it would have been appropriate to mention something about the potential human risks associated with observing the process too closely.

The picture on the cover was a very interesting one but I question the wisdom of publishing photographs of potentially unsafe practices without some comment concerning the potential human risk involved.

DONALD E. BARBER
University of Minnesota
Minneapolis, Minnesota
11/18/76

The cover note in our November issue mentions that this photograph is a double exposure—Edward Breinan does not literally "observe" the laser beam but moves away whenever the laser beam (normally covered by a gas shield) is switched on. Breinan has told us of other safety precautions taken in his laboratory, including the Lucite shield through which we see him in the cover photograph. This shield affords about five seconds of protection from the direct laser beam; long enough for one of the "kill buttons" carried by all present to turn off the beam. Also the safety glasses he is wearing afford good protection to 10.6-micron radiation.

EDITOR

Administering applied physics

As a member of an older—and perhaps, who knows?, not even better—Applied Physics Department than Caltech's, I am moved to second David Goodstein's recent letter. Our experience is that applied physics cannot be distinguished from physics insofar as methods of approach and problem solving are concerned. The stimulus for work undertaken may come as much from without as from within the physics community (consistent with the quoted Liepmann definition). About one half of the 80 PhD's from our department have gone into industry, one third are at universities, and the remainder are mainly in government labs.

The tough problem posed by Goodstein concerning the number of graduate students to be trained by a professor or a department must be faced in applied physics, of course, as well as in physics and in all graduate departments. We have no reliable model to use as a guide; so we operate empirically. We try to admit as many students each September as a rough survey of our faculty the previous February indicates there will be "room for" (translated: "research support for"). Our estimates of four to five years ago seem to have been reasonable. The system depends upon a judicious administering of research funds in order to satisfy student aspirations and education, faculty research interests, and the agencies in Washington that support the research.

We see, as the real problem, the tendency of the Washington agencies to become increasingly concerned with short-term "visible" accomplishments, and we suspect that some mission-oriented administrators have little understanding of, or interest in, an essentially academic concern, namely the proper coupling of teaching with research. It is becoming very difficult to find sufficient overlap between the academic and agency interests. If the trend in Washington is not altered, we will either retrench substantially or else surrender freedom of choice in attacking and solving problems, and thus no longer be applied physicists.

T. H. GEBALLE
Stanford University
Stanford, California
11/9/76

Kirkhoff pairs

In response to John A. Baldwin's letter in the September issue (page 88), it is possible to find dual-transform pairs for continuum electrodynamics. The starting point is Kirkhoff's laws in point form:

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = 0 \qquad \text{(KVL)}$$

$$\nabla \cdot \mathbf{J} + \frac{\partial \rho}{\partial t} = 0 \qquad \text{(KCL)}$$

The dual-transform pairs are

A, vector potential	**D**, displacement
ϕ, electric potential	**H**, magnetic field
B, magnetic flux density	$4\pi\rho$, charge density $\times\, 4\pi$
E, electric field	$4\pi\mathbf{J}$, current density $\times\, 4\pi$
ϵ, dielectric constant	μ, magnetic permeability
curl	div or grad
$\Box^1$, d'Alembertian	1

The results are pairs of equations (including the pair above):

(2) $\nabla \cdot \mathbf{D} = 4\pi\rho$

$$\nabla \times \mathbf{A} = \mathbf{B} \Leftrightarrow \nabla \cdot \mathbf{B} = 0$$

(3) $\nabla \times \mathbf{H} - \dfrac{\partial \mathbf{D}}{\partial t} = 4\pi \mathbf{J}$

$$-\nabla\phi - \frac{\partial \mathbf{A}}{\partial t} = \mathbf{E}$$

(4) $\Box^2\phi = -4\pi\rho/\epsilon \qquad \mathbf{H} = \mathbf{B}/\mu$

(5) $\Box^2\mathbf{A} = -4\pi\mu\mathbf{J} \qquad \mathbf{D} = \epsilon\mathbf{E}$

(The "1-operator" is used when there are no other operators involved.)

There are no blanks for inserting magnetic charge or current. The key is to set magnetic flux density equal to the curl of the vector potential.[1]