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Shifts of Arc Lines at Various Pressures in Magnetic Fields

An investigation of certain spectral lines emitted in a high-voltage arc between brass electrodes in nitrogen gas was made under pressures of from 1/7 to 85 atmospheres. The arc was run in and out of a magnetic field of 4,000 gauss. An empirical relation between the shift with and without a magnetic field at varied pressures for nine spectral lines has been found. There was a certain amount of scatter in the shifts of the lines, but among the hundreds of measurements of the spectral lines studied from Eastman Kodak spectrum analysis No. 2 plates, a significant pattern of shifts was found which differed for emission in a magnetic field from emission in a non-magnetic field.

Although the shift of any particular arc line under pressure is not steady the emergent pattern is quite evident. In all cases, the shift due to pressure in a magnetic field is less than in a non-magnetic field. With the exception of the first principal lines of copper, the shift of which seems to be anomalously changed by the magnetic field, lines most shifted by the pressure are most affected by the magnetic field.

In Fig. 1 pressure shifts of spectral emission lines of zinc, copper and lead in a magnetic and non-magnetic field are shown. It is apparent that, in addition to a decreased pressure shift in a magnetic field, the slopes of the lines for pressure shift versus pressure are less steep for emission in a magnetic than in a non-magnetic field. The ^3P–$^3P'$ lines of lead are an exception. Even for lead, the slope is not greater in a magnetic field. Lead lines were the only ones considered for which the coupling was j–j.

These results give considerable support to the theory that the normal van der Waals forces responsible for pressure shift are counteracted in a magnetic field by space-charge forces. In a magnetic field, electrons and ionized metal gas ejected from the electrodes follow different paths between the high-voltage (5,000-V. a.c.) electrodes. It is suggested that a space charge made up of ions of vaporized metal is present in the space of the discharge when a magnetic field is applied. The magnetic field is perpendicular to the electric field between the electrodes. Motion of the charged particles is reversed by the a.c. electric field 120 times per second. In their much slower acceleration from zero velocity, the positive ions are