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EFFECT OF CATHODE LENGTH ON THE CHARACTERISTICS OF THE GRIDDED CORONA VOLTAGE STABELIZER DEVICE

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ABSTRACT

The present work is intended to investigate the properties of a gridded wire-plate corona device when used as corona voltage stabelizer (GCVS). In particular it is devoted to the investigation of the dependence of the stabelization on the cathode length (L_c).

INTRODUCTION

The need for voltage stablization has been so common and important that certain preferred circuits and standard practices have been developed. The corona voltage stabelizer at normal atmospheric pressure was investigated[1]. The basic mechanism of various corona modes and corona stabelization have been studied by Loeb[2]. More work has been done on the wire-plane [3,4,5] and gridded devices[6] for CVS devices.

The study of the cathode length variation is found to be more complicated as it is necessary to take into consideration the fact that the discharge of electricity is confined to that portion of the anode wire covered by luminous glow. If the length of the cathode is varied the operating length of the wire increases and therefore the corona current increases. The present work is devoted to study the effect of cathode length on the characteristics of GCVS device.

EXPERIMENTAL SET UP:

The arrangement of the GCVS device is shown in Fig.(1) which consists of a highly polished plate serves as cathode of area 14.2 x 6.2 cm^2. Ankor wires of diameter 0.33 mm were used as anode and grid wires. The distance between the single anode wire and the cathode plane h_a is 2 mm, the distance between the double wires grid and the cathode plane h_g is 5 mm and the separation between the grid wires is 3 mm The limiting resistance on both anode R_a and grid R_g is each 20 MΩ .

Two equal mica strips have been used to insulate the two rounded ends of the plane cathode from the anode wire and also to vary the effective cathode length L_c from 1.2 to 13.2 cm which is fixed by the separation distance between the two mica strips.The GCVS device is placed in a closed enclosure inside which the relative humidity R.H. and temperature T are kept constant during the running time of the experiment i.e. R.H. = 30% and T = 25°C.

RESULTS AND DISCUSSION

The variations of the corona current I_a with the anode applied votlage V_a was determined and shown in Fig.(2). It has been found from this figure that for a given applied voltage, the corona current I_a increases as L_c expands,and for a given L_c the steady corona current starts by a very small region where it increases nonlinearly with increasing the applied voltage beyond which it almost increases linearly according to the relation

$$I_a = m\,V_a + I_o \qquad (1)$$

where m and I_o are constants.

Applying the least squares fit to the present experimental results in these linear region of the corona current curves the constant values of m and I_o corresponding to different values of L_c were determined and represented in table (1). Applying the least-squares fit for m and I_o represented in Fig. (3), empirical formulas of the second order have been determined for m and I_o in terms of L_c . Thus an empirical formula was determined for I_a interms of V_a for different values of L_c in the form.

$$I_a = \left[(-196.3 - 8.1\,L_c + L_c + 0.47\,L_c^2) + (39.53 + 1.83\,L_c - 0.084\,L_c^2) \times 10^{-3}\,V_a\right] 10^{-6}\ \text{amp.} \qquad (2)$$

where L_c in mm and V_a in volts.

Table (1) The computer values of m and I_o

L_c(cm)	I_ox10^{-6}(Amp.)	m x 10^{-6} (ohm^{-1})
13.2	-221.3 ± 0.0239	0.0490 ± 0.0041
12.2	-225.6 ∓ 0.0188	0.0494 ∓ 0.0043
11.2	-228.1 ∓ 0.0389	0.0495 ∓ 0.0039
10.2	-230.0 ∓ 0.0267	0.0495 ∓ 0.0039
9.2	-231.0 ∓ 0.0340	0.0493 ∓ 0.0040
8.2	-231.0 ∓ 0.0340	0.0489 ∓ 0.0069
7.2	-230.3 ∓ 0.0180	0.0481 ∓ 0.0063
6.2	-228.5 ∓ 0.0630	0.0476 ∓ 0.0013
5.2	-225.7 ∓ 0.0188	0.0468 ∓ 0.0013
4.2	-222.0 ∓ 0.0113	0.0457 ∓ 0.0067
3.2	-217.4 ∓ 0.0134	0.0445 ∓ 0.0067
2.2	-211.8 ∓ 0.0860	0.0431 ∓ 0.0013
1.2	-205.3 ∓ 0.0794	0.0416 ∓ 0.0025

In Fig.(2) the computed values (full curves) of I_a vs. V_a are plotted. On the same figure the experimental values (circles) are represented, it show good agreement.

In the steady corona region the effective voltage V_{ae} between the anode and the cathode is given by

$$V_{ae} = (1 - m\,R_a)\,V_a - I_o R_a \qquad (3)$$

Substituting for $R_a = 20\ M\Omega$ and $(m,\ I_o)$ from table (1) the relation between V_{ae} and V_a is determined and represented in Fig. (4) for various values of L_c. From this figure it is clear that the slopes of the plateau regions are positive and increase with decreasing L_c.

From Eq.(3)

$$\frac{dV_{ae}}{dV_a} = 1 - mR_a \qquad (4)$$

The values of dV_{ae}/dV_a vs. L_c are illustrated in Fig. (5) which are constructed from the basic data of the corona current with the help of eq. (4). It is clear that the value of dV_{ae}/dv_a decreases with decreasing L_c from L_c = 13.2 to 10.2 cm after which it increases with decreasing L_c.

The values of the internal resistance r_d of the device are calculated by the equation.

$$r_d = \frac{V_{ae}}{I_a} \qquad (5)$$

Fig.(6) gives the relation between (r_d) and the applied voltage V_a for different values of L_c. From this figure it is clear that the value of r_d increases gradually with the decrease of V_a comming to steep rise.

Fig.(7) shows the relation between L_c and the a.c. resistance r_a of the device which is denoted by eq.(6).

$$r_a = \frac{dV_{ae}}{dI_a} \qquad (6)$$

From Fig.(7) it is clear that r_a decreases with increasing of L_c until L_c = 11.2 cm while it increases with increasing L_c for L_c = 12.2 cm and 13.2 cm.

Most often stabilizer devices are used incircuits where the load resistance is constant and the source voltage is subject to variations. Then as the source voltage rises, the current through the device increases, and nearly all voltage change is absorbed across R_a, so that the voltage across the device remains practically constant (or increases insignificantly) provided the device current remains within the normal glow region of the characteristic.

Nevertheless, the cathode length L_c was found to be an interesting parameter which affects the working conditions. Thus it is necessary to select the suitable L_c for any experiment and fix this value during the time of the results.

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تأثير طول المهبط على خصائص جهاز مثبت الجهد الهالى الشبكى

دكتوره/ اعتماد عبدالغنى جاد

قسم الطبيعة بكلية البنات ـ جامعة عين شمس

ملخص البحث

يتناول هذا البحث تأثير تغير طول المهبط على خصائص جهاز مثبت الجهد الهالى الشبكى الذىيتكون مهبطه من لوح معدنى مستوى وسلكى المصعد والشبكه .

وقدوجد من خلال هذا البحث أن طول المهبط له تأثير فعال على خصائص التشغيل للجهاز ، ولذلك من الضرورى عند تصميم جهاز مثبت للجهد الهالى إختيار طول المهبط المناسب للحصول على معامل تثبيت جهد جيد.

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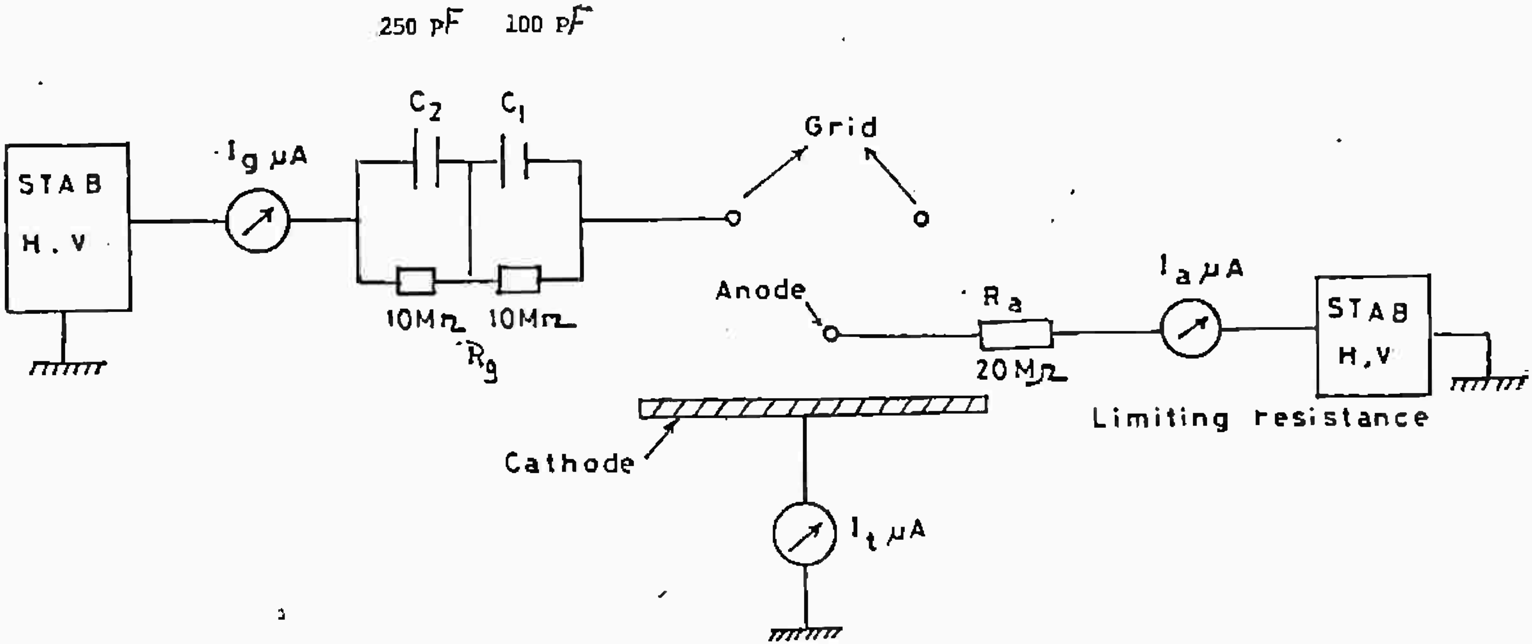


Fig. (1) The arrangement of the corona voltage stabilizer.

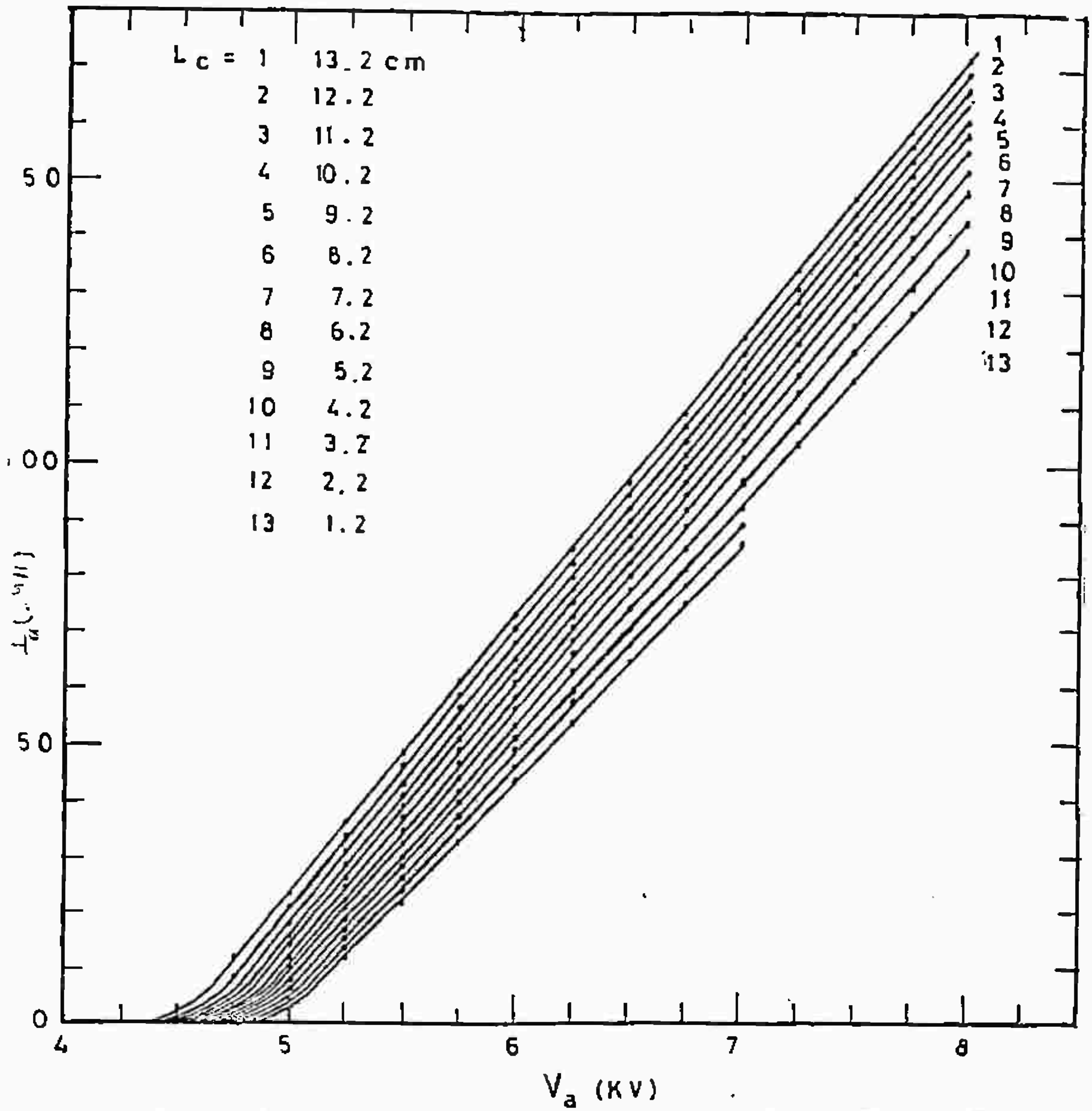


Fig. (2) I_a Vs. V_a for different values of L_c.

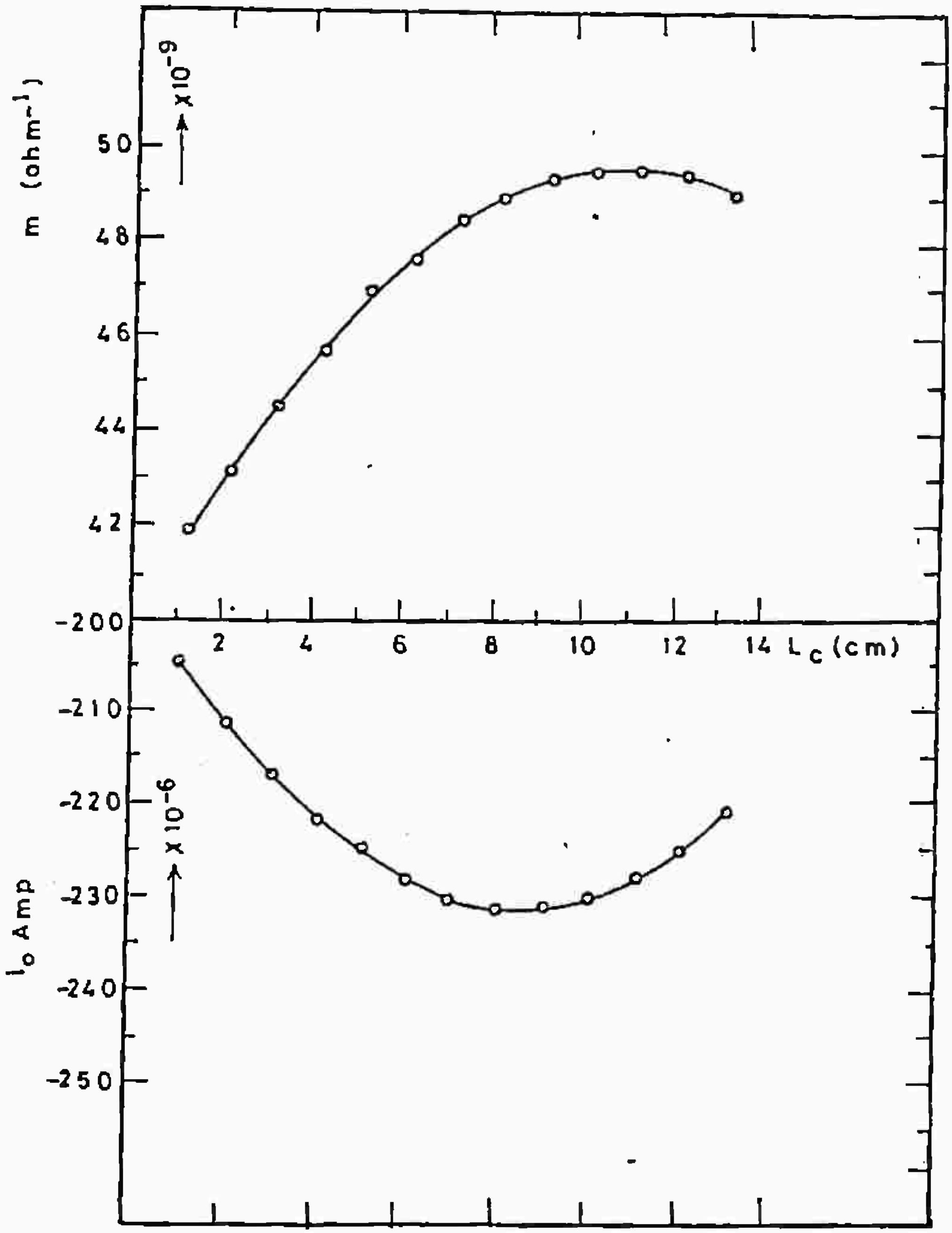
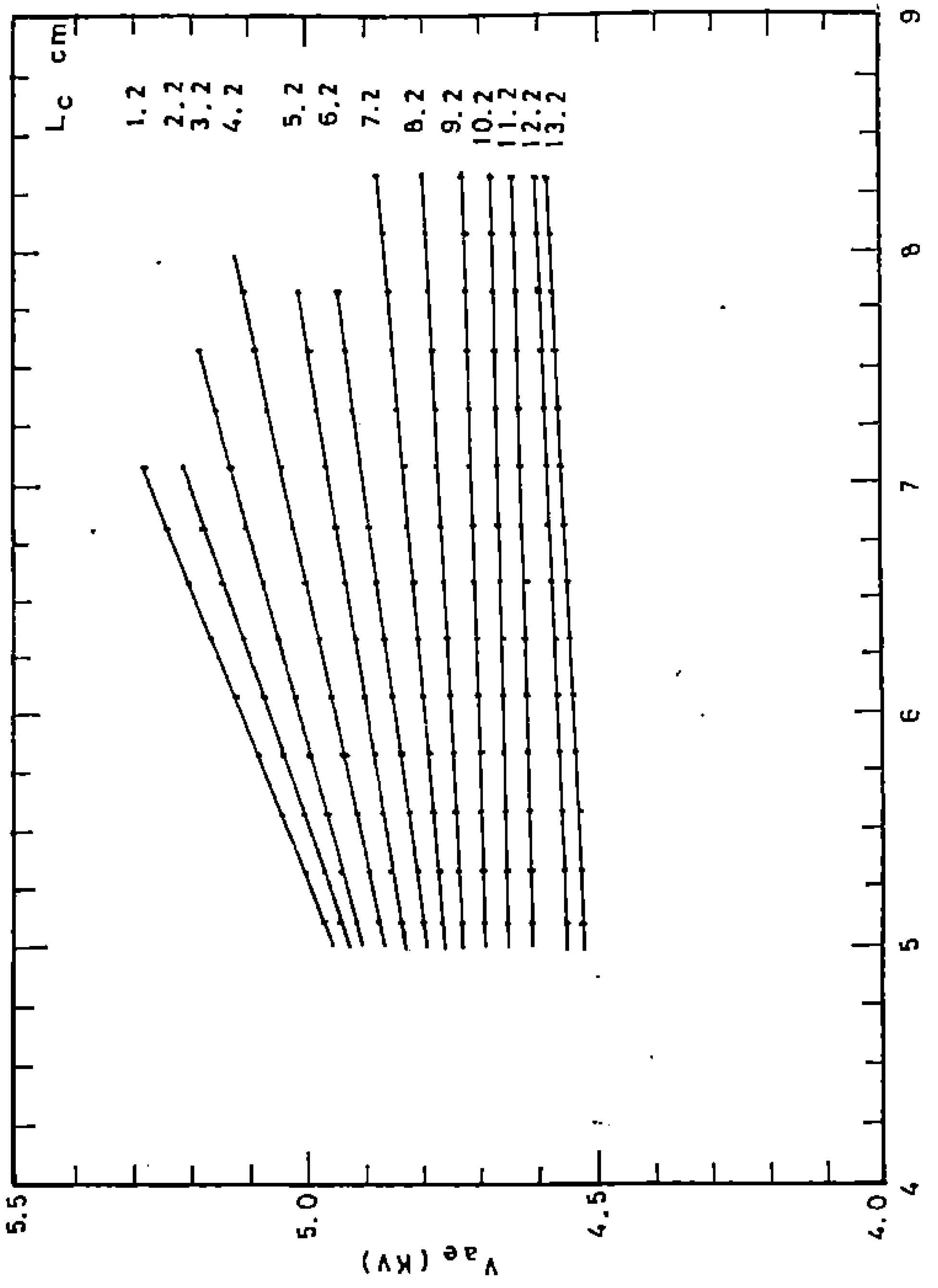


Fig. (3)m & I_o vs. L_c for various values of L_c.


L c cm
1.2
2.2
3.2
4.2
5.2
6.2
7.2
8.2
9.2
10.2
11.2
12.2
13.2
V a (KV)
V ae (KV)
4
5
6
7
8
9
5.5
5.0
4.5
4.0

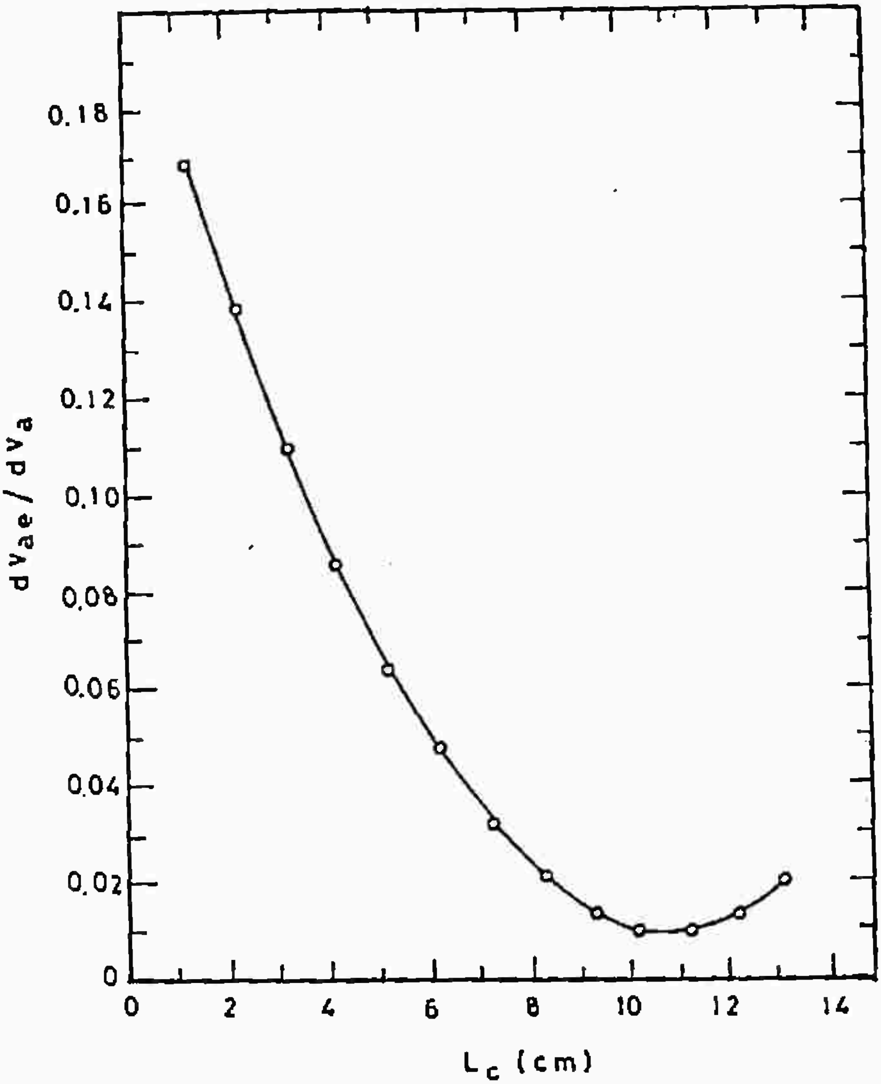


Fig. (5) $\frac{dV_{ae}}{dV_a}$ Vs. L_c.

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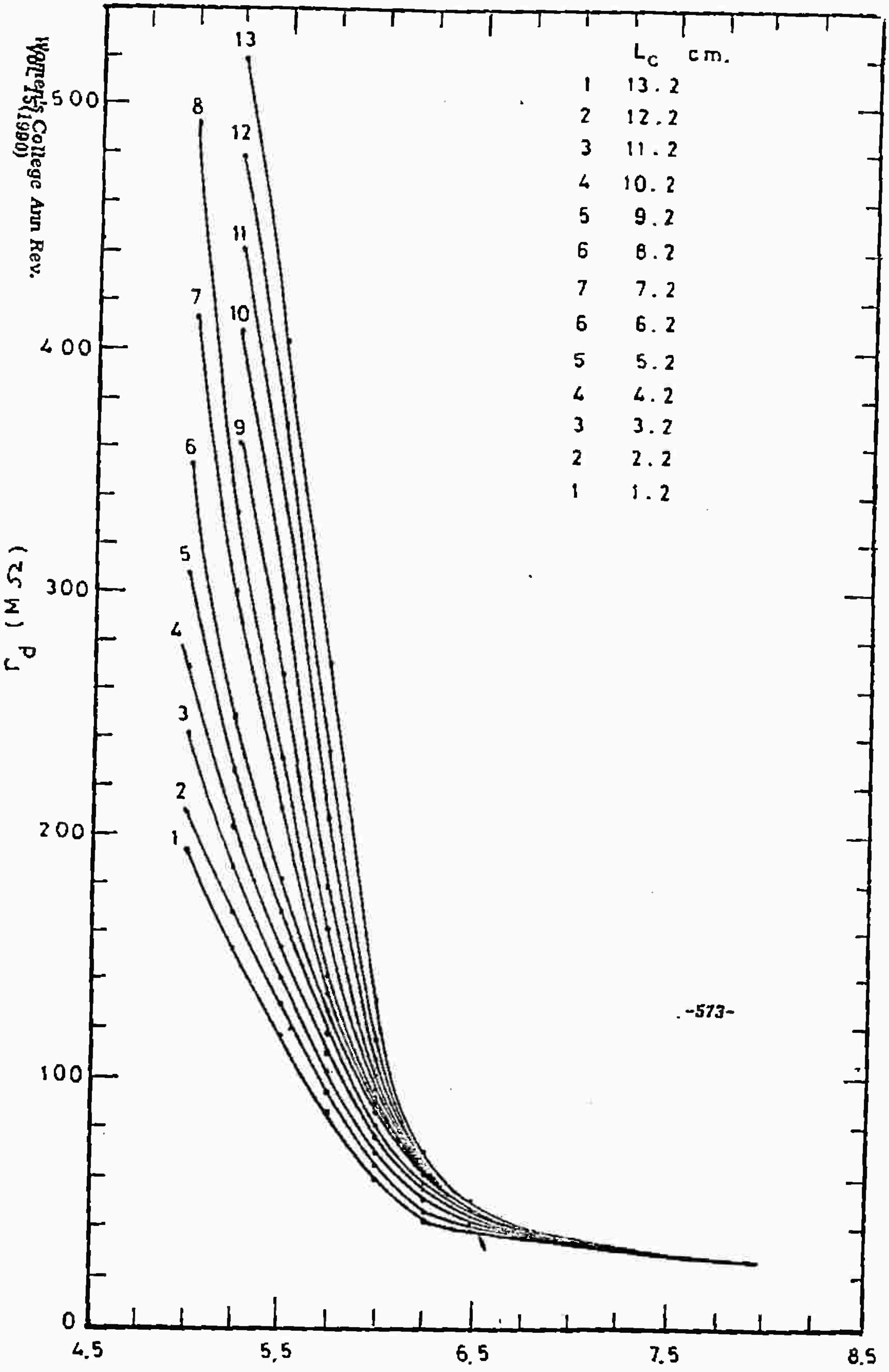

Fig. (6) r_J vs. V_a

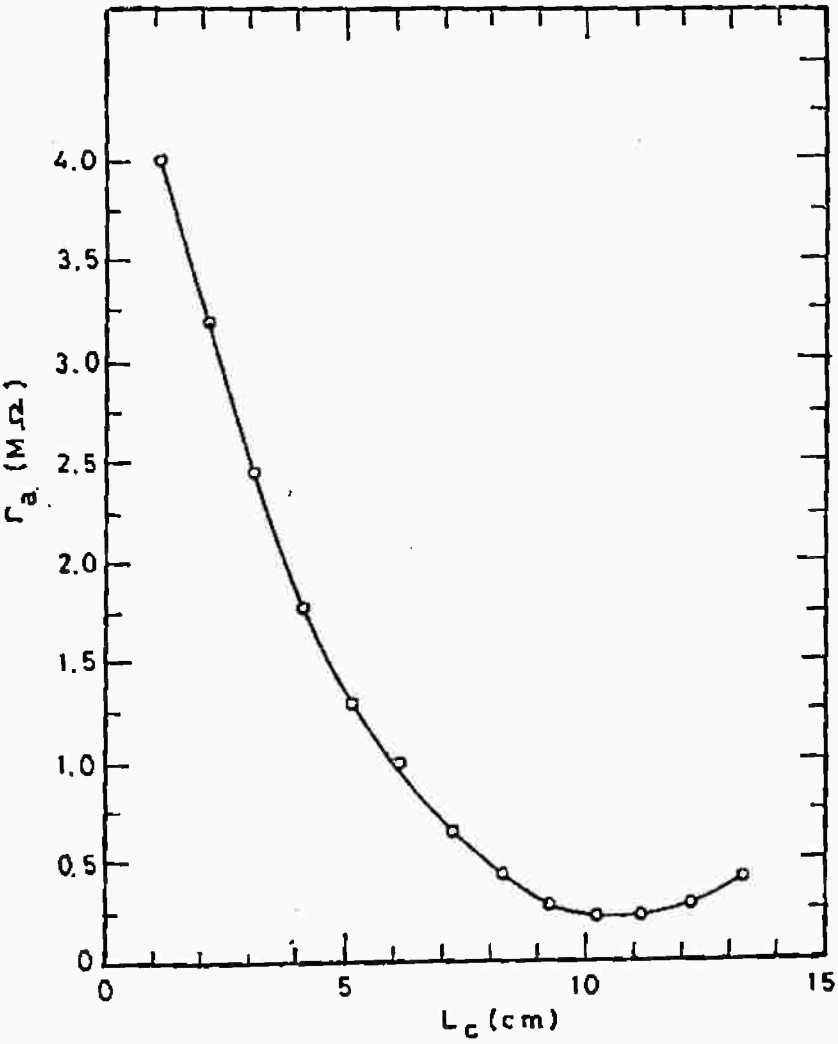

Fig. (7) r_a vs. L_c.

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