AGA's CONTRIBUTION TO ENGINEERING AND SCIENCE

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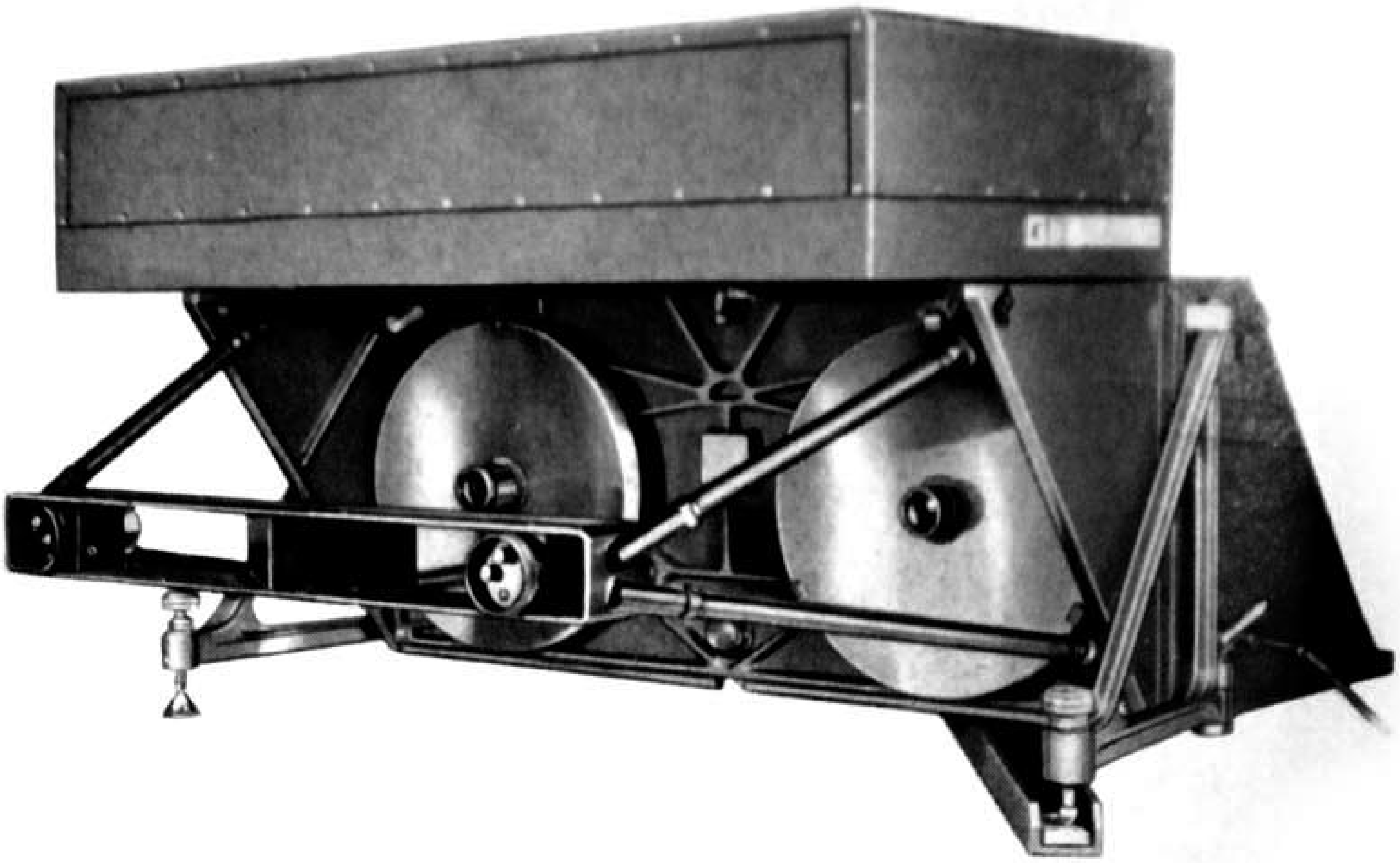
THE AGA GEODIMETER

For accurately determining the position of points in the field which serve as fixed points for mapping purposes it has been customary hitherto to start from a base line the position of which is exactly determined by astronomical methods and the length of which, usually a maximum of 7 km, is measured directly with a carefully calibrated invar tape 24 m in length. From the terminal points on this base line the angles to a third point are then determined, which together with one terminal point of the base line determine the first side in a chain of triangles having sides of about 20—40 km. The position of these triangle points is, of course, all the more uncertain, the further the distance from the base line is, owing to the fact that the inevitable errors which occur when determining the angles are added progressively. Moreover, the position of the triangle points must be so selected that clear visibility is obtained in four directions, and consequently they should preferably be located at high points on the ground. Where natural points of this kind are not available special towers of a permanent or temporary character must be built. Furthermore, certain data, such as the determination of distances between isolated islands, are difficult to obtain with the necessary accuracy, as it is not always possible to set out a base line of sufficient length. For these reasons attempts have been made for a long time past to find a practical method which would permit the distance between two points to be measured directly with an accuracy corresponding to a maximum error of a few cm/10 km. The methods of determining distances with the help of radio waves has been tried out, but the difficulties are considerable, since it is difficult to determine the rate of propagation at the frequencies employed with sufficient accuracy. Moreover, the presence of electrically conducting objects in, or close to, the direction of measurement gives rise to appreciable errors that are difficult to check.

A Swedish geodesist, Dr. Erik Bergstrand, demonstrated at the end of the 1940s that it was possible in practice, by employ-



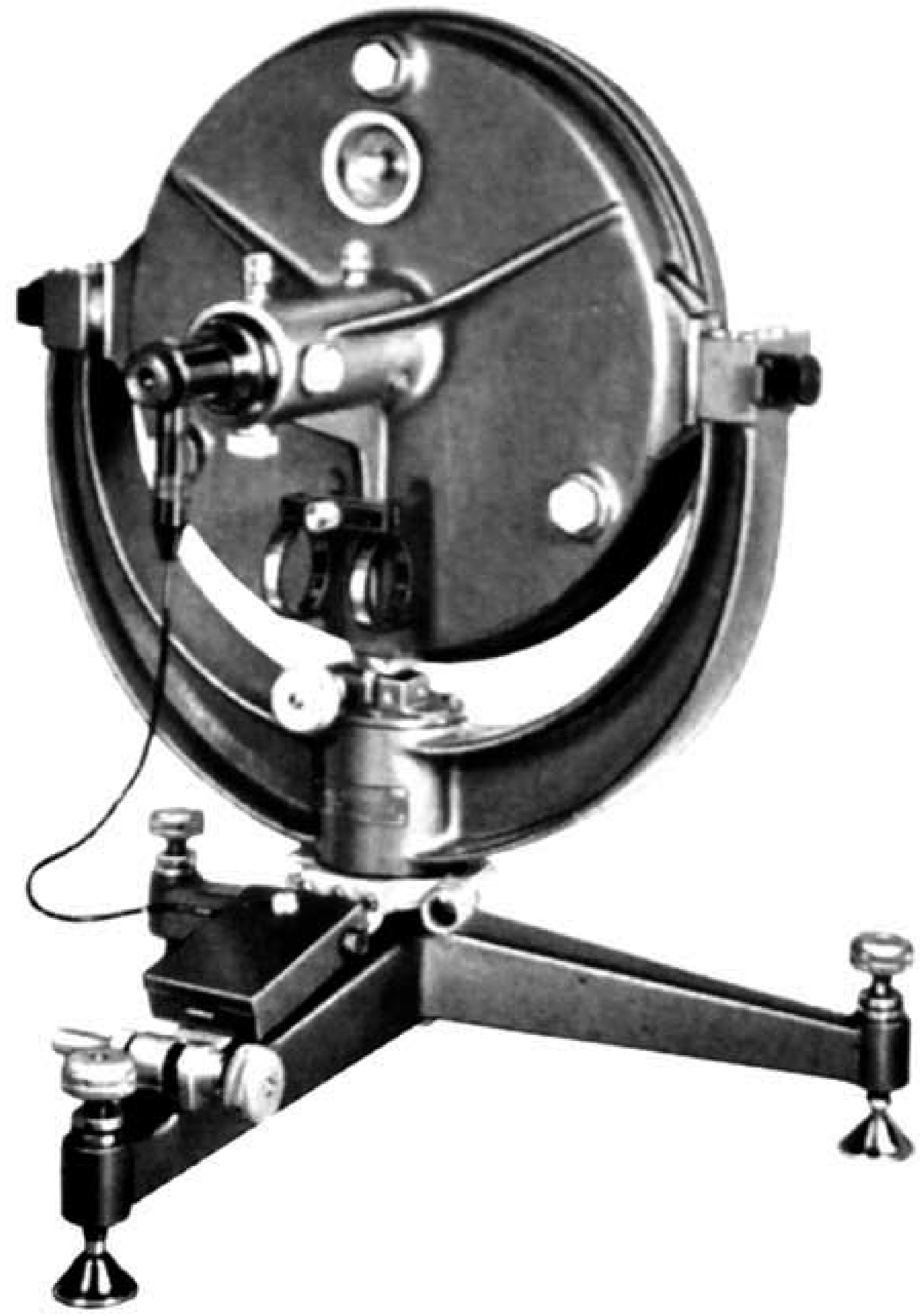
The geodimeter as seen from the rear (mirror) side.

ing light, to carry out direct determinations of length with the high degree of accuracy necessary in geodetic measurements. The advantages resulting from the use of light are considerable, inasmuch as the rate of propagation of light waves is very accurately known and the disturbing influence of electrically conducting objects referred to above is entirely eliminated.

The principle of the Geodimeter, the name adopted for the Bergstrand instrument in the improved form in which it is now manufactured by AGA, is based on a modification of the method employed by Fizeau more than 100 years ago in his experiments for determining the speed of light.

Thanks to the introduction of modern electronic and optical appliances, however, the sensitivity and accuracy have been increased to a very high degree.

The light ray employed for the measurements is divided up into flashes by means of a Kerr cell and a crystal-controlled high frequency generator; 10,000,000 such flashes being transmitted per second. After reflection in a reflecting device located at the other end of the section measured, the flashes are received by the geodimeter's receiver in which a highly sensitive photoelectric cell converts the light impulses into electrical impulses. The distance is ascertained by measuring time taken by the light ray in its passage over the measured section. Since the speed of propagation of light is accurately known and the flashing frequency is well defined by the crystal-controlled generator, the accuracy in the determination of the distance will also be very high. The Geodimeter is equipped with a built-in calibrating device by



The plane mirror, part of the geodimeter. — One of the difficulties encountered with this new method of measurements was the speedy adjustment of the plane mirror to make the reflected beam strike the geodimeter receiving mirror. It was like playing with a sunspot at a distance of some twenty kilometers. The present design renders it possible for the observer to 1) adjust the field glass at right angle to the plane of the mirror 2) direct the beam from the mirror on to the geodimeter receiving mirror, all in about five minutes' time.

means of which the effect of instrument errors is considerably reduced.

The reflecting device is constructed in two forms. In one of them a flat mirror with a high degree of precision is employed, arrangements being provided for adjusting its direction. The direction of the light ray may be subjected to slight variations owing to changes in the temperature of the air. The flat mirror must therefore be placed under the supervision of a special observer who adjusts the mirror's position as required so that it is at right-angles to the incident rays. The other reflecting device has a somewhat lower efficiency but it possesses the advantage that it reflects the rays in the correct direction, i.e. towards the source of light, within an angle of about 1° from the optical axis. It therefore requires no further supervision after it has been ascertained that its axis is directed within 1° from the Geodimeter.

The Geodimeter is built up on a framework of cast aluminium, thus obtaining excellent stability combined with a relatively low weight. The components employed have been selected with a special view to unfavourable climatic conditions. For transport purposes the instrument is placed in two transport cases provided with special shock-absorbing suspension arrangements. The reflecting device is stored in a special carrying equipment which can be borne on the shoulders.