SUMMARY

1. National changes in population probably will be of the order of ten per cent or less per decade.

2. Regional changes in population are large in some areas, amounting to more than 40 per cent in eight years.

3. The power used per industrial worker is growing rapidly and may reach ten horsepower by 1960.

4. Residential and rural use of energy is growing rapidly with no indication of saturation because the use in some areas is at present two or more times the national average.

5. Load growth indicates that the 1947 generating capacity may have to be doubled by 1960.

6. The percentages of fuel and hydro generating capacity have remained quite constant over the years and are now approximately 70 per cent fuel and 30 per cent hydro.

7. The electric energy generated is increasing at a very rapid rate having more than doubled in the decade from 1937 to 1947.

8. The only sources of energy now available are

(*a*). Water power.
(*b*). Coal.
(*c*). Crude oil.
(*d*). Natural gas.

9. Improvements in the thermal efficiency of boilers and turbines since 1920 have had a marked effect on the total national energy requirements.

10. The feasible hydroelectric reserve in the United States probably will be completely developed in the next 30 to 40 years. The Pacfiic Northwest reserve may be developed in as short a period as 20 years.

11. Coal will continue to be the most important single resource for the future development of power until atomic energy or some other source of energy, not now used, is developed.

12. The United States has one-half of the coal reserves of the world These reserves are estimated to be sufficient to last 3,100 years at the maximum annual use attained to date.

13. The gasification of coal in place gives promise of eliminating mining losses and effecting a material reduction in the cost of extracting the energy from coal without removing it from the natural beds

14. Transmission voltages probably will go to higher values, but we appear to be approaching the point of diminishing returns from an economic standpoint.

15. Distribution plant needs more engineering and new ideas to reduce investment and improve efficiency.

16. The national copper supply is approaching depletion. The known copper reserves are of low grade ore and high prices, or subsidies have been necessary to stimulate production. The rate of consumption in 1948 indicates that the annual copper deficit will be of the order of 500,000 tons.

REFERENCES

1. Experiment in Underground Gasification of Coal, Gorgas, Alabama, **James J. Dowd, James L. Elder, J. P. Capp, Paul Cohen.** Bureau of Mines Report R.I. 4164, August 1947.

2. Underground Gasification, **Milton H. Fies, W. C. Schroeder.** *Mechanical Engineering* (New York, N. Y.), February 1948, pages 127–35.

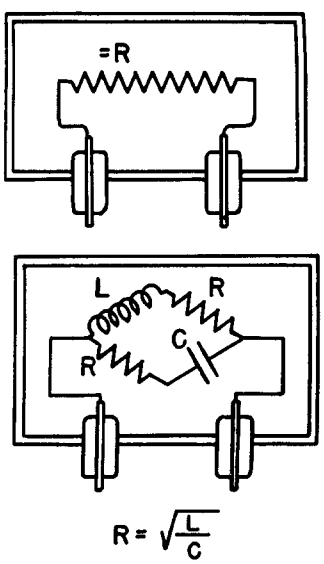
Electrical Essay

Which Box Contains the Network?

Two exactly similar boxes of perfectly conducting material contain respectively, one, a resistor of R ohms, and the other the network shown in Figure 1, with $R=\sqrt{L/C}$. The resistor, and the network, are joined to externally accessible terminals as shown in the figure.

By purely electrical measurements at the box terminals, determine which box contains the simple resistor, and which the network. It is assumed that the resistor and the elements of the network show only their indicated lumped characteristic; that is, that under all tests, the stray capacitance and inductance of the resistors are negligible, the stray capacitance and resistance of the inductor are negligible, the stray inductance and resistance of the capacitor are negligible, and that the stray inductance, capacitance, and resistance of all leads are negligible.

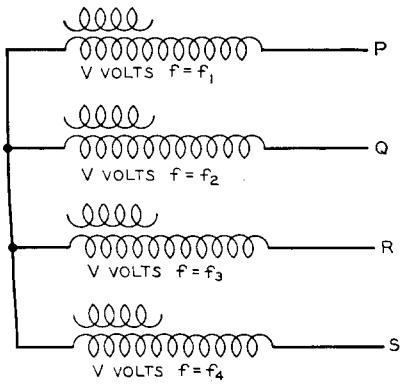
Figure 1



Answer to Previous Essay

The following is the author's answer to his previously published essay (*EE, Nov '48, p 1073*).

Figure 1



Four of the transformers are connected as in Figure 1, of this answer and are all excited respectively to give V volts in their secondaries but at four different frequencies, f_1, f_2, f_3, f_4. Then the rms voltage from any one terminal to any other will be $\sqrt{2}\,V$ volts. The remaining two transformers may be left unexcited, or connected in any way which will leave the foregoing arrangement essentially unaltered.

Many of the author's friends believed they had found solutions to the electrical problem by using polyphase voltages of a single frequency. However, single-frequency alternating voltages, or more generally, single-frequency sinusoidal functions of a variable t in their combining properties, are isomorphic with (that is, correspond in a one-to-one way to) vectors in a plane, and not to segments (matches) in 3-dimensional space. It is not possible to set down four points in a plane in such a way that the distances between all pairs of the four points are the same.

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Table III. Values of Statistic F and Critical Values for the Tachometer Problem

Factors	Sum of Squares	Degrees of Freedom	Mean Square	F	Critical (One Per Cent)
Location	7.814	2	3.907	11.13	8.02
Conductivity	6.061	2	3.031	8.64	8.02
Coefficient	1.646	2	0.823	2.34	8.02
Thickness	7.226	2	3.613	10.29	8.02
All other variables	3.159	9	0.351		

Table IV. Asphalt-Treating Cycles

Baking time (hours)	1	2	4	6
Vacuum (minutes)	2.5	5.0	7.5	10.0
Pressure (minutes)	2.5	5.0	10.0	15.0
Number of pressure cycles	1	2	3	4
Release between cycles (minutes)	1.0	2.5	5.0	10.0

the vacuum time beyond the point where the desired absolute pressure was achieved; short-pressure cycles did as much as long ones but there was a steady gain with the number of cycles; finally, no time of rest was required between pressure cycles. As a result of these tests, a very high quality insulation was obtained while the best arrangement of the time cycle permitted 25 per cent more production on the existing facilities.

In these few simple cases advanced here to illustrate the type of problem confronting engineers, the fundamental purpose is to demonstrate the logic rather than the mathematics of significance tests. Our first intention is to measure the uncertainty of inductive conclusions rather than rely on intuitive estimates of the odds. It is important that statistical methods be studied not as a new course in algebra but as a logical approach to physical realities that are essentially unstable within limits. Such realism is sure middle ground between rash assurance and blind idealism. The risks which are involved are unavoidable, and the quantitative expression of them is truly a scientific procedure.

Electrical Essays

Network

An electrical engineer finds the two boxes built to Dr. Slepian's specifications as outlined in his December 1948 essay (*p 1141*). The engineer removes the contents of the boxes and installs in each box an air core transformer and one of the resistances he removed from the boxes. The transformers were especially designed for this problem. Subtractive polarity, unity turn ratio, and negligible winding resistance are some of the features of the design. The most important items, however, are the self-inductance of the windings, which is the same for all of them, and the mutual inductance, which is equal to three-fifths the value of the self-inductance. The resistance is added for the purpose of permitting safe testing with direct current, and further masking of the negligible resistance of the windings. The internal connections are shown in Figure 1.

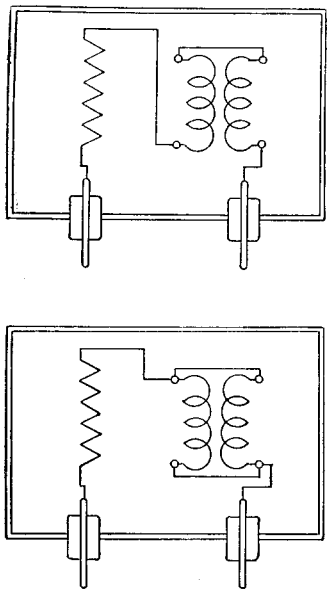

Figure 1

$$M = \frac{3}{5}L$$

Is it possible to determine by purely electrical measurements at the box terminals which box contains the transformer with series connected windings? What difference, if any, would it make if iron core transformers were used by the engineer?

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Flux Linkage of an Open Circuit

The engineers employed at the company where I work certainly have me confused. The other day I overheard two of them talking about the voltage or electromotive force induced in a turn on a machine by the varying flux linkage of that turn.

Now I think I know what the flux linkage of a *closed* curve or circuit is, but you know, a turn on a machine is not a closed curve or circuit. It may be nearly closed, or it may be part of a larger circuit which is closed, but most always it itself is not closed. Now how can you tell whether a closed tube of magnetic flux links a circuit or not, if that circuit is not closed?

I walked over to the machine where the engineers were talking, and what do you know! It had a wave winding on