

TEN MEN AND THE TELEPHONE



FOREWORD

In 1878, when his great invention was only two years old, Alexander Graham Bell dreamed of a vast telephone network that would unite every American city, town and village. He lived to see it happen...and to see the beginning of a world-wide system that today makes each and every telephone a link to almost any place on the face of the earth.

It took a great many men to make Bell's dream come true, however; men with ideas, imagination, talent and courage. Bell himself, in his later years, said: "The telephone system as we now know it is the product of many, many minds, to whom honor should be given for the wonderful and beneficial work it has accomplished."

This booklet contains glimpses into the lives of ten of these men...ten out of the countless thousands who have helped to create today's far-flung telephone services.

ALEXANDER GRAHAM BELL

inventor of the telephone



"MR. WATSON, COME HERE, I WANT YOU!" THIS SIMPLE SENTENCE, THE FIRST EVER SPOKEN OVER A TELEPHONE, HERALDED A NEW AGE IN COMMUNICATIONS. THE DATE WAS MARCH 10, 1876; THE PLACE, BOSTON, MASSACHUSETTS. IT WAS AN HISTORIC MOMENT. WHEN HIS ASSISTANT,

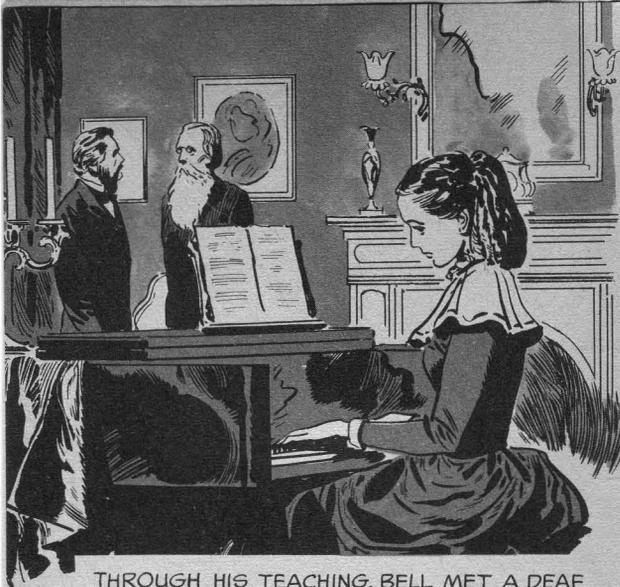
THOMAS A. WATSON, RUSHED FROM THE OTHER END OF THE EXPERIMENTAL LINE TO EXCLAIM, "I HEARD EVERY WORD YOU SAID, DISTINCTLY!" 29-YEAR-OLD ALEXANDER GRAHAM BELL KNEW THAT HIS DREAM OF TRANSMITTING THE HUMAN VOICE OVER WIRES HAD COME TRUE.



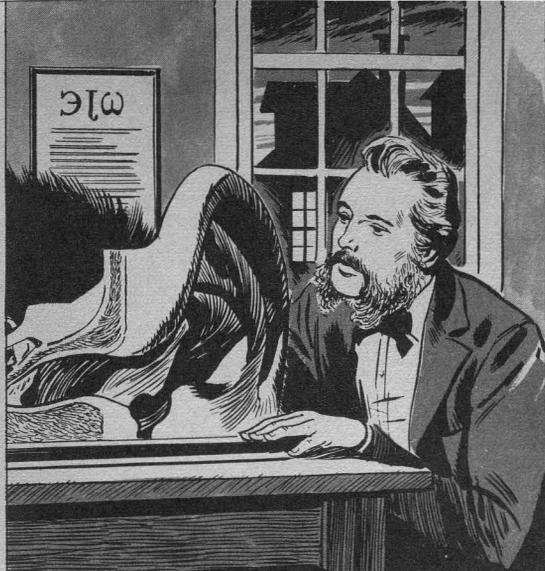
AS A BOY IN SCOTLAND, BELL BECAME INTERESTED IN THE MECHANICS OF SPEECH AND LEARNED TO MANIPULATE HIS DOG'S VOCAL CHORDS TO PRODUCE A FAIR IMITATION OF THE HUMAN VOICE.



BELL GREW UP TO BE A TEACHER OF ELOCUTION, MUSIC, AND "VISIBLE SPEECH" FOR DEAF CHILDREN. LATER HE BECAME A TEACHER OF THE DEAF IN BOSTON, AND A PROFESSOR AT BOSTON UNIVERSITY.



THROUGH HIS TEACHING, BELL MET A DEAF YOUNG LADY WHO BECAME HIS WIFE AND LIFE-LONG COMPANION. HER FATHER, GARDINER G. HUBBARD, WAS ONE OF THE SMALL GROUP OF MEN WHO BACKED BELL'S EARLY TELEGRAPHIC EXPERIMENTS.



AS A TEACHER, BELL USED A WORKING MODEL OF THE HUMAN EAR. MARVELING AT THE ABILITY OF THE TINY EAR DRUM TO TRANSMIT SOUNDS, HE DECIDED TO ATTACH A SIMILAR DIAPHRAGM TO HIS HARMONIC TELEGRAPH.



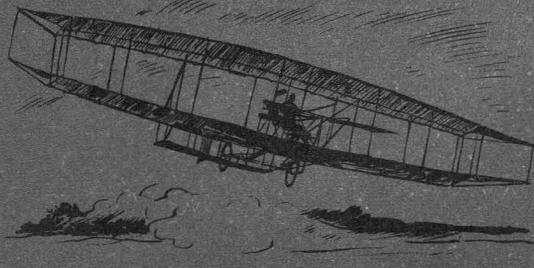
IN 1875, BELL TOOK HIS THEORY TO JOSEPH HENRY. THE VENERABLE PHYSICIST WAS DEEPLY IMPRESSED. WHEN BELL DOUBTED HE HAD THE ELECTRICAL KNOWLEDGE TO CONTINUE, HENRY SAID SIMPLY, "GET IT!"



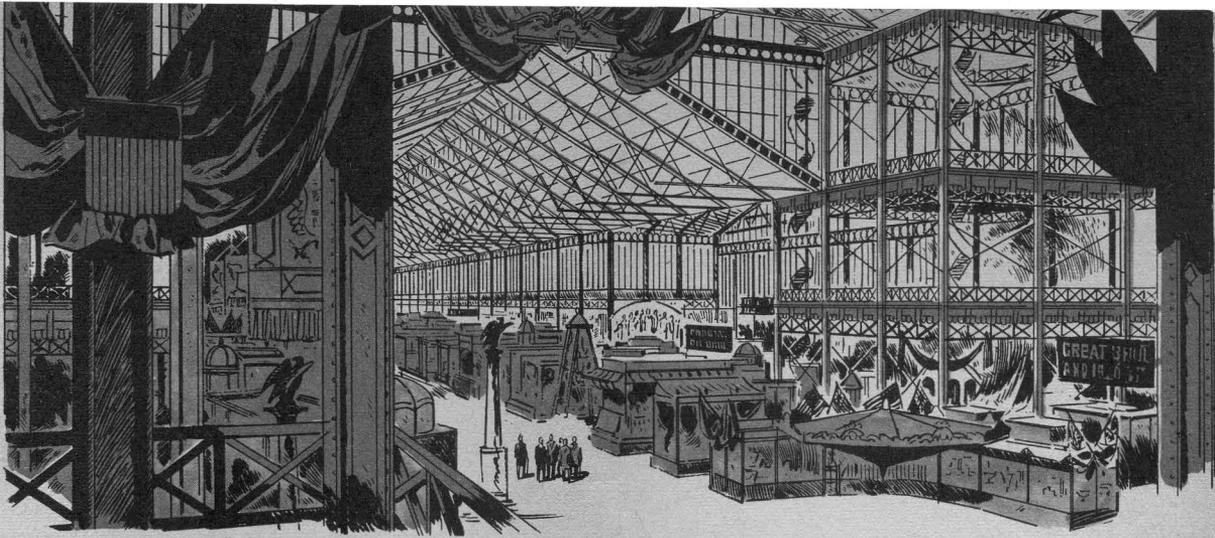
BELL BEGAN AGAIN, SEEKING THE NECESSARY KNOWLEDGE. HIS CONSTANTLY INQUIRING MIND, PLUS HIS ABILITY TO OVERCOME DISCOURAGEMENT, GAVE HIM STRENGTH TO CARRY ON.



BELL'S PIONEERING MIND LED HIM INTO MANY FIELDS. IN 1901 HE DESIGNED AND TESTED GIANT MAN-CARRYING KITES.

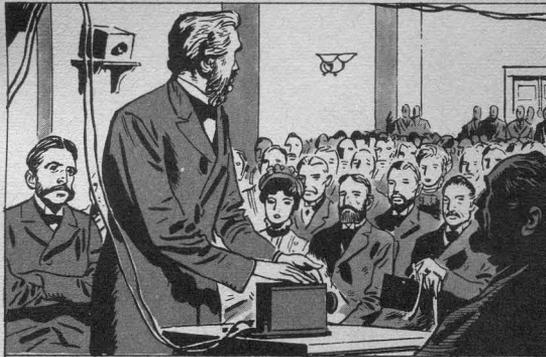


HE HELPED FINANCE S. P. LANGLEY'S FLIGHT TESTS, AND HIS "AERIAL EXPERIMENT ASSOCIATION" ENCOURAGED OTHERS IN AVIATION PIONEERING.

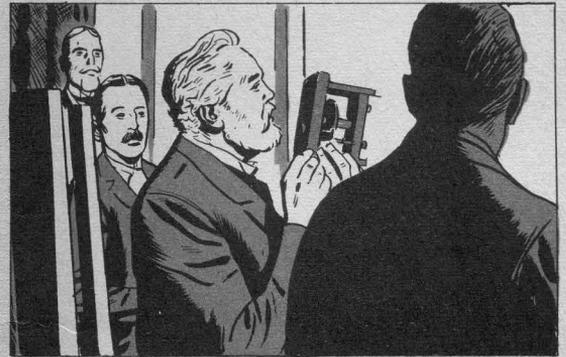


IN 1876, BELL EXHIBITED HIS NEW TELEPHONE AT THE CENTENNIAL EXHIBITION IN PHILADELPHIA. ONE SUNDAY, WHEN HIS ENTRY WAS ABOUT TO BE JUDGED, THE TIRED COMMITTEE BEGAN TO TURN AWAY. SUDDENLY, THE EMPEROR OF BRAZIL INSISTED

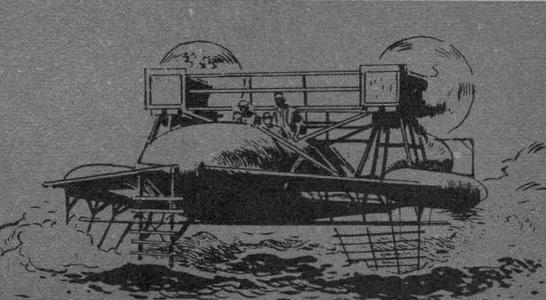
UPON TESTING BELL'S DEVICE. A MOMENT LATER HE EXCLAIMED, "GOOD HEAVENS, IT TALKS!", ATTRACTING THE ATTENTION OF THE ASTOUNDED GROUP. ANOTHER JUDGE CALLED THE TELEPHONE "THE MOST WONDERFUL THING IN AMERICA."



PEOPLE STILL SCOFFED, HOWEVER. BELL AND WATSON SPENT MANY MONTHS GIVING DEMONSTRATIONS BEFORE THE WAY WAS PAVED FOR THE DEVELOPMENT OF THE GREAT TELEPHONE NETWORKS WE KNOW TODAY. BY MID-1877 THE TELEPHONE WAS PUT INTO COMMERCIAL USE.



IN 1915, THE FIRST COAST-TO-COAST TELEPHONE LINE WAS OPENED. BELL SPOKE TO WATSON IN SAN FRANCISCO USING HISTORICAL REPLICAS OF THE ORIGINAL TELEPHONE INSTRUMENTS. "MR. WATSON," SAID BELL FROM ACROSS THE CONTINENT, "COME HERE, I WANT YOU!"



IN 1917, AT 70 YEARS OF AGE, BELL DEVELOPED HYDROFOIL SPEEDBOATS — SOME CAPABLE OF MORE THAN 70 MILES AN HOUR.



BELL'S LEGACY IS SUMMED UP IN HIS OWN WORDS: "DON'T KEEP FOREVER ON THE PUBLIC ROAD, GOING ONLY WHERE OTHERS HAVE GONE."

EMILE BERLINER

microphone transmitter



IN 1897, ONE OF THE MOST IMPORTANT PATENT CASES IN THE UNITED STATES WAS DECIDED BY THE SUPREME COURT. IT ESTABLISHED A FORMER IMMIGRANT BOY, WHOSE FORMAL EDUCATION HAD ENDED AT AGE 14, AS THE RIGHTFUL INVENTOR OF THE MICROPHONE. THIS TRANSMITTER GAVE THE BELL TELEPHONE

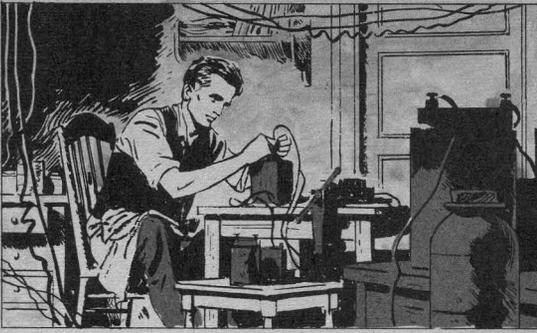
SYSTEM, HOLDERS OF THE PATENT, AN ADVANTAGE OVER HIGHLY-COMPETITIVE TELEPHONE SYSTEMS OF THE DAY. IN THE YEARS SINCE, EMIL BERLINER'S MICROPHONE, HIS GRAMOPHONE, AND HIS CONTRIBUTIONS TO PUBLIC HEALTH HAVE ENRICHED THE LIVES OF US ALL.



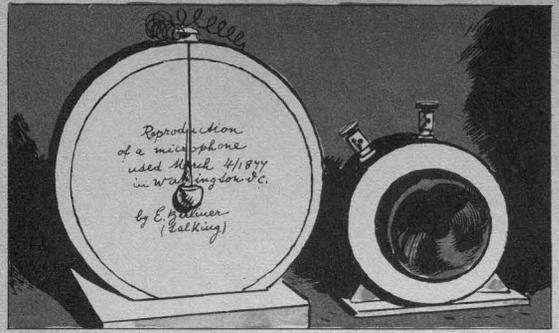
BERLINER WAS BORN IN THE KINGDOM OF HANOVER IN 1851. WHEN HE WAS 15, THE PRUSSAINS INVADDED HIS COUNTRY. FOUR YEARS LATER, HIS PARENTS WERE ABLE TO SEND HIM TO AMERICA.



AFTER HIS ARRIVAL IN THE UNITED STATES IN 1870, BERLINER WORKED AS CLERK, SALESMAN, PAINTER, TEACHER, BOTTLE WASHER, TRAVELER IN "GENTS' CLOTHING" AND MEANWHILE STUDIED AT COOPER UNION IN NEW YORK.



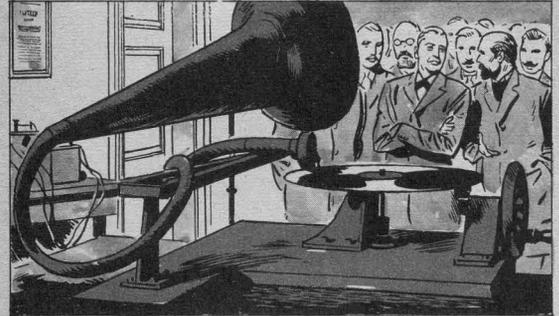
IN 1876, WITH LITTLE BUT THE INTUITION OF A BORN INVENTOR, HE PUT TOGETHER A BATTERY-OPERATED TRANSMITTER IN A 7X12 INCH WOODEN SOAPBOX. ITS PRINCIPLE HAS NEVER BEEN CHANGED OR SUPERSEDED.



BERLINER'S TWO GREAT CONTRIBUTIONS WERE THE INTRODUCTION OF LOOSE CONTACTS, ABLE TO VARY IN PRESSURE, AND THE USE OF BATTERY CURRENT, AS OPPOSED TO WEAKER VOICE-PRODUCED CURRENT.



SOON AFTER HIS MICROPHONE PATENTS WERE ACQUIRED BY AMERICAN BELL, BERLINER SUFFERED A BREAKDOWN. BUT HIS ABILITY TO OVERCOME ALMOST ANY OBSTACLE TOOK HIM BACK TO WORK LONG BEFORE DOCTORS THOUGHT IT POSSIBLE.



IN 1887, HE PATENTED THE GRAMOPHONE WITH A HORIZONTAL DISK. THIS, PLUS HIS MASTER DISK FROM WHICH MANY RECORDS COULD BE MADE, IS THE BASIS OF OUR HUGE RECORDING INDUSTRY.



IN THE EARLY 1900 S, LEARNING THAT 300 OUT OF EVERY 1,000 BABIES WERE DYING IN THEIR FIRST YEAR, BERLINER STARTED A SUCCESSFUL CAMPAIGN AGAINST RAW MILK. THE IMMIGRANT LAD NOT ONLY HELPED

MAKE POSSIBLE OUR GIANT TELEPHONE, RADIO AND TELEVISION NETWORKS AND GAVE US RECORDED MUSIC, BUT HE ALSO CONTRIBUTED VITALLY TO THE HEALTH OF HIS ADOPTED LAND.

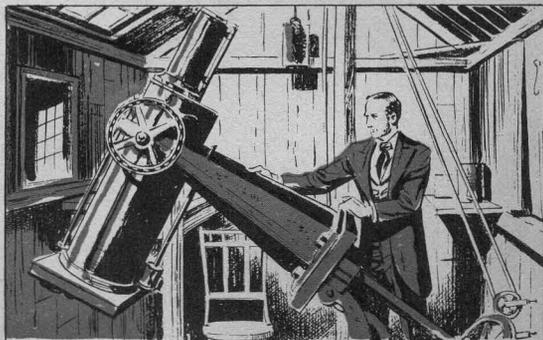
FRANCIS BLAKE improved transmitter



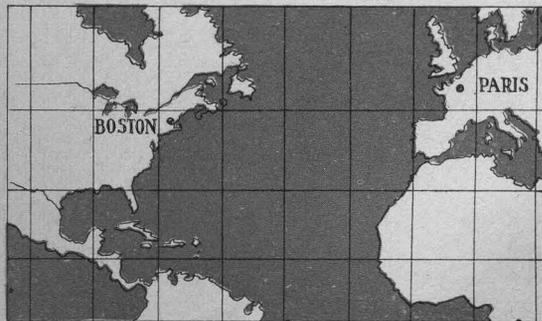
FRANCIS BLAKE, INVENTOR OF THE BLAKE TRANSMITTER, WAS BORN OF A MIDDLE-INCOME FAMILY IN NEEDHAM, MASS., IN 1850. INSTEAD OF ATTENDING COLLEGE, HE CHOSE TO ENTER THE U.S. COAST SURVEY SERVICE. INVENTOR, ADVENTURER, PERFECTIONIST AND INSATIABLE SEEKER OF KNOWLEDGE, BLAKE LATER CENTERED HIS ACTIVITIES IN HIS BEAUTIFUL ESTATE, "KEEWAYDIN," IN WESTON, MASS. IT CONTAINED STABLES, A THEATRE, BOWLING ALLEYS, A SQUASH COURT, A PHOTOGRAPHIC LABORATORY AND AN ELECTRICAL AND MECHANICAL WORKSHOP.



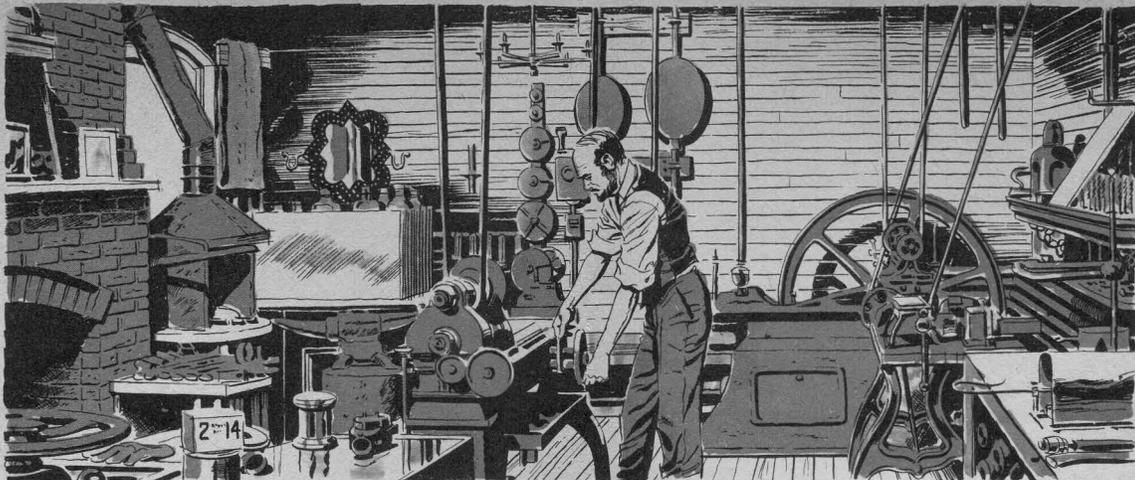
AFTER HIGH SCHOOL, BLAKE MADE HYDROGRAPHIC SURVEYS OF AMERICAN RIVERS AND PERFORMED SIMILAR TASKS IN FLORIDA, CUBA AND CENTRAL AMERICA. IN THIS WORK HE BEGAN TO ACQUIRE A SCIENTIFIC EDUCATION.



IN 1867, AT HARVARD COLLEGE OBSERVATORY, BLAKE HELPED DETERMINE THE DISTANCE TO SAN FRANCISCO BY TIMING TELEGRAPH SIGNALS.

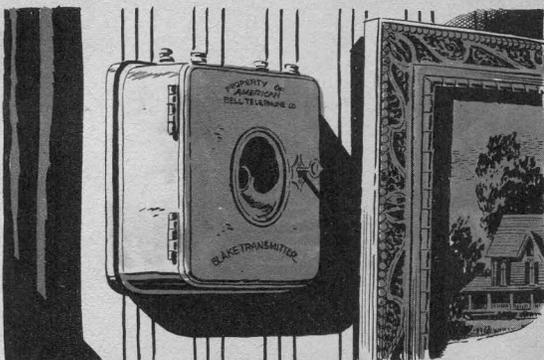


BLAKE WAS TWICE SENT TO EUROPE TO MEASURE THE TRUE DISTANCES TO THE UNITED STATES. THESE DUTIES AROUSED HIS INTEREST IN ELECTRICAL TRANSMISSION.

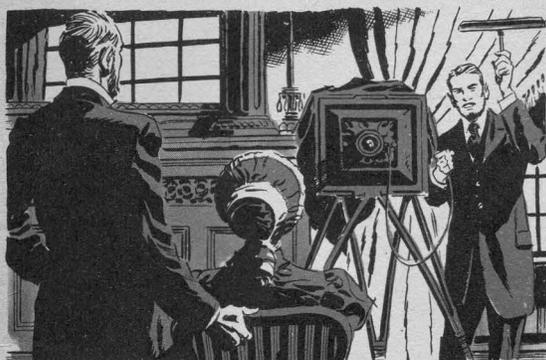


IN 1877, WHILE SURVEYING BOSTON HARBOR, BLAKE BEGAN EXPERIMENTS IN PHYSICS IN HIS "KEEWAYDIN" LABORATORY. HE HAD ALREADY BECOME A FINE AMATEUR MECHANIC

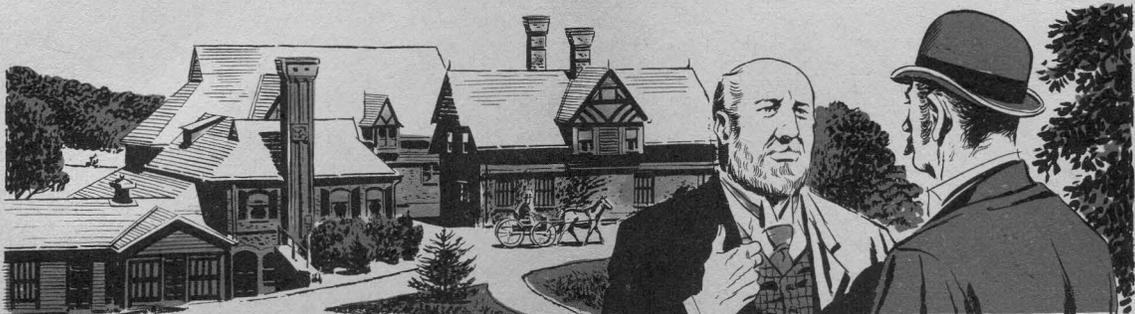
WITH A KNOWLEDGE OF TELEGRAPHY GAINED FROM HIS EARLIER WORK. THIS LED, IN 1878, TO HIS INVENTION OF THE VARIABLE CONTACT TRANSMITTER.



BLAKE'S INSTRUMENT TRANSMITTED THE VOICE WITH EXTREME CLARITY. IT SOON SUPPLANTED OTHER TRANSMITTERS AND REMAINED THE STANDARD FOR MANY YEARS.



BLAKE NEVER CEASED HIS TELEPHONE EXPERIMENTS. HE ALSO DEVELOPED THE FASTEST CAMERA SHUTTER OF THE DAY... AND A MATHEMATICAL FORMULA FOR MINCE PIE!

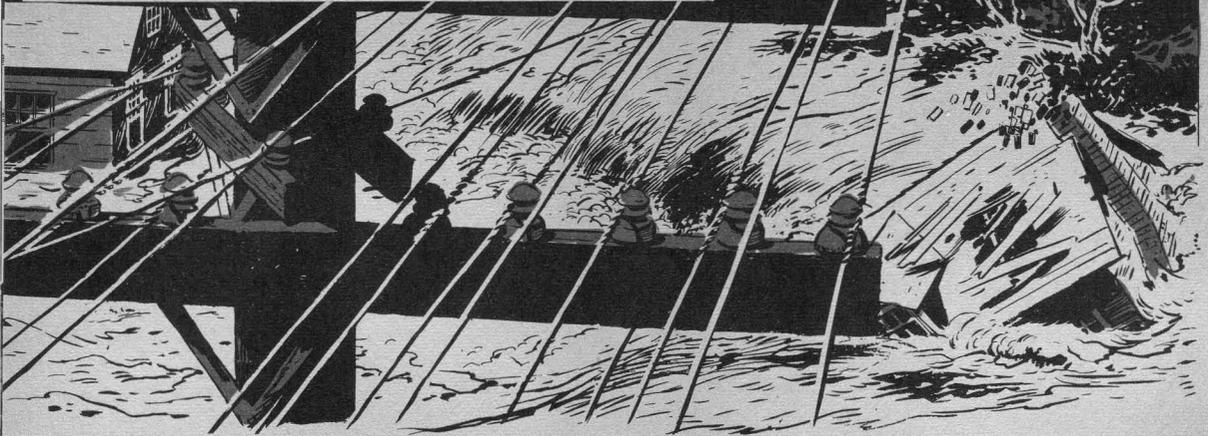


BLAKE'S KEEN MIND WAS NEVER STILL. HE INVENTED A MICROTOME WHICH HE DONATED TO THE MASSACHUSETTS GENERAL HOSPITAL. HE READ AVIDLY, SPOKE FRENCH, TAUGHT HIS INFANT DAUGHTER READING AND MATHEMATICS AND BECAME A GENTLEMAN FARMER. HIS

CAREER PATH THAT THE MEN WHO MADE THE TELEPHONE CAME FROM ALL WALKS OF LIFE, RICH AND POOR, SCHOOLED OR SELF-TAUGHT. INVENTIVE ACCOMPLISHMENT IS A MATTER OF WILL RATHER THAN WEALTH, OF EFFORT RATHER THAN OPPORTUNITY.

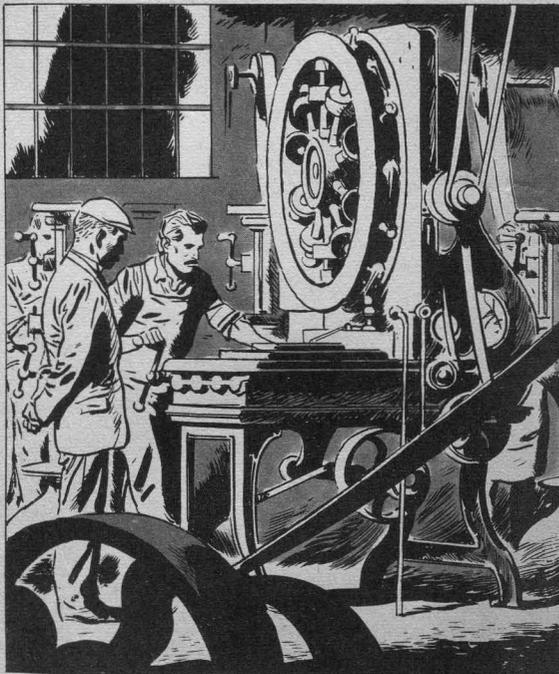
THOMAS B. DOOLITTLE

hard-drawn copper wire

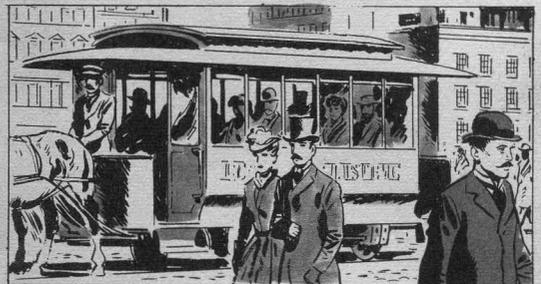


TODAY'S LONG DISTANCE TELEPHONE LINES SOAR ACROSS EVERY NATION ON EARTH, STURDY ENOUGH TO SUPPORT NOT ONLY THEIR OWN TREMENDOUS WEIGHT, BUT THAT OF SNOW AND ICE AND THE FORCE OF THE WINDS. THOMAS B. DOOLITTLE, THROUGH HIS PROCESS OF "HARD-DRAWN"

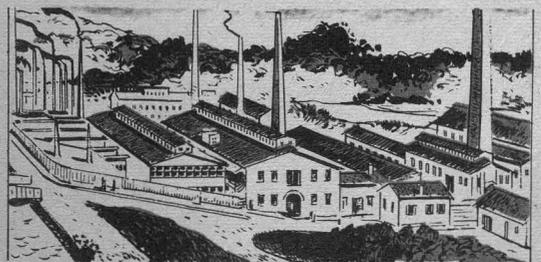
COPPER WIRE, WAS LARGELY RESPONSIBLE FOR MAKING THEM POSSIBLE. DOOLITTLE WAS A MAN WHOSE UNSHAKABLE FAITH IN THE TELEPHONE, EVEN IN THE DAYS WHEN IT WAS CONSIDERED JUST A NOVELTY, LED HIM TO PREDICT THAT IT WOULD "MAKE NEIGHBORS OF 100 MILLION PEOPLE."



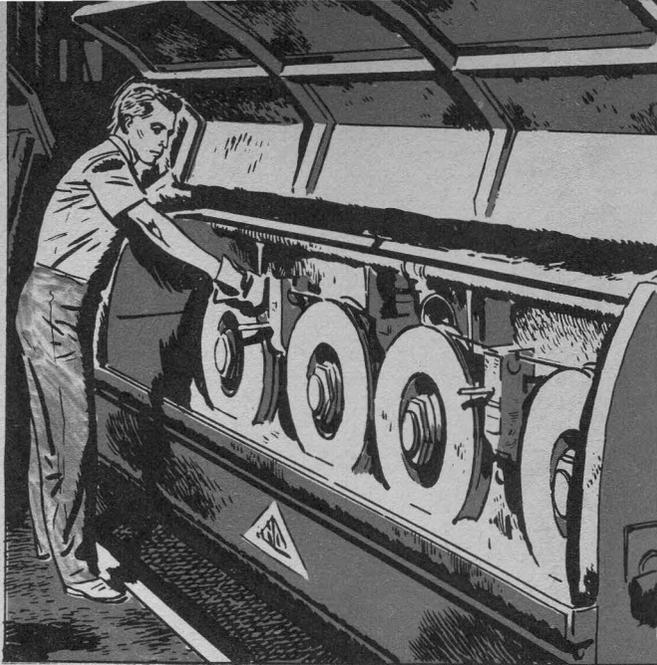
BORN IN 1839 AT WOODBURY, CONNECTICUT, DOOLITTLE BECAME AN APPRENTICE MECHANIC AT 17. AS A FOREMAN AT COLT'S ARMORY DURING THE CIVIL WAR, AND IN LATER SIMILAR WORK, HE BECAME AN EXPERT AT HIS TRADE.



IN 1876, HE INVENTED A FARE-REGISTERING DEVICE FOR STREETCARS. MEANWHILE, HE HAD BECOME AN AMATEUR TELEGRAPHER AND IN 1877, ESTABLISHED A SOCIAL TELEPHONE SYSTEM IN BRIDGEPORT, CONNECTICUT.



IN 1877, DOOLITTLE WAS ASKED TO CONSTRUCT A PRIVATE TELEPHONE SYSTEM FOR THE ANSONIA BRASS AND COPPER WORKS. IRON WIRE WAS UNSATISFACTORY, BUT COPPER WIRE WAS AN EXCELLENT CONDUCTOR.



HOWEVER, THE SOFT ANNEALED WIRE MADE IN THOSE DAYS WAS TOO WEAK FOR TELEPHONE WORK. DOOLITTLE BEGAN EXPERIMENTING WITH COLD-DRAWN COPPER WIRE. COPPER, WHEN DRAWN COLD INTO WIRE, BECOMES HARDER ON THE SURFACE AND THUS STRONGER, BUT DOOLITTLE WAS FIRST TO MAKE PRACTICAL USE OF THIS KNOWLEDGE.



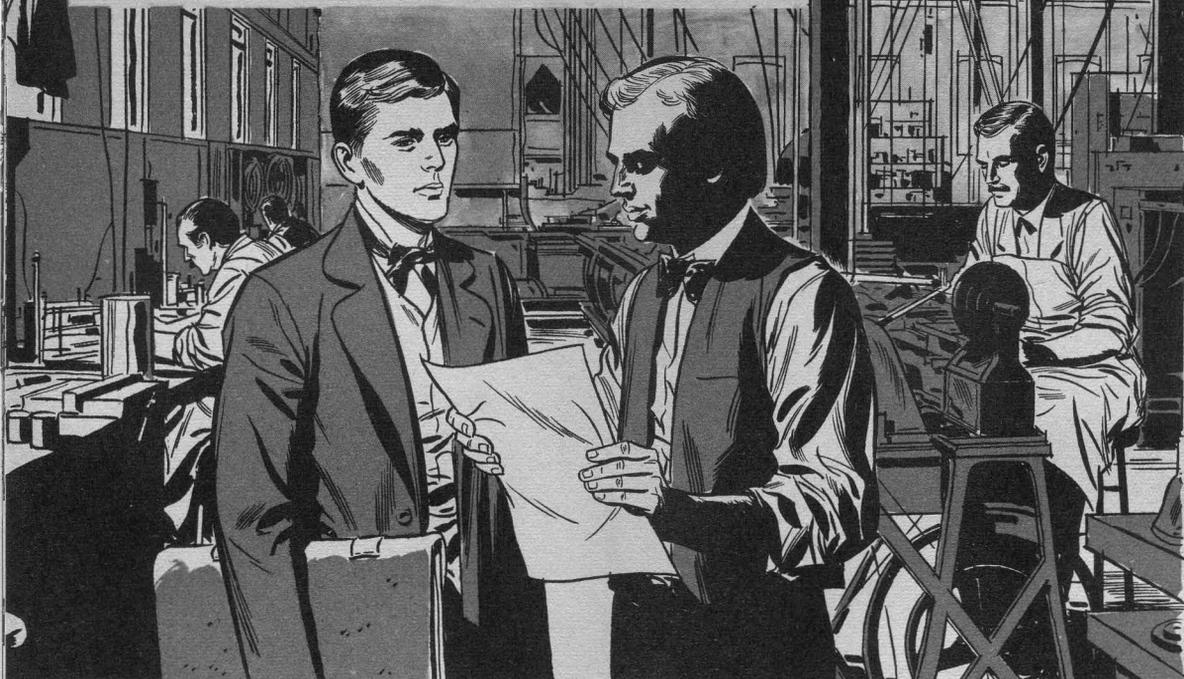
DOOLITTLE JOINED THE AMERICAN BELL TELEPHONE COMPANY AND REMAINED WITH ITS SUCCESSORS UNTIL THE AGE OF 75. DURING THOSE YEARS HE VISITED THOUSANDS OF COMMUNITIES IN HIS EFFORTS TO DEVELOP NATION-WIDE TOLL LINES.



WELL-LOVED BY HIS FRIENDS AND NEIGHBORS, THOMAS B. DOOLITTLE RETIRED TO HIS HOME IN BRANFORD, CONNECTICUT. HIS SON CHARLES ONCE REMINDED HIM THAT HAD HE PATENTED HIS INVALUABLE PROCESS, HE WOULD HAVE BEEN A MILLIONAIRE. "SON," SAID DOOLITTLE, "AFTER ALL, A MAN ONLY GETS A PLACE TO SLEEP AND EAT IN THIS WORLD, WEALTH TO THE CONTRARY."

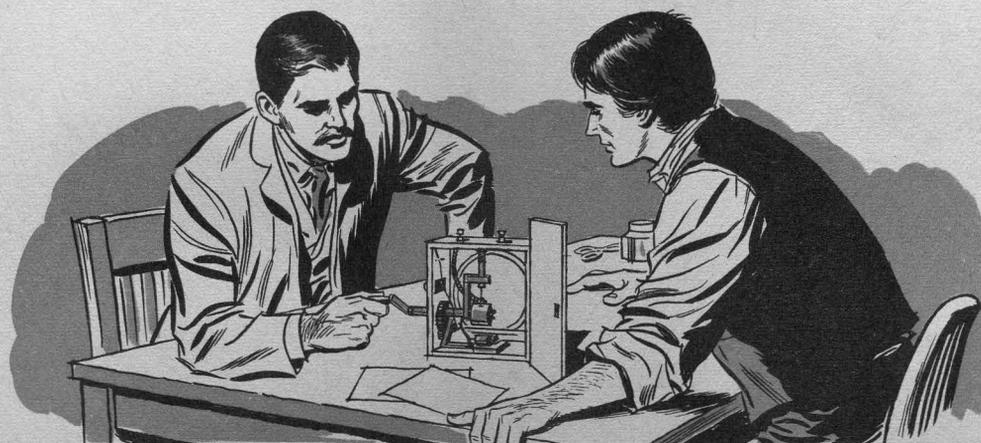
CHARLES E. SCRIBNER

switchboard improvements



ONE MORNING IN 1876, AN 18-YEAR-OLD BOY APPEARED IN THE SHOP OF THE WESTERN ELECTRIC MANUFACTURING COMPANY IN CHICAGO. HE HAD INVENTED AN AUTOMATIC TELEGRAPH REPEATER AND WANTED THE COMPANY TO BUILD A MODEL OF IT. THE BOY,

CHARLES E. SCRIBNER, ATTRACTED THE ATTENTION OF ENOS BARTON, LATER PRESIDENT OF WESTERN ELECTRIC. THIS BEGAN THE CAREER OF A MAN WHO WAS TO BECOME ONE OF THE MOST PROLIFIC INVENTORS IN THE FIELD OF TELEPHONY.

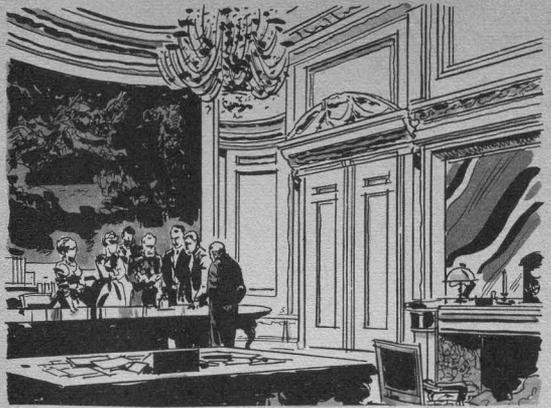


SCRIBNER, AN ELECTRICALLY-MINDED YOUNGSTER FROM TOLEDO, OHIO, SOON JOINED THE COMPANY. HE PROVED A RARE FIND AND WAS SENT TO STUDY

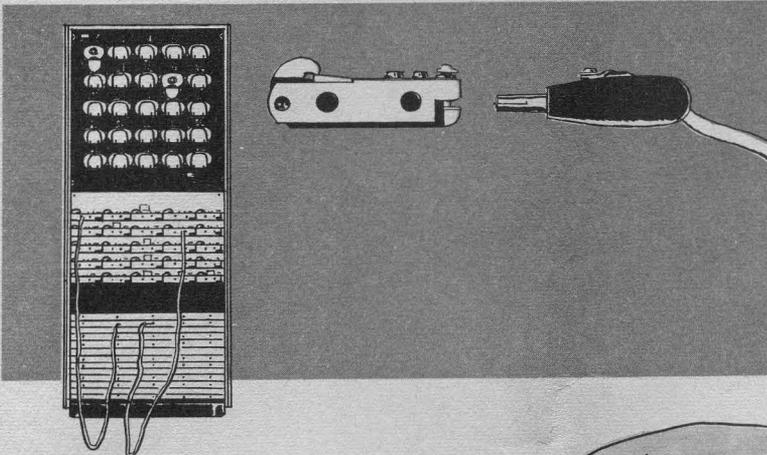
UNDER THOMAS EDISON, WHO LATER SAID, "MR. SCRIBNER WAS THE MOST INDUSTRIOUS INVENTOR I HAVE EVER KNOWN."



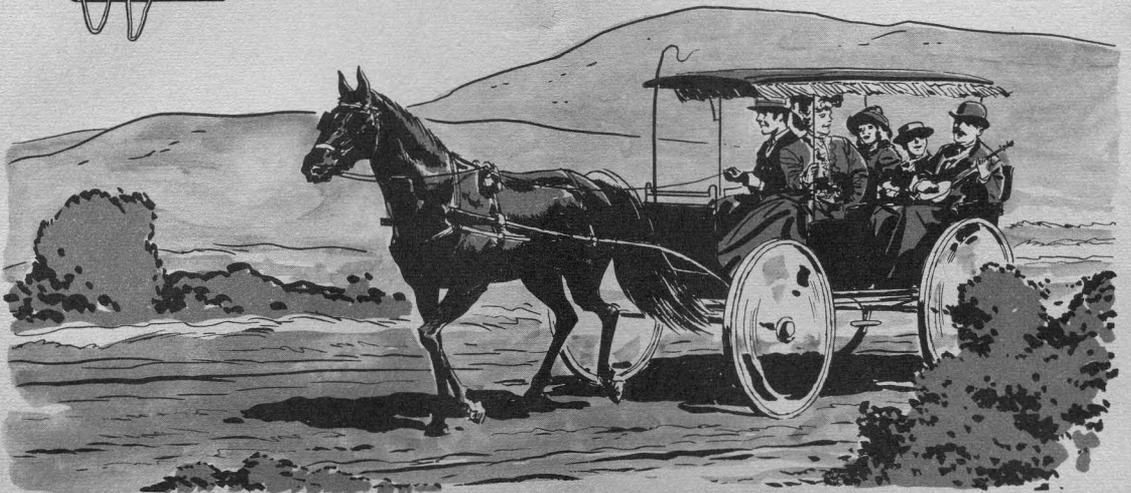
YOUNG SCRIBNER USED TO RIDE TRAINS TO TOLEDO EVERY WEEKEND FOR MONTHS, AS HE SAID, TO "VISIT HIS MOTHER." ENOS BARTON, SUSPECTING THE TRUTH, FINALLY ASKED "WHY DON'T YOU MARRY THE GIRL?!" AND HE DID.



AN EXPERT ON CIRCUITS AND SYSTEMS AT 21, SCRIBNER WAS SENT TO EUROPE. HE INSTALLED A TELEPHONE IN THE OFFICE OF THE PRESIDENT OF FRANCE AND HELPED NEGOTIATE THE BRITISH PATENT RIGHTS.



INVENTOR OF THE "JACK-KNIFE" SWITCH AND HOLDER OF 441 PATENTS, SCRIBNER MADE HIS GREATEST CONTRIBUTION IN DEVELOPING MULTIPLE SWITCHBOARDS. HIS WERE THE DIRECT FORE-RUNNERS OF OUR HUGE AND COMPLEX MODERN ONES.

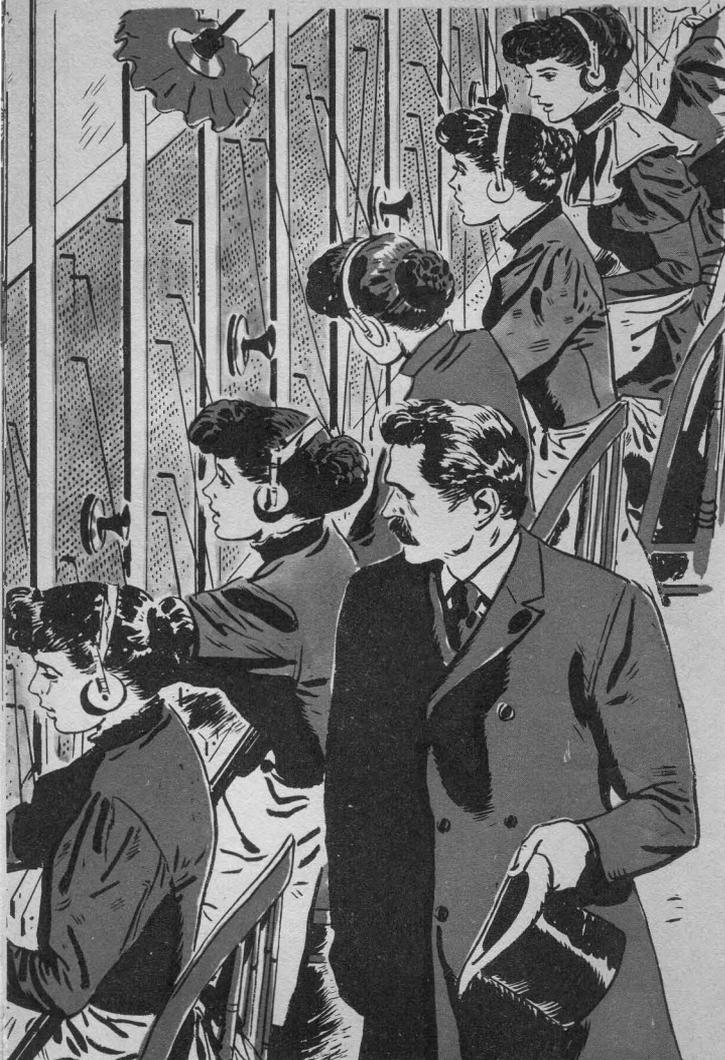


IN LATER LIFE, AT HIS HOME IN JERICHO, VERMONT, SCRIBNER WAS KNOWN AS A MAN WITH A WARM PHILOSOPHY AND A DEEP ENJOYMENT OF LIFE, WHO LOVED HIS CHILDREN DEARLY AND PLAYED

PIANO AND GUITAR. FRIENDS RECALL HAVING OFTEN SEEN SCRIBNER AND HIS WIFE RAMBLING THE COUNTRY ROADS IN A "SURREY WITH A FRINGE ON TOP," HAPPILY HARMONIZING AN OLD-TIME TUNE.

ALMON B. STROWGER

automatic dialing



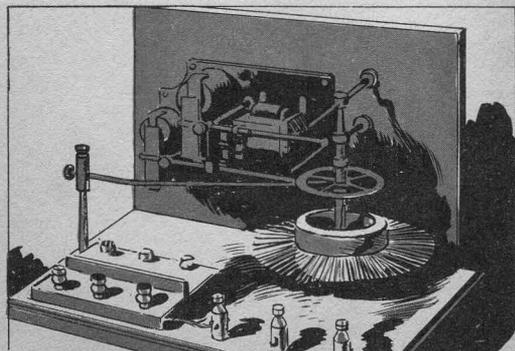
ALMON B. STROWGER, INVENTOR OF THE INVALUABLE AUTOMATIC TELEPHONE EXCHANGE, NEVER INTENDED TO BE AN INVENTOR, AND THEREFORE IS ONE OF THE LEAST KNOWN OF THE MEN WHO CONTRIBUTED TO THE TELEPHONE. IN 1889 STROWGER STUDIED THE OPERATION OF THE HAND-OPERATED EXCHANGE IN KANSAS CITY, MISSOURI, AND THEN BUILT HIS WONDERFUL INVENTION FROM A CARDBOARD COLLAR BOX, SOME STRAIGHT PINS AND A PENCIL.



IN 1862, ALTHOUGH WEIGHING A MERE 110 POUNDS, HE VOLUNTEERED AS A BUGLER IN THE 8TH NEW YORK CAVALRY.



AFTER THE WAR, STROWGER TAUGHT SCHOOL IN ILLINOIS, MICHIGAN AND KANSAS, AND BECAME PRINCIPAL OF THE PENFIELD SCHOOL. HE LATER OWNED UNDERTAKING ESTABLISHMENTS IN TOPEKA AND KANSAS CITY.

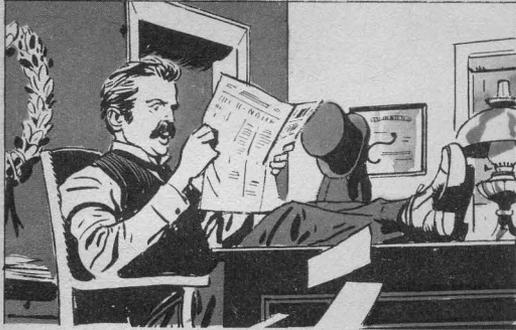


STROWGER'S "AUTOMATIC TELEPHONE EXCHANGE" PATENT WAS FILED IN 1889. HIS "WIPER BLADE", IMPELLED BY ELECTRIC MAGNETS, ALL BUT ELIMINATED THE POSSIBILITIES OF HUMAN ERROR.

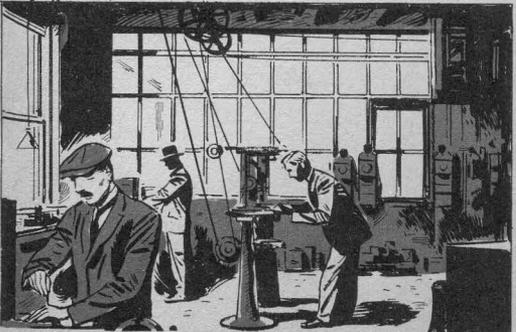


HIS UNIT FIRST WENT INTO ACTION AT HANOVER COURT HOUSE AND BECAME NOTED FOR ITS BRAVERY AND EXCELLENCE IN THE

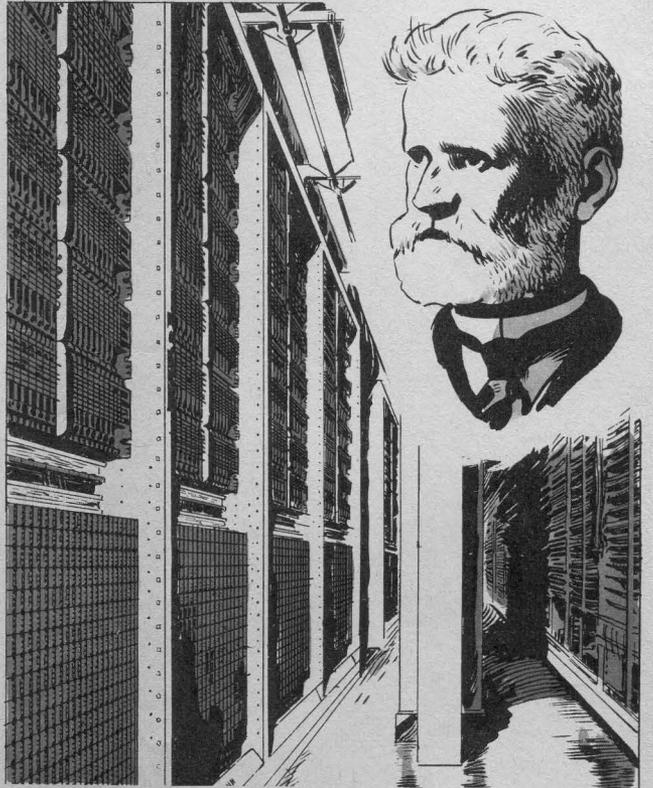
SABER CHARGE. IN 1864, SHORTLY BEFORE THE CIVIL WAR ENDED, HE WAS MUSTERED OUT AS 2ND LIEUTENANT.



IT IS SAID THAT STROWGER, READING THAT A RIVAL HAD RECEIVED BUSINESS HE FELT SHOULD HAVE BEEN HIS, BECAME CONVINCED THAT A TELEPHONE OPERATOR HAD CALLED THE WRONG MORTUARY, AND DECIDED TO BUILD A TELEPHONE SYSTEM WITH NO OPERATORS.



IN 1892, STROWGER AND OTHERS UNVEILED THE WORLD'S FIRST AUTOMATIC TELEPHONE EXCHANGE, IN LA PORTE, INDIANA. A SPECIAL TRAIN CARRIED EXPERTS FROM MANY NATIONS TO ATTEND ITS OPENING DAY.



STROWGER RETIRED TO ST. PETERSBURG, FLORIDA, WHERE HE BECAME A SORT OF ELDER PHILOSOPHER TO HIS MANY FRIENDS. HE REMAINED VIRTUALLY UNKNOWN TO THE REST OF THE WORLD, AND YET, BECAUSE OF HIS "COLLARBOX" HUGE AUTOMATIC TELEPHONE EXCHANGES OPERATE ALL OVER THE GLOBE, AND WE IN THE U.S. CAN NOW DIAL DIRECTLY TO ALMOST ANY CORNER OF OUR VAST COUNTRY.

JOHN J. CARTY

phantom circuit



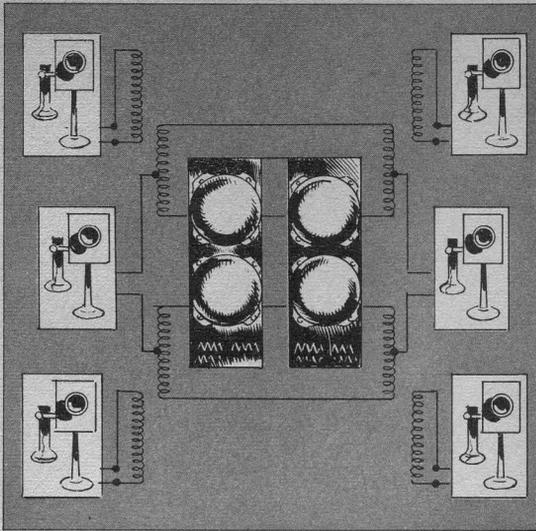
BORN IN CAMBRIDGE, MASSACHUSETTS, IN 1861, CARTY WON A "WALK-A-STRAIGHT-LINE" CONTEST BY KEEPING HIS EYES FASTENED ON A DISTANT TREE. YEARS LATER HE SAID, "THE SUCCESSFUL MAN KEEPS HIS EYES ON THE GOAL... HIS 'PINE TREE'..."



AT 19, CARTY BECAME A BOY TELEPHONE OPERATOR IN BOSTON. HIS APTITUDE SOON MADE HIM A CAPTAIN, FIRST STEP IN A GREAT CAREER. IN 1881 CARTY CONNECTED THE FIRST "METALLIC" (2-WIRE) CIRCUIT, ESTABLISHING A WORLD-WIDE STANDARD IN TELEPHONY.

IN THE 1880S THE RAPID GROWTH OF THE TELEPHONE HAD LED TO CITY SKIES BLACK WITH WIRES, AND POLES AS HIGH AS 90 FEET, CARRYING 30 CROSS ARMS AND 300 WIRES. THE "PHANTOM CIRCUIT," INVENTED BY JOHN J. CARTY, A MAN WHO COMBINED THE "VISION OF THE PROPHET WITH THE PRECISION OF THE ENGINEER," GREATLY HELPED TO REDUCE THE NUMBER OF WIRES NECESSARY.





CARTY'S FAMOUS "PHANTOM CIRCUIT" OF 1886 IS A METHOD OF TRANSMITTING 3 CONVERSATIONS SIMULTANEOUSLY OVER TWO PAIRS OF WIRES, DECREASING THE AMOUNT OF WIRE AND SPACE REQUIRED.



CARTY BECAME CHIEF ENGINEER OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY. HIS FAITH AND FORESIGHT WERE MAJOR FACTORS IN THE COMPLETION, IN 1915, OF THE FIRST TRANSCONTINENTAL TELEPHONE LINE.



IN 1917, AT THE AGE OF 56, CARTY ACCEPTED A COMMISSION IN THE U.S. ARMY, AND WAS LARGELY RESPONSIBLE FOR THE CREATION OF THE SIGNAL CORPS OF WORLD WAR I. HE SPENT NEARLY A YEAR OVERSEAS, AND RECEIVED SEVERAL IMPORTANT DECORATIONS.



GENERAL CARTY WAS KNOWN AS A PROPHET AND PHILOSOPHER. HE ONCE SAID, "WHILE HUMAN BEHAVIOR PRESENTS THE MOST IMPORTANT AND FORMIDABLE PROBLEM OF ALL THE AGES, I BELIEVE ITS SOLUTION CAN BE ACHIEVED... WE MUST ACCELERATE PROGRESS IN ALL THE SCIENCES TO PREPARE THE INDIVIDUAL MAN TO FUNCTION AS A SANE AND PEACEFUL UNIT."

MICHAEL I. PUPIN loading coil



MICHAEL IDVORSKY PUPIN, ELECTROPHYSICIST, INVENTOR AND EDUCATOR, CAME TO AMERICA IN THE STEERAGE CLASS OF THE GERMAN LINER "WESTPHALIA" AT THE AGE OF 16. A SERBIAN

SCHOOLBOY, HE SOLD HIS CLOTHES TO MAKE THE VOYAGE, AND MANY A NIGHT WAS FORCED TO HUG THE SMOKESTACK FOR WARMTH. HE ARRIVED IN NEW YORK IN 1874 WITH JUST 5¢ IN HIS POCKET.

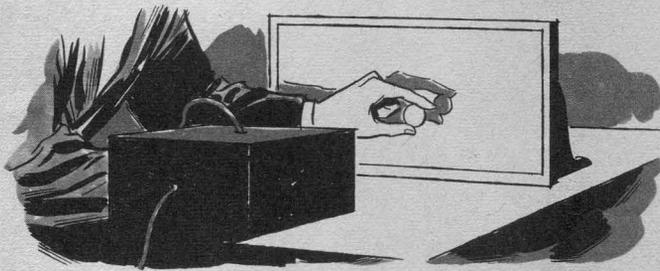
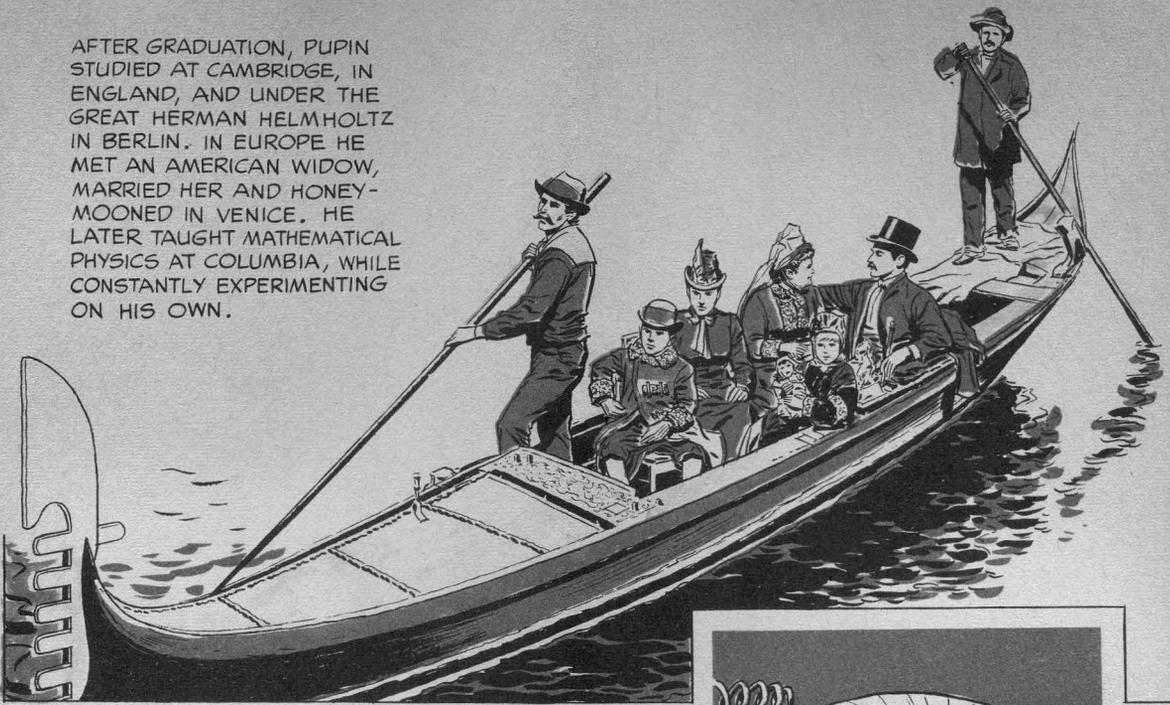


AS A BOY, PUPIN WAS A HERDSMAN. WHEN ON GUARD, HE AND HIS FRIENDS SIGNALLED EACH OTHER BY PLUCKING AT KNIVES STUCK IN THE GROUND. IT WAS HIS FIRST EXPERIENCE WITH SOUND TRANSMISSION.

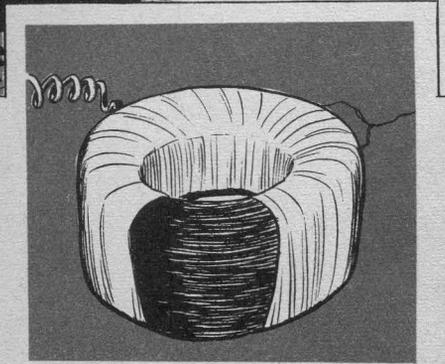


AFTER FOUR YEARS OF HARD LABOR AND STUDY IN THE U.S., PUPIN ENTERED COLUMBIA UNIVERSITY. THERE HE LEARNED TRUE SPORTSMANSHIP IN THE "CANE RUSH" AND WAS PRESIDENT OF HIS JUNIOR CLASS.

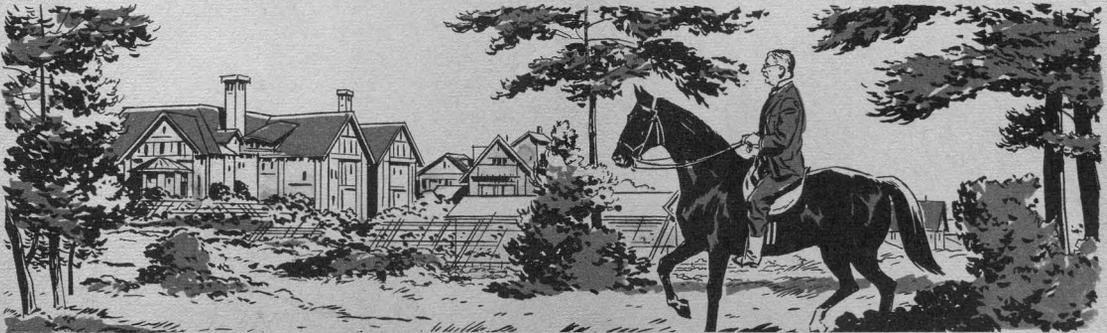
AFTER GRADUATION, PUPIN STUDIED AT CAMBRIDGE, IN ENGLAND, AND UNDER THE GREAT HERMAN HELMHOLTZ IN BERLIN. IN EUROPE HE MET AN AMERICAN WIDOW, MARRIED HER AND HONEY-MOONED IN VENICE. HE LATER TAUGHT MATHEMATICAL PHYSICS AT COLUMBIA, WHILE CONSTANTLY EXPERIMENTING ON HIS OWN.



PUPIN MADE THE FIRST X-RAY PHOTO IN AMERICA AND DISCOVERED SECONDARY X-RAY RADIATION. HE ALSO DID VALUABLE WORK IN RADIO AND MANY RELATED AREAS.



HIS GREATEST INVENTION WAS THE PUPIN COIL, PLUS HIS SYSTEM OF PLACING THESE COILS AT SPECIFIED INTERVALS ALONG TRANSMISSION LINES.



THE WORK OF PUPIN, CLOSELY PARALLELED BY THAT OF G. A. CAMPBELL, DEVELOPED THE LOADING COIL METHOD, MAINTAINING CLEAR TONE DISTINCTIONS OVER LONG DISTANCES. PUPIN RETIRED TO HIS FARM IN NORFOLK, CONN.,

IN THE EARLY 1900S. THE IMMIGRANT LAD, WHO HAD ARRIVED IN AMERICA ALONE AND UNABLE TO SPEAK ENGLISH, HAD BECOME A WELL-TO-DO LANDOWNER AND A BELOVED AND RESPECTED MEMBER OF HIS COMMUNITY.

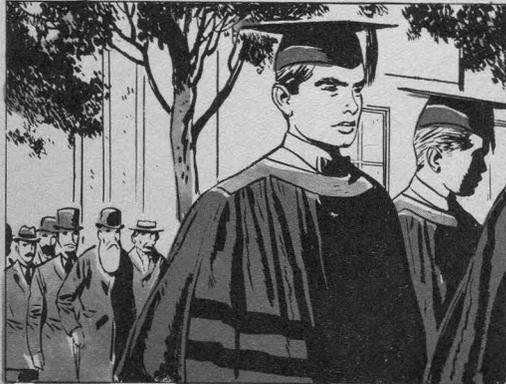
LEE De FOREST audion tube



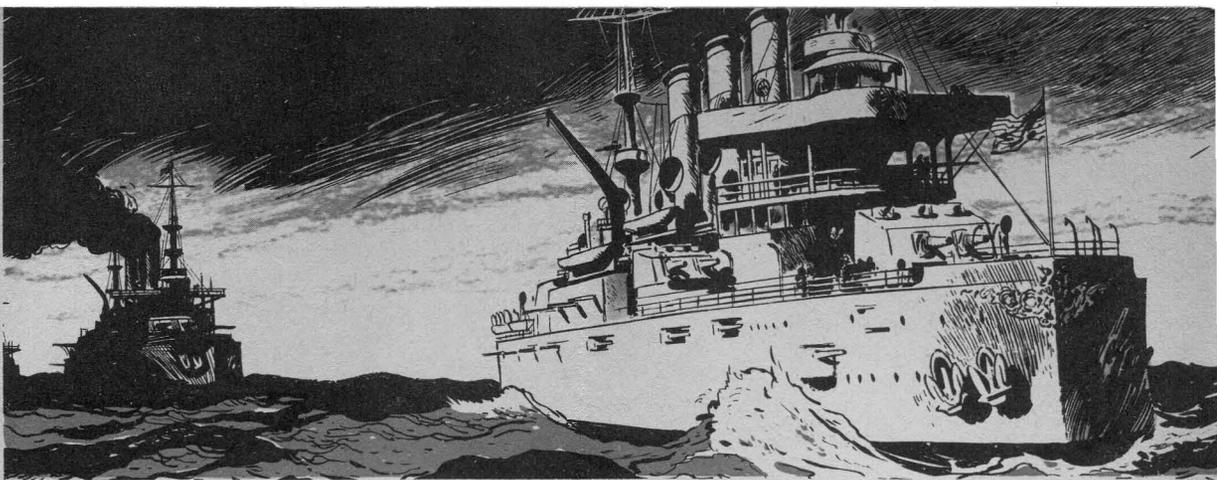
IN 1906, A SERIOUS YOUNG MAN NAMED LEE DE FOREST DEVELOPED THE FIRST "AUDION" TUBE, THE NOW FAMILIAR VACUUM TUBE USED IN RADIO, TELEVISION AND OTHER ELECTRICAL MACHINES. IN SO DOING HE PRODUCED A DEVICE WHICH MAGNIFIED ELECTRICAL SIGNALS, THEREBY TAPPING ENERGIES WHOSE VERY EXISTENCE MIGHT OTHERWISE HAVE REMAINED COMPLETELY UNKNOWN.



DE FOREST, BORN IN 1873, GREW UP IN TALLEDEGA, ALABAMA, WHERE HIS FATHER WAS THE FIRST PRESIDENT OF A NEGRO COLLEGE. YOUNG DE FOREST DEMONSTRATED EARLY TALENT BY BUILDING A WORKING MODEL OF A LOCOMOTIVE.



HE RECEIVED A B. S. AT YALE UNIVERSITY IN 1896, AND THOUGH OFTEN LACKING MONEY FOR FOOD, WENT ON TO GRADUATE SCHOOL. HE WAS DETERMINED TO BE AS GREAT AS GUGLIELMO MARCONI.

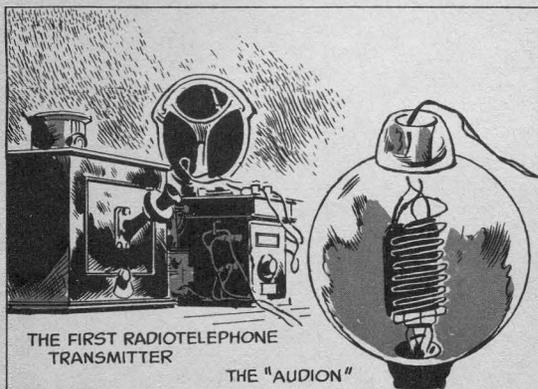


IN SEPTEMBER, 1905, MAJOR UNITS OF THE U. S. NAVY PUT TO SEA ON THEIR ANNUAL CRUISE. FOR THE FIRST TIME, THEY WERE ABLE TO COMMUNICATE WITH EACH OTHER BY WIRELESS, DUE TO DE FOREST'S DRIVE AND ELECTRICAL

GENIUS. IN A FEW SHORT YEARS HE HAD OBTAINED DOZENS OF PATENTS, BUILT THE NAVY'S FIRST 5 HIGH-POWERED RADIO STATIONS, AND HAD A COMPANY FORMED AROUND HIM UNDER HIS OWN NAME.



IN 1906, DE FOREST WAS DISCHARGED FROM THE COMPANY HE HAD HELPED ORGANIZE AND STRIPPED OF HIS PATENTS...ALL, FORTUNATELY, BUT THE PENDING ONES. AMONG THEM WAS THE AUDION, LATER CALLED ONE OF THE TWENTY GREATEST INVENTIONS OF ALL TIME.



THE FIRST RADIOTELEPHONE TRANSMITTER

THE "AUDION"

DE FOREST'S AUDION TUBE, NOW SO FAMILIAR IN MANY FORMS, WAS AN EPOCHAL DEVELOPMENT. IT MADE LONG DISTANCE TELEPHONING PRACTICAL AND OPENED THE FIELD OF ELECTRONICS.



EVER THE INVENTOR, BUT HIGHLY INDEPENDENT, DE FOREST MADE AND LOST THREE FORTUNES. IN 1910 HE GREATLY INCREASED THE POPULARITY OF RADIO BY BROADCASTING THE OPERA "PAGLIACCI" FROM THE METROPOLITAN OPERA.



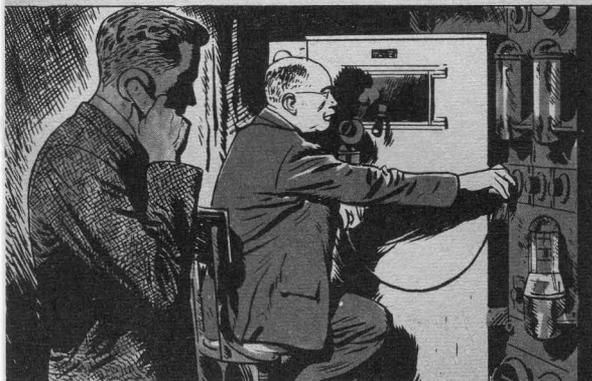
IN 1916, DE FOREST TESTED A TRANSMITTER IN AN ARMY PLANE OVER MITCHELL FIELD, LONG ISLAND — ONE OF MANY EXPERIMENTS MADE AS A RESULT OF HIS INVENTION.



DE FOREST WAS THE "FATHER OF RADIO" IN MORE WAYS THAN ONE. HE WAS THE WORLD'S FIRST "DISC JOCKEY," IN 1916, ON THE FIRST SPONSORED RADIO PROGRAM.



IN THE EARLY 1920'S DE FOREST TURNED TO THE PROBLEM OF SYNCHRONIZING SOUND WITH MOTION PICTURES. HIS "PHOTOFILM" HELPED CREATE THE AGE OF MODERN MOVIES.



LATER, HE WAS ABSORBED IN THE LITTLE-KNOWN FIELD OF TELEVISION. HE FILED OVER 30 RELATED PATENTS AND STRONGLY FAVORED CULTURAL PROGRAMMING IN RADIO AND TV.



MOVING TO LOS ANGELES IN 1930, DE FOREST BECAME A MOUNTAINEERING ENTHUSIAST, AND CLIMBED MOUNT WHITNEY TO CELEBRATE HIS 70TH BIRTHDAY. A CONTROVERSIAL AND COMPLEX MAN, BRILLIANT, WILLFUL, EGOTISTICAL, ADVENTUROUS AND POETIC, DE FOREST, THROUGH HIS INVENTION OF THE AUDION TUBE, ALTERED THE COURSE OF HUMAN HISTORY.

HAROLD S. BLACK negative feedback

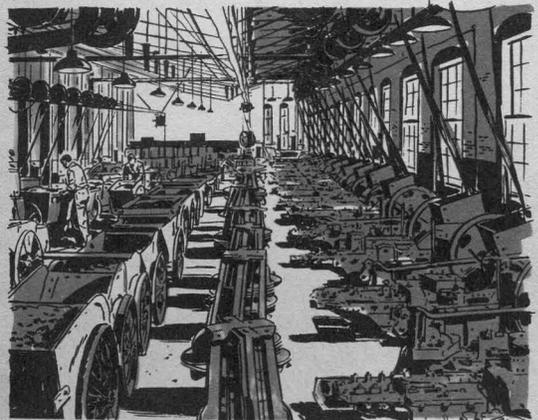


ONE DAY IN 1927, A YOUNG MAN BOARDED THE LACKAWANNA FERRY ON HIS WAY TO WORK IN NEW YORK. THERE IN A FLASH HE ENVISIONED THE ANSWER TO A PROBLEM HE HAD PONDERED FOR YEARS-- HOW TO RID AMPLIFIERS OF DISTORTION WHICH ACCUMULATES AS TELEPHONE

LINES LENGTHEN AND MORE AND MORE AMPLIFIERS ARE ADDED. AN ACCIDENTAL BLANK PAGE IN HIS NEWSPAPER SERVED TO RECORD EQUATIONS THAT LED TO A SOLUTION DESTINED TO COMPLETELY REVOLUTIONIZE THE ART OF SIGNAL AMPLIFICATION OVER LONG DISTANCES.



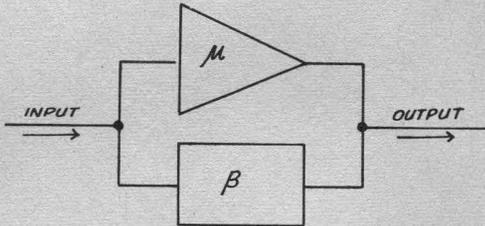
BLACK WAS BORN IN LEOMINSTER, MASS., IN 1898. HE SHOWED EARLY INTEREST AND SKILL IN THINGS ELECTRICAL, SETTING UP TELEGRAPH SYSTEMS, BUZZERS AND MICROPHONES.



WHILE AT WORCESTER POLYTECHNIC INSTITUTE, BLACK WORKED DURING HIS VACATIONS, ONCE IN A STEEL AND WIRE PLANT. HE GRADUATED IN 1921 AND JOINED WHAT IS NOW THE BELL TELEPHONE LABORATORIES.

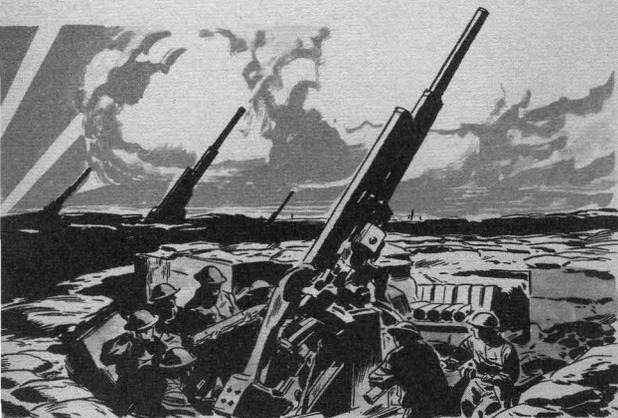


ASSIGNED TO SYSTEMS DEVELOPMENT, BLACK LEARNED THE VALUE OF TEAMWORK. THE FACILITIES AND CO-OPERATION AVAILABLE IN A LARGE ORGANIZATION SUCH AS BELL TELEPHONE LABORATORIES ENCOURAGES INDIVIDUAL CREATIVITY.

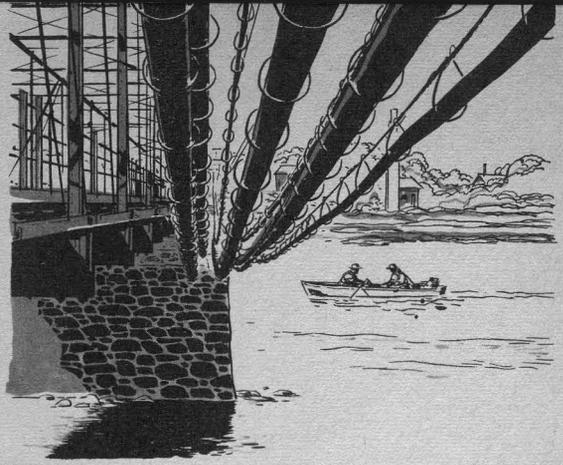


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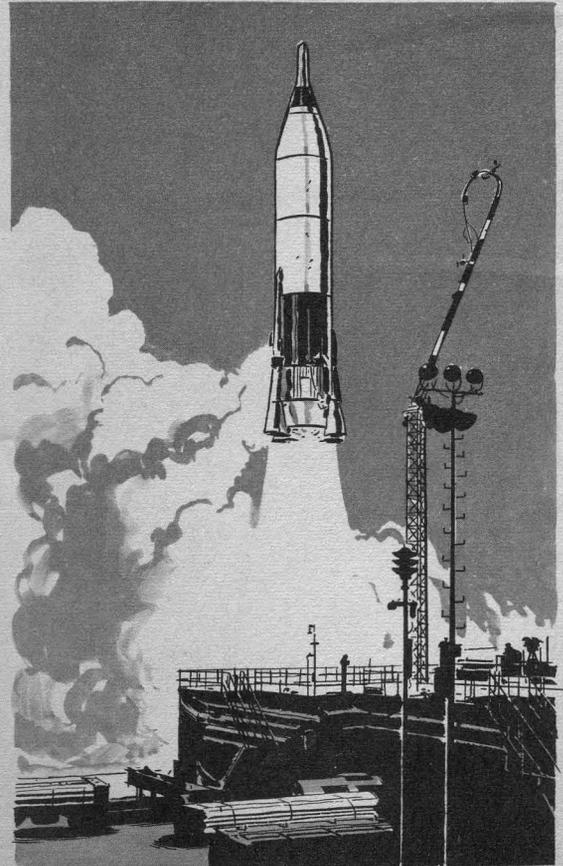
NOT ONLY ELECTRONICS BUT MANY OTHER FIELDS OF HUMAN ENDEAVOR ARE INDEBTED TO HAROLD S. BLACK FOR THE CONCEPT OF NEGATIVE FEEDBACK, WHICH MATHEMATICIANS EXPRESS AS SHOWN.



IN SEPTEMBER, 1942 BLACK'S WORK ON MILITARY SYSTEMS TOOK HIM TO WAR-TORN ENGLAND. NEGATIVE FEEDBACK WAS, AND STILL IS, INDISPENSABLE TO MANY NEW WEAPONS, RADAR, AND ANTI-AIRCRAFT FIRE CONTROL.



BLACK'S NEGATIVE FEEDBACK AMPLIFIERS WERE USED COMMERCIALY IN 1936 BETWEEN NEW YORK AND PHILADELPHIA. THEY SERVED AS REPEATERS IN THE COAXIAL CABLE, WHICH CARRIED HUNDREDS OF MESSAGES SIMULTANEOUSLY, AND, THANKS TO NEGATIVE FEEDBACK, WITH GREAT CLARITY.



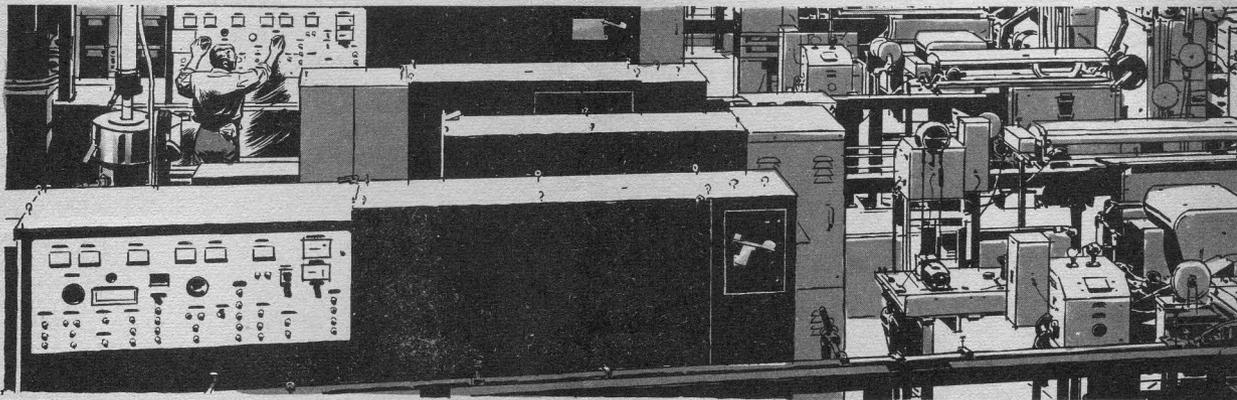
BLACK'S PRINCIPLE OF NEGATIVE FEEDBACK AND ITS EXTENSIONS ARE VITAL TO THE SUCCESS OF AUTOMATION, SERVO-MECHANISMS, AND THE CONTROL OF GUIDED MISSILES AND SPACE VEHICLES OF TODAY.



AND NOW...

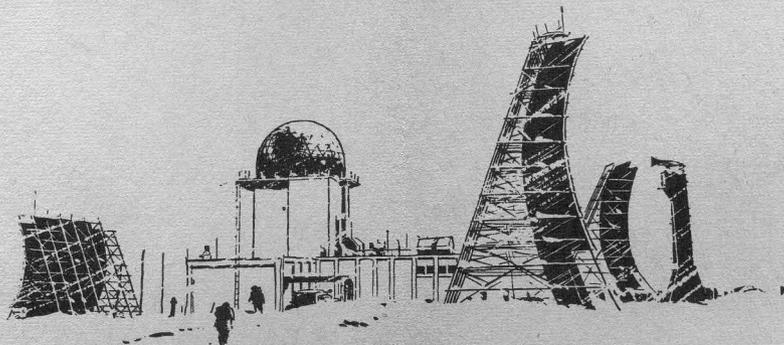
TODAY, THE BELL TELEPHONE SYSTEM, BUILT BY SUCH MEN AS THESE, IS AN IMMENSE UNDERTAKING. RESEARCH ON COMMUNICATIONS OF THE FUTURE IS TODAY'S BUSINESS IN THE BELL LABORATORIES AT MURRAY HILL, N. J.

SOME 12,000 SCIENTISTS, ENGINEERS, TECHNICIANS AND THEIR ASSOCIATES CARRY ON WORK BENEFITING NOT ONLY THE TELEPHONE SYSTEM, BUT THE NATION AND THE WORLD AS WELL.



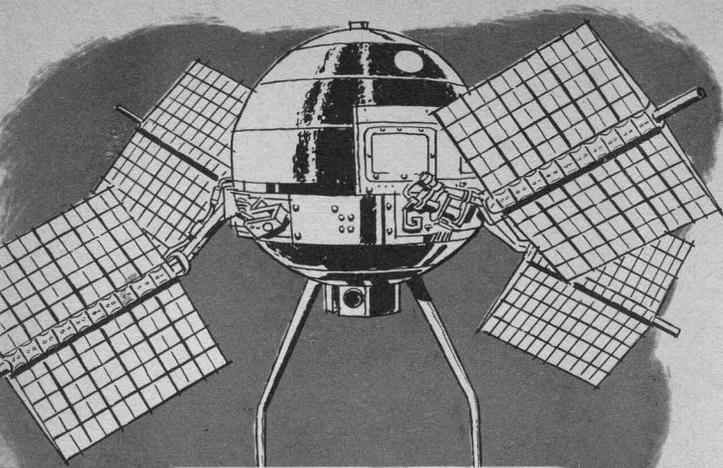
WESTERN ELECTRIC, THE MANUFACTURING BRANCH OF THE BELL SYSTEM, MUST SUPPLY LITERALLY HUNDREDS OF THOUSANDS OF ITEMS. OVER A BILLION DOLLARS A YEAR IS SPENT IN

BUYING MATERIALS FROM SOME 40,000 SUPPLIERS. YET STANDARDS OF QUALITY ARE SO HIGH THAT THE AVERAGE CUSTOMER RARELY EXPERIENCES TROUBLE OR EVEN INCONVENIENCE.

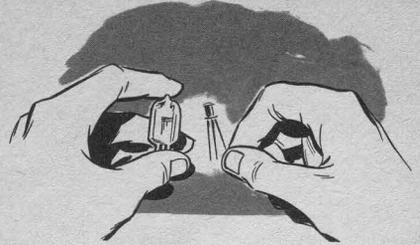


THE SAME TYPES OF SCIENTIFIC AND ENGINEERING TALENTS APPLIED TO THE TELEPHONE ARE AT WORK ON MILITARY REQUIREMENTS. BELL SYSTEM CONTRIBUTIONS HAVE RANGED FROM

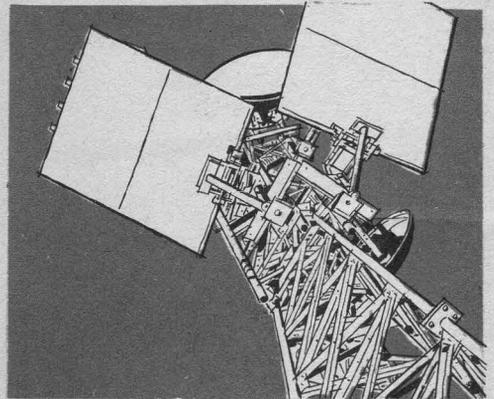
SUBMARINE SONAR TO THE RADIO VOICES OF OUR SATELLITES. ONE EXAMPLE IS THE "DEW" LINE, SPANNING THE ARCTIC TO ALERT THE NATION TO THE APPROACH OF ENEMY AIRCRAFT.



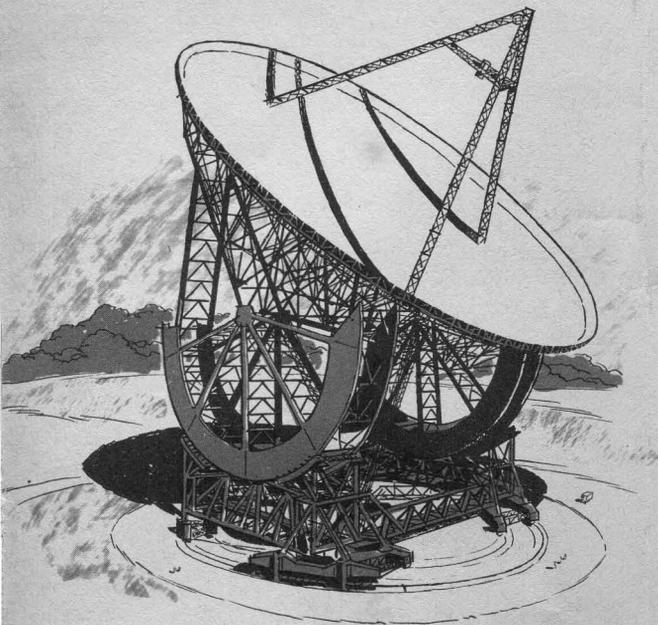
BELL LABORATORIES' SOLAR CELLS TAKE THE PLACE OF BATTERIES, CONVERTING THE SUN'S ENERGY INTO AN UNFAILING SOURCE OF ELECTRICITY.



THE 1956 NOBEL PRIZE IN PHYSICS WAS WON BY 3 SCIENTISTS AT THE BELL LABORATORIES FOR THEIR INVENTION OF THE TRANSISTOR. THIS TINY DEVICE IS "THE GIANT OF THE ELECTRONIC AGE," OPENING NEW VISTAS IN AUTOMATIC CONTROLS, SPACE EXPLORATION, MEDICINE AND THE CONSTRUCTION OF MINIATURE RADIOS.



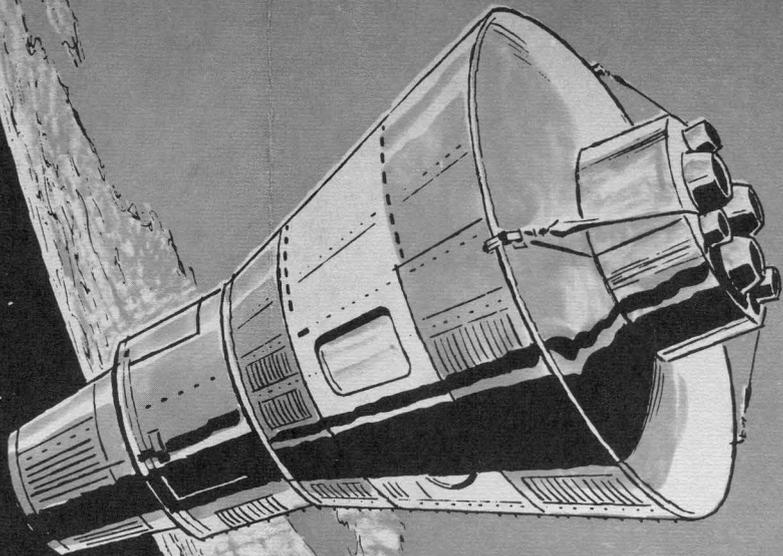
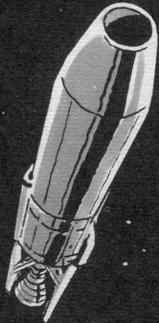
BY RADIO-RELAY, SUPER-HIGH FREQUENCIES CALLED MICROWAVES CARRY TELEPHONE CALLS, RADIO AND TV PROGRAMS FROM TOWER TO TOWER ACROSS THE COUNTRY.



YOUNG BELL LABORATORIES' PHYSICIST KARL G. JANSKY BUILT THE WORLD'S FIRST RADIO TELESCOPE IN THE EARLY 1930 S. TODAY'S RADIO ASTRONOMERS USE HUGE "DISHES" LIKE THESE TO DETECT AND RECORD RADIO WAVES FROM OUTER SPACE, ENABLING THEM TO "MAP" THINGS FAR BEYOND THE RANGE OF SIGHT.

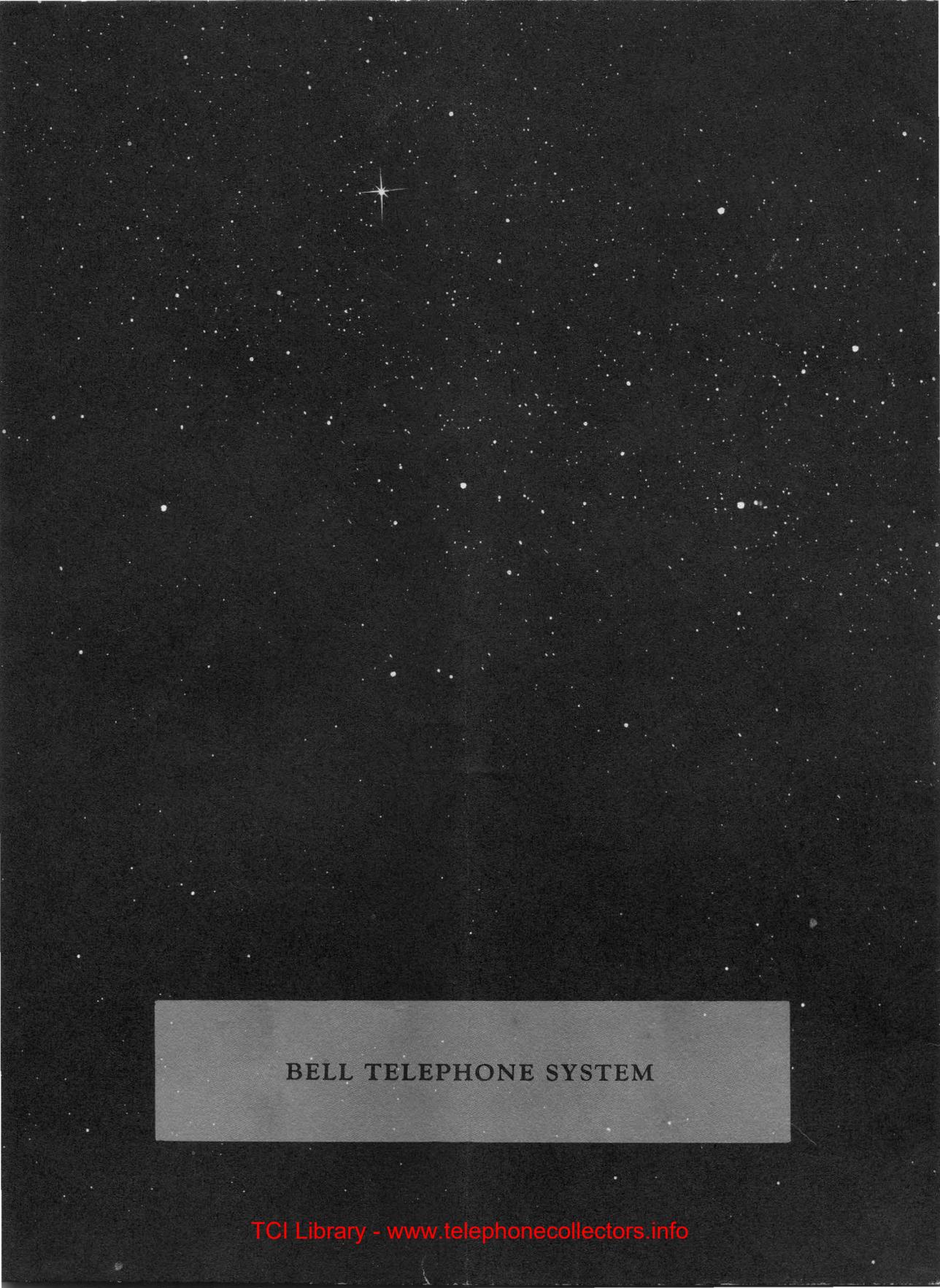


MANY STARTLING INNOVATIONS ARE IN STORE FOR THE AVERAGE TELEPHONE USERS, TOO. A FEW YEARS FROM NOW, EACH OF US MAY BE CARRYING A POCKET RADIOTELEPHONE ALLOWING US TO TALK WITH ANYONE, ANYWHERE, ANYTIME.



THE BELL SYSTEM'S GUIDANCE AND TRACKING NETWORK FOR MANNED FLIGHTS INTO SPACE, SUCH AS PROJECT MERCURY, GIVES US A GLIMPSE INTO A NEW AND WONDERFUL AGE. IN THE NEAR FUTURE, TOO, THE BELL SYSTEM WILL EXPERIMENT WITH WORLD-WIDE EARTH-SATELLITE COMMUNICATION.

THE WORLD'S GROWING POPULATION AND CLOSER TIES BETWEEN PEOPLE AND NATIONS MEAN CONTINUING DEMANDS FOR MORE AND BETTER COMMUNICATION. THE BELL TELEPHONE SYSTEM IS PLANNING FAR AHEAD TO MEET AND SURPASS THESE DEMANDS. TELEPHONE RESEARCH NOW HELPS TO PROBE THE HEAVENS AND ONE DAY WILL HELP CARRY US TO THE STARS.



BELL TELEPHONE SYSTEM