Ewing's "Thermodynamics."

THE very appreciative review of my book on "Thermodynamics for Engineers," which appeared in NATURE of September 16 over the well-known initials "H. L. C.," points out what is certainly a misstatement. Will you kindly allow me space to correct it?

On p. 123, in speaking of the Mollier chart, the co-ordinates of which are the total heat I and the entropy ϕ , I should have said that the critical point is "near," not "at," the point of inflection of the boundary curve. It is, as "H. L. C." suggests, a little above the point of inflection. The isothermal line which passes through the critical point suffers inflection in touching the boundary curve there. The line of constant pressure which passes through the critical point also has a singular point there, namely, a point at which

$$\left(\frac{d^2 I}{d\phi^2}\right)_p = 0, \text{ and } \left(\frac{d^3 I}{d\phi^3}\right)_p = 0.$$

Without undergoing inflection, it has a "stationary tangent" at the critical point. These features of the curves of constant temperature and of constant pressure which pass through the critical point are apparent in the $I\phi$ chart for carbonic acid, given on p. 148. It will also be apparent from that chart that the point at which both these singularities occur lies a little above the point of inflection of the boundary curve itself.

The following corrections should therefore be made on p. 123 of my book:

In line 1, for "at" read "near."

In the footnote, delete the last two sentences and substitute: "Hence also, at that point,

$$\left(\frac{d^2 I}{d\phi^2}\right)_p = \left(\frac{dT}{d\phi}\right)_p = 0, \text{ and } \left(\frac{d^3 I}{d\phi^3}\right)_p = \left(\frac{d^2 T}{d\phi^2}\right)_p = 0,$$

since on the $T\phi$ chart the constant-pressure line through the critical point runs level and suffers inflection there. Thus on the $I\phi$ chart the constant-pressure line through the critical point has zero curvature there, though it does not suffer inflection."

Also, on p. 149, line 1, for "coincides with" read "is a little above."

J. A. EWING.

The University, Edinburgh, October 13.

A Diver's Notes on Submarine Phenomena.

SIR RAY LANKESTER in one of his delightful popular papers describes how he found that the glowing light produced by rubbing quartz pebbles together could still be got when the rubbing was done under water, as, for example, when holding the pebbles submerged in a bucket. On the supposition that if the effect were connected with entangled or surface-adhering air it should be enhanced under a high pressure, an experiment was made. My occupation involves a good deal of diving work, and on a recent occasion I took down a few suitable pebbles to a depth of 21 fathoms. On rubbing them together sparks were produced to just about the same extent as when tried in a few inches of water. The light on the bottom was dim enough to allow of the sparks being seen, yet visibility was relatively good.

Wave-action at this depth can be very violent. The wreck of a freshly sunk Atlantic liner at the same place was battered to pieces in the course of a single gale, and the large stones strewn the bottom are flung about amongst her remains whenever there

is a big, long swell running. As many of these stones are quartz, there may probably be considerable illumination on such occasions.

In connection with light under water, I may mention that if, as often happens, one's hand gets cut when working at a fair depth the blood streaming out into the water looks quite black, like ink, at the source, thinning out to a bluish cloud as it gets more diluted with sea-water. No trace of redness can be made out. Similarly, an abrasion looks like a dab of tar on one's hand. I presume that this effect is caused by the absence of red rays, which are cut off by the upper layers of water, and that it could be predicted; but I do not understand why in the same circumstances crabs (*C. pagurus*) look as red as they do on deck.

The volume of air in his dress at a given time is a matter of much importance to a diver. He has to control his buoyancy to suit the work in hand, and on a change of depth must rapidly adjust the valve to maintain the same volume during and after the change of pressure. Failure to do so results in a "squeeze" or a "blow-up," either of which may be fatal.

Fish with swim-bladders must have a similar practical interest in this application of Boyle's law, and a diver who considers the matter will be able to sympathise with them in the difficulties they must often encounter from their relatively slow means of adjusting volume.

Usually when a mine or similar explosion takes place under water numbers of swim-bladdered fish float to the surface. Stunned or injured, they have risen above the depth for which they were adjusted, and the resulting expansion of the bladder gases then overcomes any efforts they may make and surges them upwards, hopelessly out of control. In addition to the distension so often described, many of them, as I have found, are killed by rupture of the bladder and resulting internal hæmorrhage. It is curious that the escaped gas from the bladder often finds its way into the heart and great vessels, producing a condition like that due to compressed-air illness.

The diver going down to a wreck where blasting has been going on generally finds that numbers of fish have fallen to the bottom through a converse process and are lying there dead. On a recent occasion where blasting was going on almost daily the accumulation of dead pollack, pout, horse-mackerel, etc., on the bottom attracted swarms of spotted and spiny dogfish, which could always be seen cruising about among the wreckage, often with dead fish in their mouths. The blasting, of course, went on just the same, and heavy charges were often fired in the midst of these shoals, but I have never been able to find a dead dogfish on the bottom (having constant negative buoyancy, they always sink when dead). On the contrary, I have (from the ship) seen them rise to the surface immediately after an explosion in pursuit of the stunned swim-bladdered fishes and tear them to pieces as if nothing had happened. Dogfish have no swim-bladder, and its absence enables them, as in this case, to dash from a hydrostatic pressure of 57 lb. per sq. in. to atmospheric pressure and back again with their prey without ill-effects. Moreover, it is probably this absence of an included gas space which renders them so immune to submarine explosions.

Another point about swim-bladders. In the North Atlantic sunfish and basking sharks idling at the surface of deep water, with positive buoyancy yet without swim-bladders, are familiar and somewhat puzzling objects. With such means as one has aboard ship I find the specific gravity of skates to