The word LASER is an acronym for Light Amplification through the Stimulated Emission of Radiation.

Lasers generate a very special kind of light called coherent light. Ordinary light is made up of many different frequencies or wave lengths. There interfere with one another and cause the light to spread out as it travels. By way of contrast, the coherent light of laser beams consists of a single frequency (or color) which can travel billions of kilometers without spreading out enough to be undetectable.

The coherent light produced by lasers has two additional properties that are significant. First, it can be focussed into very small spots ——about a hundred millionths of a square centimenter, for example. This makes lasers of great interest for efficiently transporting energy and delivering it accurately to apinpoint location. It is this aspect of lasers that makes them of use as scalpels in surgery or welding devices on production lines.

The second interesting property of lasers is that their high frequency beams can be used to convey massive amounts of information. The electromagnetic signals which bring us radio or television programs, for example, are like small country lanes when compared to the informational freeways provided by the laser.

Today there are hundreds of different kinds of lasers, but a few of them dominate most applications. For example, solid state lasers use crystalline materials such as the synthetic ruby with which I produced the first coherent light. Today many solid state lasers use a synthetic crystal called YAG (an acronym for Yttrium Aluminum Garnet). These lasers are used extensively for cutting, drilling, soldering and welding a wide range of materials. They are also employed in many medical procedures.

Another popular laser uses carbon dioxide gas to generate powerful beams in the infrared portion of the spectrum. Such beams are invisible to the human eye and deliver their energy in the form of very intense heat. For this reason, carbon dioxide lasers are frequently used in materials processing and medicine.

Some lasers use ionized forms of gases such as krypton and argon. They emit colorful beams of light——red, yellow, blue, green, blue violet or ultra-violet. Because of their vivid colors, these lasers are used in the dazzling light shows associated with the world of entertainment. However, they are also useful in medicine, photography and the manufacture of compact audio discs.

The helium-neon laser emits a beam of red light of very low power. Used with care, it is thus safe enough for such things as classroom demonstrations, aligning optical systems or establishing straight lines for road and tunnel construction.

The last class of laser in general use is a tiny, transistor-like semiconductor device. It is used to send information in the form of telephone conversations, computer data, or television signals through glass fibers about the size of a human hair. You may already have a laser or two of this kind in your home, for they constitute the heart of compact disc players.

Probably no one is more pleased and surprised than I about the diversity and extent of laser applications today. However, the one which gives me the greatest personal pleasure and satisfaction is the field of medicine.

One of the first practical applications of the laser used a ruby laser to repair detached retinas. Today doctors use lasers extensively in opthalmology to treat sarcoma and as an aid in cataract operations. The laser is used in pediatry, gynecology, brain surgery and gastroenterology.

Last year nearly one million people throughout the world received some form of laser medical treatment.

How and why did the laser come about? Some 28 years ago (around 1958) a number of scientists started to think about making coherent light. They knew that if coherent light could be achieved they could use it to convey 10,000 times more information than with any existing electromagnetic signal such as microwaves. They knew also that because of its focussing properties such a beam could deliver immense amounts of energy with great accuracy, a characteristic which would lend itself to applications from welding to surgery.

Not all the scientists of the time were convinced that coherent light could be produced, so that those working in the field faced skepticism from their colleagues.

However, many scientists were intrigued by the possiblity of making coherent light and highly motivated to be the first to produce it. Interest and activity quickly built up to the point that an intense international race began, one involving many of the major industrial and university laboratories throughout the world.

A particularly notable paper was published in the December 1958 issue of the *Physical Review*. This paper discussed several possible approaches to making a laser and made a specific proposal. The proposal stimulated several scientists and thus increased the heat of competition——but unfortunately it didn't work.

In the meantime, I had been working on another device known as a maser. The maser I worked on produced coherent microwaves by means of a synthetic ruby crystal.

Like many other scientists at the time, I became intrigued with the possibility of generating coherent light. When I looked into the matter, I was at first discouraged for I found some published data which said that certain properties of rubies made them very unfavorable candidates to produce coherent light. I thus turned my attention to a number of other materials, but found problems with all of them.

I then returned my attention to the ruby. Since certain aspects of this material were beneficial, I decided to study the difficulties in detail to see if I could overcome them. When I made a series of careful measurements, I discovered to my surprise that the published data was incorrect (by a factor of 70!). I concluded that while ruby was still theoretically a difficult material to "Lase", it was in principle workable.

At this very moment, one of the authors of the 1958 *Physical Review* article announced at a professional meeting that ruby would never work. At the industrial laboratory where I was employed, my project was not popular and I received little support. But now as a result of these comments it was even more difficult for me to proceed. A leading expert in the field had publicly stated that my approach would lead to a technical dead end.

Nevertheless, I was so highly motivated by what I was doing I insisted on proceeding with my project, despite growing criticism from the administrators of the laboratory in which I worked and admired experts in the field.

On May 16, 1960 I was able to generate the first coherent light in the form of a burst of deep red light from a small ruby crystal.

I think my experience may hold a valuable lesson for those pursuing advanced research : if you are convinced you are right, persist in your work despite the skepticism of those around you, and you may succeed in accomplishing something that no one has ever done before.

What does the laser hold for the future ? The laser has already shown its versatility in many diverse applications——from a diagnostic research tool to removing birthmark, from the treatment of cancer to the guidance of weapons, from price code readers at supermarket checkout counters to the new compact disc players.

In the future, I expect that computers will communicate within themselves and with each other by means of fiber optic networks. In addition, the optical computers of the future (now under development in laboratories) will be laser-driven and many times more powerful than today's most advanced digital models.

I also see the Atlantic transoceanic wire cable being replaced by laser-driven optical fibers, and similar fiber cables spanning the entire Pacific ocean.

The laser revolution already underway in medicine will expand dramatically. Esentially, every doctor's office will have at least one laser, and almost all surgery will be performed by laser. The reason is simple : compared to conventional surgery, laser surgery means less bleeding, less pain, less anesthetic, fewer complications, less scarring and faster healing.

These are a few of the future applications of the laser that I can foresee. However, I hope that minds better than my own will invent many more uses for thisversatile device, and that the laser will outstrip its origins as a simple invention and become a valuable servant for the future of mankind.