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STORED POWER

By Arthur McCann

A brief science item suggesting a problem and a challenge. It offers no solution—but perhaps some of our electrical engineer readers can make further suggestions and contributions?

THE "pickaback" plane, *Mercury*, hopped off for Africa recently, staggering under an enormous load of gasoline that weighed about as much as the plane. The *Mercury* came down short of its goal for lack of energy. Man's methods of storing and releasing energy are so thoroughly ineffectual that, even when boosted into the air by a helper and started on its way, it failed.

There's power enough in this world; it isn't that we lack. But it isn't where we need it. Waterfalls eternally wasting their energy in tropic jungles or desolate semi-arctic regions, in uninhabitable high-mountain territory or otherwise remote country. Vast coal beds in Alaska with stored energy that we can't use because the cost of shipping that coal consumes more energy and effort than it can release.

The industrial revolution came with the steam engine because the steam engine gave them power *where they wanted it*. Before that invention, water wheels had been the only usable source of industrial power, and the only way to ship power was on belts or shafts. As our modern cities are laced and festooned with the feeder lines of electric power, their mill cities were laced and festooned with creaking, squealing "power lines" of rope drives and belt shafts. Ropes running from pole to pole over squeaking pulleys transmitted the turning power of water wheels as much as a mile from the stream to "distant" plants. They couldn't ship it farther.

The steam engine fed on coal—and they could ship coal-power. Because they could ship it, they made it ship it-

self on the railroad that it made possible. Industry, suddenly released from the shackles of rope belts and millwheels, spilled out over the world. They'd learned to ship power.

The steam engine, like all heat engines, was heavy and clumsy. Worse than others, it was a two-stage process, converting heat of combustion to latent heat of steam, then tapping the latent energy of steam for mechanical power. But you could ship coal, and the coal made the locomotive go.

The internal-combustion engine that used the heat of combustion directly made for a lighter engine and the automobile. Industry sprawled a little farther, edging back farther from the railroads. And—man sprouted wings because he had a lighter system of energy-storage-and-release. Energy stored in gasoline and released directly in the internal-combustion engine.

And—he's stuck right there. Electric power can't be shipped, yet electricity is the only truly flexible form of energy. A cool glow of red-hot coal can be stepped up, by electricity, to the blazing incandescence of a carbon arc. Normally, the energy of a cool source cannot increase the temperature of a hotter body. Electricity is the most versatile, useful energy we know. And we can't ship it because we can't store it.

We can feed it along pipes, of course, just as they shipped water power along ropes and pulleys. (We use copper ropes and porcelain insulators instead of pulleys, and we can ship it that way almost two thirds as far as a man can see from an airplane.) That's not a

very satisfactory advance. Waterfalls in tropic jungles go on wasting power, and the coal fields of Alaska are useless because we can't ship their energy without shipping their useless bulk. And our wings are clipped because the gasoline weighs more than the plane. Those distance-record planes are fuel tanks with wings, and the only thing they carry forward is the distance record.

Because we can't store energy in directly usable form.

A condenser does, of course. The Leyden jar stored enough to knock out a whole line of soldiers who didn't know what they were in for. The modern development of the gadget will store energy enough to blast a tree or explode a heavy copper conductor to incandescent gas. But it won't run a motor for thirty seconds. The only way we have of storing electric energy enough to run even a small motor—such as a starting motor—is in the indirect form of electrochemical energy. And a noteworthy commentary on the perfection of our energy-storage methods is the fact that that battery uses lead as a fuel—the common epitomization of weight!

We need a direct storage, a direct method of hording electric energy either as an electric field or in the form of its twin brother, the magnetic field.

THE CONDENSER represents the former, of course, storing a microscopic amount of energy in a strained-field phenomenon. At present, the difficulties experienced with condensers—they tend to discharge instantaneously—are largely illusions due to the small quantity rather than to inherent quality. They miss the ideal properties with respect to utility in only one way: the quantity is so tiny. That is not an insuperable handicap—all known forms of electric energy storage have that fault in practically equal degree. But the condenser approaches the ideal in these respects: it can be charged and discharged at any

rate the conductors leading to it will stand. It will handle very respectable voltages. It is dry, light, compact, and will last forever. It is essentially easy and cheap to manufacture, and maintenance is zero. It's one inherent fault is that it supplies energy at a constantly diminishing pressure; the voltage falls steadily as energy is withdrawn.

Theoretically, a condenser of huge capacity, then, would be an excellent method of storing power for shipment and use at a point distant from its source. No one, however, has remotely approached the necessary capacity. An automobile would need a condenser of about 10 megafarad capacity—10,000,000 farads, when a microfarad, a millionth of a farad, is the usual unit of capacity in modern equipment. We need an improvement of about 100,000,000 times. Not so good.

Well, how about the magnetic energy storage? The inductance coil, the other handy method of storing energy that can be directly withdrawn as electricity, is little further advanced. A coil of wire wound round a magnetic core stores energy in the form of magnetic strain in space—so long as the current flows. Where the condenser is static energy, the magnetic field is kinetic energy; it escapes instantly if the current is broken. If we had a super-inductor, with a powerful current flowing ceaselessly, we could tap off a bit of that current, and, as a little was diverted, the magnetic field would relapse, giving up its energy to rebuild the current. Magnetic energy can be "stored" in a sense in permanent magnets—but once made static in this way, it becomes inactive.

So, seemingly, the magnetic method is even worse than the electrostatic.

Perhaps we can find a new method, a different angle of attack, that can really strain those near-infinite numbers of individual atoms in a single bit of matter, just slightly, perhaps, but enough to have real stored power that we can ship.