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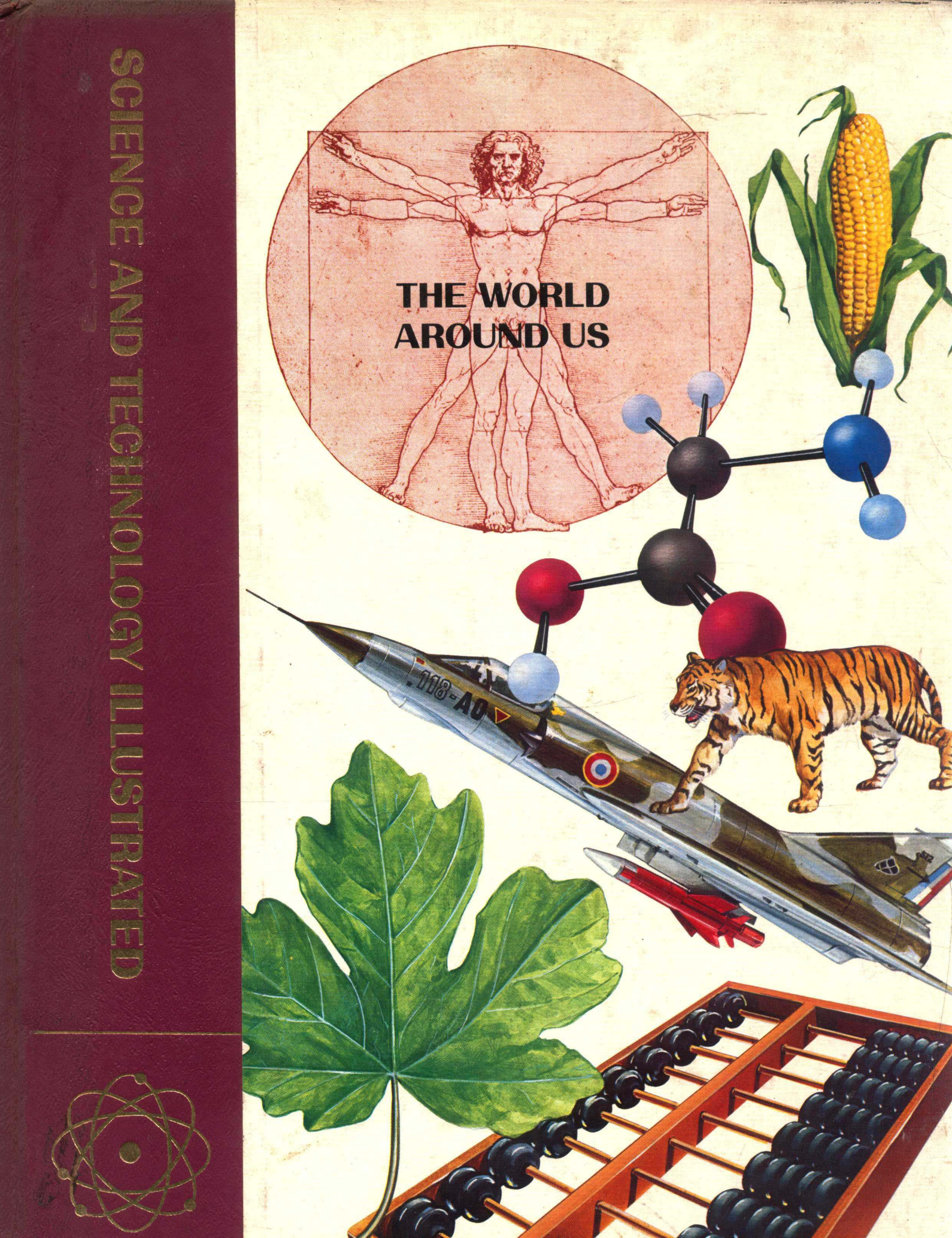

Science and Technology Illustrated

The World Around Us

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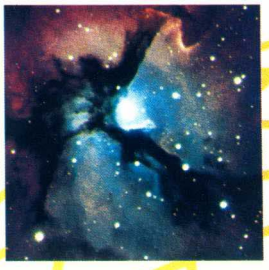

Volume 27

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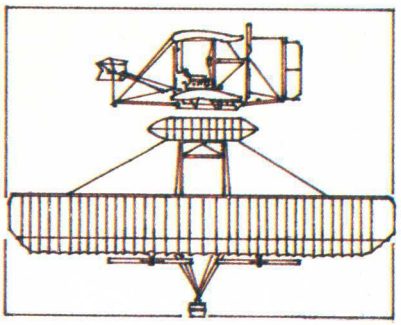


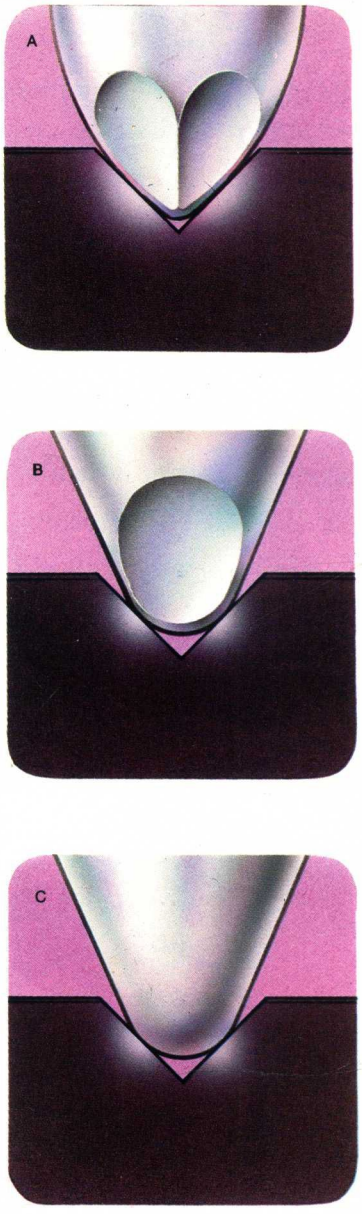
Turntable, Phonograph

In the simplest record player and in the most sophisticated sound studio, the turntable performs the same basic function: to spin a record at a constant speed (typically 33-1/3 or 45 revolutions per minute). The turntable is accompanied by a tone arm, at the end of which is mounted a cartridge, or pickup, which consists of the stylus (needle) and the transducer. The stylus receives mechanical signals from the grooves of the record, and the transducer changes these vibrations into electrical impulses. At present, phonograph records offer excellent fidelity in sound reproduction. The modern turntable may, however, go the way of the hand-cranked phonograph, as affordable advances in taped sound reproduction threaten to make the common turntable obsolete.

Drive Mechanisms

Early turntables were spun by a spring-driven motor, which was wound manually before each record was played. These primitive contraptions gave way to heavy, nonmagnetic metal platters designed to be driven smoothly and noiselessly by electric motors. The drive shaft of the motor spins at a constant speed. This motion can be imparted to the turntable rim by rubber-tired drive wheels. By moving these rubber "idlers" up or down on the drive shaft of the motor, which varies in diameter along its length, the speed of the turntable can be changed. One disadvantage to this arrangement is that the idler wheels may also transmit an excessive amount of motor vibration to the turntable platter, where it can be picked up by the cartridge, resulting in an annoying low-frequency rumble superimposed on the reproduced music.

Two alternatives to this rim drive accomplished by rubber friction wheels are belt drive and direct drive. Belt drive utilizes a large, flat rubber belt that is wound from the motor shaft to the underside of the turntable platter. As the motor turns, so does the platter, with the belt absorbing irregular vibrations from the motor and spinning the record at a constant speed. In a direct-drive turntable, the platter is mounted right on the shaft of a special motor that, by rotating the shaft, directly rotates the platter, with no idler wheels, belts, or other intermediary elements.

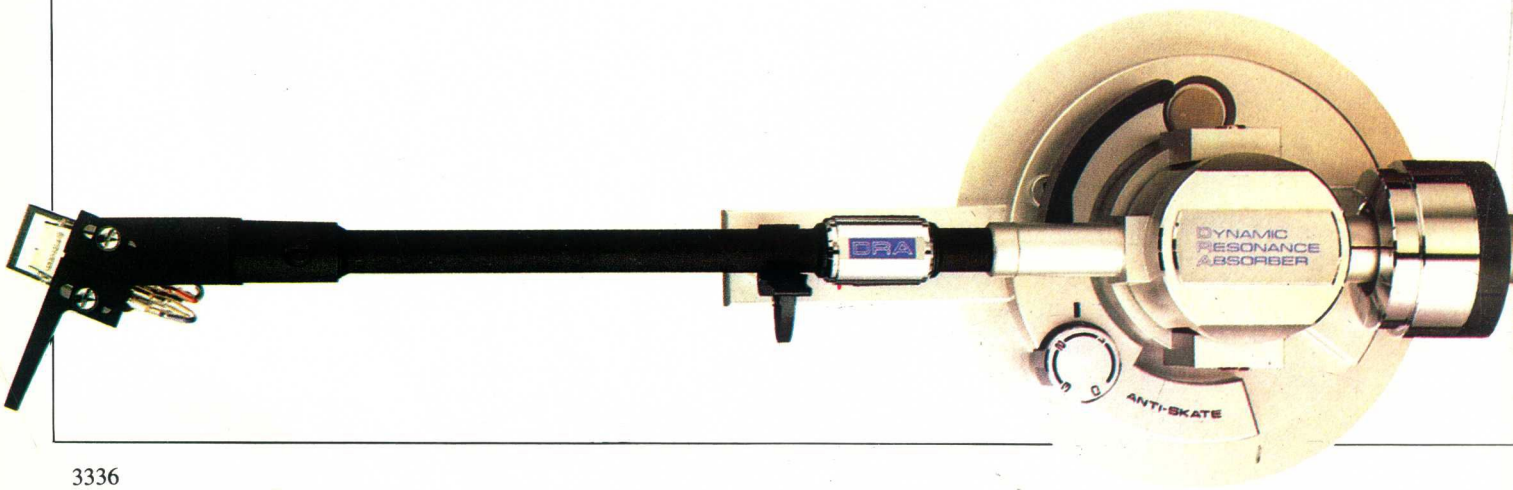


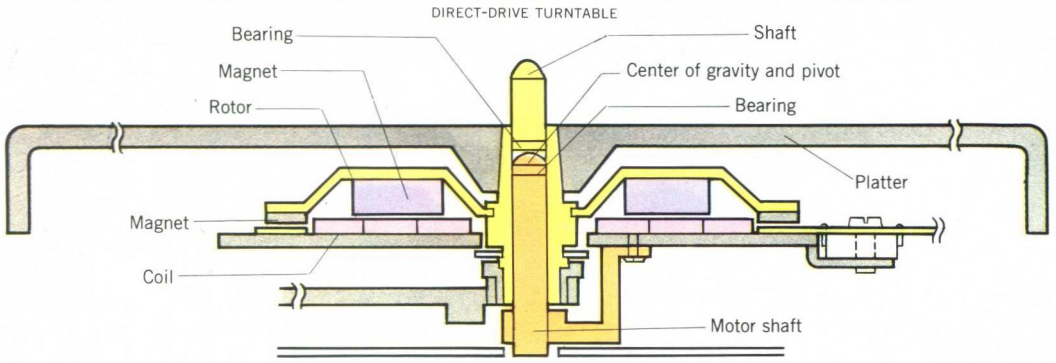
Tone Arm

Once the motor and drive system has accomplished the task of driving the turntable at the correct speed, the tone arm and pickup are introduced to the system. The tone arm holds the pickup and counterbalances its weight. It should be balanced so that there is only enough weight to keep the needle of the pickup riding in the grooves of the record just firmly enough to accurately track its modulations, so as not to introduce distortion in the reproduced sound. As the needle rides the record's grooves, it exerts pressure on the inside of each groove. If this force becomes great enough, the stylus will climb out of the groove and skip across the surface of the record, toward the center of the disk. This is called skating and is compensated for by a counterforce called antiskating, which is usually applied near the pivoted end of the tone arm.

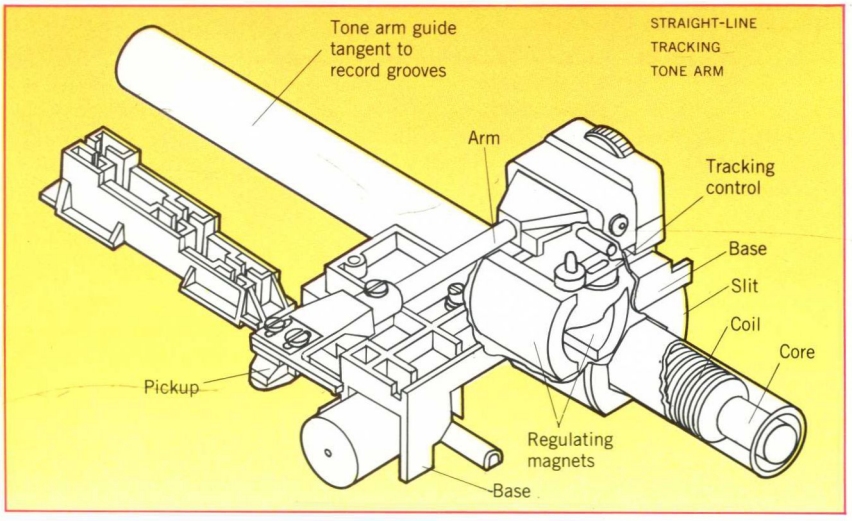
The most sophisticated element of the turntable system is the pickup, which holds the needle, or stylus, and transduces its mechanical motions into electrical impulses that are passed on to the amplifier and speakers. In a stereo system, the pickup contains two independent electrical generating units that receive impulses from one stylus and then send the

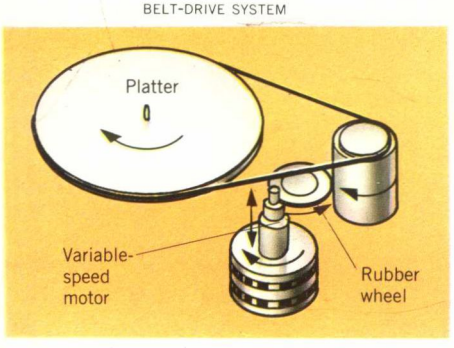
Above: Drawings of 3 types of phonograph needles, or styluses. From top, (A) diamond, (B) elliptical, and (C) spherical.
Below: Modern tone arm made of antiresonating materials and equipped with antiskating mechanism and counterweight.





Right: Diagram of a direct-drive turntable, in which the platter is mounted directly on the motor shaft. This permits high stability and extremely even rotation.





Left: Belt-drive turntable system.

Above: Straight-line tracking tone arm, which permits record play with the needle in exactly the same position as the original needle that cut the master record.

Below: Front-loading turntable.

appropriate signals to each of the separate amplifier channels.

One mechanism used to accomplish this aspect of the turntable's function is the magnetic pickup system. Two electromagnetic coils establish a magnetic field that provides constant steady voltage in the transducer. As the stylus moves back and forth in the varying grooves of the record, it disrupts the equilibrium of this voltage. The variations in the voltage appearing across each coil compose the electrical signal that is sent to the amplifier, where its strength is boosted before it is sent out to the speakers.

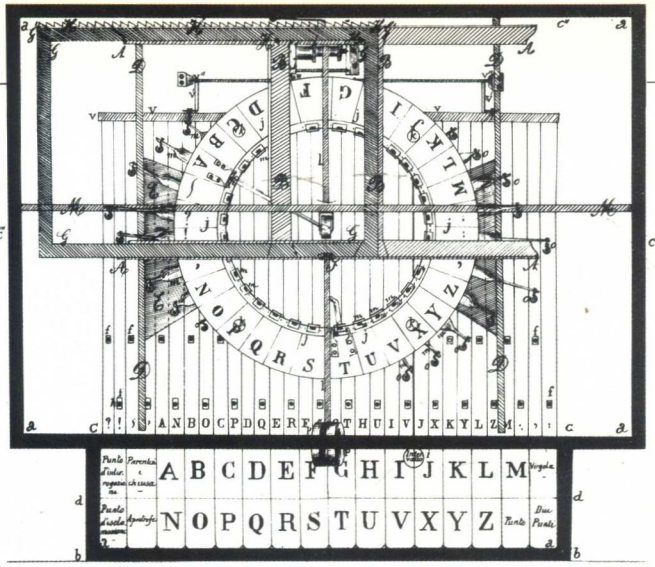
The other two pickup systems, crystal and ceramic, operate on another principle, the piezoelectric effect (deformation of crystals releases electrical energy), to transform stylus vibrations into electrical impulses. The stylus follows the modulations in the groove of the record, and the resulting mechanical impulses cause the crystal or ceramic material in the pickup to be twisted. This deformation creates changes in the voltage that is fed to the amplifier.

Typewriter

Since the very first patent announcing its existence, early in the 18th century, the typewriter has gone through an impressive series of evolutions and improvements. Some early typewriters resembled combinations of clocks and soapboxes; others looked like pianos (one actually featured a piano keyboard). The earliest models wrote much more slowly than handwriting; some modern machines, by contrast, can type about 100,000 characters per minute. Yet, today's machines very much resemble the first practical models, which first appeared in the United States in the late 19th century.

The definition of the typewriter has varied only slightly from the description in the patent granted by Queen Anne of England in 1714 to the inventor Henry Mill. It is a machine that can sequentially make inked impressions of letters on paper, "so Neat and Exact as not to be distinguished from Print."

All typewriters—whether manual or electric—share general components. The keyboard, for example, is a series of keys (anywhere from 44 to 96) that correspond to letters and other symbols of writing. Striking a key activates either a type bar, a long metal "hammer" that hits an inked ribbon at a central location and leaves a mark on paper, or a type-head, a small plastic ball that swivels and tilts into position before striking the paper. The cylindrical platen is the roller around which paper is inserted and maneuvered. In all manual and many electric models, there is a movable carriage, which is the structure that supports the platen.



Right: Diagram of a 'writing spinet' patented by an Italian inventor in the 1850s. The surprisingly modern design makes use of a forerunner of the daisy-wheel principle. Each letter matrix—the part that strikes the typewriter ribbon—is placed on the edge of a rotating disk that changes position according to the letter to be typed.

The Manual Typewriter

The manual typewriter has changed very little since the famous Remington model of 1864 (used by Mark Twain to submit the first book manuscript in typewritten form). By depressing a key on the keyboard, the typist imparts physical energy that, through a complicated system of levers, pivots, wires, and linkages, flips the type bar so that it strikes the paper.

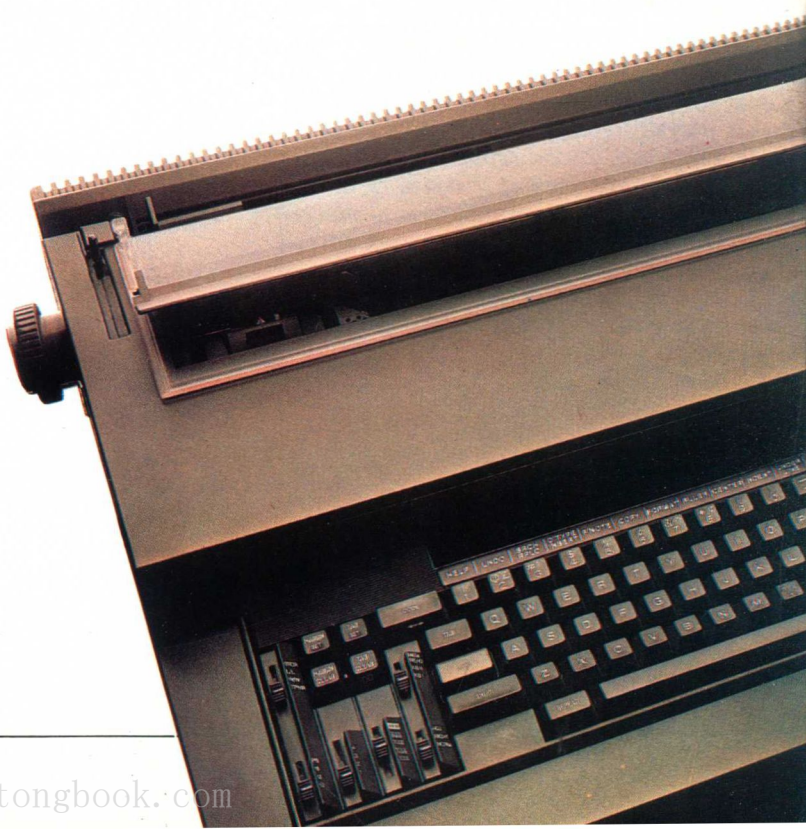
Each type bar has a raised symbol that, when flipped toward the center of the carriage, strikes an inked ribbon, leaving its impression on paper. As soon as the type bar hits the ribbon, it triggers the carriage to move left by the space of one character (or letter). With the invention of the shift key in 1878, two raised symbols (usually upper case and lower case of the same letter) could be placed on each type bar; the shift key caused a minor adjustment in the carriage, so that a capital letter would be printed instead of a small letter.

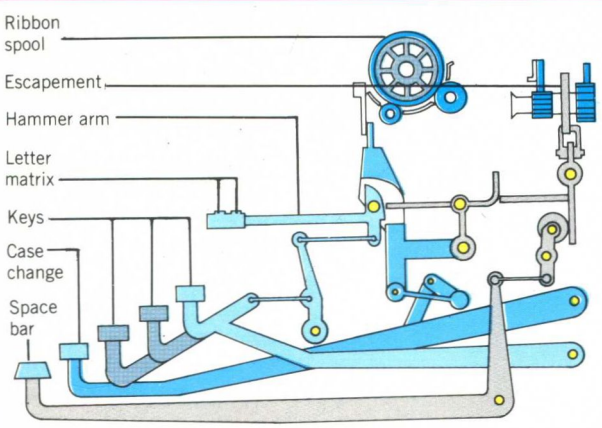
The Electric Typewriter

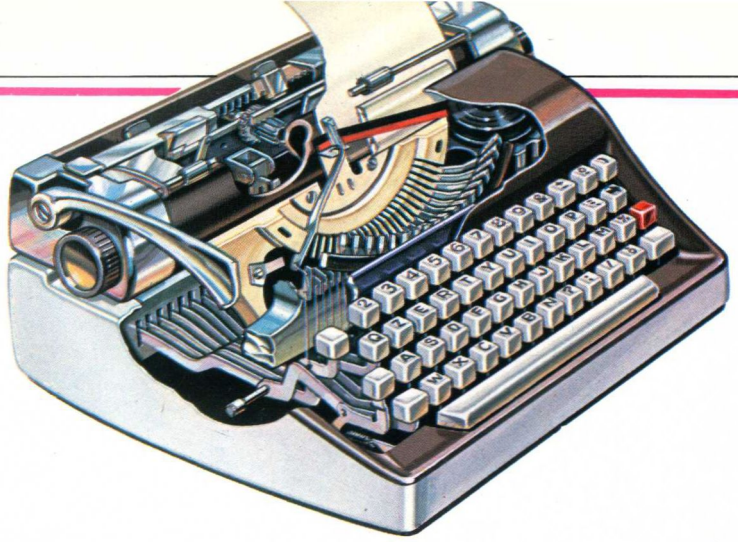
The electric typewriter, which was first patented in 1872 by Thomas Edison, functions in essentially the same way as the manual. With an electric motor instead of fingertip pressure as the source of power, however, the electric typewriter is faster and produces more uniform letters. Triggered by the light touch of a key, the machine automatically engages a drive shaft that is constantly turning. In this way, the electric motor controls key stroke, the movement of the carriage, and line spacing.

An important landmark associated with the electric typewriter is the spherical type-head, or ball, first introduced in 1961 by IBM. This plastic, nickel-plated sphere,

Right: Electronic typewriter with a magnetic memory that employs floppy disks to memorize texts and a video monitor to display them during typing, correcting, and editing. The letters that strike the typewriter ribbon are not on individual arms, as in old-style machines, but are arranged around the edge of a daisy wheel, illustrated below.







Above: At left, diagram of the linkages that cause pressure on the keys to force the letter matrix against an inked ribbon, typing a letter.

Right: Portable manual typewriter. The positioning of letters on typewriter keyboards varies somewhat from country to country. The keyboard shown on the portable is an Italian model. On an American, or International, keyboard, the Z shown in top row of keys is replaced by a W, among other changes.

less than 1.5 inches (38 mm) in diameter, can be quickly swiveled to the proper letter and tilted up against the ribbon. In addition, the entire housing for the type-head slides by cable across the manuscript page from left to right, so that the movable carriage is no longer necessary. Since these balls are easily inserted and removed, it is now possible, without disturbing the paper, to type in a wide variety of fonts; for example, italic and mathematical symbols, as well as alphabets like Greek.

Modern Speed

The type-head reacts with incredible speed to impulses, firing off more more than 15 strokes per second. Those impulses may come from a typist's fingers or, more commonly in an age of data processing and word processors, from the impulses on magnetic tape and other computerized inputs. When the A key is hit, for example, a series of selector rods that reacts only to A is activated. These rods, in turn, maneuver two steel bands at the bottom of the type-head housing. One rotates the shaft of the type-head (for swivel), and the other changes the attitude of the head (for tilt). Thus, for 88 characters, there are 88 different sets of selector rods. Despite the tangle of levers and rods inside, the end result is speedier and more efficient typing.

The latest generation of typewriters features computerized electronics. Each machine comes with a tiny microprocessor, which shoots electronic impulses to electromagnets within the typewriter; these electromagnets instantly maneuver the mechanical components that control margins, tabulation points, centering, column alignment, revisions, corrections, and other functions. Many of these same machines have electronic "memories," where thousands of characters—such as in the text of a standard and often-used business letter—can be stored and then recalled at the push of a button. The letter is then typed out automatically.

Typhoid Fever

Travelers departing for tropical and subtropical areas routinely undergo a battery of immunizing injections, among which invariably is the vaccination for typhoid fever. Though today the mortality rate of this disease is less than 5 percent (complications account for most deaths associated with typhoid), and occasionally there are cases so mild as to be symptomless, a typhoid bout of average severity would be enough to put a damper on most anyone's vacation.

Salmonella Typhi: The Typhoid Bacteria

Salmonella typhi, a rod-shaped bacterium with a tail, flourishes in milk, dairy products, shellfish, and meats and vegetables that have come in contact with sewage-contaminated water. Though animals and fish may carry the bacteria, they do so only because they have been contaminated by man. Only humans contract the disease, which they do simply by swallowing *Salmonella typhi*.

The bacteria reproduce at a high rate in the mesenteric lymph glands located in the abdomen. From the mesentery—connective tissue between the abdomen and blood vessels and nerves—they pass into the bloodstream, which carries them to the liver, spleen, intestines, and other parts of the body. By the time *Salmonella typhi* lodge in the small intestine, where they cause ulceration and inflammation, the initial symptoms of typhoid fever appear, from 10 to 14 days after infection. The disease lasts about 4 weeks.

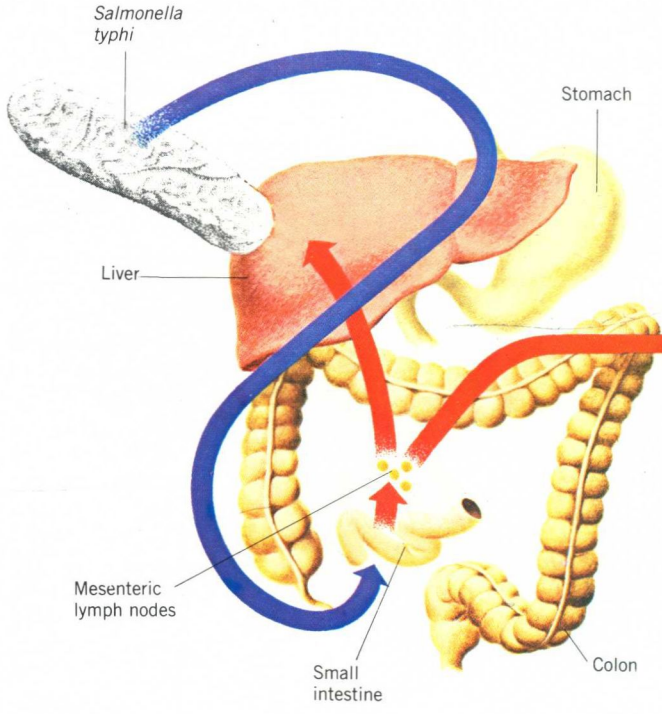
Symptoms

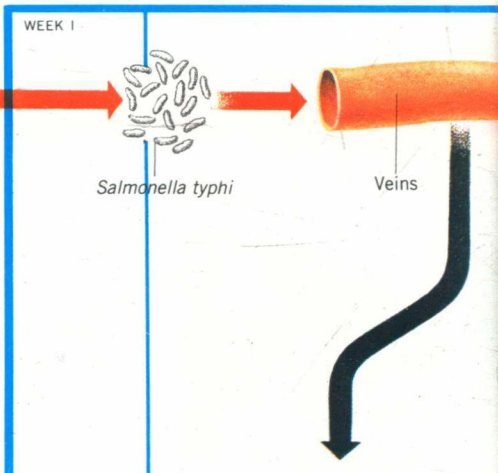
Typhoid fever manifests itself gradually, and in the early stages it resembles any number of infections. You feel tired, less alert than usual, have a sort throat and not much appetite. You may also have constipation, abdominal pain and distention (or swelling), and a fever. Toward the end of this initial phase, which usually lasts about a week, you may get a rose-colored rash on your abdomen and trunk.

As the disease progresses, fever becomes persistent, and the patient becomes increasingly dull of mind, lethargic, and perhaps delirious. The constipation of the first week is replaced with greenish-yellow diarrhea, and the abdomen becomes more tender and swollen.

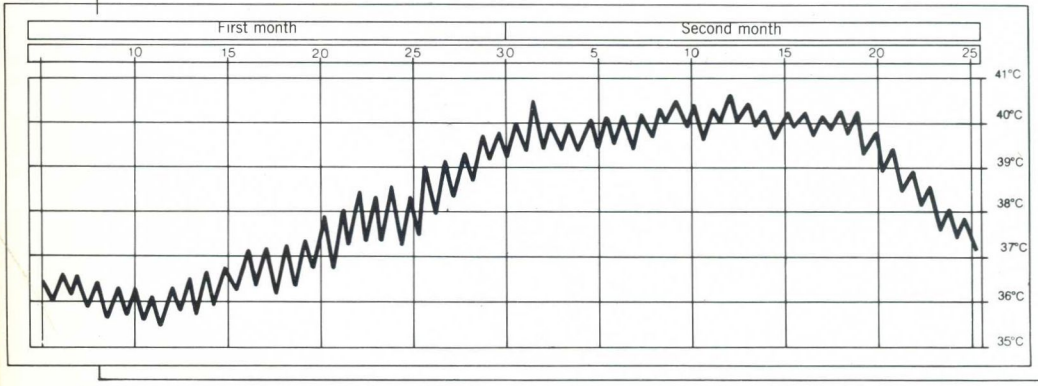
The 10 days after the first symptoms appear is the best time to get an unambiguous diagnosis. Bacterial cultures from blood samples are the preferred diagnostic tests, since sometimes it is impossible to isolate cultures from the excreta, and sometimes tests based on fecal samples yield negative results even though the patient does indeed have typhoid fever.

By the third week of the disease, a serological test can be performed. This entails taking a blood serum sample and isolating *Salmonella typhi* antibodies. The difficulty with this method is that not all these antibodies become active early in the disease, and some never rise to a level high enough to be considered a positive diagnostic. Serological tests, for this rea-





At the end of the incubation period, bacteria return to the blood and increase in number. Symptoms include fever, weakness, loss of appetite, and stomach pains.



Below: Fever chart for a patient with typhoid fever.

Right: Across these pages, diagrams illustrating the typhoid fever cycle.

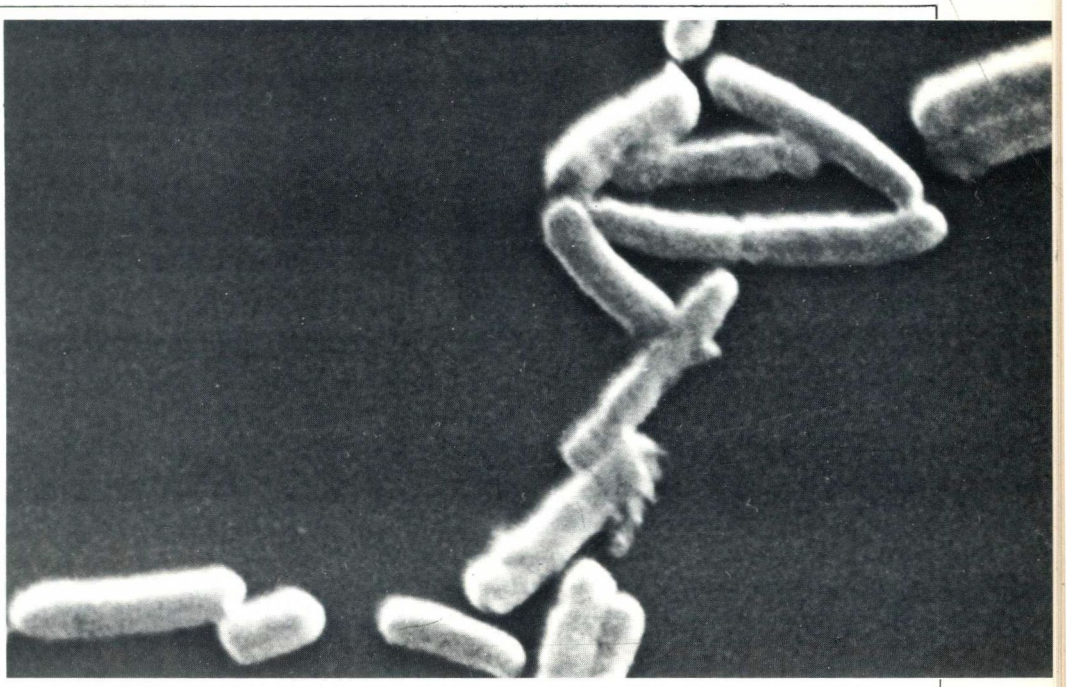
son, are often used to locate carriers whose bacterial cultures were negative.

If a diagnosis is not made early on, the patient, now dehydrated and very weak, falls into a state known as "coma vigil." The patient is semiconscious, does not know where he is though his eyes are usually open, and generally talks continually and incoherently. The most serious complications, associated with typhoid perforation of the bowel and intestinal hemorrhage, occur at this stage. It is rare today for typhoid to progress this far.

Treatment

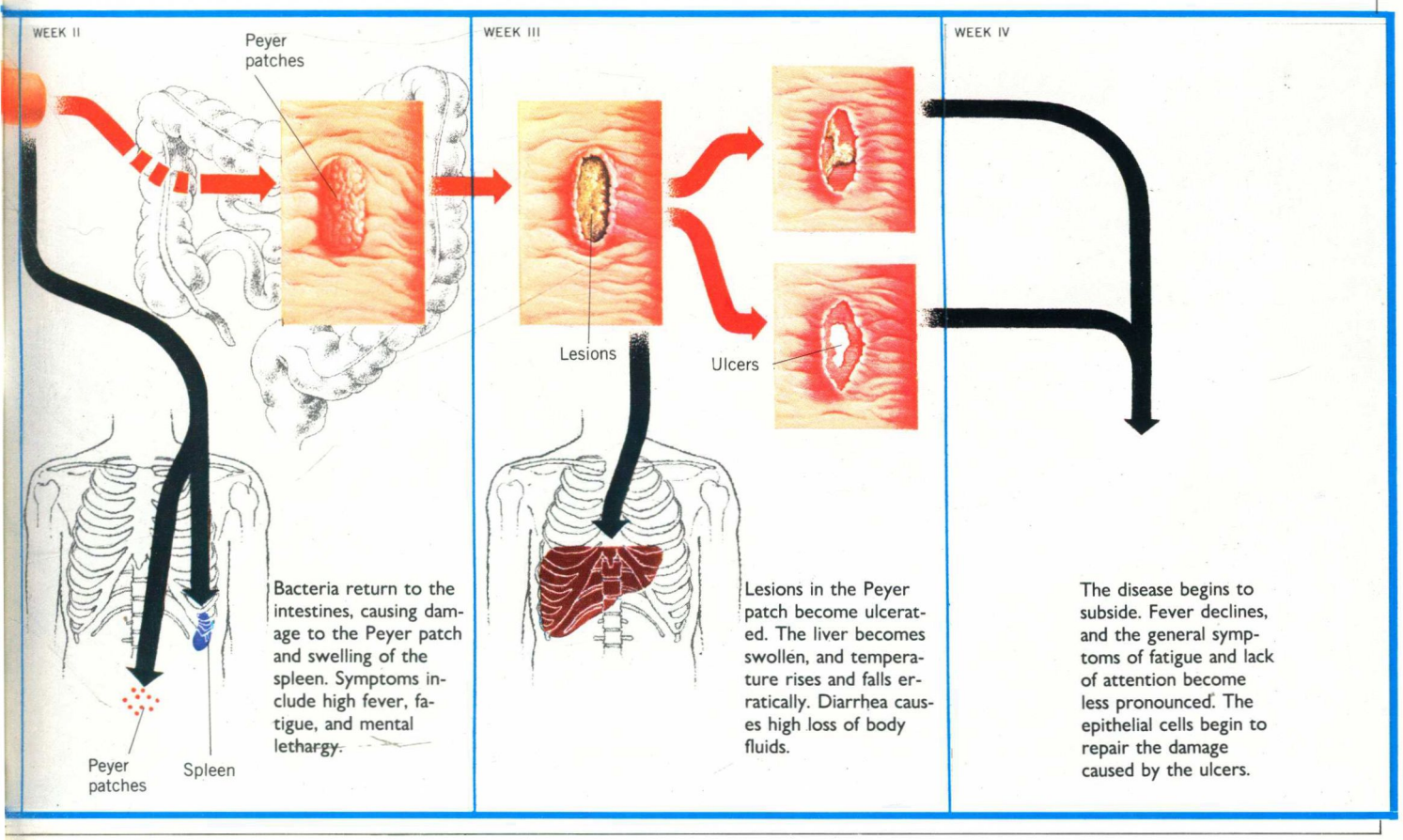
Chloramphenicol and corticosteroids are the preferred drugs in the treatment of typhoid fever. The patient is medicated for about two weeks in order to prevent relapse. Dosage can be oral unless the disease has progressed beyond the initial stages and the patient is unable to swallow the medication.

In caring for typhoid sufferers, special attention must be paid to stopping the spread of *Salmonella typhi*. Bed linen is disinfected and washed separately; urine and feces are treated with carbolic acid before they are disposed of. Patients are isolated until after six consecutive negative fecal and urine tests are run. These tests cannot be started until 48 hours after the drug treatment has ended.



Above: Microscope photo of *Salmonella typhi*, the bacteria that cause typhoid fever.

Typhoid was once one of the deadliest diseases known to man. Thanks to improved sanitation and public health facilities, typhoid has been effectively suppressed in most areas of the world.



Tyrannosaurus

As you enter the Hall of Late Dinosaurs at the American Museum of Natural History in New York City, you are confronted by a monstrous skeleton topped by a huge skull with 6-inch-long (15-cm) serrated teeth. This towering skeleton portrays *Tyrannosaurus rex,* the "king of the tyrant lizards." This great beast, the largest terrestrial carnivore (meat-eater) ever to inhabit the Earth, roamed North America and Mongolia during the Upper Cretaceous period (70 million years ago.)

Roots

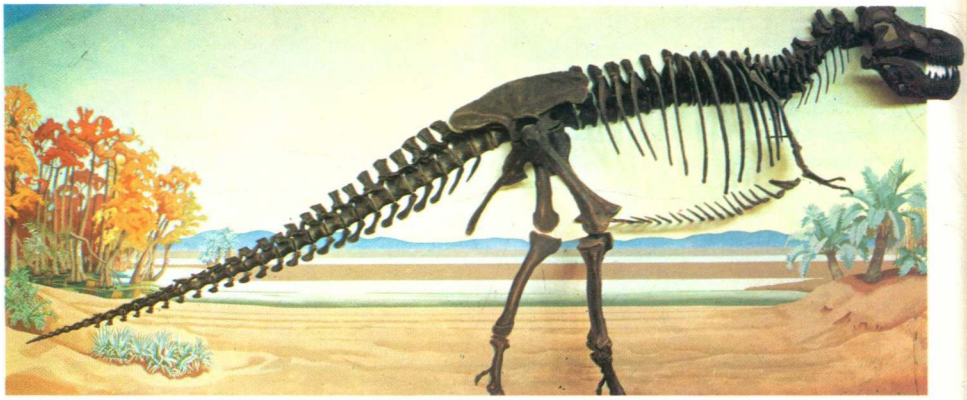
Tyrannosaurus was the largest and one of the last of a long line of meat-eating dinosaurs (the carnosaurs), of the order Saurischia. The carnosaurs first appeared early in the Jurassic period, about 180 million years ago, having probably evolved, during the preceding Triassic period, from the smaller predatory dinosaurs known as coelurosaurs. In the Jurassic period, Tyrannosaurus's ancestors, the megalosaurs, fluorished. Some were very impressive. Allosaurus was 30 feet (9 m) long and had a huge, tooth-filled head and short, powerful, three-clawed forearms; it weighed about 2 tons. But even it was small against Tyrannosaurus, which was 16 feet (5 m) tall, 42 feet (13 m) long, and 8 tons in weight.

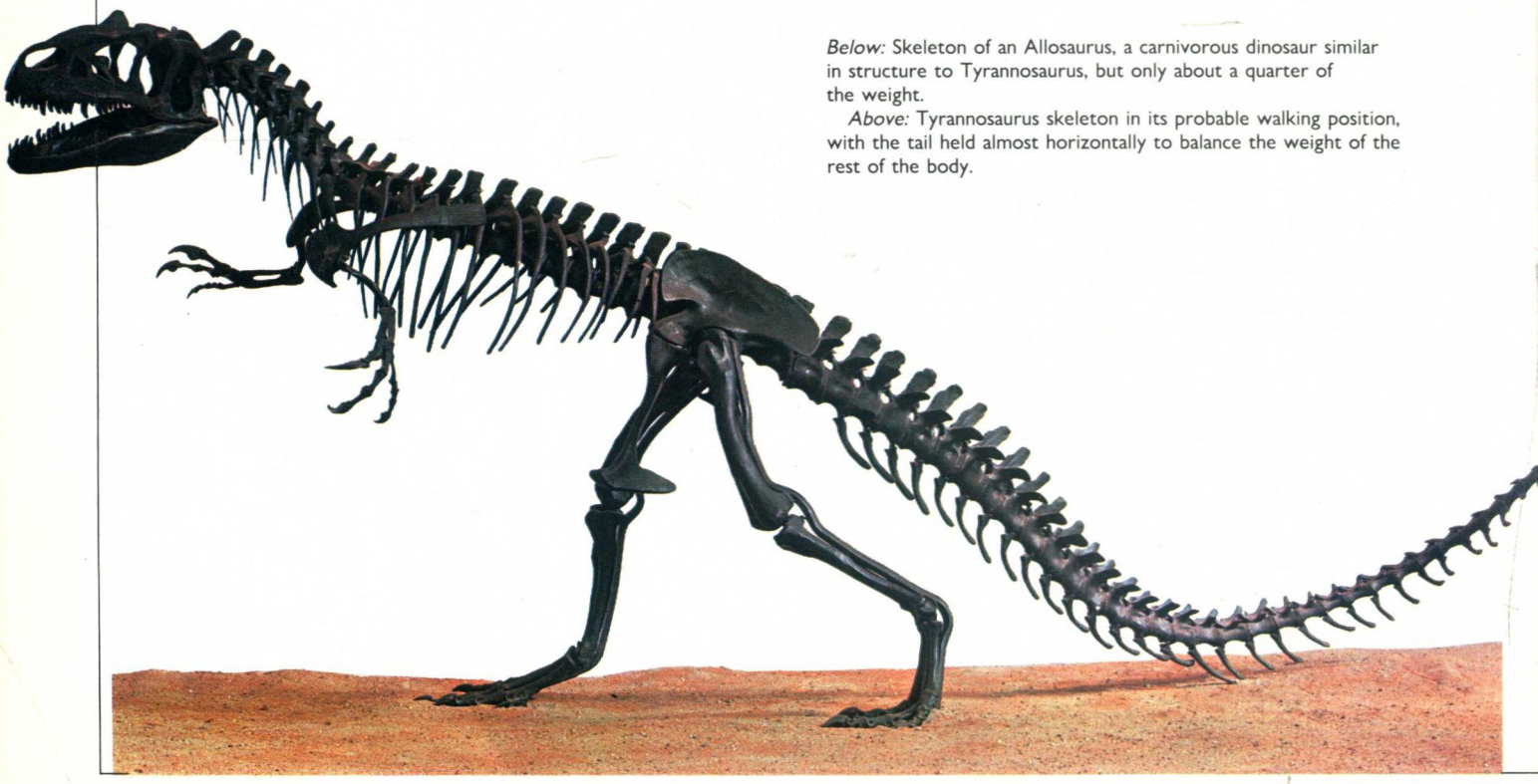
To Catch a Dinosaur

Tyrannosaurus was an efficient predatory machine adapted to stalking the larger herbivores of the Cretaceous, especially the hadrosaurs (duck-billed dinosaurs) and ceratopsians (horned dinosaurs). With its sturdy pelvic girdle fused to the backbone to tolerate vertical strains, the huge creature could stand almost 20 feet (6 m) tall when necessary. This enabled it to attack its prey from above—a handy ability if it was tackling a Triceratops, which defends itself by presenting a predator with a face bristling with long, sharp horns. Its forelegs were so stunted in size that they could not be used for fighting, walking, or even feeding. The only function scientists can determine for these two-clawed tiny limbs is that they aided the beast in rising from a prone position by digging into the ground and keeping the upper body from sliding forward while the great legs raised the hindquarters.

The carnosaurs have frequently been portrayed as walking upright and dragging their tails behind. Today, however, there is much evidence against this. It is considered more likely that Tyrannosaurus and the other carnosaurs held their bodies almost horizontally, with the tail stiffened outward, off the ground, for balance. Also, the structure of the tyrant lizard's hips and the fossilized tracks that have been found indicate that rather than having a graceful stride, the beasts waddled in a ducklike manner and were pigeon-toed as well.

Tyrannosaurus must have been able to move swiftly on occasion. Certainly, one of its main food items, Triceratops, could do so, galloping at estimated speeds of up to 30 miles (48 km) per hour. Tyrannosaurus and the other carnosaurs probably hunted in a fashion similar to that of modern lions hunting a herd of zebra.



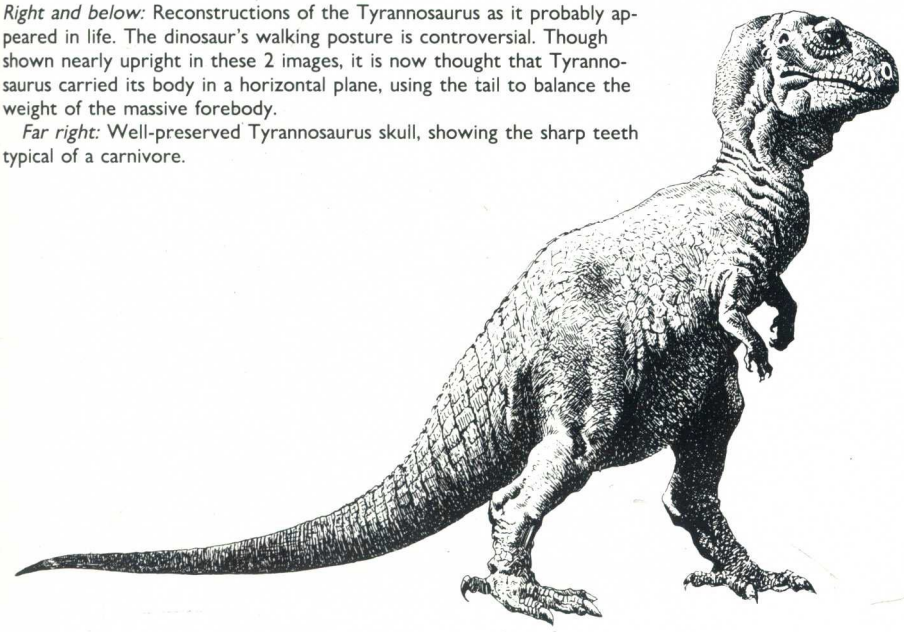


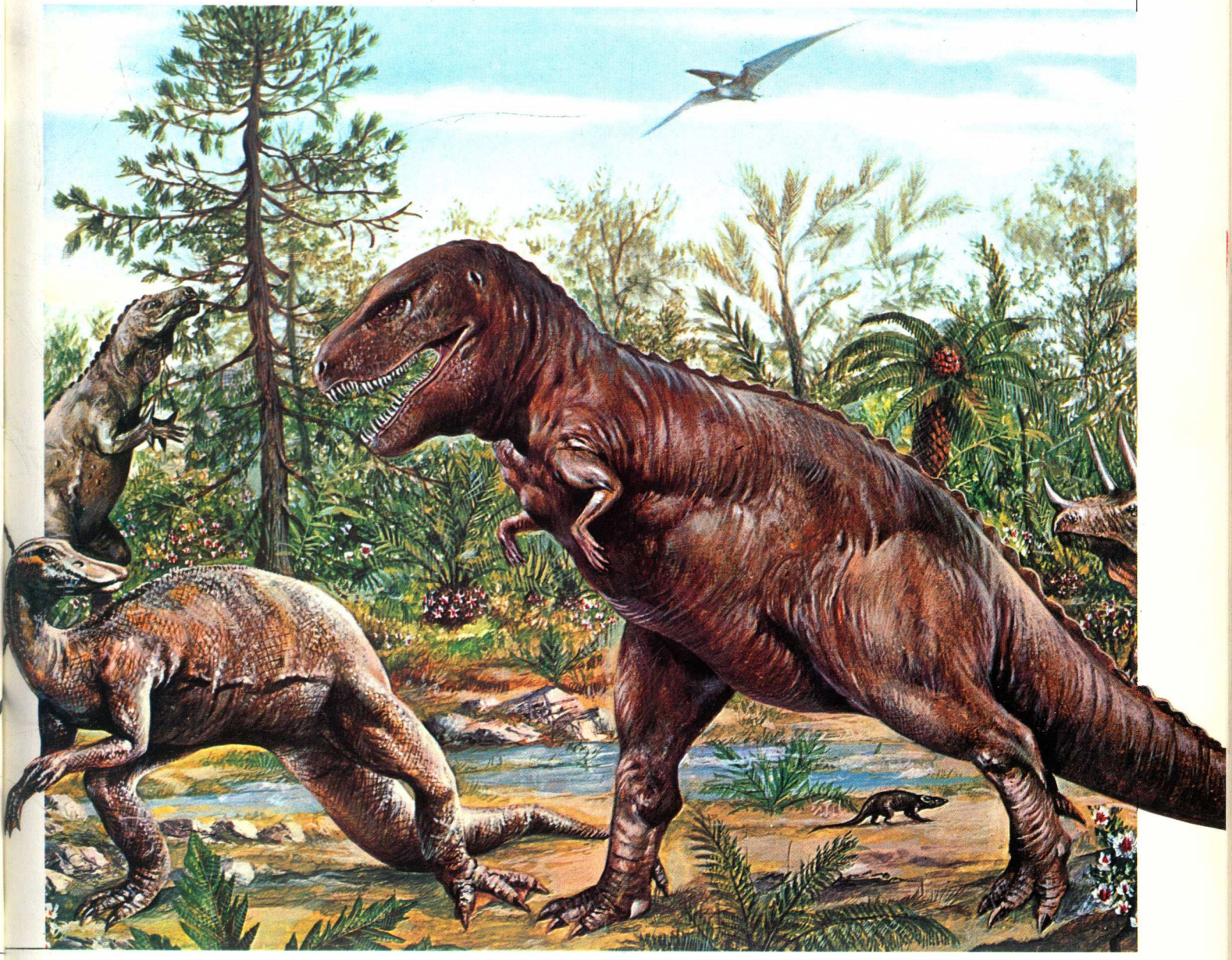
Below: Skeleton of an Allosaurus, a carnivorous dinosaur similar in structure to Tyrannosaurus, but only about a quarter of the weight.

Above: Tyrannosaurus skeleton in its probable walking position, with the tail held almost horizontally to balance the weight of the rest of the body.

Right and below: Reconstructions of the Tyrannosaurus as it probably appeared in life. The dinosaur's walking posture is controversial. Though shown nearly upright in these 2 images, it is now thought that Tyrannosaurus carried its body in a horizontal plane, using the tail to balance the weight of the massive forebody.

Far right: Well-preserved Tyrannosaurus skull, showing the sharp teeth typical of a carnivore.





UFO (Unidentified Flying Object)

At 5:20 P.M. on October 10, 1966, a young mother in Newton, Illinois, responded to the excited calls of her children. Upon joining them in the backyard, she saw a cigar-shaped metal craft hovering about 50 feet (15 m) above. The elliptoid seemed to be about 20 feet (6 m) long and 8 feet (2.5 m) wide, and it was surrounded by a sparkling blue haze. As if on signal, it suddenly rose and disappeared at incredible speed.

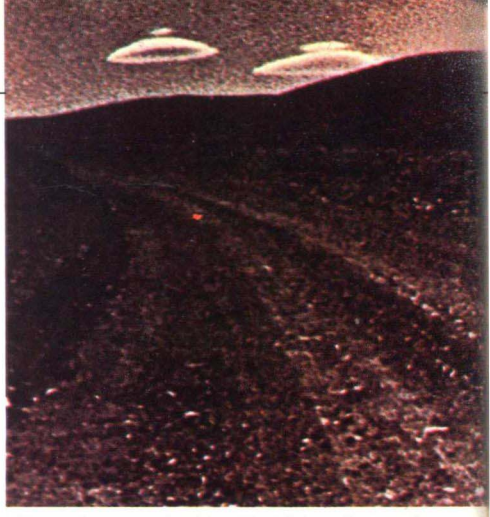
In São Paulo, Brazil, at noon on September 10, 1957, a "flying saucer" was seen by three fishermen who watched it fall into the sea, after which they salvaged some of the pieces. After being chemically analyzed, the material was pronounced to be magnesium of a higher purity than is normally attainable, lending credence to the possibility that the craft was indeed extraterrestrial.

History of UFOs

These are only two of thousands of reports that have been compiled on UFOs, or unidentified flying objects, since the late 1940s. Man's preoccupation with visitations from the sky, however, goes back to medieval and even ancient times. Comets and falling stars were very frightening to people in those early days, and history books are crammed with stories of unusual celestial "happenings." But in 1947, the phenomenon of the UFO rapidly gained popularity as the result of a large number of sightings, mostly in the United States. At first, the objects were known as "flying saucers," but they were dubbed "UFOs" by the U.S. Air Force, which began a study of the subject known as Project Blue Book.

UFOs Explained

While some scientists feel there is definitely some substance to the evidence of the existence of extraterrestrial spacecraft, the consensus is that most, if not all, UFO phenomena can be explained as aircraft, reflections, gases, meteors, balloons, and even mirages. Also, there is an unusual lack of corroborative radar and other surveillance-system data on the subject. But some photographs of UFOs defy all attempts to explain them.



Above: Purported unidentified flying objects photographed above the Argentine Andes. They may be lens-shaped cloud formations, lit from behind by the sinking Sun.

Reported cases may not be a true barometer of the number of actual sightings, since polls indicate that many people are reluctant to relate experiences of this kind. A great number of those who do report UFO sightings, however, hold respected positions; these include police officers, doctors, pilots, and scientists. Sightings