PHYSICS

Gun Firing Into Gun Devised For Super-Pressure and Heat

New Apparatus to Produce Momentary Pressures And Temperatures Greater Than Any Yet Made by Man

IN THE laboratory high pressures or high temperatures can be obtained separately but not together. All materials soften when highly heated and consequently will not withstand high pressure unless the temperature is moderate.

The record for high pressure is held by Dr. P. W. Bridgman of Harvard University, and stands around 600,000 pounds per square inch. This is equivalent to the pressure at the bottom of a pile of bricks 100 miles high. Temperatures around 5,000 degrees Fahrenheit have been obtained in the laboratory, but only at moderate pressures.

Higher in Nature

Nature, however, produces vastly higher pressures and temperatures and produces them both together. Inside the stars, pressures are measured in millions of tons per square inch, and temperatures in millions of degrees. Even inside our own earth they are measured in thousands. How matter behaves under these conditions is at present entirely in the realm of hypothesis based on enormous extrapolation from experimental data. We would like to have more direct evidence.

Now comes Dr. C. Ramsauer with an ingenious though simple contrivance, which he describes in the current number of the *Physikalische Zeitschrift* of Leipzig, by which high pressures and high temperatures can be produced simultaneously—but only for a fraction of a second. However, science is accustomed to phenomena of short duration. Speeding electrons and cosmic rays flash by in a millionth of a second, yet what vast fields of new knowledge they have opened up. And materials can withstand momentarily pressures and temperatures that would be fatal if prolonged. Much may therefore be learned from Dr. Ramsauer's apparatus in which matter for the first time approaches a little way toward the conditions to be found in the stars.

The apparatus consists merely of a gun which shoots a cylindrical projectile straight into the barrel of another similar gun. The projectile is brought to rest by compressing the air or other gas contained in the second gun. Not only is the pressure thus enormously raised but also the temperature, for, as anyone knows who has pumped up an automobile tire, rapid compression of a gas heats it up. This is also shown by the diesel engine, in which the explosive charge is heated by mere compression to the ignition point.

Calculation shows that if the gas is perfect and its specific heat or thermal capacity is constant, a projectile having a velocity of 300 feet per second, brought to rest in a distance of three feet—the length of the second tube—will compress the air therein to 375 pounds per square inch, and raise its temperature to 2,240 degrees Fahrenheit. These are very moderate figures. But if the speed of the projectile is raised to 3,000 feet per second, which may easily be done, the pressure jumps to 14 billion pounds per square inch, and the temperature to 216,000 degrees.

No Gas is Perfect

Of course it is not expected that anything like these figures will actually be reached. No gas is perfect, the specific heats are not constant, and other things may happen in this as yet unexplored region, which equations based on observations at much lower pressures and temperatures cannot predict. Nevertheless the calculation indicates that by this simple means very high pressures and temperatures can be produced, and produced simultaneously.

The apparatus as actually constructed consisted of a single long tube, the firing being done at one end and the compressing at the other end. A number of slits near the middle allowed the products of combustion to escape. For speeds up to 600 feet per second, compressed air was used to fire the gun. Under these circumstances it was found that the projectile bounced back and forth between the compression and the gun chambers as many as 24 times. Smokeless powder was used for higher speeds, but at 1,500 feet per second the apparatus was damaged. These are of course only preliminary trials. The real research is yet to be carried out.

It may be asked—what information can be gathered from such a research? Dr. Ramsauer points out three problems that can be attacked at once:

1. The maximum possible density that a gas can attain without shattering its molecules or stripping its atoms of their planetary electrons.
2. The sort of radiation that a gas so compressed and heated emits.
3. The electrical conductivity of a gas under high pressure and temperature.

These are all problems of importance for theoretical physics.

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RADIO

Better Microphones And Loud Speakers Sought

VERY LITTLE real progress in the technical improvement of radio broadcasting has been made in the past four years. This is the opinion of Stuart Ballantine, president of the Boonton Research Corporation, who recently discussed the problem at a meeting of the Franklin Institute in Philadelphia.

The loud speaker is the weakest link in the receiving end of the chain of sound and electrical impulses from studio to listener. According to Mr. Ballantine, it produces more distortion than any other parts of the system, with the exception of the microphone. The conventional loud speaker not only fails to reproduce a high enough range of frequencies but its sound output fluctuates too much over the range it does cover. New high-fidelity receivers and loud-speakers have been developed which are capable of accurately reproducing sounds from 60 to 8000 cycles and whose performance is noticeably superior to present types.

In the transmitters which are important in controlling radio quality because they serve so many receivers, Mr. Ballantine believes that high quality transmission is realizable without wholesale scrapping of present equipment and at only reasonable additional cost.

The ear responds to sound frequencies from 16 to 16,000 cycles per second. The separation between radio broadcasting stations is only 10,000