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REDUCED RATES!

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Sent to Fort Kearney on the mornings of MONDAY and FRIDAY, will connect with **PONY** leaving St. Joseph, WEDNESDAYS and SATURDAYS.

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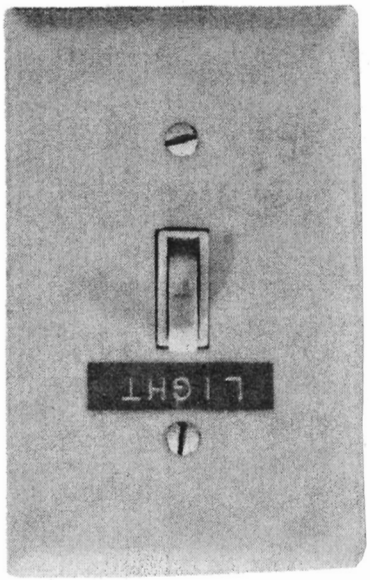
WELLS, FARGO & CO., Ag'ts.

New York, July 1, 1861.



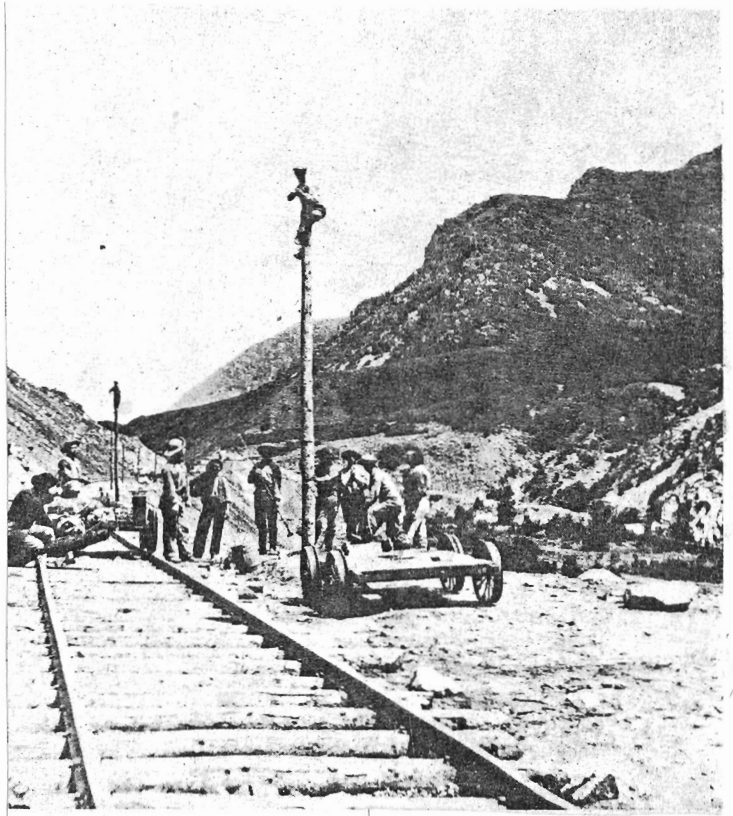
CULVER PICTURES, INC

The transcontinental telegraph replaces the Pony Express.

In 1860, the telegraph from the east coast went only as far west as St. Joseph, Missouri. If you needed to get news to the west coast, it took months carried by ships, wagon trains or stagecoaches. This proved frustratingly slow for most people, so a relay system of horse riders called the Pony Express was devised to speed things up. The very first rider left St. Joseph on April 3, 1860. Stations were located 10 to 15 miles apart. Each rider rode about 75 miles before the mail was passed on to the next rider. It took eight days for a mail pouch to be carried from Missouri to California. When a rider was hired, he was issued a rifle and a Colt revolver to be used strictly for defense, a Bible, and a horn to be blown on approaching a station. 75 horses were used to run the route. At first it cost $5 to send a letter weighing ½ an ounce to California. Later, it dropped to $1. The fastest Pony Express delivery took place in 1861 when President Lincoln's inaugural speech was carried to California in 7 days and 17 hours. Buffalo Bill Cody was probably the most illustrious rider. In October, 1861, the first telegraph line was connected through to California. Now messages could reach the west coast in minutes. After only 18 months, the Pony Express became obsolete.

In a second or two it becomes horse and rider, rising nearer – growing more and more defined – nearer and nearer, and the flutter of hoofs comes faintly to the ear – another instant a shout and a hurrah from our own upper deck, a wave of the rider's hand, but no reply, and a man and a horse burst past our excited faces, and go winging away like a belated fragment of a storm!

- Mark Twain



Building the telegraph

PHOTO: UTAH STATE HISTORICAL SOCIETY

Erecting a pole circa 1948

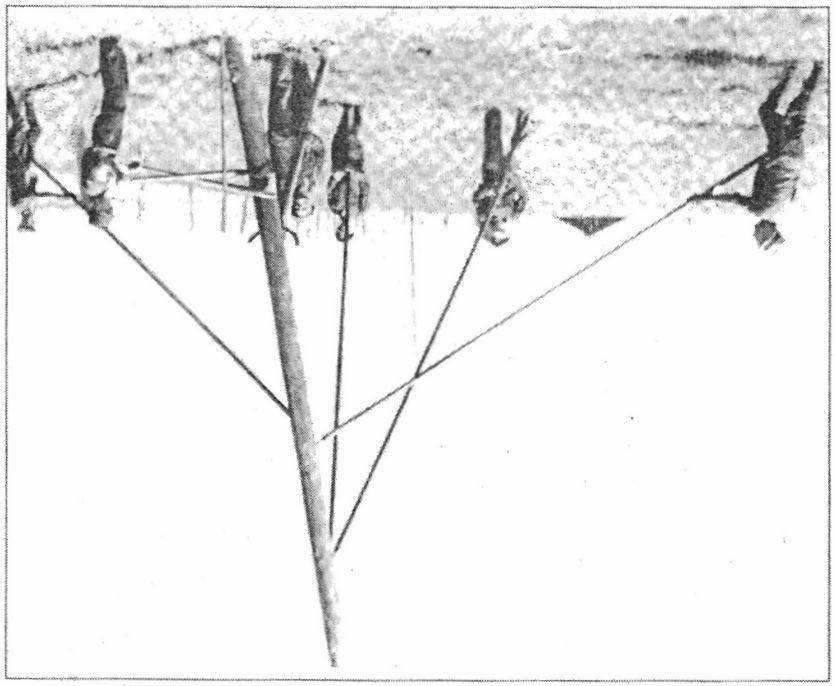


PHOTO: NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

"First come two men with a tape, a load of stakes and some paint. They measure off the pole spacing. They quickly appraise the local conditions, paint a few symbols on a stake and drive it into the ground. Repeating this process, they move down the line. Pretty soon a truck loaded with poles comes along. The driver and his helper read the symbols on the stake and kick off the necessary pole. Then comes the assembly truck. The driver reads the stake's message, unloads insulators, nuts and bolts, a transformer, guys and anchors. Next comes the post hole diggers and mechanics. The stake tells the diggers where the hole should be dug, and it tells the mechanics what hardware should be attached to the pole. Then a gang of men with pike poles and equipment follow, quickly setting the pole in place. Then comes the truck to string the wire. As it moves along, the linemen secure the conductors, hand the transformers and otherwise prepare the line for service."

-- M.O. Swanson, the Rural Electrification Agency's first chief engineer, on early line construction technique

POWER TRANSMISSION
REGIONAL HISTORY

Thomas Edison invented the incandescent bulb in 1879. Three years later he began generating and delivering electricity via direct current to 85 customers in lower Manhattan. By 1900 residents in every major American city had electric power, and by the 1950s, virtually the entire country was electrified. But rural Northeastern Nevada was still without power. The region was known as the "Last Great Power Desert".

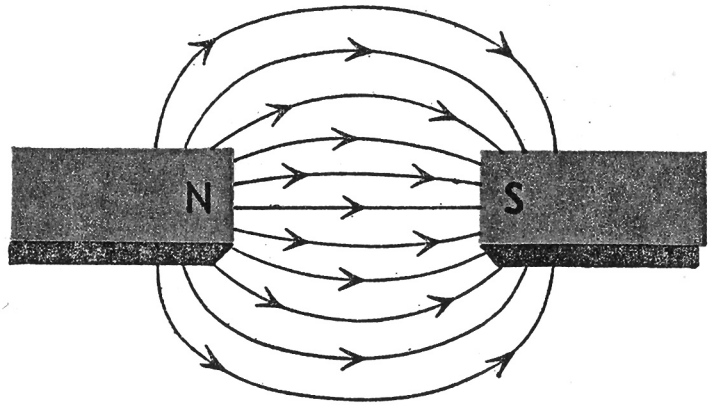
In 1925 University of Nevada electrical engineering graduate Harry Cazier applied to establish a private power company in Wells, NV which eventually became the first rural electrification project in Nevada. Wells Power Company started with the smallest hydro-electric generating plant General Electric made at 120 kilowatts. It was located at the headwaters of Trout Creek, eight miles west of Wells in the East Humbolt Range. On December 17, 1927 Wells Power Company energized the plant and within a year, two gas engines were added to supplement the output of the power plant during peak demand. These were followed by a 50-kw generator from a mining company, and then three 90-kw diesel generators. Within a few more years, two 300-kw generators and a 500-kw Worthington were put on line.

In 1960, Wells and surrounding areas were converted from private to public power when Wells Power Company was sold to Wells Rural Electric Company. Under WREC, power was extended to Clover Valley, Ruby Valley, Metropolis and a number of ranches that had been working off of their own small but loud diesel generators. In November of 1960, a 138 kv transmission line was completed from Idaho Power Company's King station near Hagerman, Idaho approximately 130 miles south to Wells.

During WWII electric power in Wendover was supplied from four generating sources: Wendover Air Force base, the State Line Hotel & Casino, Peterson's Market & Western Service Station. After the war, Wendover Power took over the base generators. In 1962, Wendover Power Company was sold to Wells Rural Electric Co-op and power was extended to customers in Oasis, Prequop Station, the Lee and Jiggs area, the O-Neil country north of Wells and the Marys River country north of Deeth. In 1979 Carlin's municipal power plant was shut down and its customers began getting electricity from WREC. In 1986 a power line was finally built to Pine Valley, one of the last places in the states still not served by central station electricity.

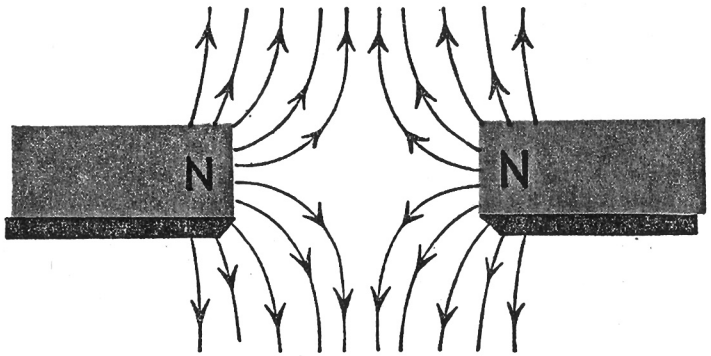
A	Alfa	I	India	R	Romeo
B	Bravo	J	Juliett	S	Sierra
C	Charlie	K	Kilo	T	Tango
D	Delta	L	Lima	U	Uniform
E	Echo	M	Mike	V	Victor
F	Foxtrot	N	November	W	Whiskey
G	Golf	O	Oscar	X	X-ray
H	Hotel	P	Papa	Y	Yankee
		Q	Quebec	Z	Zulu

This is the setup of a simple telegraph system.

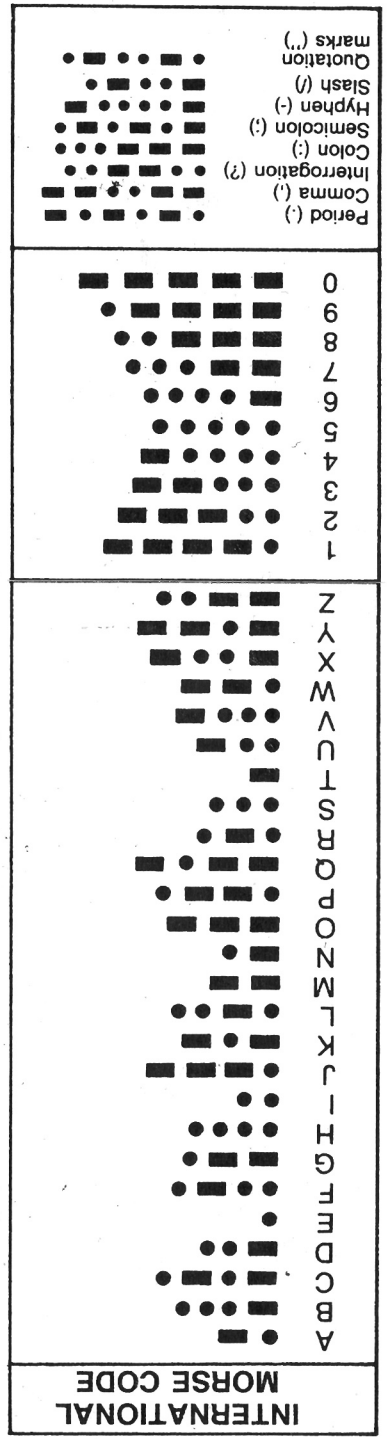


Imaginary lines of force pull opposite poles together.

There is a way of mapping out magnetic lines of force. All you need do is to put the magnet on a table and lay a card over it. Then scatter some tiny bits of iron (iron filings) all over the card. Tap it with a pencil, and the filings will line up to give a very real-looking picture of the lines of force.



Here, the lines of force are pushing two similar poles apart.



LOCATED IN FRONT OF SILVER SMITH CASINO, WENDOVER

In an electromagnet, the wire is coiled into a spiral.

P = POWER
E = VOLTAGE
I = CURRENT
R = RESISTANCE

AT&T SYSTEM 1972

Fig. 11-10. TD2 system broadband routes, 1980.

This system was designated the Transmission Surveillance System—Radio (TSS-R).

Like a pump, a battery keeps current flowing.

To make electricity useful, the current must keep on flowing. If you wanted to make a water system where there would be a lasting current, you could hook up a pump and a loop of pipe as in the picture. The pump keeps up a difference of pressure between its outlet and its return connection, and this sends the water around the loop again and again.

In the same way you can hook up a loop of wire to the two posts (or *terminals*) of a battery, which is a kind of electrical pump.

TELECOMMUNICATIONS

The transmission of words, sounds, images or data in the form of electronic or electromagnetic signals or impulses. - West's Encyclopedia of American Law

Communications are the nervous system of the entire SAC organization, and their protection is therefore, of the greatest importance. I like to say that without communications, all I control is my desk, and that is not a very lethal weapon. - Gen. T.S. Power, CINCSAC, May 1959

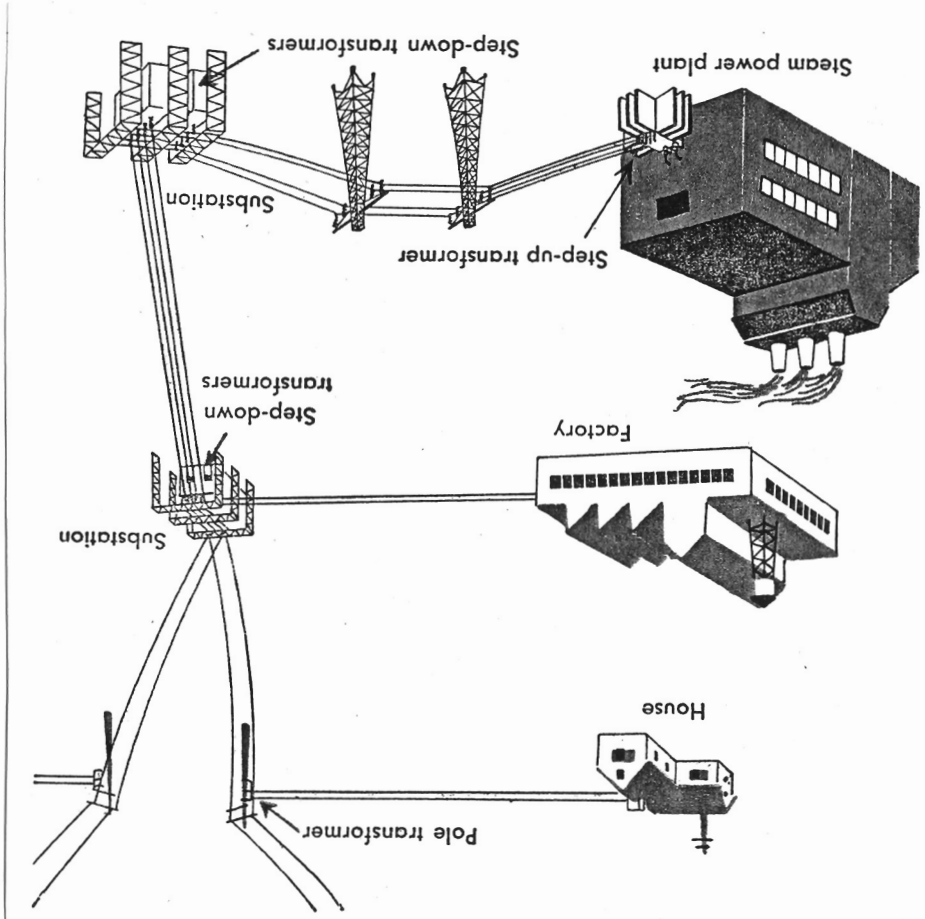
Communications is the foundation of democracy. - AT&T facility placard

Telegraph, telephone, radio, radar, broadcast television, cable television, satellite television, fax, cell phones and computer networks allow us to exchange ideas. Until recently, federal and state governments regulate frequency allocation, the pricing of telecommunication systems and the content of transmitted material. The Telecommunications Act of 1996 (Pub. L. No. 104-104) deregulated much of the telecom industry allowing competition in markets previously reserved for government-regulated monopolies. Now private monopolies, adhering to corporate reasoning, are formed instead.

The first telegraph system in the US was completed in 1844. It was originally used as a way of managing railroad traffic. The Associated Press was formed in 1848 to pool telegraph expenses, and other wire services soon followed. In 1856, Western Union Telegraph Company became the first dominant national telegraph system. In 1861 they completed the first transcontinental line, connecting San Francisco first to the midwest and then to the east coast. Interest grew in the international applications of the telegraph, and in 1865 the International Telegraph Union was formed to establish international communication standards. In 1866 the first transatlantic cables were completed. The telegraph era ended after WWII, with the advent of high-speed transmission technologies that did not use wires. By 1988 Western Union was reorganized to handle money transfers and related services.

The invention of the telephone in the late 19th century led to the creation of the American Telephone and Telegraph Company. The company owned virtually all telephones, equipment and transmission wires for personal and business service in the nation. AT&T also maintained military circuits. The backbone of the system for a time was the L Carrier Coaxial System (L CXR or, publicly, the Transcontinental Cable aka Long Lines), a network which went over both cable and microwave. L CXR was developed prior to WWII as a high capacity telephone and television transmission system. Coaxial cable and repeaters were buried underground to take advantage of the constant temperature. Most lines were used for civilian traffic, but as the Cold War went into full swing, L-3 was chosen as the primary transmission medium for defense critical circuits. Main stations linking coaxial cable routes together were fully hardened to withstand a 20 megaton blast 2 ½ miles away. Microwave horns were covered with a protective shield to withstand radioactive fallout. After the Cuban Missile Crisis, the newly formed National Communications System developed the AUTOVON stand alone defense telephone system and co-located the AUTOVON switching centers in the main L CXR stations.

On May 28, 1961, two microwave repeater stations and an underground repeater station on the main L CXR route were blown up. One of them, the Wendover Notch site, was in Nevada. The others, Cedar Mountain and Knolls were in Utah. The two accused of the crime were Bernard Brous of Long Island, NY, and Dale Jensen of Reno, NV. Also involved were Brous's wife Minne and Robert Bortoli. Brous admitted to being the leader of what he called the "American Republican Army" which, he said, advocated the political and big business overthrow of the United States. He claimed AT&T had refused him a contract 3 years earlier, driving him to financial ruin.



Electricity on the Move

1, 2

Transformers like this reduce power for safe use in homes.

Fig. 3. Typical supports.

Transmission refers to the movement of large currents over grid systems that can span continents. From the generator, electrons travel a short distance to a nearby transmission station where voltage is increased to high levels with a transformer. The power is then sent into a grid consisting of thick cables supported by high towers. A transmission grid connects generators to each other and to substations where voltage is reduced for distribution. Grids are transportation systems. A high-voltage transmission grid is an interstate for electrons. Transmission lines are rated from 115kv to 765kv. Distribution lines are generally between 69kv to 138kv. As the electrons move further down the system, voltages are dropped below 69kv and routed to various local substations and transformers. When electricity arrives to homes it is rated at 240v, which is what larger devices such as laundry machines may draw, but power at most wall sockets is stepped down to 120v.

Interconnections permit a utility to spread its generating plants over a wide area, and provide regional backup in case of problems at a given plant. In 1963, a New York utility went down and inadvertently caused domino-like massive failure of a series of other generating plants, which ostensibly could have taken down every utility in the country. To prevent this sort of thing from ever happening, the US was divided into 3 main interconnections: Western, Eastern and Texan/ERCOT. Each region is self sufficient, though they are tied together with DC interties. Instead of individual utilities having to build extra generators to cover routine or emergency shut-downs, they can buy power from each other as needed via the interconnection.

This high level of system integration can lead to problems. In August, 1996 a series of failures during a period of heavy demand led to a destructive cascade as plant after plant switched out of the grid to avoid equipment damage. As more and more power is forced through a transmission line, its temperature rises and it expands or 'sags'. The 1996 blackout was started by a line sagging into a tree branch and shorting out. As current was rerouted to alternate lines, some of them also sagged into trees. Within minutes much of the west was off line. Over time, expansion and contraction can cause lines to wear out. Lines face other stresses including sabotage, wind, weather and solar flares which can induce large current in grids. The power grids themselves act as giant antennas, and when the earth below them is particularly non-conductive, the electromagnetic energy will travel through the grid instead.

Smith diagram showing circles of constant standing wave ratio, each corresponding to a particular terminal impedance as follows: (a) The terminal impedance (p_1) is $\widetilde{Z}(1) = 2 + j0$. (b) The terminal impedance (p_2) is $\widetilde{Z}(1) = 1.5 + j2$. (c) The terminal impedance (p_3) is $\widetilde{Z}(1) = 0 + j0$.

In 1982 AT&T settled a lawsuit against antitrust violations because of its monopolistic holdings. It divested itself of its local operating companies but retained control of its long-distance, research and manufacturing activities. The breakup of the Bell System meant defense related costs could no longer be passed on to the consumer. But ultimately, it was demand for bandwidth that killed the L Carrier System. A microwave or coaxial link can only carry a small percentage of the capacity that a single fiberoptic strand can, and with the explosion of the Internet, bandwidth is king. MCI and other companies began laying fiber optic across the US, and by 1990 almost all the L CXR systems had been shut down. Some of the main stations have an after life as fiber switching centers. And most of the Long Lines microwave towers have been sold to American Tower for conversion to PCS and Cellular mounting surfaces.

Fig. 3-12. The Smith chart transmission-line calculator. By means of the chart, the input impedance and standing-wave ratio may be determined for a transmission line of any length terminated in any impedance. [Smith, *Electronics* 12 (1939): 31.]

Before 1996, the Federal Communications Commission (FCC) restricted persons or entities from acquiring excessive power through ownership of multiple radio and TV facilities. The rule was based on the assumption that if one person or company owned most or all of the media outlets in an area, the diversity of information and programming on these stations would be restricted. The Telecommunications Act of 1996 eliminated this limit, rendering smaller independent stations virtually extinct, undermining diversity of station ownership and programming. Clear Channel Communications, Infinity Broadcasting and Citadel Communications have since increased their combined holdings from roughly 80 stations to 1,200. An accompanying merger-and-acquisition frenzy has bid up prices for existing stations and frequencies to unprecedented levels, all but locking out independent broadcasters from most major markets and reducing the number of owners by more than 20 percent.

Direct Current (DC) can be thought of as a constant gush of electrons. Alternating Current (AC) operates by oscillating back and forth at a specific frequency. In the United States, this frequency was arbitrarily set at 60 Hertz or cycles per second. In Europe, 50 Hertz is used. Generators connected to a common grid must be kept in synchronous operation to maintain the 60Hz frequency. Since electricity cannot be stored, grids must remain constantly energized. The amount of power generated must remain the amount demanded at any given time. Instabilities in the system, if not corrected, can cause it to collapse and result in blackouts.

Most transmission systems operate with AC, which can be transmitted economically across long distance lines. But High-Voltage DC lines have been used on some routes since the 1960s. DC transmission fell out of favor after its early beginnings in the 1880s because there was no efficient way to change its voltage and transmit it more than a few miles. Later, technological advances led to several western DC projects including the Pacific DC Intertie in 1970 and the Intermountain-Adelanto DC tie in 1986. These systems convert generated AC to DC with a rectifier before transmission, and then back to AC with an inverter for distribution to end users. Using HVDC overcomes the problem of synchronizing at 60Hz as DC has no frequency. Though it is generally only economical over very long distances, using voltages of 500kv or higher.

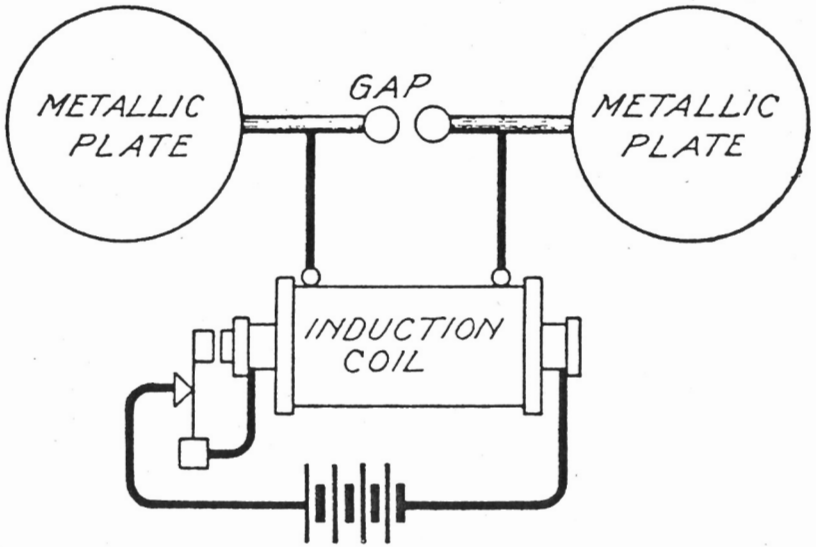
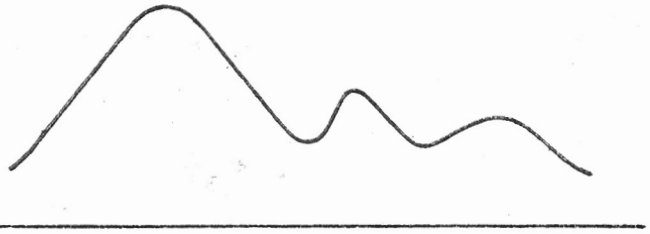


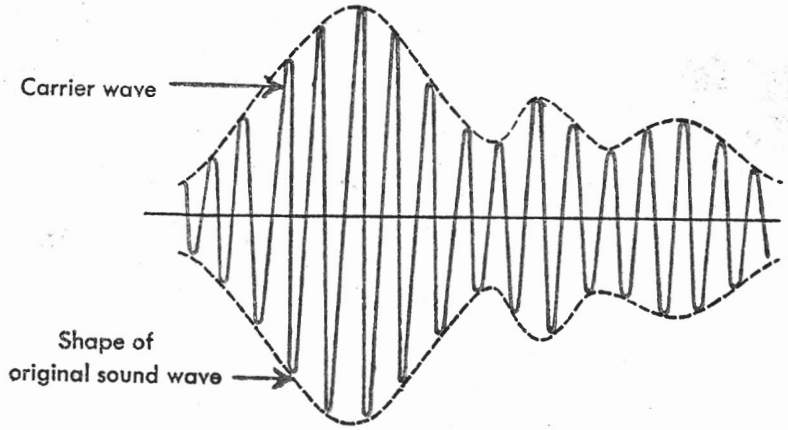
Fig.1 *World's first radio transmitter and receiver were built by Hertz in 1884. The spark transmitter (left) operated near 100 MHz, in the vicinity of today's FM band. A capacitor made of large metallic plates was excited by an induction coil. Radiator was a rudimentary dipole antenna, broken at the center for the spark gap. The receiver (right) consisted of a resonant wire loop with a gap. A tiny spark could be seen in a dark room when the loop was adjusted.*

WESTERN SYSTEMS COORDINATING COUNCIL
MAP OF PRINCIPAL TRANSMISSION LINES
JANUARY 1, 1998

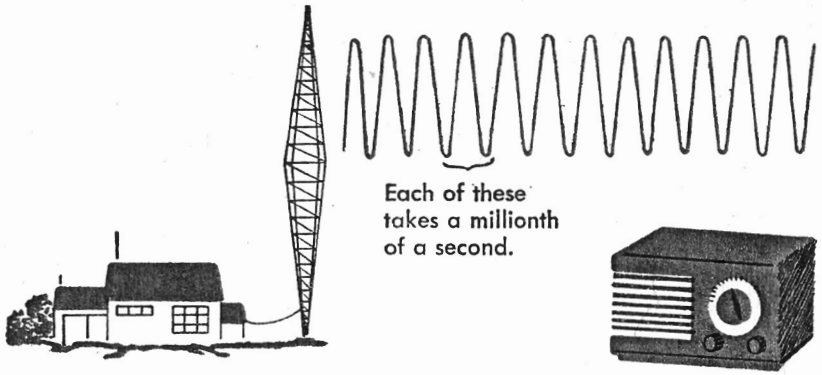
1. BONNEVILLE POWER ADMINISTRATION
2. WASHINGTON WATER POWER COMPANY
3. SEATTLE CITY LIGHT
4. TACOMA CITY LIGHT
5. PACIFICORP
6. PORTLAND GENERAL ELECTRIC COMPANY
7. PUGET SOUND ENERGY
8. CHELAN COUNTY PUBLIC UTILITY DISTRICT
9. DOUGLAS COUNTY PUBLIC UTILITY DISTRICT
10. GRANT COUNTY PUBLIC UTILITY DISTRICT
11. NEBRASKA PUBLIC POWER DISTRICT
12. TRI-STATE GENERATION & TRANSMISSION ASSOCIATION
13. WESTERN AREA POWER ADMINISTRATION - MID-PACIFIC AREA
14. PACIFIC GAS AND ELECTRIC COMPANY
15. STATE OF CALIFORNIA - DEPT OF WATER RESOURCES
16. SIERRA PACIFIC POWER COMPANY
17. SACRAMENTO MUNICIPAL UTILITY DISTRICT
18. DEPT OF WATER & POWER - CITY OF LOS ANGELES
19. SOUTHERN CALIFORNIA EDISON COMPANY
20. METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
21. SAN DIEGO GAS & ELECTRIC COMPANY
22. BRITISH COLUMBIA HYDRO & POWER AUTHORITY
23. WEST KOOTENAY POWER LTD
24. THE MONTANA POWER COMPANY
25. IDAHO POWER COMPANY
26. WESTERN AREA POWER ADMINISTRATION - UPPER MISSOURI AREA
27. WESTERN AREA POWER ADMINISTRATION - LOWER MISSOURI AREA
28. NORTHERN CALIFORNIA POWER AGENCY
29. WESTERN AREA POWER ADMINISTRATION - LOWER COLORADO AREA
30. ARIZONA PUBLIC SERVICE COMPANY
31. SALT RIVER PROJECT
32. TUCSON ELECTRIC POWER COMPANY
33. WESTERN AREA POWER ADMINISTRATION - UPPER COLORADO AREA
34. WESTPLAINS ENERGY
35. PUBLIC SERVICE COMPANY OF COLORADO
36. COLORADO SPRINGS UTILITIES
37. TRANSMISSION AGENCY OF NORTHERN CALIFORNIA
38. PLAINS ELECTRIC GENERATION & TRANSMISSION COOPERATIVE, INC.
39. BUREAU OF RECLAMATION, U.S. DEPT. OF INTERIOR
40. PUBLIC SERVICE COMPANY OF NEW MEXICO
41. EL PASO ELECTRIC COMPANY
42. NEVADA POWER COMPANY
43. BLACK HILLS POWER & LIGHT COMPANY
44. ARIZONA ELECTRIC POWER COOPERATIVE
45. PLATTE RIVER POWER AUTHORITY
46. TRANSALTA UTILITIES CORPORATION
47. DESERET GENERATION & TRANSMISSION CO-OPERATIVE
48. BASIN ELECTRIC POWER COOPERATIVE
49. IMPERIAL IRRIGATION DISTRICT
50. INTERMOUNTAIN POWER AGENCY
51. COMISION FEDERAL DE ELECTRICIDAD
52. TURLOCK IRRIGATION DISTRICT
53. MODESTO IRRIGATION DISTRICT
54. CITY OF FARMINGTON
55. TEXAS - NEW MEXICO POWER COMPANY
56. CITY OF VERNON
57. UTAH MUNICIPAL POWER AGENCY

Now suppose that at a certain moment this sound wave is hitting the microphone in the broadcasting station:



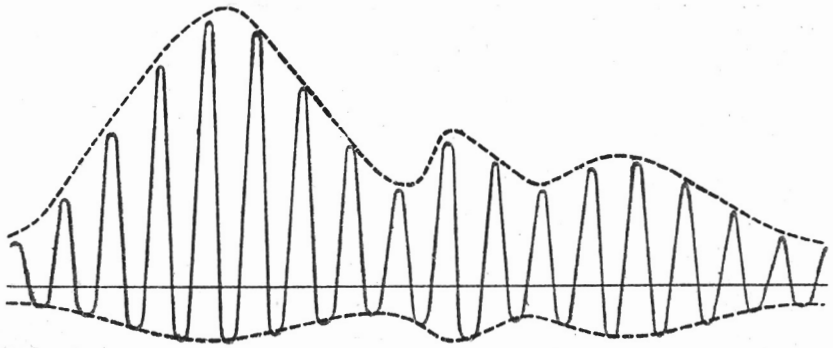


A carrier wave takes the shape of the original sound wave.

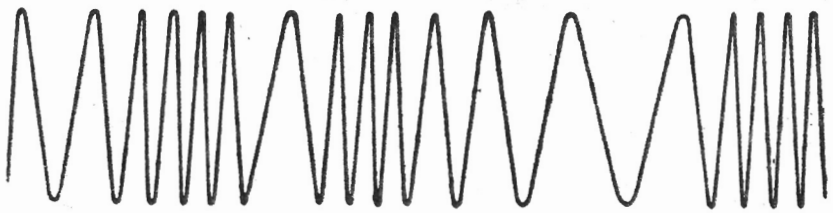


Amplitude Modulation (AM)

The oldest method of transmitting voice and music through the airwaves is by amplitude modulation. (Modulate means to change a wave so it can contain and carry information.) This is accomplished by combining a sound wave from a microphone, tape, record, or CD with a "carrier" radio wave. The result: a wave that transmits voice or programming as its amplitude (intensity) increases and decreases. Amplitude modulation is used by stations broadcasting in the AM band and by most international shortwave stations.



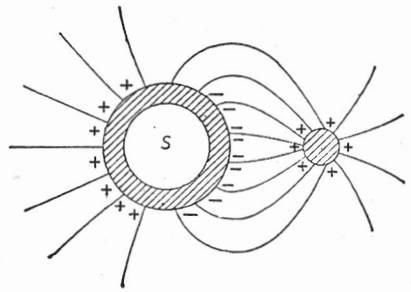
Single sideband, a modified form of amplitude modulation, takes up less band space than a regular AM signal. A sideband is eliminated—then replaced by the receiver (if it has a BFO/SSB control) when you tune it in. Single sideband is used extensively by utility stations, ham stations, some radio pirates, and a few international shortwave broadcast stations.



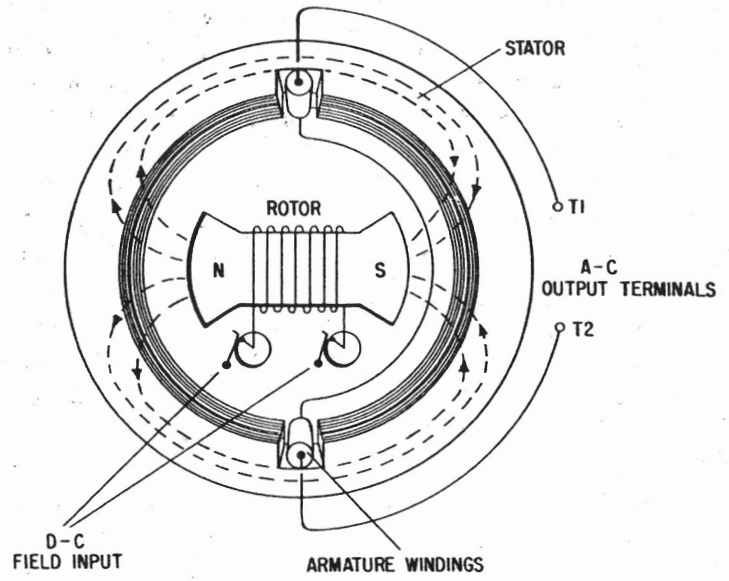
In FM, the frequency of the waves is changed, not the height.

Frequency Modulation (FM)

FM broadcasting provides stereo capability and better fidelity than AM. It is inherently insensitive to most manmade noise and atmospheric static but it requires more bandwidth. As a result, FM is more often used with the VHF and UHF parts of the spectrum where space is less of a problem. FM proved its worth in North Africa during WWII when VHF repeaters were set up along the coast from Tunisia to Algiers.



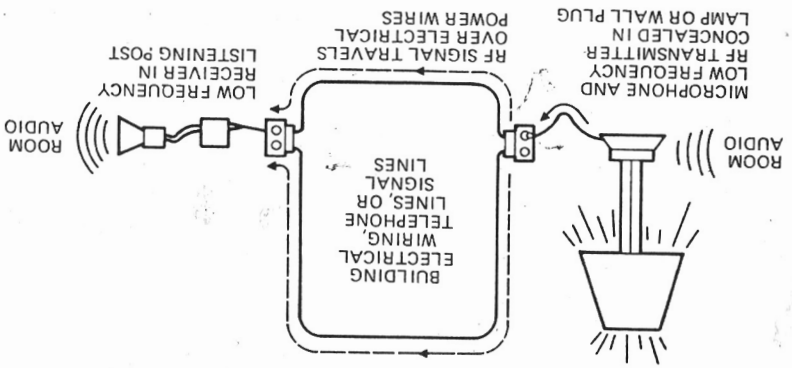
Showing induction and external field. Space S is completely shielded.

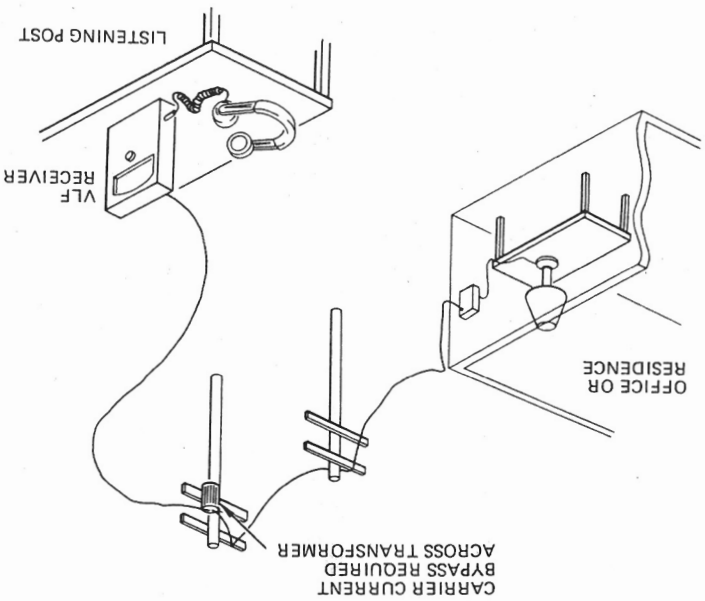


B. 284

Figure 16-1.—Essential parts of a rotating-field a-c generator.

FIGURE 9. CARRIER CURRENT TRANSMITTER





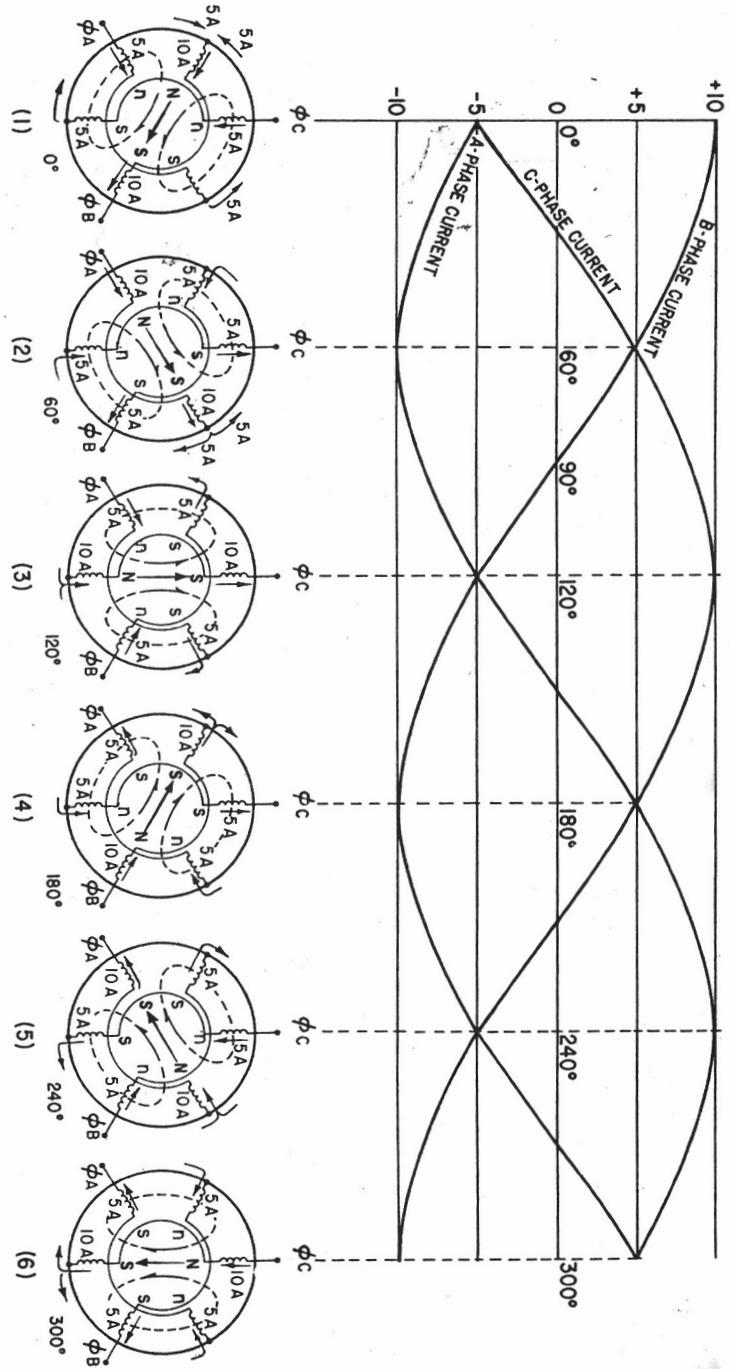


Figure 17-1.—Development of a rotating field.

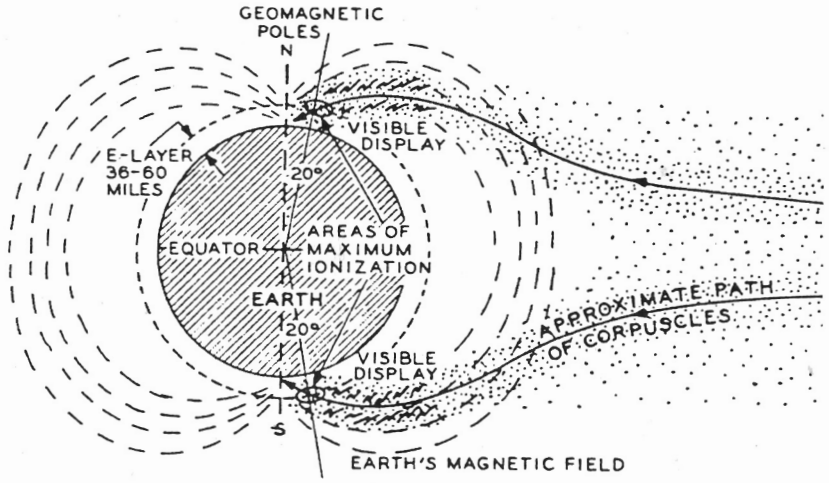
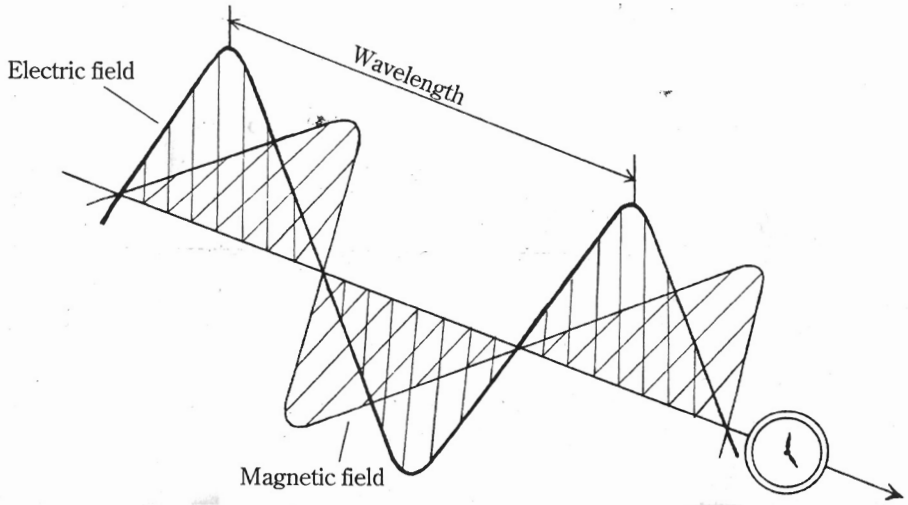


Fig.18 *Maximum aurora display is concentrated in a broad belt near 70 degrees latitude from each geomagnetic pole. The visible ionization occurs at a height of 60 to 70 miles in the E-layer of the ionosphere.*

Aurora display is most prevalent at northern latitudes, but on occasion can be seen as far south as New Mexico or Arkansas. Aurora reflects VHF signals which are modulated by rapid oscillation of aurora, resulting in a characteristic "growl" or "hiss" superimposed on the signal.



Radio waves are made up of an electric and a magnetic field.

PHOTO: RICHARD MENZIES

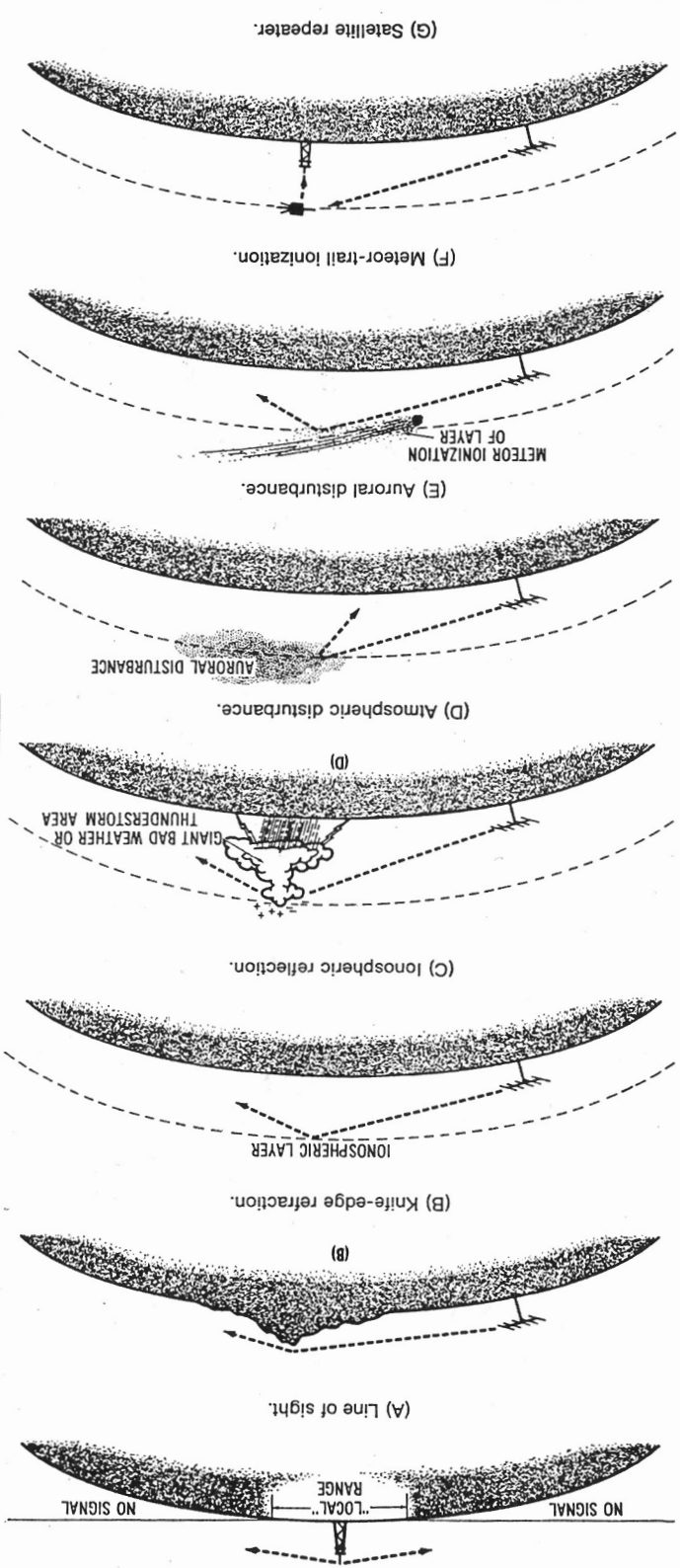
The wireless transmission of energy was first proposed and tested by Nikolai Tesla in 1899. On returning to New York in 1900, he wrote and published the landmark treatise "The Problem of Increasing Human Energy" in Century magazine. It included a long discourse on alternative energy sources such as solar, wind power, and his own wireless transmission system. This was the same man who, 12 years earlier, had invented polyphase alternating current (AC), the system used today by virtually every commercial electric power network. Tesla also pioneered high-power RF work, which basically required that he invent the radio first. While there's no doubt that Enrico Marconi did the real grunt work needed to get wireless telegraphy going as an industry, it necessitated using 14 Tesla patents, as later proven in the U.S. Supreme Court.

In 1974, Robert Golka took up residence in Wendover's 60,000 square foot Enola Gay aircraft hangar. Over the next 8 years he assembled the world's largest Tesla coil from sundry salvaged military hardware and attempted to recreate Tesla's experiments with ball lightning and wireless electricity. He had limited luck. Neighbors complained his experiments disrupted their television reception and he was perceived as a freeloader. Golka was eventually forced out of town in 1980 when the USAF who had been charging him a nominal dollar a year rent on the hangar, donated the entire inactive air base to the town of Wendover. The town, in turn, upped Golka's rent 2,400 percent, resolutely terminating his residency.

For more on Robert Golka's Wendover tenure, see Robert Frank's film "Electricity and How to Get It" starring William Burroughs as The Fed, and Golka as himself.

As the earth rotates, it passes through different ionospheric conditions.

Each layer of the ionosphere has a different effect on radio skip conditions.



In 1987 Golka relocated his lab to Leadville, Colorado, not far from the town of Colorado Springs, where Tesla had investigated wireless transmission a century earlier. He brought with him thirty tons of equipment on three flatbed trucks, his eventual aim to broadcast electrical waves that would traverse the globe by a process he refers to as "Thumping the Schumann Cavity". The Schumann Cavity, also known as the Earth-Ionosphere Cavity, exists at the base of the ionosphere, around 60 miles straight up. It is a thin approximately concentric cavity with electrically conducting walls which supports standing frequencies, or resonates, at a number of VLF frequencies known as atmospheric harmonics. Thumping the cavity basically amounts to getting it to vibrate, or oscillate, more vigorously than usual at one of these resonances. This is done by reinforcing the waves as they return to the broadcast site after having circled the globe, similarly to the way in which coaxial waveguide technology reinforces given frequencies. The result would be a standing wave of electricity encircling the earth which could ostensibly be tapped by some municipal electric company, and then doled out to consumers. According to Golka and Tesla, wireless would be a highly economical alternative because electrical impulses (such as lightning) can be sent around the globe with far less loss in amplitude than in a transmission line, space being a better conductor than copper wire.

Today, various scientific projects such as HAARP in Alaska continue to experiment with resonant auroral electrojet modification.

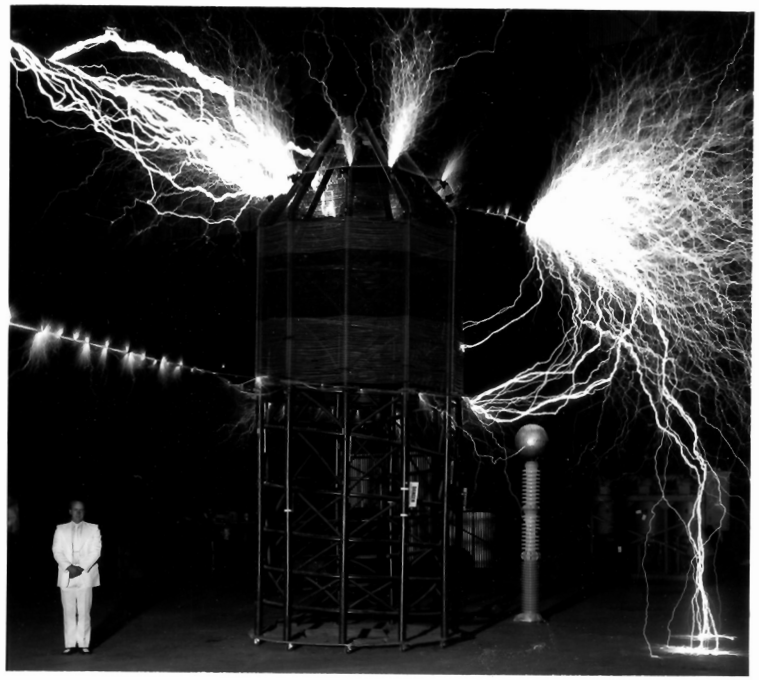


PHOTO: RICHARD MENZIES

Fig. 7-13. Electric and magnetic fields in circular waveguide. [Southworth, *Principles and Applications of Waveguide Transmission* (1950): 120.]

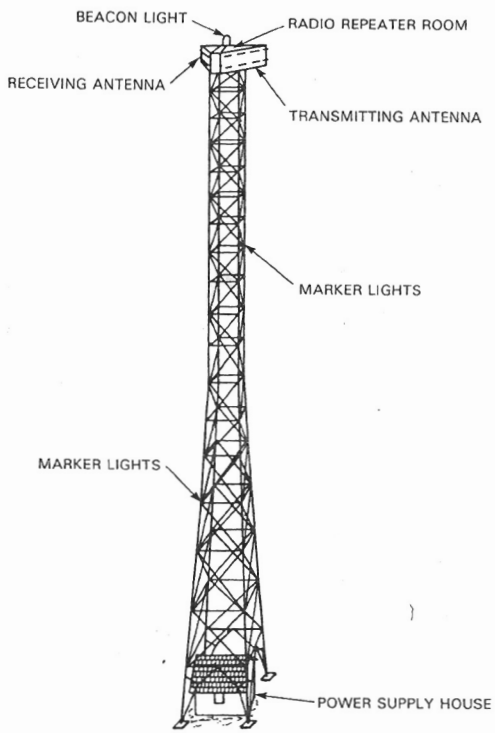
Three of the thousands of modes of oscillation possible on the sun.

Radio Frequency Spectrum

Between the very low frequencies, which can be heard as sound, and the very high frequencies which can be seen as light, are the very useful frequencies we use for radio communications. Although the exact limits are only roughly defined and subject to change as our technology advances, the most usable frequencies are clustered in the center of this radio spectrum. The bar graph below illustrates radio's position in the frequency spectrum.

Sound to Light Spectrum

International and Federal Communication Commission Regulations have designated certain portions of the radio spectrum for various services, from TV broadcasts to two-way police communications. The graphs below give an expanded view of the spectrum from 0.5 to 500 megahertz and show some of the principal FCC assignments.



(a)

THE MOUNTAIN RADIO PROJECT

HYPER-MINIMAL GUIDE TO BUILDING AND OPERATING A LOW POWER FM RADIO STATION
(DOCUMENT #0207)

Use the internet: your greatest tool in creating something lo-tech / analogue is hi-tech / digital.
The list below also illustrates wiring order from source to antenna:

(1) SOUND SOURCE / MIXER / LAPTOP WITH AN APPROPRIATE STEREO CONNECTOR
(1) LOCKED 1 WATT PLL STEREO FM TRANSMITTER WITH POWER SUPPLY
(VERONICA, BROADCAST WAREHOUSE OR PCS ELECTRONICS)
(1) ~3 FOOT LENGTH OF RG-58 RF CABLE WITH APPROPRIATE CONNECTORS (HEAVY, RF STANDARD)
(1) SWR METER TO MEASURE OUTPUT, AND ALLOW FOR TUNING AND CALIBRATING
(1) ~3 FOOT LENGTH OF RG-58 RF CABLE WITH APPROPRIATE CONNECTORS (HEAVY, RF STANDARD)
(1) RF POWER AMPLIFIER WITH POWER SUPPLY; 20-100 WATTS TO COVER SMALL CITIES
(SEE ABOVE MANUFACTURERS)
(1) 50-200 FOOT LENGTH OF RG-58 RF CABLE (CABLE LENGTH BASED ON ANTENNA LOCATION)
(1) DIPOLE OR ADJUSTABLE FM ANTENNA (THE COMET CFM-95SL IS A FINE CHOICE)

The crucial element is high quality RF cable and prime antenna location. If you can't find a hill with a drop-off facing your broadcast target, you'll need to construct a tower or use a fairly tall building to allow the FM propogation wave that will be generated by the antenna to spread out and down, and to avoid feedback that can destroy your equipment.

GOOD LUCK,
Ray Rug + Peter Crik of The Mountain Radio Project - Los Angeles, California, USA
themountainradio@hotmail.com

ELF and VLF
atmospheric harmonics:
(IN HERTZ)

7.8, 14, 20, 26, 33, 39, 45

an approximately concentric cavity made electrically conducting media (The "Earth-Ionosphere Cavity")

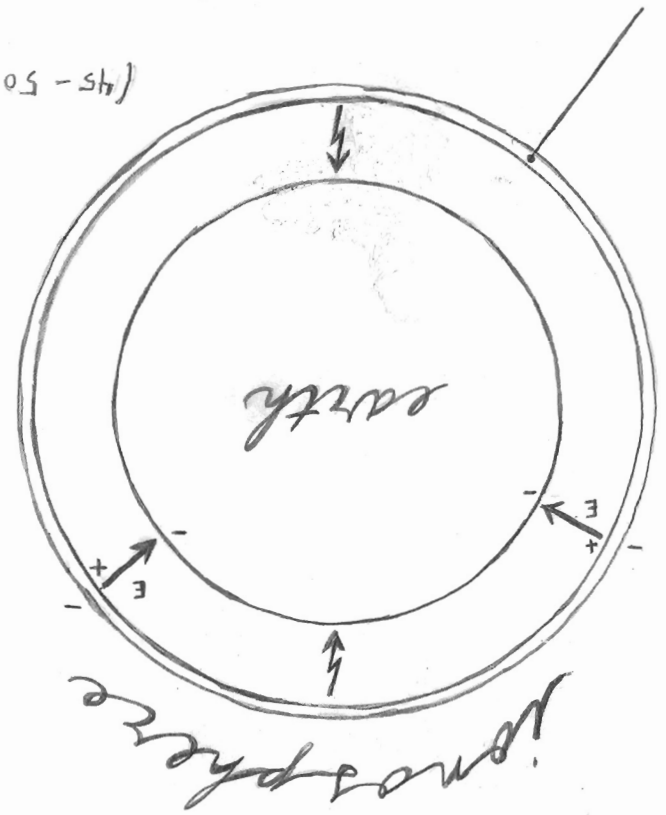


Fig. 3-5. Directional antenna and ground-system arrangement for Station WOR's 50-kw broadcasting station (1935). The central element or 'tower' was a copper cable suspended from a steel messenger supported by the two other radiators. The ground plane consisted of a buried grid of No. 10 copper wires.

7-14 (A) trap dipole, (B) vertical, and (C) beam antennas are popular with ham radio operators.

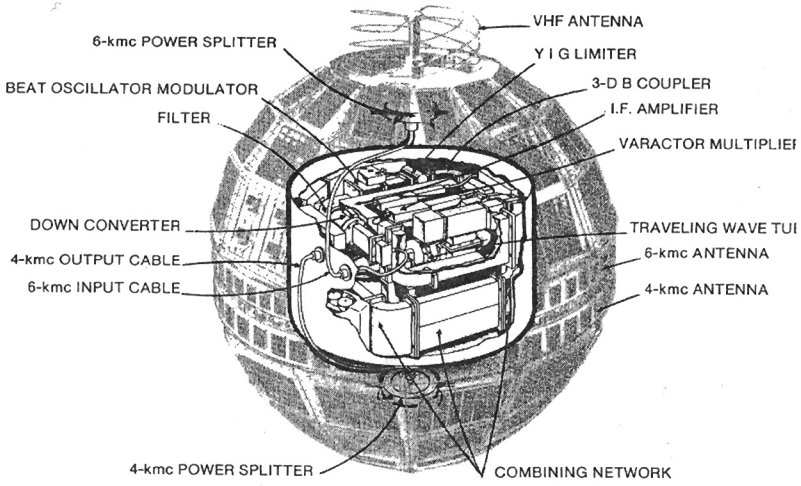


Fig. 13-8. The *Telstar I* electronics canister. All the active components of the repeater were in a hermetically sealed compartment 20 inches in diameter by 17 inches in height.

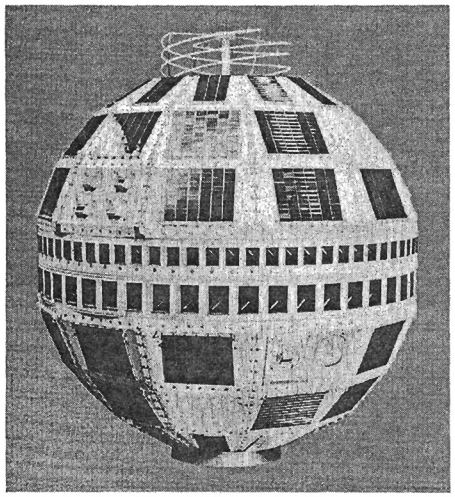
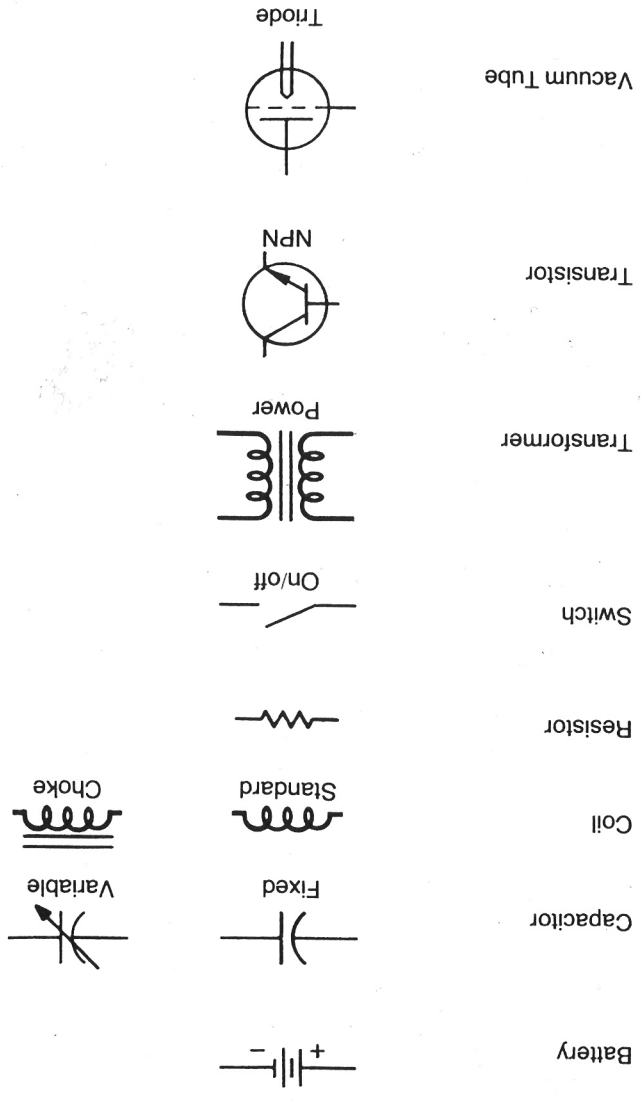


Fig. 13-5. The Bell System's experimental communications satellite, *Telstar I*, as it appeared before launch. Dark areas are solar cell arrays.



LOCAL POWER

GENERATING STATIONS
SUBSTATIONS
TRANSMISSION TOWERS

Suborbital tracks of *Telstar I* for the first 24 hours. Portions with mutual visibility are shown by solid lines.

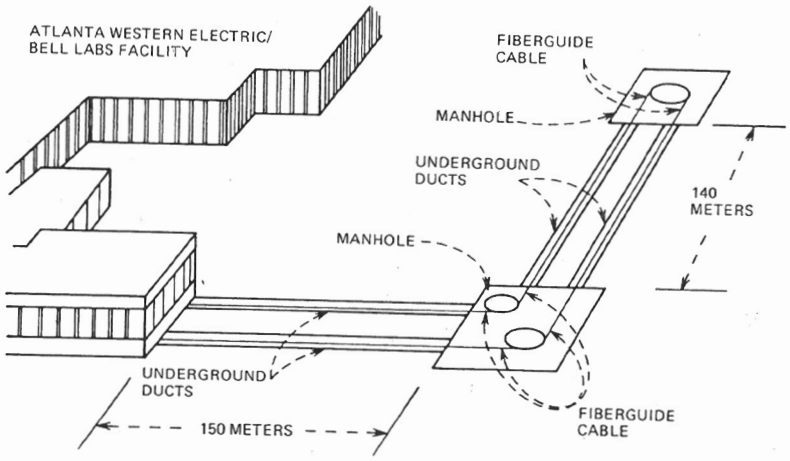


Fig. 20-45. Atlanta optical fiber trial installation.

THINK ABOUT THE DIFFERENCE BETWEEN VARIOUS WIRES AND CABLES AS WATER FLOWING THROUGH PIPES. THE TELEPHONE LINE IS LIKE A GARDEN HOSE. COAXIAL CABLE IS LIKE A FIRE HOSE. BUT FIBER-OPTIC CABLE IS LIKE A CONCRETE CONDUIT 6 FEET ACROSS.

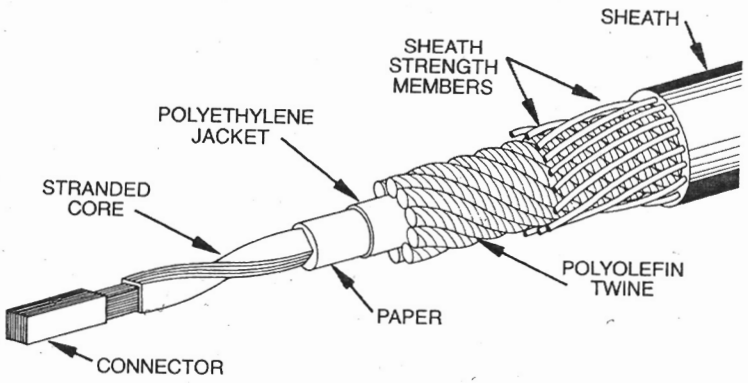
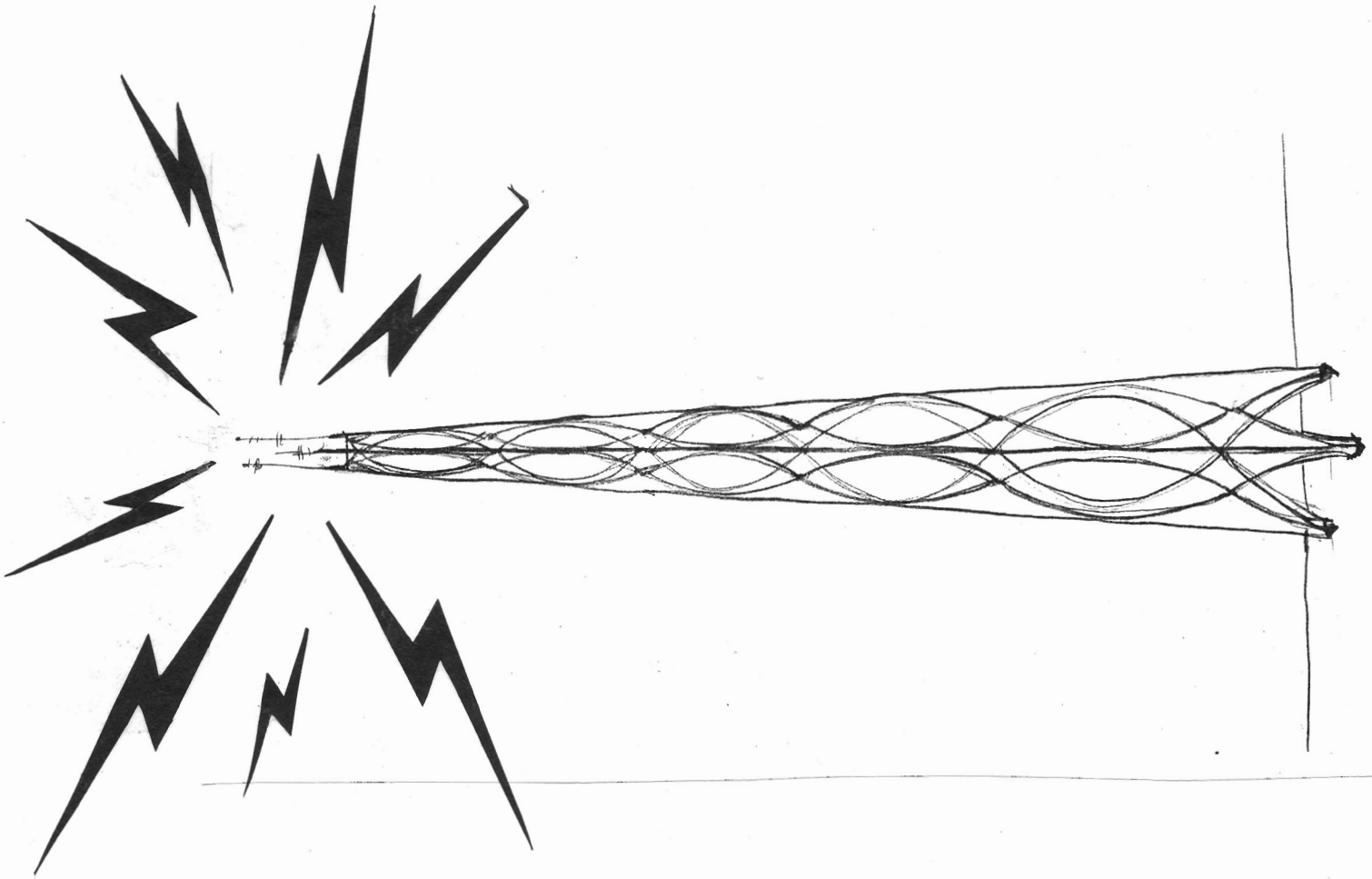


Fig. 20-46. The cable used in the Atlanta system contained 12 ribbons—each encapsulating 12 glass fibers.

A

4, 5

B



TELECOM TOWERS AND SUPPORT STRUCTURES

(50 MILE RADIUS)

D

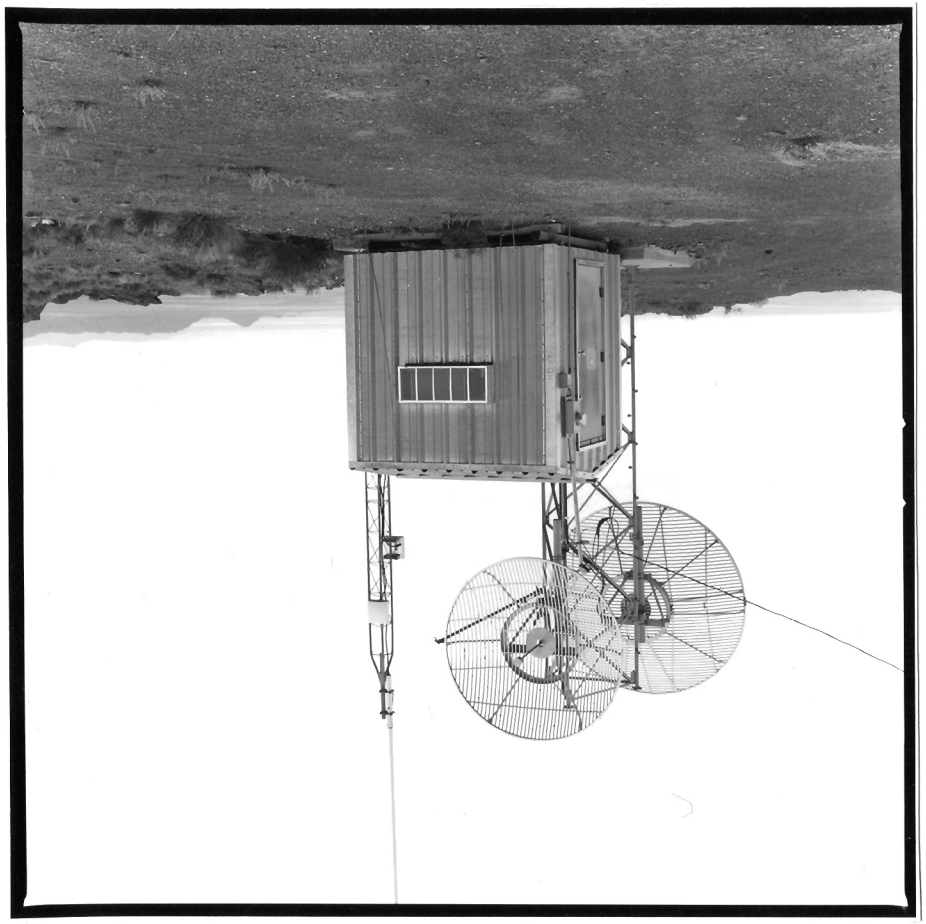
E

7

F

G

8



6

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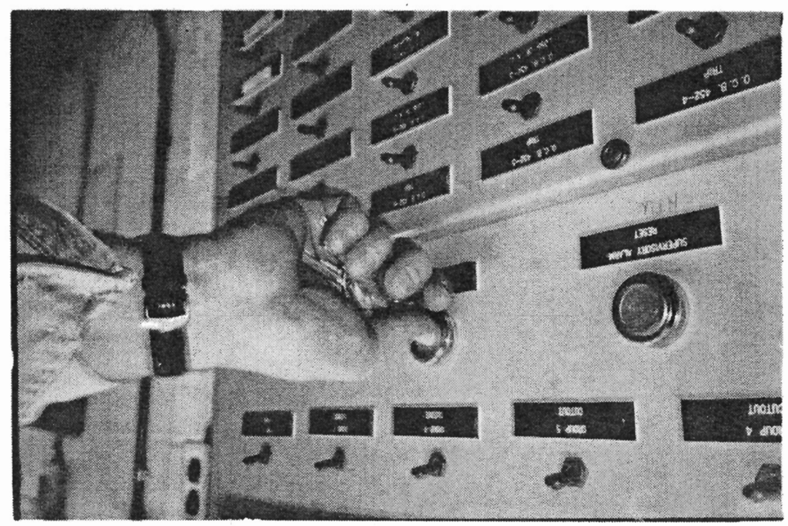
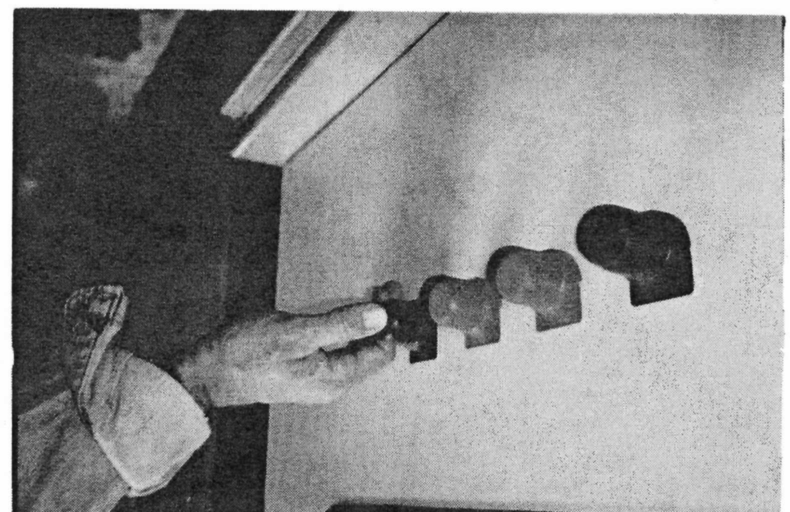
I, J





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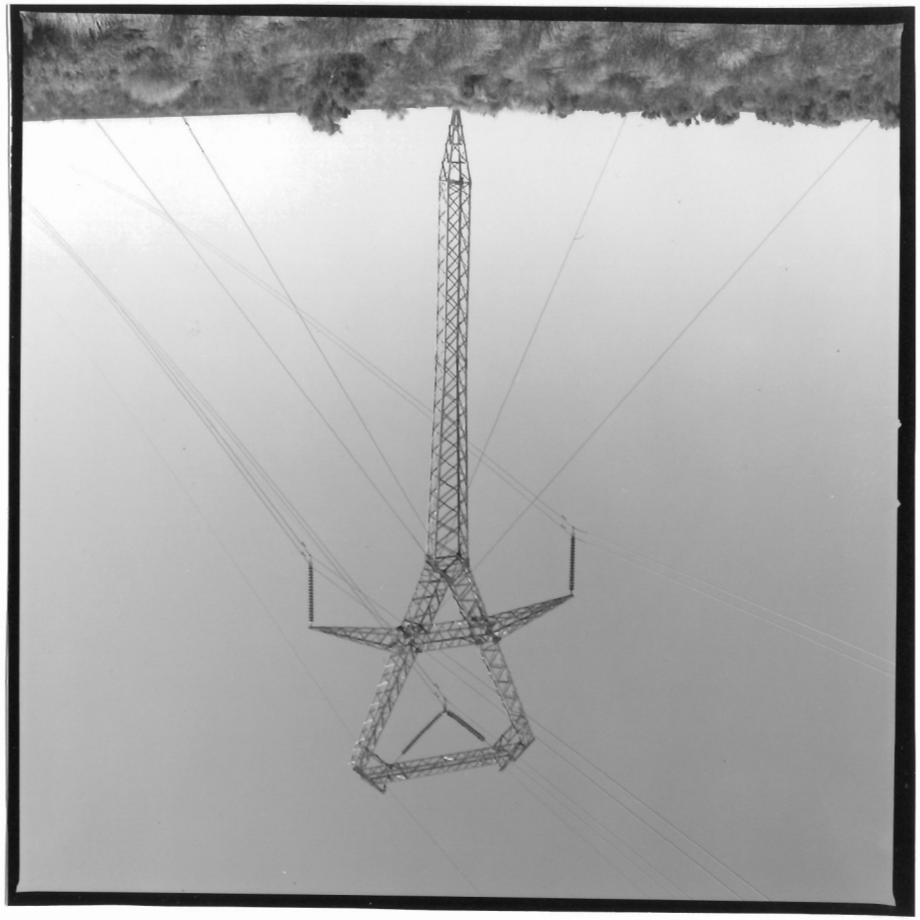
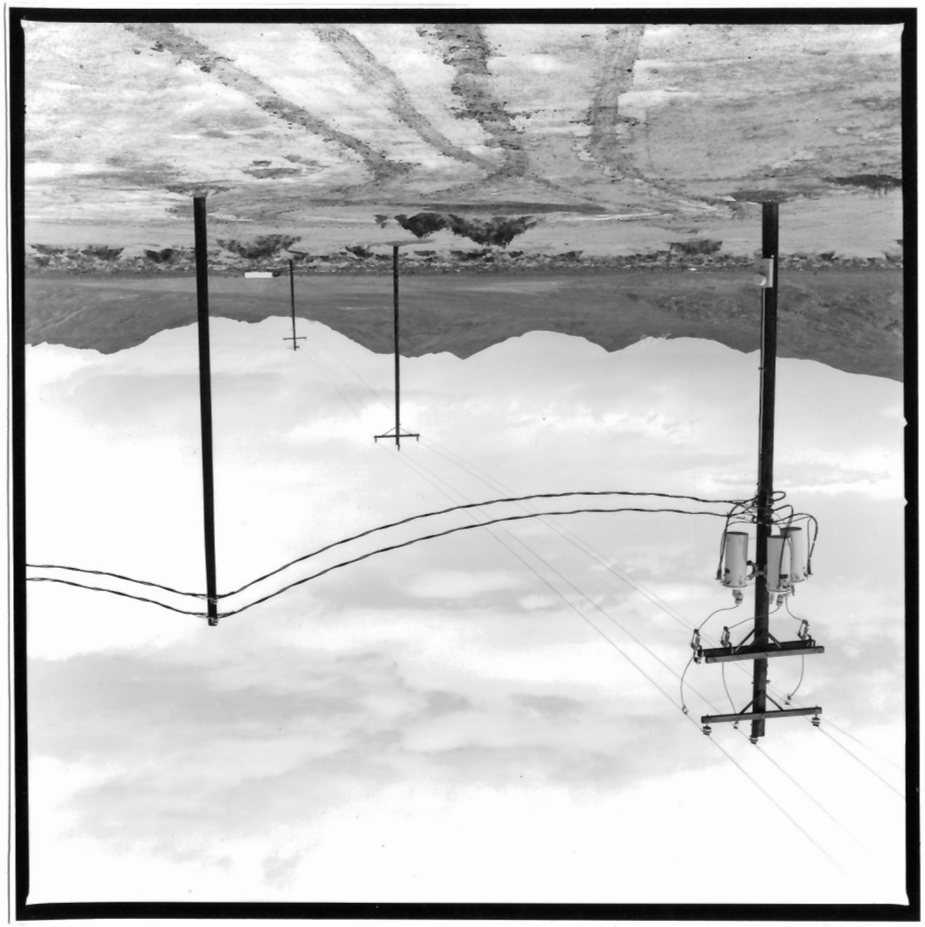


R, S

R, S

19

M



22, 23

X

PHOTO INDEX- POWER

A Burbank Gas Power Plant Control Room

B Substation Transformer

C Gadsby Gas Power Plant - Sublevel

D Burbank Gas Power Plant - Pipe

E Upper Salmon HydroElectric Power Plant - Turbine Shaft

F Upper Salmon HydroElectric Power Plant - Sublevel

G Intermountain Coal Power Plant - Storage Piles & Conveyor Belts

H Intermountain Coal Power Plant - Cooling Tower Resevoir

I Substation Reset & Trip Switches

J Substation Reset & Trip Switches

K Upper Salmon HydroElectric Power Plant - Tool Rack

L Bingham Open Pit Copper Mine

M Underground Electric Cable Signage

N 1000mcm Insulated Copper Cable

O Underground Electric Cable Signage

P 500kv HVDC Intermountain Line, Delta to Los Angeles/Adelanto

Q 500kv AC Idaho Power Line, Twin Falls to Las Vegas

R Oasis Substation

S Wendover Substation

T 138kv AC Idaho Power Line, Wendover to King/Upper Salmon

U 138kv AC Idaho Power Line, Wells to King/Upper Salmon

V Pole Transformer Bank & 7,200v 3-Phase Distribution Line

W Pole Transformer Bank & 7,200v 3-Phase Distribution Line

X 7,200v 3-Phase Dist. Line, Wendover Peak Repeater Site Feed

Y 1,440v Single-Phase Distribution Line

RECOMMENDED LINKS

SPACE WEATHER
http://spaceweather.com/
http://www.spacew.com/www/aurora.html
http://www.sec.noaa.gov/
http://pwg.gsfc.nasa.gov/istp/outreach/afromspace.html

VLF
http://www.star.stanford.edu/~vlf/
http://www.spaceweather.com/glossary/inspire.html

RADIO PLASMA IMAGER
http://image.gsfc.nasa.gov/rpi/

DRAGNs (Double Radio Source Associated with Galactic Nucleus)
http://www.jb.man.ac.uk/atlas/dragns.html

IONOSPHERE
http://www.haarp.alaska.edu/haarp/resources.html
http://www.tpub.com/neets/book10/40c.htm

SUN SPOTS, SOLAR MAGNETIC STORMS, SOLAR WIND
http://sohowww.nascom.nasa.gov/hotshots/X17/eit_195s.gif
http://www.aber.ac.uk/~dphwww/research_ips.shtml
http://solar-center.stanford.edu/magnetism/magneticfields.html
http://pwg.gsfc.nasa.gov/istp/outreach/theretohere.html
http://www.sec.noaa.gov/NOAAscales/#SolarRadiationStorms

GEOMAGNETIC STORMS: POWER SYSTEM IMPACT
http://www.metatechcorp.com/aps/PowerCastAd.htm
http://www.mpelectric.com/storms/
http://www.eia.doe.gov/cneaf/electricity/page/prim2/chapter1.html#netw
http://www.metatechcorp.com/aps/electro.htm

VAN ALLEN BELTS
http://csep10.phys.utk.edu/astr161/lect/earth/magnetic.html

SCHUMANN CAVITY RESONANCES & WIRELESS POWER TRANSMISSION
http://www.innerx.net/personal/tsmith/Schumann.html
http://sprite.gi.alaska.edu/schuchar.htm
http://www.totse.com/en/fringe/tesla/theory1.html

POLAR ELECTROJET, ELF GENERATION & HAARP
(High Frequency Active Auroral Research Program)
http://www.haarp.alaska.edu/haarp/elfhrp.html
http://www.projectfreedom.cng1.com/haarp_2.html
http://www.haarp.alaska.edu/haarp/haarpFactSheet.html

SATELLITE OBSERVATION
http://www.satellite.eu.org/satintro.html

US FREQUENCY ALLOCATION & THE ELECTROMAGNETIC SPECTRUM
http://www.ntia.doc.gov/osmhome/allochrt.pdf

1996 TELECOMMUNICATIONS ACT
http://www.fcc.gov/telecom.html

PUBLIC EMERGENCY RADIO
http://coldwardc.homestead.com/files/PER/WGU20.html
http://www.ncs.gov/n3/shares/shares.htm

RADIO & FREE SPEECH
http://www.iaru.org/
http://www.grove-ent.com/
http://www.motherjones.com/mother_jones/JA99/lowpower.html
http://www.freeradio.org
http://www.frn.net/
http://www.freespeech.org/
http://www.democracynow.org/
http://www.prometheusradio.org/
http://gary.burkett.org/Glossary.html

SCANNING
http://liun.hektik.org/scanner/LIFreq/links.html

AT&T LCXR (TRANSCONTINENTAL CABLE & MICROWAVE TOWERS)
http://www1.shore.net/~mfoster/LCXR.htm
http://users.shore.net/~mfoster/L4.html
http://users.aol.com/mikhail999/longline.htm
http://www.drgibson.com/towers/index.html

AT&T AUTOVON
http://www.ncs.gov/n3/shares/shares.htm

WESTERN UNION AUTODIN
http://autodin.net/alp/

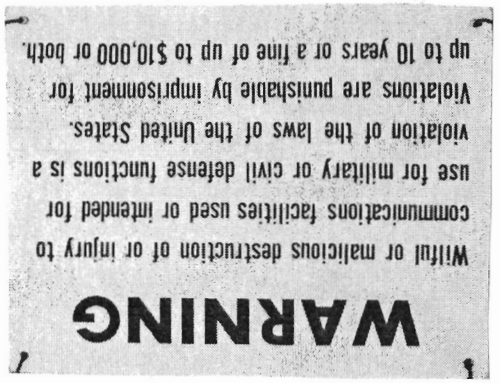
PASSIVE REPEATERS/RADIO MIRRORS
http://www19.addr.com/~longline/places-routes/Thurmont_repeater/

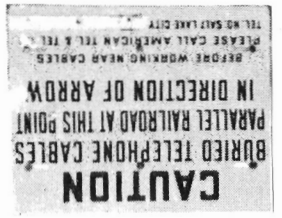
MICROWAVE TRANSMITTER TOWERS & SAFETY ISSUES
http://www.reach.net/~scherer/p/mcrwvtwr.htm#select

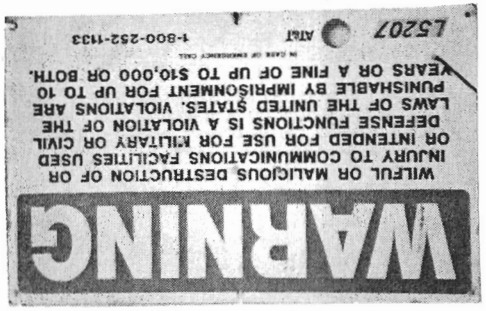
TELEGRAPH HISTORY
http://school.discovery.com/homeworkhelp/worldbook/atozscience/t/549720.html#HEAD2

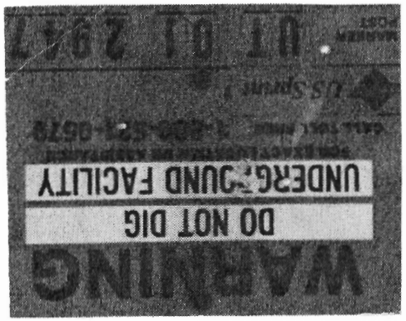
CHRONOLOGY OF COMMUNICATION RELATED EVENTS
http://people.deas.harvard.edu/~jones/cscie129/pages/comm_chron1.html

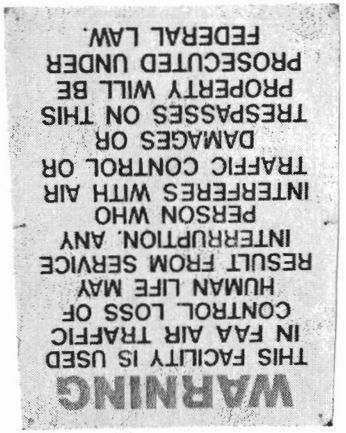
TELECOMMUNICATION RESOURCES & TERMS
http://ftp.fas.org/nuke/guide/usa/c3i/index.html
http://www.navyrelics.com/tribute/research_resources.html
http://www.wld.com/conbus/weal/wtelcomm.htm
http://www16.brinkster.com/shelli/ipt/ipt_transmit.htm
http://www.softcopy.co.uk/web_data/ew426idx.htm
http://www.amlwireless.com/list.htm

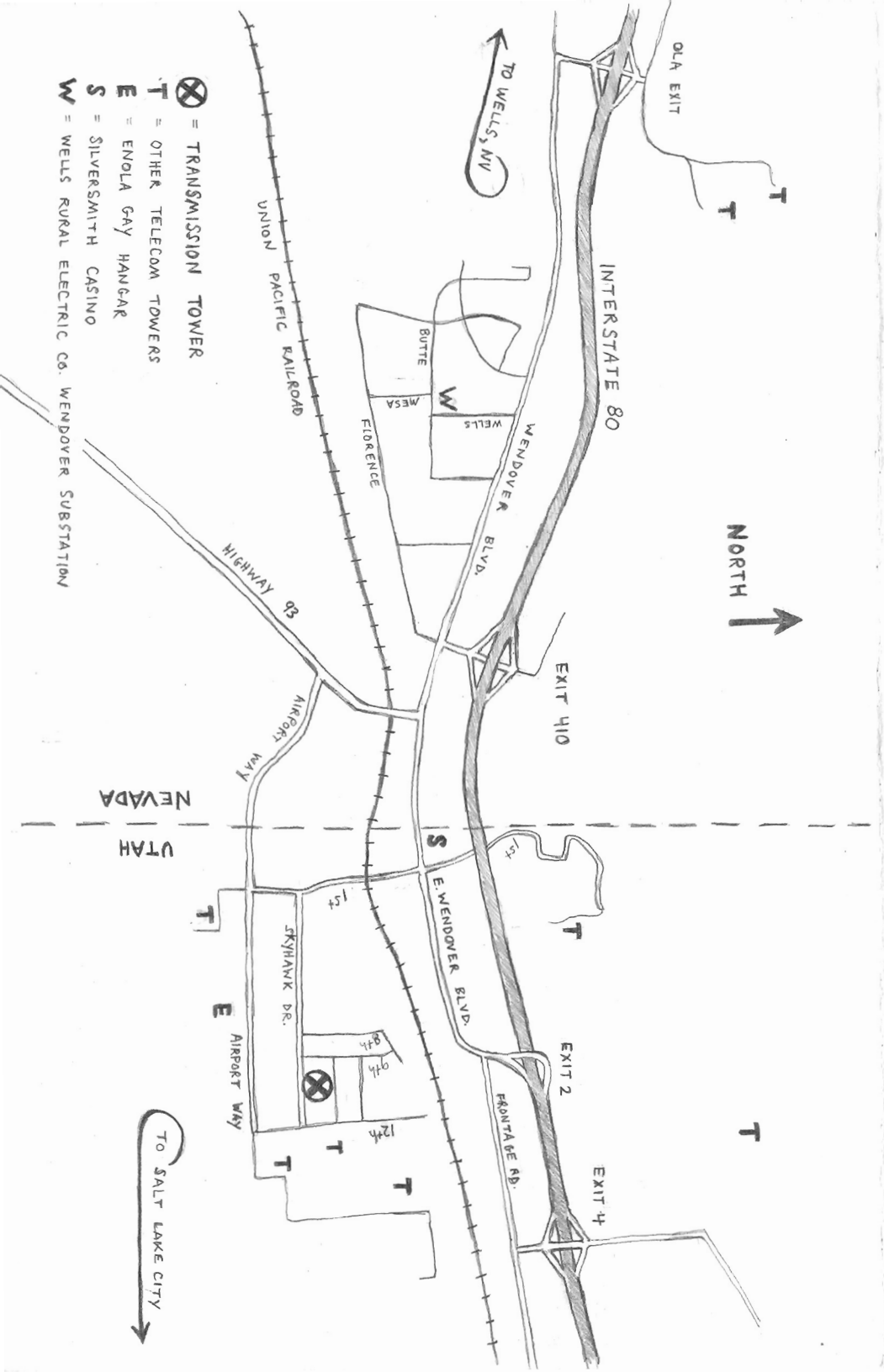












ELECTRIC POWER
http://school.discovery.com/homeworkhelp/worldbook/atozscience/e/176740.html
http://www.howstuffworks.com/power.htm
http://www.media.utah.edu/UHE/e/ELECTRICAL.html
http://www.eia.doe.gov/cneaf/electricity/page/prim2/chapter1.html#netw
http://americanhistory.si.edu/csr/powering/transmit/trmain.htm
http://www.eia.doe.gov/cneaf/electricity/chg_stru_update/chapter3.html

SUPERCONDUCTING TRANSMISSION LINES
http://www.amsuper.com/cablefact.htm
http://hyperphysics.phy-astr.gsu.edu/hbase/solids/scapp.html#c2

ELECTRICAL TRANSMISSION TOWERS
http://www.painterbrothers.com/transmissiontowers.html
http://www.fusionanomaly.net/electricaltransmissiontowers.html

HIGH VOLTAGE TRANSMISSION LINES
http://www.bsharp.org/physics/stuff/xmission.html

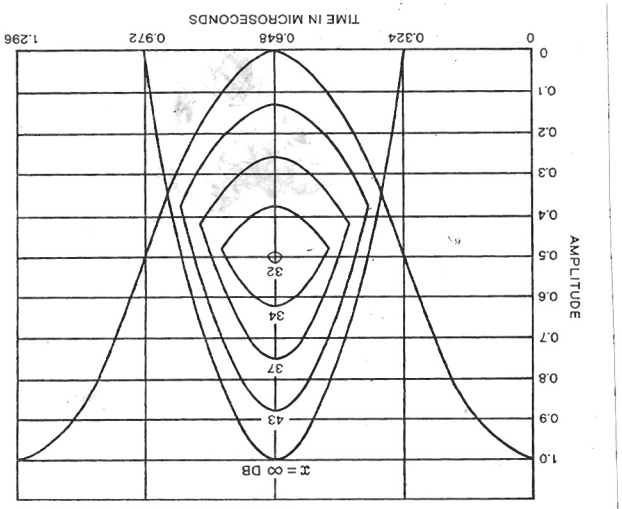
ADELANTO CONVERTER STATION
http://web.ladwp.com/~bulkpower/Eastern_Stations/Adelanto/ippinfo.htm

BOOKS REFERENCED AND SITED

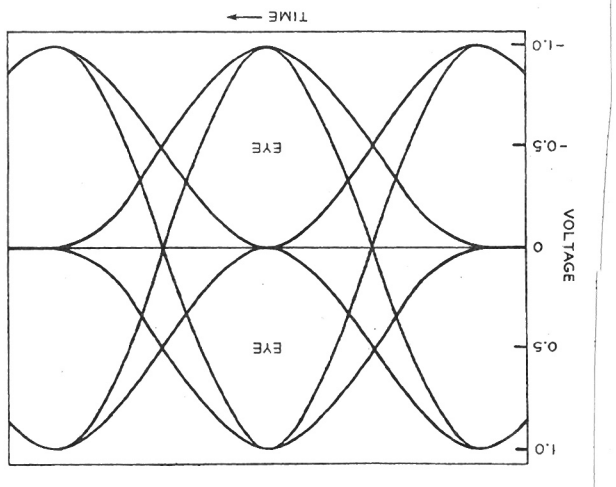
ALL ABOUT ELECTRICITY, BY IRA M. FREEMAN
BASIC ELECTRICITY, BUREAU OF NAVAL PERSONNEL, RATE TRAINING MANUAL
BEYOND LINE OF SIGHT: A HISTORY OF VHF PROPATAGION,
EDITED BY EMIL POCOCK - W3EP
DESERT CROSSROADS,
US DEPT. OF THE INTERIOR - BUREAU OF LAND MANAGEMENT
A HISTORY OF ENGINEERING AND SCIENCE IN THE BELL SYSTEM:
TRANSMISSION TECHNOLOGY, EDITED BY E.F. O'NEILL
THE HISTORY OF WELLS RURAL ELECTRIC COMPANY, BY RICK STERBER
MONITOR AMERICA: THE NATIONAL COMMUNICATIONS GUIDE, 3RD EDITION
THE OLD TRAILS WEST, BY RALPH MOODY
PONY EXPRESS, BY FRED REINFELD
REMARKABLE LUMINOUS PHENOMENA IN NATURE,
COMPILED BY WILLIAM CORLISS
SHORTWAVE RADIO LISTENING FOR BEGINNERS, BY ANITA LOUISE MCCORMICK
UNDERSTANDING TELECOMMUNICATIONS, RONALD R. THOMAS
VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA, 3RD EDITION
VHF AMATEUR RADIO, WILLIAM ORR - W6SAI
WIRE TAPPING AND ELECTRONIC SURVEILLANCE COMMISSION STUDIES,
NATIONAL COMMISSION FOR THE REVIEW OF FEDERAL AND STATE LAWS
RELATING TO WIRETAPPING AND ELECTRONIC SURVEILLANCE;
WASHINGTON, 1976

PHOTO INDEX - EXCHANGE

1 AT&T L CXR Coaxial Reapeater Station Door
2 AT&T L CXR Coaxial Reapeater Station
3 AT&T L CXR Microwave Horns (Wendover Notch)
4 QWest Fiber Optic Cable Spools
5 Buried Cable Signage
6 FAA Microwave Repeater
7 AT&T L CXR Microwave Repeater Tower (Wendover Notch)
8 Microwave Repeater & Support Hut
9 Broadband Internet Tower & Relic
10 Cellular Phone Masts
11 Tower
12 Microwave Passive Repeater
13 Microwave Passive Repeater
14 De-horned AT&T L CXR Microwave Tower (Cedar Mountain)
15 Microwave Tower
16 Microwave Complex & Support Hut
17 Microwave Complex & USAF Tower
18 RFS Microwave Repeater
19 AT&T Passive Repeater
20 Microwave Telemetry Station
21 Fiber Optic Telemetry Station
22 Microwave Tower Support Hut
23 Fiber Optic Support Hut
24 AT&T L CXR Outhouse
25 Tower Support Hut
26 Fiber Optic Repeater Station
27 Microwave Tower Support Hut
28 Microwave Tower Support Hut
29 Microwave Tower Complex Outhouse



Atoms Are Made of Electricity



NOTICE

GUIDELINES FOR WORKING IN RADIOFREQUENCY ENVIRONMENTS

- All personnel should have electromagnetic energy (EME) awareness training.
- All personnel entering this site must be authorized.
- Obey all posted signs.
- Assume all antennas are active.
- Before working on antennas, notify owners and disable appropriate transmitters.
- Maintain minimum 3 feet clearance from all antennas.
- Do not stop in front of antennas.
- Use personal RF monitors while working near antennas.
- Never operate transmitters without shields suring normal operation.
- Do not operate base station antennas in equipment room.

ALL PHOTOS EXCEPT WHERE NOTED: DEBORAH STRATMAN

THANK YOU...

ELIOT IRWIN
MIKE SLATTERY
ROB RAY
JOEL ROSS
JACOB ROSS
BRANT VEILLEUX
JASON CREPS
STEVE FAVAZZA
KENNETH MORRISON
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GADSBY POWER PLANT
BURBANK POWER PLANT
INTERMOUNTAIN POWER PLANT
IDAHO POWER LOWER SALMON PLANT
EXPERIMENTAL SOUND STUDIO

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LEF FOUNDATION
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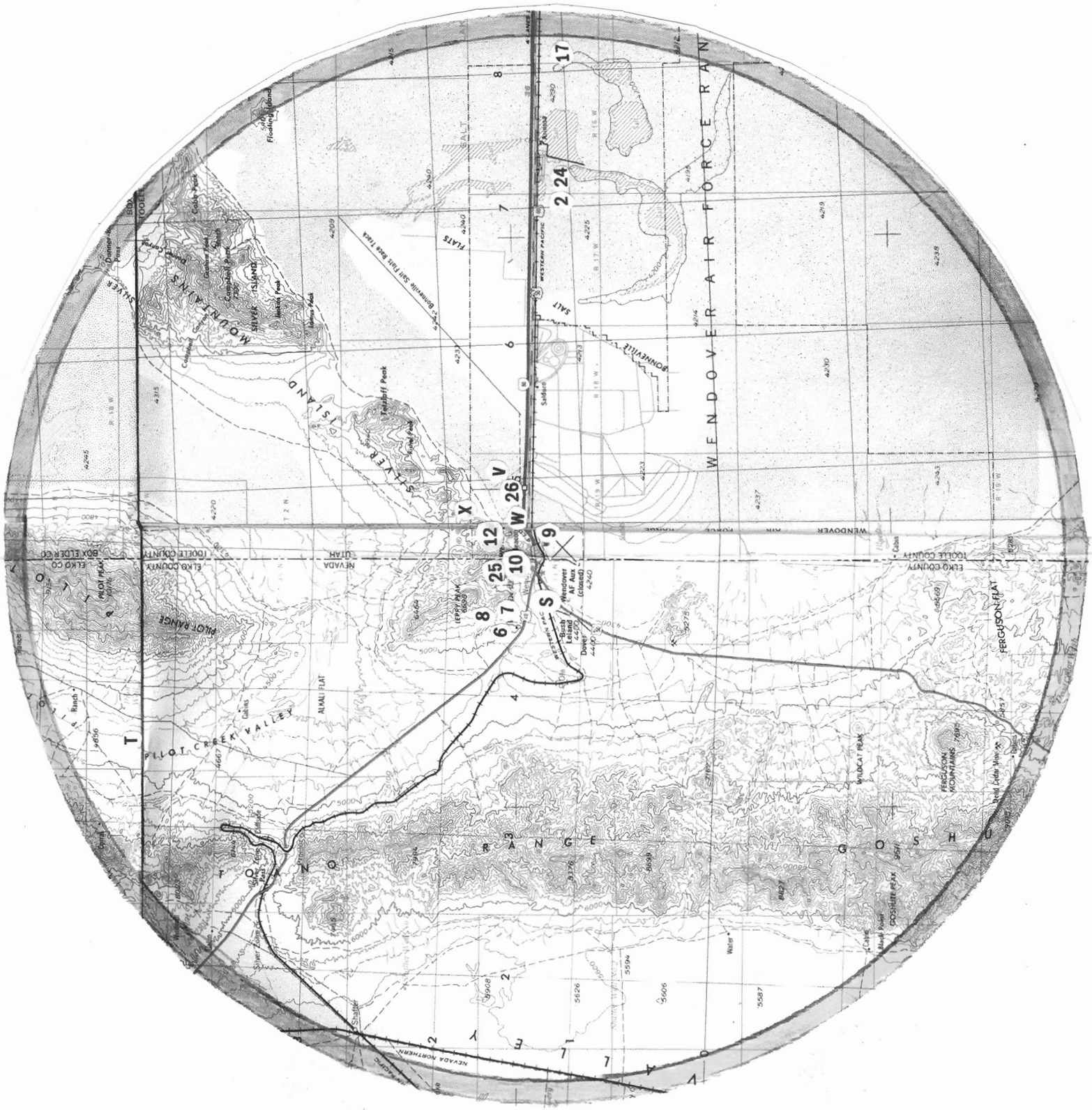
THE CENTER FOR LAND USE INTERPRETATION

FOR INFORMATION ABOUT *POWER/EXCHANGE* CONTACT:

PYTHAGORAS
1958 W. WALNUT ST.
CHICAGO IL, 60612
delta@pythagorasfilm.com

CENTER FOR LAND USE INTERPRETATION
9331 VENICE BLVD.
CULVER CITY, CA 90232
clui@clui.org

neighboring tower locations



scale 1:250,000