Astatic Galvanometers; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention refers to astatic systems of galvanometer-needles.

The invention consists in adding to such systems a second system of small compensating magnets which counteract the component exerting a directing force on the system.

Of the accompanying drawings, Figure 1 shows an astatic system of magnetic needles arranged according to this invention. Fig. 2 shows an astatic system of magnetic needles to which the device forming the object of this invention is attached in a modified form. Fig. 3 shows a specially-constructed astatic system of magnetic needles with the device forming the object of this invention attached.

The same letters of reference indicate the same parts in all the drawings.

$S^2$ is a spindle, preferably made of brass or any other non-magnetic material and having attached to its upper end a ring or hook or similar device adapted to suspend it by a fine thread, as is usual in sensitive galvanometers and like instruments.

N S and S N are the magnetic needles proper, which are supposed to be arranged in the way usual in astatic galvanometers—*i. e.*, they are supposed to be made of approximately equal magnetic strength and to be fixed on the spindle $S^2$ in such a way that the directing influence exerted upon the one by the magnetic field of the earth is approximately counteracted by the directing force exerted on the other.

N′ S′ and S′ N′ are small magnets, the strength of which is made of such intensity that the sum of both their fields is stronger than the difference in the strength of the fields of the magnets N S and S N, but that the difference of the intensities of their fields is smaller than this difference.

The magnets N′ S′ and S′ N′ are supposed to be fitted onto the spindle $S^2$, so that they can be turned about said spindle; but they are supposed not to fit the spindle too loosely, so that they will readily retain any definite position once given them.

In the modification of my astatic system shown in Fig. 2 only one magnet N′ S′ is provided, but it is hung in such a way that its position can be altered not only in relation to the axis of the spindle $S^2$, but besides also with relation to a second axis $S^3$, comprising a right angle with $S^2$.

In Fig. 3 a modification of the astatic system proper is shown. Instead of using two magnets of approximately equal strength three are used, the one in the middle, N S, being of double the strength of the other two, *s n* and *s n*, above and below, and besides for each of these magnets a pair of compensating magnets N′ S′ is provided.

The operation of this system is the following: Since the sum of the magnetism of the compensating magnets N′ S′ and S′ N′ is slightly larger and the difference is slightly smaller than the difference between the intensities of the magnetic fields of the magnets N S and S N, a considerable alteration of the position of the compensating magnets N′ S′ and S′ N′ will cause a very small variation of the intensity of the field resulting from the addition of all four fields.

It is well known that according to methods hitherto practiced it was impossible to make a pair of needles so far astatic that the directing force of the field of the earth could be neglected in comparison with the directing force caused by the torsion of the thread by which the system is suspended. With the system above described, however, it is obvious that by regulating the relative position of the compensating magnets N′ S′ and S′ N′ a very accurate compensation of the divers fields can be obtained, and it has been found by experiment that it is quite easy by this means to obtain a degree of accuracy in the compensation which renders the instrument sufficiently insensible against any local disturbances of the earth's magnetism.

When a compensating magnet N′ S′ is mounted in such a way that it can be shifted around two axes comprising a right angle, as

indicated in Fig. 2, a second compensating magnet can be dispensed with.

A system as described, when properly adjusted, will remain uninfluenced by any external magnetic disturbances, provided that such disturbances do not cause the intensity of the magnetic field to assume different values at the same time within the space comprised by the system. Such, however, can easily take place when the cause of the disturbance is comparatively near the instrument. If this is the case, I employ the modification shown in Fig. 3. In this system the needle N S is fixed in the center of the whole system, and the needle S N is divided into two smaller needles, each possessing approximately half the amount of magnetism of the needle N S. The magnetism of each of the smaller needles *s n* is adjusted by a pair of compensating magnets N′ S′.

When the whole system is properly adjusted according to the above description, it will be seen that it will not even be disturbed by variations in the magnetic field which cause differences in the intensity within the space comprised by the system, provided only that the variation of intensity is practically constant between the needles *s n s n*. If this is the case, as it will be in the great majority of cases, too much torque exerted, for instance, on the upper needle *s n* will be naturally compensated by a corresponding lack of torque exerted on the lower needle *n s*, the whole system thus remaining uninfluenced.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. The combination of a swinging system of astatic needles and, attached thereto, a second adjustable magnetic system considerably weaker than said first system.

2. The combination of an astatic system of needles and, attached thereto, an adjustable magnetic system considerably weaker than any one needle of the astatic pair.

3. In galvanometers the combination with the astatic system of needles of a pair of compensating needles magnetized so much that the sum of their magnetic fields is stronger and the difference of their magnetic fields is weaker than the difference between the fields of the two needles of the astatic system, such compensating needles being attached to the spindle or framework carrying the astatic needles proper and being fitted onto such spindle sufficiently tight to readily assume but not easily to lose any position that may be given them substantially as and for the purpose set forth.

4. An astatic system of magnetic needles for galvanometers in which the one of the pair of astatic needles is replaced by a pair of needles each possessing half the intensity of field of the remaining needle and being arranged symmetrically to it, each being provided with a pair of small compensating needles fitted to turn easily but not loosely on the spindle carrying the astatic system, substantially as and for the purpose set forth.

In testimony whereof I affix my signature in the presence of two witnesses.

ADOLF FRANKE.

Witnesses:
OSCAR KIELEFELD,
PAUL RAREHORN.