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Carl E. Weller
Have Gun Will Solder
Popular Science May 1963

Carl E. Weller, the man who took the wait out of soldering.

Have Gun —Will Solder

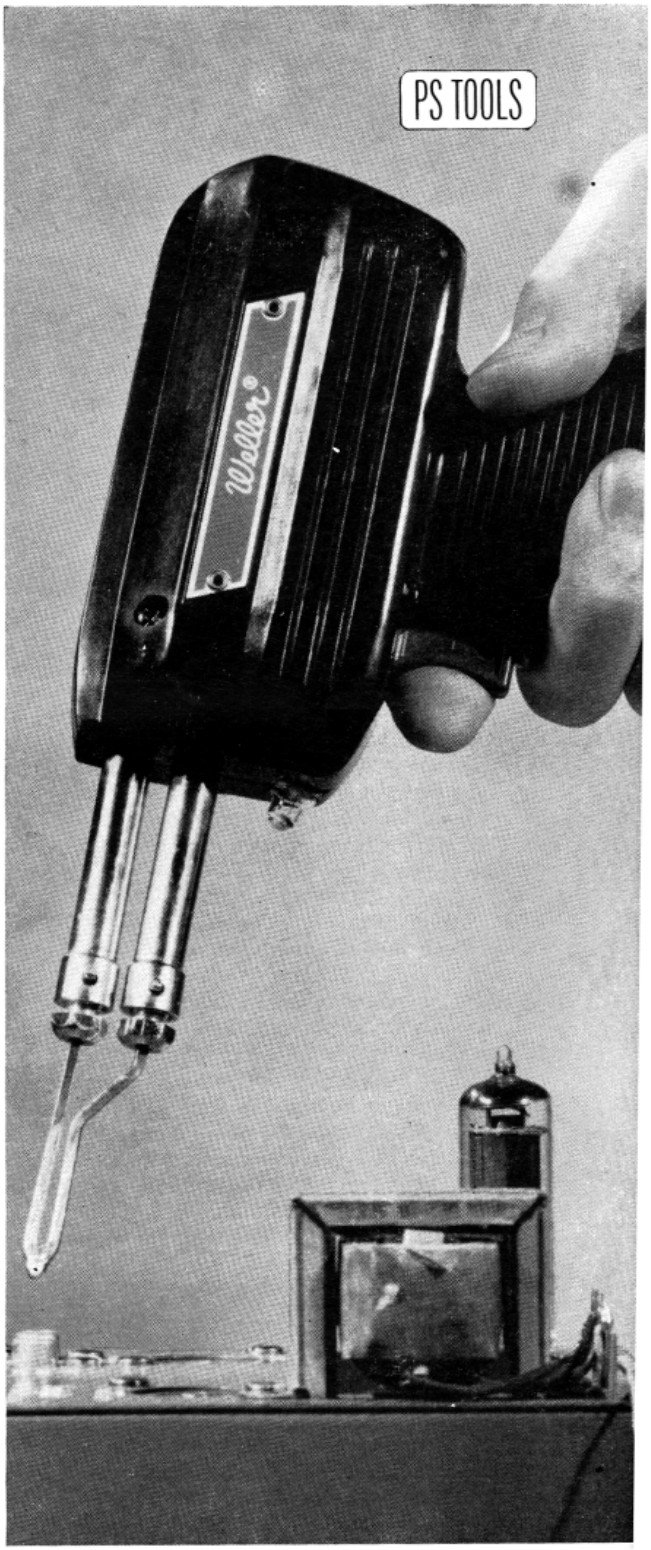
The instant-heat soldering gun is one of those rarities—a hand tool that was truly a new and needed invention

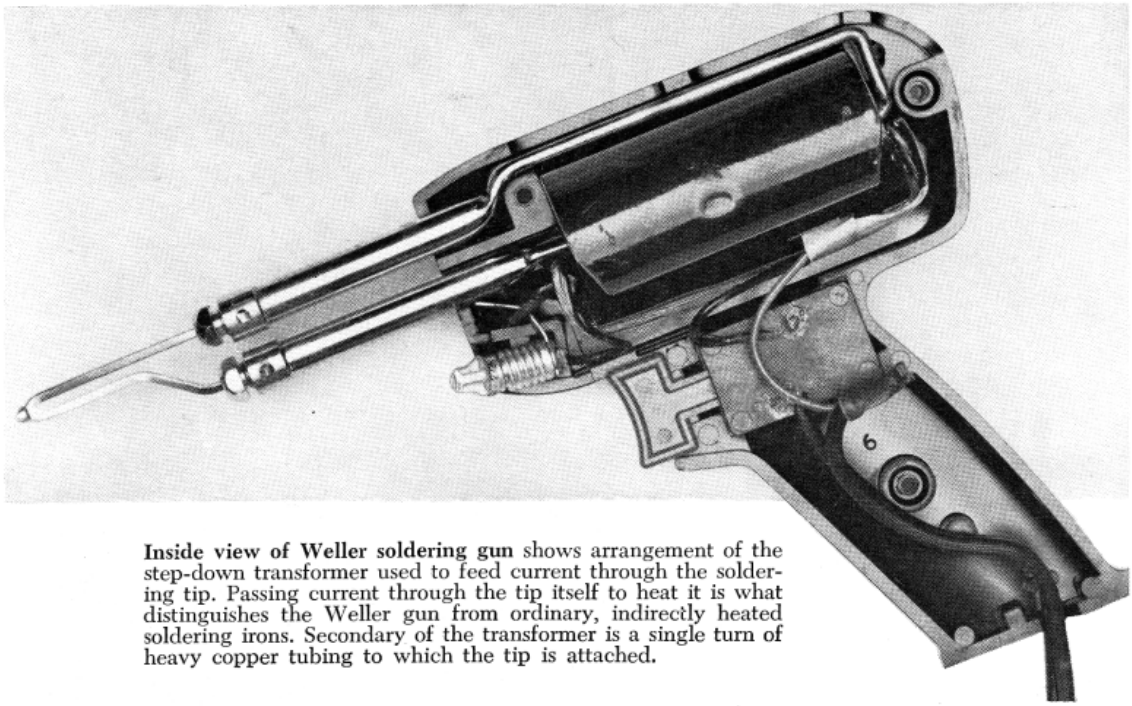
By Hubert Luckett

ANY good workman gets ideas on the job for tools that will make his work easier or faster. But few are able to parlay such an idea into a five-million-dollar business.

Carl Weller did it with his soldering gun.

Back in the Thirties, Weller was a radio repairman. The soldering iron was to his trade what the handsaw was to the carpenter, the mill file to a machinist, the Stillson to a plumber. But it was a time waster. In the shop you kept it hot all day to avoid waiting when you needed to make a solder joint. This meant frequent redressing





Inside view of Weller soldering gun shows arrangement of the step-down transformer used to feed current through the soldering tip. Passing current through the tip itself to heat it is what distinguishes the Weller gun from ordinary, indirectly heated soldering irons. Secondary of the transformer is a single turn of heavy copper tubing to which the tip is attached.

or replacement of the tip. On house calls, you twiddled your thumbs while you waited for it to heat; and when you finished the job, it was too hot to put in the toolbox.

Probably there wasn't a man in the business who didn't dream of an instant-heating soldering tool. There were plenty who, like Weller, tried to invent it.

The basic difficulty with the conventional iron—its indirectly heated working tip—was correctly analyzed by many. Current flowing through a coil of resistance wire had to heat the wire first; then the hot wires had to heat the copper tip by thermal conduction. A lot of heat got soaked up before the tip reached soldering temperature.

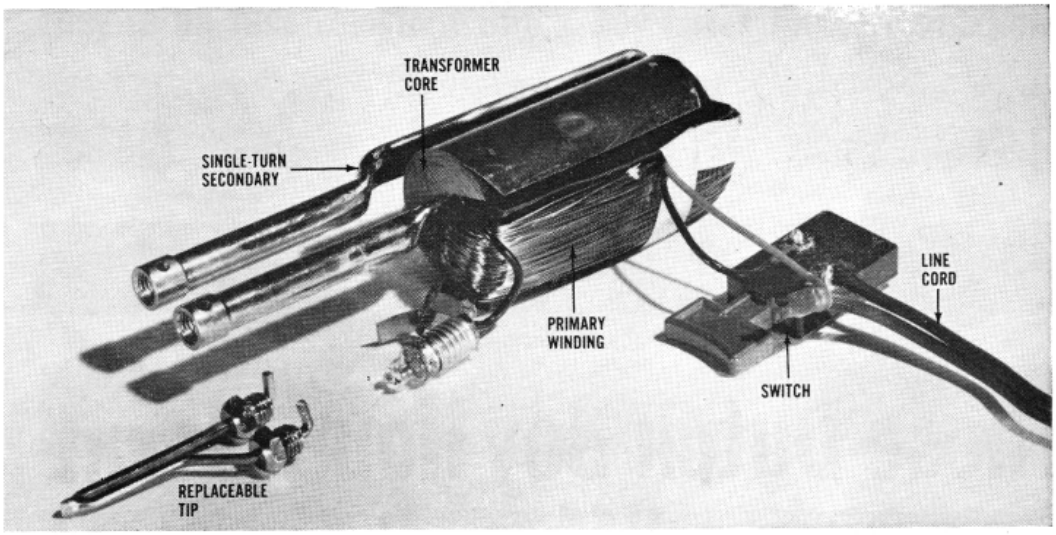
More than one would-be inventor asked the right question: Why not use the electric current to heat the tip directly? But Weller got to the Patent Office first with the right answer as to *how*.

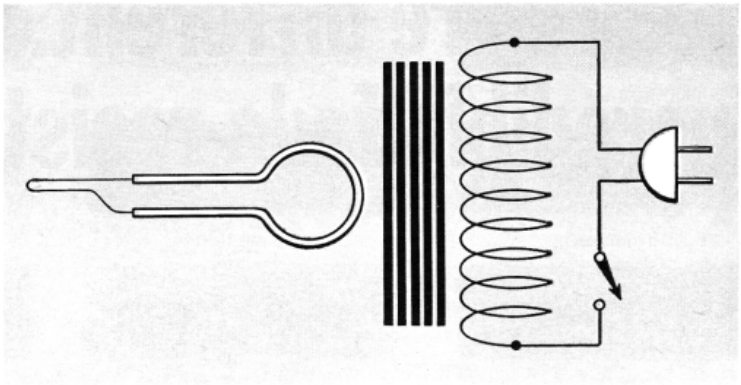
To understand the problems involved in inventing the soldering gun and to appreciate the elegant simplicity of the tool, you need to know something of the fundamentals of the soldering process itself. Soft solders form a bond by a solvent action. Part of the metal being soldered is actually dissolved by the molten solder and goes into solution with the solder to form an alloy different from the original solder. Joining two pieces of metal by soldering is actually a chemical process rather than a purely physical one of adhesion.

The role of the soldering iron or gun is not to melt the solder, as the common notion goes. The soldering iron's job is to heat the metal to be soldered to solder-alloying temperature. The metal must be kept hot enough to maintain the solder in a molten condition long enough for the alloying process to take place. (Of course, the molten solder must be in intimate contact with the metal; the metal surface must be clean; and a flux must be used to prevent formation of an oxide film on the hot metal.)

It is not enough for a soldering tool simply to get hot enough to melt solder. It must be capable of producing a sufficient *quantity* of heat to bring up to temperature the metal being soldered—and it must be able to transfer that heat efficiently and rapidly from the soldering-iron tip to the metal.

Imperfect understanding of these facts doomed many of the early attempts to make a direct-heating soldering iron. Because soldering irons—and most other electrically heated appliances—had always used a high-resistance alloy wire to obtain heat from electricity, the idea never occurred to would-





Coiled, flat ribbon of iron makes transformer core. To wind laminations through preformed wire coil, Weller invented a production machine. Real secret of gun's performance is copper-tubing secondary winding. It not only conducts heavy current without overheating, but acts as heat sink to cool upper end of hairpin tip and thus concentrate heat at soldering peen.

be inventors to try anything else. They tried to beat the warm-up time lag by using the resistance wire itself as the soldering tip to be applied to the work.

Some drawbacks to the scheme were recognized: With the current-carrying conductor in contact with the work, there was a shock hazard. Using a step-down transformer to feed a lower voltage to the resistance wire was a logical solution. But it couldn't be too low or there wouldn't be enough voltage to force enough current through the resistance to give enough heat. (Ohm's Law, $I=E/R$—current equals voltage divided by the resistance; also, heating effect is determined by the equation, watts$=I^2R$.) So they still wound up with an uncomfortably high voltage.

But what really doomed this approach was something else: Alloys that make good resistance wire (poor electrical conductors) are also poor heat conductors. Although the wire got hot enough, insufficient heat went into the metal to be soldered.

Weller, too, went through all these steps in perfecting his soldering gun—and ran into the same blind alley. Then his knack for ignoring the traditional solutions paid off. Instead of starting from the assumption that resistance wire was necessary to convert electricity into heat, he took off from the premise that a good heat conductor was necessary for the soldering tip. Practically, this meant using copper.

But no engineer in his right mind would even consider connecting a chunk of copper across a power line—it would be a dead short. The copper would get hot all right, but so would the connecting wires—hot enough to melt. Two problems had to be solved: 1) how to concentrate the heat at the soldering tip; 2) how to limit the current flow to a practical value.

Have Gun—Will Solder

[*Continued from page 165*]

The answers to the questions were in the textbooks. The resistance of copper is quite low, but it does have some. And it increases with temperature. If a circuit is entirely copper wire of uniform size, the whole length of the wire will get uniformly hot. But if part of the circuit is much smaller in cross section, that part will have more resistance and will start to heat faster. As it heats, the resistance goes up still more and it heats still faster. The heat, then, tends to concentrate at that point. These facts gave Weller his clue.

Limiting the current flow was simply a matter of applying Ohm's Law: If you are committed to a circuit of very low resistance, then you have to use a very low voltage. A step-down transformer, lowering ordinary 110-volt power to a much lower value than had been considered before, was the answer.

Weller designed a pistol-shaped soldering gun using these ideas and got his patent on it in 1941. He tried to peddle it to the major manufacturers, but they all rejected it as impractical. In desperation, he built 274 guns by hand in his basement workshop and sold them to individual radio service shops. The men on the job were so enthusiastic about the new instant-heat soldering tool that he started to manufacture them on a modest scale in 1946—the beginning of the Weller Electric Corp.

The man behind the gun had only a public-school education. Energetic, untalkative, single-minded when he's grappling with a problem, Weller prefers to run his business from behind a lathe rather than an executive's desk. He thinks with his hands as well as with his brain. One of his pet ideas is that anything you want to know, you can find in a book somewhere. He has proved it repeatedly by making himself an expert on such widely diverse subjects as tax law, production-machinery design, and reciprocating magnetic motors.

Today, the Weller Electric Corp. of Easton, Pa., has two factories in Puerto Rico, too. Weller has invented and makes a number of other tools—a power sander, a saber saw, and the Magnastat soldering iron with built-in temperature control for production-line work.

And it all started because a radio repairman got impatient waiting for his soldering iron to get hot. ■ ■

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