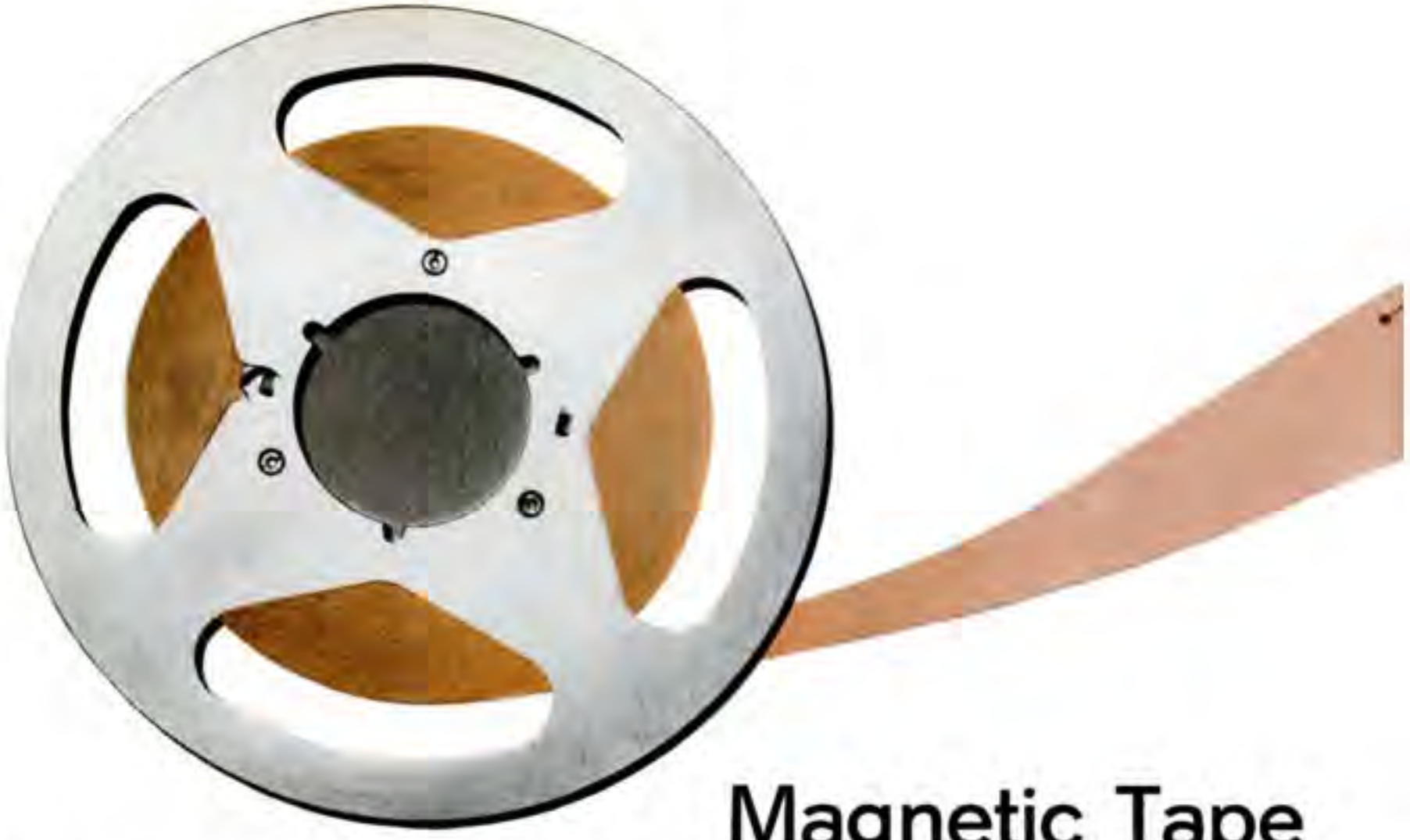

Magnetic Tape Reels off Changes in Way We Live

IT ALREADY HELPS TV AND M.D., MAY ONE DAY HELP YOU KEEP HOUSE

by ROBERT O'BRIEN

THIS year marks the 10th anniversary of the appearance of the tape recorder on the American consumer market. Few technological achievements have spread so far so fast.

In one decade the portable box with its revolving reels and shiny ribbons has developed from an experimental military accessory to a peacetime tool of astonishing versatility. Already it has altered important aspects of entertainment and industry, education, commerce, medicine and a dozen fields of technological research. Here are some of the things it promises in the foreseeable future:

- Household operations may be managed by a robot housekeeper activated and directed by tape.
- Individual medical histories from birth can be precisely recorded to help future diagnoses by any doctor.
- The news may be delivered to your door each day on a tape which you will be able to run through your television set.
- There will be rental files of TV tapes at libraries and perhaps even at drugstores.
- Your television receiver can be set to record a program during your absence and play it back for you on your return.

Already tape recording is a major industry in the U.S. Last year 430,000 recorders were manufactured here. Estimates are that production this year will reach 475,000 and climb to 500,000 in 1958.

Minnesota Mining and Manufacturing Co. (3 M), maker of Scotch tape and world's largest producer of magnetic tape, predicts that its 1957 output combined with that of its major competitors—Audio Devices, Reeves Soundcraft and Orradio—will total $11.7 million worth, or about nine billion feet of tape.

Nine years ago audio tape recording revolutionized the technique of radio broadcasting. Today video tape recording (VTR) is triumphantly passing its first network performance tests: its fast, cheap, high-quality playback is meeting television's urgent need for a method of reproduction that will satisfactorily bring nationwide programming order out of the chaos of daylight-saving schedule times. The industry now is in full cry after compatible VTR that will record and play back both black-and-white and color television programs.

While all this has been going on, tape has been cutting an impressive swath in other directions. Its ability to reproduce music with the utmost fidelity, for example, promises radical changes in the record industry.

Last year 3,000 people crowded into San Francisco's War Memorial Opera House for a demonstration sponsored jointly by the Ampex Corporation and the San Francisco Symphony Orchestra. At one point in the overture to Mozart's *Marriage of Figaro*, the musicians suddenly lowered their instruments—while the music went on. For the first time, members of the audience became aware that the orchestra had been pantomiming all along and the music had come from a recording. Concealed speakers had been playing back sounds from a triple-track, stereophonic tape made by Ampex during rehearsal.

Because of this purity of reproduction and ease of editing, record manufacturers use magnetic tape for the master recordings from which they make their disks. Motion picture companies use it for all sound tracks. Music lovers, delighted by its concert hall realism, are demanding recorded tapes in such numbers that the LP is sure to face a stiff fight for control of the high-fidelity market when hi-fi tapes come down in price. Right now a symphony like Tchaikovsky's Sixth on tape costs $18.95 as against $3.98 on the average LP record.

Figures substantiate this trend to tapes in hi-fi listening. Three years ago RCA Victor, the biggest producer, brought out 20,000 recorded tapes covering 10 titles; this year it plans to issue 200,000 tapes and 180 titles. In the last five years the companies marketing recorded tapes have increased from one to 55. The current summer catalogue carries more than 1,000 titles, and offers everything from rock 'n' roll to Rachmaninoff.

Recorded books and textbooks are bringing bright new hopes to the blind, and educational tapes take world-renowned thinkers and scholars into the nation's understaffed classrooms.

On file at the National Tapes for Teaching repository at Kent State University, Kent, Ohio, for example, are more than 6,000 master tapes of lectures by international authorities on an encyclopedic range of subjects. For a small service fee any school in the world may obtain a duplicate copy of any tape in the library. The repository sent out 12,000 tapes in the last school year and expects to triple that amount next year.

Home recordists are building family sound

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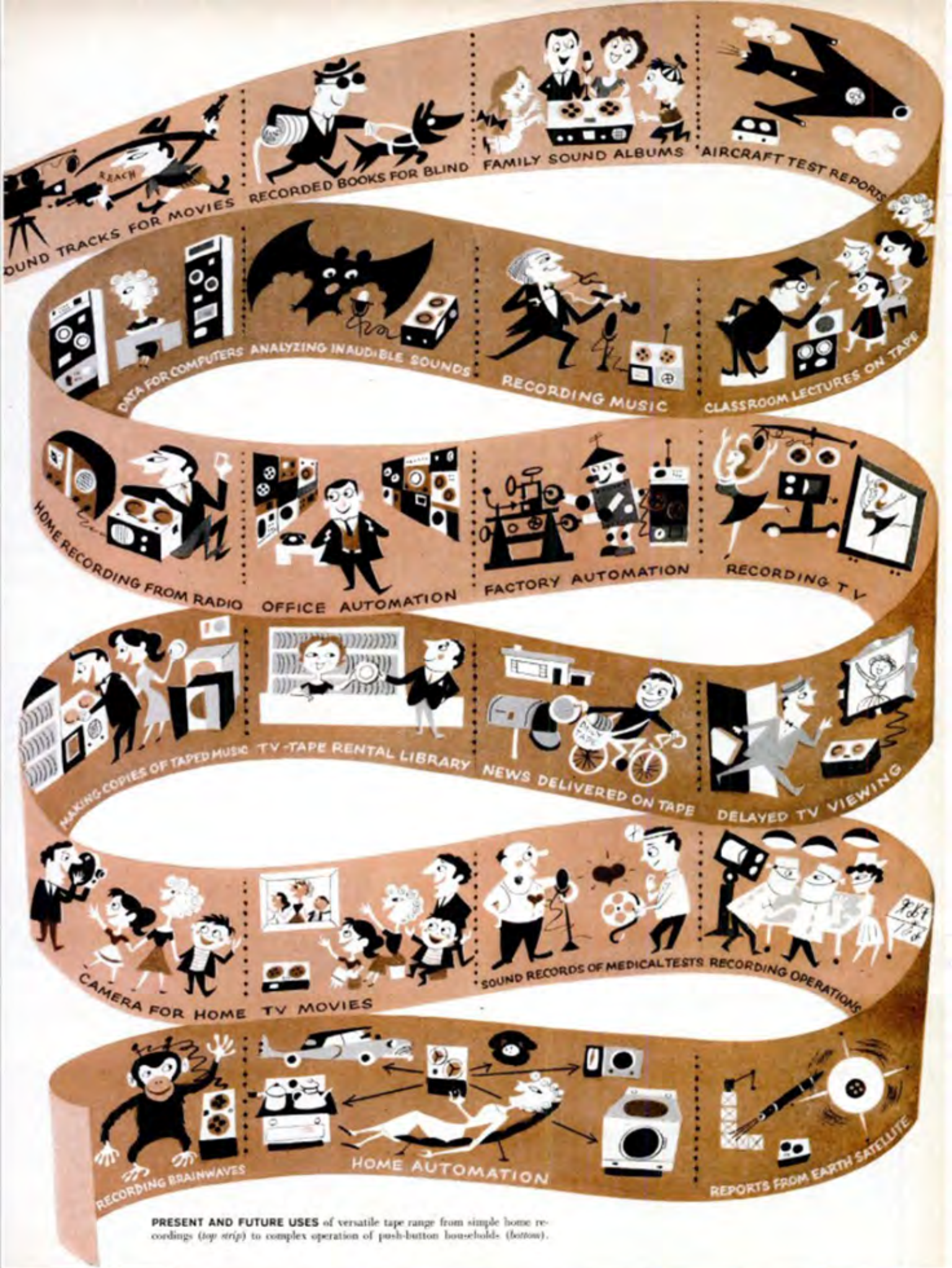

PRESENT AND FUTURE USES of versatile tape range from simple home recordings (*top strip*) to complex operation of push-button households (*bottom*).

STOREHOUSE OF FACTS, one 2,400-foot-long reel of magnetic tape holds as much information as the 60,000 business machine cards stacked in background or as many numbers as there are in the Manhattan telephone directory.

CONCEALED RECORDERS, used to tape conversations secretly, take many forms. They can be hidden in a briefcase (*top*) or a book (*center*). Microphones like the two small instruments at left of book can be secreted in clothing or furniture, or worn as a wrist watch or pin (*right of book*). Lined up directly below book are (*from left*) microphone attachment for base of telephone, tie-clip microphone and throat microphone worn under scarf. At bottom of picture is pocket-size wireless microphone and battery which transmits to a recorder. At far left is a telephone receiver with a microphone attachment.

albums. Now at last, they know what they sound like practicing their piano lessons. And they belong to the Voicerespondence Club, World Tape Pals, Tape-Respondents International, the National Tapespinners, and crisscross the continent with tape-by-mail letters to friends they have never seen.

Hard-pressed doctors driving their rounds can snap on tape playbacks in their cars and hear a weekly recorded digest of medical journal articles on the latest developments in medicine.

The tape recorder is also the tool of the eavesdropper, the sly listener-in, a new breed of electronic confidence men who are after not cash but characters. An innocent-looking briefcase may conceal a battery-driven recorder. A wrist watch or natty tie clip may be a microphone cunningly disguised. The person at the other end of your telephone conversation may have a little rubber suction cup stuck to his telephone base and a wire leading from it to his tape recorder. Furthermore, the meaning of what you said can be distorted, since an important characteristic of tape is the simplicity with which it can be edited. Words can be erased, phrases transposed, sentences pulled apart and put back together again in a different way.

"Never again," a Senate committee investigator told me, "will I ever talk over the telephone about anything more incriminating than dogs, kids or the weather."

A million bits of information

MOST striking and portentous of all, perhaps, are the accomplishments of magnetic recording in telemetry (the transmission of measurements), in computer and data processing machine operation and in plant control engineering.

Technologists may require a million bits of information on the performance of a jet bomber during a one-hour test flight, a steady stream of telltale temperatures, vibrations, speeds, stresses, pressures which will show what was happening to the aircraft at any given moment during the flight. High-speed, multichannel magnetic tape takes down each split-second reading and stores it for instant playback when the engineers are ready to re-create and study the flight in detail.

Perhaps the plane cracked up. What went wrong? Perhaps it was the test of a suicide rocket which blew itself and its instruments to pieces in mid-air. Was it a failure or a success? In the past, weeks, months and sometimes lives were lost before human processing gave the answers. The tape will tell in seconds.

Such miracles are commonplace today and hasten man's assault on the frontiers of the universe. Vanguard, the satellite, will radio information from more than 200 miles in space as it wheels in its lunar orbit. Its signals will be recorded on an electronic log of magnetic tape.

With its instantaneous assimilation of every kind of coded impulse and its capacity to deliver them just as fast, tape has become a means of communication between man and his "giant brains"—his Bizmacs, Univacs, Ramacs and IBM 650s and 705s and 709s. Tape flashes information into a 705, for instance, at the rate of 15,000 letters or numbers a second. If the unabridged text of *Gone with the Wind* were recorded on tape, it could be transferred through the machine to another reel of magnetic tape in three and one half minutes. IBM's new 709 system is even faster: it can achieve 42,000 additions or subtractions of multidigit figures in one second. More important, the 709 is the first machine that can perform scientific and engineering calculations; it can apply them to business problems and come up with answers that are based on a mastery of detail that is impossible to the human brain.

Tape is to the old business-machine marvel, the punched card, as microfilm is to the printed page. One reel of half-inch tape about the size of a dinner plate can carry as much information as 60,000 standard punched cards, a stack about 35 feet high. G.E. now runs off on magnetic tape its quarterly social security report on 30,000 employes and turns in to the government a 10½-inch, two-pound reel in place of the 900 typewritten pages the report used to fill.

Costly as they are—a typical IBM 709 system would lease for about $56,000 a month, and sell for around $3 million—electronic computers are such time- and money-savers in the long run that this year they will represent a $250 million business, with no ceiling in sight. More and more they are operating from tape, clicking away day and night in big banks, publishing houses, government bureaus and military agencies, the home offices of insurance companies and large industrial concerns and dozens of other important commercial establishments all over the country.

They make up payrolls involving tens of thousands of employes in a bizarre fraction of the time it took hundreds of human hands and minds to do the job. They record and memorize huge inventories. They forecast sales. They determine optimum distribution patterns for manufacturers' products. They calculate what might happen to a motor car axle or a submarine hull under a thousand different stress conditions. They keep the books on millions of credit customers or subscribers. And in a day and age when speed pays off, they are the quintessence of speed.

"Computers using magnetic tape," said a Midwest executive, "can handle 100 times as much information 100 times as fast as the old methods. That's bucks in the bank." That is also, he said, the beginning of the end of the human being as clerical worker in the U.S. The automatic office—with no workers on hand except

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TAPE-OPERATED MACHINE duplicates hand motions of a highly skilled worker to stamp intricate airplane wing parts in Fond du Lac, Wis. factory.

attendants for the machines—is a possibility, although not for the near future.

In quite a different manner tape has taken industry a step closer to its future.

You can electronically record motion on tape. You can duplicate, for instance, the hand movements of a master mechanic skillfully guiding a lathe. Then you can play back the tape to a control unit, and without a human being within a thousand miles it will show the lathe the master's way, will mill an aluminum slab in the fabrication of an aircraft wing, say, to the same thousandth of an inch. This is what made the automated factory possible.

Tape recording—the latest in a line of devices that began with the tracings of a forefinger in the dust—came in a time of urgent need. Technicians, scientific researchers, weapons manufacturers, industrialists, doctors, teachers—all were in danger of being swamped in a postwar tide of accumulating data and information. How could they store it? How could they remember it? They had to have something cold and quick and suprahuman. It turned out to be the magnetic recorder.

The alphabet of the magnetic recorder is electrical impulses. It records, plays back and communicates anything translatable into electrical impulses; instruments known generally as transducers perform this function for it. (The home thermostat is a familiar transducer. It converts temperature into an electrical impulse, sends the impulse to the furnace and the impulse starts the furnace or shuts it off.)

A microphone is a transducer which translates sound waves into electrical impulses. When a microphone is attached to a recorder, it produces impulses which travel along a wire to the machine's magnetic recording head and there combine with the head to set up a magnetic pattern.

Ribbon with a coat of iron

THE tape itself, drawn past the recording head at constant speed, is a frail ribbon that a child can snap and that looks like a brown gift-wrap ribbon. In width it varies from one quarter of an inch to two inches, depending on the complexity of recording for which it is intended. From front to back it varies in thickness from one to five mils (a mil is 1/1000 of an inch) and is in two layers. One is a glistening plastic backing to provide support; the other is coated with myriads of iron oxide particles held in a resinous material.

These particles are themselves magnetized and as they pass through the magnetic pattern around the recording head they arrange themselves instantly in a precise reflection of that pattern.

When the tape is passed across the playback head, the process occurs in reverse. The head converts the pattern back into electrical impulses and sends them through an amplifier to a speaker. The speaker then transforms them into the original sound waves.

Audio tape records and reproduces sound with no trace of extraneous noise, such as the scratching needle or surface imperfections of a phonograph record. It can be cut, edited and spliced back whole again. William H. Miltenburg, RCA Victor's manager of recordings and chief engineer, and Jascha Heifetz once checked the playback of a master tape the violinist had just recorded. A brilliant descending run of 32nd notes cascaded from the speakers. Heifetz cocked his ear and frowned. "I heard a clinker," he said. He returned to the microphone, Miltenburg adjusted the recorder, technicians bent forward, rapt, and Heifetz raised his bow and hit one perfect 32nd note. "I cut the bad one out of the run, put the good one in, and everybody was happy," Miltenburg said.

Tape can be stored easily and compactly. It does not deteriorate; test tapes have been played back 10,000 times without appreciable quality loss. It can be wiped clean simply by passing it in front of an erasing head, which obliterates the magnetic pattern of the iron oxide particles. Beyond all these virtues, it possesses that cold, priceless integrity of the machine: whatever it knows, it will tell with total fidelity.

The modern history of magnetic recording goes back to 1935 when a machine called Magnetophon, using coated paper tape, created a sensation in Berlin radio circles. In the war years that followed, Nazi engineering skill improved it greatly. Americans who stumbled on the Magnetophon shortly after D-day in 1944 quickly learned that it was far superior to the wire recorders used by the Allied field armies.

As the war drew to a close, John T. Mullin, a canny and imaginative U.S. Signal Corps technician, picked up two Magnetophons in Frankfort as war souvenirs. In the fall of 1945 he returned to his home in San Francisco and put his machines to work recording movie sound tracks. He never missed a chance to show them off at radio and sound conventions. One of his demonstrations was witnessed by Alexander M. Poniatoff, Myron J. Stolaroff and other officials of the Ampex Corporation, which had manufactured electric motors during the war and was now casting about for another product, something new and with a future.

The next day they called on Mullin. The conference lasted less than an hour. When it was over, Ampex was in the magnetic recorder business, with Mullin as consultant.

A few months later a man from Bing Crosby Enterprises dropped in to Mullin's San Francisco studio. As he watched the swiftness and ease with which Mullin edited and spliced the Magnetophon tapes, he lighted up like a forty-niner confronting the nugget of his dreams. "Wait'll Bing hears about this," he said, and took the next plane back to Hollywood.

For months Crosby had been trying to find a satisfactory way of recording his radio show in advance of broadcast time rather than endure the weekly Armageddon of a live show. But putting it on disks involved editing several short recordings and dubbing from disk to disk in a lengthy process that was as harrowing as the real thing. The over-the-air results, furthermore, were not worth it: the show obviously came from a can. Mullin's Magnetophons cut the show's recording time from four days to four hours, and once and for all proved that a show does not have to be live to be good.

The next April Ampex delivered its first playback units to Crosby, and sold 24 more of them, at $4,500 each, to the American Broadcasting Company for its radio network. Technicians from 3 M announced that they had mastered the large-scale production of high-quality tape—and magnetic recording was on its way.

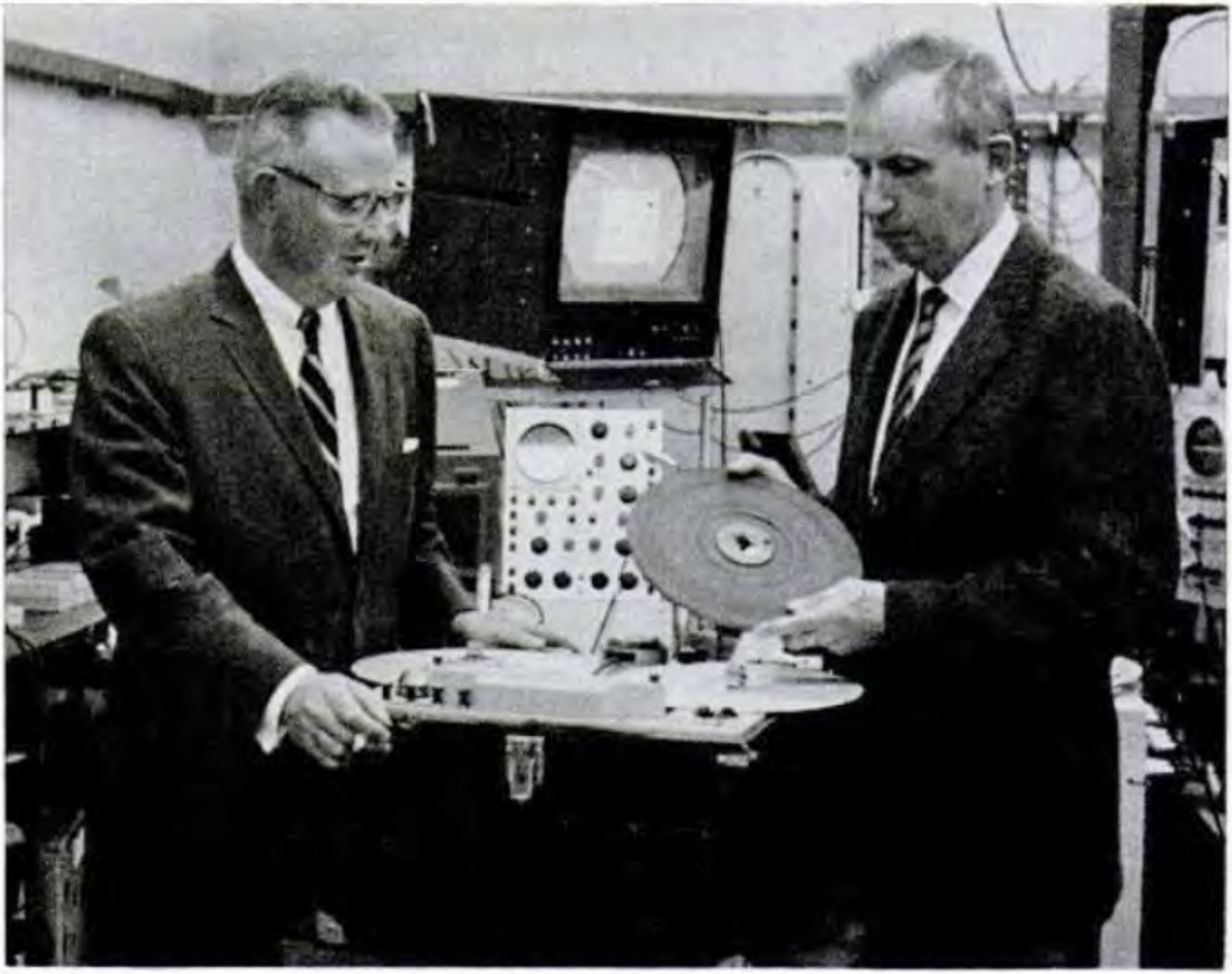
With Crosby's sponsorship and financial backing, Mullin, his assistant Wayne R. Johnson, and Frank C. Healey, general manager of 3 M's Mincom division, buckled down to the creation of a machine that would tape-record a television program.

Closing TV's refrigerators by tape

TELEVISION was wide open for tape recording: first, to replace the costly, complicated and disappointing kinescope process of reproducing programs; second, to solve simply and cheaply the time-zone delay problem; and third, to bring about additional minor, but fervently wished for, technical miracles. These included instantaneous playback and the taping of commercials to avoid such on-the-air crises as the failure of the refrigerator door to open.

In November 1951, and again in December 1952, Healey, Mullin and Johnson demonstrated the magnetic recording of a televised picture. A year later RCA engineers presented the first public exhibition of the magnetic tape recording of black-and-white *and* color television signals. RCA in conjunction with NBC scored another experimental triumph in May 1955 when a closed circuit hookup carried a color program previously recorded on an RCA machine. In April 1956 Ampex came up with its VR-1000, a production line tape recorder scarcely larger than an office desk which could reproduce a 64-minute, black-and-white television program on one 12½-inch reel of tape.

Phillip L. Gundy, manager of Ampex's audio division, announced that 13 machines were ready for delivery at $75,000 each. CBS



PROTOTYPE TAPE RECORDER, Germany's wartime Magnetophon, is displayed by John T. Mullin (*right*), who brought the first models to U.S., and Frank C. Healey, another pioneer in development of American tape industry.

snapped up five. NBC took three. ABC bought three. Government agencies cornered the other two. The rush for production models at $45,000 each (delivery of the first 100 will start this fall) buried Gundy in a $5.5 million avalanche of orders.

By necessity, most of what happens in television happens in public and so VTR tended to outshout other advances that were taking place. But these were even more important.

In 1949 an instrumentation researcher at the Point Mugu Naval Air Missile Test Center borrowed one of Crosby's recorders and with it recorded missile flight test data—acceleration, fin flutter, rate of fuel consumption, flight curves, temperatures and a dozen other vital elements.

Until then aircraft test pilots took down flight data on pads strapped to their knees. Movie cameras trained over their shoulders photographed a nightmarish array of 70 or 75 jittery needles and gauges. The notes were often agonizingly inadequate. The film had to be developed, the pictures carefully scanned. The scrawls of pen-recorders had to be processed and analyzed. It was the technology of Kitty Hawk and the biplane era.

Transducers, attached to a hundred critical points and converting all data into electrical impulses, plus multichannel recorders, airborne or on the ground, rendered this system archaic almost overnight. Now a magnetic recorder can remember and re-create every nuance of airflow across the wing of a fighter plane streaking across the sky. It can tell 10,000 vital details of the screaming stratospheric arc of projectile flight, even though the missile has long since plummeted to its end somewhere in the south Atlantic.

Equally significant, a recent national convention of the Institute of Radio Engineers noted the arrival of the day when man's command of telemetry assures him the remote control of any high-velocity projectiles he may launch into outer space—the essential preliminary to the visionary and daring assault he is slowly mounting against the ramparts of the universe.

Steering the big ICBM

A BROAD step toward this command has been taken with the installation of compact, specialized tape recorders in ICBM test missiles. The tape presumably can be used for two purposes—to steer the missile by means of prerecorded instructions to the missile's guidance system, or to record information picked up in the course of the flight. The information could be played back as the missile re-enters the earth's atmosphere.

The sheerest veil of the imagination divides this combination from one which could conceivably obliterate international boundaries and submit the world to a surveillance from which there would be no hiding place. This would be the installation of a high-powered magnetic camera in a man-made satellite similar to those now being prepared for launching. The all-encompassing eye of this camera, peering down from the satellite orbit, could scan every nook and cranny of a foreign land, perhaps even a continent, and record what it saw on magnetic tape. When the satellite passed over its observation stations, its radio could transmit the pictures to ground receivers for enlargement, examination and study.

SATELLITE TAPE RECORDER will transmit information to ground stations from orbit in space. Instrument package containing recorder is inserted in a model of satellite by Researcher George Ludwig of the State University of Iowa.

Telemetry is only one way in which science is employing tape. There are countless other uses.

What sound does a human muscle make? Gundy, now president of Ampex's new audio division, says doctors have tape-recorded electrical impulses from the muscles of the arm and played them back as sounds. "Mine," he says, "made a groaning noise."

What are the harmonics of a heart beat? The inhuman awareness of tape captures them forever.

What is the highest-frequency cry of a bat like? Man never heard it until scientists recorded on tape its fantastic pitch of 100,000 cycles a second, too high and thin for the human ear. Then they played the recording back at ever diminishing speed until the sound entered the bounds of human hearing and came through in a series of eerie whistles.

This is another kind of magnetic magic. It lets you play tricks on time. You can take down a four-second rocket sled ride on a magnetic tape, and in the playback stretch it out for an hour. You can record the rise and fall of temperature over the course of a day, speed up the playback and read it off in a minute.

Technologists say that magnetic recording "suggests a potential for which there is no end in sight." These are some of the things they see ahead:

Within the next five years, they say, you will be able to buy low-priced home magnetic recorders and playback units with tapes in cartridge form, so that no threading or rewinding of tape is involved in their operation.

You will probably be able to go to your music store with a blank tape and there, for perhaps as little as a quarter, run off from the store's master tape the top tunes of the week or any other 30 minutes of music you'd like to take home with you. When you're tired of what you have, you'll be able to take the tape back and for another quarter have something new recorded on the same tape.

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Playbacks by "Hear-and-See"

ONE firm, RCA, has demonstrated a magnetic "Hear-and-See" tape player that will take a reel of tape containing a recorded television program and play it back to your television screen. The "Hear-and-See" player, which probably will take 10 years to perfect, presupposes TV tapes available for rental at your branch public library, or possibly at drugstores. Another possibility is that you will be able to subscribe to a TV tape-a-day containing an hour of news or other selected topical highlights. Every morning a delivery boy would pick up yesterday's tape off your front porch and leave a new one in its place.

The second stage of "Hear-and-See" will enable you to tape a program off your own television set and thus build a library of favorite programs, to play whenever you wish. Engineers even foresee the day when the recorder will take down a show while you're away, turn itself off, and be waiting to play it back for you when you return home.

Finally, an electronic camera will take motion pictures of your family and friends on a magnetic tape which you will then be able to play back immediately through your television set.

Needless to say, any or all of these developments will have a vast and seismic effect on the entertainment industry, including motion pictures. No one is rash enough to predict exactly what may happen, beyond the forecast that someone is quite likely to get trampled underfoot in the rush for new markets in recorded tapes.

At some date you may even be able to install some form of automatic programing in your home. If this comes to pass, you will set up the entire family schedule for the next day on magnetic tape, push a few buttons, check instruments, and go to bed.

Putting out the cat

ACTIVATED by a timer in the morning, the robot housekeeper will shut the windows, rouse you with a soft stereophonic air, start the coffeemaker and the toaster, open the garage doors, start the car, handle such chores as turning up the heat during the day, prepare dinner, set off the electric dishwasher, switch on the television set to your favorite program, and quietly play *Goodnight, Sweetheart* while putting the cat out at bedtime.

It is very probable that your family doctor will keep on file a reel of tape with your name on it, on which he will store an album of the physiological sounds you make, as long as you live. He will record your prenatal sounds. He will take down your respiratory sounds, and your heart sounds. If he hears something to check, he will mail your tape to a metropolitan clinic for analysis.

Tape libraries such as these will be invaluable assets in medical schools, where they will enable students to familiarize themselves, for example, with a wide range of "live" heart sounds. Another use of tape could be the recording, by VTR, of operations as actually performed by leading surgeons. These tapes would remain as permanent demonstrations to medical students everywhere.

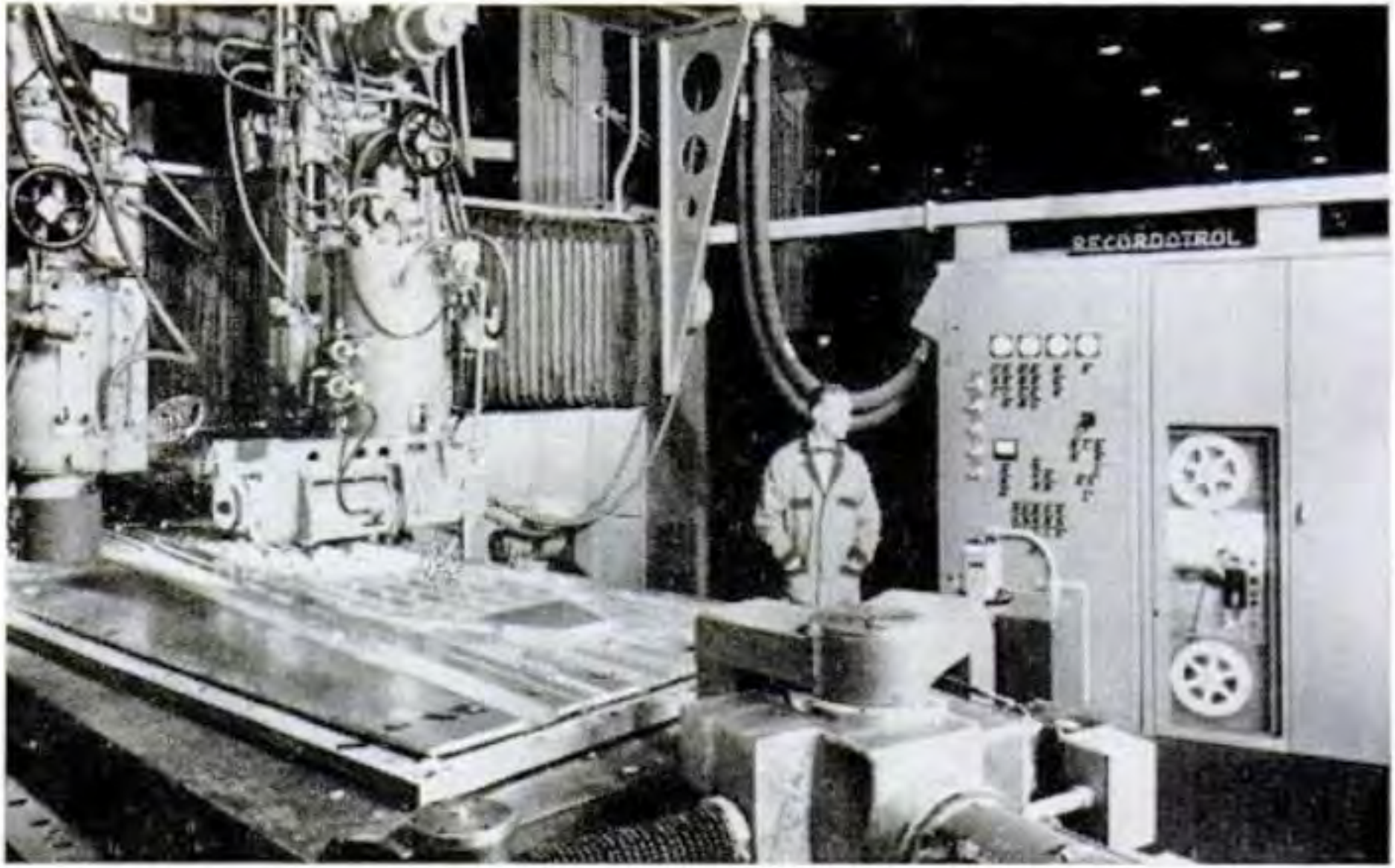
Research also is making possible the general recording of brain wave patterns and it is in this experimentation that tape has performed its strangest, most thought-provoking trick.

In a West Coast laboratory electrodes were imbedded on the brain of an ape. The ape was then prodded into waving his arms, and the nerve impulses from the brain to the arm muscles were recorded on tape. Later, when researchers replaced the electrodes and played the tape back into his brain, the ape waved his arms, just as he had before.

"What do you make of this?" they were asked.

They did not want to say. But one researcher shook his head uncertainly and said, "Science fiction stuff."

TEACHING BY TAPE, St. Scholastica Academy in Covington, La. has classrooms equipped with recorders which leave teacher free to give personal instruction to part of class while other students listen to recorded lectures.



TAPE-OPERATED MACHINE duplicates hand motions of a highly skilled worker to stamp intricate airplane wing parts in Fond du Lac, Wis. factory.