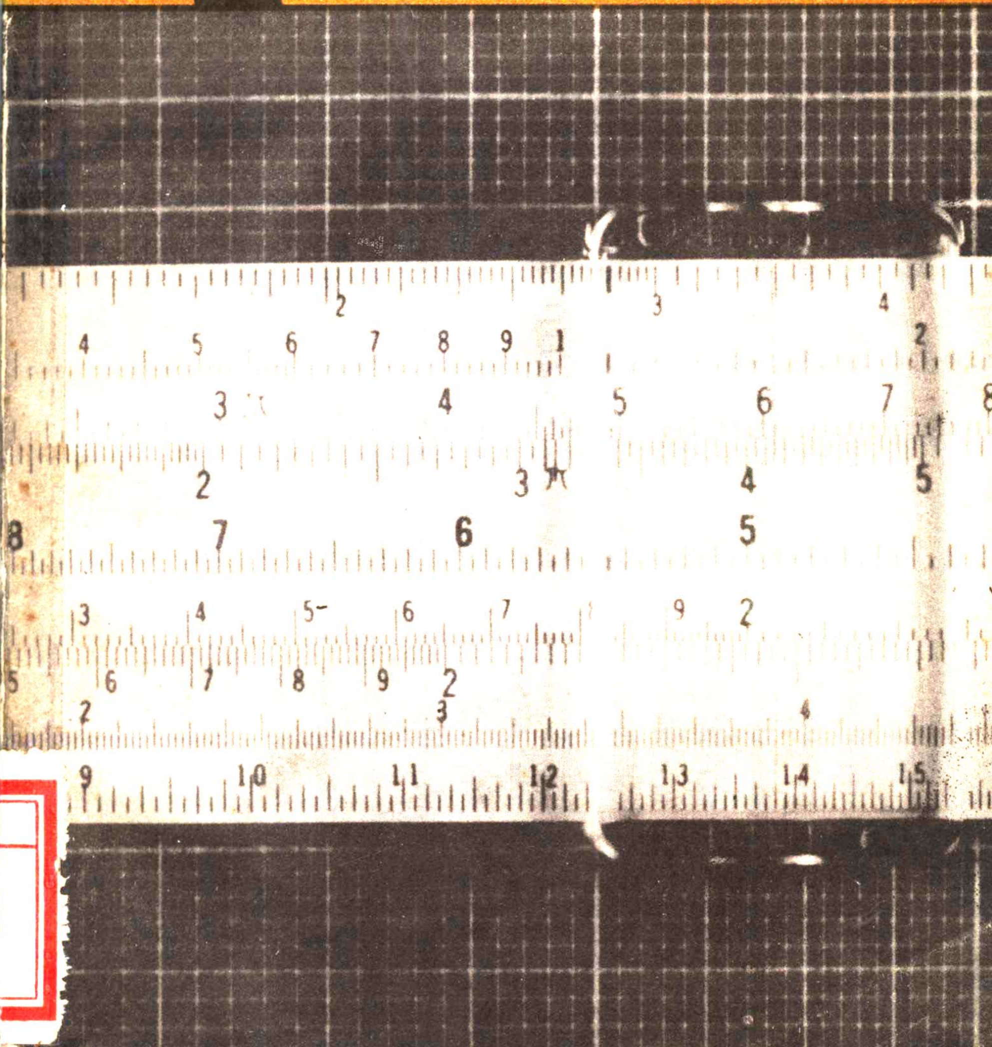
ENGLISH LANGUAGE SERVICES, IN



SPECIAL ENGLISH

# Book 2 Engineering

## Electrical Engineering



# Engineering

## Book 2 Electrical Engineering

*prepared by*

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# PREFACE

*Special English* is a series designed for use by non-native speakers of English who have already learned enough English to carry on a conversation on general matters or to read with only infrequent reference to a dictionary, except to look up technical words. This book is the second of two that provide specialized advanced English instruction for students interested in the field of engineering. The lessons have been prepared in such a way as to give the student practice in using the vocabulary of engineering in context.

*Engineering, Book 1* deals mainly with civil and mechanical engineering, *Book 2* with electrical engineering and electronics. *Book 2* consists of nineteen lessons, each of which is based on a dialogue or reading. In each lesson there are definitions of technical words used in the text and supplementary sentences that present these words in context. All words defined in the book are to be found in an appended glossary. In each lesson there are exercises for classroom work or self-study. A key to these exercises is provided. Abundant illustrations add meaning and interest to the text.

To provide the student with valuable practice in the comprehension, pronunciation, and expression of spoken English as it relates to engineering, a number of pre-recorded tapes based on the text is available.

The *Special English* series was prepared by the Materials Development Staff of English Language Services, Inc., under the co-direction of Edwin T. Cornelius, Jr., and Willard D. Sheeler. Oliver Rice served as Project Editor. Technical content was provided by Dr. Louis de Pian of the School of Applied Science of George Washington University.

The drawings were done by Walter Glinka and Leonard Hyams.

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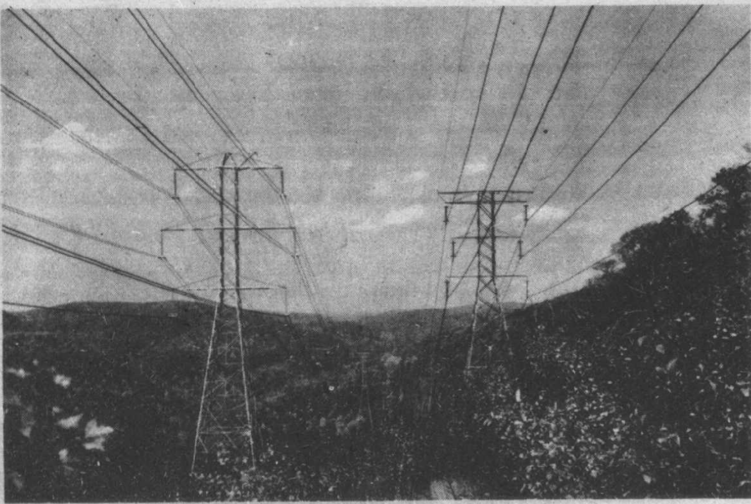

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# LESSON 1

## ELECTRICAL FUNDAMENTALS

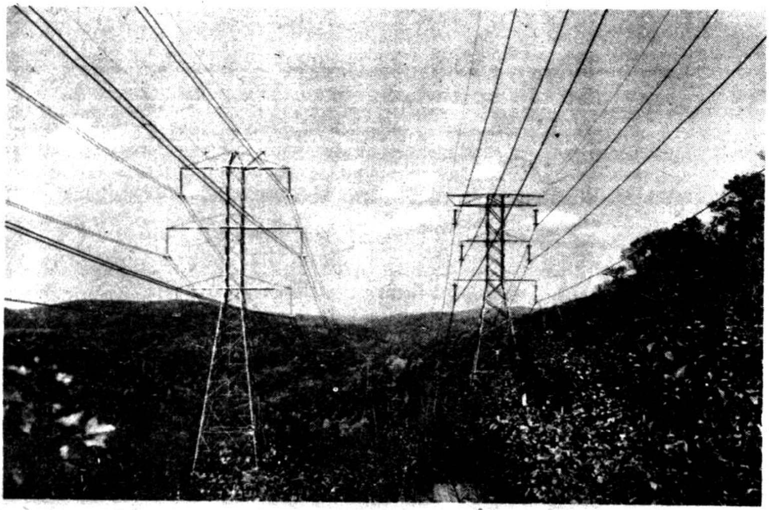
### A. Dialogue

*Mr. Adams:* I'd like to talk to you about electricity, and I suppose the best place to start would be to ask: What is electricity?

*Engineer:* That's a hard one. We know a great deal about electricity, and we can make it do all sorts of things, but it's very difficult to define exactly what it is. One way might be to say that electricity consists of a quantity or stream of electrically-charged particles. These particles can be in the form of stored-up energy or they can be in motion.

*Mr. Adams:* I suppose electricity in motion would be called an electric current.

*Engineer:* That's right. We sometimes explain electrical effects by drawing a comparison with water moving in a closed system. A generator can then be thought of as a kind of pump that pushes the electricity



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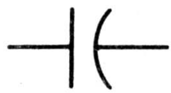
*Mr. Adams:* I suppose electricity in motion would be called an electric current.

*Engineer:* That's right. We sometimes explain electrical effects by drawing a comparison with water moving in a closed system. A generator can then be thought of as a kind of pump that pushes the electricity through the element and the time derivative of the voltage across it. In this case, the element is a capacitor, and its property is called capacitance. And an inductor is the element in which the voltage and the time derivative of the current are involved.

## B. Terminology Practice

**capacitance:** the effect, or action, of a capacitor; the **charge*** of a capacitor divided by the voltage across it

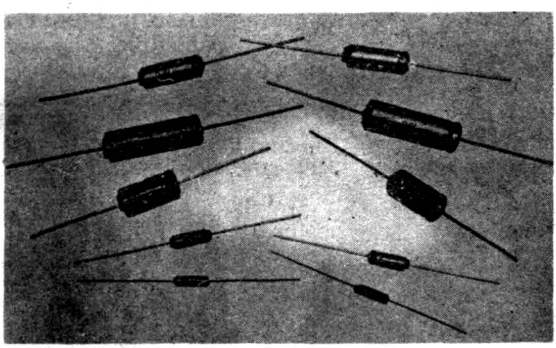
Its property is called capacitance.
Some capacitance will be added to the circuit.
This will cancel the effects of the capacitance.



**capacitor:** a device consisting of two conductors separated by a non-conductor; sometimes also called a condenser

The element is a capacitor.
The capacitors will have to be small.
A bad capacitor is causing the trouble in your radio.

**condenser:** *see* capacitor



Photograph Philips, Eindhoven, The Netherlands

**conductor:** a substance that allows electric current to flow readily

Silver is the best conductor.
The most commonly used conductor is copper.
Water is a fairly good conductor.

* for words in boldface, see the Glossary

**current:** as used here, electric current, the flow of electricity

They differ in relation to the voltage and the current.

The instrument will indicate the amount of current.

Current will cause heating.

**derivative:** the change of a quantity divided by the change of its variable as the change of the variable becomes extremely small

The relationship may involve the time derivative.

The derivative of the current must be considered.

You must first find the derivative of this quantity.

**generator:** as used here, a device producing electric power

How does a **d.c.** generator operate?

We need more than one generator here.

Mechanical power is supplied to the generator.

**inductance:** the property of a circuit that, with a change of current, results in a voltage

Its property is called inductance.

This device is designed to measure inductance.

The inductance in the circuit is increasing.

**inductor:** a device producing inductance

I can guess what an inductor is.

This inductor prevents the flow of high-frequency currents.

You have a choice of several values for the inductor.

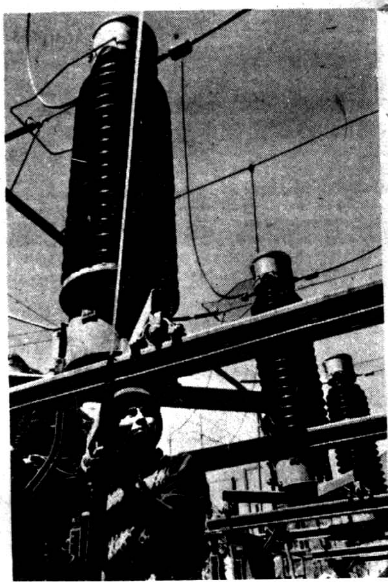
**insulation:** *see* insulator

**insulator:** a device or substance having in a high degree the property of insulation, that is, the tendency to block the flow of electric current

Porcelain is a good insulator.

Some substances are good insulators only when they are dry.

Air sometimes serves as an insulator.



IBM World Trade Corporation

**linear:** as used here, the relationship in which one quantity is related to another by multiplication with a constant

If the relationship is linear, we have a linear resistor.

Linear relationships make mathematical solutions easier.

Under these circumstances, you can assume a linear relationship.

**property:** an ability to produce an effect or action

Its property is called resistance.

What is the property of this element?

You have to consider the properties in relation to each other.

**resistance:** the property by which voltage is produced by the flow of current

Its property is called resistance.

This device will give a change of resistance.

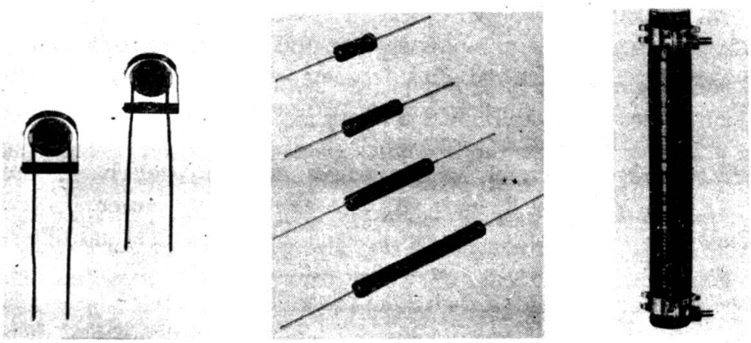
You must add resistance to prevent failure.

**resistor:** a device that has resistance

The element is a resistor.

This resistor will allow large currents.

There are many types of resistors from which to choose.



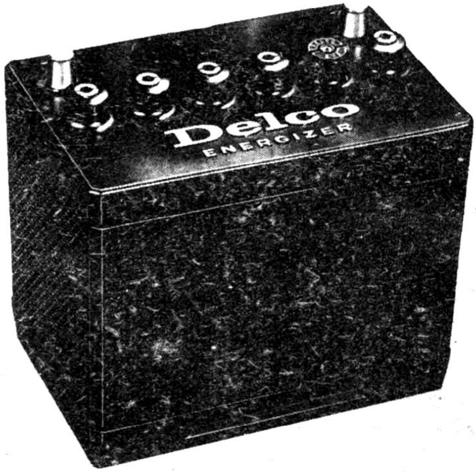
Photograph Philips, Eindhoven, The Netherlands

## C. Check-Up

1. *Which of the following are elements and which are properties?*

| | |
|---|---|
| inductance | capacitance |
| capacitor | inductor |
| resistance | resistor |

2. *What is the difference between current and voltage?*




Delco-Remy

# LESSON 2

## CIRCUIT ELEMENTS

### A. Dialogue

*Mr. Adams:* Is there any energy involved with circuit elements?

*Engineer:* Oh yes, and it's very important, too. You see, voltage times charge gives energy, and voltage times current gives power.

*Mr. Adams:* I see. So when voltages, currents, and charges are present, there will also be energy or power.

*Engineer:* Exactly. However, each type of element has different energy properties.

*Mr. Adams:* Could you give me more details on this?

*Engineer:* Yes. In a resistance, the energy is dissipated. It is changed to thermal energy. The actual power dissipated is proportional to the square of the voltage or the current. We sometimes use this property for electrical heating.

*Mr. Adams:* What happens in the case of a capacitance?

*Engineer:* Here things are a little more complicated. The property of capacitance appears with the existence of an electric field. Energy may be stored in this field, and then we speak of energy stored in the capacitor. This energy is proportional to the square of the voltage across the capacitor and may be returned to the circuit when the voltage or its charge becomes zero.

*Mr. Adams:* I'd like to learn a little more about this energy storage, but first could you tell me about the inductance?

*Engineer:* Here we have a similar situation. However, a magnetic field is involved now. The energy stored in this field is also the energy stored in the inductor. It is proportional to the square of the current through the inductor and is returned to the circuit when this current becomes zero.

*Mr. Adams:* Now can you explain how the stored energy may be returned to a circuit?

*Engineer:* Let me give you a simple example. Take a battery, a resistance, and a capacitance in series. As the current flows, energy from the battery goes to the resistance, where it is dissipated into heat, and to the capacitor, where it is stored. The capacitor, with its stored energy, may now be disconnected from the circuit and connected to another circuit, to which it may supply this energy. You may compare it with a spring like that on an automobile. Energy is stored when the spring is pushed in; the energy is released when the spring returns to its original position.

*Mr. Adams:* Well, thanks a lot. I think I have a clearer idea now.

## B. Terminology Practice

**battery:** a device which gives a constant voltage and is capable of supplying a constant current

Take a battery and a resistance in series.
The battery of this car needs replacing.
Is this radio operated by a battery?

**charge:** as used here, an electric charge, the quantity of electricity

Voltage times charge gives energy.

There will be a flow of charge through the wire.

The total amount of charge will remain constant.

**dissipate:** as used here, to change into heat with the result that available energy is diminished

The energy is dissipated.

You must provide a way for the energy to be dissipated.

The instrument will measure the power that is dissipated.

**proportional:** having a constant ratio

The power is proportional to the square of the voltage.

The charge is proportional to the voltage.

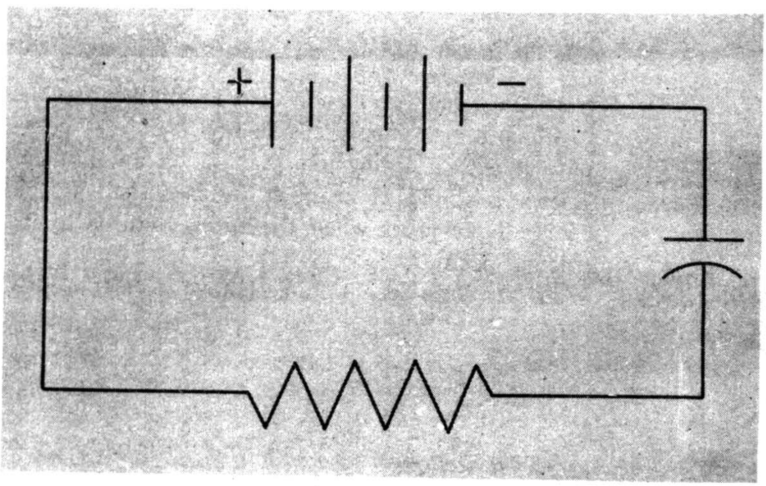
Are you sure that this quantity is proportional to the other?

**series:** as used here, a circuit connection in which the same current flows through all the elements

Take a resistance and capacitance in series.

Add an inductance in series with the other elements.

The series connection increased the resistance.




**square:** as used here, a quantity multiplied by itself

The power is proportional to the square of the voltage.

You should have used the square of the current.

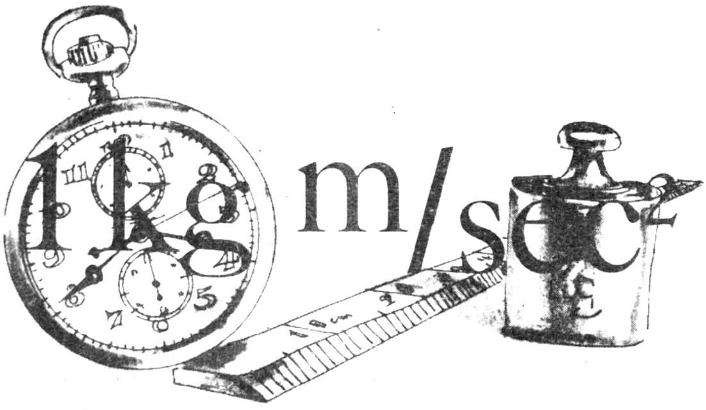
Did you include the square of the charge?

## C. Check-Up

*Insert the proper terms in the blanks.*

| | |
|---|---|
| battery | inductance |
| capacitance | power |
| dissipated | series connection |
| energy | square |

1. Voltage times charge gives ______.
2. Voltage times current gives ______.
3. In a resistance, the energy is ______.
4. The property of ______ is involved with an electric field.
5. The property of ______ is involved with a magnetic field.
6. A circuit connection in which the same current flows through all the elements is called a ______.
7. Sixteen is the ______ of four.
8. A device which supplies a constant current at a constant voltage is called a ______.




# LESSON 3

## THE MKS SYSTEM OF UNITS

### A. Reading

The CGS and the MKS are the two most commonly used metric systems of units. These initials mean "centimeters, grams, seconds" and "meters, kilograms, seconds." Because of its larger units, the MKS system is more convenient for engineering purposes.

Both systems, when first introduced, used three basic quantities: length, mass, and time. These are sufficient for measurements and descriptions of mechanical phenomena. To deal with electromagnetic phenomena, however, some fourth, electrical, quantity has to be added. The MKS system uses any of the following as the fourth unit: ampere, volt, ohm, henry, farad, or coulomb. Of course, these units are related to electromagnetic theory so that, if one is defined, all the others can be worked out.

On January 1, 1948, the following resolutions were adopted by the International Committee on Weights and Measures:

1. The newton is the force which gives the mass of one kilogram an acceleration of one meter per second per second.

2. The joule is the work done when the point at which one newton is applied is moved by one meter in the direction of the force.

3. The watt is the power which corresponds to the production of energy of one joule per second.

4. The ampere is the constant current which, if flowing in two parallel wires, which are very long, extremely thin, and placed one meter apart in a vacuum, will produce between the wires a force of $2 \times 10^{-7}$ newtons per meter of length.

5. The volt is the potential difference between two points in a wire carrying a current of one ampere, where the dissipated power between these two points is one watt.

6. The ohm is the resistance between two points in a body having a potential difference of one volt when a current of one ampere is flowing.

7. The coulomb is the charge transported in one second by a current of one ampere.

8. The farad is the capacitance of a capacitor with a potential difference of one volt when it is charged with a charge of one coulomb.

9. The henry is the inductance of a circuit in which one volt is produced when the current in the circuit varies by one ampere per second.

## B. Terminology Practice

**acceleration:** the rate at which velocity changes

The force gives the mass an acceleration.
This instrument will measure the acceleration of the car.
What is the largest acceleration allowable?

**ampere:** a unit of current

The system uses the ampere as the fourth unit.
Your measurements must be in amperes.
How many amperes would you expect to find?

**CGS:** the system of units using centimeters, grams, and seconds

The CGS and the MKS are the two most commonly used systems.

The CGS units are used widely by physicists.

The CGS system has simplified measurements.

**coulomb:** a unit of charge

The system uses the coulomb as the fourth unit.

The charge of this body is $1.6 \times 10^{-19}$ coulombs.

The coulomb is used throughout the world as a unit of charge.

**electromagnetic:** having to do with both electric and magnetic phenomena

If electromagnetic quantities are included, a fourth quantity has to be added.

Maxwell is considered the founder of electromagnetic theory.

Electromagnetic waves travel with the speed of light.

**farad:** a unit of capacitance

The system uses the farad as the fourth unit.

Divisions of the farad are often used.

A microfarad is a millionth of a farad.

**henry:** a unit of inductance

The system uses the henry as the fourth unit.

This formula gives the inductance in henrys.

A millihenry is a thousandth of a henry.

**joule:** a unit of energy or work

The joule is the work done.

One joule is $10^7$ ergs, where an erg is the CGS unit.

This expression gives the energy in joules.

**kilogram:** a unit of mass and weight, equal to 1000 grams (2.2046 pounds)

It gives the mass of one kilogram.

It weighs ten kilograms.

Give me the weight in kilograms.

**mass:** the property of a body that is commonly taken as a measure of the quantity of matter in it

On the moon a man would have less weight than he has on the earth, but the same mass.

The formula $E = mc^2$ relates energy to mass and the velocity of light.