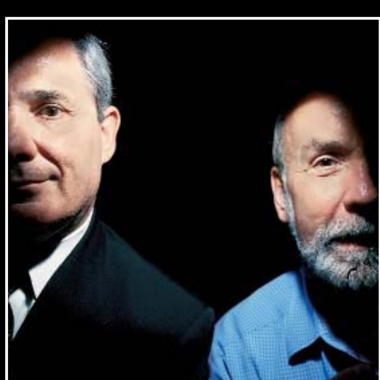
DEMO

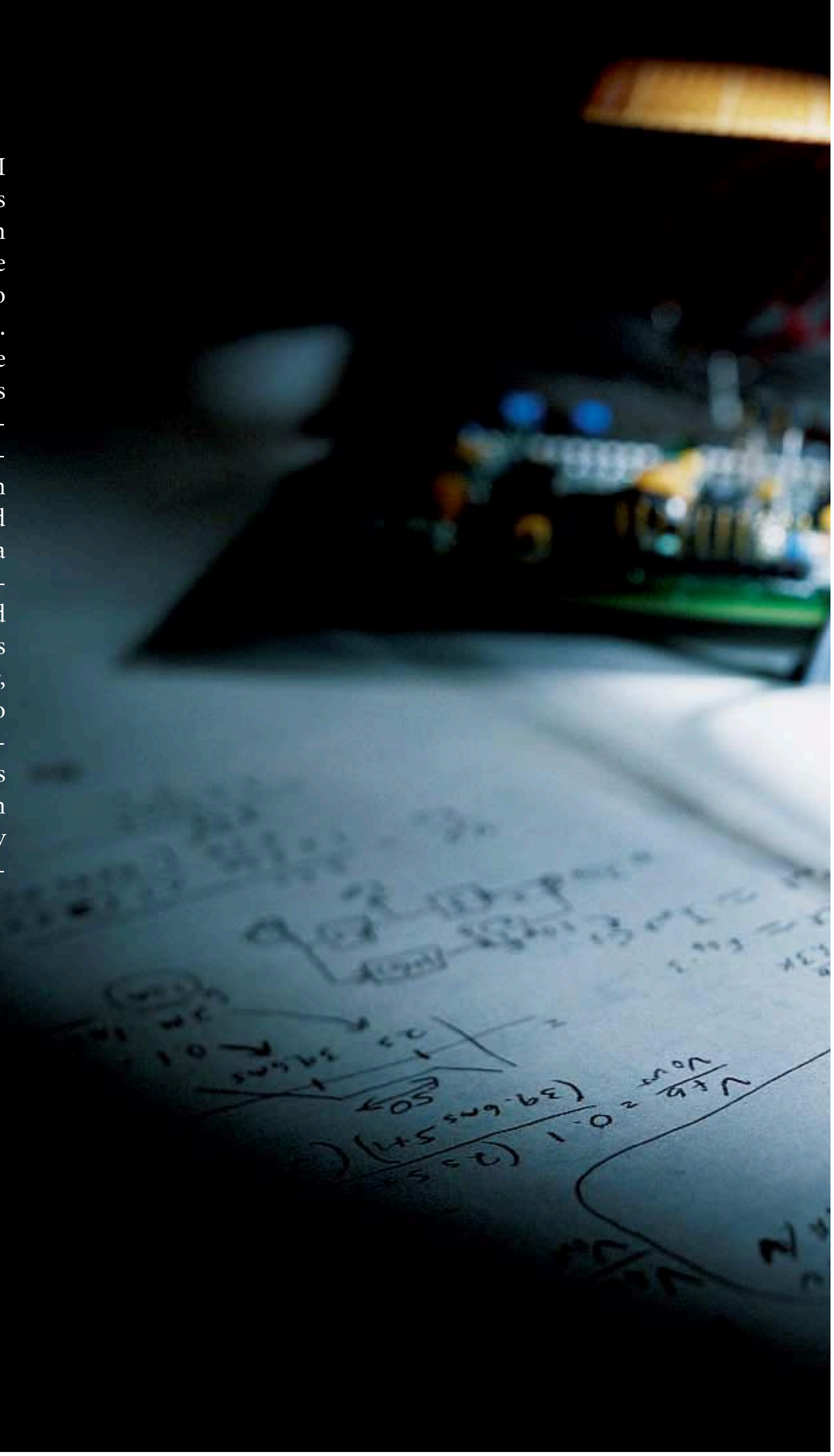
ARTIFICIAL RETINA

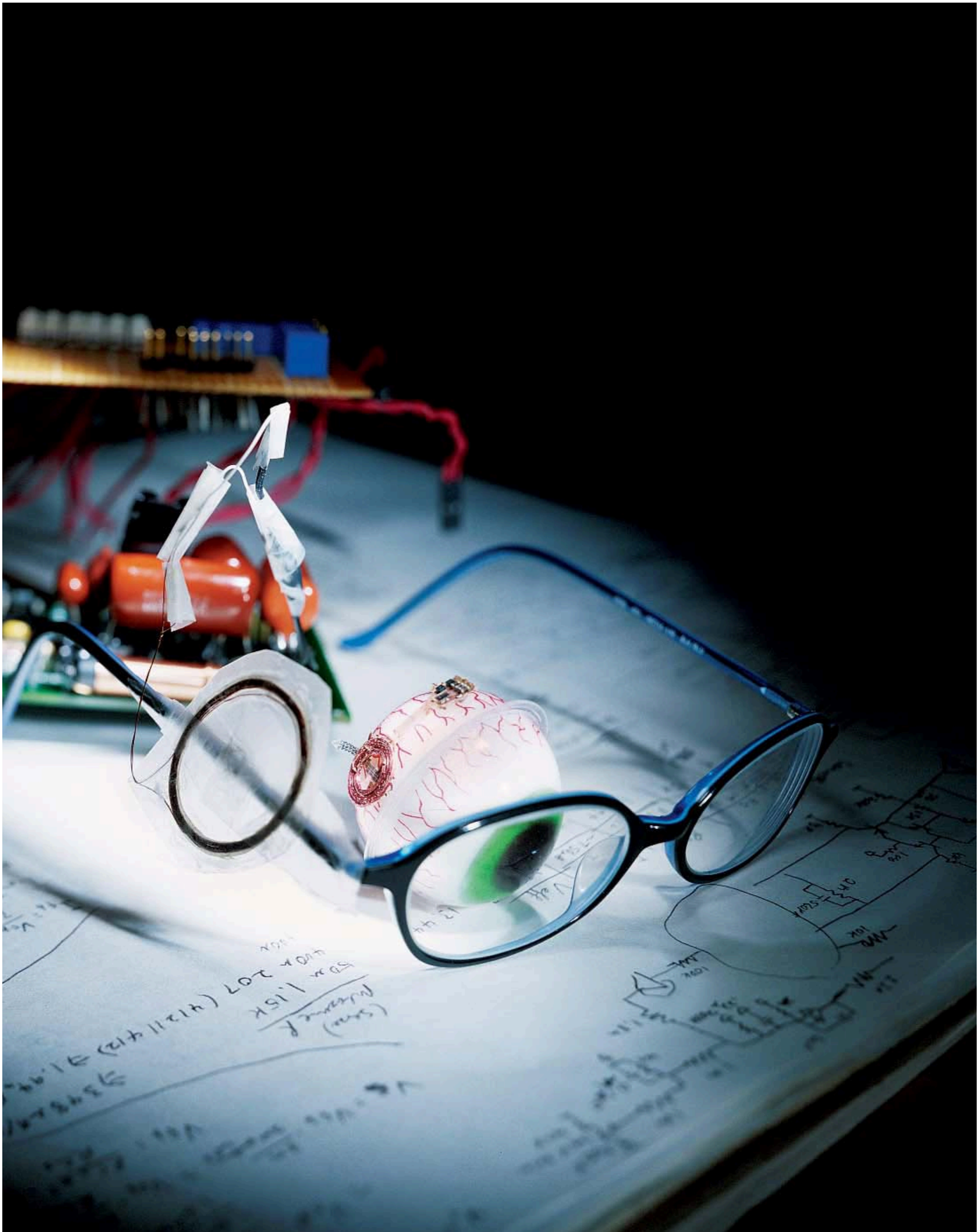
Blindness has defied doctors' search for a cure for decades. Joseph Rizzo and John Wyatt have developed an electrical implant that could finally help millions of people see again.

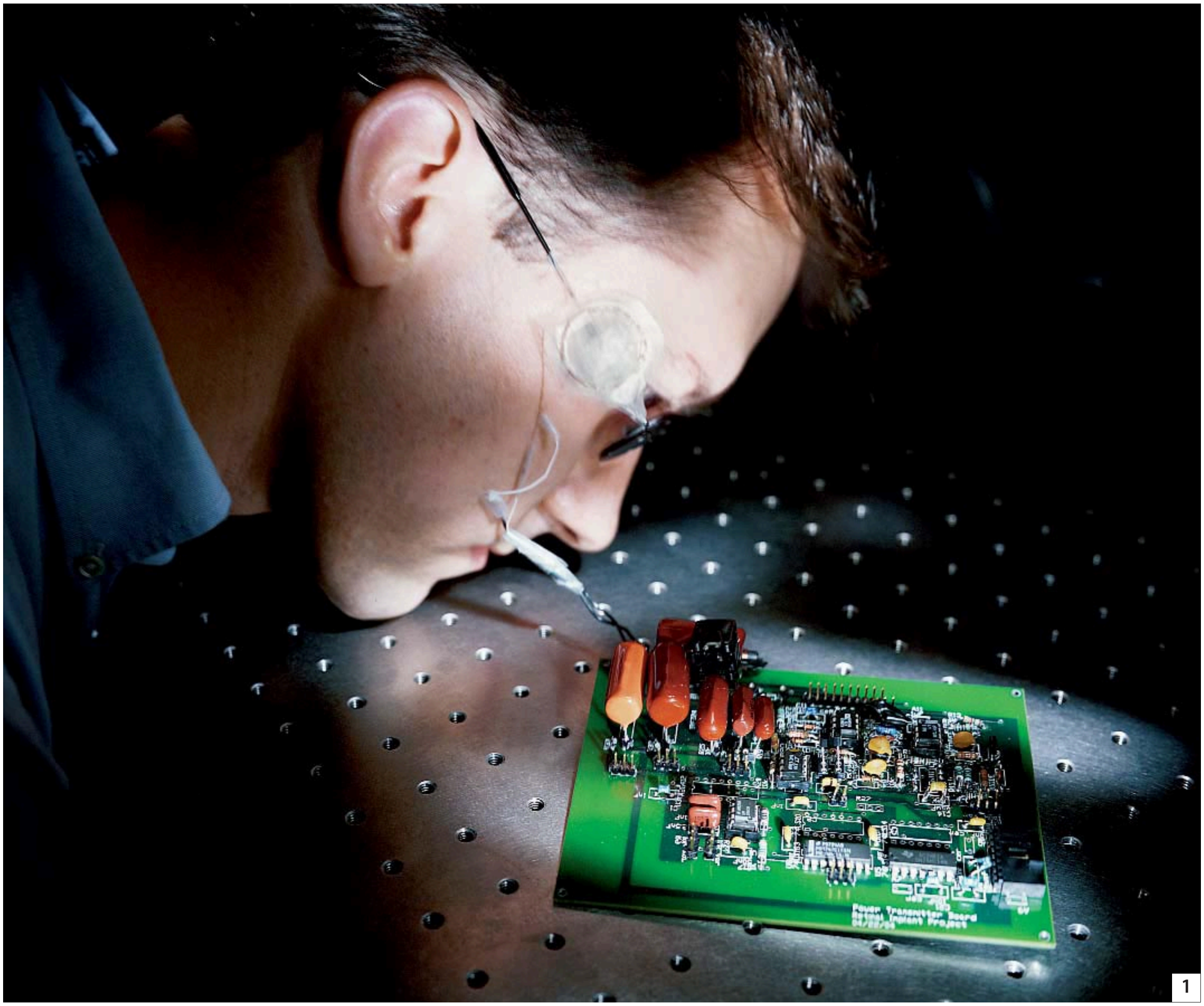
IN THE MID-1980s, neuroophthalmologist Joseph Rizzo III was researching retinal transplants to restore blind people's vision. One day, removing a lab animal's retina, a tissue-thin membrane that lines the back of the eyeball's interior, he had an epiphany. "The moment I made the cut, I said to myself, 'What in the hell are you doing?'" Rizzo recounts. He realized he was cutting nerve connections that are actually spared in many forms of blindness. The retina's light-sensing cells die off in retinitis pigmentosa and age-related macular degeneration, which affect millions worldwide; but the nearby neurons that ferry the signals from those cells to the brain remain intact. So Rizzo conceived of a retinal prosthesis—an implant that would take a wireless signal from a video camera, bypass the light receptors, and stimulate the healthy nerve cells directly to feed the image to the brain. Rizzo, working at the Massachusetts Eye and Ear Infirmary and the Boston VA Medical Center, teamed up with MIT electrical engineer John Wyatt Jr. to pursue the scheme. In 1988, they launched the Boston Retinal Implant Project, which today comprises 27 researchers at eight institutions. The team has already done short-term human tests and hopes to test a permanent prosthesis by 2006. Wyatt and Rizzo recently gave *TR* contributing editor Erika Jonietz a peek at their progress.



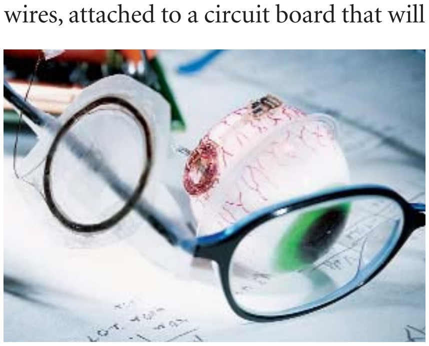
Pushing back the darkness: Joseph Rizzo (left) and John Wyatt's retinal implant (opposite page) sits on top of the eyeball and uses a tiny electrode array to stimulate sight-generating neurons.







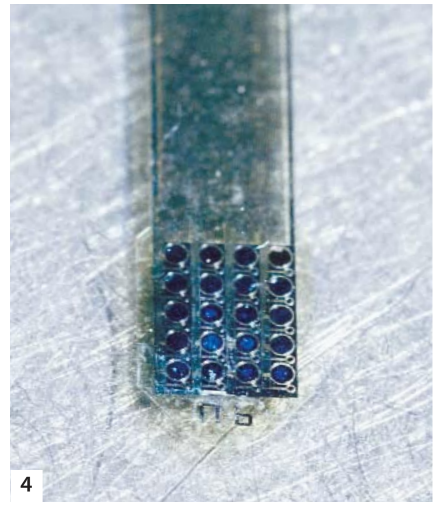
1. IMAGE RELAY. In a small, windowless workroom jammed with tables and equipment in his MIT lab, Wyatt explains how a real-time image is captured and relayed to the retinal prosthesis. While he talks, a visiting scientist named Shawn Kelly models the system's external parts. The idea: a small, commercial digital video camera (the researchers haven't chosen one yet) would be mounted on a pair of glasses. As the user "looked" about, a transmitter—now just a coil of wires, attached to a circuit board that will be packaged and worn on a belt—would send images wirelessly from the camera to the implant in his or her eye. "Here's the transmitter coil," Wyatt says, pointing out two concentric copper rings taped to the earpiece of the glasses. Using radio waves, he says, the inner ring sends the data to the prosthesis, while the outer coil sends it power.



2. MESSAGE RECEIVED. Placing the glasses next to a model of an eyeball, Wyatt shows how the transmitter coil lines up with a similar receiver coil on the implant, which sits on the surface of the eye. "In our design, we put almost all of the mass of the implant outside the eyeball," Wyatt says. "For years, we wanted to put everything inside. But the eye doesn't like stuff inside; that's why it doesn't have a zipper." Between 1998 and 2000, the team did a series of experiments with an internal implant, placing electrodes inside the eyes of blind volunteers for a matter of hours and firing the electrodes in different test patterns. "People saw spots and occasionally lines, but they didn't see quite as much as we had hoped," Wyatt says. "We think that people might see better if they have more time to spend with the implant and really learn how to use it." So the team worked on developing a prosthesis better suited to permanent use. The current outside-the-eyeball design is the result. The implant is attached to the eye's surface with small sutures to keep it from shifting as the eye moves normally in its socket. The only thing that penetrates the eye is a little electrode array 10 micrometers thick, two millimeters wide, and three millimeters long. The array slips underneath the retina, where the electrodes stimulate surviving nerve cells in response to images from the camera, providing a small patch of vision.

3. SYNTHETIC VISION. Wyatt pulls the implant off the model and sets it down atop a nearby circuit board to get a better look. A flexible, whitish polymer that molds to the eye forms its base. The electronics sit on the pentagon at the top. Wyatt points to a small black square in that region that acts as the implant's brain. This chip, designed in his lab, receives image data and power from the transmitter and figures out the pattern of electrode firings that will best recreate the image from the camera. At the bottom of a thin connecting piece of polymer are the receiver coil and, to its left, on a clear, flexible strip, the electrode array itself.

4. GETTING CLOSER. Rizzo moves the implant under a magnifier to examine the array. It currently consists of only 15 electrodes, each 400 micrometers across. "An electrode will drive a cluster of nerve cells nearby," says Rizzo. Although this will provide only a small area of low-resolution vision, Rizzo thinks it will help with his first goal: improving blind people's quality of life by allowing them to walk around unfamiliar areas more easily than they can with canes—"and a cane's pretty good," he says. After 16 years of research, Rizzo and Wyatt know achieving even that limited goal will be a giant step forward in artificial vision.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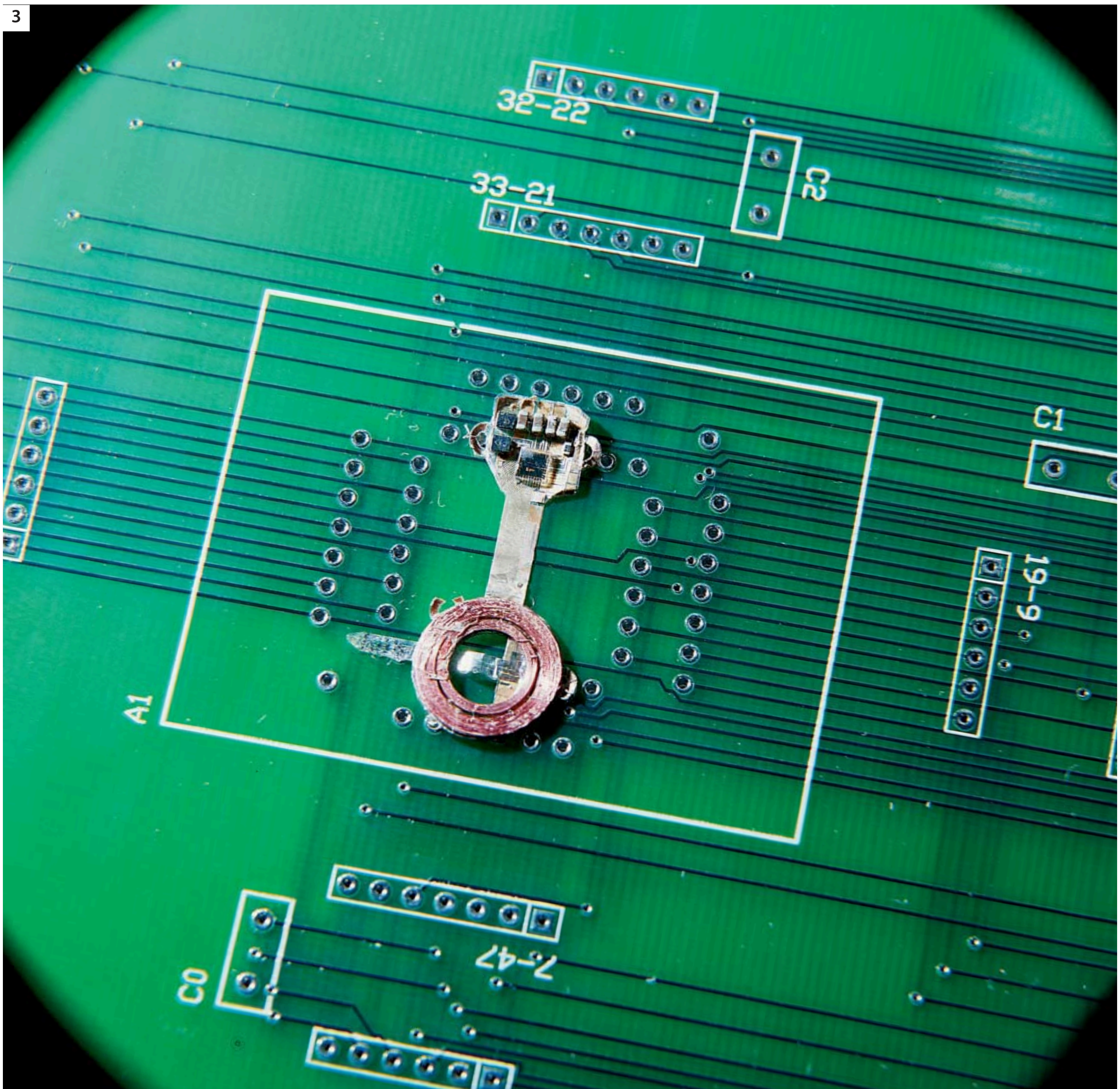

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