HOW TO INSPECT, REPAIR, TEST, CALIBRATE, READ AND COMPUTE ELECTRIC RECORDING, AND INTEGRATING METERS

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ROBERT FERRIS

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Trieste

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INSPECT, REPAIR, TEST, CALIBRATE, READ AND COMPUTE

Electric, Recording,

AND

Integrating Meters,

BY

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PREFACE.

In presenting this little book to the "fraternity" it may be that some apologies should go with it. In 1897 after having tired of traveling, the writer made up his mind that to be successful it was necessary to become "efficient." I discovered I was not. I had a general experience, but I could not find a general job. What was wanted was men with special experiences. I adopted a specialty, it was meters. I accepted what was offered to go into a factory and get a training that would fit me to take charge of a meter department in a large station. After remaining there six months it was my good fortune to find a place with a large station, but I discovered again that what I learned in the factory only applied in part to what I was expected to know now. For instance (it may sound queer) in the factory I was taught all about meters except how to read one. You can go into any factory where they make meters today and you will find men actually capable of testing and calibrating, but who could not read a meter. My value to that station was in proportion to the meters they had that I knew about, was to the total number of meters they had of all makes, so possibly I was too much of a specialty. There were some things I learned in the factory that I had to forget. There were things I needed to know that I did not get at the factory. In other words there is a big difference between factory accuracy and commercial usefulness. During all this time I thought of the many who though capable did not have the opportunity that I had, and who if they did have they probably couldn't afford to sacrifice the salary they were getting to accept what would be offered to learn the meter business. So I made notes; I studied the requirements of the men who have the care of meters; I compiled my notes, and this little book is the result. It is dedicated to the men who handle the pliers.

THE AUTHOR.

PART ONE.

1. ANY MAN of the average intelligence can become an expert meter man. Of course a technical education is desirable but the writer contends that it is not necessary. Some things however are necessary, and it is the object of this little book to explain them in as few plain every day terms and phrases as possible. By this is meant in the language of the practical electrician.

2. THE FIRST THING TO DO is to find out what it is we want to know; next is to find out how to go about it. When we discover that we want to know how to calibrate a meter we must stop and think of what we must know first; master that, then take the next step, always being sure that we are not attempting to skip anything. The average man forgets a great deal during his life so we will assume that what is first needed is a little drilling in arithmatic.

3. TO SECURE AN INTELLIGENT SOLUTION of arithmetical problems for use in meter work one must become familiar with the generalization of Intergers, Common Fractions, Decimal Fractions, Percentage, Involution, Evolution, Ratios and Proportions.

4. THE "SLIDE RULE" too should be studied with appreciation of the amount of labor that can be saved by its use, for the reason that with it, results can be obtained while one would be putting down the initial figures in the "paper and pencil" method of calculating.

5. CALCULATING SLIDE RULES can be purchased anywhere and a book of instructions go with them. It would do no good to explain the "Rule" here, besides the book on the "Rule" cannot be improved upon. The book may be dry reading at first but it will be time well spent.

6. BESIDES THE ABOVE REQUIREMENTS there are a few more, but we will take a little run

through arithmetic, and later, on the principle that we have forgotten, we will take up the others:

7. SIGNS.

Equality, =
Addition, +
Multiplication, ×
Subtraction, —
Division, ÷
Percent, %
To be Squared, 2^2
To be Cubed, 3^3
Square Root, $\sqrt{}$
Cube Root, $\sqrt[3]{}$
Ratio, :
Proportion, :: or =
Degree, °

8. THE VALUE OF SIGNS in arithmetic should be thoroughly appreciated. The student should learn to use them exclusively.

9. ADDITION: Only like numbers and like orders can be added. The sum expresses units of the same kind as its addends.

10. SUBTRACTION: Only like numbers and like orders can be subtracted, one from the other The remainder or difference expresses units of the same name, as those expressed by the minuend and subtrahend. The increase of any order in the subtrahend is equivalent to a corresponding decrease of the same order of the minuend.

11. MULTIPLICATION: Is a short process of finding the sum when the several addends are equal.

12 DIVISION: Is the process of finding one factor when the product and the remaining factors are given

13. A DECIMEL FRACTION expresses one or more of the equal decimal parts of a unit. The nearer any figure of a decimal fraction is to its decimal point,

the higher its value; the further it is removed from the decimal point, the less its value.

14. A COMMON FRACTION expresses one or more of the equal parts of a unit. One of the equal parts is called a fractional unit.

NUMERATOR denotes figures above the line.

DENOMINATOR denotes figures below the line.

15. ADDING FRACTIONS: Rule. Reduce to equivalent fractions of a common denominator, add the resulting numerators, and place the sum over the common denominator.

16. SUBTRACTING FRACTIONS: Rule. Reduce to equivalent fractions of a common denominator, and place the difference between the resulting numerators over the common denominator.

17. TO ADD OR SUBTRACT MIXED NUMBERS: Add or subtract the fractions and intergers separately, and combine the results.

18. MULTIPLICATION OF FRACTIONS: Multiplying is to increase; to do so multiply the numerator or divide the denominator.

19. DIVIDING FRACTIONS is to decrease their value. To do so divide the numerator or multiply the denominator.

20. MULTIPLYING OR DIVIDING both terms of a fraction does not change its value.

21. TO MULTIPLY MIXED NUMBERS: Rule. Whole number $\times$ whole number. Upper digit $\times$ lower fraction. Lower digit $\times$ upper fraction. Fraction $\times$ fraction. Product of all added together.

22. DIVISION OF FRACTIONS: Inverting any number simply demonstrates the number of times it is contained in a unit, as the unit takes the place of the numerator so must the number take the place of the unit. Divide 6 by 7; answer, $\frac{6}{7}$. By inverting the divisor we find $\frac{7}{1}$, $\frac{1}{7}$. If 7 is contained in one unit $\frac{1}{7}$ of one time it is contained in 6 six times $\frac{1}{7}$, or $\frac{6}{7}$. Divide 5 by

$\frac{1}{8}$. Ans. $6\frac{1}{4}$. $\frac{1}{8}$ is contained in a unit $\frac{8}{1}$ times, therefore it is contained in $\frac{5}{1}$, $\frac{5}{1} \times \frac{8}{1} = \frac{40}{1} = 6\frac{1}{4}$. Ans.

23. TO ASCERTAIN the number of times the divisor is contained in a unit invert the divisor and multiply by the unit in the dividend. Divide 3 by $\frac{1}{4}$. Ans. $5\frac{1}{4}$. Divide $\frac{3}{4}$ of $\frac{5}{8}$ by $\frac{1}{2}$ of $\frac{1}{4}$. Ans. $\frac{3}{4}$. $\frac{3}{4}$ of $\frac{5}{8}$ means $\frac{3}{4} \times \frac{5}{8}$, therefore $(\frac{3}{4} \times \frac{5}{8}) \div (\frac{1}{2} \times \frac{1}{4}) = (\frac{3}{4} \times \frac{5}{8}) \times (\frac{4}{1} \times \frac{4}{1})$ $= \frac{60}{32} \times \frac{16}{1} = \frac{960}{32} = \frac{30}{1}$.

24. PERCENTAGE. The Base, the number on which the percentage is calculated. The Rate, the number denoting the per cent. The Percentage; the sum (in hundreds) obtained from multiplying the base by the rate. The Amount, the base increased by adding the percentage. The Difference, the base diminished by subtracting the percentage.

25. Base $\times$ Rate = Percentage. (Point off two places from the right.)

Base + Percentage = Amount.

Base — Percentage = Difference.

Percentage $\div$ Base = Rate.

Percentage $\div$ Rate = Base.

Amount $\div$ (1.00 + Rate) = Base.

Difference $\div$ (1.00 — Rate) = Base.

To find loss or gain in percent. find difference between initial and final values and divide this difference by the initial value.

26. INVOLUTION is the process of multiplying a number by itself one or more times The product thus obtained is called a power of that number. The second power of 2 is 4. $2 \times 2 = 4$. Third power of 2 is 8. $2 \times 2 \times 2 = 8$.

27. THE SMALL FIGURE placed to the right of and a little above a figure is called the Exponent and shows how many times the number is to be used as a factor, or to what power it is to be raised, as $2^2 = 2 \times 2 = 4$. $4^3 = 4 \times 4 \times 4 = 64$.

28. THE ROOT of a number is that number which used the required number of times as a factor produces

the number. 2 is a root of 4 since $2 \times 2 = 4$. 4 is a root of 64 since $4 \times 4 \times 4 = 64$.

29. THE SECOND POWER of a number is called its square. 4^2 should be read 4 squared. The third power of a number is called its cube. 4^3 would be read 4 cubed.

30. EVOLUTION is the reverse of Involution. It is the process of finding the root of a number that is considered as a power.

31. THE SQUARE ROOT of a number is that number when used twice as a factor produces that number. 3 is the square root of 9 since $3 \times 3 = 9$, or $\sqrt{9} = 3$.

32. THE CUBE ROOT of a number is that number which if used three times as a factor produces that number. 3 is the cube root of 27 since $3 \times 3 \times 3 = 27$, or $\sqrt[3]{27} = 3$.

33. THE RADICAL SIGN ($\sqrt{}$) placed before a number, indicates that some root of that number is to be found

34. THE INDEX of a root is a small figure placed over and to the left of the radical sign to show what root is to be found. Thus $\sqrt{50}$ means that the square root of 50 is to be found. Again, $\sqrt[3]{150}$ means that the cube root of 150 is to be found. (When no index is used the square root is to be found.)

35 THE STUDY of Involution and Evolution is one of necessity. The writer recommends that the student who is not familiar with it can best get results by securing the services of one who does understand it and can teach another. After being thus taught learn to use the "slide rule"

36. RATIO AND PROPORTION: Ratio is the relation of one quantity to another of the same kind, or it is the quotient obtained by dividing one quantity by another of the same kind. Two dots (:) means is to, indicate ratio. 8 : 4 means 8 is to 4. The two quantities compared are the terms of the ratio. First is the antecedent; second is the consequent; two terms collect-