PROBES FOR FIELD MAPPING BY ELECTROLYTIC TANK ANALOGUE-A COMPARISON OF DIFFERENT PROBE DESIGNS

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ABSTRACT

This paper makes a comparison of different types of probes designed for field mapping by electrolytic tank analogue technique. Both single probes used in potential measurement and double probes used in gradient measurements have been studied. It has been found that surface needle probe which avoids the meniscus effect compares best for mapping of potentials. Surface liquid probe gives better accuracy for mapping equi-gradient lines.

1. INTRODUCTION

Electrolytic tank method of field plotting offers quite a convenient analogue method for solving electrostatic and magnetostatic problems in electrical engineering, heat flow problems in mechanical engineering and in other allied fields. In this conductive field analogue technique, a single probe is used for plotting equipotential lines and double probes are used for plotting equi-gradient lines. In literature different probe designs have been reported and this note attempts in comparing the different types of probes with regard to the accuracy attainable.

2. PROBE DESIGNS

The main sources of error to be considered in the probe design are :

(i) Polarization, (ii) meniscus at the probe tips.

Double probes introduce much larger errors due to the above causes than single probes do.

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Fig. 1 (A, B, C) shows six types of probes, both single and double. In the surface needle probe, to eliminate meniscus effects a very thin insulating disc is allowed to float on the surface of the electrolyte. In the submerged glass probe, meniscus effect is avoided near the probe tip. A liquid probe consisting of a small insulating tube filled with electrolyte, reduces the polarization effects. Surface liquid probe is a combination of the ideas of liquid probe and the surface probe.

3. Experimental Study

As an experimental model for field plotting, concentric cylindrical configuration was chosen because of the following reasons :

(*a*) The construction of the model to a high degree of accuracy is possible.

(*b*) The field is free from boundary effects.

(*c*) The field distribution lends itself for precise calculation.

(*d*) The field is non-uniform and hence the accuracy study in a non-uniform field is possible.

With each single probe, the equipotentials were plotted and compared with the theoretical ones calculated by using the expression

$$V_r = \frac{ln\, r/b}{ln\, a/b} \qquad \text{where,}$$

V_r = potential at any radius 'r'

V = potential of inner cylinder

b = the inner radius of the outer cylinder

a = the outer radius of the inner cylinder

ln = logarithm to the base 'e'.

With double probes, equi-gradient lines were plotted and the average results were compared with the theoretically calculated values using the expression

$$E_r = \frac{V}{r\, ln\, (a/b)}$$

A representative field plot for the system used is shown in Fig. 2. Fig. 3 shows the error in measurements with single probes, plotted against equipotentials. Fig. 4 shows the error in gradient measurement by double probe method plotted against radius. From Fig. 3, it is found that the surface needle probe gives the best result and the commonly used metal

probe, the worst. Because of the size, the surface needle probe cannot be used to plot the equipotentials very near the eleetrodes.

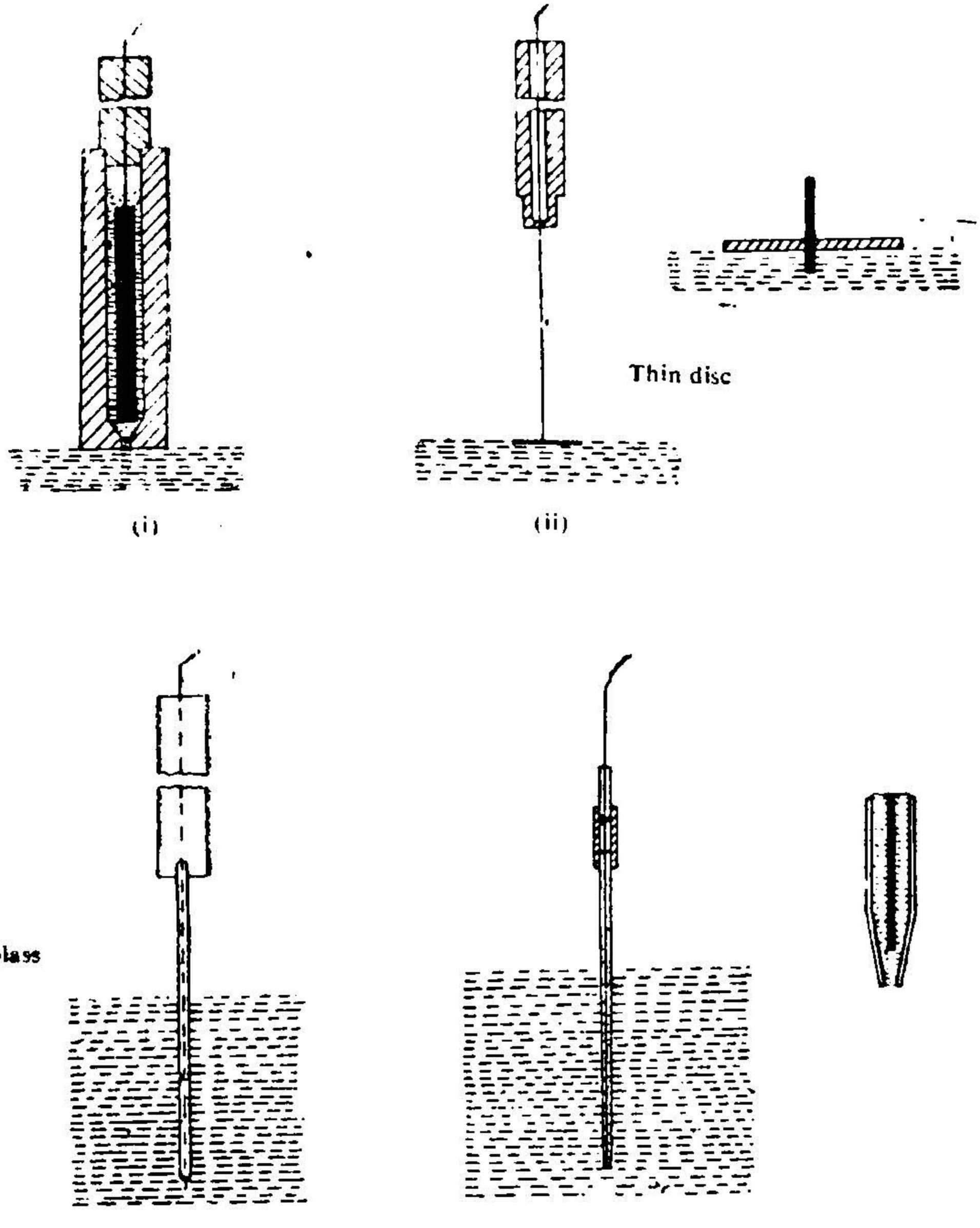
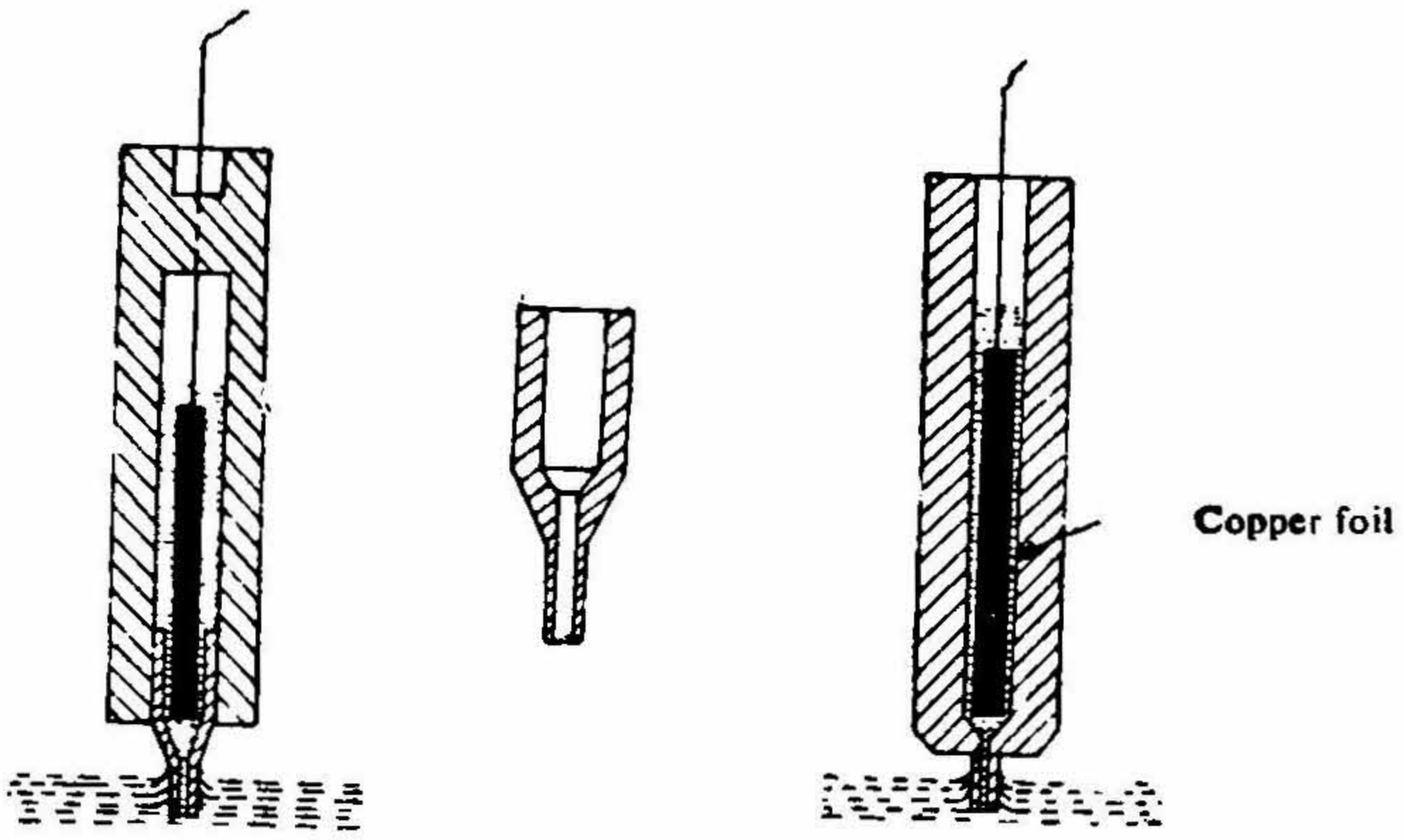


FIG. 1 (A)

(A) Single probes for potential measurements

(i) Surface liquid probe
(ii) Surface metal probe
(iii) Submerged probe
(iv) Submerged liquid probe



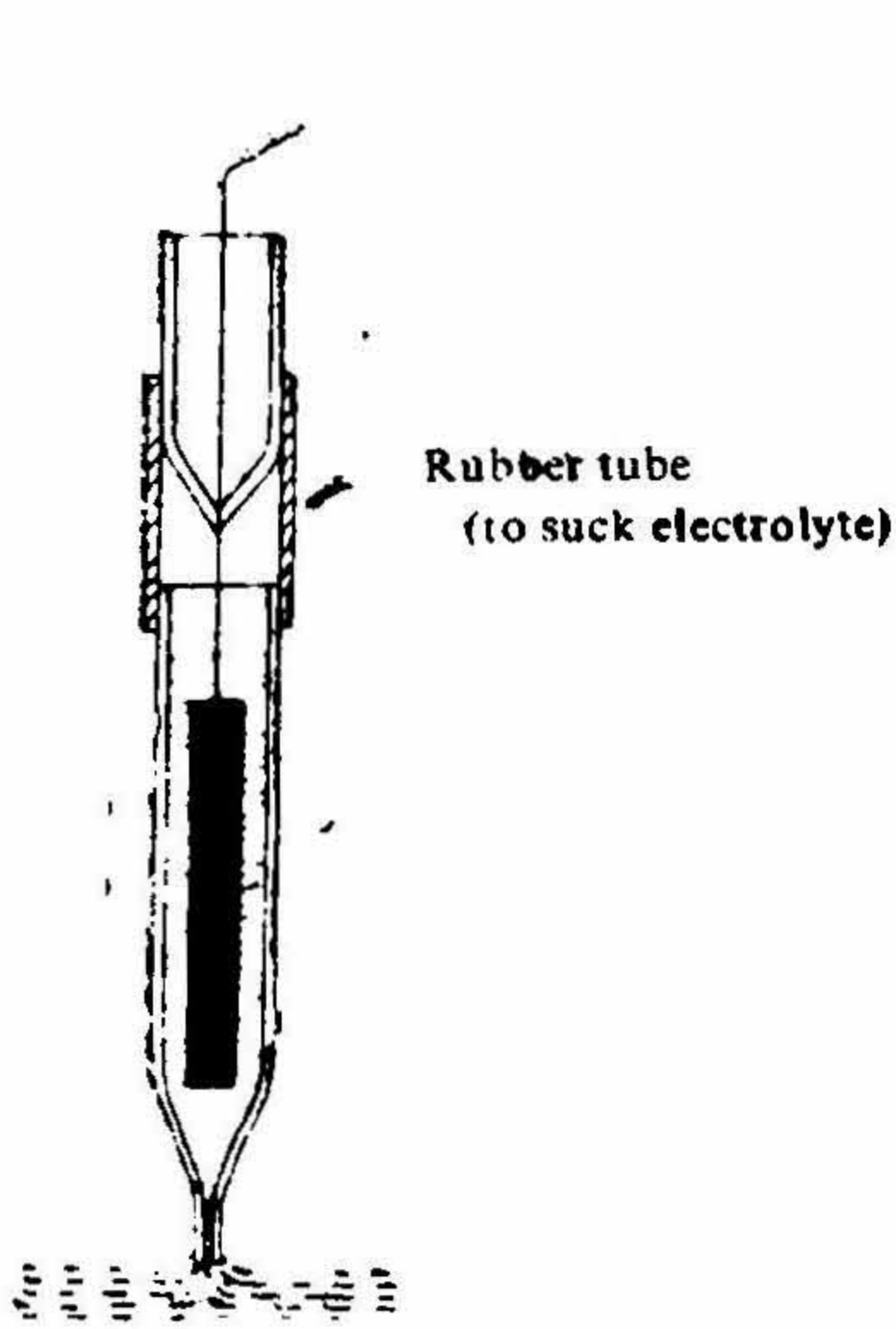


FIG. 1 (B)

Liquid probes for potential measurement

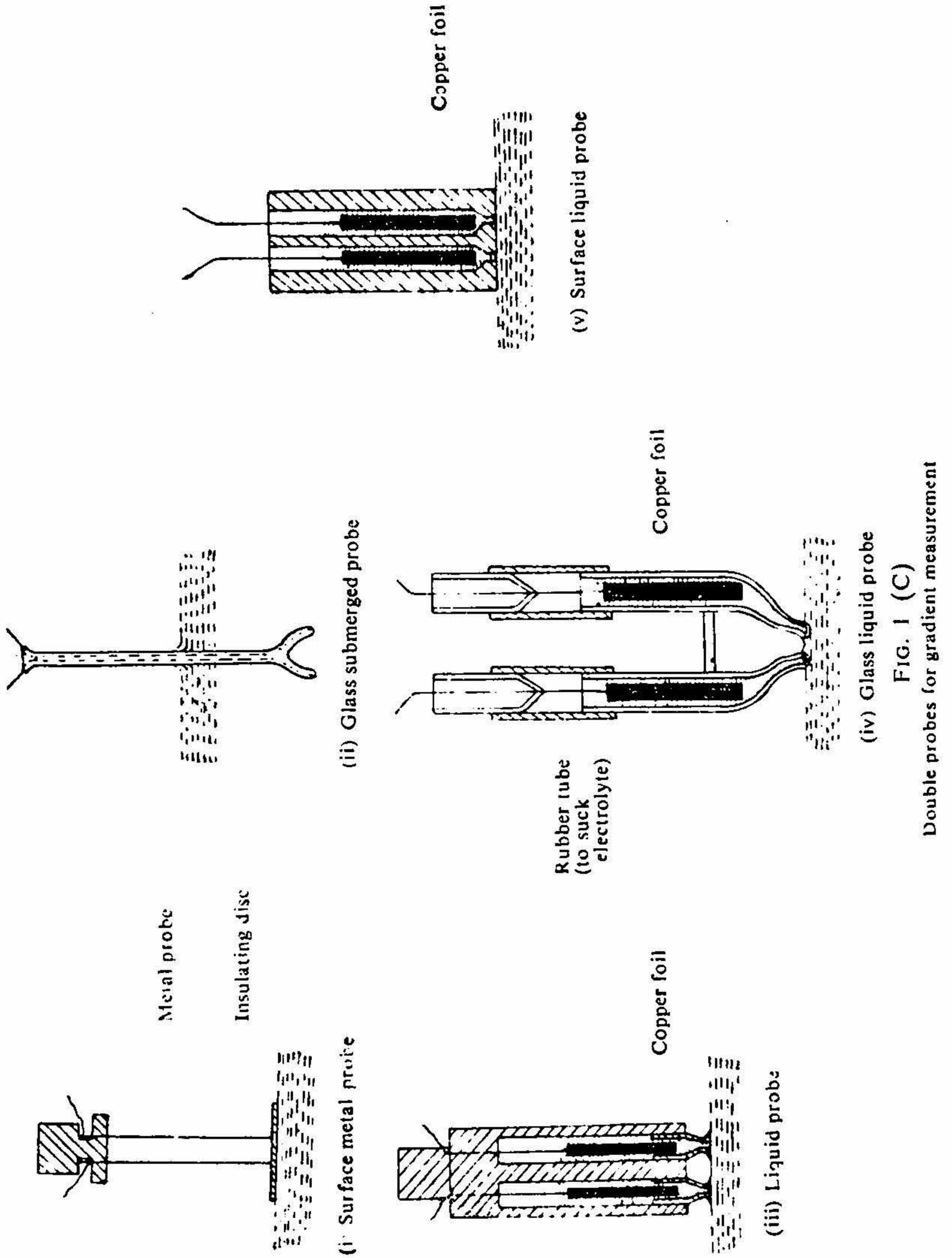


FIG. 1 (C)
Double probes for gradient measurement

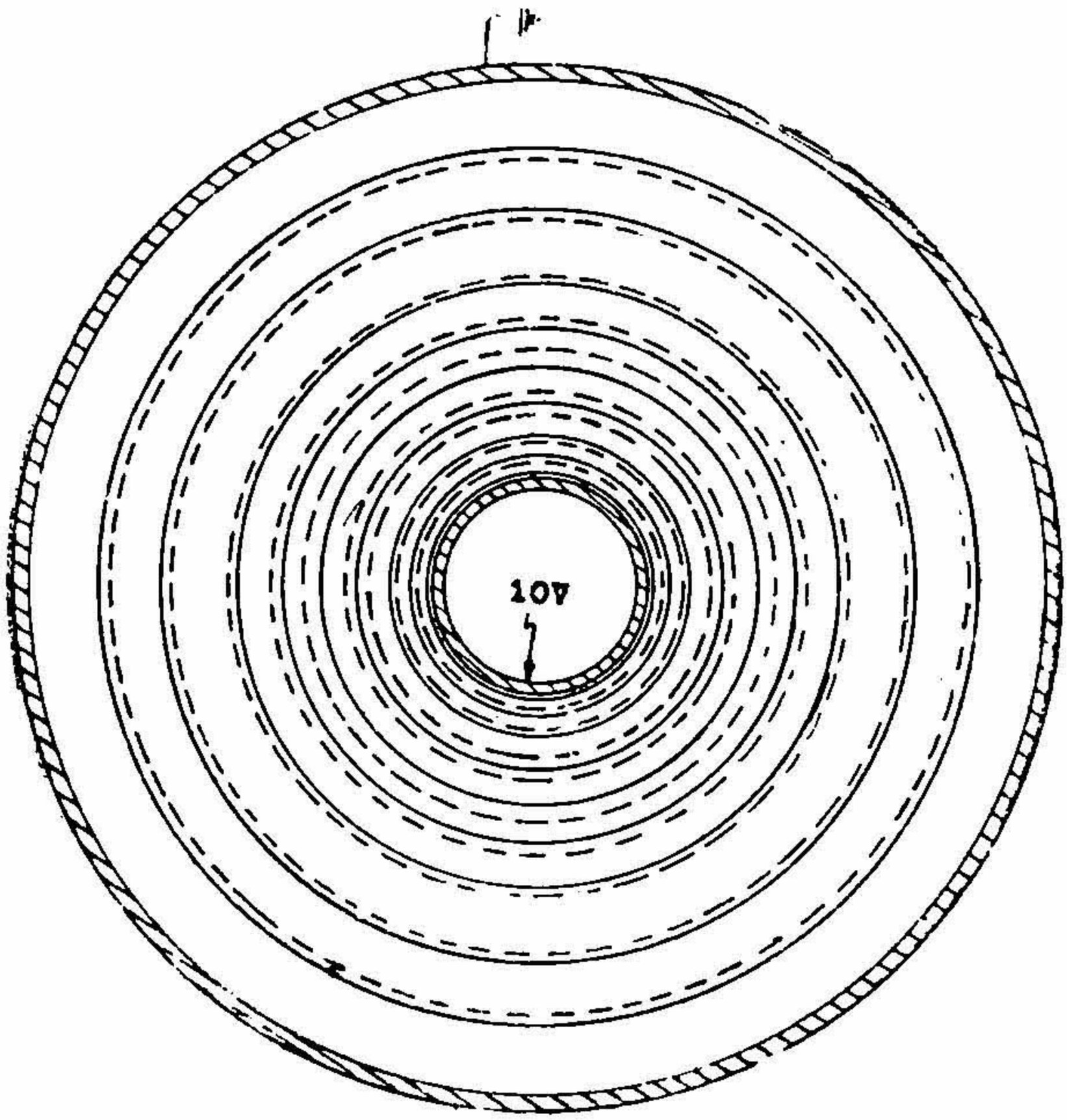


FIG. 2.

Reduced size of a typical field plot

————Experimental ————Calculated

(The equipotentials are 90%, 80%, 70%, upto 10% from the inside cylinder)

From Fig. 4, it becomes evident that surface liquid probe gives better accuracy. It is reasonable as the probe eliminates the meniscus error and reduces the effect of polarization. Also smaller and accurate spacings between the two probes can be maintained.

The new probe designed and named submerged liquid probe is suitable only for the measurement of potentials. It is not suitable for the measurement of gradients because of the size which restricts the probe submersion. It has got a better accuracy when compared to ordinary metal probe and submerged glass probe.

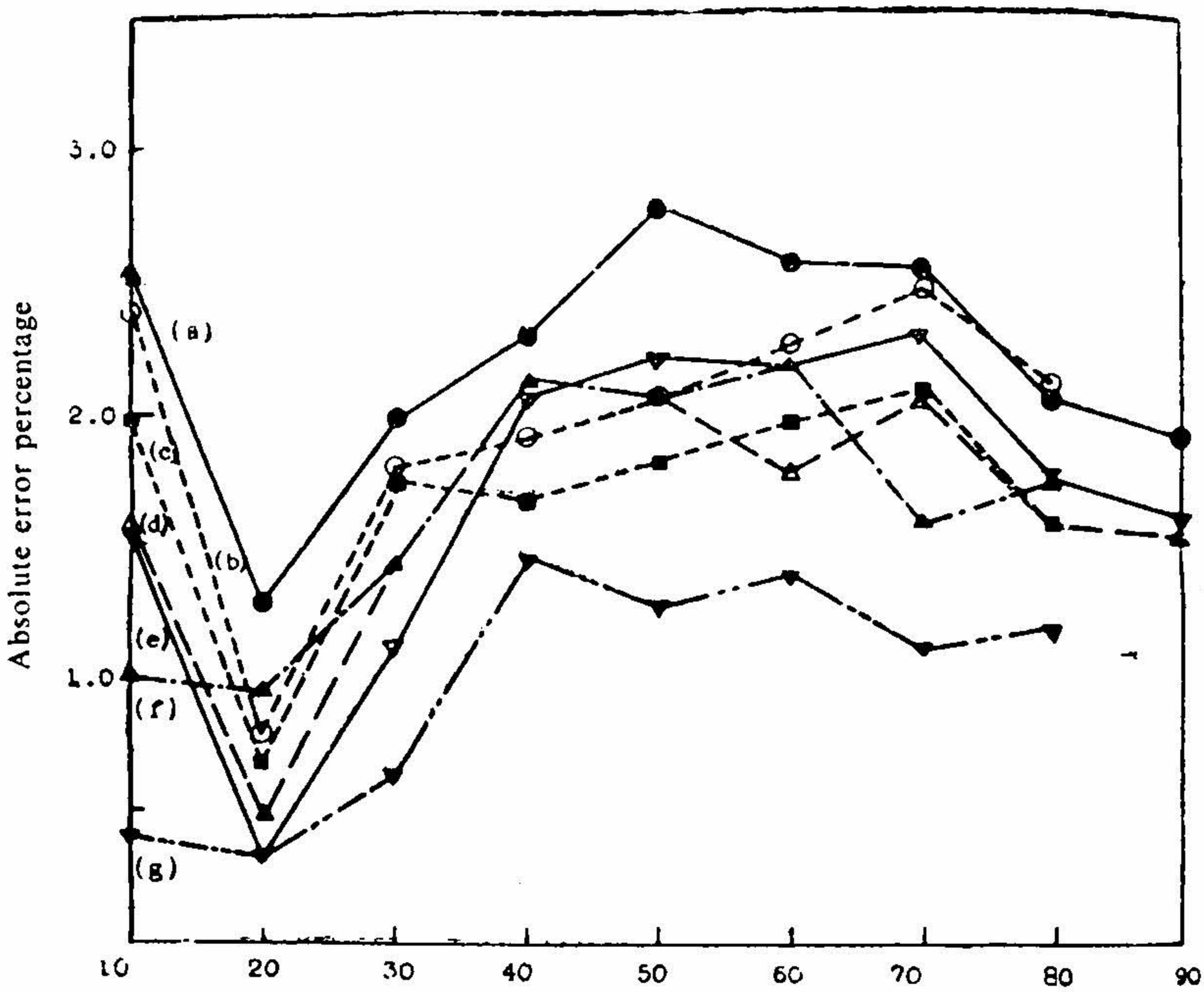


FIG. 3.

Error plot for single probes

(*a*) Metal probe
(*b*) Liquid probe (Glass capillary type)
(*c*) Liquid probe
(*d*) Submerged liquid prode
(*e*) Submerged glass probe
(*f*) Surface liquid probe
(*g*) Surface metal probe.

4. CONCLUSIONS

While plotting by conductive liquid analogue technique, the probe has its own contribution towards introducing error in the field plot. In literature, we find different types of probes and this work attempts at evaluating the best among them. Surface needle probe with its simplicity in construction can be considered best for plotting equipotentials. Surface liquid probe gives better accuracy for plotting equigradient lines.

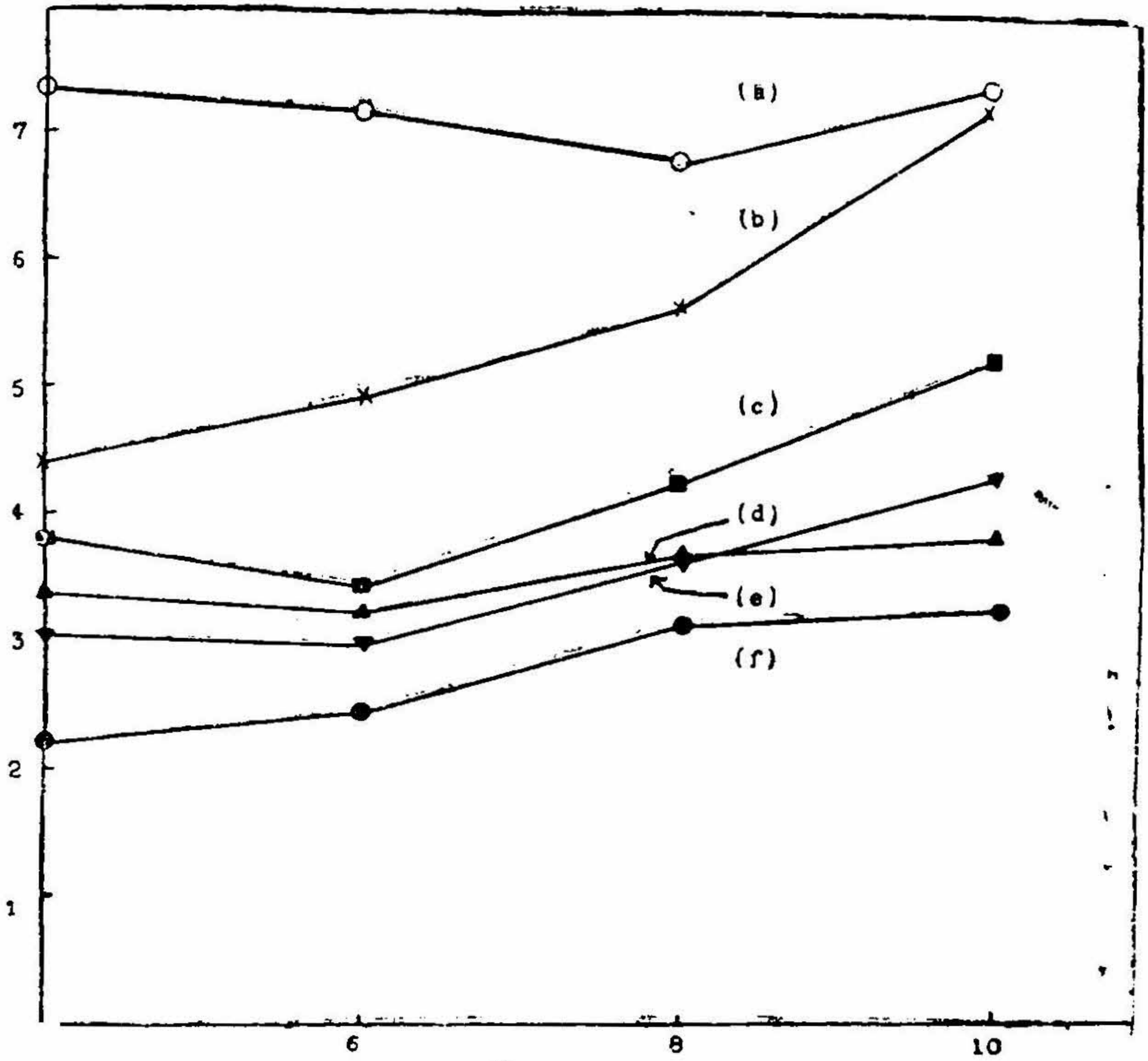


FIG. 4.

Error plot for double probe.

(*a*) Metal probe **(*b*) Submerged glass probes**
(*c*) Surface metal probe **(*d*) Liquid probe**
(*e*) Liquid probe (glass capillary type) **(*f*) Surface liquid probe.**

5. ACKNOWLEDGEMENT

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A MATHEMATICAL DESIGN FOR EXPERIMENTAL EVALUATION OF I. L. L. OPERATIONS*

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ABSTRACT

This is an attempt to set up an Experimental design for evaluation of Inter-library loan operations. The study is based on Local situation at I. I. Sc., and Bangalore Libraries and interpreted in a general way applicable for the Special and academic libraries in different regions in India.

The three Union Catalogues of Serials published by the Regional Centre of Insdoc at Bangalore, give evidence of the coverage, potentiality and resources in terms of scientific periodicals available in Mysore State especially in Bangalore area and with particular reference to the Indian Institute of Science Library. In the present day Library operations, no library can claim to be self-sufficient or can subscribe to all periodicals covering the demand of its clientele. Library co-operation, of late, is becoming one of the main activities of academic and scientific libraries.

Some time ago, a meeting was initiated by the author and local librarians at Bangalore met at the Bangalore University Library to discuss matters pertaining to inter-library loan operations among the academic and scientific libraries in Bangalore area. Of course, any implementation of the operation concerning inter-library loan activity depends on the framework of rules established by each library or Institution.

In the initial meeting, an impact was made on the importance of inter-library loan facilities and library co-operation. A suggestion was

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* Some aspects of this paper were evolved out of a course "GLS-Research Methods", which the author took as a part of doctoral work at the University of Chicago.

also made that each library should look into its own inter-library loan policy and come up with more flexible arrangements towards achieving efficiency in library co-operation.

The type of materials and the content to which such material can be lent among each library will depend of course on the revised inter-library loan policies of respective institutions and also it very much depends on the uniform policy that the Libraries will come up with in the Bangalore region.

The article which I am presenting here will confine only to the design aspect of inter-library loan pattern in the Bangalore area with reference to I. I. Sc. Library that may be applicable to other areas as well.

Type of variables available	
Books	The I. L. L. operation could be evaluated in various phases taking into consideration different variables in correlation to others. Let us pick 2 variables in the area of requesters and 3 in the type of material.
Periodicals	
Photocopies	
Microfilms	
Faculty	
Grad. Student	
Others (Research, workers, Scientists, Administrators, etc.)	Books (N_1), Periodicals (N_2) and Faculty (F), Student (S) and others (such as Research workers, Scientists Administrators, etc.) There is variation between Academic libraries and Industrial Libraries in terms of type of material requested (Books/Periodicals). F, S, and O' are variables representing the 3 types of requesters. Let us represent this by 'y' which is an independent variable standing for the type of requesters in the Indian Institute of Science Library in terms of their request for Books or Periodical articles which also is an independent variable. Let us call it 'x'.
Due Date	
Request Date	
Department	
Subject	
N. A. L. Library	
Bangalore Univ. Library and other academic Libraries in Bangalore	
Major University or Technical Libraries outside Bangalore.	
INSDOC main/regional Centres.	

Now, the relation 'x' to 'y' in a tabular representation will be:

		Type of Material	
		x	
		Books	Periodical Articles
y *Type of Requester*	$F \begin{cases} R_1 \\ R_2 \end{cases}$		
	$S \begin{cases} R_1 \\ R_2 \end{cases}$		
	$O' \begin{cases} R_1 \\ R_2 \end{cases}$		
Total Cases		N_1	N_2

R_1 – In Libraries of Bangalore

R_2 – In I.I.Sc. Library.

Since this experimental design is for evaluation purpose, we have to study the availability of material in two major sources. (Major Academic and Technical Libraries/INSDOC Centres, Tata Institute of Fundamental Research and National Aeronautical Laboratory, etc.). Therefore, for this purpose let us introduce a test variable and call it 't'. In terms of two major sources, let us dichotomize t into $\begin{cases} t_1 \\ t_2 \end{cases}$.

Statistically speaking t_1 and t_2 are partial conditional relations.

t_1 – Availability in I.I.Sc. Library

t_2 – Availability in Bangalore Libraries.

By tabular representation we have the relation of independent variable 'x' to test variable 't' as follows :

		x	
		Books	Periodical Articles
t	I. I. Sc. Library	a	a_1
	Bangalore Academic/ Industrial Libraries	b	b_1
	Total Cases	N_1	N_2

Correlation of xt is given by the cross-product, which can be obtained as follows :

$$xt = \frac{ab_1 - a_1 b}{aa_1 \; bb_1} = \text{point correlation}$$

Now, the relation between type of material borrowed (x) and whether the faculty is from I.I.Sc. Library (R_1) or Scientists from other Libraries (R_2) could be calculated in the following way.

t_1 (I. I. Sc. Library)

	Books	Periodical Articles
y I. I. Sc. Faculty		
y Scientists outside I. I. Sc.		

Pratial conditional relations $xy : t_1$

t_2 (Bangalore Libraries)

	Books	Periodical Articles
y I. I. Sc. Faculty		
y Scientists outside I. I. Sc.		

Partial conditional relations $xy : t_2$

These partial conditional relations are with respect to the Faculty of either I. I. Sc. or other Scientists. Similarly, we can obtain p. c. relations with respect to other requesters (namely, students and others).

Also, relation *ty* could be calculated for each case *F*, *S* & O respectively————(2).

Now, the p. c. relations of variables as related to original variables could be expressed by a general formula.

$$(xy) = (xy : t_1) + (xy : t_2) + (xt)\ (ty)$$

In controlled experiment, the two matched terms should be alike.

$xt \to 0$ and $ty \to 0$

The formula : $xy = (xy : t_1)\ (xy : t_2)$

The other case is such when the partial relations $\to 0$. i. e. t_1 & $t_2 \to 0$

The formula will be $(xy) = (xt)\ (ty)$.

But for our purpose t_1 & t_2 does exist.

That is the type of meterial borrowed (Periodical Articles or Books) through the I. I. Sc. or other Libraries in Bangalore System should be the base for sample for systems analysis.

There are several variables that are to be taken individually and the sample for Systems should have at least records for a period of one year. This is only a design to select sample and variables for any library that would like to evaluate their I. L. L. System with a pattern similar to Bangalore Academic/Technical Libraries.

Plan for File Organization in I. I. Sc. System

a. Requests :

- → Loan
- → Photocopy or Microfilm] Alphabetical
- → I. I. Sc. Library
- → INSDOC Centres] Date

Variables : Type (Book *or* Photocopy *or* Microfilm).
Libraries (other *or* I. I. Sc. *or* Bangalore Libraries.

b. Receipt : → Borrower | Alphabetical

Variables : Type (Faculty, Student, others).

c. Arrival : Bangalore or outside Bangalore.
List by date requested and date received.

Variables : 2 (Bangalore, outside Bangalore).

d. Mechanics : (Follow → Flow chart skeleton)

when material arrives, list by – due date – name – department – short title.

e. Bus. Operations :

Variables : Charge to Departments.

I. L. L. Grant of I. I. Sc. Lib. Budget.

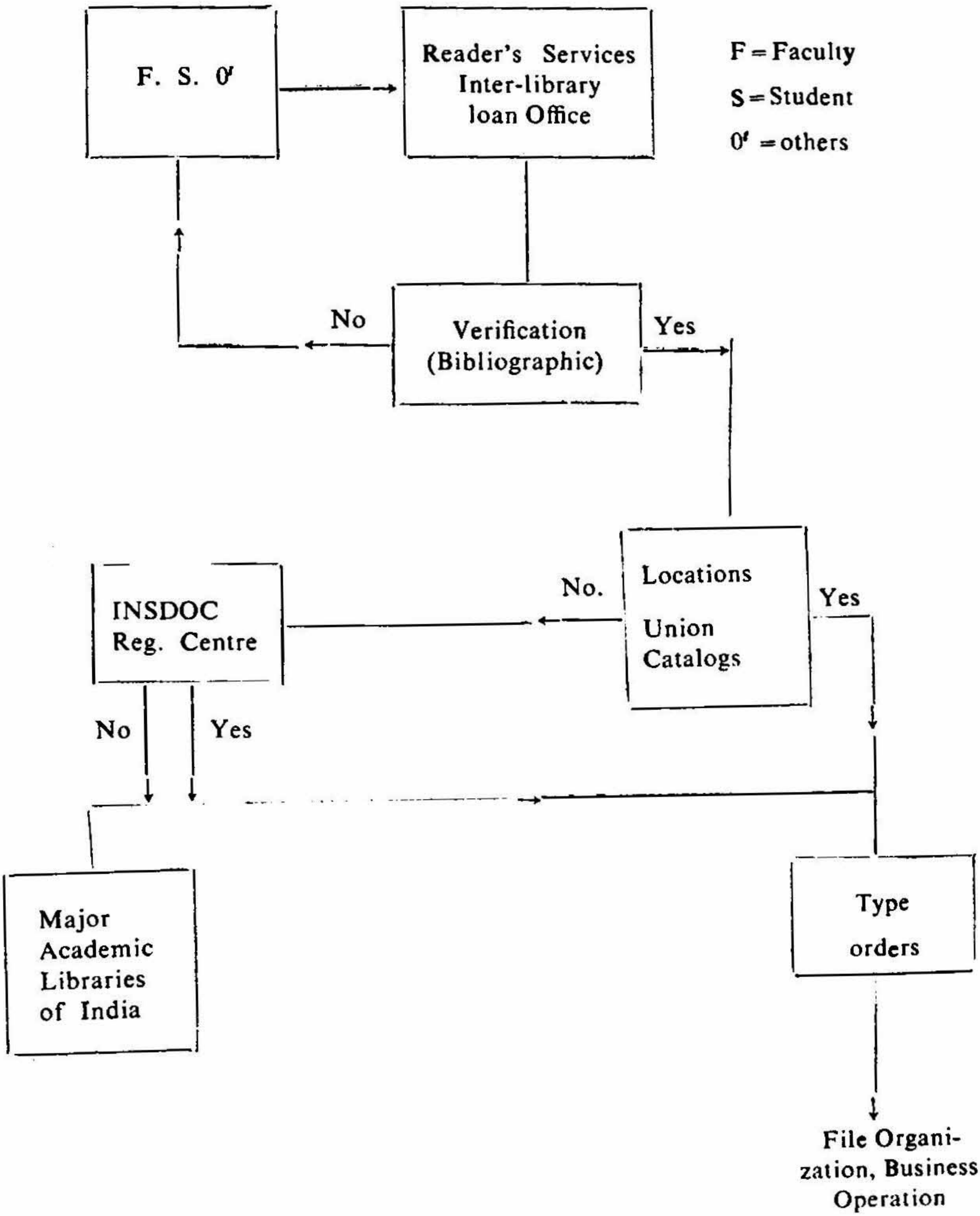
f. Completed Files : (*Retrospective*)

Requests arranged by borrower and kept for one year. I. L. L. files arranged by title or author and by department, kept for two years.

CLERICAL OPERATIONS IN I. I. SC. SYSTEM

1. Type I. L. L. requests
2. Through Insdoc Regional Centres
3. Processsing of incoming books (records of postage, etc.)
4. Processing incoming Insdoc's processed material.
5. Returning books (packing and sending of forms and postage etc.)
6. Payments (Departmental budgets/I. L. L. operational grant of I. I. Sc. Library).
7. Statistics
8. Files
9. Orders for Photocopying material on loan.
10. Order supplies.
11. Overdues.

I. I. Sc. Library Interlibrary Loan Flow Pattern



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