

man and Ferraro *did* develop³ the theory of plasma oscillations, on the walls of conducting slabs and cylinders, at a time when these were being independently discovered in the laboratory by Tonks and Langmuir, and by J. J. Thomson. Chapman and Ferraro deduced that neutral beams of ions and electrons would pass freely across a magnetic field under conditions where plasma oscillations occurred on the boundaries; if they had awaited laboratory demonstration of this, the progress of magnetic storm theory would have been retarded by two decades.

Prof. Alfvén still believes that Birkeland's model of the current system in magnetic storms can explain the observed facts, in spite of the careful refutation of this model by Vestine and Chapman⁴. Recently, at my suggestion, Mr. C. B. Kirkpatrick⁵ has re-examined the Birkeland model, substituting current sheets for line currents, in an attempt to make it fit the facts. He fully confirms Chapman and Vestine's conclusion that even with substantial modification the Birkeland current scheme cannot be valid.

Prof. Alfvén makes no specific criticism of my extension of Chapman and Ferraro's work; doubtless his stimulating comments on this will be available in due course. All workers in the field must welcome careful critical discussion of this difficult subject.

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¹ Chapman, S., *J. Atmos. and Terr. Phys.*, **1**, 189 (1951).

² Alfvén, H., "Cosmical Electrodynamics", 203 (Oxford Univ. Press, 1950).

³ Chapman, S., and Ferraro, V. C. A., *Terr. Mag.*, **36**, 77 (1931).

⁴ Vestine, E. H., and Chapman, S., *Terr. Mag.*, **43**, 351 (1938).

⁵ Kirkpatrick, C. B. (to be published shortly).

Geomagnetic Effects of Solar Flares

FROM a study of the geomagnetic effects produced at widely separated stations on three occasions of intense solar flares, McNish¹ concluded that "the change in the magnetic field caused by the chromospheric eruption consisted of an augmentation of the diurnal-variation departure, obtaining at that time in each element". This result, which has had important repercussions on the theory of the solar and lunar daily magnetic variations, was supported by Newton's² paper concerning the geomagnetic flare effects occurring at Abinger (England) during 1936-46.

A recent investigation of the geomagnetic solar flare effects at Lerwick (Shetland Islands) and Eskdalemuir (Dumfriesshire, Scotland) during 1936-49 has brought to light the interesting fact that while McNish's conclusion is fully substantiated by the horizontal (H) and declination (D) components of the magnetic flare effects at both stations, the vertical (V) component generally opposes in sense both the V component of the corresponding flare effect at Abinger and that of the normal magnetic daily variation at the respective Scottish stations. This result is

interpreted as indicating that there are substantial differences between the space distribution of the ionospheric currents producing the geomagnetic effects of flares and those producing the normal daily magnetic variations. The 'normal' departures at Lerwick, Eskdalemuir and Abinger during most of the daylight hours are such as might be produced by an approximately east-west ionospheric current flow with maximum concentration north of Lerwick, while the magnetic effects produced at the three stations by solar flares are generally such as to show that the ionospheric current flow producing these effects has a zone of maximum current concentration not far south of Eskdalemuir.

The results of the investigation will be published in full elsewhere.

I am indebted to the Director, Meteorological Office, for permission to publish this note.

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¹ McNish, A. G., *Terr. Mag.*, **42**, 109 (1937).

² Newton, H. W., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 200 (1948).

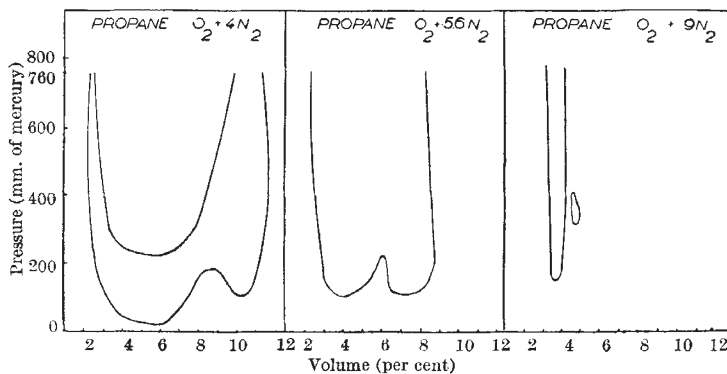
Inflammability Ranges of Propane - Air Mixtures under Reduced Pressure

INVESTIGATIONS of the inflammability ranges of propane-air mixtures have led investigators to assume the possible existence of a complex system of overlapping ranges occurring at high concentration in propane and presumably appearing when a powerful enough source of ignition is used.

Ignition in our case was obtained by a spark produced by an air condenser charged at 22,000 volts passing through two small platinum electrodes at the base of a closed tube 4 cm. in diameter and 80 cm. high. The device used allowed us to employ either a single spark, corresponding to a single charge and discharge of the condenser, or a train of such sparks (duration of whole less than one second). The single spark gave the classical inflammability-range¹ whereas the train of sparks led to a considerably widened one.

The particular shape of the inflammability limit diagram led us to the hypothesis of an overlapping system of two different ranges, due to two different mechanisms of combustion.

The effect of increasing the nitrogen content in these mixtures was further investigated in the hope of separating the two ranges. The accompanying diagrams show the different concentration and



Inflammability ranges of propane-air-nitrogen mixtures