The Graphic Laboratory of Popular Science

By Dr. Michael Ference

Gas Cells—Substitute for Inefficient Heat Engines

SADI CARNOT (1796-1832) was a brilliant young French physicist and army officer who in one of the masterful memoirs of modern science laid the foundation of the present-day heat engine. Today, more than a hundred years later, engineers are embarrassed by the appalling inefficiency with which they convert the heat energy of, say, a pound of coal into the useful mechanical work of turning a dynamo. By efficiency is meant the ratio of the amount of heat actually turned into mechanical work to the amount given by the fuel consumed.

For example, the efficiency of a good locomotive now reaches 10 per cent; in triple-expansion marine engines, about 20 per cent; in steam turbines, 25 per cent; in a good automobile engine, 25 per cent; and in the best Diesel engines, about 34 per cent. To make the comparisons fair, boiler losses are included in

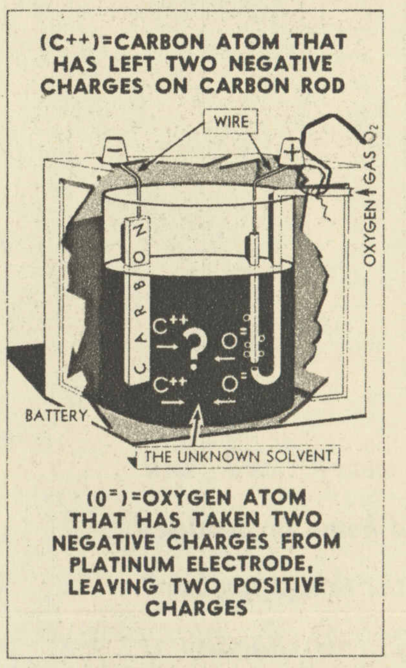


Figure 2—Famous carbon-oxygen cell. A fortune awaits the person who discovers a solvent for carbon that will also conduct electricity readily.

these figures for steam engines. The tables below show where the heat of combustion of fuel goes. It is interesting to note the small amount that is converted into useful work; the rest is wasted.

TYPICAL STEAM ENGINE

Useful work	9%
Exhaust steam	57%
Up the chimney	22%
Boiler losses	12%
	100%

AVERAGE AUTOMOBILE

Useful work	21%
Into cooling system	36%
Out of exhaust	35%
Friction	8%
	100%

As a further illustration of these ideas let us see what steps are necessary according to present engineering practice for the conversion of energy of coal into electrical energy. The first step is to burn the coal in a boiler. When the carbon of the coal and the oxygen of the air unite to form carbon dioxide gas a very large amount of heat is evolved. We note from the table that about 34 per cent of this heat is lost via the chimney and boiler radiation, leaving only 66 per cent of the heat energy for the conversion of water into steam at 200 degrees centigrade or 392 Fahrenheit (corresponding to a steam pressure of 225 pounds per square inch). If this steam enters an ordinary steam engine and after being used is exhausted into the atmosphere at 100 C. or 212 F., as is the case in many engines, then the maximum theoretical efficiency with which the engine can change the heat content of the steam into mechanical work is only 21 per cent. That is, more than three-quarters of the heat put into the engine is thrown away, even though the engine is perfect. In specially designed condensing steam engines, where the pressure is very low in the condenser and hence the exhaust temperature is correspondingly low, the efficiency may rise to 35 per cent.

The reason for this low efficiency is this: The laws of physics and chemistry dictate that no machine whatsoever taking in steam at 200 C. and exhausting it at 100 C. can convert into mechanical work more than 21 per cent of the available heat, for if a machine did convert more than 21 per cent, then it would be possible to construct a perpetual motion machine. Such a state of affairs certainly cannot exist. The important idea of Sadi Carnot is that if the engineer had at his disposal a mechanically perfect heat engine, still the efficiency with

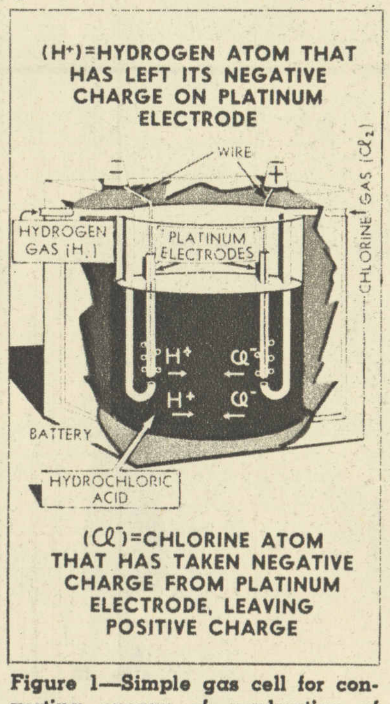
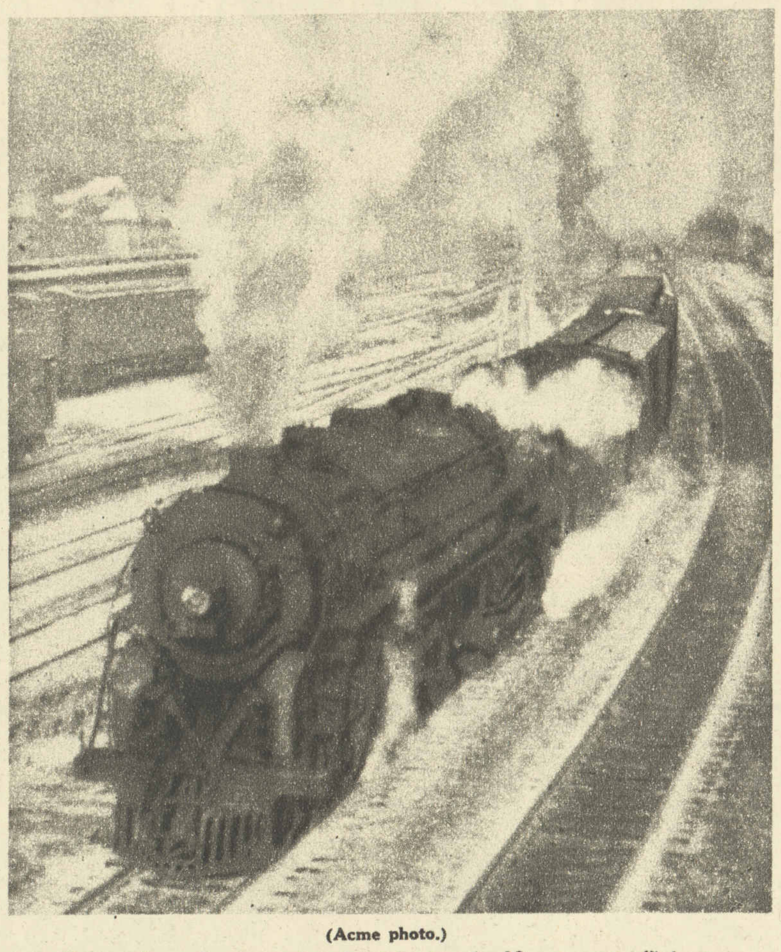


Figure 1—Simple gas cell for converting energy of combustion of hydrogen and chlorine directly into electrical energy.

which it could abstract heat and do work would be determined by the temperature at which the steam entered and that at which it was exhausted; and only if the exhaust temperature were at the absolute zero (—454.9 F.) would the efficiency reach 100 per cent.

Is it possible for our engineers to stop such a waste of natural resources? The answer is yes. By means of an electric cell or battery it is possible to convert directly into electrical energy the energy available when coal and oxygen combine, thus eliminating the necessity of the highly inefficient steam engine. These cells, sometimes called gas cells, or more appropriately fuel cells, operate on a principle as old as modern chemistry itself.

A simple type of a gas or fuel cell is sketched in Figure 1. Hydrogen and chlorine gases are allowed to bubble past platinum rods that are immersed in hydrochloric acid—a good conductor of electricity. It is found that both gases in the presence of the platinum dissolve in the hydrochloric acid and in doing so leave an electrical charge on the platinum rods or electrodes. The hydrogen gas leaves a minus charge of electricity and the chlorine a plus charge. In this way a battery is formed whose voltage is of the order of one volt. By combining a large number of these cells any desired voltage may be obtained.



(Acme photo.)

The modern steam engine is at best only 10 per cent efficient.

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However, the cell described above is only of academic interest. What the physical chemists, especially in hard-pressed Germany, have been investigating is the possibility of making a solvent in which the carbon of coal will go into solution, leaving a negative charge on the carbon electrode, and at the same time oxygen of the air will also dissolve, forming carbon dioxide and thus releasing the energy of this reaction not as heat but as electricity (Figure 2). In this way they can utilize the energy of the coal and oxygen with a theoretical efficiency of 100 per cent. To date no one has been able to produce the conditions under which such a transformation will take place. A fortune awaits the person who succeeds.

It is of interest to point out that a group of British chemists have succeeded in combining a combustible fuel gas (such as is used in gas burners) with oxygen in a cell containing a liquid mixture of two common chemicals, sodium carbonate and calcium carbonate. Such cells, however, are still in the laboratory stage of development.

Another and more practical approach to the general problem of conserving natural resources was emphasized by Dr. F. W. Godwin of the Armour institute research foundation in a paper on colloidal coal. The problem was to utilize the coal dust of the mines of southern Illinois by suspending the fine particles of coal in a fuel oil. If a suitable oil is chosen and the correct size of coal dust particles used such a suspension was found to be stable for some months.

The chief advantages of the colloidal coal as a fuel are: First, it offers operators of coal fields an opportunity to make good use of the coal dust; and, second, the heat content of colloidal fuel is about 11.2 therms per cubic foot, or approximately 5 per cent greater than that of good fuel oil.

A notable experiment in the use of this so-called colloidal fuel has been reported. In 1932 the Cunard steamship company prepared 150 tons of colloidal fuel containing 40 per cent coal. This was used in place of oil in firing one of the twelve boilers of the steamship Scythia on a round trip between Liverpool and New York. No special equipment was employed. The experiment was a complete success, and it is especially significant in that it demonstrated beyond doubt that colloidal fuel can be used in ordinary oil-handling and oil-burning equipment.

Mostly About Dogs

By BOB BECKER

Background of the Irish Terrier

ABOUT sixty years ago a dog fancier in the British Isles stated that "to Sir Walter Raleigh, through potato skins and hardships, we owe the Irish terrier."

Sir Walter Raleigh, occupying as he does a rather romantic place in history, has been associated with many exploits, but we never have been able to figure out just how he could be credited with the Irish terrier. Without doubt he may have brought English terriers into Ireland, but to give him credit for the origin of the Irish terrier seems a bit far-fetched. There have been terriers in Ireland from time immemorial—not one type, but several, each varying somewhat in different localities. It is reasonable to believe that from this old terrier stock our modern Irish terrier has been developed. Today the exact origin of the breed is a subject for debate. Some believe that the old black-and-tan of England is in some way mixed up in the family tree of the "Irisher." But nobody is able to say with certainty what all the steps were in producing the Irish terrier.

This puppy has a Hollywood career ahead of it. It's owned by Louise Campbell, a Northwestern university graduate now in motion pictures, who is holding the puppy in this picture.

(Tribune photo.)

Champion Knocklong Dandy, an Irish terrier that has won high honors in American dog shows. Dandy is owned by John Mulcahy.

It makes no difference. The important thing today is that the Irish terrier is smart in appearance, loyal in his allegiance to his master, a companionable pal, afraid of nothing on two or four legs, and a real example of terrier character.

When we consider the early days of Ireland it is easy to see how these qualities have become the heritage of the Irish terrier. Residents of the Emerald isle found terriers useful around their homes. They wouldn't keep a dog that was mean and bit children. The weak dogs died. Those lacking in fighting qualities failed to breed. Thus down through the early years those terriers kept by the people on small farms were the result of the survival of the fittest—rugged, active, pugnacious dogs (as far as other dogs were concerned), but friendly to humans and with one important attribute—a strong sense of property. They had the guard dog instinct developed. This was the type of dog from which (according to the best evidence on hand) our smart, courageous Irish terrier of today has come. Add the influence of the early black-and-tans and very likely the ancestral canine picture is complete.

Weighing about 27 pounds, the Irish terrier of today is far ahead of the early representatives in appearance and conformation. He has been nicknamed "the daredevil" not without reason. He'll tackle anything, and once in a scrap you can be pretty sure that the little Irisher will be the last to leave it. Gay, active, affectionate, pugnacious, it's no wonder that the Irish terrier fanciers today are so keen about the breed.

It is fortunate that breeders have not changed the weight of the dog, because as he stands today the Irish terrier is what you might call a handy size. By that we mean he is large enough for a guard dog around the home, yet small enough to live in rather moderate-sized quarters. He doesn't take up too much room in a car, either. A good specimen must give the impression of speed, with a racy, trim outline. He must not be cobby in type, a conformation that is much desired in some other breeds. The color of the Irish also is a pleasing one to most dog fanciers. He must be whole-colored, with bright red, red wheaten, or golden red preferred. As is the case in most whole-colored dogs, a small white spot is allowed on the breast. Although this white spot is permissible, it is not desirable in the show ring. White anywhere else on the body is most objectionable.

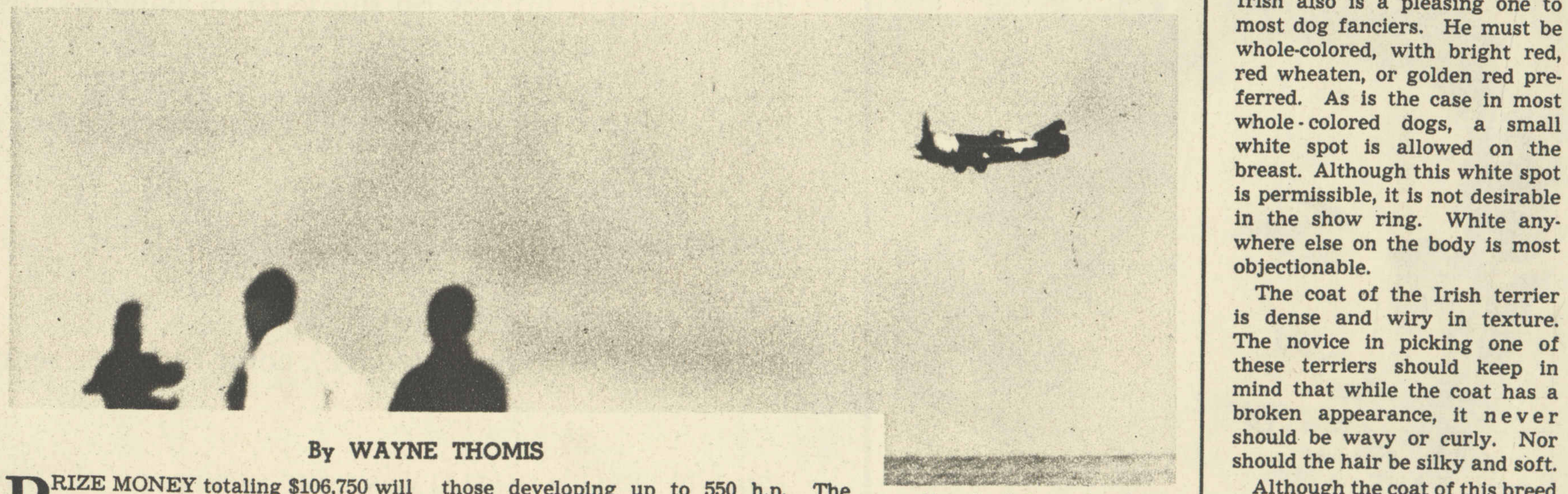
The coat of the Irish terrier is dense and wiry in texture. The novice in picking one of these terriers should keep in mind that while the coat has a broken appearance, it never should be wavy or curly. Nor should the hair be silky and soft.

Although the coat of this breed doesn't require as much attention as some of the others because of its color, an Irish terrier must be given a haircut occasionally in order to have a good coat and also look well.

1938's Streamlined Air Races

(Associated Press photo.)

Frank Fuller, winner of the 1937 Bendix event, getting a signal from flagman at Cleveland national air races.



(Associated Press photo.)

Earl Ortman crosses the finish line of the Thompson trophy race at the Cleveland show in 1937. He was a close second to Rudy Kling.

By WAYNE THOMIS

PRIZE MONEY totaling $106,750 will be the lure to race pilots at the 1938 national air races on the magnificent Cleveland, O., airport Sept. 3-5. The purses this year are nearly $40,000 ahead of the best previous total in the ten-year history of aviation's premier event. The four days of action during the last five years are to be compressed into three. This is a far cry from the ten-day meetings of the late twenties and early thirties.

General rules and regulations for the meet include the following items:

1. There will be no races for airplanes with engines of the 397 cubic inch displacement class. Instead the minimum will be for 549 cubic inch engines, or those developing up to 550 h.p. The maximum will be for engines of 1,860 cubic inch displacement, or about 1,200 horsepower.

2. No airplane entering the Bendix trophy race—2,200 miles, from Los Angeles to Cleveland—may also enter the Thompson and Greve trophy races, which are closed-course pylon events.

3. The Thompson race will be 300 miles around a ten-mile course, the Greve for 200 miles around the same course. These are extreme limits for some of the smaller ships. One problem this year will be to get enough fuel aboard them to last out the Thompson race, at least. The lengthening of the course also means a more grueling test of engines.