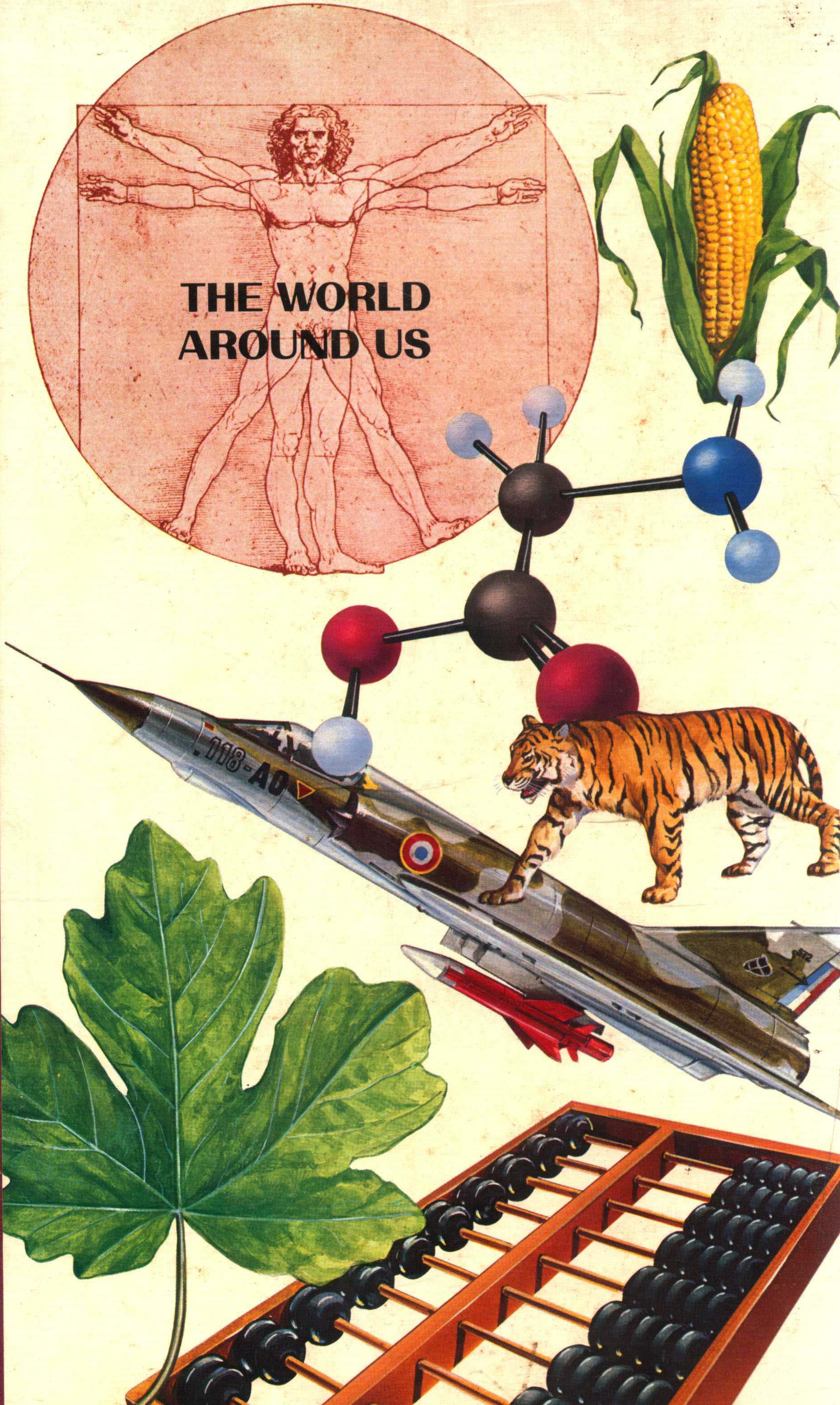
SCIENCE AND TECHNOLOGY ILLUSTRATED

# THE WORLD AROUND US



# Science Technology

## The World Around Us

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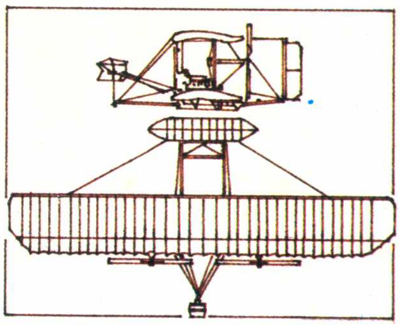

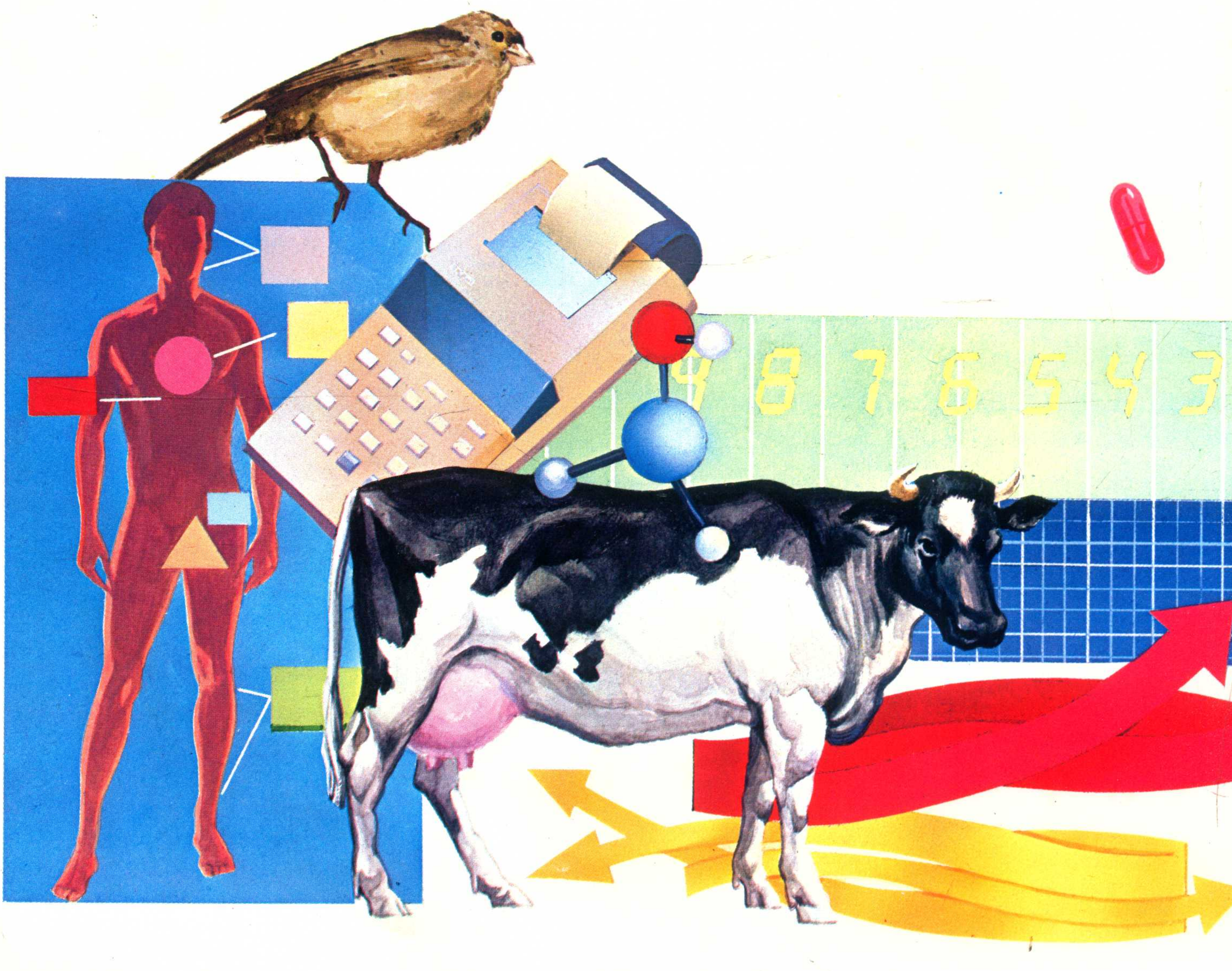

# Science and Technology Illustrated

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*The World Around Us*

# Science Technology

## The World Around Us

# and Illustrated

1768

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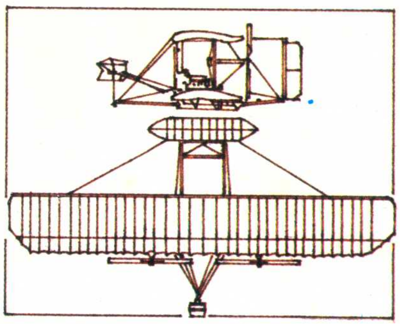
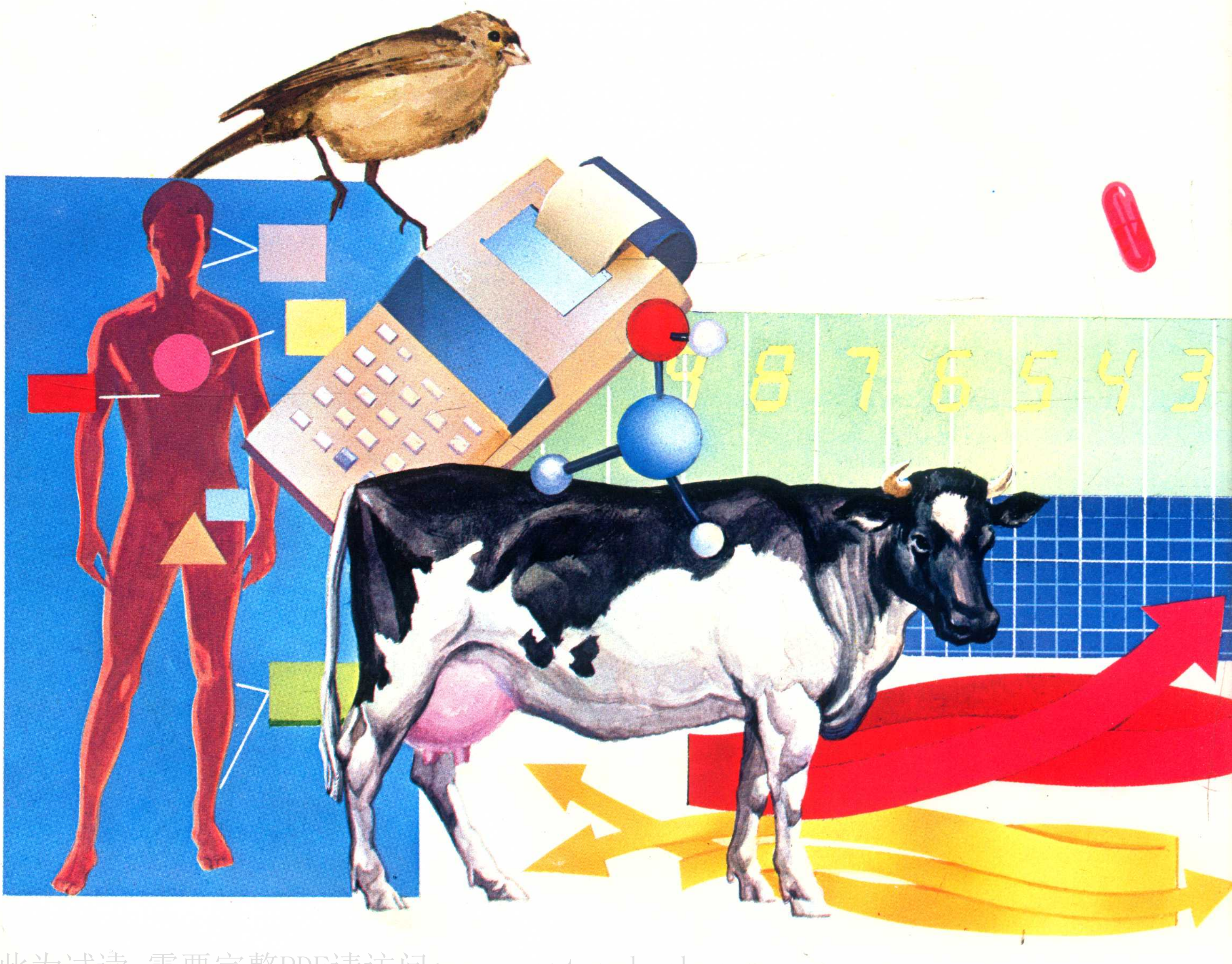




There is nothing new about flu. In the 5th century B.C., Hippocrates described the symptoms, and they were miserably similar to today's signals: chills, fever, general achiness, coughing, and sneezing. Yet, we speak of influenza with increasing casualness (a "touch of the flu" is almost synonymous with a "bit under the weather" these days), even though it is a disease that has killed millions of people in the 20th century alone and is still a serious seasonal health hazard.

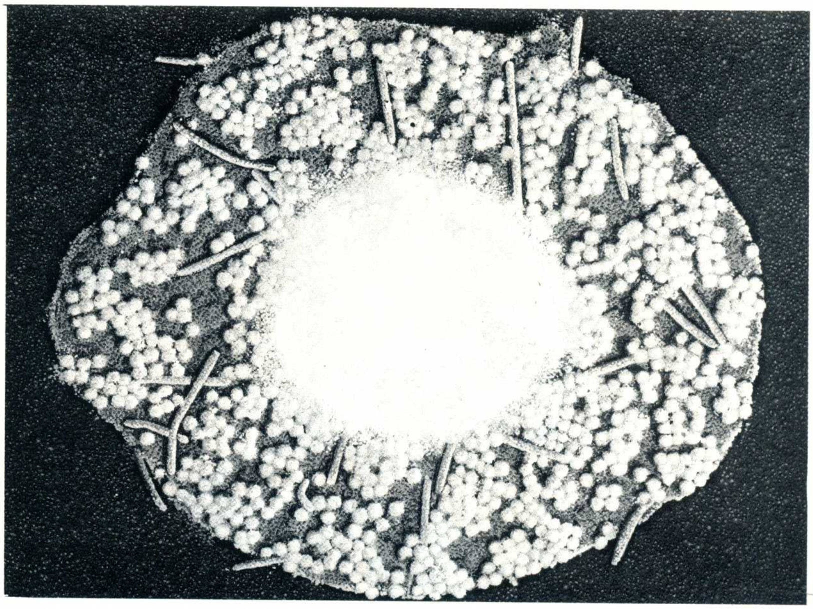
Influenza is a viral disease that affects the respiratory tract. The disease is so highly contagious that an estimated 900 million people contracted it during the 1918 pandemic. The period of incubation is only 24 to 48 hours, and the worst of the illness is usually past after 3 days, but the disease can lead to severe and sometimes fatal complications.

### The Phase of Infection

The trouble begins with the basic influenza virus—a sheath of protein around a tiny strand of RNA that altogether measures a mere 100 millimicrons (0.004 inch) in diameter. Humans are affected by A-strain viruses, which tend to cause widespread epidemics, and B-strain viruses, which usually cause localized outbreaks. These viruses invade the epithelial, or surface, cells of the respiratory tract and lungs, just as the common-cold viruses invade the epithelial cells of the nose. Viruses must invade "host cells" in order to reproduce and, once inside, they multiply very quickly.

After the invasion has begun, the body responds by producing antibodies, specialized cells that attack foreign invaders. Unfortunately, in the case of influenza, antibodies can only attack viruses in transit—that is, those that lie outside the epithelial cells. The viral infection causes inflammation of the lining of the nose, leading to the production of a watery fluid. This fluid dilutes the virus and, combined with a sneeze, expels it from the nose.

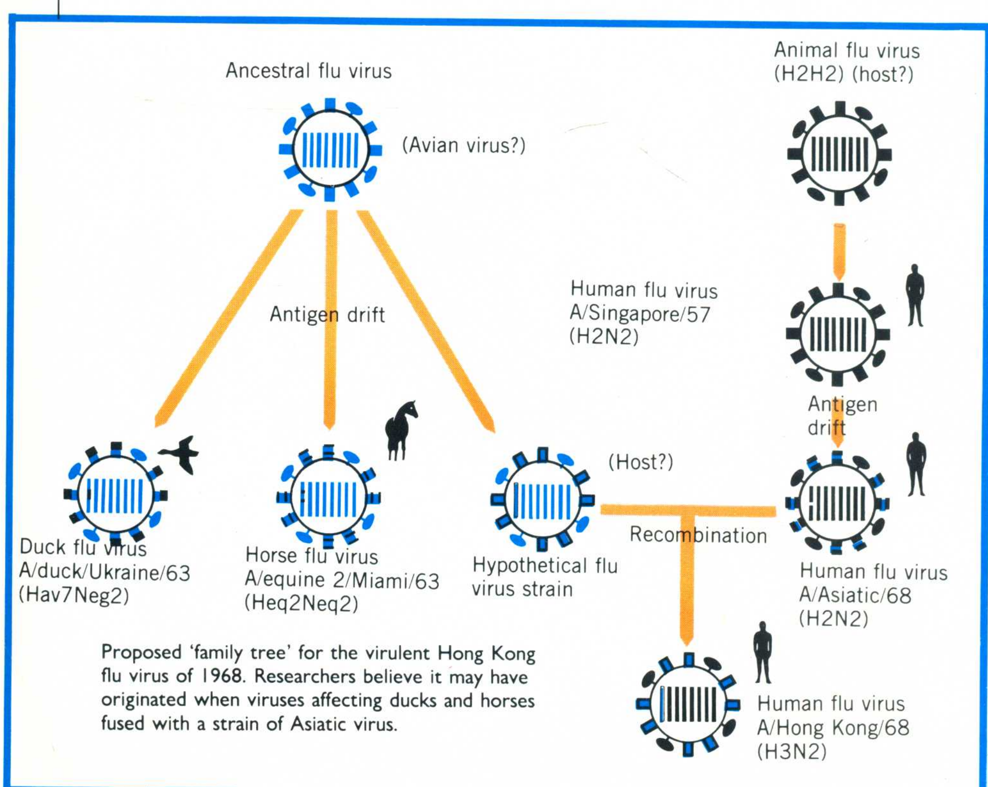
This flushing process, undertaken by millions of cells at once, produces an enormous amount of fluid. In the common cold, the result is merely annoying: a runny nose. In influenza, however, the result can be far more deadly. Fluid can collect in the lungs and literally suffocate a victim (usually young children or the elderly) by blocking the exchange of ox-



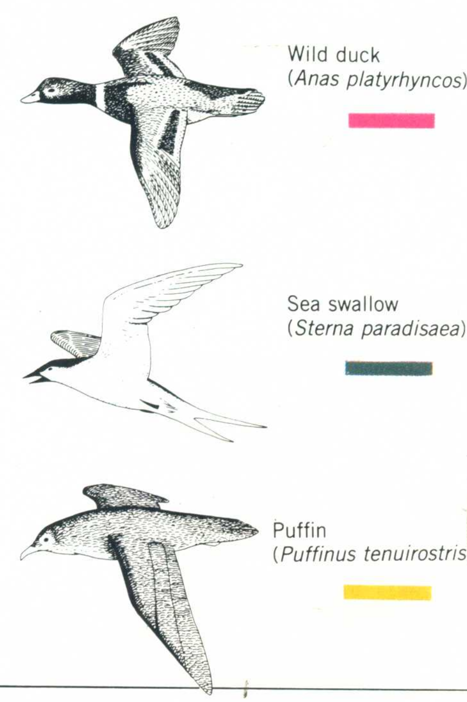
*Left:* Microphotograph shows a section of human lung tissue infected by flu virus. Influenza is a disease of the respiratory tract and, though not usually fatal in itself, can create conditions that favor more serious complications like bacterial pneumonia.

*Top right:* Humans are not the only organisms to suffer from influenza. The microphotograph shows the red blood cells of a chicken infected by flu virus.

*Below:* Migrating birds may even carry the disease from continent to continent. The birds shown are among those that have been linked to the spread of particular flu epidemics. Their migratory routes are shown on the map.




Proposed 'family tree' for the virulent Hong Kong flu virus of 1968. Researchers believe it may have originated when viruses affecting ducks and horses fused with a strain of Asiatic virus.



ygen in the lungs. Such a condition is rare, but lungs can fill with fluid rapidly and with no outward sign of trouble.

More commonly, influenza weakens the respiratory system so that complicating infections, like bronchitis or bacterial pneumonia, can gain a foothold. The combination of fluid and warmth in the lungs creates perfect breeding conditions for bacteria. Elderly and chronically ill people, in particular, are susceptible to these bacterial complications that make influenza so dangerous. In 1918, before the widespread use of antibiotics, the flu pandemic killed an estimated 20 million people—12.5 million in India alone over a period of several months.

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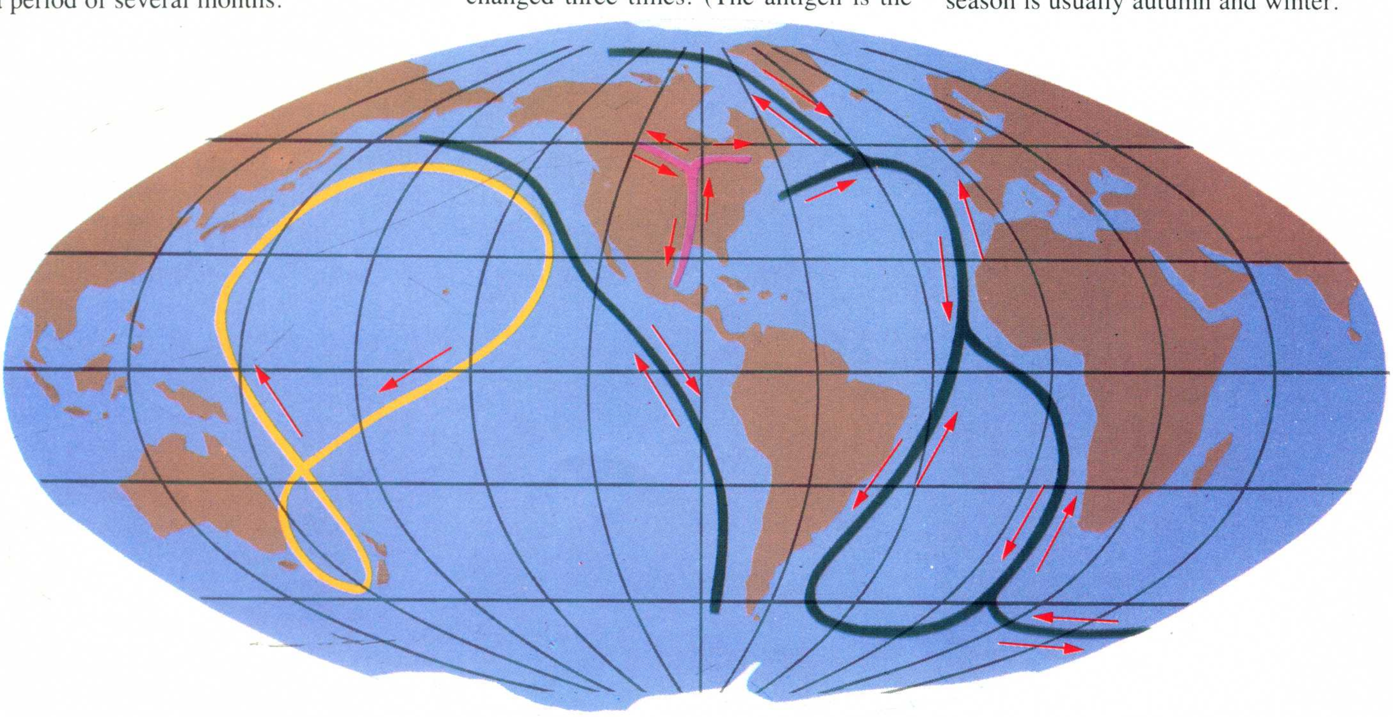
### Viral Mutations

Influenza is particularly insidious as a human disease because the infecting viruses continue to mutate and change. Since 1933, when the A-strain virus was first isolated and identified, the basic antigenic structure of the virus has completely changed three times. (The antigen is the part of the virus that triggers the host's antibody defense.) Just as the human immune system built up defenses against the earlier A2 (or Asian) flu virus, the virus changed its antigenic nature so thoroughly that by 1968 it had essentially become a new virus, the A2 Hong Kong.

As each new flu strain is isolated and identified, new vaccines can be produced. Unfortunately, there are no drugs that combat the flu virus—only general medications to relieve the symptoms. Although the origin of the term "influenza" is somewhat misleading (it stems from the Italian for "influence" of cold weather), it is not altogether inappropriate. The flu season is usually autumn and winter.



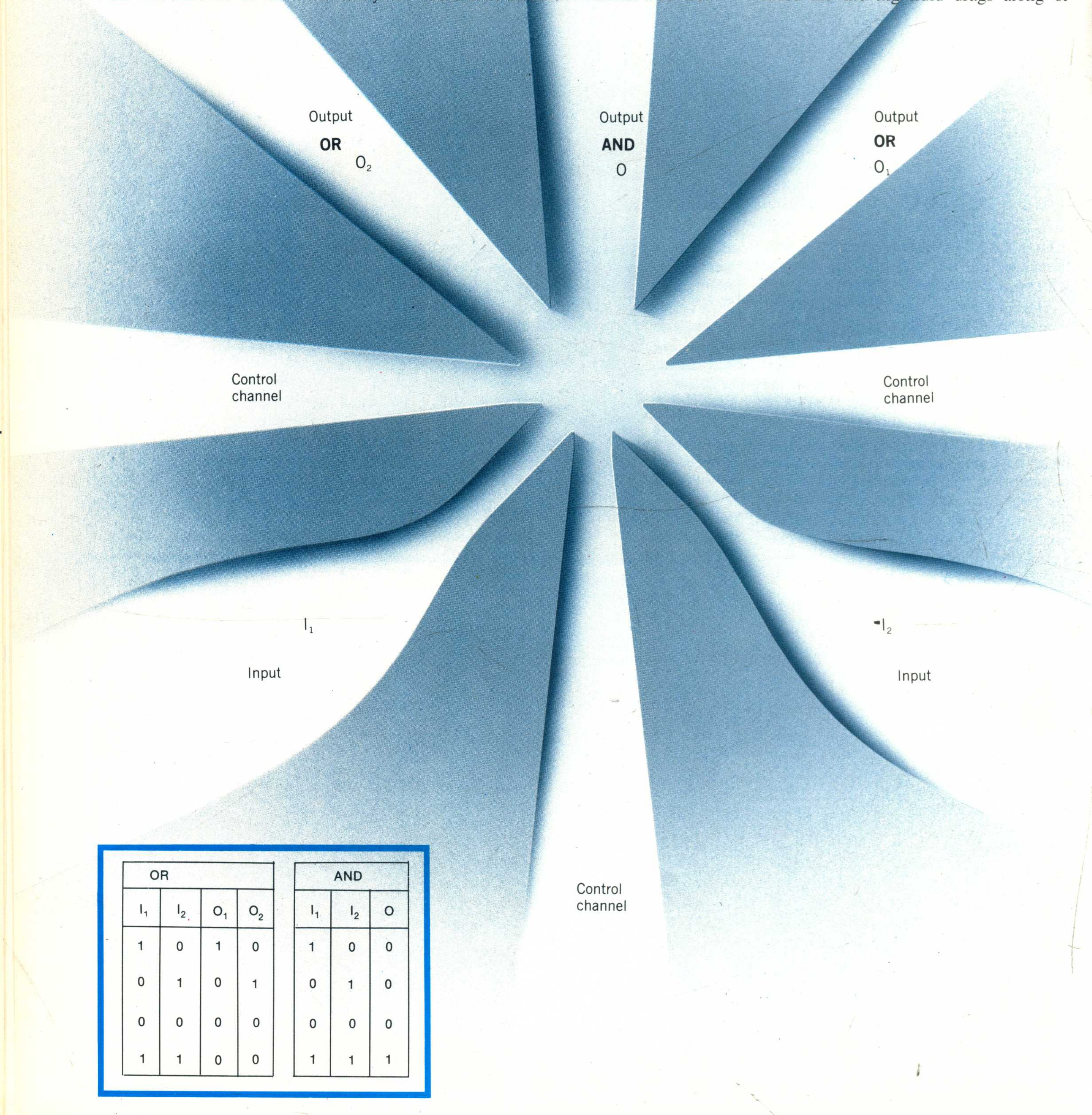
# Fluidics

Since the discovery of the basic principles of electricity, scientists and teachers have explained to laypeople and students that electric currents act a little like currents of air or water. Fluidics is a field of technology based on the converse of this principle—that simple flows of air or water (both are fluids, or nonsolid substances) can behave quite like electric currents.

Fluidics began in 1959, with the work of researchers at the Diamond Ordnance Fuze Laboratories of the U.S. Army in Washington, D.C. Basing their explorations on the previous discoveries of Rumanian engineer Henri Coanda in the 1920s and 1930s, they created the first fluidics devices. In the years since then, fluidics has been used in the construction of amplifiers, oscillators, computers, flowmeters, sensors, and process-control valves—all working solely on streams of gas or liquid. These jets are used as signals. Like a flow of electric current, the push of the jet can be used to control or monitor a device.

### Coanda Effect

Most applications of fluidics use the Coanda effect, named after its discoverer. Coanda learned that an even jet of fluid, such as a gas or liquid spurting from a tube, tends to follow the contour of a nearby curved surface. The fluid "sticks" to the surface, flowing along it like a stream over a sidewalk, provided the angle between the jet and the surface is not too sharp. The Coanda effect works because the moving fluid drags along or




| OR | | | | AND | | |
|---|---|---|---|---|---|---|
| $I_1$ | $I_2$ | $O_1$ | $O_2$ | $I_1$ | $I_2$ | $O$ |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 |

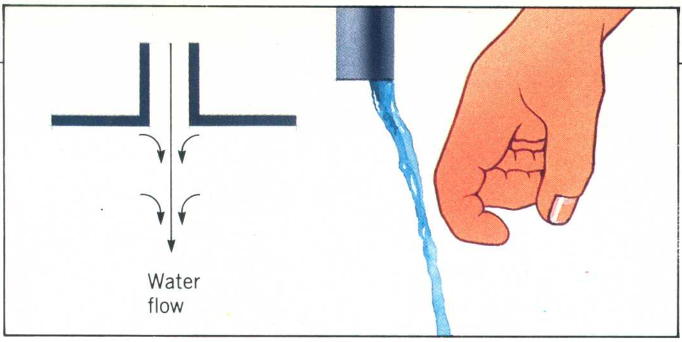
"entrains" nearby air molecules (or liquid molecules, if the jet shoots out into a liquid). The entrained molecules between the jet and the surface cannot be immediately replaced by others because the jet is in the way. The result is a creation of a partial vacuum between the jet and the surface—a vacuum that is filled by the jet, which bends and attaches to the surface.

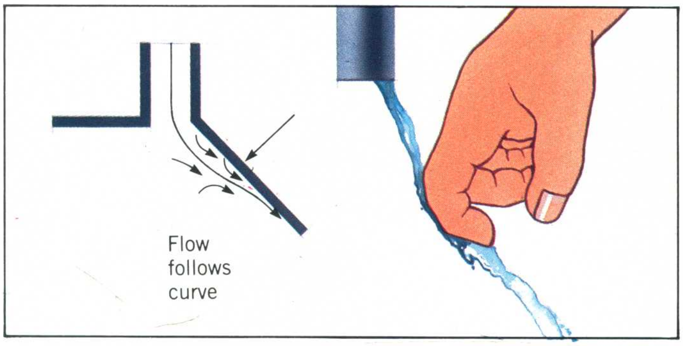
The use of the Coanda effect is shown in the common "flip-flow" circuit, a device that turns signal *A* (that is, output jet *A*) into signal *B* (that is, output jet *B*). The flip-flop circuit is basically a small tube—the supply tube—that forks into two equivalent branches, each corresponding to a signal, *A* or *B*. Because of the Coanda effect, the fluid from the supply tube will stick to one or another of the two branches. Now, imagine two small vents going into the area of intersection, one on the side of branch *A*, the other on branch *B*. To transform the signal from, say, *A* to *B*, the vent opposite *B* is opened. A jet of fluid from that vent nudges the supply stream, flip-flopping it from one branch to the other.

### Applications of Fluidics

The flip-flop circuit and other fluidics circuits are physical representations of logical circuits, mathematically identical to the electric circuits that are used in computers to perform functions such as "and," "or," and "not." (The term fluidics is, in fact, a combination of fluid and logic.) Logic circuits have an enormously wide range of applications, especially for the control of industrial processes. Fluidics circuits are slower than electric circuits because gases and liquids flow at a much more leisurely pace than electricity. Unlike electric devices, however, fluidics circuits have no moving parts, can use any fluid (although most use air), have few size limitations, can be made out of any moldable material, and are unaffected by high temperature, intense vibration, and radiation. Further, they are not interfered with by the emissions of nearby electromagnetic devices.

Entirely fluidic computers exist, used mostly in special, often high-radiation environments such as nuclear reactors and spacecraft, where simple nonelectric circuits are needed to resist deterioration. Fluidics is also used in jet engines, for controlling the flow of compressed air and fuel, and in many high-temperature and hydraulic industrial control processes. In many cases, fluidics is preferred by engineers, who know that generally it is much easier for the people who make and use these devices to deal with flows of air rather than flows of current.

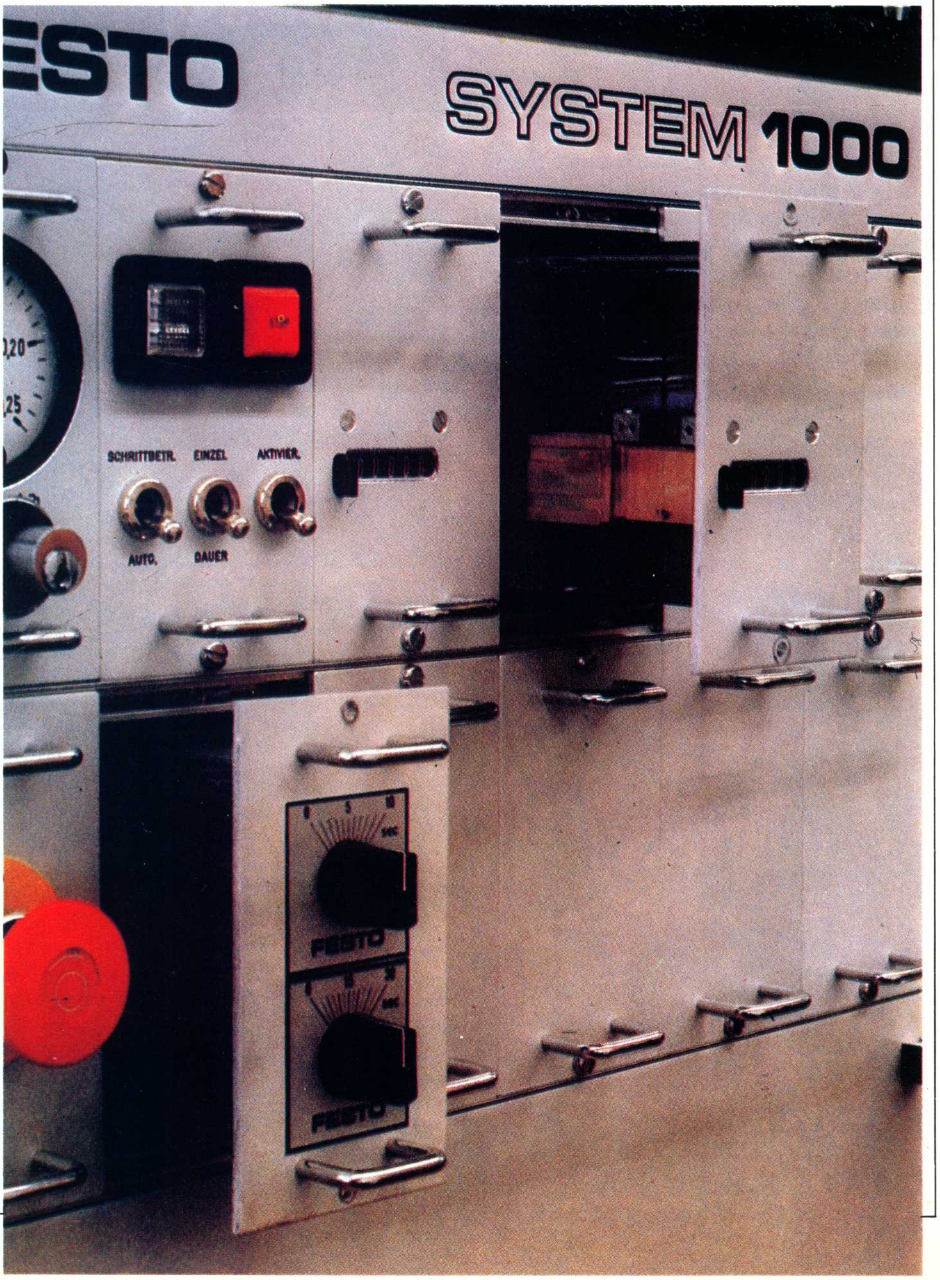



*Right:* Commonplace example of the Coanda effect, whereby a stream of fluid in motion tends to follow the contour of a nearby surface. In this case, the fluid is water and the surface it follows is a finger.

*Left:* Structure of an AND/OR logic gate of the sort used in a fluidic computer. The box in the corner of the illustration is a 'truth table,' which describes in binary form the logic values of the input and output signals of the fluidic circuit.

*Below:* Main panel of an industrial control system based on low-pressure fluidic data analysis and transmission.



# Fluorescence

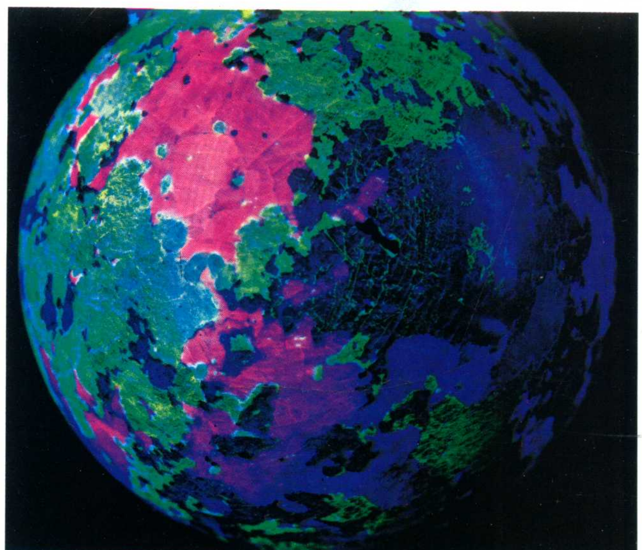
Television tubes are one of the most familiar instances of the use of the process of fluorescence. The television screen is coated with minerals called phosphors that glow, or fluoresce, whenever they are struck by a beam of electrons; the more intense the beam, the brighter the glow. By regulating the intensity of an electron beam that strikes the screen almost everywhere at once, an image can be produced. Fluorescence therefore forms an essential part of the means by which your television set converts the electric impulses it receives from the antenna into light.

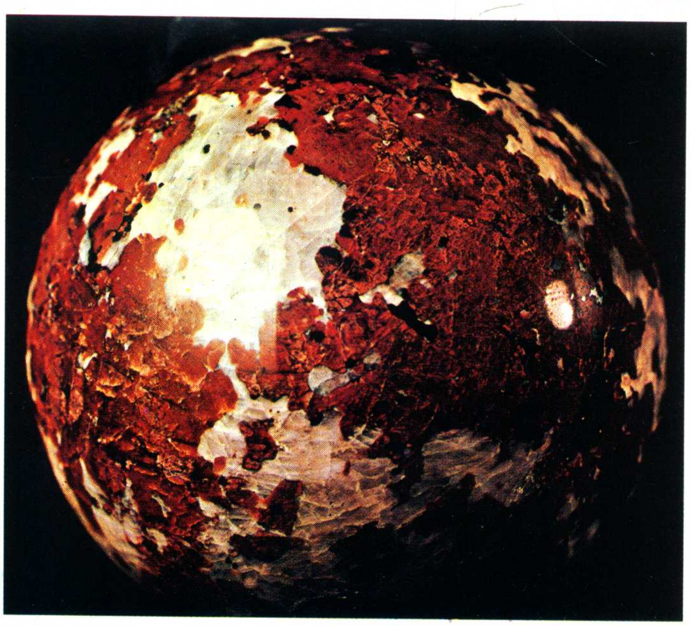
Fluorescence is defined, generally, as the process by which light is emitted by a substance immediately upon being exposed to a form of radiation—whether it be a form of electromagnetic radiation, such as ultraviolet or X rays, or a beam of particles, such as electrons. The word "fluorescence" was coined in 1852 by the British scientist Sir George Stokes, to describe the light emanating from fluorspar (fluorite, a calcium- and fluorine-containing compound) exposed to ultraviolet light.

## Afterglow

In certain respects, fluorescence resembles a phenomenon known as phosphorescence, from the Greek word for "light-bearing." The two are usually distinguished on the basis of the length of their respective afterglows. Fluorescence ceases almost immediately after the exposure to radiation ceases, while phosphorescence has an afterglow that may last for seconds. The light emission, in both cases, is caused by the movement of electrons in atoms between levels, or states, of different energies. In fluorescent materials, the transition from state to state is almost im-


*Right:* The phenomenon of fluorescence, as shown in the oversize illustration, is a result of the emission of light by electrons boosted to a higher energy level by exposure to some form of radiation.





*Left:* The minerals calcite, willemite, and franklinite appear respectively white, red, and black under ordinary light. *Above:* If the sample is illuminated with ultraviolet light, however, calcite and willemite show dramatic color changes. Franklinite, which does not fluoresce, remains black.