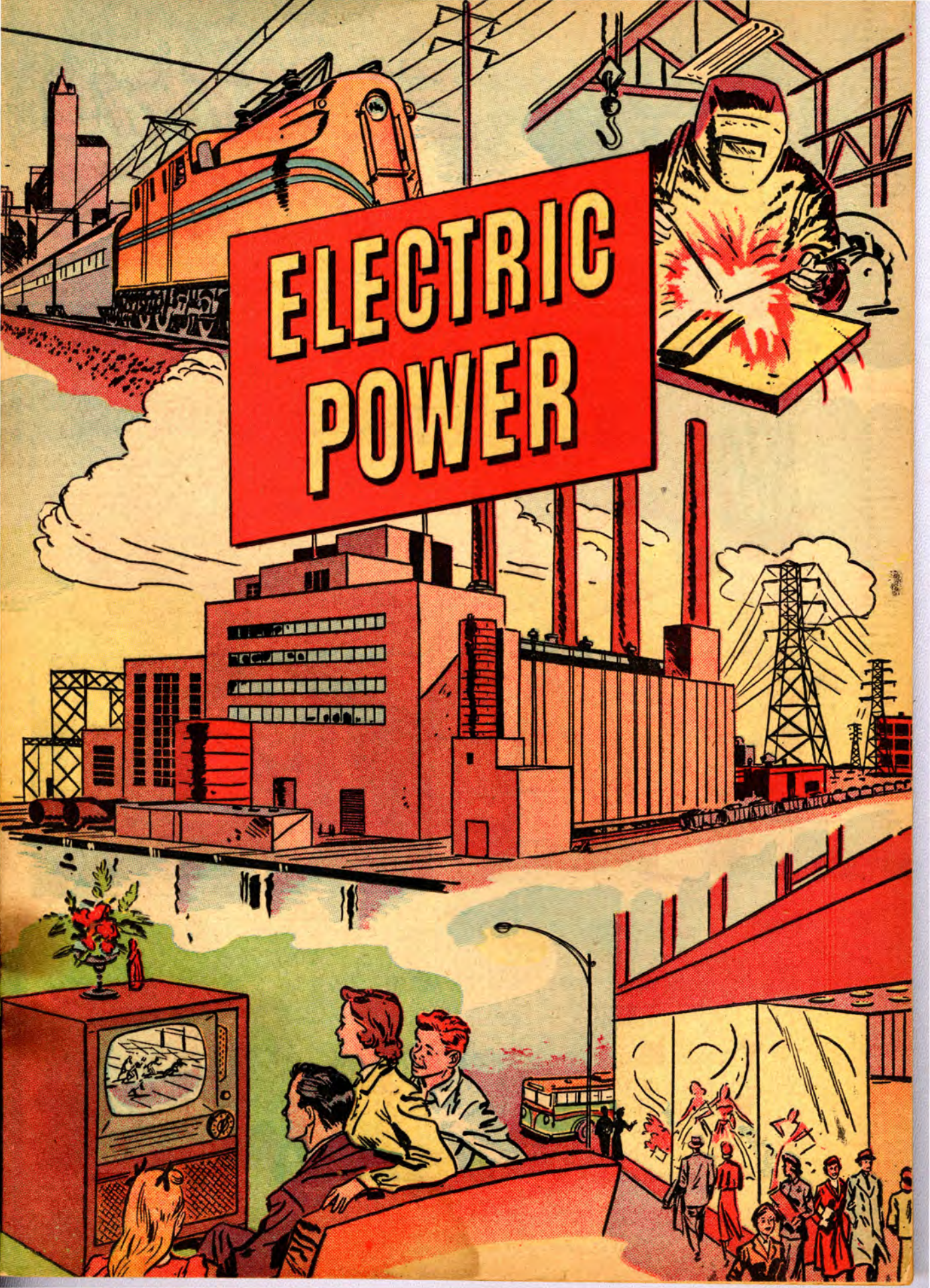
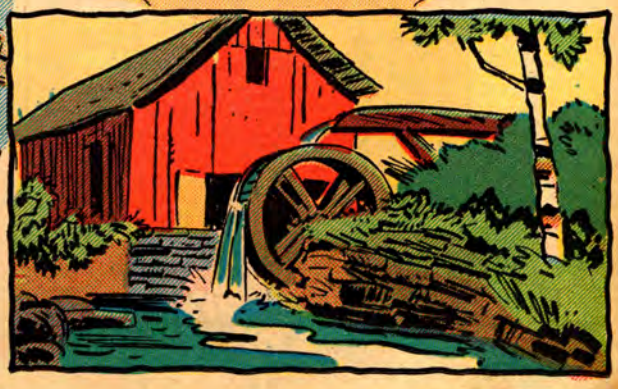

ELECTRIC
POWER

ELECTRIC POWER

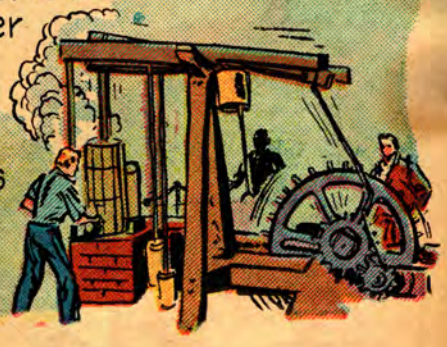
IS MAN'S ANSWER TO THE AGE-OLD NEED FOR POWER TO HELP HIM DO HIS WORK.

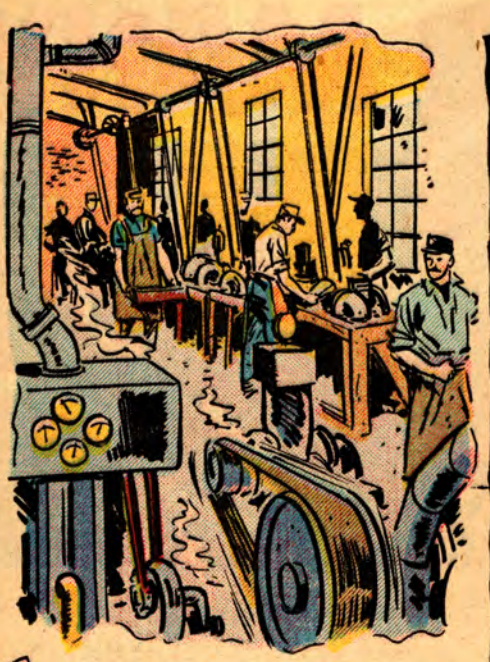
In olden times, people had to work with their own muscles and crude tools. Later they learned to use animals, too. With only muscle power, **100,000** men worked 20 years to build the Great Pyramid at Gizeh.



Man learned to harness the power of wind and water. But not until the invention of the steam engine could he **MAKE** power when and where he wanted it.

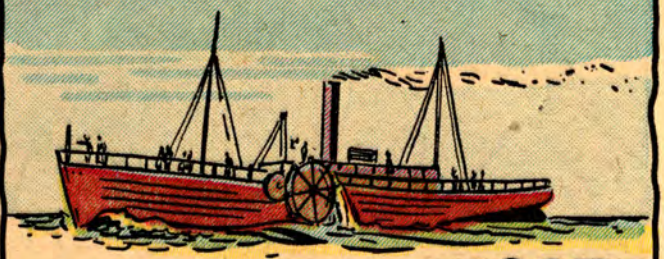
Thomas Newcomen invented the **STEAM ENGINE** in 1705. Others, especially James Watt, made it a better machine. At first, it was used to pump water from coal mines



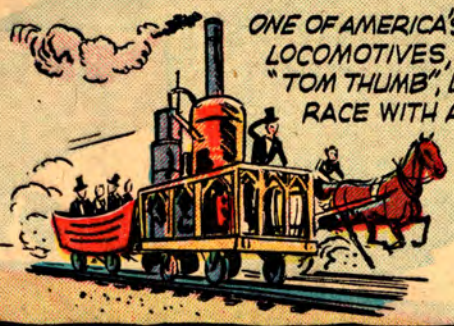


Soon men began to use the steam engine for **POWER** in their factories. One engine usually supplied power for all the workers. But the power could be sent only a short way by gears, belts, and pulleys.

The steam engine brought a **NEW AGE** to transportation.

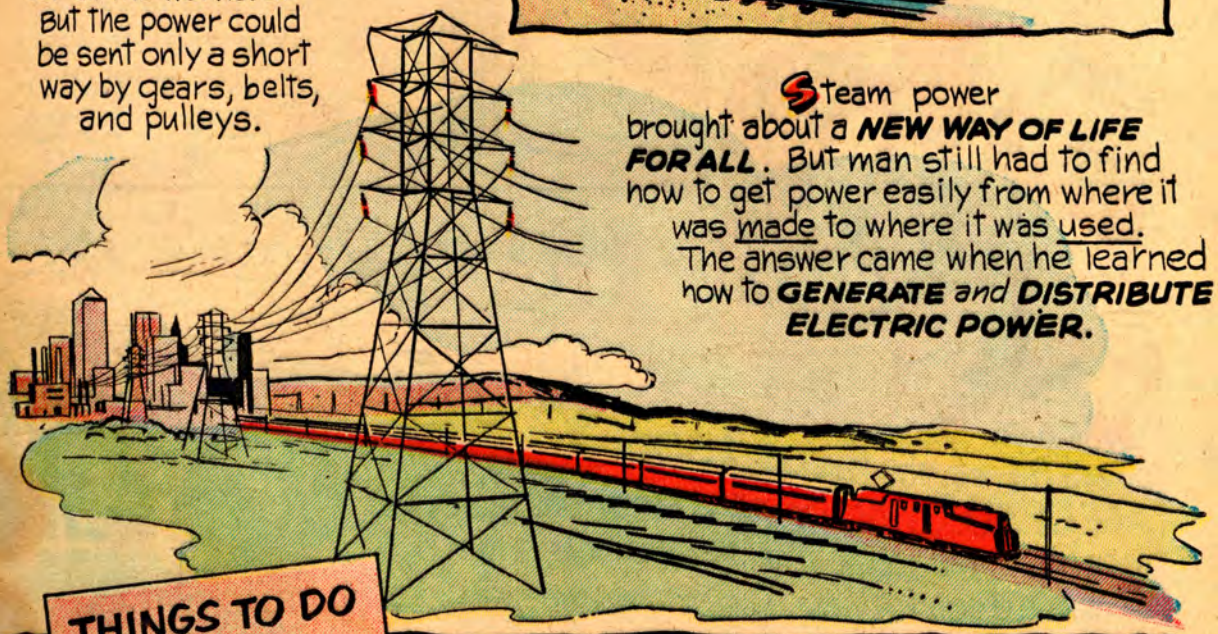


ROBERT FULTON'S "CLERMONT" **1807**



ONE OF AMERICA'S FIRST LOCOMOTIVES, THE "TOM THUMB", LOST A RACE WITH A HORSE CAR. **1830**

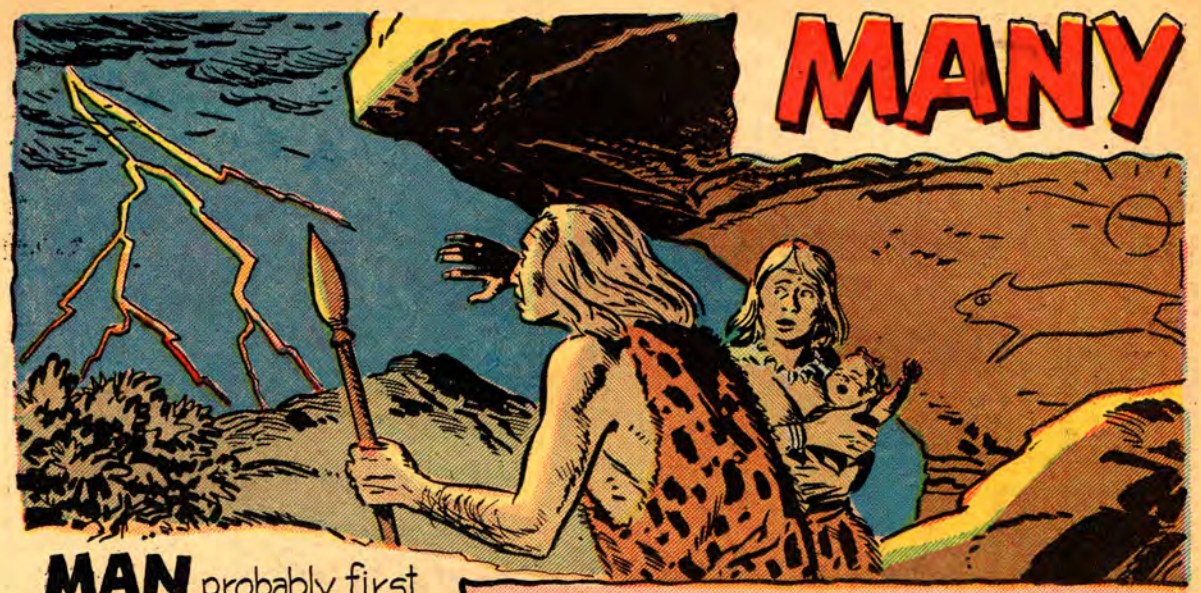
Steam power brought about a ***NEW WAY OF LIFE FOR ALL***. But man still had to find how to get power easily from where it was made to where it was used. The answer came when he learned how to ***GENERATE*** and ***DISTRIBUTE ELECTRIC POWER.***



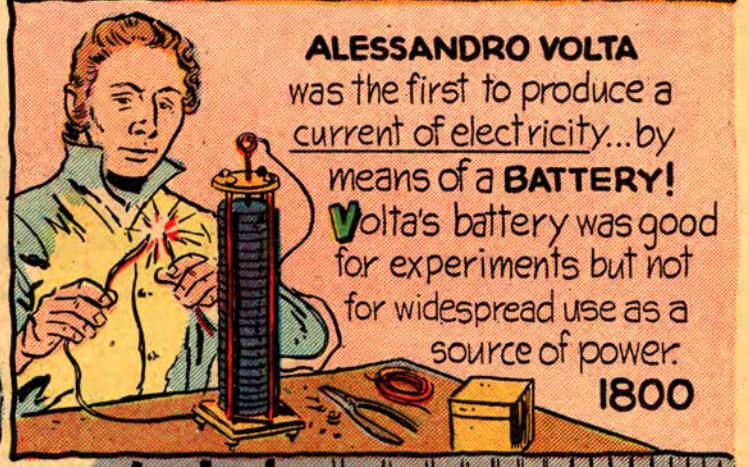
THINGS TO DO

1. List jobs around your home still done by muscle power. Can they be done by electricity?
2. Make a scrapbook of pictures of your town before and after electricity came to it.
3. Find out when the first electric power station was built in your area. How much power did it produce?
4. Learn how a steam engine works. Draw a diagram of it.

MANY



MAN probably first learned about electricity from lightning. But he could not control it or put it to useful work.



ALESSANDRO VOLTA was the first to produce a current of electricity... by means of a **BATTERY!** Volta's battery was good for experiments but not for widespread use as a source of power.

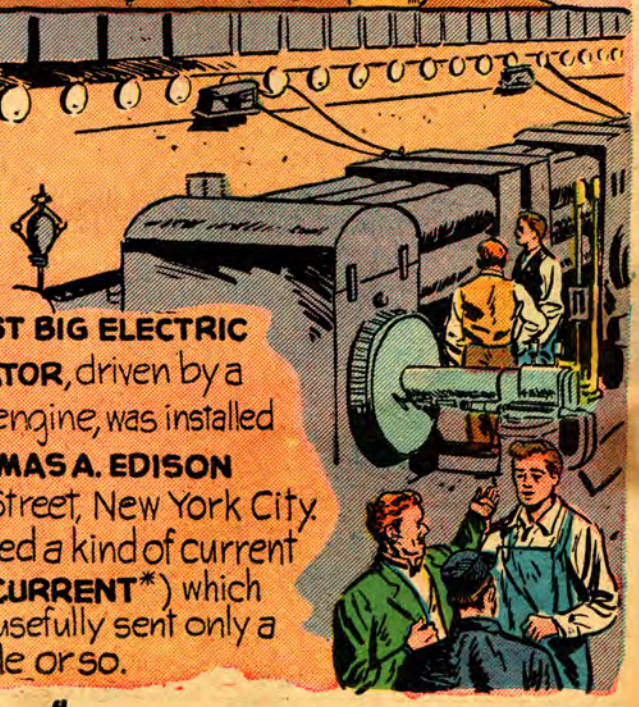
1800

1831

MICHAEL FARADAY paved the way for the **AGE OF ELECTRICITY** when he showed how to generate electricity by moving a magnet through a coil of wire.

1882

The **FIRST BIG ELECTRIC GENERATOR**, driven by a steam engine, was installed by **THOMAS A. EDISON** at Pearl Street, New York City. It produced a kind of current (**DIRECT CURRENT***) which could be usefully sent only a mile or so.

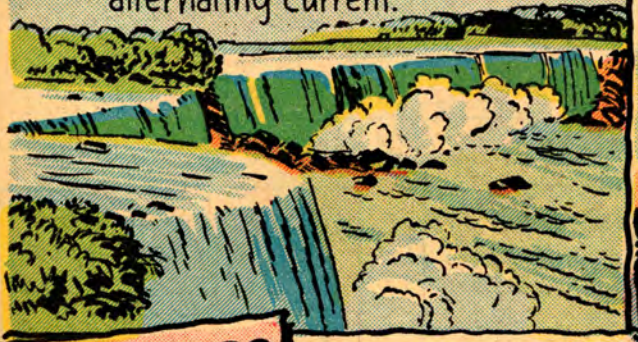


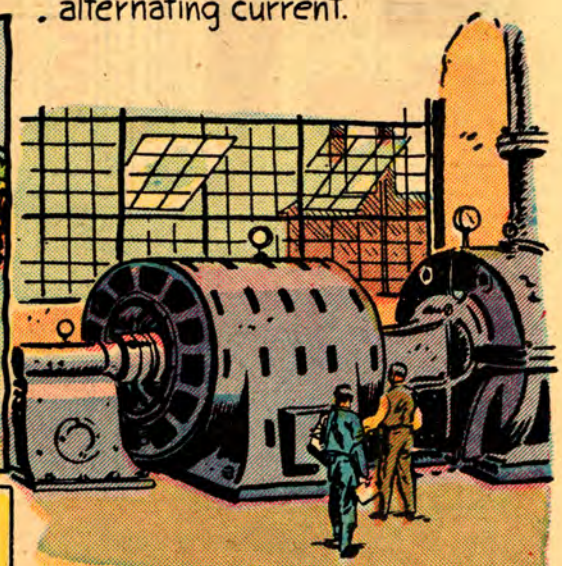
* SEE PAGE 22

MEN from many nations helped us learn how to produce ELECTRIC POWER.

GEORGE WESTINGHOUSE believed that another kind of current (**ALTERNATING CURRENT***) would be more useful because it could be sent over long distances. The first alternating current system lighted the town of Great Barrington, Mass., on March 20, 1886. Today almost all electric power is generated as alternating current.

In 1895, mighty **NIAGARA FALLS** was harnessed to produce alternating current.





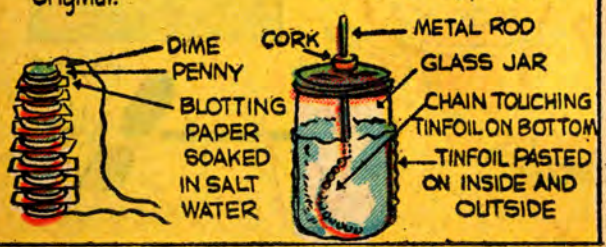
THINGS TO DO

1. Here are some other great names in the story of electricity: **THALES, AMPERE, OERSTED, FRANKLIN, HENRY.** Find out more about them and share your information with your classmates.

2. Build a simple **BATTERY** from clean dimes and pennies. Touch the wires to a sensitive voltmeter or to your tongue. Try to light a flashlight bulb with your battery. It is similar to Volta's original.

3. Build a **LEYDEN JAR.** Read in a physics or general science book how to charge and discharge it.

The Leyden Jar was man's first piece of electrical apparatus.



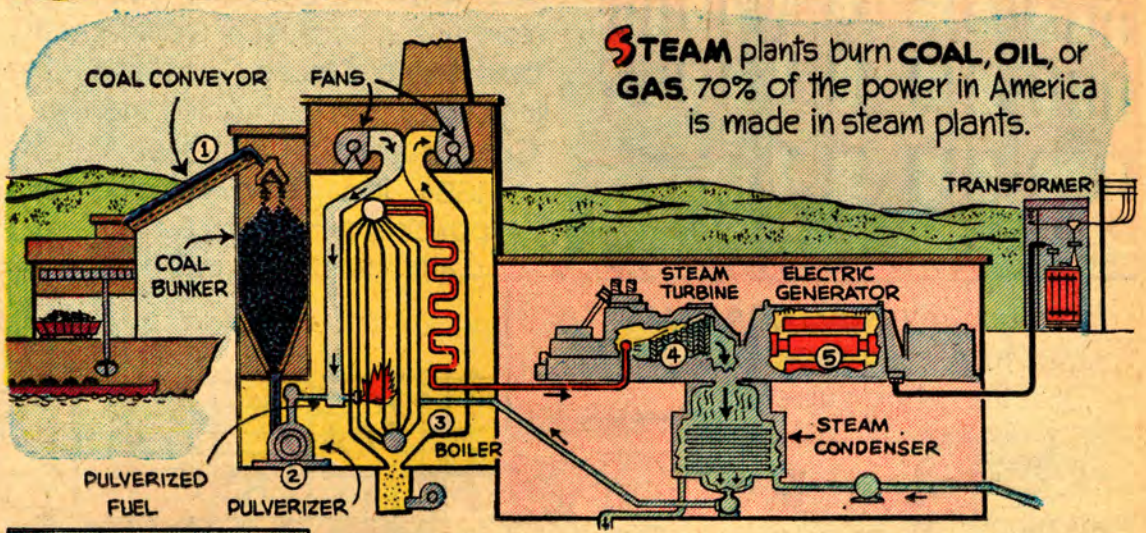
The **STEAM TURBINE** took the place of the steam engine for turning electric generators. The first turbogenerator was put into service at Hartford, Connecticut, in 1900.

ELECTRIC POWER meant that at last men were able to produce power in **ONE CENTRAL LOCATION** and distribute it **INSTANTLY AND ECONOMICALLY** to wherever it had to be used.

* SEE PAGE 22

A POWER STATION

is a marvel of modern science and engineering, costing many millions of dollars.



STEAM plants burn **COAL, OIL,** or **GAS.** 70% of the power in America is made in steam plants.

① **C**oal is carried by conveyor belts to the **COAL BUNKERS.** It is cleaned and weighed on the way.

② **R**olling metal balls in the coal **PULVERIZER** grind the coal fine as a lady's face powder.

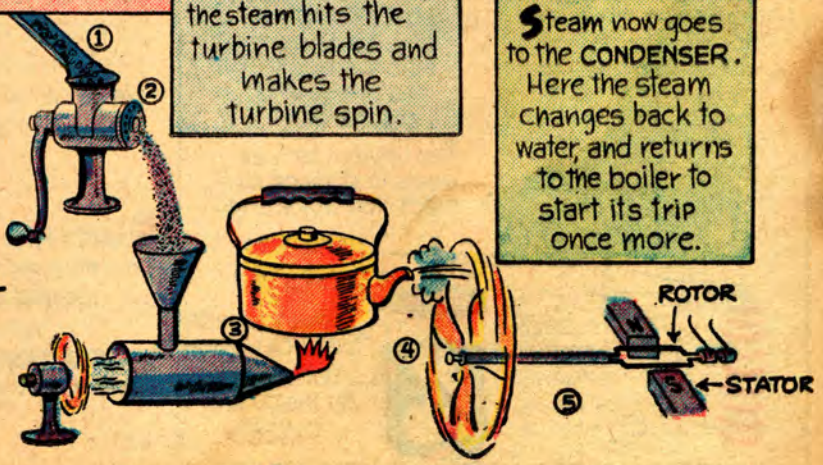
③ **P**owdered coal is blown into huge **BOILER-FURNACES.** Miles of tubing in the furnace carry water, which turns to super-heated steam.

④ **R**ushing through fine nozzles in the **STEAM TURBINE,** the steam hits the turbine blades and makes the turbine spin.

⑤ **T**he turbine turns the **ROTOR,** or moving part of the **ELECTRIC GENERATOR.** When the coils of wire on the rotor sweep past the magnetic poles of the **STATOR,** or motionless part of the generator, electricity is formed (or induced) in them.

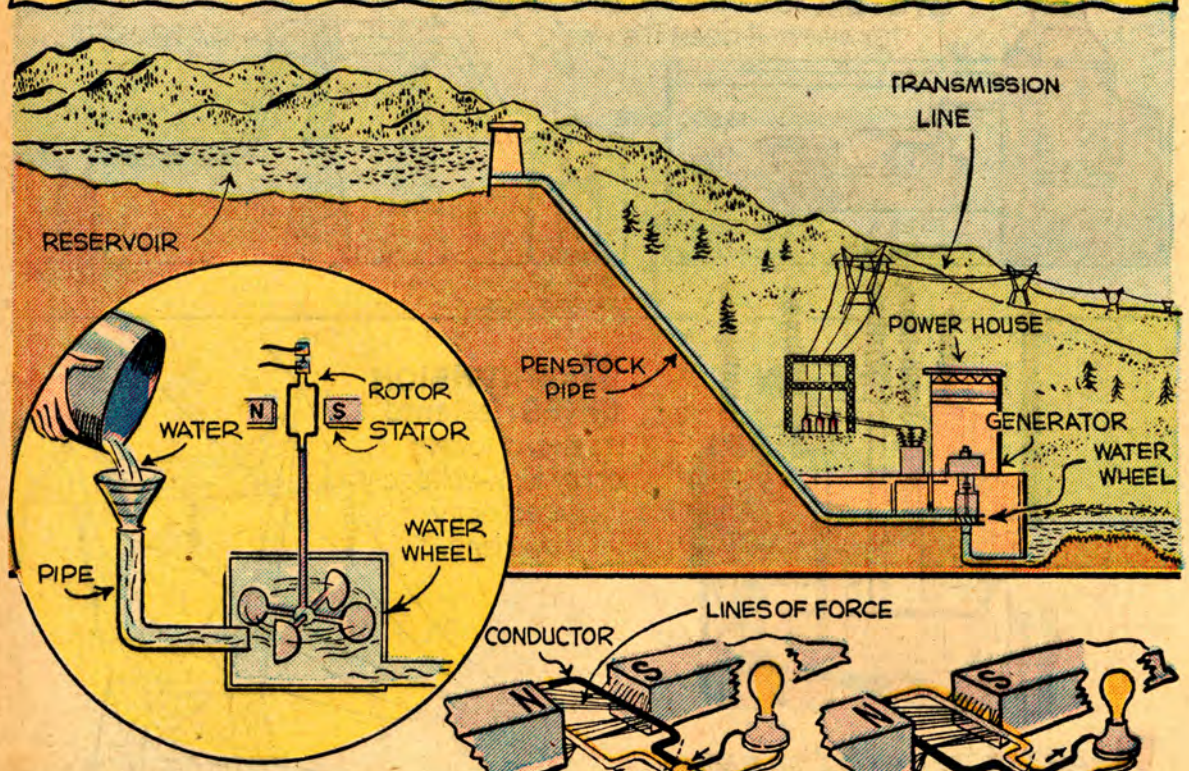
Steam now goes to the **CONDENSER.** Here the steam changes back to water, and returns to the boiler to start its trip once more.

An electric power station **TRANSFORMS** energy. In the boiler, the **CHEMICAL ENERGY** of the fuel is changed to **HEAT ENERGY.** The turbine changes the heat energy into **MECHANICAL ENERGY,** and the generator changes this into **ELECTRICAL ENERGY.**



WATER is used for power in parts of the country where waterfalls, lakes, or dams can serve the purpose. About 30% of the electric power in America is generated in this way.

WATER is piped from a high stream or lake, or tunneled through the bottom of a dam to great water wheels. It turns the wheels and rotates the generators located above.



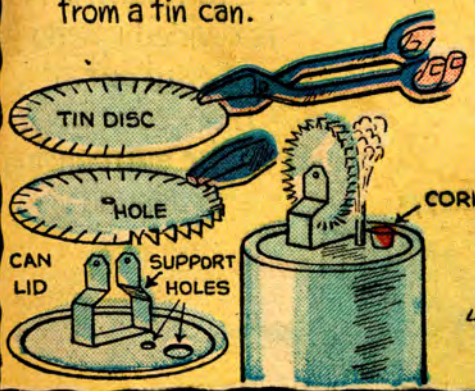
HOW AN A-C GENERATOR WORKS

When a loop of wire spins between the poles of a magnet, it cuts magnetic lines of force. This produces an electric current in the wire. The current reverses direction each half turn and is therefore called alternating current (A.C.).

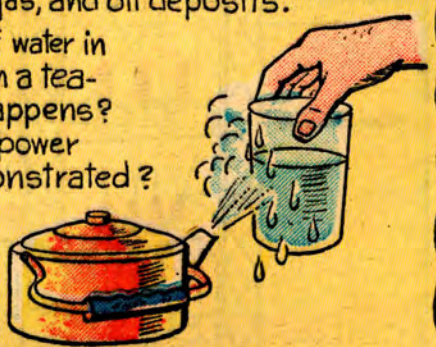
THINGS TO DO

1. Draw a map showing the location of America's important coal, gas, and oil deposits.

2. Make a simple turbine from a tin can.



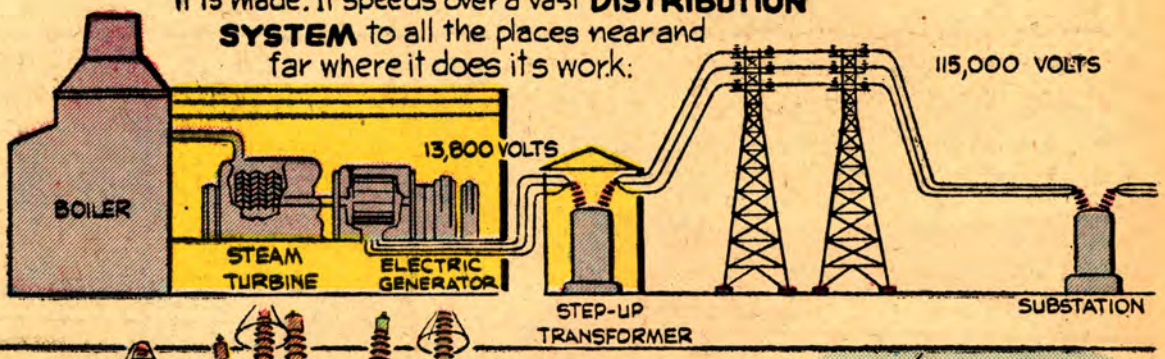
3. Hold a glass of water in the steam from a tea-kettle. What happens? What part of a power plant is demonstrated?

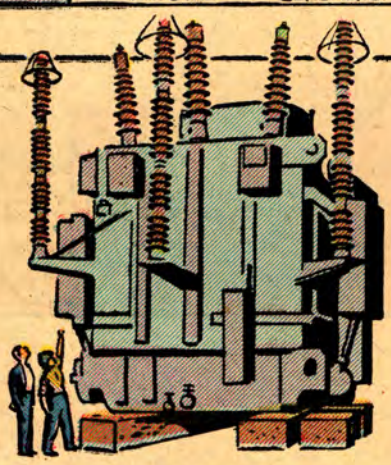


4. Find out about job opportunities in the power industry from someone who works for your power company.

ELECTRIC POWER NEEDS A

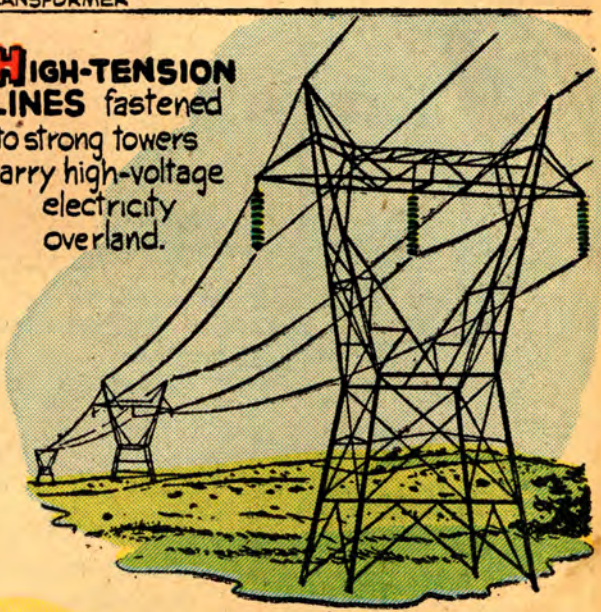
ELECTRICITY must be used the instant it is made. It speeds over a vast **DISTRIBUTION SYSTEM** to all the places near and far where it does its work.



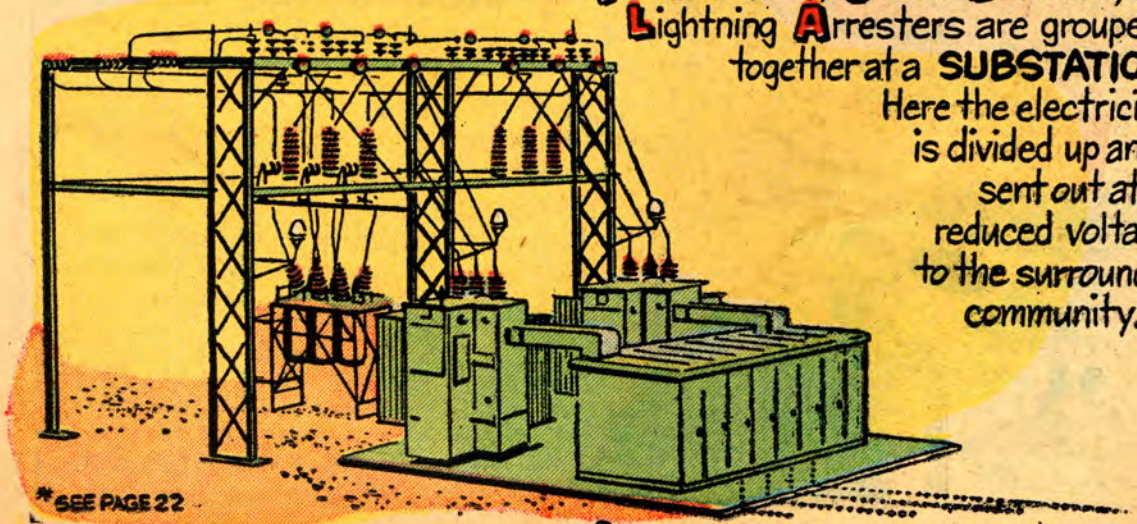


HEART of the distribution system is the **TRANSFORMER**. It raises the voltage* of electricity for long-distance transmission or lowers it for use.

HIGH-TENSION LINES fastened to strong towers carry high-voltage electricity overland.

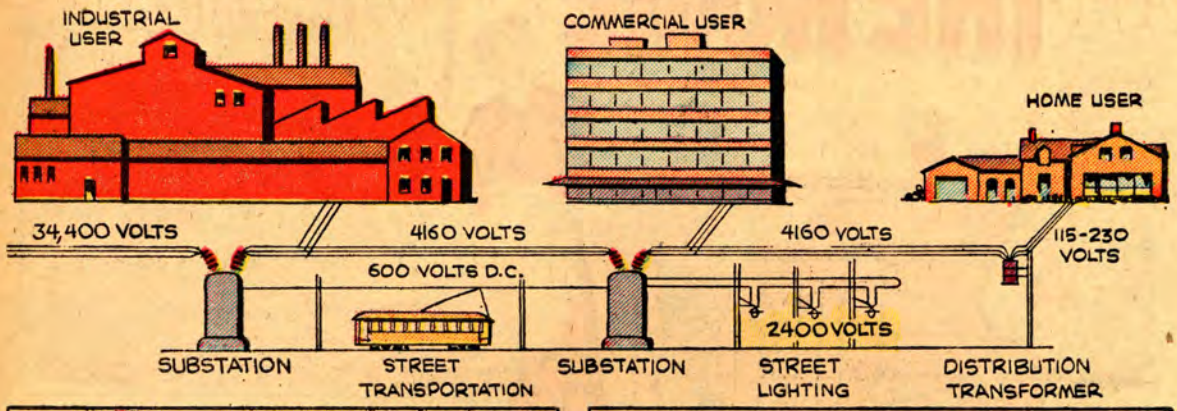


Transformers, **C**ircuit **B**reakers, and **L**ightning **A**rresters are grouped together at a **SUBSTATION**. Here the electricity is divided up and sent out at reduced voltage to the surrounding community.



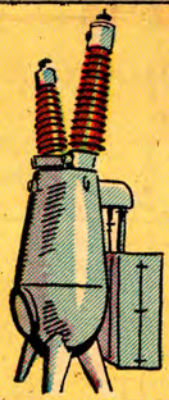
*SEE PAGE 22

DISTRIBUTION SYSTEM...



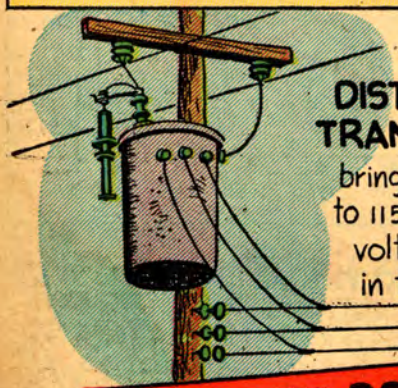
CIRCUIT BREAKERS

are giant switches which automatically turn off the electricity in case of emergency... turn it on again when the emergency is over.



LIGHTNING ARRESTERS

protect electrical equipment when lightning hits the line. They by-pass the extra electricity from the lightning harmlessly into the ground.



DISTRIBUTION TRANSFORMERS

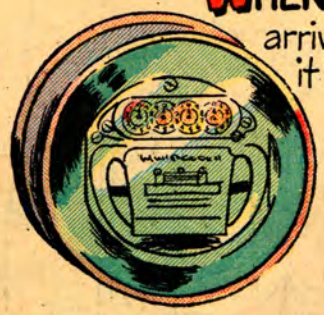
bring electricity to 115 volts or 230 volts for use in the home.

WHEN ELECTRICITY

arrives at the home, it is measured by a

WATT-HOUR METER

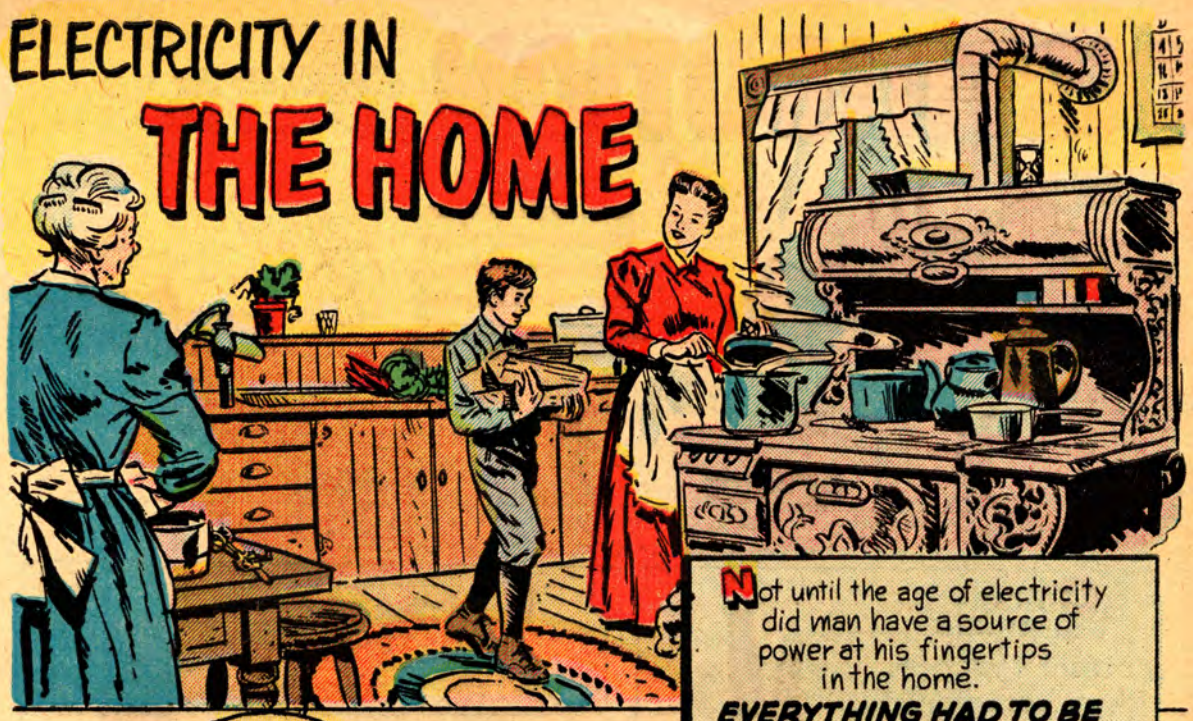
and goes to all parts of the house.



THINGS TO DO

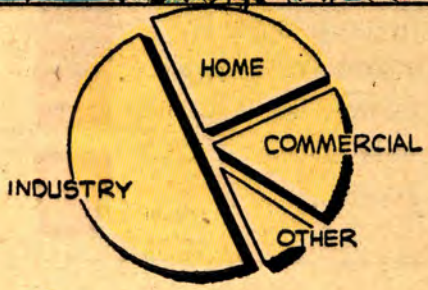
1. Learn how to read the watt-hour meter in your home. Read it at the beginning and end of a month and determine how much electricity was used. See if you can figure the cost of the month's electric bill.
2. Find a transformer in your home and trace the wires to and from it.
3. Give a sales talk on why electric light is better than kerosene lamps as it might have been given in the early days of electric power.
4. Locate a substation in your neighborhood. Try to identify the equipment.
5. Locate the pole transformer which serves your house. See how many other houses are connected to it.

ELECTRICITY IN THE HOME

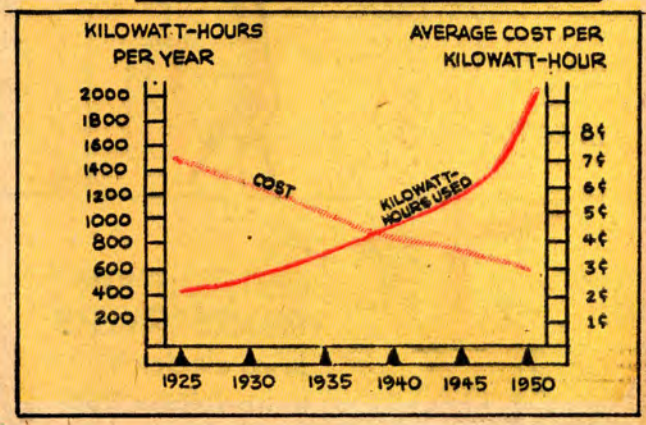


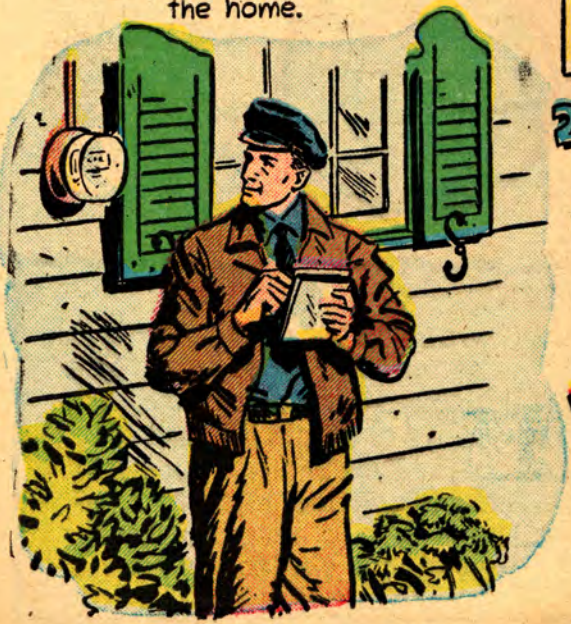
Not until the age of electricity did man have a source of power at his fingertips in the home.

EVERYTHING HAD TO BE DONE BY HAND.



About ¼ of all the electricity produced in America is used in the home.

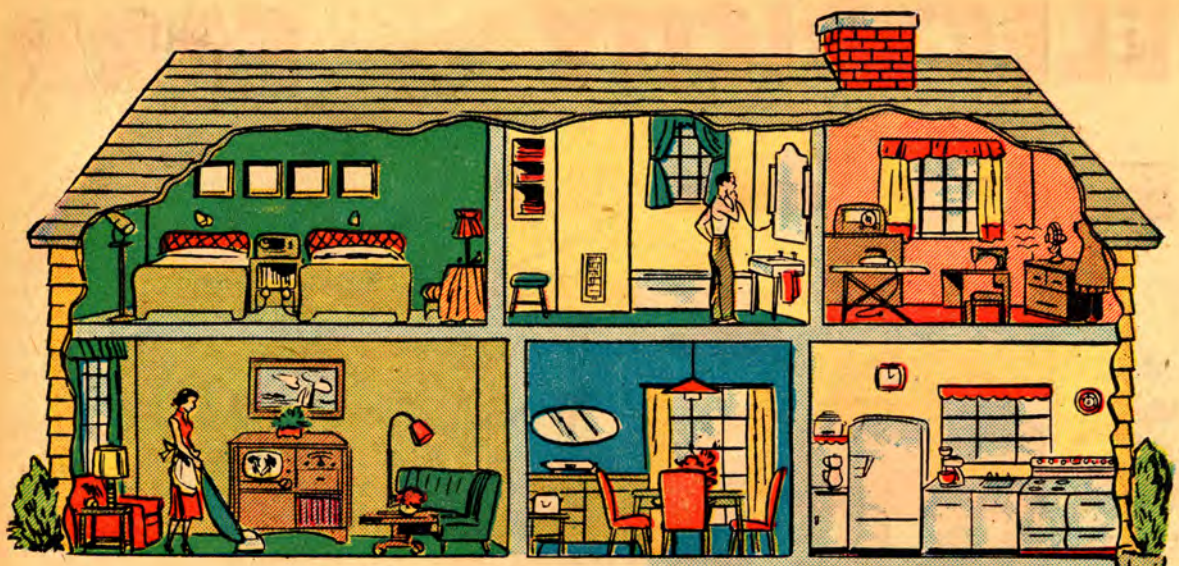




25 YEARS AGO THE AVERAGE HOME used about 7 kilowatt-hours* of electricity a week, paid 7¼¢ a kilowatt-hour for it. Now the average home uses about 40 kilowatt-hours a week, costing less than 3¢ each.

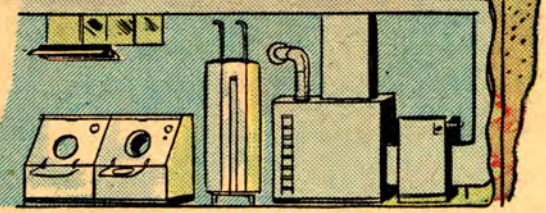
THE ORDINARY WATT-HOUR METER is a marvel of accuracy and precision. Nothing you buy is so accurately measured as electricity.

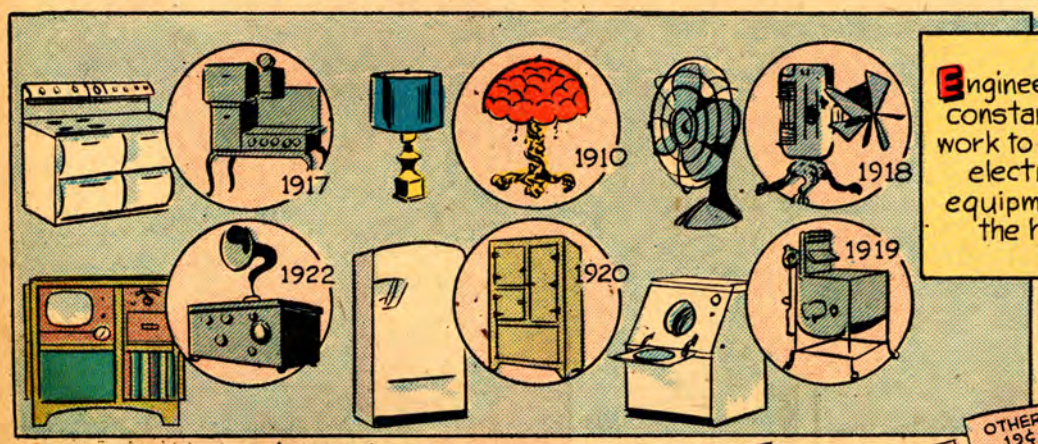
* SEE PAGE 22



Lighting is the basic job electricity does in the home. At first it was the only job. Today ⅓ of the electricity in the home is used for lighting ∴ ⅔ for hundreds of other household tasks.

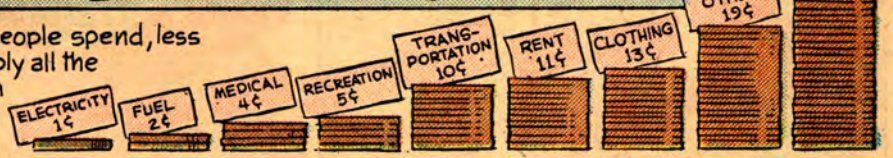
HOW MANY CAN YOU FIND HERE?





Engineers are constantly at work to improve electrical equipment for the home.

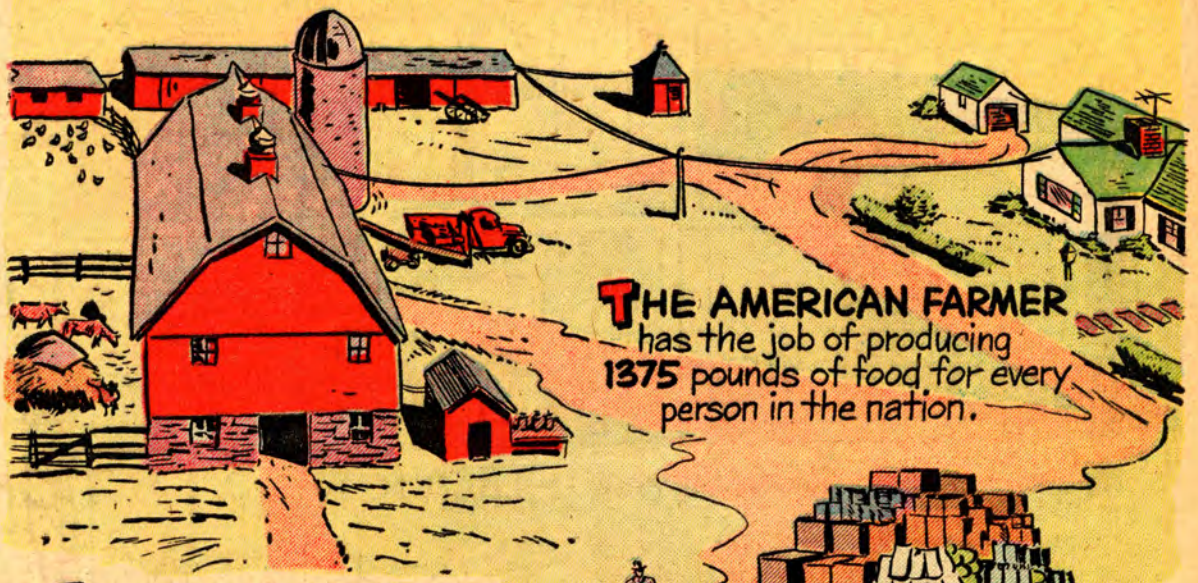
Of every dollar that people spend, less than 1¢ goes to supply all the electricity they use in their homes.



THINGS TO DO

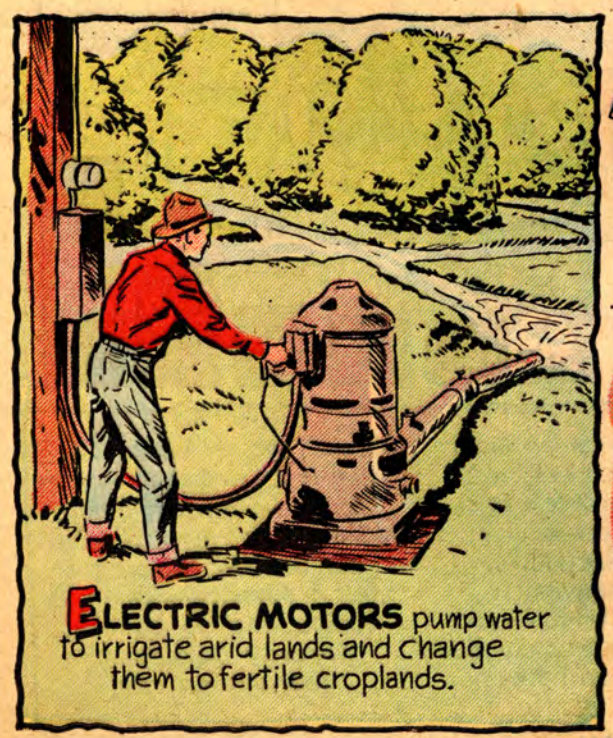
1. On how many ways is electricity used in your own home?
2. Make a list of the things you do in a day which are possible only because of electricity.
3. A man can do about as much work in a 40-hour week as 3 kilowatt-hours of electricity. How many such "electrical men" work for you in your own home?
4. Count the number of electric lamps and motors you have in your home.
5. Eight electrical appliances can be found in more than half of America's electrified homes. What do you think they are? Make a list, then see page 23.

ELECTRICITY ON THE FARM

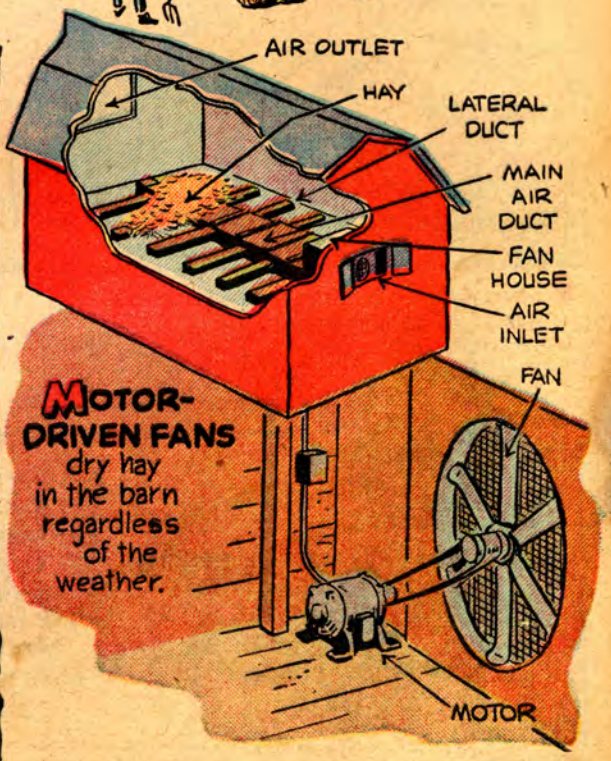


THE AMERICAN FARMER has the job of producing **1375** pounds of food for every person in the nation.

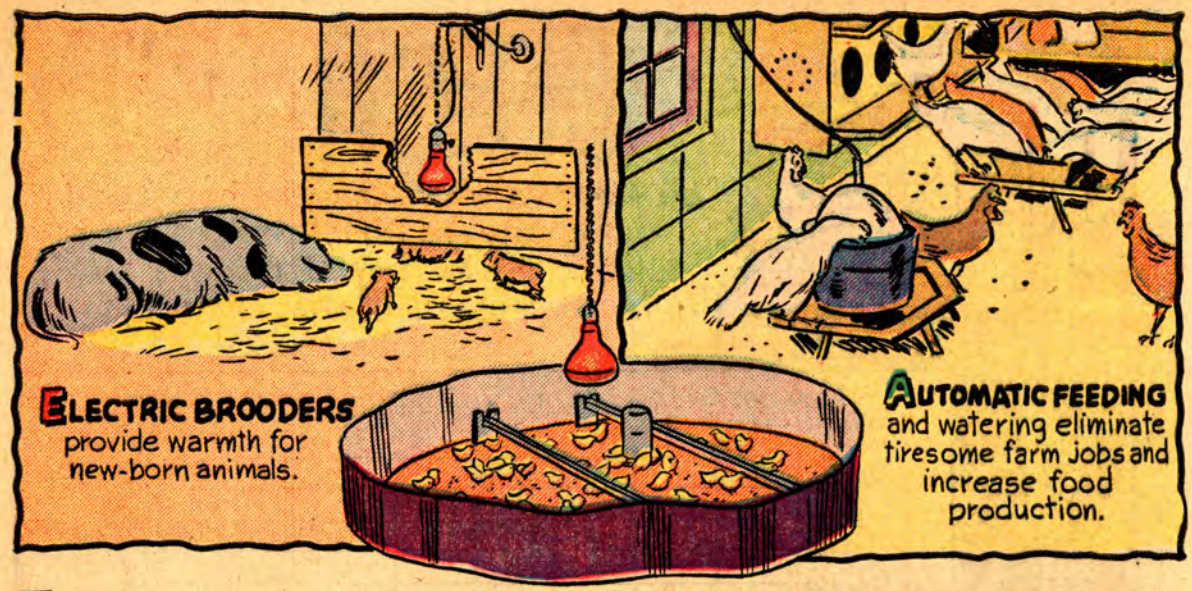
Electricity helps the farmer produce more food at lower cost...provides the farm home with the conveniences of city life.



ELECTRIC MOTORS pump water to irrigate arid lands and change them to fertile croplands.



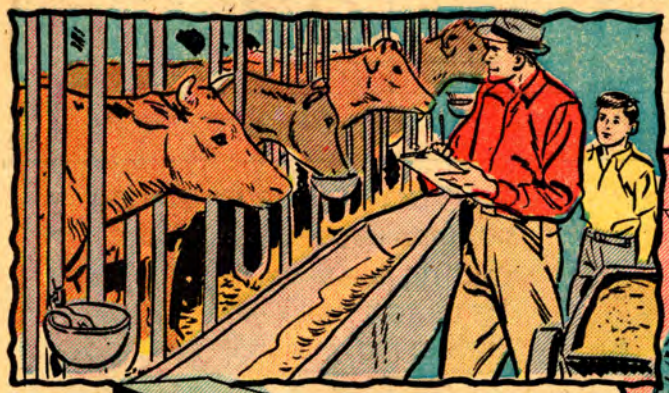
MOTOR-DRIVEN FANS dry hay in the barn regardless of the weather.



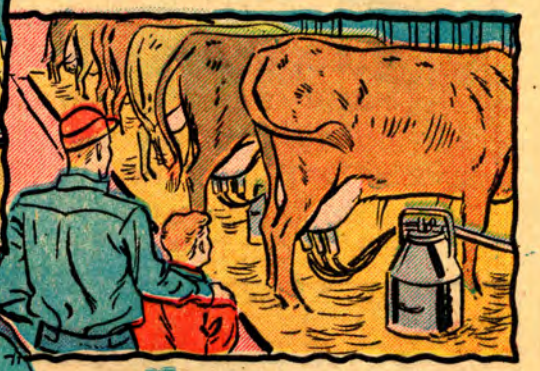
ELECTRIC BROODERS provide warmth for new-born animals.

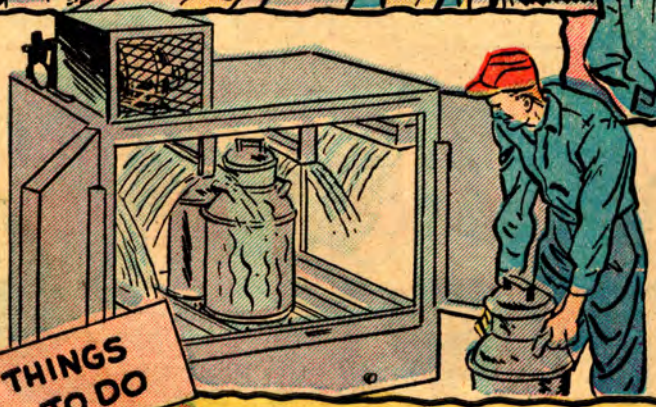
AUTOMATIC FEEDING and watering eliminate tiresome farm jobs and increase food production.

ELECTRICITY HELPS IN MILK PRODUCTION



AUTOMATIC WATERING of cattle increases milk production 10%.





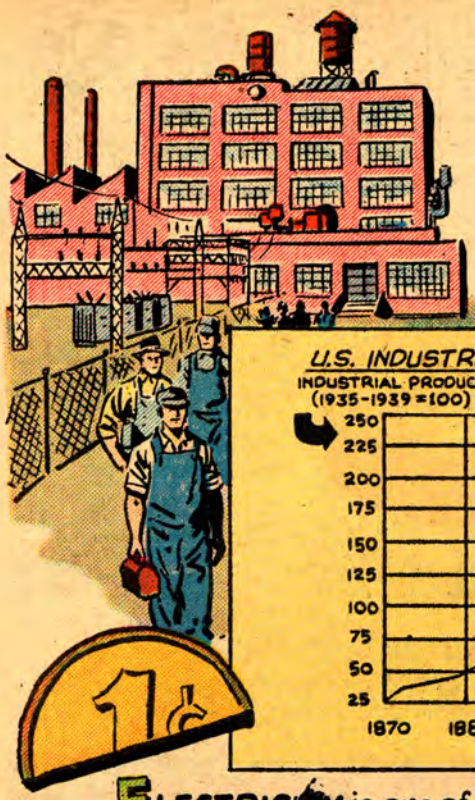
MILKING MACHINES save work, insure clean milk.

MILK COOLERS safeguard health, prevent milk spoilage.

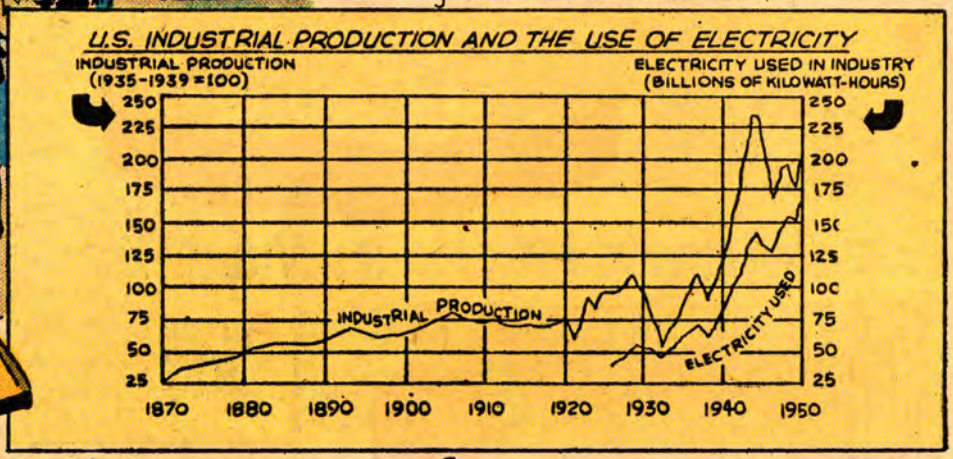
THINGS TO DO

1. Visit a farm and make a report on the uses of electricity you see there.
2. There are about 300 uses of electricity on the farm. How many can you think of?
3. If you live on a farm, study one job which is not now done electrically and figure out how much time and money could be saved by doing it electrically.

ELECTRICITY

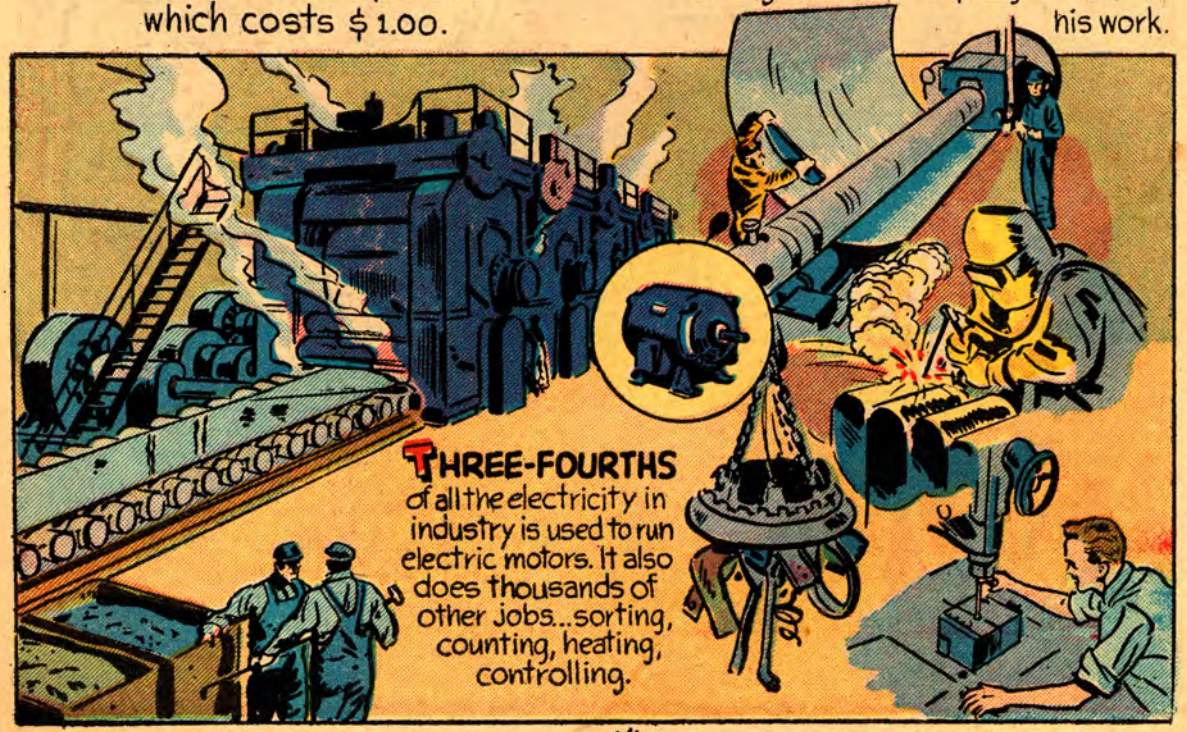


AMERICA'S industrial might is the secret of our security and high standard of living. Electricity is the lifeblood of industry. Large industries use half of all the electricity generated in America.



ELECTRICITY is one of industry's cheapest raw materials. You pay only ½¢ for the electricity used to make a product which costs $1.00.

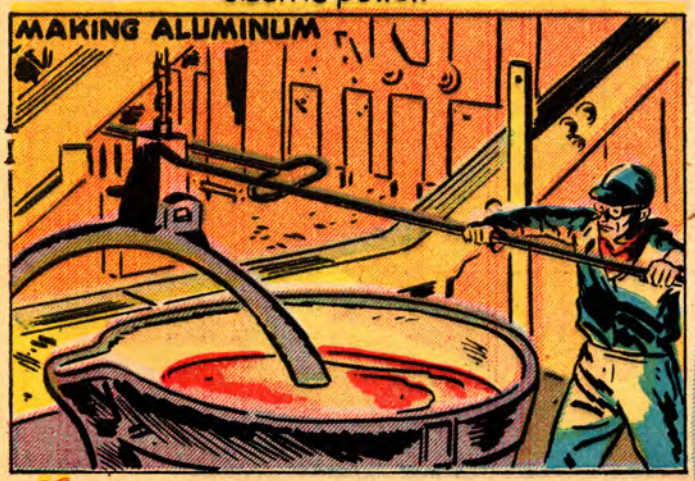
IN 1900 the average American workman used about ⅒ kilowatt of electric power on his job. Today he uses 7½ kilowatts. This is like having 100 men helping him do his work.

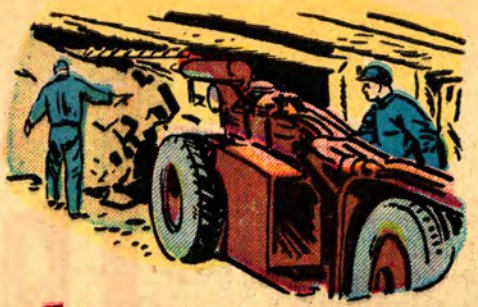


THREE-FOURTHS of all the electricity in industry is used to run electric motors. It also does thousands of other jobs...sorting, counting, heating, controlling.

IN INDUSTRY

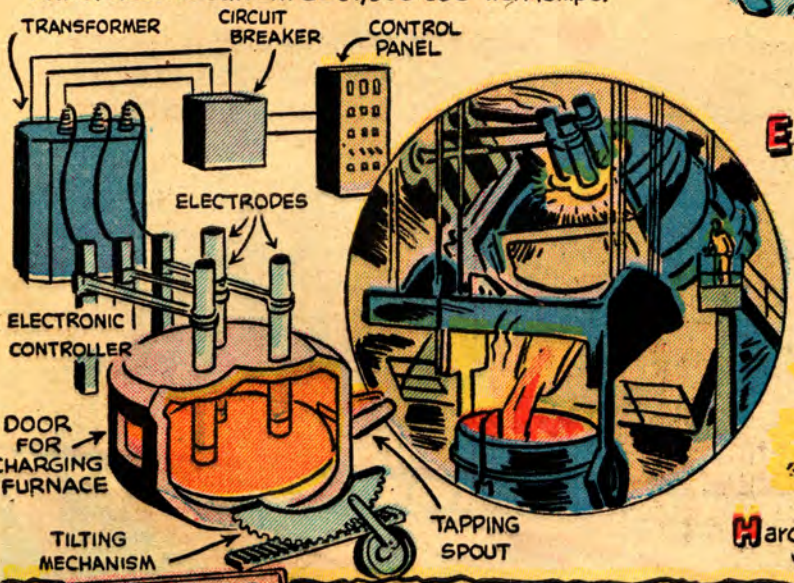
MANY INDUSTRIES, like the **ALUMINUM** and **MAGNESIUM INDUSTRIES,** would be impossible without great quantities of cheap electric power.





ELECTRICITY helps industry produce more. Miners with electrically-operated equipment can produce about 3 times as much coal as miners with hand tools alone.

HUGE ELECTRIC FURNACES help make America's steel. A furnace like this uses as much electric current as 14,500 100-watt lamps.

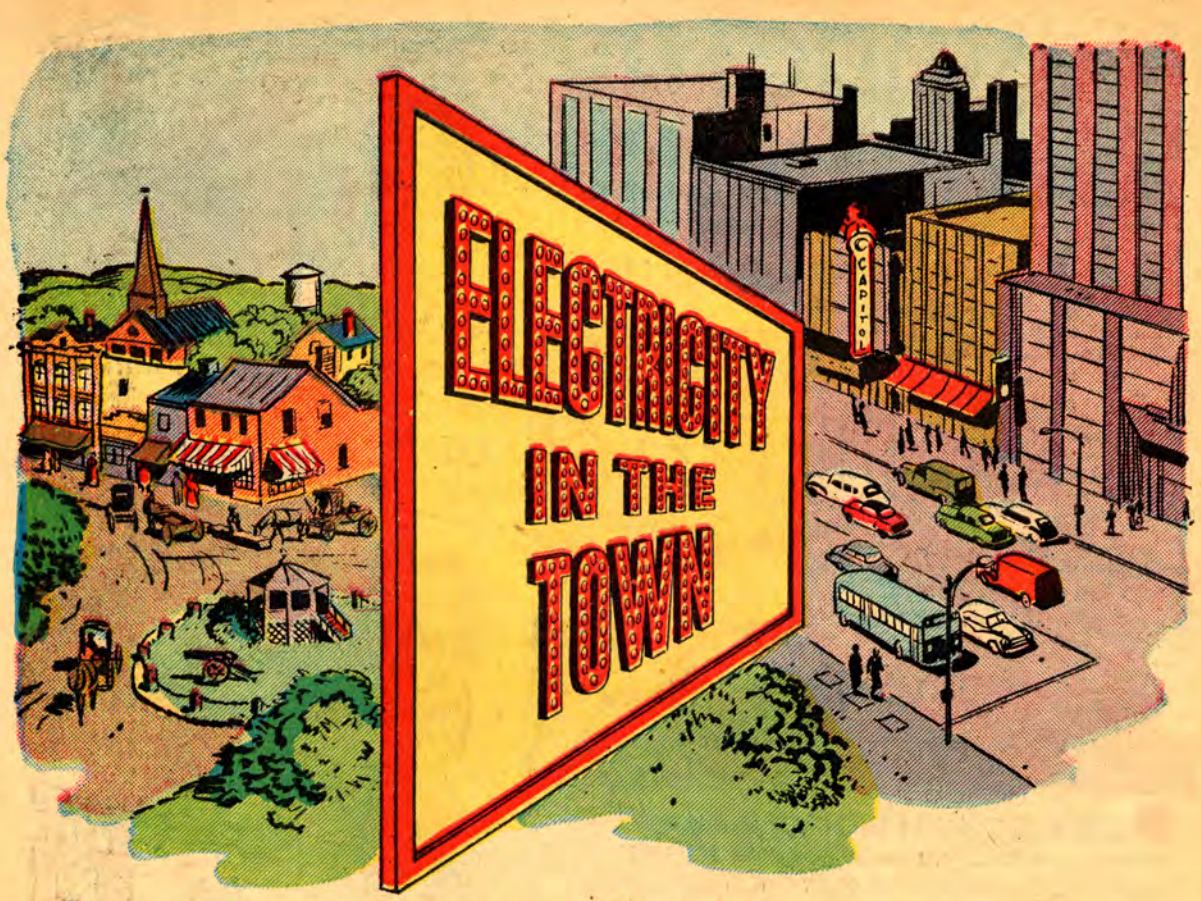


ELECTRONIC HEATING flows tin on sheets of steel, hardens the surface of metals, bonds plywood, helps make plastic products.

Hardening the teeth on a gear with electronic heat.

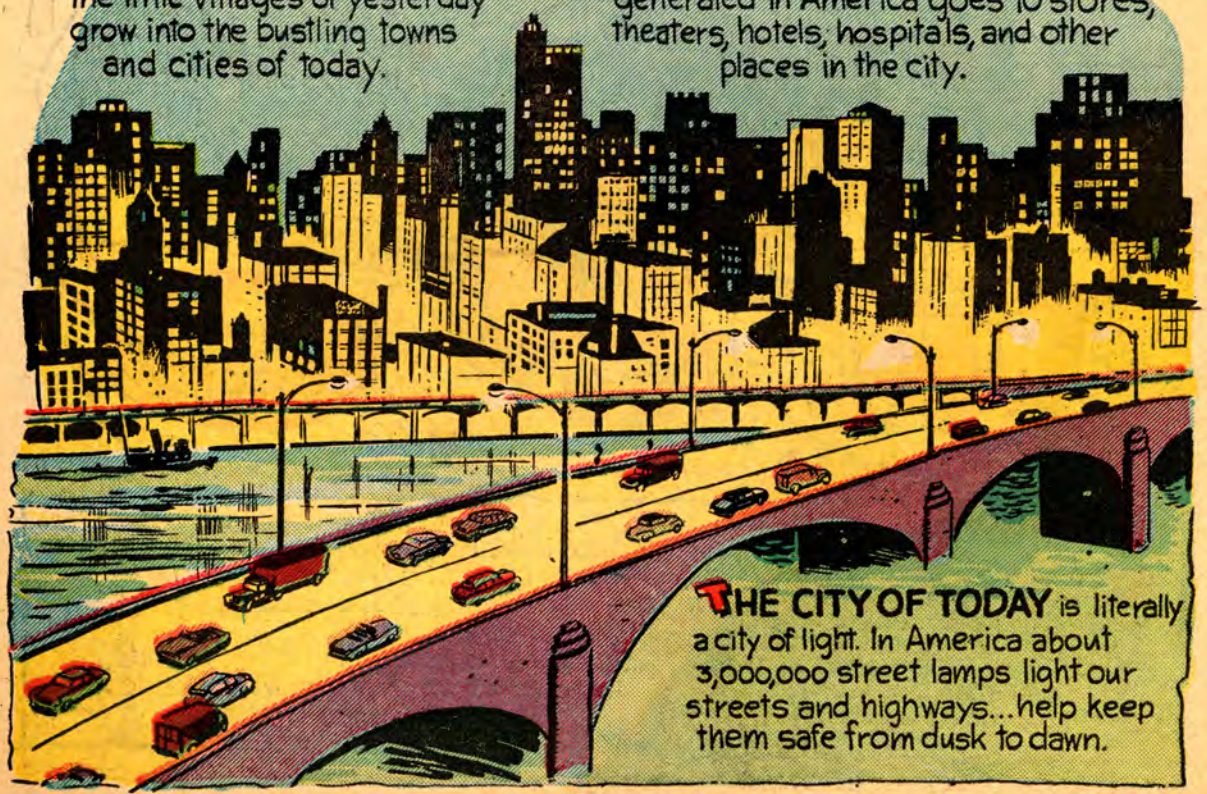
THINGS TO DO

1. Make a list of industries in your area that depend upon electric power. What do they do with it?
2. Make a scrapbook of pictures which show how electricity is used in industry.
3. What industries do you think are the largest users of electric power? You will find the correct answers on page 23.
4. Select some product of industry and imagine all the ways electricity helped in making it.



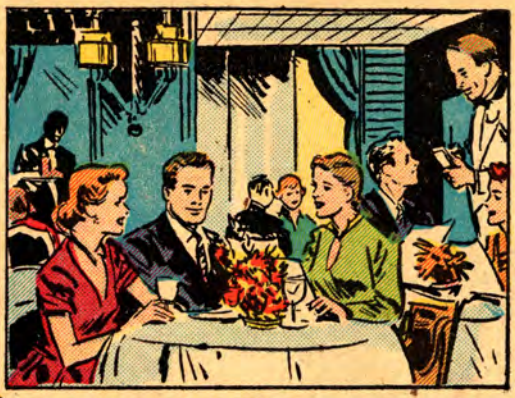
ELECTRIC POWER has helped the little villages of yesterday grow into the bustling towns and cities of today.

NEARLY 1/5 of all the electric power generated in America goes to stores, theaters, hotels, hospitals, and other places in the city.



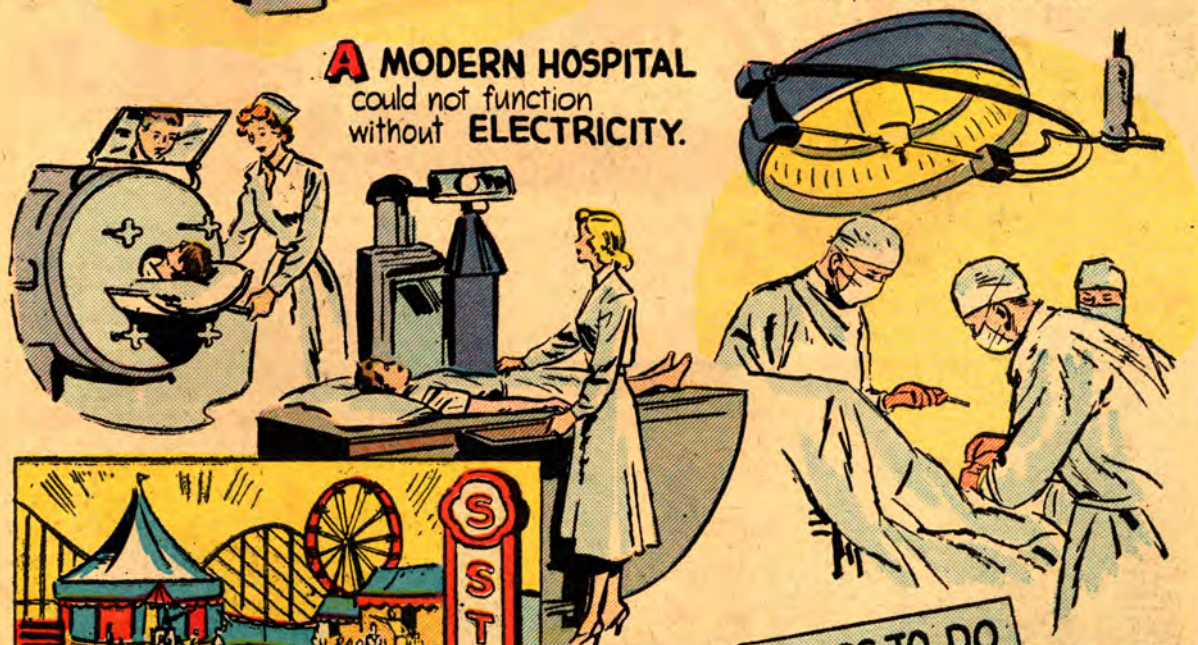
THE CITY OF TODAY is literally a city of light. In America about 3,000,000 street lamps light our streets and highways...help keep them safe from dusk to dawn.

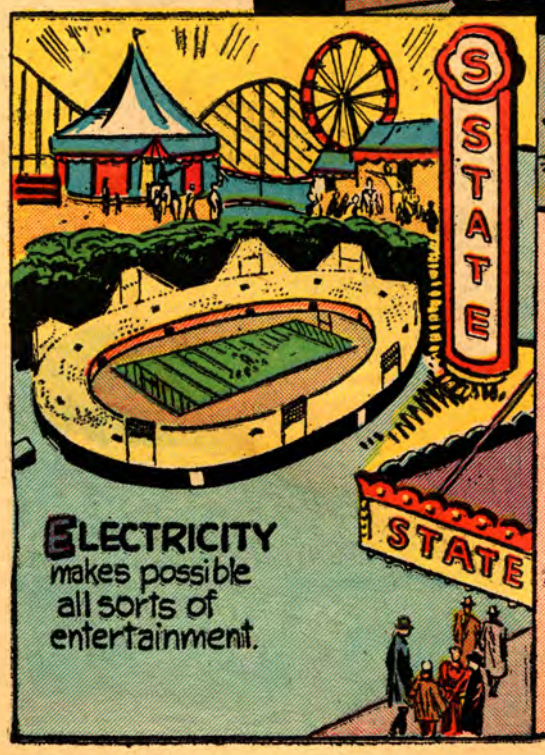
EACH YEAR city dwellers move 500,000,000 miles up and down in elevators. A 3-foot moving stairway can carry 6,000 persons an hour.



AIR CONDITIONING..made possible by electricity... keeps restaurants, theaters, offices, and other places comfortable and healthful.

A MODERN HOSPITAL could not function without **ELECTRICITY.**





ELECTRICITY makes possible all sorts of entertainment.

THINGS TO DO

1. Suppose your town were suddenly without electricity for a day. Write the newspaper headline and story as it might appear in the local paper.

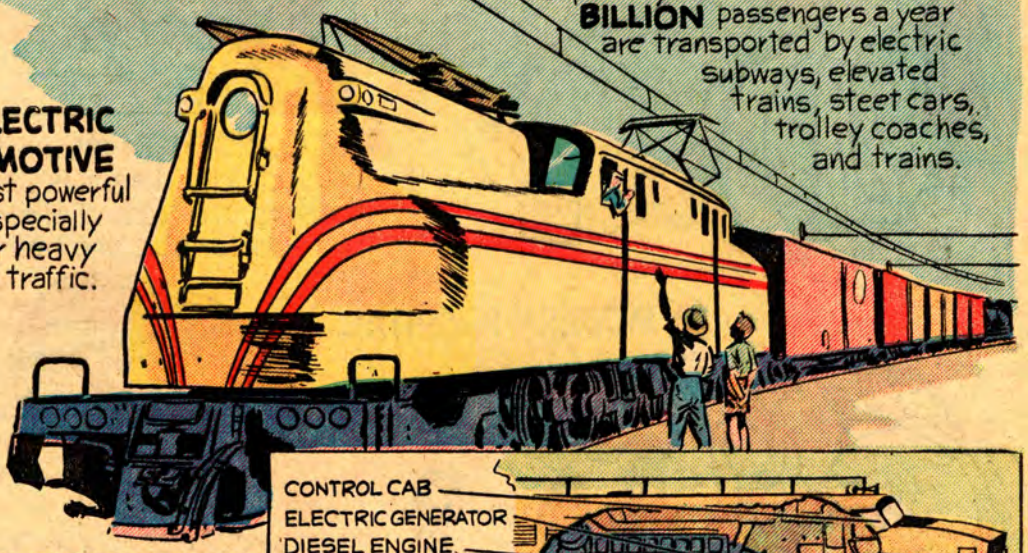
2. Walk down the main street of your town and make a list of all the ways electricity is being put to work.

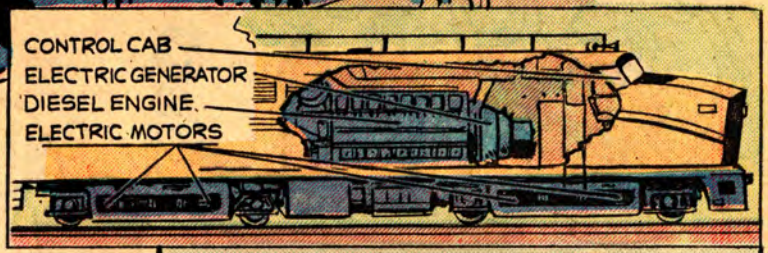
3. Ask some older person to tell you what your town was like before electricity came to it. Describe what a day in your life would have been like then.

ELECTRICITY IN Transportation and

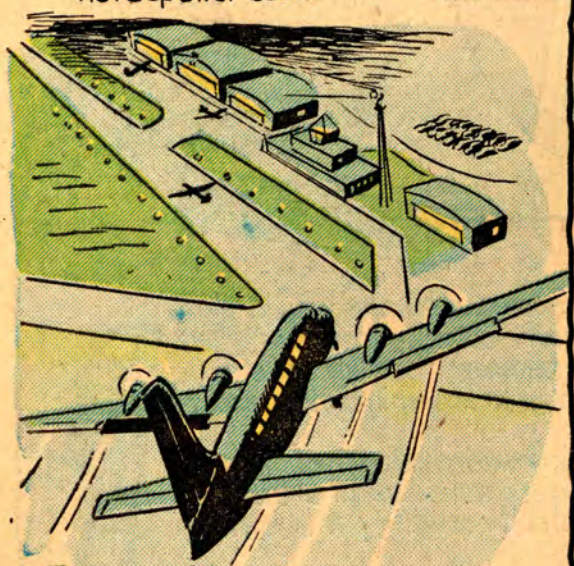
ELECTRICITY MOVES PEOPLE... especially in cities. About **12 BILLION** passengers a year are transported by electric subways, elevated trains, steet cars, trolley coaches, and trains.

THE ELECTRIC LOCOMOTIVE is the most powerful known...especially useful for heavy loads and traffic.



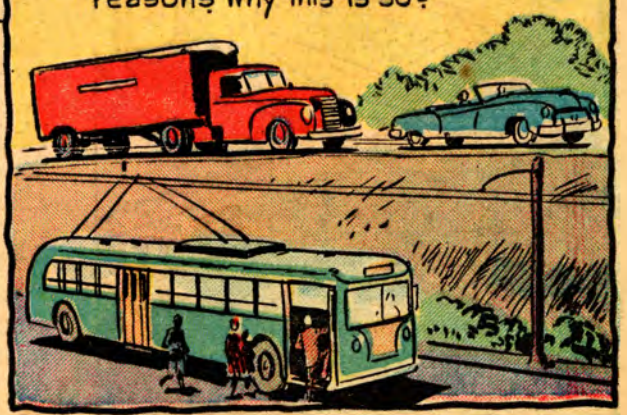


THE DIESEL-ELECTRIC TRAIN carries its own power station. Its locomotive may have 2 or 3 cabs of about 2000 horsepower each.

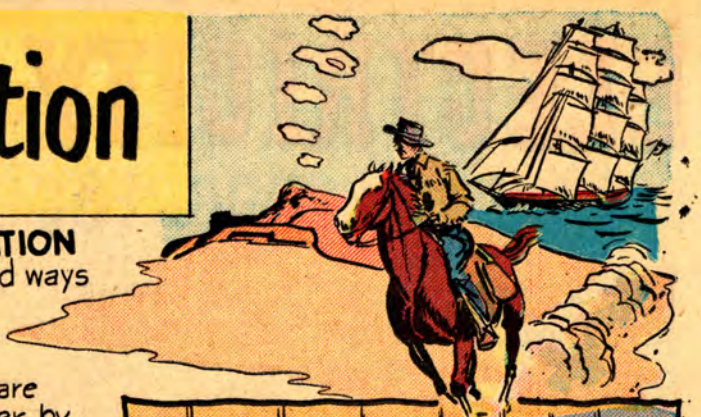


AIRPORT LIGHTING permits round-the-clock air travel. **RADAR** on ships and electrical equipment on trains make travel faster, safer.

MODERN TRAVEL on land, sea, or in the air would be impossible without electricity. Can you think of some reasons why this is so?

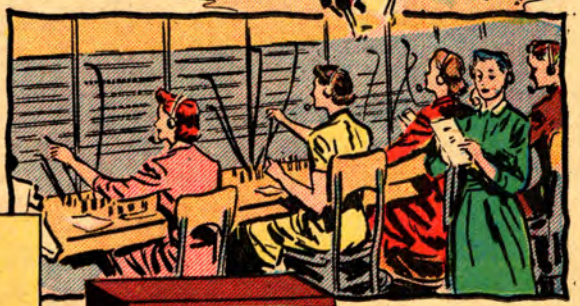


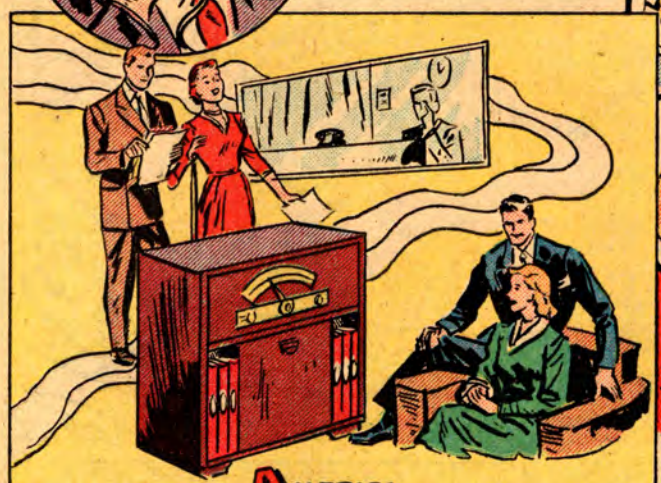
Communication



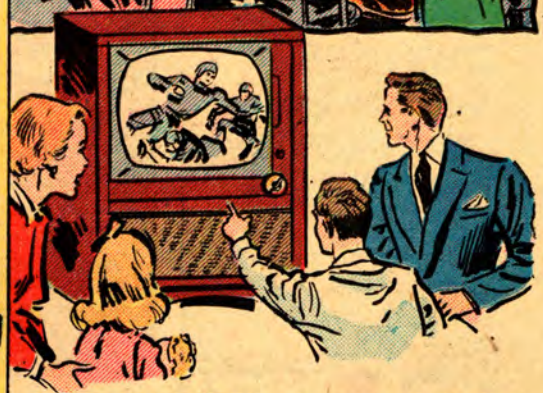
ALL MODERN COMMUNICATION depends upon electricity. The old ways were clumsy and slow.

Americans are linked together by **45 MILLION** telephones and 163 million miles of telephone wire and cable.

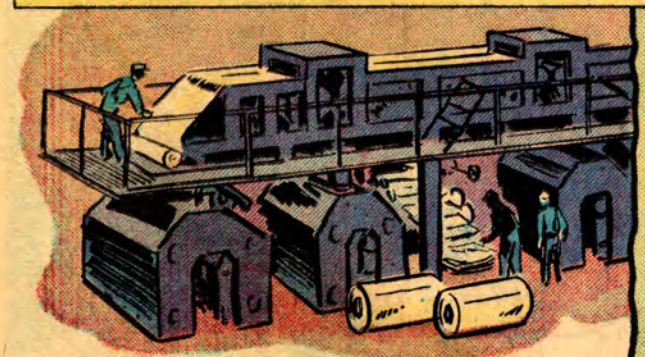




AMERICA has 105 million **RADIOS** to tune in on 3000 AM and FM broadcasting stations.



TELEVISION is America's fastest-growing means of communication. It brings the world into your living room.



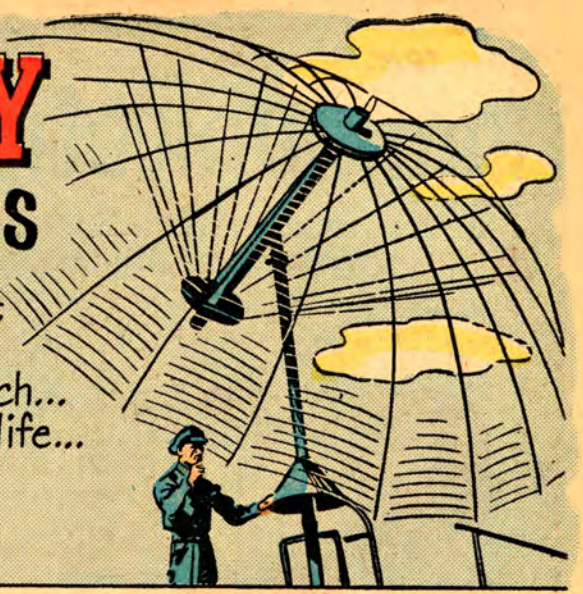
EACH YEAR in the U.S., electrically-operated **PRINTING PRESSES** turn out nearly 12 million tons of printed material.

THINGS TO DO

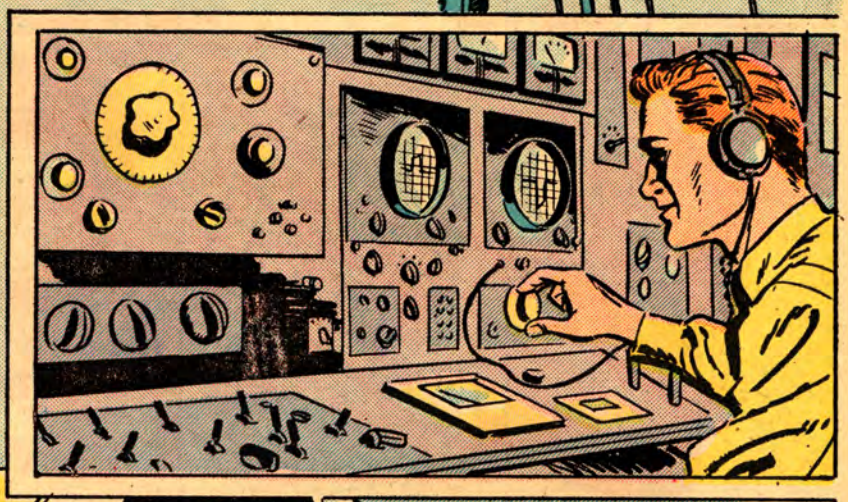
1. Write a report on what each of these people did to apply electricity to communication: ***MORSE, BELL, MARCONI.***
2. The average telephone call requires about ¼ watt-hour of electricity, and Americans make 162,000,000 calls a day. Figure out how much electricity they use for telephoning in a single day.
3. Collect pictures which show how transportation has progressed in America from early days.

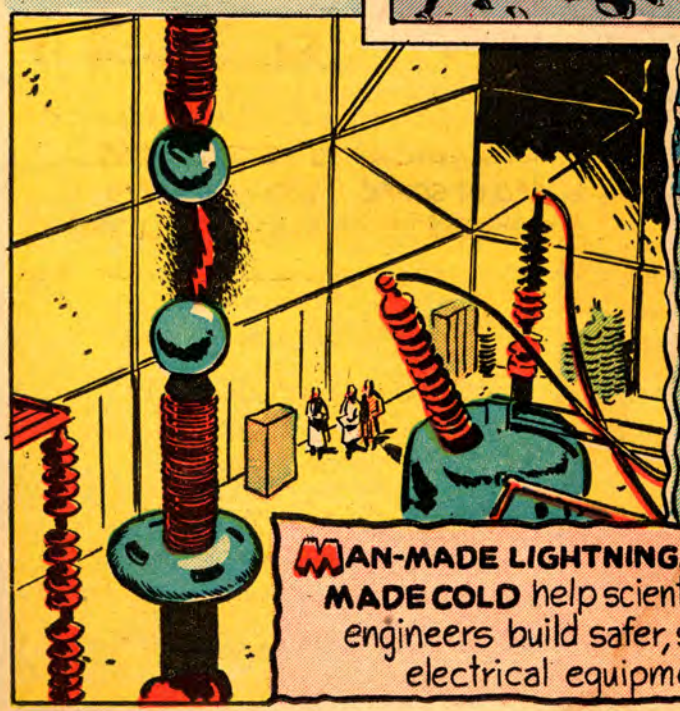
ELECTRICITY and HUMAN PROGRESS

Besides making man's life safer, easier, richer, and more pleasant, electricity is constantly at work in scientific research... Safeguarding our nation and its way of life... helping bring even greater electrical wonders to come.



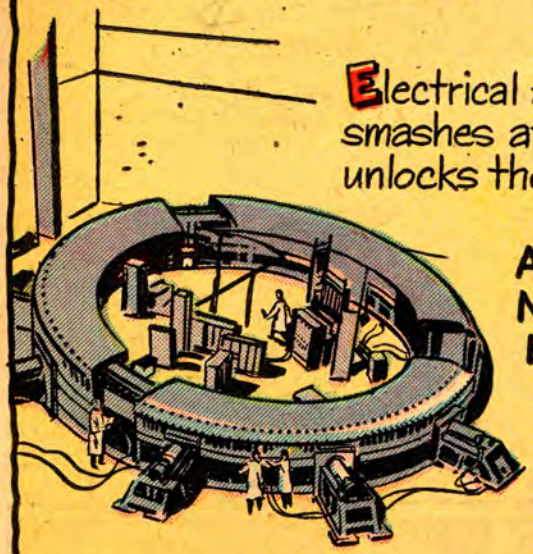
ELECTRICAL COMPUTERS solve problems impossible for human minds alone.



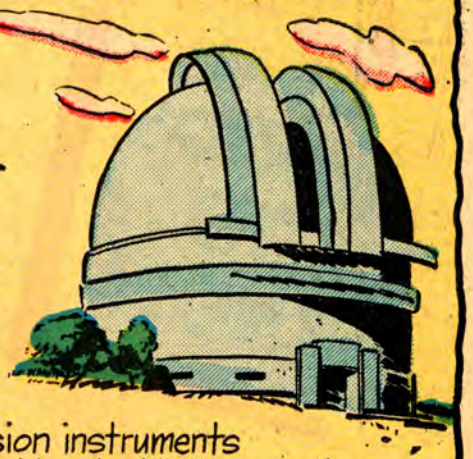


MAN-MADE LIGHTNING...and **MAN-MADE COLD** help scientists and engineers build safer, surer electrical equipment.

ELECTRICITY HELPS EXPLORE THE MYSTERIES OF THE TINY..AND THE VAST

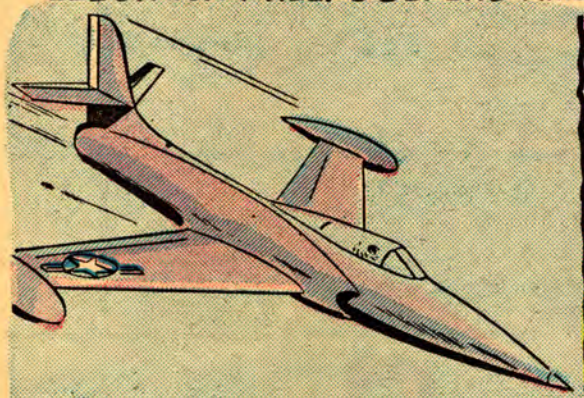


Electrical apparatus smashes atoms... unlocks the **SECRET OF THE ATOM** and **NUCLEAR ENERGY.**

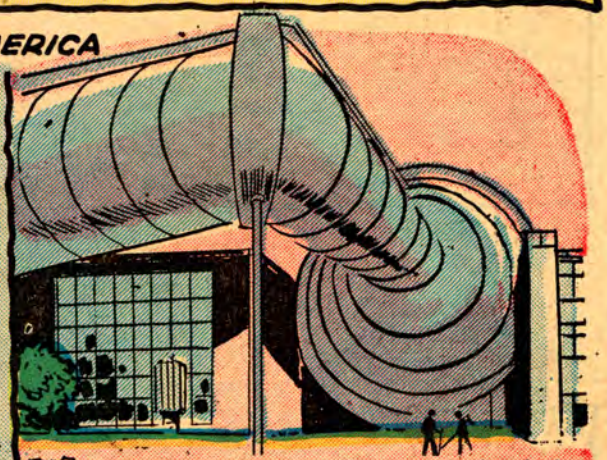


Precision instruments powered by electricity scan the heavens...advance man's knowledge of the universe.

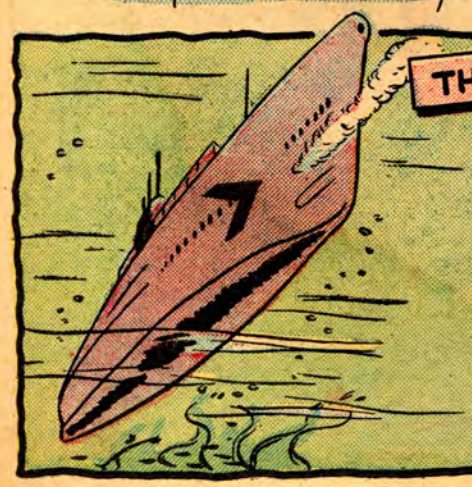
ELECTRICITY HELPS DEFEND AMERICA



Electrical equipment aims and fires guns, detects enemy planes and submarines, flies airplanes automatically.



WIND TUNNELS, driven by electric motors, move air faster than the speed of sound...help engineers design and test super-speed planes.

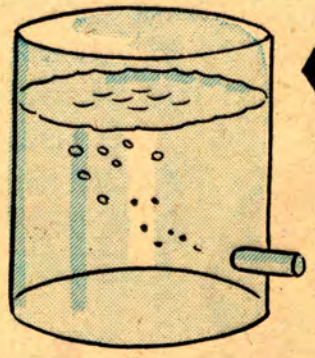


THINGS TO DO

1. Collect clippings from newspapers and magazines to show how electricity is contributing to human progress.
2. Make a scrapbook of pictures to show how electricity helps in national defense.
3. Visit a scientist in your neighborhood and find out what part electricity plays in his work.

SOME WORDS TO KNOW

An electric current in a wire is something like water flowing through a pipe...



VOLTAGE is like the water pressure (height of water).

AMPERAGE is like the flow of water (gallons per minute).

VOLTAGE (volts) is the pressure that forces an electric current through a wire. The rate of flow of the electricity is measured in **AMPERES**

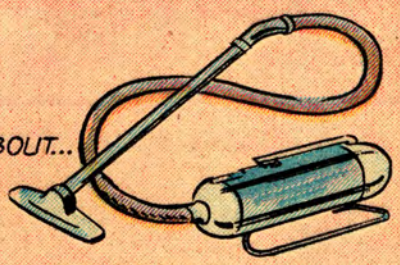
THESE APPLIANCES USE ABOUT...

1/40 AMPERE

60 WATT

1/2 AMPERE

8 AMPERES



3 AMPERES

ONE MAN POWER = 75 WATTS

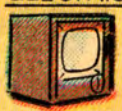
A **WATT** is a measure of electric **POWER**. It is the **RATE** at which electricity is used. A man can work at a rate of about 75 watts for a short time...for long periods at about half this rate.

You buy ELECTRICAL ENERGY by the **KILOWATT-HOUR.** It tells how much work electricity does. A 100-watt electric lamp used for 10 hours consumes 1 kilowatt-hour of electricity.

HERE IS WHAT 1 KILOWATT-HOUR OF ELECTRICITY DOES FOR YOU...

Runs your ELECTRIC CLOCK for three weeks

Cooks a meal on an ELECTRIC RANGE



Operates your TELEVISION SET for a whole evening

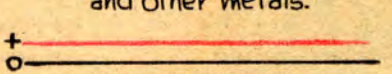
Does 2 hours of ironing with an ELECTRIC IRON

Runs an ELECTRIC FAN for 24 hours

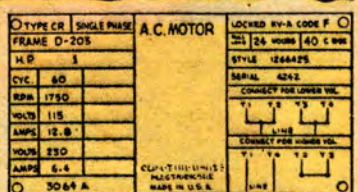
A.C. means **ALTERNATING CURRENT** A.C. surges back and forth in the wires which carry it. Usually it does this 60 times a second and is called 60-cycle current.

THIS IS HOW A.C. IS PICTURED

D.C. means **DIRECT CURRENT**. It always flows in the same direction. D.C. is used to run many kinds of motors. It is also used in plating metals and making aluminum and other metals.



THIS IS HOW D.C. IS PICTURED

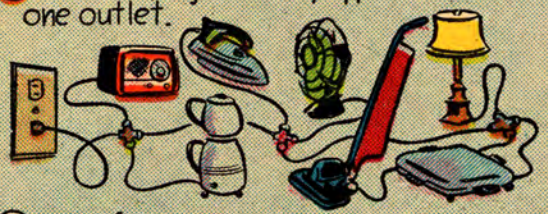


Here is a label from an electric motor. What do the electrical terms on it mean?

Some DOs and DON'Ts in using Electricity—

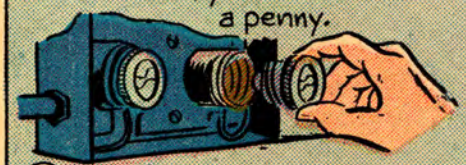
DON'T

1. **DON'T** plug too many appliances into one outlet.



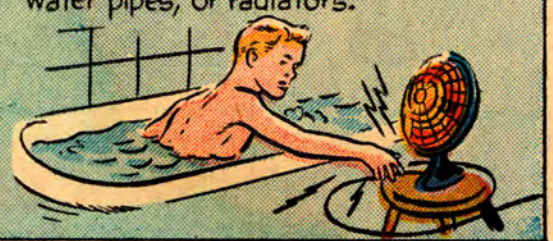
2. **DON'T** pull plugs out by the electric cord.

3. **DON'T** replace a blown fuse with one able to carry too much current or with a penny.



4. **DON'T** overload a household circuit. Usually one circuit can safely carry only 15 amperes (1800 watts).

5. **DON'T** touch electric appliances while in the bathtub or while touching faucets, water pipes, or radiators.



DO

1. **REPLACE** worn lamp cords and broken plugs.

2. **OPEN** the main switch before replacing a fuse... especially if the basement floor is wet.

3. **KEEP** electric cords away from where people walk on them and fray them.

4. **DISCONNECT** your flatiron when it is not in use.

5. **LOOK** for the Underwriters Laboratory label on electrical equipment you buy.

ANSWER TO QUESTION 5 on page 11:

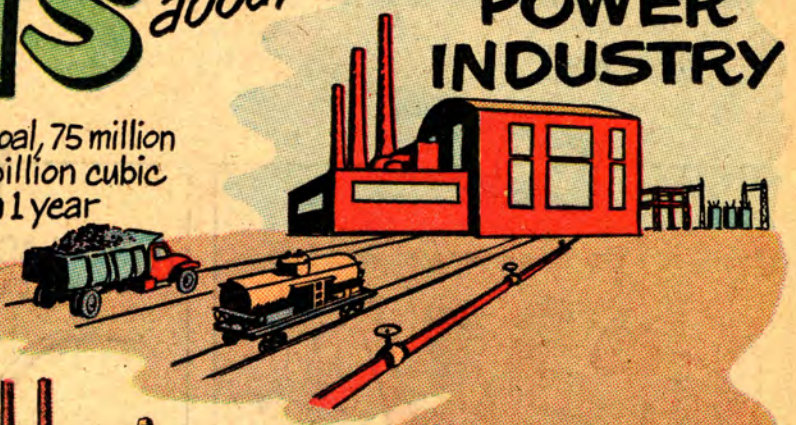
1. Radios 96%
2. Electric irons 87%
3. Refrigerators 86%
4. Electric clocks 78%
5. Electric washers 72%
6. Toasters 69%
7. Vacuum cleaners 57%
8. Electric coffee makers 50%

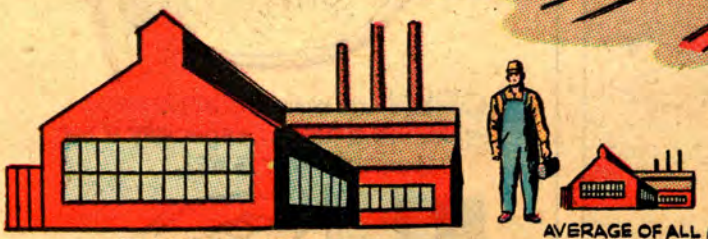
ANSWER TO QUESTION 3 on page 15:

1. Iron and steel
2. Chemical
3. Metals other than iron and steel
4. Paper
5. Food
6. Textiles
7. Stone, clay, and glass
8. Petroleum and coal

FACTS about the ELECTRIC POWER INDUSTRY

92 MILLION tons of coal, 75 million barrels of oil, and 630 billion cubic feet of gas are burned in 1 year in the generating of electric power.

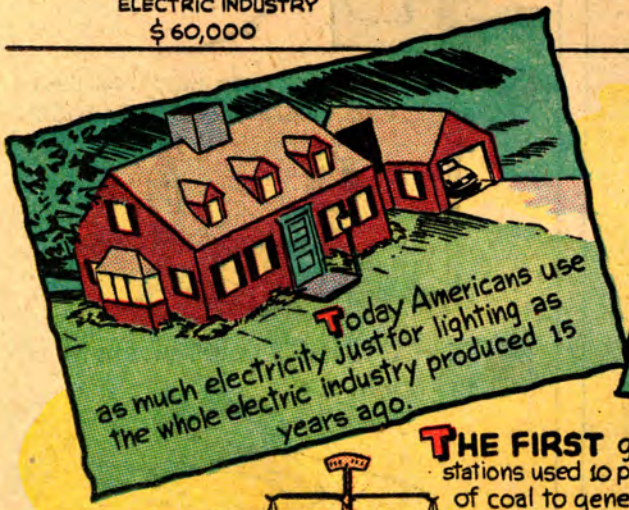




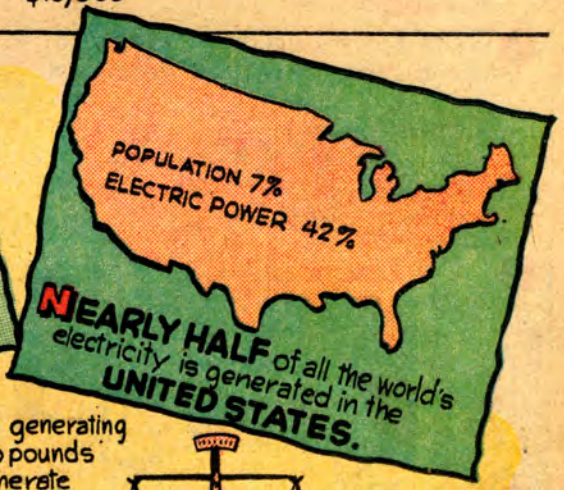
ELECTRIC INDUSTRY
$60,000

AVERAGE OF ALL MANUFACTURING
$10,000

There is an investment of $60,000 in equipment for every worker in the electric power industry.

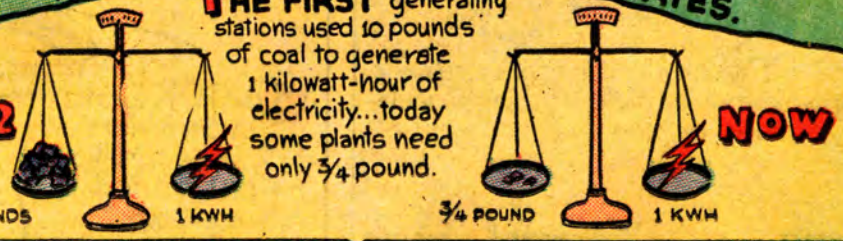


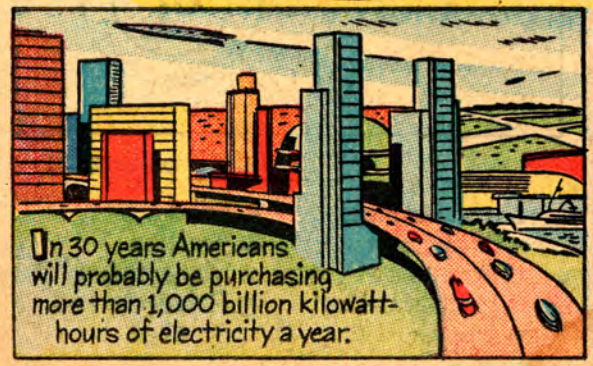
Today Americans use as much electricity just for lighting as the whole electric industry produced 15 years ago.



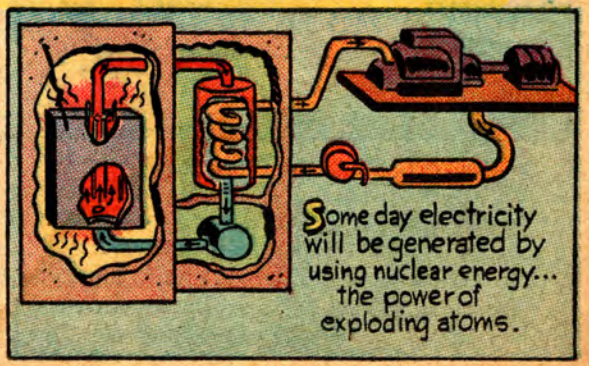
NEARLY HALF of all the world's electricity is generated in the **UNITED STATES.**

THE FIRST generating stations used 10 pounds of coal to generate 1 kilowatt-hour of electricity...today some plants need only ¾ pound.





In 30 years Americans will probably be purchasing more than 1,000 billion kilowatt-hours of electricity a year.



Some day electricity will be generated by using nuclear energy... the power of exploding atoms.