Fig. 2

transmission appears to peak somewhere in the range $2.5 < a^2/\lambda X < 3.0$. Similar behaviour has been noted for focusing with a mirror in the near field². The transmission percentage could be increased by better choice of α , optimum taper design, appropriate optical coating, etc. It appears to be true, however, that the percentage transmission for a given tube depends on its position in the laser near field.

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Surface Charges on Arc Track Oxide Layers

IN experiments by us and by others¹, with arcs driven by magnetic fields along non-refractory metal electrodes, it has been found that the arc velocity increases when the arc travels over the electrode surfaces a second and subsequent times, within a short time interval after the first run. Other experiments with a short arc rotating around annular electrodes² have shown that, above a certain gas pressure, the forward velocity was no longer limited by the time taken for the transfer of emitting sites along the cathode surface, as occurred with a single passage of the arc. In each case the time needed to set up new emitting sites has apparently been considerably reduced by the previous passage of the arc. If cold-cathode arc emission is due to the charging of oxide layers by positive ions³, then a possible cause of these results would be that some positive ions remain un-neutralized on cathode oxide layers for appreciable times.

In order to investigate this possibility, cathode and anode tracks on various non-refractory metals have been examined by electrometer methods. Two methods were used in order to check whether their results were in agreement, as in fact they have proved to be. In the first,

the arc track to be examined was formed on a rotating disk by arcing to a radial electrode, and driving the arc outwards across the disk and electrode by a magnetic field. The arc track thus formed passed periodically under a probe connected to the grid of an electrometer pentode, and the voltage across the valve was displayed on a cathode-ray oscilloscope. By this method it was possible to measure pulses occurring at each passage of the track under the probe within 8 msec of its formation, and then at any time thereafter. The Kelvin vibrating electrode method with the same electrometer and probe, and a thin strip electrode, was used to confirm the results.

It has been found that on both cathode and anode tracks of all metals tested (aluminium, copper, brass and platinum) the polarity of the pulses has been that corresponding to negative charges on the tracks. After a rapid initial decay, the pulse height decreased relatively slowly and after 6 weeks was still about 25 per cent of the initial value. The p.d. between that of the arc track and that of the surrounding metal surface was mainly in the range 0.1–0.5 V within a few msec of the passage of the arc, and was generally somewhat lower on the anode than on the cathode, an exception being a high-current high-velocity arc on brass where the reverse was found.

The pulses in the rotating disk method could arise from: (1) variation of capacitance between the probe tip and disk; (2) collection at the probe of electrons emitted from the track; (3) differences between the distribution of charge or the oxide thickness on the track and that on the surrounding surface. The first possibility may be eliminated since surface measurements showed a small depression in the region of the arc track, which would tend to give rise to an extremely small positive pulse.

Although there is the possibility of significant electron emission within a very short time of the establishment of the tracks, for various reasons it appears to be more likely that the voltages measured are differences in surface p.d. between the track and the rest of the surface, due to dipole layers on the oxide caused by adsorbed gas. They could arise because the oxide layer is thicker on the track than on the rest of the surface with both having the same negative-charge density, or because the oxide thicknesses are the same but the track offers more adsorption sites and the charge density there is greater, or there could be a combination of the two effects.

No evidence has therefore been found of positive ions remaining un-neutralized on the surface oxide layers, although if they were responsible for emission from the cathode for a short time, their presence could be masked by emitted electrons and the negative dipole layer. The anode track p.d. suggests that oxide growth effects rather than positive ions are largely responsible for the results.

Any association between the higher arc velocities on second and subsequent runs and the negative dipole layers of the oxide will need further investigation. Suggestions that electron emission can occur from negative ions on oxide layers⁴ have referred to oxide layers of about 1000 Å, and there is no evidence that if oxide thickness is increased on arc tracks it can reach this value.

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