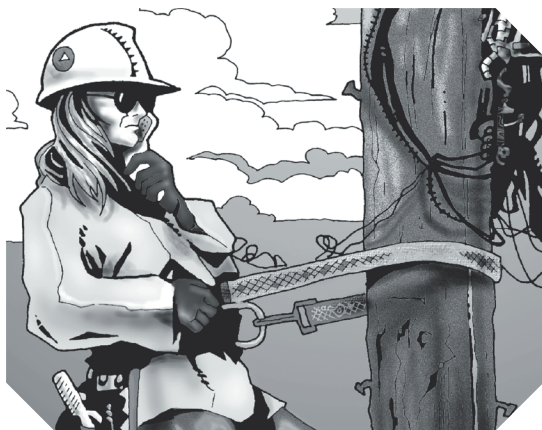


GURPS[®]

Fourth Edition

HIGH-TECH[™]

ELECTRICITY AND ELECTRONICS[™]



Written by **WILLIAM H. STODDARD**

Edited by **NIKOLA VRTIS**

Illustrated by **DAN SMITH**
and **NIKOLA VRTIS**

Additional Material by **S.A. FISHER,**
MICHAEL HURST, PHIL MASTERS,
and **HANS-CHRISTIAN VORTISCH**

GURPS System Design ■ **STEVE JACKSON**

GURPS Line Editor ■ **SEAN PUNCH**

GURPS Project Manager ■ **STEVEN MARSH**

Production Artist and Indexer ■ **NIKOLA VRTIS**

GURPS FAQ Maintainer ■

VICKY "MOLOKH" KOLENKO

Chief Executive Officer ■ **PHILIP REED**

Chief Creative Officer ■ **SAM MITSCHKE**

Chief Operating Officer ■ **SUSAN BUENO**

Director of Sales ■ **ROSS JEPSON**

Page Design ■ **PHIL REED** and **JUSTIN DE WITT**

Art Direction and Prepress Checker ■ **NIKOLA VRTIS**

Lead Playtester: Roger Burton West

Playtesters: Frederick Brackin, Rory Fansler, Jonathan Lang, M.A. Lloyd, and Garðar St. Ólafsson

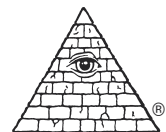
GURPS, *Pyramid*, Warehouse 23, the pyramid logo, *High-Tech*, *Electricity and Electronics*, and the names of all products published by Steve Jackson Games Incorporated are trademarks or registered trademarks of Steve Jackson Games Incorporated, or used under license. **GURPS High-Tech: Electricity and Electronics** is copyright © 2019 by Steve Jackson Games Incorporated. All rights reserved. Additional art acknowledgments can be found on p. 2.

The scanning, uploading, and distribution of this material via the Internet or via any other means without the permission of the publisher is illegal, and punishable by law. Please purchase only authorized electronic editions, and do not participate in or encourage the electronic piracy of copyrighted materials. Your support of the author's rights is appreciated.

STEVE JACKSON GAMES

Stock #37-1634

Version 1.0 – October 2019



CONTENTS

INTRODUCTION 3	Tool Kits 14	Video Transmission and Reception 34
<i>About GURPS</i> 3	Safety Equipment 15	Video Recording 34
About the Author 3	<i>Heathkits</i> 15	ACTIVE RANGEFINDING 35
1. BASIC SCIENCE 4	3. POWER AND MACHINERY 16	Sonar 35
THE PROGRESS OF SCIENCE 4	ELECTRICAL ENERGY 16	Radar 35
The Discovery of Electricity 4	Generation 16	Lidar 35
Electromagnetism 4	Storage 17	5. COMPUTATION 36
From Science to Technology 4	Transmission 18	COMPUTERS 36
The Invention of Electronics 4	<i>The Battle of the Currents</i> 19	Processing Power 36
<i>Who Invented Vacuum Tubes?</i> 5	ELECTRICAL EQUIPMENT 20	<i>From High-Tech to Ultra-Tech</i> 38
TECHNOLOGIES 5	Heat and Light 20	Programs and Languages 38
Energy and Information 5	<i>Light Levels</i> 20	SPECIAL-PURPOSE DEVICES 39
Storage and Flow 5	Electrochemical Processes 22	DIGITAL INTERFACES 39
Wired and Wireless 5	Magnets 22	Physical Controls 39
Near and Far Fields 5	Motors 23	Touch Screens 40
<i>Miniaturization</i> 6	MEMS 24	Voice-Controlled Systems 40
Analog and Digital 6	ELECTRICAL CONTROL 24	Virtual Reality 41
SKILLS 6	Switching 24	Brain-Computer Interfaces 41
UNDERSTANDING THE DEVICES 8	Variable Power 25	NETWORKS 41
TL (Tech Level), Dates 8	Remote Control 25	Local Networks 41
<i>Breakable!</i> 8	<i>Safety Devices</i> 25	Long-Range Networks 41
Cost 8	Automatic Control and Robotics 25	Digitally Encoded Voice and Video 41
Weight 9	4. SIGNALS AND WAVES 26	6. ELECTRONIC WARFARE 42
Power 9	MODES OF TRANSMISSION 26	SECURITY AND ESPIONAGE 42
HP, HT, DR 9	Wired 26	Electric Fences 42
Combined Devices 9	Wireless 27	Locks and Lockpicks 42
<i>Electrical Hazards</i> 9	<i>Who Invented Radio?</i> 27	Screening 43
2. LABORATORIES AND WORKSHOPS 10	<i>Bandwidth</i> 28	Alarms 43
EXPERIMENTAL APPARATUS 10	<i>Tuning In</i> 29	Bugs and Taps 44
<i>Spark Gaps</i> 10	Optical 30	THE ELECTRONIC BATTLEFIELD 45
Detection and Measurement 10	<i>Communications Satellites</i> 30	Surveillance and Countersurveillance 45
Static Electricity 11	AUDIO 30	Communications and Encryption 46
Tesla Coils 12	Audio Transducers 30	<i>Triangulation</i> 47
SCIENTIFIC AND MEDICAL	Audio Generation 31	Fuzes and Guidance 48
ELECTRONICS 12	Audio Amplification 32	ELECTRONIC WEAPONS 49
Bioelectrical Signals 12	Audio Transmission and Reception 32	Electric Stunners 49
Transducers and Meters 12	Audio Recording 33	Jammers 49
Transmission and Recording 13	VIDEO 33	<i>Psychotronics</i> 50
Analog Computers 13	Scanners and Printers 33	EMP 50
Medical and Surgical Tools 13	Cameras and Displays 33	Directed Energy Weapons 50
CONSTRUCTION AND REPAIR 14		Weapons Tables 50
Hand Tools 14		INDEX 52

Additional Art Acknowledgments

- P. 7: Photo by Arthur Rothstein. From the Library of Congress, Prints & Photographs Division, FSA/OWI Collection, Washington, D.C. 20540 USA. LC-USF34-029235-D.
- P. 16: Drawing by Alessandro Volta. From the Library of Congress, Prints & Photographs Division, Washington, D.C. 20540 USA. LC-USZ62-95339.
- P. 26: Photo by Waldon Fawcett. From the Library of Congress, Prints & Photographs Division, Washington, D.C. 20540 USA. LC-USZ62-116809.
- P. 46: Photo by George Grantham Bain. From the Library of Congress, Prints & Photographs Division, Washington, D.C. 20540 USA. LC-DIG-ggbain-36282.
- P. 48: Photo by U.S. Office of War. From the Library of Congress, Prints & Photographs Division, FSA/OWI Collection, Washington, D.C. 20540 USA. LC-USZ62-132627.

INTRODUCTION

Jenkins fetched a collection of glass and metal contrivances he called "Leyden jars," which he said would promise us an **electrifying** evening. Miss Hathaway, ever the bold spirit, invited him to demonstrate, and at his instruction, placed her hand across two metal tabs that protruded, one from the inside and one from the outside. She jumped and nearly knocked the thing over, and pronounced the sensation most remarkable. At that, everyone would have their turn, and not wanting to seem timid, I took mine as well and felt as if a spark had leapt to my fingers on a hot, dry day. Then Miss Hathaway challenged Jenkins to partake of his own bottles, and he reached out a hand to one that remained undischarged – and fell across a chair. We feared he had hurt himself, but in a moment he stood up and pronounced the electric charge uncommonly strong, at which I told him that he must learn to measure the proof of the electric fluid when he bottled it. Much laughter, and I went away pleased for once to be the evening's **bright spark of wit**, as Miss Hathaway pronounced me.

– **GURPS Steam-Tech**

GURPS High-Tech: Electricity and Electronics is a supplement to **GURPS High-Tech**. It examines one of the characteristic features of the high-tech era (TL5-8) – the use and control of electricity – in greater depth. **High-Tech** provides statistics for basic devices, including large devices intended for stationary or vehicular use. This supplement builds on what's in **High-Tech** and provides more detailed or updated treatments of select equipment along with many new types of devices. The information in this book can help a campaign in several ways.

In the first place, **Electricity and Electronics** adds to the equipment presented in **High-Tech** or the **Basic Set**. If you're playing a skilled technologist or a brilliant inventor, this supplement gives you more choices for equipment – or for devices you might invent a few years early! The emphasis is on portable devices that could fit into a backpack or the trunk of a car, and be taken along on adventures.

In the second place, the history of electrical technology is one of rapid change. New devices emerge all the time. In this book, you can learn when they came on the market, and equip characters with historically plausible gear for the Age of Steam or the Cold War.

In the third place, some of these innovations emerged in multiple forms. An inventor in a transitional period can have exotic experimental devices with distinctive advantages and disadvantages.

In the fourth place, this material looks ahead to the edge of TL9: to equipment that isn't yet commercially available, but that has been created in prototype versions. Rather than an inventor of yesterday, you can play one of today!

In addition to lists of gear, **Electricity and Electronics** provides *historical context*: the discovery of new scientific

principles, their translation into new engineering designs, and their impact on society. It also expands and clarifies existing game mechanics: for electric power, for electric shock, for radio communication, for illumination levels, and various other topics. There's useful material for every phase of GMing, from creating a world to deciding what dice the players should roll.

ABOUT GURPS

Steve Jackson Games is committed to full support of **GURPS** players. We can be reached by email: info@sjgames.com. Our address is SJ Games, P.O. Box 18957, Austin, TX 78760. Resources include:

New supplements and adventures. **GURPS** continues to grow – see what's new at gurps.sjgames.com.

Warehouse 23. Our online store offers **GURPS** print items, plus PDFs of our books, supplements, adventures, play aids, and support . . . including exclusive material available only on Warehouse 23! Just head over to warehouse23.com.

Internet. To discuss **GURPS** with our staff and your fellow gamers, visit our forums at forums.sjgames.com. You can also join us at facebook.com/sjgames or twitter.com/sjgames. Share your brief campaign teasers with #GURPShook on Twitter. Or explore that hashtag for ideas to add to your own game! The **GURPS High-Tech: Electricity and Electronics** web page is gurps.sjgames.com/electricityandelectronics.

Gamer and Store Finder (gamerfinder.sjgames.com): Connect with other people and places playing our games. Add yourself to our database so they can find you as well!

Bibliographies. Bibliographies are a great resource for finding more of what you love! We've added them to many **GURPS** book web pages with links to help you find the next perfect element for your game.

Errata. Everyone makes mistakes, including us – but we do our best to fix our errors. Errata pages for **GURPS** releases are available at sjgames.com/errata/gurps.

Rules and statistics in this book are specifically for the **GURPS Basic Set, Fourth Edition**. Page references that begin with B refer to that book, not this one.

ABOUT THE AUTHOR

William H. Stoddard is a professional copy editor, specializing in scientific and scholarly publications. He and his wife live in Riverside, California, with their cat Macavity, three computers, and more than 100 shelf-feet of books. He has been a roleplaying gamer since 1975, and has been writing for **GURPS** since 2000, when he composed **GURPS Steampunk** – which itself had a fair bit of information on electrical devices!

WEIGHT

Weights of devices are given in pounds, down to 0.1 lb. Smaller devices are described as “negligible” (“neg.”), with five to 12 negligible-weight devices adding up to a quarter pound. Weight includes batteries, if applicable. Larger devices, too heavy to be carried, are usually labeled “stationary,” though they may be transportable in large vehicles such as trucks or ships.

POWER

Rather than accounting for the exact power consumed by a device, *High-Tech*, pp. 13-15, defines standard categories of power availability. This book takes the same approach, with slightly more detail.

Rechargeable batteries (*Secondary Batteries*, p. 18) are often built into devices and not intended to be replaced. Such devices are listed as “rechargeable” with a duration.

For what *High-Tech* describes as *external power*, this supplement distinguishes five categories.

Peripheral Power (TL8). Supplies a small amount of power to an external device connected to a computer, letting it operate without an internal power supply. The universal serial bus (USB), an industry standard for peripherals since 1996, supplies five volts. With the increased prevalence of digital devices, USB ports are often built into automobiles and power outlets.

Automotive Power (TL6). An outlet provides access to a car’s generator or battery; originally designed to power a cigarette lighter (p. 21). Supplies six volts (at TL6) or 12 volts (at TL7-8).

Household Power (TL6). Used for ordinary appliances, from lamps to desktop computers. Supplies 110-120 volts in North America and Japan; 220-240 volts elsewhere.

Major Appliance Power (TL6). Used for large appliances such as electric stoves, or for home workshops with large power tools. Supplies 230-240 volts.

Industrial Power (TL6). Used for heavy-duty equipment – for example, in a factory or on a warship. Typically supplies 480 volts.

HP, HT, DR

HP: A device’s HP are determined by its weight, using the “Unliving/Machine” column in the table on p. B558. Devices with “negligible” weight have 1 HP. In a few cases, HP are stated explicitly.

HT: If not stated otherwise, a device has HT 10.

DR: Most devices have DR 2, unless a higher DR is specified. Fragile devices such as light bulbs or vacuum tubes can be assumed to have DR 0.

COMBINED DEVICES

For some equipment, early versions had to be combined with other devices (such as a display device) in order to get the most benefit from them. (Popular combinations were often later manufactured as a single unit.) Such a *combined device* is

ELECTRICAL HAZARDS

With the development of generators and power lines, the dangers of electricity became widely known, helped by Edison’s campaign against alternating current (*The Battle of the Currents*, p. 19). Different types of current produce different forms and levels of injury (pp. B432-433).

The rules for *lethal electrical damage* mainly reflect continuing current flows, such as from power lines (*Transmission*, pp. 18-19). They best fit the effects of direct current (DC). For DC, the HT roll to avoid heart stoppage is at -1 per 2 points of rolled damage; for alternating current (AC), -5 per 2 points; for radio-frequency current (as from a Tesla coil; see p. 12), disregard the effect. Any current that causes more than 1 point of injury prevents letting go of the source. Someone who makes a DX roll after touching a source that inflicts only 1 point can jerk back and avoid taking that injury.

Shocks from household current don’t necessarily cause burns. To reflect this, as an optional rule, damage rolls less than 1d (see table under *Transmission*, p. 18) can inflict 0 burning damage, like a weak crushing attack. However, they may still trigger a HT roll, if the current passes through the torso. If the actual roll comes to 0, this is unmodified; if it’s less than zero, treat the negative damage as giving a *bonus* to HT.

Nonlethal electrical damage comes from sources with high voltage but low current: static charges or capacitors (pp. 17-18) that discharge in a fraction of a second, or pulsed sources such as electric stunners (p. 49). The current is actually high, but the *average* current over a second or more is low (see *Storage and Flow*, p. 5). A discharge with high enough energy (-5 or more to the HT roll for stun) can cause a heart attack if the modified HT roll fails by 10 or more, or on a critical failure.

Lethal current may ignite fires, if it creates sparks or flows through resistive material; treat the rolled damage as a fire source (*Making Things Burn*, p. B433). Sparks from nonlethal damage may ignite Super-Flammable materials; roll 3d vs. (12 minus the HT modifier) for the shock to see if this happens. For example, roll 3d against 7 if the HT modifier is +5, or against 16 if it’s -4).

At industrial or higher voltages, *arc flash* can occur, producing heat enough to melt metal or start fires (3d burn damage for 1 second) and dazzling light (treat as 1,000,000 lux for -1 to HT; *Light Levels*, p. 20). If the eyes aren’t protected against ultraviolet with welder’s goggles, roll vs. HT as for crippling injuries (pp. B422-B423) to see if visual impairment is lasting or permanent.

Lightning is technically a static discharge, but releases enough energy to cause lethal electrical damage or ignite fires. A typical lightning bolt causes 6d burn damage. It’s less lethal than this suggests; roll vs. HT to check for heart failure, but at -1 per 5 points of injury. Larger bolts are possible; multiply the damage from a large bolt by 1d-2 (minimum $\times 1$). Lightning rods (p. 15) protect buildings against such damage; a Faraday suit (p. 15) protects an individual wearer.

fussier to operate (-2 to the relevant skill). The penalty is less severe than for improvised equipment (-5 for technological skills; p. B345), because the components are *designed* to be used together; it’s just a question of setting them up properly.

ACTIVE RANGEFINDING

Devices for sensing objects at a distance were largely products of military research; see *Surveillance and Countersurveillance* (pp. 45-46) and *Alarms* (pp. 43-44). Active detection systems send out energy of various kinds – high-frequency sound, radio waves, and (later) laser beams – and pick up reflected energy.

The energy emitted by active rangefinding gear can be detected at twice the sensor's range. This can be increased by a skill roll at -1 per additional 20% of the sensor's range, out to a maximum of -10 for an additional 200%.

The size of the target affects target detection. Apply a bonus or penalty to operator skill equal to half the target's SM, rounded down.

A skilled operator, using Electronics Operation (Sensors or Sonar), can enhance the performance of rangefinding gear. A sensor operator can detect targets more distant than the rated range with a roll at -2 per *doubling* of range (-1 for a half-level increase giving $\times 1.5$ range). This penalty can be avoided by focusing longer on a target ($\times 4$ for doubled range, or $\times 15$ for quadrupled range) and thus sending out proportionally more impulses; however, this gives the target a bonus to detect the emissions (+2 or +4).

For more active-rangefinding equipment, see *High-Tech*, pp. 45-47.

SONAR

Sound was initially used to locate submerged objects. Research began almost immediately after the sinking of the *Titanic* in 1912. Within two years, experimental devices had been invented in Britain, Germany, and the United States. Prototype systems for detecting submarines were created by 1918, and sonar came into full use during World War II (TL7). Wearing headphones as well as viewing a screen gives +1 to rolls to interpret sonar readings.

Standard sonar uses kilohertz frequencies; in water, its resolution ranges from 3" to 1/10". Imaging sonar, as in medical ultrasound and industrial materials testing, relies on low megahertz frequencies, achieving a resolution from 1/16" to 1/300".

Echo Sounder (TL6). A ship-mounted device that uses sonar to measure the depth under the hull. Gives warning of submerged hazards and can be compared with charts of known depths. Household power. \$600; 10 lbs. 1913.

Echo Sounder (TL8). A digital system that can store mapping data and display maps on a screen.

Handheld Sonar (TL8). A handheld device that produces sonar images of underwater objects, terrain, and life forms, with a resolution of 1/10". Range is 10 yards. 8 \times S/20 hours. \$10,000, 16 lbs.

RADAR

Shortly after discovering radio waves, Hertz demonstrated experimentally that they could be reflected from solid objects.

By 1935, radar systems for aircraft detection were being tested in a number of countries.

Radar uses a number of frequency bands. Higher frequencies have shorter wavelengths and can detect smaller objects and features. Wavelengths longer than a foot are used for special purposes such as ground penetration. Standard radar operates at wavelengths measured in centimeters, from an inch to a foot, and can detect vehicles, human beings, and other large animals, but not identify what they are. Millimeter-wave radar has imaging capabilities, though its resolution is coarser than that of human vision.

Radar Gun (TL7). A device that applies radar to measure speed, primarily used by police forces to detect speeders. Measures vehicle speed to the nearest Move rating by frequency changes in reflected waves caused by the Doppler effect. Automotive power. \$500, 4.5 lbs. [1947] 1954.

Ground-Penetrating Radar (TL7). A radar set using comparatively low frequencies that can penetrate soil and rock, mounted on a tricycle base for maneuverability, with two different antennas for low and high frequencies. Low frequencies (30-300 megahertz) penetrate to 10-50 yards, with image resolution 1-10 yards. High frequencies (300-1,000 megahertz) penetrate to 0-10 yards, with image resolution 1-3 feet. Has a variety of uses, from archaeological studies or treasure hunting, to prospecting and engineering, to finding military threats. Roll vs. Electronics Operation (Scientific) to gain +2 to a relevant skill. Rechargeable/8 hours. \$9,500, 77 lbs. [1910] 1975.

Radar Gun (TL8). A digital version with a numerical readout. Automotive power. \$500, 2.25 lbs.

Cellidar (TL8). A passive variant on radar, using microwave emissions from cell-phone towers. Requires analog-to-digital conversion and a dedicated computer of Complexity 3; an improvised version can be created from two or more cell phones and a laptop computer. Variant systems can be based on other transmitters in microwave-frequency bands, such as FM radio. Such systems are hard to spot, since they don't emit radar frequencies, and conventional radar jamming and stealth are ineffective against them. Average complexity. Rechargeable/10 hours. [1999].

LIDAR

One of the first uses of lasers was measurement of ranges to objects – including the moon, as early as 1962! Observations of atmospheric scattering led to the use of lasers in meteorological research. Many other applications have been developed since then.

Laser Measuring Tool (TL8). A handheld device that bounces laser beams off of surfaces to measure the dimensions of rooms and other spaces, up to 100 yards. Results are displayed on a digital readout and can include calculated areas, volumes, and diagonal dimensions. Gives +1 to effective skill for Cartography, Engineer, or other tasks that involve measurement. XS/10,000 readings. \$50, 0.25 lb. 1993.

Devices for sensing objects at a distance were largely products of military research.

Reconnaissance UAVs (TL8)

Unmanned aerial vehicles (“drones”) were originally created for military purposes. Experimental models saw specialized use in World War II; their use for surveillance dates to 1959. UAVs gained acceptance as effective combat equipment after Israel used them against Syria in 1982.

At TL8, UAV control systems incorporate specialized computers that give them enhanced autonomy. Widespread civilian use began in 2015, as technological advances (including smaller computers and longer-lasting batteries) made UAVs more affordable. The following examples illustrate options available to adventurers.

RQ-16A T-Hawk: A “micro air vehicle” originally built by Honeywell for the U.S. Army for reconnaissance and bomb detection, but subsequently turned to civilian uses. The entire package is 14” in diameter and can be carried in a backpack, with another pack holding the 32-lb. remote-control system. The main body holds a vertol system powered by a gasoline engine. Two pods at the sides carry the onboard control

system and a modular sensor (a video camera and passive IR sensor are standard). The onboard autopilot provides Piloting (Vertol)-10 and Dodge-8. The remote-control system uses a touch-screen interface (p. 40) and track pen for +2 to *the operator’s* Piloting rolls, and communicates with the craft by spread-spectrum radio (-4 to detect; see below). Fuel tank/40 minutes. Two T-Hawks and one control unit are \$750,000, 69 lbs. 2007.

Phantom 4 Pro: A quadcopter designed for civilian professional use in photography and video, but adaptable to more adventurous tasks. Dimensions are 12” long, 7” wide, and 4.5” high. It carries a high-definition camera that can film video or take bursts of still photographs. An onboard autopilot provides flight stabilization and obstacle avoidance using infrared cameras with an 8-yard range; treat it as having Piloting (Helicopter)-14 and Dodge-9 for avoiding obstacles. Its remote control system uses a touch-screen interface that gives +1 to *the operator’s* Piloting rolls. Rechargeable/30 minutes. \$1,500, 3 lbs. 2017.

Reconnaissance UAVs Table

Terms and notation are as defined in *Vehicle Statistics* (pp. B462-463).

TL	Vehicle	ST/HP	Hnd/SR	HT	Move	LWt.	Load	SM	Occ.	DR	Range	Cost	Loc.	Stall	Notes
8	Phantom 4 Pro	6	+2/3	10	5/22	0.0015	N/A	-3	N/A	4	11	\$1,500	4H	0	[1, 2]
8	RQ-16A T-Hawk	11	+3/2	12	5/29	0.01	0.001	-2	N/A	8	19	\$375K	2s	0	[1, 2]

Notes

[1] Controller has 4-mile range limit for the Phantom 4 Pro; 7-mile range limit for the RQ-16A T-Hawk.

[2] Ceiling is 1,640’ for the Phantom 4 Pro (because of limitations of the control systems) and 10,500’ for the T-Hawk.

COMMUNICATIONS AND ENCRYPTION

Military application of telegraphy began in 1855, during the Crimean War. British field units drove wagons carrying telegraphic apparatus, batteries, and miles of wire, managed by squads of six to eight soldiers; messages could be sent to advance bases a few miles away. Telegraphy remained vital to military operations as late as World War I.

Radiotelegraphy came into use at the start of the 20th century, originally for naval warfare, as radio apparatus was so large and heavy that only a warship could transport it. By World War I, radio apparatus was mounted in aircraft or carried in wagons. World War II saw the use of voice radio, often small enough to be toted by the operator. Since then, radio gear has grown steadily smaller.

Spread Spectrum (TL7)

Military radio operates in a noisy environment and is often intentionally jammed (pp. 49-50). Spread-spectrum radio reduces these problems by using a wider bandwidth; it also makes signals harder to intercept. The first version was based on *frequency hopping* (coordinated changes of frequency by transmitter and receiver). It gives -4 to rolls to detect a radio signal and +4 to Electronics Operation (EW) to avoid interference from selective jamming (see p. 49). Such systems have x2 cost and unchanged weight.



INDEX

- 3D printers, 24.
- Accelerometers, 13.
- Acoustic hailing devices, 32, 51.
- Acoustic missiles, 49.
- Active denial systems, 50, 51.
- Air Taser Model 34000, 51.
- Alarms, 43-44.
- Alkaline battery, 16, 17.
- Alternating current (AC) power, 19; *damage*, 9.
- Alternators, 17, 29.
- Amplifiers, *acoustic hailing device*, 32; *guitar*, 32; *history*, 5; *lock-in*, 11, 44.
- Analog electronic devices, *overview*, 6.
- Answering machines, 33.
- Antennas, 28; *triangulation*, 47.
- Antistatic wrist straps, 14.
- Arc converters, 29.
- Arc welders, 21, 50.
- Arcs, *damage from*, 9; *electrical*, 20-21; *light*, 20; *relative efficiency*, 22.
- Artificial intelligence, 38.
- Audio, *gear*, 30-33; *radio option*, 32; *signal generators*, 11; *skills*, 30; *see also Radio*.
- Autoclaves, 13.
- Automatic control, 25.
- Automobiles, 24.
- Automotive power outlet (power source), 9.
- Autotransformer, 25.
- Bandwidth, 28.
- Batch processing, 39.
- Batteries, *damage from*, 18; *history*, 4; *primary*, 16-17; *rechargeable*, 9, 18; *secondary*, 18.
- Baudot code, 26.
- Bells, 23.
- Bioelectrical signals, 12.
- Biometric identification, 43.
- Blu-ray players, 34.
- Booster bags, 45.
- Brain-computer interfaces, 41.
- Breakable rules option, 8; *DR of items*, 9.
- Broadband modems, 41.
- Bugs, 44-45; *detectors*, 44; *skills*, 44.
- Bullhorns, 32.
- Buzzers, 23.
- Calculators, 39.
- Camcorders, 34.
- Cameras, 33, 34, 45.
- Capacitors, 17-18; *connecting multiple*, 17.
- Carbon filament bulbs, 21; *relative efficiency*, 22.
- Carbon-zinc batteries, 17.
- Cars, 24; *alarms*, 44; *battery rechargers*, 18.
- Cassette, *players*, 33; *recorders*, 33.
- Cattle prods, 49, 51.
- Cathode-ray tubes (CRTs), 33, 39; *light pens*, 40.
- Cautery pens, 14.
- CD players, 33.
- Cell phones, *jammers*, 50; *illumination level*, 20; *rangefinding*, 35; *satellite phone*, 30; *signals intelligence*, 47.
- Celldar, 35.
- Central processing unit (CPU), 36.
- Chaff, 45.
- Cigarette lighters, 21.
- Circuit breakers, 25.
- Circular saws, 24, 51.
- Clocks, *computer*, 36.
- Cloud computing, 41.
- Cognitive radio mode, 30.
- Coherer-based spark-gap option, 28.
- Combined devices, 9.
- Communications, *audio gear*, 30-33; *military*, 46-48; *overview*, 5; *satellites*, 30; *video gear*, 33-34; *wired*, 26-27; *wireless*, 27-30; *see also Radio*.
- Compact computer-design option, 37.
- Complexity, *computer*, 39.
- Computers, 36-38; *analog*, 13; *architectures*, 36; *design options*, 37; *emissions interception*, 45; *interfaces*, 39-41; *languages*, 38; *logic*, 36; *memory*, 36; *networks*, 41; *overview*, 6; *physical controls*, 39-40; *processing power*, 36-37; *programs*, 38; *radio peripherals*, 30; *specifications*, 37; *ultra-tech*, 38.
- Construction gear, 14.
- Controls, 24-25.
- Converter boxes, 34.
- Cost, *cutting edge*, 8; *statistic*, 8.
- Countersurveillance gear, 45-48.
- Crystal-based spark-gap option, 28.
- Cutting-edge equipment, 8.
- Daisy wheel printers, 23.
- Damage, *from electrical sources*, 9, 18; *from power lines*, 18; *high-voltage systems*, 19; *shock*, 9, 19; *to breakable components*, 8; *see also Weapons*.
- Damage Resistance (DR), *of gear*, 9.
- Dates, *of gear*, 8.
- Dazzlers, 50, 51.
- Dead man's switches, 24.
- Deadbolts, *electric*, 42.
- Decryption, 48.
- Dedicated computer-design option, 37.
- Defibrillators, 14.
- Detection gear, 10-11; *using*, 10.
- Diathermy apparatus, 13.
- Dictation machines, 33.
- Digital, *cameras*, 34; *interfaces*, 39-40; *micromirror devices*, 34; *music players*, 33; *overview of digital devices*, 6; *TV tuners*, 30; *voice recorders*, 33.
- Digital video, *radio option*, 34; *recorders*, 34.
- Digitally encoded voice and video, 41.
- Diode-based spark-gap option, 28.
- Direct current (DC) power, 19; *damage*, 9.
- Direct sequence, 47.
- Directed energy weapons, 50, 51.
- Displays, 33-34; *see also Video*.
- Distributed computing, 41.
- Dot matrix printers, 23.
- Drills, 24, 50.
- Drones, 46.
- DVD players, 34.
- E-readers, 39.
- Earbuds, 31.
- Earphones, 31.
- Echo sounders, 35.
- EEG headsets, 12.
- Electric arcs, 20.
- Electric organs, 31.
- Electrical gloves, 15.
- Electrician, *gear*, 14-15; *skill*, 6; *tool kits*, 14-15.
- Electrobats, 24.
- Electrocauterries, 13.
- Electrochemical processes, 22.
- Electroconvulsive therapy devices, 14.
- Electrodeposition, 22.
- Electrodes, 12.
- Electrolysis, 22.
- Electromagnetic pulse (EMP), 50.
- Electromagnets, 22-23; *heating*, 21; *history*, 4; *lock*, 42; *motors*, 23-24; *related skill*, 8; *relays*, 24.
- Electromechanical computer-design option, 37.
- Electrometers, 10.
- Electronic, *organs*, 32; *switches*, 25.
- Electronics Operation skill, 6.
- Electronics Repair (ER) skill, 6.
- Electronics repair tool kits, 15.
- Electroplating systems, 22.
- Electroscopes, 10.
- Emergency stops, 25.
- Encryption, 48.
- Energy, *generation equipment*, 16-17; *hazards*, 9, 18; *overview*, 5; *storage*, 17-18; *transmission*, 18-19; *see also Power Sources*.
- Engineer skill, 7.
- Engineering, *overview*, 4.
- Espionage gear, 42-45.
- Experimental apparatus, 10-12.
- Facial recognition identification, 43.
- Fans, 23.
- Far fields, *overview*, 5.
- Faraday suits, 15.
- Fast computer-design option, 37.
- Fax, 27; *bandwidth*, 28.
- Feats of Science Hobby Skill, 7.
- Fences, 42, 44.
- Fingerprint identification, 43.
- Fire, *caused by electricity*, 9.
- Flashbulbs, 21.
- Flashlights, 22; *standard wattage*, 20.
- Flow, *electricity*, 5.
- Fluorescent lights, 21; *relative efficiency*, 22.
- Flywheels, 18.
- Fuel cells, 17.
- Fuses, 25.
- Fuzes, 48.
- Galvanometers, 10-11, 29.
- Game consoles, 39.
- Geiger-Müller tubes, 12.
- Generators, 17.
- Gloves, 15.
- GPS, 39.
- Graphic user interface (GUI), 40.
- Grid-leak receivers, 29.
- Ground fault interrupters, 25.
- Ground-penetrating radar, 35.

- Guidance, *for weapons*, 48-49.
 Guitar amplifiers, 32.
GURPS, 6, 13, 16, 36-39, 50;
Basic Set, 3, 8; *High-Tech*,
 3, 9, 14, 17, 22, 26-28, 33-
 37, 42, 48, 50; *Low-Tech*, 4;
Low-Tech Companion 1: Philosophers and Kings, 7;
Martial Arts, 7; *Power-Ups 2: Perks*, 15; *Psi-Tech*, 50;
Ultra-Tech, 18, 25, 38.
 Half-wave dipoles, 28.
 Hand crank generators, 17.
 Hand tools, 14.
 Hand-geometry identification, 43.
 Hard-wired programs, 38.
 Hardened computer-design option, 37.
 Hazards, 9.
 Headphones, 31.
 Health (HT), *of gear*, 9.
 Hearing aids, 32.
 Heart monitors, 12.
 Heat pumps, 21.
 Heaters, 21.
 Heathkits, 15.
 Heating Pads, 21.
 HF/DF, 48.
 High-capacity computer-design option, 37.
 High-fidelity audio, 7, 30, 32; *bandwidth*, 28; *microphones*, 31.
 High-frequency direction finding, 48.
 High-voltage systems, 19.
 History, 4-5.
 Hit Points (HP), *of gear*, 9; *negligible weigh and*, 9.
 Hobby Skill, 7.
 Holepunched keycard reader, 43.
 Homing weapons, 49.
 Hot plates, 21.
 Hot sticks, 15.
 Household devices, 23.
 Household power (power source), 9, 18.
 Huffduff, 48.
 Hydrophones, 31.
 Illumination, *see Lighting*.
 Incandescent, *bulb heaters*, 21; *lights*, 21.
 Induction, *cookers*, 21; *furnaces*, 21.
 Inductive charging, 19.
 Industrial power (power source), 9, 18.
 Information transmission, *overview*, 5; *see also Audio, Communications, Radio, Video*.
 Infrared, *missiles*, 49; *motion detectors*, 44.
 Inkjet Printers, 24.
 Insulation resistance testers, 15.
 Integrated circuits, 5, 6.
 Intercept units, *signals intelligence*, 48.
 Intercoms, 27.
 Interfaces, *digital*, 39-41.
 Isolators, 44.
 Jammers, 49-50.
 Joysticks, 40.
 Key switches, 42.
 Keyboards, 40.
 Keycard readers, 43.
 Keyloggers, 45.
 Keypad combination locks, 42.
 Kill switches, 25.
 Knife switches, 24.
 Lab-on-a-chips, 13.
 Lamps, *see Lighting*.
 Large-scale integration (LSI) computer-design option, 37.
 Lasers, *designators*, 49; *measuring tools*, 35; *overview*, 5; *pointers*, 21, 51; *scalpels*, 14.
 Lead-acid batteries, 18.
 Leyden jars, 18.
 Lidar, *gear*, 35; *missiles*, 49.
 Light bulbs, 21, 22.
 Light levels, 20.
 Light meters, 13.
 Light pens, 40.
 Light-emitting diode (LED) bulbs, 21; *relative efficiency*, 22.
 Lighting, *breakable*, 8; *bulbs*, 21, 22; *conical beams and lux*, 21; *determining illuminating effect*, 20; *DR of, 9 geometry of area*, 20, 22; *illumination levels*, 20; *lamp types*, 21-22; *luminous gases*, 21; *relative efficiency*, 20, 22; *standard wattages*, 20; *vacuum-tube invention*, 5.
 Lightning, *damage from*, 9; *study of*, 4, 27; *rods*, 15.
 Lineman's pliers, 14.
 Lithium-ion batteries, 18; *rechargers*, 18.
 Lock-in amplifiers, 11, 44.
 Lockpicking kits, *electronics*, 42.
 Locks, 42.
 Loudspeakers, 31.
 Low-voltage systems, 19.
 Luminous gases, 21; *relative efficiency*, 22.
 Machine language, 38.
 Machine Operation skill, 6.
 Macroframe computer category, 37.
 Magnetic stripe reader, 43.
 Magnets, *see Electromagnets*.
 Major appliance power (power source), 9, 18.
 Masers, *overview*, 5.
 Measurement, *gear*, 10-11; *using gear*, 10.
 Mechanic skill, 7.
 Media, *computer*, 36.
 Medical electronics, 13-14; *using*, 12; *transmission and recording*, 13.
 Medium computer category, 37.
 Medium-scale integration (MSI) computer-design option, 37.
 Megacomputer computer category, 37.
 Metal detectors, 13, 43.
 Meters, 12-13.
 Microelectromechanical systems (MEMS), 24.
 Micromirror devices, 34.
 Microphones, 31, 44.
 Microwave ovens, 5, 21.
 Military, *communication*, 46-48; *electronics*, 45-49.
 Mimeographs, 23.
 Miniaturization, 6.
 Minicomputer computer category, 37.
 Missiles, 48-49.
 Modems, 41.
 Modulation, 32.
 Monitors, 33, 34.
 Moore's Law, 6, 37.
 Motors, 23.
 Mouse, *computer*, 40.
 Multimeters, 11.
 Music players, *digital*, 33; *see also Audio, Radio*.
 Musical instruments, 31-32; *skill*, 7.
 Near fields, *overview*, 5.
 Needle nose pliers, 14.
 Neon lights, 21; *relative efficiency*, 22.
 Networks, *computer*, 41.
 Neural networks, 38.
 Nickel-cadmium (NiCad) batteries, 18.
 Nickel-metal hydride batteries, 18.
 Nonlinear junction detectors, 44.
 Non-nuclear electromagnetic pulse (NNEMP), 50.
 Office devices, 23.
 Ohmmeters, 11, 15.
 Optical barcode reader, 43.
 Optical signals, 30.
 Organs (musical), 32.
 Oscillators, 29-30.
 Oscillographs, 11.
 Oscilloscopes, 11.
 Pedal generators, 17.
 Pedometers, 13.
 Penlights, 22.
 Peripheral power (power source), 9.
 pH meters, 12, 13.
 Phantom 4 Pro, 46.
 Phonographs, 33.
 Photocopiers, 23.
 Photodetectors, 12-13.
 Photoelectric beams, 44.
 Photography skill, 7.
 Photophones, 30.
 Photovoltaic systems, 17.
 Physics skill, 8.
 Pliers, 14.
 Power drills, 24, 50.
 Power lines, 18-19.
 Power meters, 19.
 Power outlets, 19.
 Power requirements, *equipment statistic*, 9, 16.
 Power sources, *cutting off power*, 19; *damage from*, 9, 18; *equipment statistic*, 9, 16; *generators*, 17; *rechargeable*, 18; *see also Batteries*.
 Pressure mats, 44.
 Printers, 23, 33.
 Projectors, 34.
 Protective gear, 15.
 Prototypes, 8.

There is nothing wrong with your television set. Do not attempt to adjust the picture.

– Opening credits, The Outer Limits

“You belonged to the technocratic elite even before you picked up that book,” Kivistik said. “The ability to wade through a technical text, and to understand it, is a privilege.”

– Neal Stephenson,
Cryptonomicon

- Proximity sensors, 44.
 Psychotronics, 50.
 Public address systems, 32.
Pyramid #3/37: Tech and Toys II, 37.
 Quarter-wave monopoles, 28.
 Radar, *gear*, 35; *guns*, 35; *missiles*, 49; *spoofers*, 50.
 Radio-frequency identification (RFID), 19, 43; *capture devices*, 45; *keycard reader*, 43; *shielded wallet*, 45.
 Radio signal generators, 11.
 Radiophotos, 27.
 Radios, 27-28; *antennas*, 28-29; *computer peripherals*, 30; *direction finders*, 48; *interference*, 27; *inventors*, 27; *new option*, 32; *oscillators*, 29-30; *shielded caps*, 50; *shortwave*, 30; *signals intelligence*, 47-48; *software-defined*, 30; *spark-gap transmitters*, 28-29; *spread spectrum*, 46-47; *trench*, 29; *tuning*, 29; *see also Audio*.
 Radiosondes, 13.
 Random access memory (RAM), 36.
 Rangefinding gear, 35.
 RDF (radio-directing finding) missiles, 49.
 Reading the stats, 8-9.
 Receive-only spark-gap option, 28.
 Receivers, 29.
 Recorders, 33.
 Rectenna, 19.
 Reel-to-reel tape recorders, 33.
 Regenerative receivers, 29.
 Relays, 24.
 Remote controls, 25.
 Repair gear, 14.
 Residual-current devices, 25.
 Resistive elements, 21.
 Resonant cavity microphones, 44.
 Retinal pattern identification, 43.
 RFID, *see Radio-Frequency Identification*.
 Robotics, 25.
 Robovacs, 25.
 Rotary spark-gap option, 28.
 Rotary switches, 24.
 RQ-16A T-Hawk, 46.
 Safety, *equipment*, 15, 25; *switches*, 24.
 Satellite phone repeaters, 30.
 Scanners, 33.
 Scientific electronics, 12-14; *transmission and recording*, 13; *using*, 12.
 Screening devices, 43.
 Security gear, 42-45.
 Seismic ground sensors, 45.
 Send-only spark-gap option, 29.
 Sewing machines, 23.
 Shielded caps, 50.
 Shock, 9, 19.
 Shopvacs, 23.
 Shredders, 23.
 Signals, *audio gear*, 30-33; *bioelectrical signals*, 12; *generators*, 11; *modes of transmission*, 26-30; *rangefinding gear*, 35; *tracers*, 11; *video gear*, 33-34.
 Signals intelligence (SIGINT), 47-48; *gear*, 48.
 Signature identification, 43.
 Silicon-controlled rectifiers, 25.
 Singing Arcs, 32.
 Skills, 6-8.
 Slow computer-design option, 37.
 Small computer category, 37.
 Smart, *cards*, 43; *locks*, 42; *plugs*, 25.
 Smartphone features, 13, 33, 37, 39, 40, 45.
 Solar panels, 17.
 Soldering, *irons*, 14, 50; *lasers*, 14.
 Solid-state devices, 21.
 Sonar gear, 35.
 Spark gaps, 10; *transmitters*, 28-29; *see also Radios*.
 Speakers, 31, 40.
 Special-purpose devices, 39.
 Spectrum analyzers, 11, 48.
 Spotlights, 21-22.
 Static electricity, *antistatic wrist straps*, 14; *damage*, 9; *equipment*, 11.
 Stethoscopes, 14, 42.
 Storage, *computer*, 36; *electricity*, 17-18; *electricity overview*, 5.
 Stored-program computers, 36, 39.
 Strip chart recorders, 11.
 Stun, *batons*, 49, 51; *guns*, 49, 50.
 Stunners, 49, 50.
 Stylophone skill, 7.
 Stylophones, 32.
 Styluses, 40.
 Supercapacitors, 18.
 Superheterodyne receivers, 29.
 Surgical tools, 13-14.
 Surveillance gear, 45-48; *skills*, 45.
 Switching, 24-25.
 Symbolic languages, 38.
 Synthesizers, 32.
 Tables, *computer-design options*, 37; *current source*, 18; *electrically powered vehicles*, 24; *illuminating effect*, 22; *illumination levels*, 20; *light sources*, 22; *light sources*, 22; *melee weapons*, 50-51; *ranged weapons*, 51; *reconnaissance UAVs*, 46; *typical bandwidths*, 28; *weapons*, 50.
 Tactical headsets, 31.
 Taps, 44-45; *skills*, 44.
 Tasers, 49, 51.
 Tasertron TE-76, 51.
 Tech level (TL), 8.
 Technologies, *history*, 4-5; *overview*, 5-6.
 Telautographs, 25.
 Telegraph, *keys*, 24, 26; *sounders*, 26.
 Telegraphy, 26; *bandwidth*, 28; *military*, 46.
 Telemetry, 13.
 Telephony, 26-27; *bandwidth*, 28.
 Telepresence robots, 25.
 Teletypes, 26, 40.
 Televisions, 34; *bandwidths*, 28; *cameras*, 33; *digital tuners*, 30.
 Telex, 26.
 Terminals, 40.
 Tesla coils, 12, 13, 27, 48; *damage*, 9; *Faraday suits*, 15; *skill*, 7.
 Tesla Model S, 24.
 Test, *equipment*, 15; *lights*, 15.
 Theremins, 32; *skill*, 7.
 Thermistors, 12.
 Thermometers, 13, 14.
 Thyratrons, 25.
 Thyristors, 25.
 Tool kits, 14.
 Touch screens, 40.
 Torpedoes, 49.
 Trackpads, 40.
 Transducers, 12-13, 21, 30-31.
 Transformers, 19.
 Transistors, 5, 6; *computer-design option*, 37.
 Transmission, *electrical energy*, 18-19.
 Transmitters, 29.
 Trautonium skill, 7.
 Triangulation, 47.
 Tungsten filament bulbs, 21; *relative efficiency*, 22; *wattage and*, 20.
 Typewriters, 23.
 Unmanned aerial vehicles (UAVs), *reconnaissance*, 46.
 Vacuum cleaners, 23, 25.
 Vacuum tubes, *computer-design option*, 37; *inventors*, 5; *overview*, 5.
 Van de Graaff generators, 11-12.
 Variable power, *as controls*, 25.
 Vehicles, *see Cars*.
 Very-large-scale integration (VLSI) computer-design option, 37.
 Video, *gear*, 33-34; *radio option*, 34; *skills*, 33.
 Videotape recorders, 34.
 Videotelephony, 41.
 Virtual reality gear, 41.
 VLSI, 38.
 Voice-controlled systems, 40.
 Voice over Internet protocol (VOIP), 41.
 Voice recorders, 33.
 Voiceprint identification, 43.
 Voltage, *multiplier circuits*, 17; *testers*, 15.
 Voltaic piles, 16.
 Voltmeters, 11.
 Wallets, *shielded*, 45.
 Watches, 39.
 Wattmeter, 19.
 Waveform analysis, 11.
 Weapons, 49-51; *fuzes*, 48; *guided*, 48; *homing*, 49; *stunners*, 49, 50; *tables*, 50-51.
 Webcams, 34.
 Weight, *statistic*, 9; *negligible weight*, 9; *HP and*, 9.
 Wet cells, 16.
 White noise generators, 44.
 Wideband spark-gap option, 29.
 Wimshurst generators, 11.
 Wind generators, 17.
 Wire, *cutters*, 14; *strippers*, 14.
 Wired signals, *gear*, 26-27; *overview*, 5.
 Wireless power, 12, 19.
 Wireless signals, *gear*, 27-30; *overview*, 5.
 Wirephotos, 27.
 Workshops, *devices*, 23-24; *electrician's*, 15; *electronics repair*, 15.
 Workstation, *computer category*, 37; *terminals*, 40.
 X-ray machines, 43.
 Yablochkov candles, 20.

STUCK FOR AN ADVENTURE? NO PROBLEM.

**Warehouse 23 sells high-quality
game adventures and supplements
in print and PDF formats.**

- Free downloadable adventures for *GURPS* and *In Nomine*!
- Fun gaming accessories – shot glasses, shirts, specialty six-siders, and more!
- PDFs from Atlas Games, Amarillo Design Bureau, Goodman Games, and many others – plus gems from the up-and-comers.
- Original material for *Transhuman Space* and new *GURPS* supplements from Kenneth Hite, Phil Masters, David Pulver, Sean Punch, and William Stoddard!
- Fully searchable files of *GURPS Fourth Edition* supplements.
- Digital editions of out-of-print classics, from *Orcslayer* and the complete run of *ADQ* to *GURPS China* and *GURPS Ice Age*.
- Buy board games and roleplaying PDFs in the same order! Download digital purchases again whenever you need to.



STEVE JACKSON GAMES
warehouse23.com