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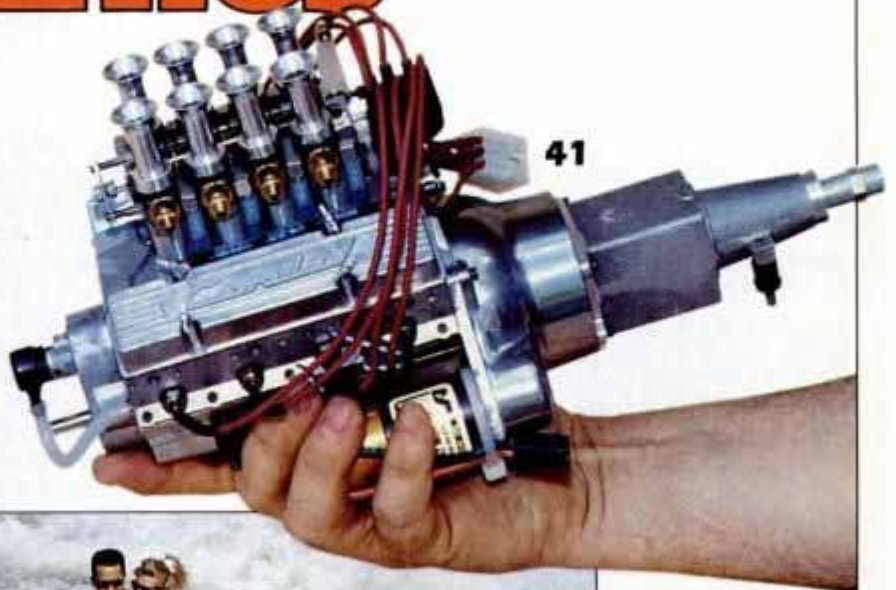


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EDITOR'S NOTES

● Some of you have asked what has happened to the 1967 Chevy Camaro convertible that we restored last year. As I write this, I'm very proud to say that it's on display in the lobby of Chevrolet's headquarters building in the General Motors Technical Center in Warren, Michigan. Our Camaro spent last summer



Dave Hansen (left) checks out our '67.

in the hands of various Chevrolet and Lintas: Campbell-Ewald executives, cruising Birmingham and Bloomfield Hills and making a big hit on Woodward. It also made the car show circuit and generally created a lot of goodwill for POPULAR MECHANICS. The day I presented the keys to Dave Hansen, Chevy's chief engineer, it was quite a sight to see our red '67 sitting next to a brand-new bright red '94 Z28 Camaro convertible outside the

Chevy building. Both cars looked great, and it would have been a tough decision if I had to choose one. I'm glad I don't have to make that decision. . . . **The last time I drove an electric car**, it was two years ago at Toyota's proving grounds in Japan. The vehicle wasn't so much a car as a big golf cart. It was sprightly but far from satisfactory as a car. What a shock it was to climb into GM's new Impact and drive it—really drive it. I've driven other electrics over the years, but this is the first one that was purpose-built and a real car. Put a conventional engine in the Impact and it would be a pretty neat 2-seater coupe. Put in an electric powerplant and it shows the way to our automotive future. Check out our report beginning on page 38. . . . **Downhill on skis at over 100 mph?** I'm outta here! But there are some people who do just that for kicks. Speed skiing is one of the newest sports, and you'll be seeing a lot of it on TV this winter. Our article on page 27 will get you started. . . . **Have you heard about the new system that utilizes both cable TV wiring and conventional phone lines to make mobile phoning more affordable?** It's another step in the convergence of telecommunications technologies that are rapidly changing us into an on-line society. Learn more about it on page 44. . . . **With interest rates at an all-time low**, this might be the best time in years to buy that boat you've been dreaming about. Our Boating '94 Guide, beginning on page 69, takes you through the boats, motors and gear that will be making news in the months to come. Till next time.

Driving an electric car prototype at Toyota's proving grounds.



Driving an electric car prototype at Toyota's proving grounds.


Joe Oldham

Popular Mechanics

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Managing Editor Deborah Frank
Graphics Director Bryan Canniff

Home Improvement

Editor Steven Willson
Associate Editor Thomas Klencek
Assistant Editor Roy Berendsohn
Contributing Editors Norman Becker
Rosario Capotosto
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Boating/Outdoors

Editor Joe Skorupa

Automotive

Detroit Editor Jim Dunne
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Science/Technology

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Electronics/Photography

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Contributing Editor Stephen A. Booth

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Electronic Production

EP Administrator Sarah Deem
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Art Editor John Bostonian Jr.
Asst. Copy Editor Nancy Coggins

Editorial Administration

Administrative Asst. Josephine Caronia
Asst. to the Editor Barbara A. Novak

Reader Service Department

Manager Norah I. Golad

Editorial Offices

224 West 57 St., New York, NY 10019
(212) 649-2000

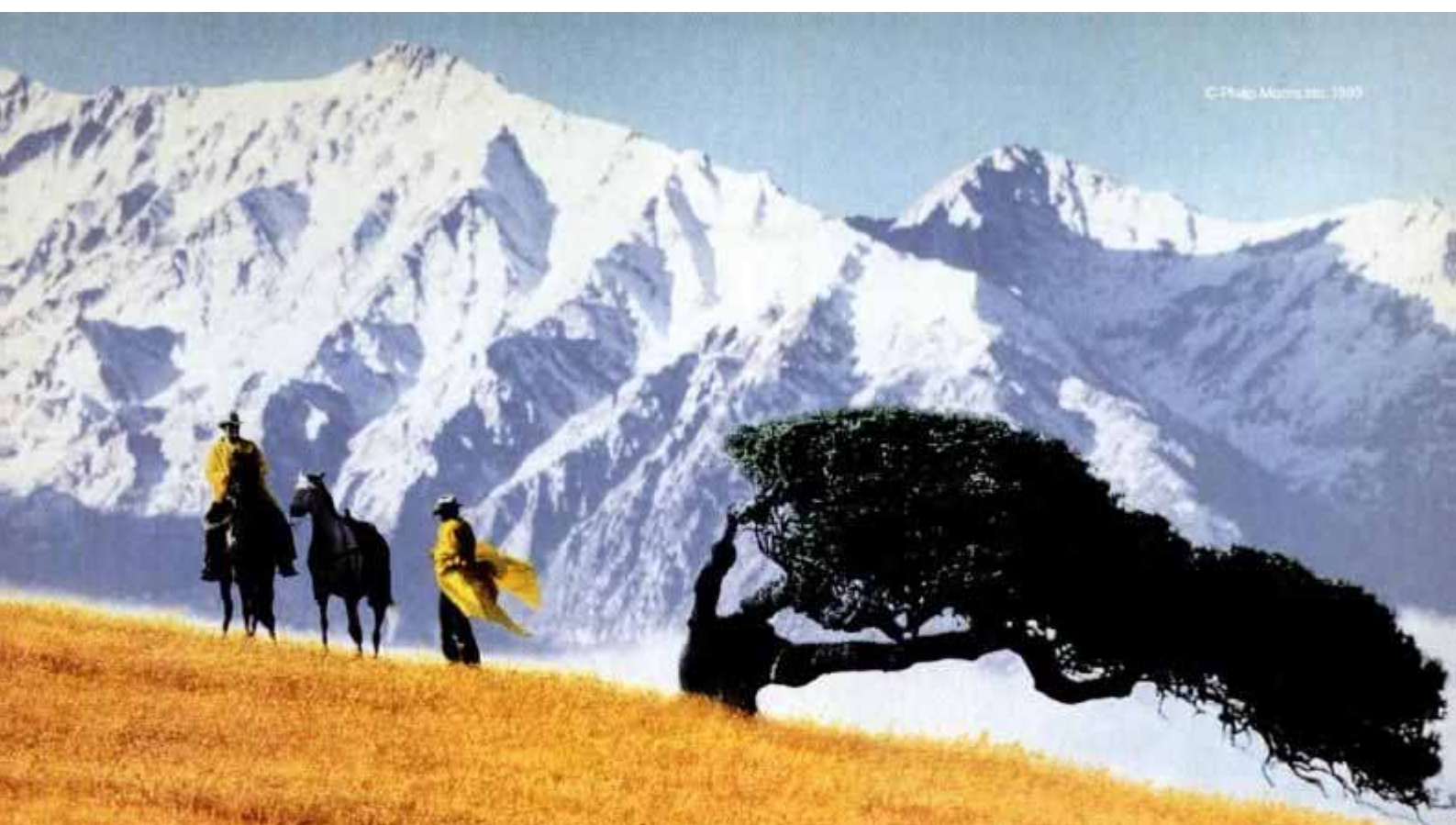
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224 West 57 St., New York, NY 10019
 Michael T. Campbell (212) 649-3142
 Robert G. Mattone (212) 649-3141
 Thomas D. Schreckinger (212) 649-3143

Chicago

1 South Wacker Dr., Chicago, IL 60606
 (312) 984-5190

Manager Richard T. Weithas

Detroit

Hearst Magazines Sales, Inc.
 2301 West Big Beaver Rd., Troy, MI 48084
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Manager D. Craig Rebold

Los Angeles

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 Santa Monica, CA 90405
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LETTERS

Cold War



Even though I've been living in the Kalahari Desert for more than 20 years, your article on tracking icebergs brought back clear memories. In 1958-'59, my father was commanding officer of the Coast Guard Air Detachment responsible for the International Ice Patrol, based at the U.S. naval base at Argentia, Newfoundland. At the time, the USCG was flying WWII vintage B-17s as they were the most reliable, heavy-duty, 4-engined aircraft for long-distance patrol over the hazardous North Atlantic. These aircraft took off and landed at Argentia on a regular basis in the most appalling weather imaginable. This was before the days of satellites and sophisticated radar, so regular, constant flights for visual identification were both essential and vital.

CHRIS SHARP
GABORONE, BOTSWANA

Popular Demand

Due to the overwhelming interest in the exhibit "Possible Dreams: Popular Mechanics And America's Enthusiasm For Technology," Henry Ford Museum in Dearborn, Michigan, has extended

Letters are subject to editing for length, style and format.

the last day of the exhibit to April 30, 1994. For complete information about museum hours, admission fees, nearby accommodations and attractions, call (800) 343-1929.

Shooting Gallery

After reading Rick Johnson's letter condemning POPULAR MECHANICS for advertising firearms, I must comment that this was one aspect of PM that I found pleasantly reassuring: PM hadn't knuckled under to the uninformed or politically correct gun control crowd.

JOHN A. VINCENT
CORRYTON, TN

PM is a publication that routinely reports on mechanical contrivances of many different types in an effort to be popular to as broad a readership as possible. A handgun is a mechanical contrivance. I do not see guns as evil. They are inanimate tools. Only man is evil.

CHARLES E. MILLER
DRYDEN, NY

Bravo to PM for not knuckling under to any special-interest group, be it pro or anti-anything. D.R. HINTZ
PORTLAND, OR

I would like to thank you, and compliment you, for your willingness in presenting an unemotional, factual assessment of firearms in an unbiased, nonjudgmental manner.

MICHAEL J. SWETT
WORCESTER, MA

This country has a problem with crime, and it has nothing to do with firearms. Since the '60s, there's been a breakdown in our social fabric. It is now acceptable

to be irresponsible and lack moral and ethical values. The problem is ignorance and narcissism, not guns.

JON SCHWARTZ
MERCER ISLAND, WA

Keep up the good work and don't let the hoplophobes get you down.

WILLIAM CHRISTOFFERSEN
BELVIDERE, IL

Do you get similar letters when you publish articles about military hardware?

RAYMOND J. SCHUERGER
SEWICKLEY, PA

It's a good thing Rick Johnson encountered this type of article before he encountered one of the fine articles you publish on military hardware. I can imagine the level of incense he may have had reading about the USS *New Jersey*, an F-16 fighter plane or the M1 battle tank.

WOODY VANKIRK
BROOKPARK, OH

You've been showing vehicles of death and destruction since day one. The new tanks, helicopters, submarines, battleships, the list goes on and on. Please

tell Mr. Johnson to get a grip.

BILL WILLIAMS
CENTERVILLE, IA

What will Rick Johnson's response be to your latest article on the Beretta 92FS, an actual firing gun? This reaction is typical of anti-gun activists in this country. Just think. If we make gun's illegal, there will be no more violent killings of innocent people. It's time to grow up and look at the whole picture. *Education* is the key to existing in this world with guns. E. RUSH
CARLISLE, PA

I thoroughly enjoyed your article on the Beretta 92FS. I'm only sorry that you must read letters of complaint from the weenies who like to read about Uncle Sam's hideous new instruments of massive destruction, but who are offended by a fine personal defense weapon available to the public. BRYAN TUCKER
IUKA, MS

Let's remember, God, guts and guns kept America free for many years.

GEORGE MALO
WASHINGTON, PA

Reader Project Of The Month

Here is a slight variation of your "Porch Classic" rocking chair featured in your September '93 issue. The rockers are bent from 16-ga., 1-in.-square tube. The vertical pieces and the front horizontals are 16-ga., 1-in.-square orna-tube. The arms are band-sawed and hand-ground from $\frac{3}{16} \times 3$ -in. flat. The rest is clear-coated redwood.

WILLIE C. SWAIN
FORT WORTH, TX



To treat symptomatic benign enlarged prostate: Only one medicine can shrink the prostate.

PROSCAR® (FINASTERIDE)

Until recently, there wasn't a medicine that could help the condition known as symptomatic benign prostate enlargement or BPH. But now there is PROSCAR, the first oral prescription medicine that can shrink an enlarged prostate.

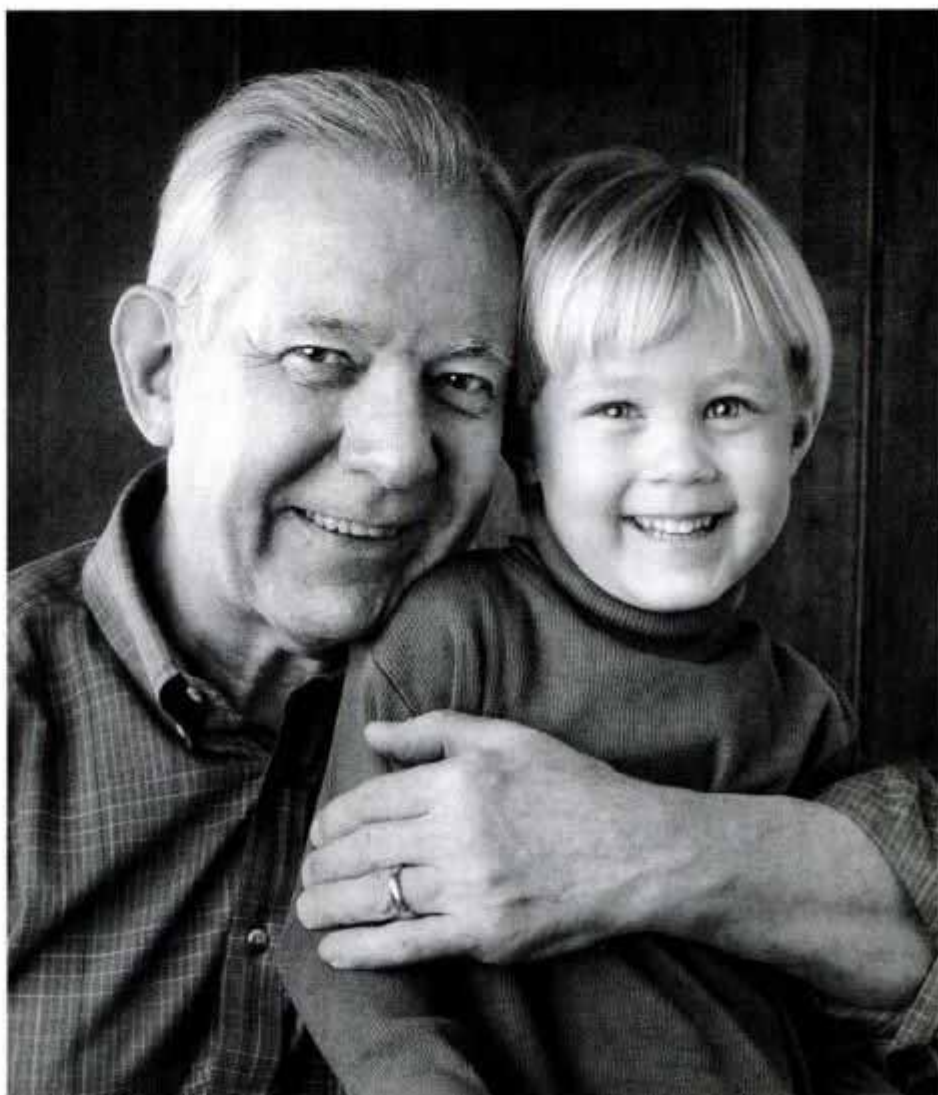
However, it is important to know the following: PROSCAR doesn't work for everyone. Even though your prostate may shrink, you may not see an improvement in urinary flow or symptoms. And you may need to take PROSCAR for 6 months or more to see whether it helps you.

How PROSCAR can shrink an enlarged prostate.

As a man ages, a key hormone can help cause the prostate to grow. PROSCAR actually blocks the production of this hormone, so it helps shrink the prostate to a smaller size in many men. As a result, some men treated with PROSCAR experience an increased urinary flow and an improvement in urinary symptoms.

Why you should see your doctor soon.

Your doctor has several options for the treatment of symptomatic BPH: watchful waiting (monitor-

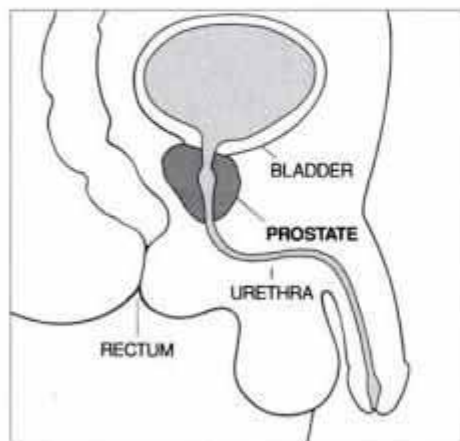


ing the condition with regular checkups), medication, or surgery. It's important to see your doctor because the problem doesn't usually get better by itself. In many cases, the prostate continues to enlarge and the symptoms may get worse. So if your urinary symptoms are bothering you, have your family doctor or a urologist assess your condition and ask if PROSCAR is an appropriate treatment for you.

It is also important to have regular checkups. *While benign prostate enlargement is not cancer and does not lead to cancer, the two conditions can exist at the same time.*

Remember, only a doctor can evaluate your symptoms and their possible causes. So, if your urinary symptoms are bothering you, don't wait any longer. You may find that your enlarged prostate can be made into a smaller problem.

For more information about prostate enlargement and PROSCAR, call 1-800-635-4452 today.



The prostate surrounds part of the urethra, the tube that carries urine from the bladder. As the prostate enlarges, it can squeeze the urethra and cause urinary problems.

TABLETS
PROSCAR 5mg
(FINASTERIDE)



PATIENT INFORMATION ABOUT PROSCAR® (Prah-s-car)
Generic name: finasteride (fin-AS-tur-eyed)

PROSCAR is for the treatment of symptomatic benign prostatic hyperplasia and for use by men only.

Your doctor may prescribe PROSCAR if you have a medical condition called benign prostatic hyperplasia or BPH. This occurs only in men.

Please read this information, as well as the leaflet which accompanies your medication, before you start taking PROSCAR. Also, read the leaflet each time you renew your prescription, just in case anything has changed. Remember, this leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss PROSCAR when you start taking your medication and at regular checkups.

What is BPH?

BPH is an enlargement of the prostate gland. After age 50, most men develop enlarged prostates. The prostate is located below the bladder. As the prostate enlarges, it may slowly restrict the flow of urine. This can lead to symptoms such as:

- a weak or interrupted urinary stream
- a feeling that you cannot empty your bladder completely
- a feeling of delay or hesitation when you start to urinate
- a need to urinate often, especially at night
- a feeling that you must urinate right away.

Treatment options for BPH

There are three main treatment options for BPH:

• **Program of monitoring or "Watchful Waiting".** If a man has an enlarged prostate gland and no symptoms or if his symptoms do not bother him, he and his doctor may decide on a program of monitoring which would include regular checkups, instead of medication or surgery.

• **Medication.** Your doctor may prescribe PROSCAR for BPH. See "What PROSCAR does" below.

• **Surgery.** Some patients may need surgery. Your doctor can describe several different surgical procedures for BPH. Which procedure is best depends on your symptoms and medical condition.

What PROSCAR does

PROSCAR lowers levels of a key hormone called DHT (dihydrotestosterone), which is a major cause of prostate growth. Lowering DHT leads to shrinkage of the enlarged prostate gland in most men. This can lead to gradual improvement in urine flow and symptoms over the next several months. However, since each case of BPH is different, you should know that:

- Even though the prostate shrinks, you may NOT see an improvement in urine flow or symptoms.
- You may need to take PROSCAR for six (6) months or more to see whether it helps you.
- Even though you take PROSCAR and it may help you, it is not known whether PROSCAR reduces the need for surgery.

What you need to know while taking PROSCAR

• **You must see your doctor regularly.** While taking PROSCAR, you must have regular checkups. Follow your doctor's advice about when to have these checkups.

• **About side effects.** Like all prescription drugs, PROSCAR may cause side effects. Side effects due to PROSCAR may include impotence (or inability to have an erection) and less desire for sex. Each of these side effects occurred in less than 4% of patients in clinical studies. In some cases side effects went away while the patient continued to take PROSCAR.

Some men taking PROSCAR® (Finasteride) may have a decrease in the amount of semen released during sex. This decrease does not appear to interfere with normal sexual function.

You should discuss side effects with your doctor before taking PROSCAR and anytime you think you are having a side effect.

• **Checking for prostate cancer.** Your doctor has prescribed PROSCAR for symptomatic BPH and not for cancer—but a man can have BPH and prostate cancer at the same time. Doctors usually recommend that men be checked for prostate cancer once a year when they turn 50 (or 40 if a family member has had prostate cancer). These checks should continue while you take PROSCAR. PROSCAR is not a treatment for prostate cancer.

• **About prostate specific antigen (PSA).** Your doctor may have done a blood test called PSA. PROSCAR can alter PSA values. For more information, talk to your doctor.

• A warning about PROSCAR and pregnancy.

PROSCAR is for use by MEN only.

PROSCAR is generally well tolerated in men. However, women who are pregnant, or women who could become pregnant, should avoid the active ingredient in PROSCAR.

If the active ingredient is absorbed by a woman who is pregnant with a male baby, it may cause the male baby to be born with abnormalities of the sex organs. Therefore, any woman who is pregnant or who could become pregnant must not come into direct contact with the active ingredient in PROSCAR.

Two of the ways in which a woman might absorb the active ingredient in PROSCAR are:

Sexual contact. Your semen may contain a small amount of the active ingredient of the drug. If your partner is pregnant, or if you and your partner decide to have a baby, you must stop taking PROSCAR and talk to your doctor. If your partner could become pregnant, proper use of a condom can reduce the risk of exposing her to your semen (discuss this further with your doctor).

Handling broken tablets. Women who are pregnant or who could become pregnant must not handle broken tablets of PROSCAR.

PROSCAR tablets are coated to prevent contact with the active ingredient during normal handling. If this coating is broken, the tablets should not be handled by women who are pregnant or who could become pregnant.

If a woman who is pregnant comes into contact with the active ingredient in PROSCAR, a doctor should be consulted. Remember, these warnings apply only if the woman exposed to PROSCAR is pregnant or could become pregnant.

How to take PROSCAR

Follow your doctor's advice about how to take PROSCAR. You must take it every day. You may take it with or between meals. To avoid forgetting to take PROSCAR, it may be helpful to take it the same time every day.

Do not share PROSCAR with anyone else; it was prescribed only for you.

Keep PROSCAR and all medicines out of the reach of children.

FOR MORE INFORMATION ABOUT PROSCAR AND BPH, TALK WITH YOUR DOCTOR. IN ADDITION, TALK TO YOUR PHARMACIST OR OTHER HEALTH CARE PROVIDER.



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PM HOTLINES

COMMUNICATE WITH US

We're trying our best to make it easier for you to communicate with us.

Here are four ways you can do it.

LETTERS

Your written letters are always welcome. If we think your letter would be interesting to other readers, we might even print it in our Letters column (unless you request that it not be printed). Our editors are listed by department on the masthead printed in the front of the magazine next to Editor's Notes. Our address is 224 W. 57th Street, New York, NY 10019.

FAX MACHINE

You can fax written mail to us if you have access to a fax machine. Our fax number is (212) 586-5562, and is available 24 hours a day.

ELECTRONIC MAIL

You can call the PM computer any day between 6 pm and 8 am (only Eastern time). The number is (212) 582-8369. Once you're on line, you can leave messages for specific editors, or direct inquiries and comments to a specific department. The department bulletin board also allows you to share your thoughts with other readers who call in.

New users get an identification number and password that allow you to access the system. Simply set your communications software to 8 bits, no parity and one stop bit (8-N-1), and set the baud at 300 or 1200. Please remember that we are not a professionally staffed, fully operational bulletin board. We're simply trying to make it easier for you to communicate with us. So please bear with us if it takes awhile to answer your message.

READER SERVICE BUREAU

Our Reader Service Bureau is operational five days a week during regular business hours. The phone number is (212) 649-3127. Please call our Reader Service Bureau, *not our editors*, for information on back issues, reprints of articles, subscription inquiries and so on. It will save us all time.

HOTLINE PHONE NUMBERS

Unfortunately, our Hotline Phone Service is temporarily discontinued.

TIME MACHINE

90 YEARS AGO: FEBRUARY 1904

Popular Mechanics



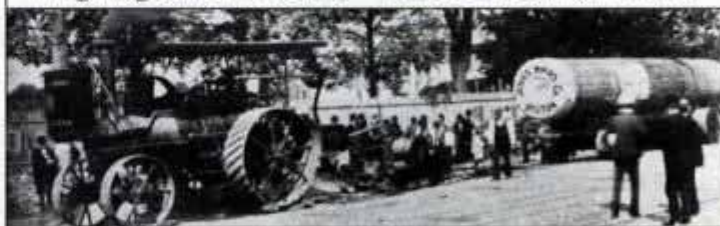
Winds Of War

As the world watched two empires gird for battle, Japan suddenly lashed out, blindsiding the Russian fleet at Port Arthur. Americans would view the conflict with detached interest. Opinion ran wide that the Russo-Japanese War was a masterful gambit in Britain's game of global chess. By checking Russia with its new ally Japan, Britain not only lamed its long-time rival but kept the Straits of Korea open for trade with China.

Colossal Column

The biggest pieces of granite ever quarried for an American building were rolling through the streets of New York. They were segments of eight great columns for the Cathedral of St. John the Divine. Weighing 90 tons each,

they traveled by lighter from Maine to Manhattan. But to deposit them on site called for a traction engine and a steam winch—and the biggest wagon built to date. Although more than 100 years have passed since construction began, the cathedral is still unfinished.



60 YEARS AGO: FEBRUARY 1934



Power Train

Slapped by the success of the automobile, train makers fought back. They even co-opted their rivals' technology. Pullman designed a self-propelled rail car driven by two gasoline engines from buses. These motors put out a mere 160 hp each, but whisked the vehicle to 90 mph, thanks in part to an automotive direct-gearing transmission. But the railroads' alternative powerplants—new and improved diesel engines—would prove the true track stars.

Radio Days

Thirteen years had passed since radio broadcasting began—where was the medium headed? The answers covered the spectrum. Shortwave transmissions were arcing around the Earth's curvature. Radio astronomy was developing. And radio phones and remote control were on the horizon. But most significant was activity on the roof of the Empire State Building, where NBC engineers were erecting experimental television antennas.



30 YEARS AGO: FEBRUARY 1964



Air Bargain

A private plane cheaper than a Chevrolet? That's what Jim Bede promised in the BD-1. The punchy little 2-seater also offered innovation aplenty—honeycombed aluminum construction, removable wing, interchangeable flaps and an engine that swung out for maintenance. Light and nimble, the plane cranked out bigger numbers for cruise speed than its engine did for horsepower. It was the first of many designs from the Bede brain trust.

Big Three

Meanwhile, the first American 3-engine airliner since the old Ford Trimotor debuted with Eastern Airlines. Boeing designed the 727 to partner with the 707 by jetting passengers

to smaller cities. Although Boeing managers figured 300 of the T-tail trijets would sell, they were wrong. More than 1800 727s have flown off the assembly line. **PM**



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a project and see
the results, it gives
you a great sense of
accomplishment."*

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Steven
Sales Associate
Hardware



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696
Every Day



Popular Mechanics™
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Rugged, all-steel construction with tough baked enamel finish. Nickel-plated lockable drawbolt and full-length staked piano hinge for added durability. With cushioned carrying handle and bottom guides. 20"Lx8 5/8"Wx8 5/8"H

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Popular Mechanics™
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Popular Mechanics™

Popular Mechanics™ Tool Chest and Rolling Cabinet Combination

This 6-drawer, 26-inch wide all-steel tool center is the perfect organizer. Includes pull-down door in roller cabinet and extra storage space. Chest: 22"Wx12"Dx13 1/4" H Cabinet: 26 1/2"Wx14"Dx31 3/4"H with casters

8996
Every Day



Popular Mechanics™ 60 Drawer Storage Cabinet

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997
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TECH UPDATE

News Of Tomorrow's Technology Today



At 60,000 ft., spaceplane could fill up on propellant from isolated fuel tank of KC-135Q instead of lugging it all up there.

On-The-Fly Fueling Could Top Off Rockets

KIRTLAND AFB, NM—Thirty years ago, Chuck Yeager shattered an altitude record in a rocket-assisted Lockheed Starfighter, the NF-104.

The AR-2 rocket on the plane's tail burned jet fuel in hydrogen peroxide, two propellants that have been eclipsed by today's punchier liquids. But two engineers now contend that the old propellants could bestow unusual new capabilities—including aerial refueling—on our space program.

The engineers are Air Force Capt. Mitchell Clapp and consultant Max Hunter, a long-time proponent of single-stage-to-orbit rocketry. Clapp and Hunter argue that hydrogen peroxide, which supplies oxygen to the combustion process, could bring back operational simplicity—something absent in current spaceflight efforts.

Unlike liquid oxygen, peroxide stays liquid at room temperature. It's also nontoxic and drugstore cheap. What's more, the liquid soaks up heat nearly as well as water and can be circulated to cool off a rocket engine. And the densities of peroxide and jet fuel actually translate to a lighter spacecraft to offset their less energetic performance.

Clapp has taken the concept one

step further. He envisions a rocket plane, about the size of an F-16, that would carry peroxide and jet fuel in a 7:1 ratio. The plane would take off full of fuel but with just enough peroxide to reach 60,000 ft. There it would rendezvous with a KC-135Q, which formerly refueled SR-71 Blackbirds. Having loaded up with peroxide from the tanker, the plane could then roar off—as far as the Moon.

Highlights This Month

- **Toxic Taxi**—Personnel carrier for chemical disasters.
- **High Chair**—Ejection seat flies itself to safety.
- **Oil Burner**—Fighting petroleum slicks with fire.
- **Head Games**—Indoor theme park via virtual reality.
- **Ice On Ice**—Inside the world's coldest laboratory.
- **Green House**—Recycled Caribbean seaside resort.
- **Weight Ball**—New gravity-mapping satellite.

Editor/Writer: Gregory T. Pope
Reporters: Philip Chien, Mike Fillon, Scott Gourley,
Rick Schrader



Customs House For Spaceport

KENNEDY SPACE CENTER, FL—If it's bound for the Space Station Alpha, it must pass through Florida. Due to open sometime this fall, NASA's Space Station Processing Center will be the biggest new facility at Kennedy since the Apollo era.

Inside, a 15-ton crane swings in a 5000-sq.-ft. airlock. The chamber leads to vast clean rooms, where technicians will inspect scientific payloads.

Processing facility will house a football field's worth of clean-room space for science racks and propulsion modules.

Airline Cockpit For Shuttle



MEDS will mimic today's displays but can be programmed for next-generation astronauts.

KENNEDY SPACE CENTER, FL—NASA will soon begin wiring an up-to-date "glass cockpit" into the Shuttle, replacing the mechanical displays that betray the spacecraft's '70s roots.

The Multifunction Electronic Display System (MEDS) will include nine screens up front for the pilots and two in the aft flight station.

Based on the cockpit planned for the Boeing 777, the full MEDS display will be in every Shuttle by 1998.

Send In The Chernobyl-Mobile

MOUNTAIN VIEW, CA—When the next Chernobyl or Bhopal strikes, a global disaster-response team may be ready to strike back. NASA's Ames Research Center and the FMC Corp. have combined their technical expertise to study such a venture.

The project centers on an all-purpose hazardous-materials assault vehicle. Based on a stretched version of the Army's M577A3 command-and-control personnel carrier, it would carry a manipulator arm to scatter sensors or disperse small robotic scouts. Bulldozer blades or hydraulic cranes are other optional

NASA/FMC toxic-disaster response vehicle would wield manipulator arm and externally mounted protective suit.

attachments. Inside, technicians would operate remote-control earth-movers, mobile cranes and other vehicles, using virtual-reality technology.

In addition, a rear airlock hatch would allow personnel to clamber directly into hazmat suits without de-



Eurostyle Manned Rockets



Ariane 5 could carry pressurized capsule and transfer booster.

PARIS, FRANCE—Although it's strapped for cash, the European Space Agency has blueprinted an ambitious manned space program.

Instead of going up aboard the now-cancelled mini-shuttle *Hermes*, astronauts would "climb the ladder" in a capsule atop the coming Ariane 5 heavy-lift booster. An automated transfer vehicle would then bring the capsule—or Europe's pressurized lab module—to rendezvous with the Space Station.

contamination procedures. The garments would derive from advanced spacesuits under development at Ames. The hatch would also dock via jetways to other vehicles.

A demonstrator vehicle could be up and running by April.



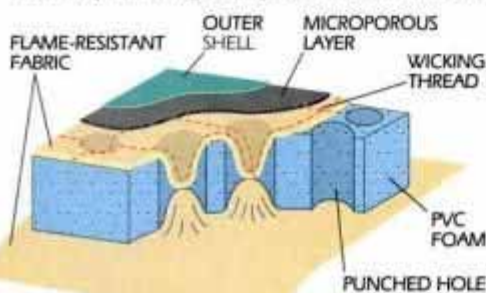
No-Sweat Survival Suit

BELLINGHAM, WA—Besides hostile ordnance, Army aviators dread cockpit fire and splashdowns. Current flightsuits guard against both by sandwiching a buoyant wetsuit between two layers of flame-resistant Nomex. But the garments are uncomfortable in hot, humid climates.



A prototype suit by Mustang Survival should let flyers breathe easier. Pores punched through the wetsuit's foam liberate trapped body heat. Meanwhile, the sandwiching fabrics are sewn together through the holes, the thread providing escape routes for sweat.

A prototype suit by Mustang Survival should let flyers breathe easier. Pores punched through the wetsuit's foam liberate trapped body heat. Meanwhile, the sandwiching fabrics are sewn together through the holes, the thread providing escape routes for sweat.



Porous survival suit would feature heat-escape avenues to relieve heat-stressed aviators.

Punchout Without The Knocks

TITUSVILLE, FL—High-speed ejections can beat up fighter pilots pretty badly. And bailing out upside-down or at low altitude is more than often lethal.

But McDonnell Douglas Missile Systems is developing a self-adjusting seat that will whisk the aviator to a head-up trajectory and a safe altitude. It's part of a fourth-generation escape-system program that's aimed at replacing the widely used ACES II ejection seat, currently being adapted for supersonic bailouts.

Instead of a single rocket charge, the new chair will have four throttleable motors. On ejection, motion sensors will quickly analyze the seat's position and control propellant flow to each motor. The motors will produce variable thrust to correct the seat's orientation and kick it to an altitude high enough for a parachute to deploy.

Subcontractors Aerojet and TRW are building rival solid-fuel and gel-propellant engines for the seat. A winner will emerge after ground tests next year. The seat will then have to withstand 15 test firings, including a 700-knot ejection from an F-16 cockpit mounted on a rocket sled.



Next-generation seat will fire four throttleable rocket engines to re-orient itself after perilous punchout.

FM ILLUSTRATION BY DON MANNES

Every Which Way



OAK RIDGE, TN—If you can roll in any direction from a starting position—while simultaneously rotating—you're riding the Omnidirectional Holonomic Platform, developed at Oak Ridge National Laboratories.

The device consists of a Y-shaped armature, each arm holding two motorized caster assemblies mounted at right angles to each other. Applications include wheelchairs and industrial robots.



A computer controls speed of wheels' motors to provide omnidirectional movement without wheel steering.

ORNL PHOTO

Control For Nose-Up Turns



Strakes will pop out to manipulate air vortices and steer jet's nose.

HAMPTON, VA—Aerodynamicists are chipping away at the problem of fighter maneuverability at high angles of attack when a jet's wings block airflow to the tail rudder.

One answer may lie in an effort at NASA's Langley Research Center, where engineers are fitting strakes—slim control surfaces—to the nose of an F-18. The jet is scheduled to begin flight tests this year.

Power Football

PALO ALTO, CA—A new foam-rubber football is so aerodynamically stable that even a toddler can throw deep.

The Aerobie football has curved fins that act like propellers to rev up its spin. The fins also boost lift by keeping the ball nose-up.

Sold by Superflight, it is the brainchild of the Stanford professor who invented the Aerobie flying ring.



Prop-like fins lock Aerobie football into spin up to 1000 rpm.

SUPERFLIGHT PHOTO

Ride Your Favorite Videogames



VirtuaFormula and AS-1 set trend toward virtual-reality theme parks.

LAS VEGAS, NV—The amusement industry is riding virtual reality for all it's worth, and the cybernetic thrills that have surfaced recently appear to be just the tip of the iceberg.

One initial showcase is Las Vegas's Luxor Hotel, where Sega and Circus Circus Inc. have teamed up to create VirtuaLand.

The centerpiece of the 20,000-sq.-ft. facility is an 8-person "motion theater" called the AS-1. Rocked by four hydraulic cylinders, the game features 3D polygon graphics provided by interchangeable CD-ROM disks. Another prime attraction is VirtuaFormula, an 8-player racing game with similar technology.

Eyes Of The Nighthawk



Adapted from chopper's sight, Nighthawk guides Hellfires from ground platform.

SANTA ANA, CA—Those mast-mounted sights on the Army's OH-58D Kiowa helicopters are popping up everywhere these days, from Bradley fighting vehicles to warships. Now McDonnell Douglas has introduced a next-generation system—Nighthawk—at reduced weight and size.

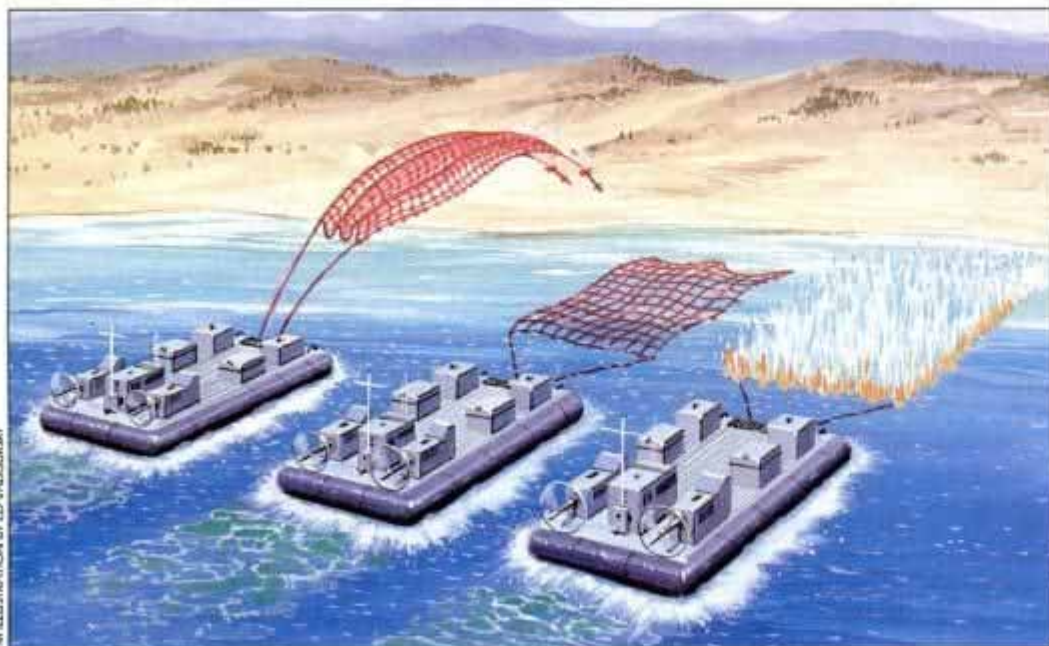
The 18-in.-dia. package features the standard infrared sensor, TV camera and laser rangefinder/designator. The laser can also help fix the Global Positioning System coordinates of its target to guide weapons.

Radar Guards Itself

WHITE SANDS, NM—Air-defense radar tends to lure antiradiation missiles that home in on an antenna's transmissions. But the Army's Missile Command has been testing a Raytheon-built Multi-Role Survivable Radar (MRSR) that dodges those bullets.

The system peppers the horizon with continuous-wave pencil beams, to elude missiles that pick up on the leading edges of radar pulses. In addition, one of the beams always scatters off the ground ahead of the antenna, thus providing decoy targets.

New radar guides forward air defenses without triggering missile attack.



PM ILLUSTRATION BY ED VALCIGORSKY

Navy's Net For Mines

WASHINGTON, D.C.—Surf-zone mines lurk as the most insidious threat to hit-the-beach operations. Among the many countermeasures under study at the Pentagon is a net woven with explosives.

Launched on twin solid-rocket boosters, the net would unfurl from an unmanned hovercraft. As the net settled through the surf, it would detonate to create a massive overpressure, neutralizing any mines.

Air-cushion vehicles spread nets laced with explosive cords to wipe out surf-zone mines.

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**3 years/36,000 miles. See dealer for details.

Sight For Smoky Eyes

CLIFTON, NJ—To equip firefighters with smoke-penetrating vision, Cairns and Brother has developed a helmet-mounted infrared imaging system that weighs only 1.4 pounds.

Called CairnsIRIS, the apparatus combines a camera, a belt-worn image processor and a head-up display. Infrared images appear in the firefighter's line of vision, à la virtual reality, although they aren't stereoscopic.



CairnsIRIS infrared camera alerts firefighter to trapped people, hidden hot spots and flashovers.

Falcons Throw Deep-Threat Bombers



Unleashed from F-16, stand-off runway destroyer glides in from high or low altitude.

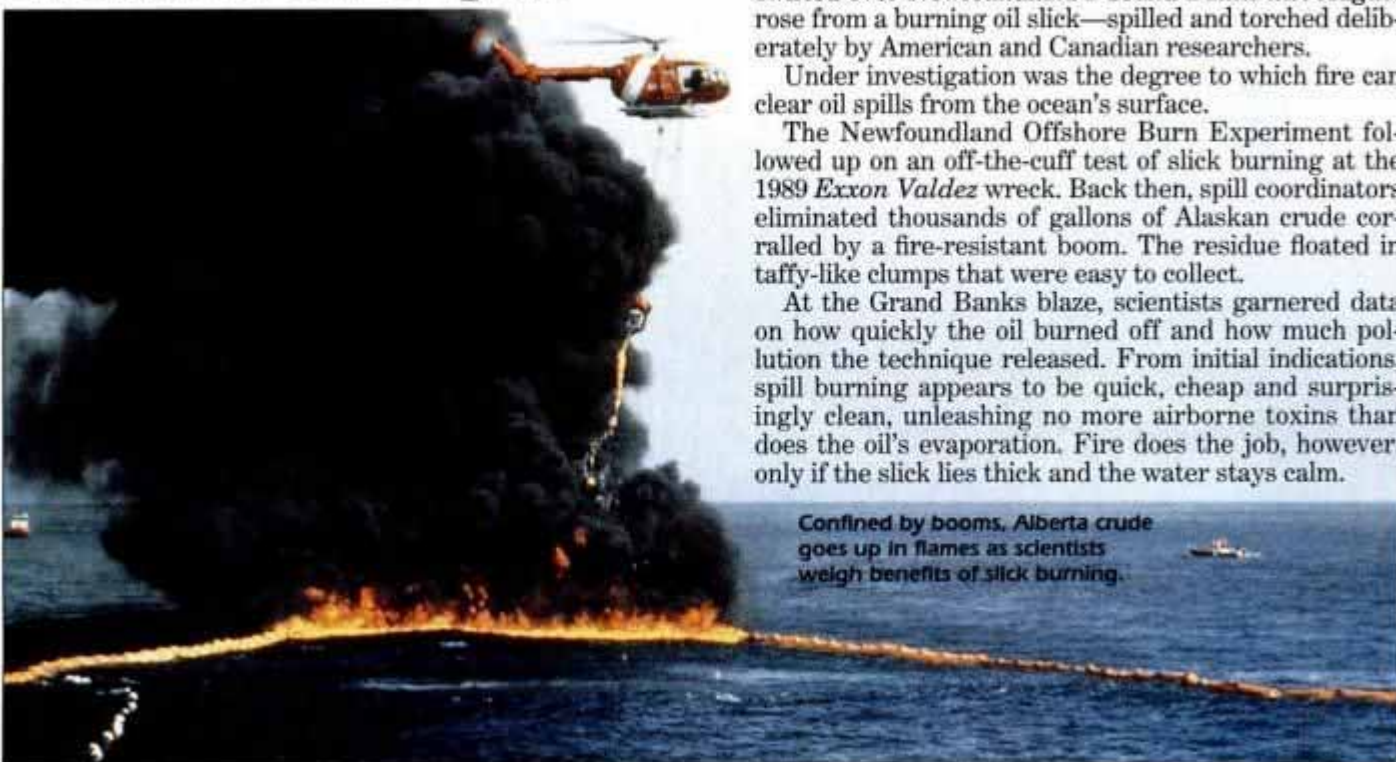
EGLIN AFB, FL—Being a multi-role fighter, the F-16 must take on risky jobs like runway destruction. But instead of swooping in for death-defying, ground-hugging runs like Europe's Tornado fighter/bomber, a Fighting Falcon could strike from miles away.

To that end, the Air Force has been testing a submunitions dispenser built by Germany's DASA. The jet releases

the stand-off weapon from a range of up to 12 miles, usually while veering away from the target. Navigating inertially and via GPS, the vehicle then flexes its tailfins to glide autonomously to its goal. Cratering or anti-armor submunitions spring from the vehicle's flanks as it flies over the target.

In Europe, similar dispensers are in production for both of Sweden's fighters: Viggen and Gripen.

Slick Fire On Purpose



Confined by booms, Alberta crude goes up in flames as scientists weigh benefits of slick burning.

OTTAWA, CANADA—The sooty black smoke that swirled over Newfoundland's Grand Banks last August rose from a burning oil slick—spilled and torched deliberately by American and Canadian researchers.

Under investigation was the degree to which fire can clear oil spills from the ocean's surface.

The Newfoundland Offshore Burn Experiment followed up on an off-the-cuff test of slick burning at the 1989 *Exxon Valdez* wreck. Back then, spill coordinators eliminated thousands of gallons of Alaskan crude corralled by a fire-resistant boom. The residue floated in taffy-like clumps that were easy to collect.

At the Grand Banks blaze, scientists garnered data on how quickly the oil burned off and how much pollution the technique released. From initial indications, spill burning appears to be quick, cheap and surprisingly clean, unleashing no more airborne toxins than does the oil's evaporation. Fire does the job, however, only if the slick lies thick and the water stays calm.

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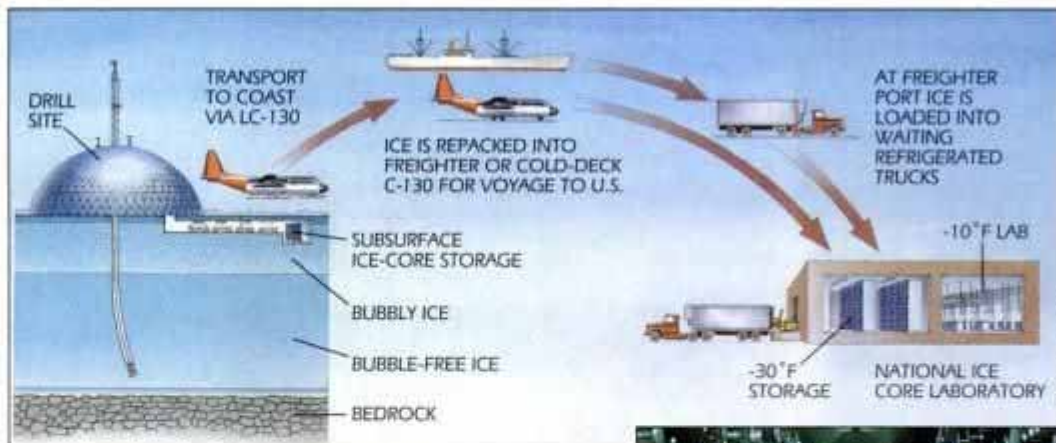
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Ice Age On Ice

DENVER, CO—Last August, the world's most valuable ice began arriving at a unique cold-storage facility. More than 2 frozen miles, cored out of the Greenland ice cap, are now undergoing analysis at the National Ice Core Laboratory.

Because the ice contains preserved atmospheric samples that date back 250,000 years, scientists aren't taking any chances on a meltdown. The lab's refrigeration plant—big enough to air-condition a shopping mall—has several layers of fail-safe systems, including automatic-transfer switches that trigger a natural-gas generator if utility power fails. There's also enough insulation to keep the ice frozen for a month. For worst-case scenarios, an 18-wheel-



Elaborate transportation protocol ensures that ancient atmospheric samples remain locked in ice, en route to lab where researchers dress for winter.

er full of dry ice can back up into a piping manifold and blast-freeze the place. Already the ice has revealed wild climatic swings even during the warm periods between ice ages—suggesting, controversially, that our own time might be prone to sharp fluctuations in climate.



U.S. GEOLOGICAL SURVEY PHOTO; ILLUSTRATION BY ADOLPHE E. BRITMAN

Foul-Weather Radar



ALLIEDSIGNAL PHOTOS

PRM allows tighter spacing on runways, thanks to phased-array antenna.

TORRANCE, CA—Airports will soon phase in phased-array radar for bad-weather landings—the Precision Runway Monitor (PRM).

Made by AlliedSignal Aerospace, the system allows air-traffic controllers to track positions of planes 10 times faster than normal radar, which sweeps out a circle every 4 seconds. By contrast, the PRM radar beam jumps around in microseconds.

Minneapolis-St. Paul International is getting the first unit.

Down-To-Earth AWACS

SUNNYVALE, CA—Airborne Warning And Control System (AWACS) planes use the AN/AYR-1 pod to pinpoint and identify friendly or hostile radar signals. Now, ARGOSystems has adapted the pod into a system called Pointer, which consists of Stingers mounted on a HumVee for the Avenger surface-to-air missile platform. Pointer will scan for hostile frequencies and tip off the gunner to look for threats in a given direction.



AWACS-style electronic support measure will alert Stingers.

ARGOSYSTEMS PHOTO

F-16XL Is Back In Black

HAMPTON, VA—The cranked-arrow wings of the F-16XL are back in a new black-and-yellow paint scheme. NASA's Langley Research Center has borrowed the bird from the Air Force to test wing add-ons that lend extra lift during takeoffs.



NASA PHOTOS

Engineers will test two different types of high-lift flaps and suction devices that draw in boundary-layer air through wing-skin perforations.

The research effort will assist the developers of future supersonic airliners, which will have to climb away from airports quickly to escape noise regulations.

F-16XL will fly again in support of future SST designs, which feature similar cranked-arrow silhouette.



PM ILLUSTRATION BY ADOLPH E. BROTMAN

Harmony combines environmentally sensitive design with conservation measures.

Superconduct This

WESTBOROUGH, MA—It's no surprise that some of the first prototypes made from the new high-temperature superconductors are military items. Both come from American Superconductor Corp.

One is a sonar transducer for the Naval Undersea Warfare Center. With a built-in Stirling-cycle cryocooler, the device puts out unprecedented power for its weight.

The other is a coil for a 1-megawatt generator at the Air Force's Wright Laboratory. The device may foreshadow a 5-megawatt unit weighing only 330 pounds. Power for airborne surveillance gear is a likely application.



Acoustic transducer (top) and generator coil (above) feature new superconducting materials.

AMERICAN SUPERCONDUCTOR PHOTOS

Recycle Your Vacation

ST. JOHN, U.S. VIRGIN ISLANDS—Ready to relax amid wood scraps, old plastic bottles, newsprint and crushed glass? No, it's not a vacation at the city dump, but rather at a new resort on Maho Bay—the ultimate in eco-tourism.

The accommodations, dubbed Harmony, consist of two 2-story buildings that showcase sustainable development. Erected within existing vegetation, the houses themselves are constructed from recycled materials, while power is supplied exclusively from 1100-watt photovoltaic-cell panels and a nearby horizontal-axis wind turbine.

Inside, climate control comes from passive measures, such as a roof-mounted wind scoop that faces downwind to draw hot air out of the interior. Solar thermal energy will heat water and make ice.

Instead of a thermostat, each unit will come with a computer terminal enabling guests to monitor their energy use.

Developed by entrepreneur Stanley Selengut, Harmony was built with technical assistance from Sandia National Laboratories.

U-Ball To Map G-Forces

KOUROU, FRENCH GUIANA—Why would anyone orbit an 80-pound ball of uranium? Not to build a space bomb, but rather to map Earth's gravitational field.

Last fall, the French space agency CNES launched the soccerball-size satellite called Stella. Around its core of depleted uranium-238 lies an alumi-

num skin dotted with 60 quartz reflectors. Ground-based lasers ricochet beams off the ball to pinpoint its distance from Earth. Gravity anomalies—such as mineral deposits and mountains—pull the sphere closer.

The uranium lends density and compactness to minimize interference from wispy atmosphere and solar wind.



Laser measures changes in Stella's orbital path caused by gravitational blips.

CNES PHOTOS



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1994 F-SERIES



BUILT FORD TOUGH

THE MECHANICS OF SPEED SKIING

Skiing's ultimate speed event is the next best thing to freefall.

BY CHARLES PLUEDDEMAN

• Speed skiing, the pursuit of peak terminal velocity, is the most intense and thrilling of all skiing disciplines. The wind tears at your body and the skis flop wildly as you fight to maintain a tuck position on the radically contoured mountain. You feel a strong surge of acceleration as you hurtle down the steepest portion of the course. Passing through the timing lights, your body punches a hole in the atmosphere that rips the air with a jet-engine roar. Slowing down in the braking area, you glance up at the digital scoreboard and see a speed posting in excess of 140 mph. Any faster and you'd need a parachute.

The origin of speed skiing dates to 1898, when a Californian, Tommy Todd, allegedly zipped to 87 mph.

SPEED SKIING



Two views of the speed skier's tuck. Boots are modified to provide sharp forward lean, above. Head is lower than butt, at right, so that airflow on the back produces downward pressure. Note the aerodynamic contours of the helmet.



PHOTOS BY NATHAN (BELOW LEFT), VANDERKAM (RIGHT)

However, the first official record was set in 1932 when Italian skier Leo Gasperi was clocked at 89 mph by the International Ski Federation (FIS) in St. Moritz, Switzerland. By the 1960s, speed skiing was a professional sport sanctioned by the FIS. In the last Winter Olympics, it was accorded the status of a demonstration sport, although it won't appear in this year's Winter Games in Norway.

The basic goal of speed skiing is to

harness gravity and defeat friction. To this end, the equipment is highly specialized. The skis are about 240 cm long, compared to 225 cm for a downhill racing ski and 200 cm for a recreational ski. In addition, the skis are wide and made of wood and steel, which contributes to their hefty 25-pound weight.

The extra width helps the skis run flat on the snow and spread out the skier's weight over the largest possi-

ble area to reduce friction. To keep the tips on the snow at speeds over 100 mph, the skis are rigid, heavily damped and shaped to cut a low profile for minimal wind resistance.

While speed skiers use widely available high-performance bindings and boots, they typically fit the bindings with a stiff racing spring and modify the boot cuffs to provide sharp forward lean in the lower leg, which allows the racer to bend low in the tuck position.

To help air pass smoothly over their bodies, speed skiers squeeze into skintight suits. Last season, the U.S. team began using a new suit developed by Swany USA, of Gloversville, New York. The suit's material is a stretch fabric that's coated with polyurethane to give it density to resist the formation of slipstream bubbles in low-pressure zones along the racer's body. Each suit is custom-cut to fit the racer's tuck position.

To smooth the airflow around the lower legs, a wedge-shaped fairing made of dense foam fits inside the suit behind each calf from the knee to the boot top. Interestingly, airflow concerns also play a part in glove design. Speed skiers use their hands as the leading edge to break the wind and to act as a controlling rudder. The gloves, also made of stretch material by Swany, have special cuffs that allow air to flow smoothly over the wrists.

Speed skiers use poles to push off at the starting point and to act as a

(Please turn to page 30)



Special equipment, clockwise from left: A wedge-shaped fairing fits inside the stretch suit at the back of each calf, poles that wrap around torso are used as a framework for bracing arms in position and aero gloves are used to break the wind and act as a partial rudder.

PHOTOS BY NATHAN (BELOW LEFT), C. J. MUELLER (RIGHT)

Olympians Bank American



Olympic-medal hopes ride with the made-in-the-U.S.A. Bo-Dyn Sled, shown during a Lake Placid, New York, practice run.

● Maybe the Jamaican team needs to be thanked for popularizing the sport of bobsledding, but the coolest running sled on the Olympic ice may just belong to the U.S. team.

Just how cool the U.S. bobsled is will be determined February 12 through 27 at the Winter Olympics in Lillehammer, Norway. From an American standpoint, the bobsled event is of particular interest. For the first time in many years, the United States has a driver already considered to be among the most skilled in the world. And that driver will be in a new, distinctive-looking bobsled with an unusual point of origin—it's the first American-made bobsled to compete in the Olympics since 1956, the last year the United States won a medal.

Subsequent American efforts in the Olympic 2-man and 4-man bobsled competitions have relied on European-made sleds. Not that Americans didn't try to build their own sleds. For the 1988 Olympics, Airflow Sciences Corp. spent more than \$1 million developing a high-strength fiberglass composite bobsled. Unfortunately, the Olympic team considered it unsafe to drive.

By comparison, "The Bo-Dyn Sled is the best bobsled project ever developed," says John Morgan, a bobsled analyst for CBS Sports. "This is the one that may put us at the top."

The current U.S. effort derives its inspiration not so much from a high-tech source as it does from the

spirit of auto racing. After watching the 1992 Olympic competition, stock-car racer Geoff Bodine (winner of the 1986 Daytona 500) felt the American team could win a medal if they had a better sled. Bodine put his money where his mouth was, contributing \$150,000 to launch a bobsled development project.

Bodine also brought in an old friend, Bob Cuneo—a race-car chassis builder in Oxford, Connecticut—to build the sled. The finished sled is called the "Bo-Dyn Sled," a melding of Bodine's name and the name of Cuneo's company, Chassis Dynamics Inc. The sled, in fact, is practically sponsored by the auto-racing community, as most of the \$400,000 needed to complete the sleds—three for each event—was raised in a paved-roots fundraising campaign held at auto races across the country.

Cuneo brought a different perspective to bobsledding, one gathered from a career in auto racing. While secretive about specifics, Cuneo can't hide the obvious. The cowl section up front in the 2-man sled is much lower than traditional designs and this, by extension, makes the aerodynamics of the sled very different. The 4-man sled is more traditional looking due to time constraints.

More remarkable is the weight of the sled. Bobsled teams historically run their sleds at the maximum weight limit, 827 pounds for the 2-

man and 1389 pounds for the 4-man. The Bo-Dyn Sled, by contrast, is "significantly lighter," says Cuneo. Moreover, the weight is distributed in a manner that gives the driver, who steers with ropes, more control.

Other changes, notes Cuneo, are not so obvious. The suspension is different, and some improvements have been made to the steering.

Chassis Dynamics also has made some highly rated runners, thanks to improvements in the metallurgy, shape and geometry of the blades.

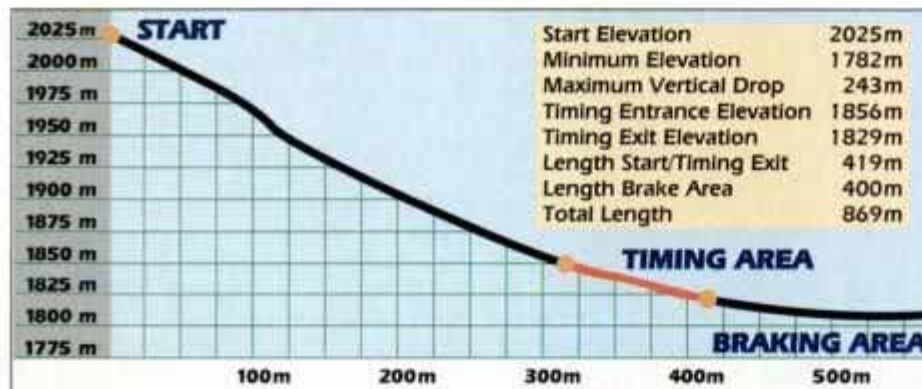
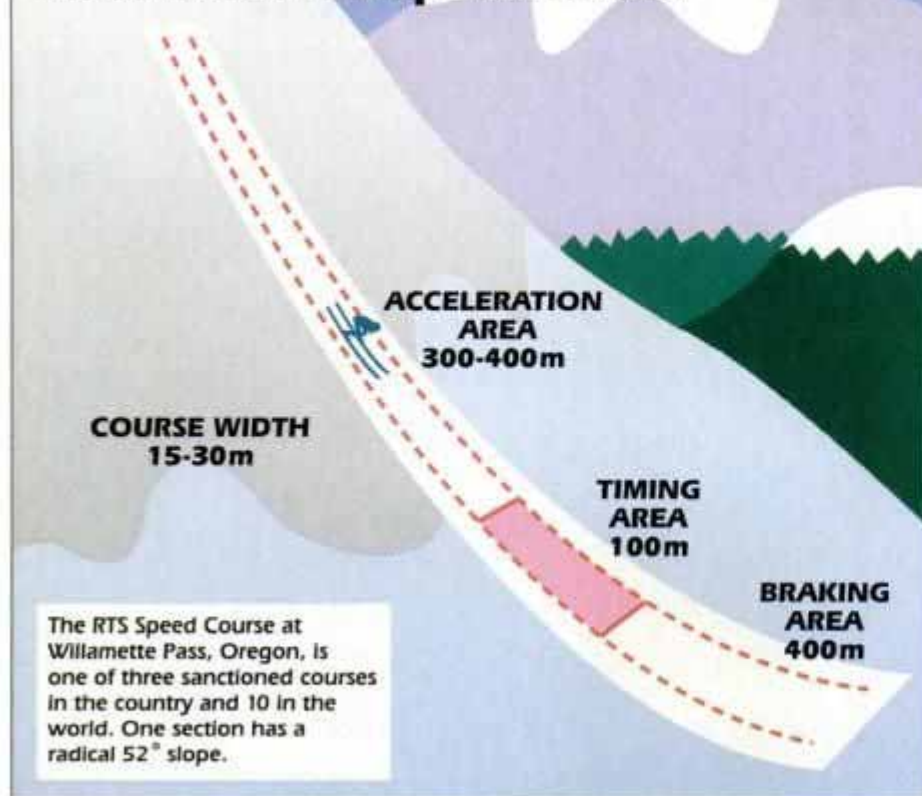
The result is a bobsled that's been nicknamed the Stealth Sled because of how quietly it runs the course. "You can't hear it coming," says Cuneo. "It's half as noisy as other sleds." Most sleds often can be heard approaching from a quarter of a mile away.

Medal hopes are riding with the 2- and 4-man sleds piloted by Brian Shimer. Shimer finished seventh in the 2-man event in the 1992 Olympics, and is currently rated among the top drivers on the World Cup tour. Shimer's skill will be tested in the Olympics since the Lillehammer course is considered very technical and very short at 1350 meters.

Still, the difference in times among medal winners is measured in hundredths of a second, so every team member's contribution is critical. That thought will be in the minds of the men sitting in a deep, red flash hurtling down an icy tube in search of a medal. —Frank Vizard

SPEED SKIING

Willamette Pass Speed Course



framework for bracing their arms next to their bodies. The poles are custom-bent to wrap around a skier's torso. Cones fitted to the end of each grip also help to streamline air.

According to 26-year-old speed skier Jeff Hamilton, of Donner Lake, California, the speed skier's helmet is his most essential piece of equipment. Hamilton should know. He's currently the second-fastest skier in the world, with a mark of 144.23 mph set last season at Les Arc, France.

"Each helmet is custom-made to fit the racer's body size and tuck position," explains Hamilton. "It directs wind from the top of the head in a straight line down to the back. A slight change in the shape of the helmet can cause a 1 mph or more difference in top speed."

Hamilton's helmet is molded in Kevlar and fiberglass by Richard Landingham of San Juan Capistrano, California. Some helmets are designed with a fin along the top to in-

crease stability and to allow the racer to steer by moving his head.

Another essential element is the preparation of ski bases. Hamilton tunes his skis to fit conditions by using a stone grinder to create varied structural patterns and then applying one of several types of wax.

There are only about 10 speed-skiing courses in the world capable of hosting a World Cup-level event. One of these is the RTS Course at Willamette Pass, near Eugene, Oregon, which will host the U.S. Nationals and a World Cup event this March. Each course must be able to safely produce speeds of at least 170 kph (about 106 mph). The current world record is 145.1 mph, set by Frenchman Philippe Goitchel in 1993 at Les Arc, France.

The racer's speed potential is dictated by the location of the starting point, which is typically 300m to 400m above the first timing light. The starting point is determined by race offi-

cialists after calculating snow and weather conditions, the steepness of the hill and the ability of the athletes entered in the meet. In an effort to promote safety, the FIS has mandated that a start point must be chosen that will not produce a speed above 228 kph (about 142 mph). The rule is intended to encourage athletes to compete for the fastest speed at each event, rather than just gunning for a new record. When a record is set, it is a true accomplishment.

The RTS Speed Course is 15 meters to 30 meters wide. Skiers study the course before each run and pick the smoothest path to the speed trap: two sets of timing lights set 100 meters apart. To start, the skier simply stands across the fall line of the hill, picks his line, and then jumps to face downhill. From there, gravity and technique take over.

Since skiers reach top speed in less than 400 meters, initial acceleration is critical. Ski tuning plays an important role here, as does the technique of keeping your skis absolutely flat on the snow and maintaining an optimal tuck position: head low and butt high to create downward pressure. Initially, Hamilton has his hands positioned in front of his helmet, but as he builds speed he gradually extends his arms out about 8 in. in front of his body.

In less than 15 seconds, acceleration goes from zero to more than 140 mph. The entire run takes just 20 seconds, but it is a very intense 20 seconds with little margin for error.

A red line in the snow signals the end of the speed trap, and the skier begins the process of slowing down—the most dangerous part of the run. On slower courses, where speeds don't go much above 100 mph, skiers can just stand up and use the wind as a brake. But at 140 mph, you must slowly untuck to dirty the aerodynamics. Below 100 mph, you can carve very wide turns to burn off speed.

For each round in a multiday event, the starting point is moved farther up the hill and speeds increase by about 10 kph. There are four to six rounds in a typical meet, and the fastest skier in the final round is the winner.

Despite its daredevil reputation, the sport is really quite safe. During the 1992 Olympics, only four skiers fell out of 450 attempted runs.

Defying the best efforts of the FIS, speed skiers continue to bump the world speed record upward at sanctioned meets. Is there a limit to speed on the snow?

"There's still more hill to climb at Les Arc," says Hamilton. "With perfect conditions, I think 150 or a little more is possible with today's gear and rules."

FM

TOYOTA COROLLA

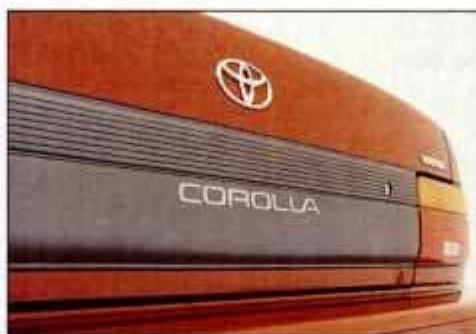


Heading for a special spot in the all-time record book.

BY MICHAEL LAMM, Contributing Editor; PM Photos by David Dewhurst

• We'll soon have another all-time world's best seller here. As the Toyota Corolla celebrated its 25th anniversary in 1993, its sales were quickly closing in on the all-time record-holder, the venerable Volkswagen Beetle. At 16 million, the Corolla had already left the Model T Ford 1 million units behind, and it's only a matter of time before it overtakes the VW Beetle, even though Beetles are still in production in some parts of the world.

While the Corolla's drivetrain remains pretty much as before, the '93 body has grown in every direction. Wheelbase, track and height are all greater by an inch-plus, and overall length stretches 2 in. more. Interior dimensions reflect these changes, and the EPA no longer classifies the



Corolla as a subcompact. It's grown up into a compact-size automobile.

Available only as a 4-door sedan and wagon, it comes in three trim levels—Standard, DX and LE. Standard equipment includes a driver's airbag (dual airbags are standard for '94), power front disc brakes, front bucket seats with a center console, a rear antiroll bar, an automatic-off headlight switch and remote releases

for the trunk and fuel-filler door. In the Standard car, you also get your choice of a 5-speed manual transaxle or a 3-speed automatic with no price difference.

The Corolla DX adds a front stabilizer bar, a right-side manually operated outside mirror, a 60/40 split/fold-down rear seat, power steering, a clock and the choice of a 4-speed

TOYOTA COROLLA



Instruments won praise for legibility.



Firm front seats drew some criticism.



Engine power pleased most owners.

automatic in lieu of the 5-speed.

Finally, the LE's standard equipment includes (in addition to or in place of the above) air conditioning, power windows, power locks, a tilt steering wheel, cruise control, a 4-way adjustable driver's seat, power outside mirrors, a tachometer and an AM/FM/ETR sound system.

The Corolla's lowest advertised price is \$11,198 and ranges up to \$15,218 for the LE. Owners in our survey paid an average of \$14,161.

Many of our buyers had owned Corollas before. Fact is, 38.1% listed previous ownership as their main reason for choosing the '93 model. So brand loyalty ranked as the primary

purchase motivator, followed closely by styling. Behind these came price/value, Toyota's reputation for reliability, reliability itself and economy of operation.

The Corolla shines, as always, in reliability and mechanical durability. Fully 91.1% of our '93 respondents experienced no mechanical problems

SUMMARY OF TOYOTA COROLLA OWNERS REPORTS*

Total miles driven	942,080	Engine power:	Good	40.9	What type of problems?	
Average miles driven	5148	Excellent	Average	2.3	(Percentages too small to tabulate)	
Purchase price:		Good	Poor	0.8	Repair it yourself?	
Average	\$14,161	Average	Excellent	54.3%	No	88.2%
Range	\$11,000-\$18,000	Poor	Good	40.9	Yes	11.8
Why did you choose the Toyota Corolla?		Handling:	Average	3.7	Dealer repairs satisfactory?	
Previous ownership	38.1%	Excellent	Poor	1.6	Yes	73.3%
Styling	36.4	Good	Excellent	37.6%	No	26.7
Price/value	17.6	Average	Good	51.1	Dealer service opinion:	
Reputation	16.5	Poor	Average	9.0	Excellent	58.0%
Reliability	12.5	Braking:	Poor	2.2	Good	32.1
Economy of operation	11.9	Excellent	Average	3.0	Average	8.0
Avg. mpg. city/hwy:		Good	Poor	0.0	Poor	1.8
1.6-liter Four	27.6/33.1	Average	Overall performance:		Dealer sales policy:	
1.8-liter Four	26.6/32.4	Excellent	Excellent	65.1%	Excellent	45.6%
5-speed manual	28.5/33.9	Good	Good	33.6	Good	39.6
4-speed automatic	26.7/32.3	Average	Average	0.7	Average	12.1
Model choices:		Poor	Poor	0.0	Poor	2.7
Corolla DX	40.3%	Control layout:	Specific likes:		Number of vehicles owned:	
Standard Corolla	33.5	Excellent	Styling	46.5%	This vehicle only	39.6%
Corolla LE	26.2	Good	Handling	43.0	Two vehicles	36.4
Body style choices:		Average	Economy of operation	29.1	Three vehicles	15.5
4-door sedan	91.7%	Poor	Comfort	24.4	Four or more	8.6
4-door wagon	8.3	Excellent	Ride quality	23.8	Principal driver:	
Engine choices:		Good	Engine power	16.9	Female	74.2%
1.6-liter Four	50.3%	Average	Specific dislikes:		Male	23.1
1.8-liter Four	49.7	Excellent	Front seats too hard	16.2%	Equal	2.7
Transaxle choices:		Good	No complaints	14.0	Age distribution of owners:	
4-speed automatic	79.7%	Average	Price too high	7.4	29 and under	17.7%
5-speed manual	20.3	Poor	Defroster system	5.9	30-49	47.3
Options/Accessories:		Excellent	Unmarked power door locks	5.9	50-plus	34.9
Air conditioning	97.9%	Good	Noises and rattles	5.1	Based on your experiences, would you buy a Toyota Corolla if you had it to do over again?	
Power steering	95.3	Average	Suggested changes:		Yes	62.0%
Power windows and locks	44.6	Poor	Improve front-seat comfort	9.3%	Maybe	30.4
Antilock brakes	36.3	Driver sightlines:	No changes	7.8	No	7.6
Sunroof	13.7	Excellent	Marked power door locks	7.0		
		Good	Standard ABS	7.0		
		Average	Smoother ride	7.0		
		Poor	Passenger airbag	6.2		
		Workmanship opinion:	Mechanical problems?			
		Excellent	No	91.1%		
			Yes	8.9		

* Percentages might not equal 100% due to rounding up or insufficient data. Survey results are based on responses from owners of 1993 Corollas.

whatsoever—one of the highest percentages we've ever recorded.

The Corolla's overall workmanship was rated good or excellent by no fewer than 97% of all owners reporting, another very high score.

However, several owners mentioned that their previous Corollas were blessed with better seats, and they couldn't understand why Toyota would change them.

Other gripes: The power door locks showed no ON/OFF markings, so people couldn't tell whether they were locked or not. Antilock brakes, which 36.3% of our owners purchased for an extra \$825, should be made standard equipment, according to 7% of our respondents. Another 6.2% would like a passenger's airbag, which is standard equipment in 1994 models.

A number of respondents also reported that the inside of the windshield fogs up easily in moist weather, and the defroster doesn't do much good in clearing it. Also, there's no timed shutoff for the electric backlite defroster.

As for driving controls, a number of owners wanted the horn buttons to be more accessible and more sensitive to the touch. This has become a common complaint about cars with airbags.

Dealers received so-so scores on both service and sales practices. While many buyers sounded happy enough with the deals they made, we heard more than a few complaints about pushy salespeople. Strong demand for the Corolla meant that dealers weren't anxious to bend on price, nor were they—according to some of our respondents—terribly generous on trade-in concessions.

We heard a fair amount of comment on price, as in excessive price. Most owners, however, didn't seem to share that opinion. The majority felt they received a good value for their dollar. Nearly 30% listed economy of operation as one of the Corolla's best-liked features. By that they meant, first, the money saved by not having to take the car back for repairs and, second, fuel economy, which worked out to an aggregate of about 27/33 mpg city/highway.

Despite the Corolla's proven reliability and the fact that most owners were generally pleased with performance, handling, comfort and economy, only 62% said they'd definitely buy a Corolla if they had it to do over again. On the other hand, only 7.6% said they definitely would not. And judging by the overall satisfaction with this car, we think the fence-sitters—the 30% who said maybe—would only make a switch if they could step up to a Camry next time around. **PM**



Clearly drawing on styling cues established by big brother Camry, Corolla's clean, smooth look was the best-liked feature of surveyed owners. Handling was a close second.

EDITORS REPORT

The Endurance Of Value

● In spirit as well as appearance, Toyota's latest Corolla is a Camry in miniature. It goes about its business with quiet efficiency, it rarely requires professional attention and its understated good looks should stay reasonably fresh for years to come.

Like the Camry, it's not the kind of car that raises pulse rates. However, it does raise expectations—not only for itself, but for its entire segment. Over the course of its past few renewals, the Corolla has become one of those benchmark automobiles that set the standard for their class.

This time around, of course, the Corolla finds itself in a new class. It's a compact now, with room enough inside for most small-family applications. Nominally a 5-passenger car, it's more realistic to call it a 2-adult/3-child car. Rear-seat legroom is a trifle snug for adults, although it's certainly competitive by current compact standards.

The same goes for the car's engine performance. No, it won't raise pulse rates. But there's enough snort under the hood to keep pace with traffic, and neither of the engines calls attention to itself in any negative way—noise, vibration or excess thirst. The 1.8-liter is a particularly noteworthy achievement, offering an excellent blend of fuel economy and power that's well matched to its task. Peak torque—115 ft.-lb.—comes up at 2800 rpm. Not only is this impressively low on the rpm band for a multivalve engine, it's also the range

where most family drivers are likely to be operating. Moreover, it's the kind of powerband that lends itself to use with an automatic transmission.

Like its powertrains, the Corolla's suspension strikes just the right balance for its intended users. Ride quality is smooth, without being flabby, and all-around handling is both predictable and competent. It's not the kind of car that inspires drivers to attack a set of S-bends, but it can give a decent account of itself if a driver is so moved.

Where the Corolla shines, though, is in conventional, all-around transportation use. That's what it was designed for, and that's what it delivers—quietly, comfortably, economically and unbreakably. Thanks to the recent appreciation of the yen versus the dollar, it's not quite the bargain it's been in years past. Even though eight out of 10 Corollas sold in the United States are assembled (along with their Geo Prizm cousins) in California, Toyota, like other Japanese manufacturers, has had to respond with price hikes. This, in turn, has given some of Corolla's domestic competitors—Ford Escort, Saturn and Chrysler's new Neon, to name three—a distinct window-sticker advantage.

However, though it's important, low purchase price is just one component of automotive value. Stir in the others—quality, long-term operating cost, comfort, all-around performance—and the Corolla still grades out as a leader. —Tony Swan

PULLING

Reception problems? These new antennas grab those weak broadcasts.

BY STEPHEN A. BOOTH, Contributing Editor; PM Illustration by Danilo Ducak

● When it comes to pulling sound and pictures from thin air, nothing beats a well-maintained outdoor antenna mounted high above ground level. But for those who can't or won't play on roofs, indoor options include passive and amplified antennas for FM radio and for VHF/UHF television. Most of those meant for TV are of the rabbit-ears species. The amplified FM antenna offerings tend to be less intrusive. Lately, we've come across some unique antennas that will work for anybody, but whose engineering might solve specific needs not addressed by more conventional models. Even from a cosmetic point of view, their designs are far from conventional.

If your mental picture of an indoor TV antenna is two telescoping rods joined at the hip in a pseudo-walnut slab, it's time to reset your vertical and horizontal controls. Gemini's G9000 (\$99.95) resembles the discus-shaped objects some people see landing in remote cornfields. But there's nothing extraterrestrial to the flying-saucer design, it's simply omnidirectional.

Most TV antennas, outdoor and indoor, are directional models. You rotate the outdoor mast until you hit pay dirt. Or you play pin-the-donkey with the indoor twin-tailed devil and hope (1) you successfully juggle the lengths and positions of the two rods, independently, to find one station, (2) what you've found won't disappear when you break body contact and step

away, (3) you remember the combination of rod direction and rod length the next time you want to tune in to station WWOE, (4) you don't poke your eye in the dark or (5) you don't impale a family member who doesn't know you've reoriented the rods from KRAP to KAOS.

The benefits of the omnidirectional Gemini G9000 antenna are twofold.

Indoors, you don't have to sweat out the conditions outlined above: There are no dipoles to adjust or point.

The omni design accepts signals from all points on the compass and, to compensate for what the G9000 lacks in length compared to dipole rods, an AC-powered amplifier boosts the incoming signals. Granted, it looks like a garbage-can lid. But unlike conventional rabbit ears, you can stow

the G9000 in a closet, attic or wherever its 50-ft. coaxial cable permits. And the higher, the better. Another option is to mount the G9000 on a rooftop mast.

The G9000's omnidirectional pickup and design also recommend it for mobile applications—campers, boats, RVs of all kinds. Moving or stationary, the self-contained, hands-off unit deploys where rabbit ears can't and certainly won't look as ridiculous.

That's the good news. If there's a downside to the G9000, it's that it might be too much of a good thing.

We used the discus in a suburban home some 35 unobstructed miles from the transmitter atop New



RF Limited's component-styled High-Q 6500 FM antenna.

POWER



York's World Trade Center. We stowed it out of sight in a second-story closet, at the same height where a TV's rabbit ears have always worked well.

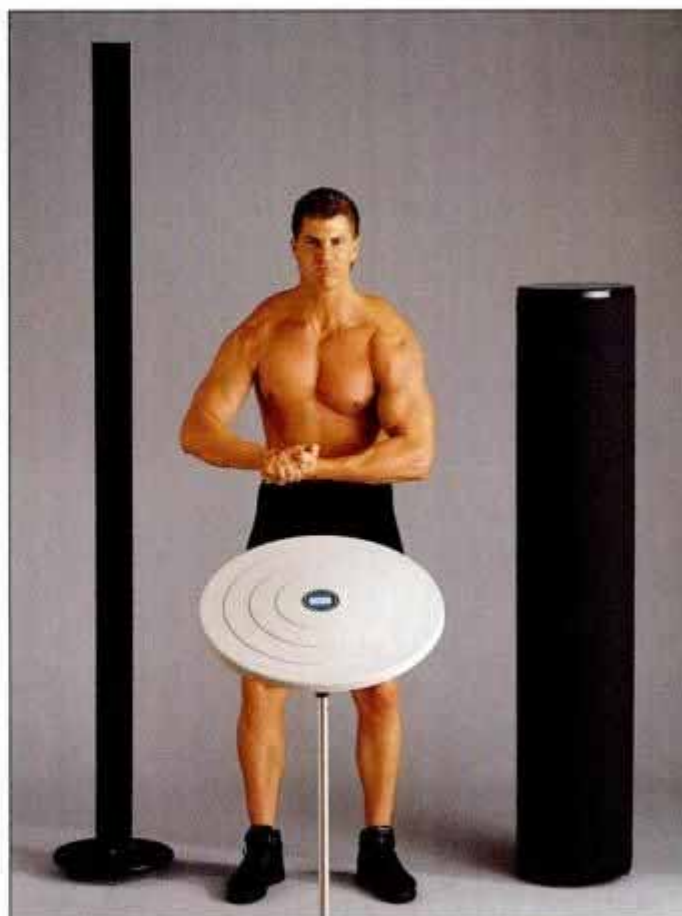
The G9000 pulled in as many stations as Gemini's excellent G2000 amplified ears—eight VHF and 12 UHF, which is one more each than a passive dipole. However, on the usually well-received VHF stations, the picture showed the wavering, overbright and color-smearing symptoms that indicate too strong of a signal. There was no tuner-overload problem with UHF reception.

The G9000's amplifier promises up to 24 decibels (dB) of gain for VHF, 23 for UHF and 18 for FM. But there's no control to adjust the amount of boost—unlike the G2000. We know that the latter's gain varies from 5 to 37.5 dB in VHF, 2 to 28 in UHF. In the past, anything above the minimal signal amplification has spoiled an excellent VHF picture. The UHF signals, which arrive from a greater distance, always benefit from greater amplification—probably about as much as the G9000 delivers.

Bottom line: The G9000 works as promised, but ought to work best for viewers who are not located near a transmitter. Gemini states its pickup range as 120 miles for VHF, 100 miles for UHF. Until the company puts variable gain on the amp, city dwellers will just have to stick to rabbit ears.

The signal reception conditions within cities differ from those in the suburbs or in the country. That's why the AudioPrism line from RF Limited offers three different FM indoor antennas.

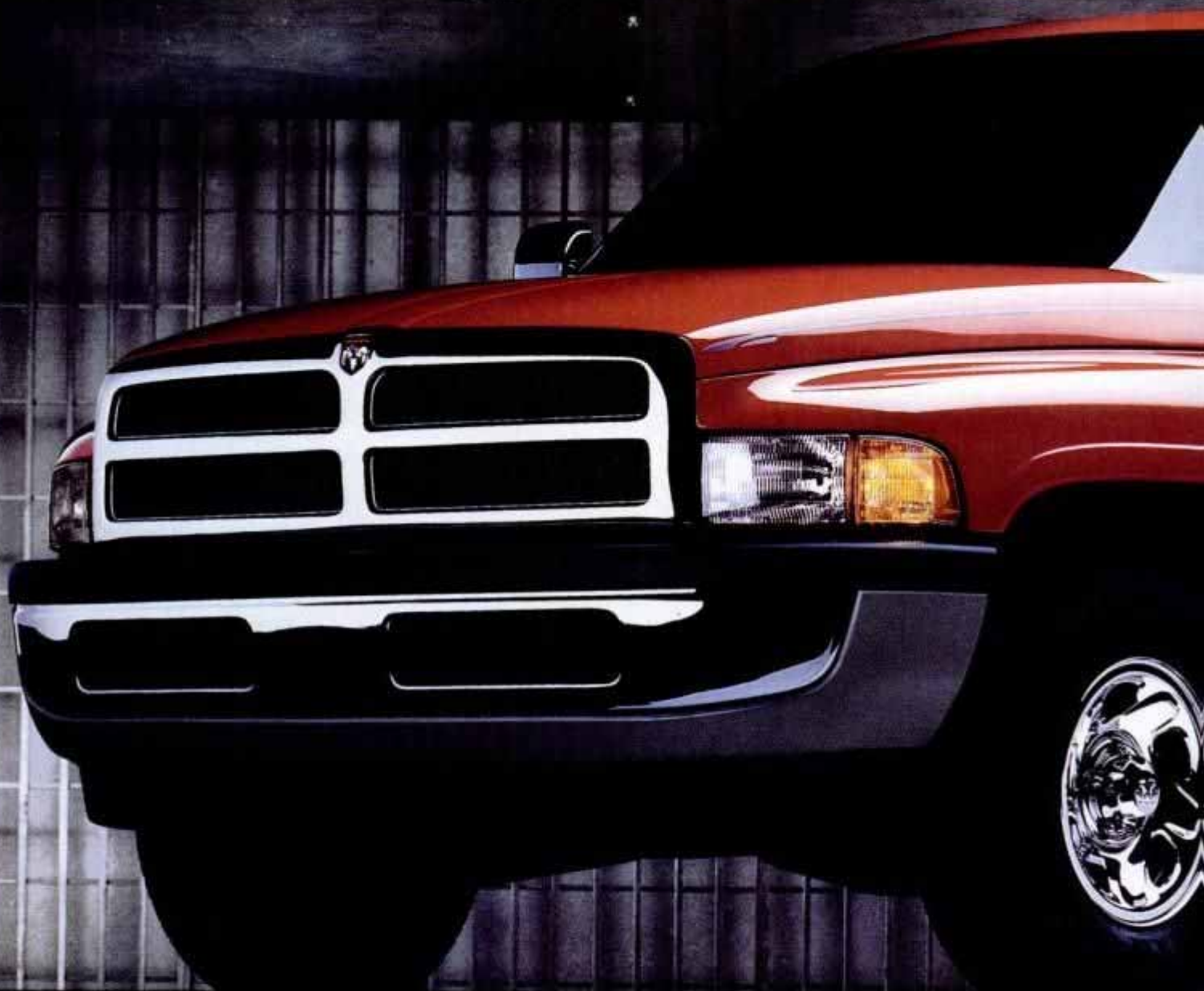
(Please turn to page 104)



Antennas with lots of muscle include the Gemini saucer-shaped G9000 VHF/UHF television model as well as a 7-ft. and a 5-ft. mast from RF Limited for FM radio reception.

INTRODUCING
MOTOR TREND'S

“TRUCK

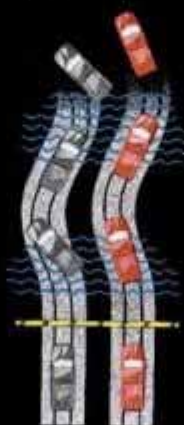


To hear the editors of *Motor Trend* talk about the new Dodge Ram is to realize the rules have changed. They proclaimed the Ram to be "...a new standard by which full-size pickups will be judged." And declared it "...a force with which to be reckoned." Our sentiments exactly.



Dodge Magnum series V-6, V-8 and Cummins Turbo Diesel engines wrote the book on power. And with the new Ram's available Magnum V-10[†], they're getting two cylinders better. To the tune of 450 lb ft of torque and 300 horsepower.

WITHOUT
ANTI-LOCK
BRAKES



Ram makes a powerful statement when it comes to safety, too. It has one safety feature no full-size pickup ever had before. A standard driver's airbag.* There's also available four-wheel anti-lock brakes. Along with high-strength steel door beams. And a dozen other safety features.

There's no rule saying trucks have to ride like trucks. That's why we gave our new Dodge Ram a new frame and improved suspension travel. We just wouldn't hear of making a noisy pickup, either. Fact is, we worked very hard to make our new Ram a standard for quietness.

Sure, pickups have always been workhorses. Now



OF THE YEAR."



they're a convenient place to conduct business. With an available center console between the front seats. Behind the seats, there's plenty of room for an ingenious optional storage system. And back in the bed, you'll find a set of tie downs so well engineered, they can support the weight of the entire truck.



We've provided an extra measure of protection, too – using more exterior galvanized steel than any other full-size pickup on the road, and making substantial use of anti-chip materials.

Here's one last point to consider: Ram also has more maximum payload than other full-size pickups. Not to mention the terrific amount of weight it carries...with the editors of *Motor Trend*.



DODGE RAM



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GM's hard-charging Impact is practical, fun to drive and a master-stroke of engineering



"Electric cars are cheap. It's all those extension power cords that are expensive."

● Electric cars may have had their share of jokes, but no one is laughing at GM's Impact—the first real-world, practical electric-powered passenger car for the 21st century. While everyone is still waiting for the big breakthrough in battery technology that promises a more potent, lighter weight and affordable power pack, Impact can deliver the goods—lively performance, acceptable range and reasonable price—with technology that exists right now. Time is one luxury

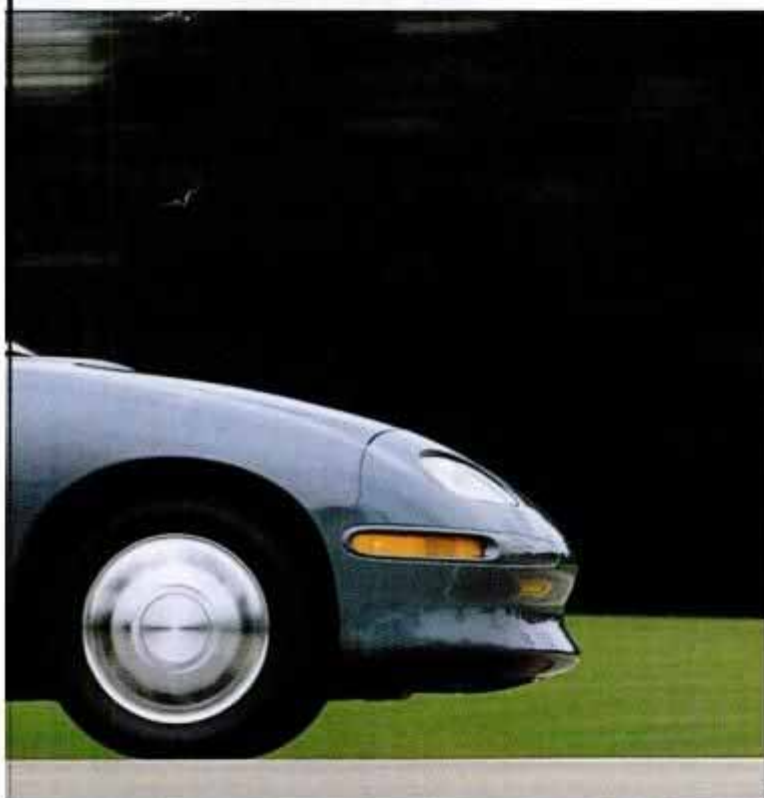
car companies don't have—not if they want to sell cars in California in 1998. That's the year that 2% of most makers' fleets offered for sale in the state must be non-polluting—zero emissions! And that means electric.

Electric vehicles are nothing new. GM had lead-acid battery-powered trucks running around as early as 1916. And while the basic physics of electric motors hasn't changed—spin a rotor inside a stator and a horde of electrons pull in harness—the motors and their controllers have.

The challenge facing electric-car builders today is to squeeze the most performance from the limited

CAR

BY CLIFF GROMER, Contributing Editor



Console controls, as well as dash display at base of windshield, are on centerline for possible righthand-drive models. Console sports conventional shift lever and buttons for keyless ignition and heating/ventilation/air-conditioning system with unique pre-conditioning feature. Advanced design controller dominates engine compartment. Battery pack also serves as structural component, while inductive charging eliminates exposed contacts.

amount of on-board power. While some manufacturers are looking at powering conventional vehicles with exotic battery technology that packs three times the power of conventional lead-acid units, the problem is that those batteries cost more than the total price of the Impact.

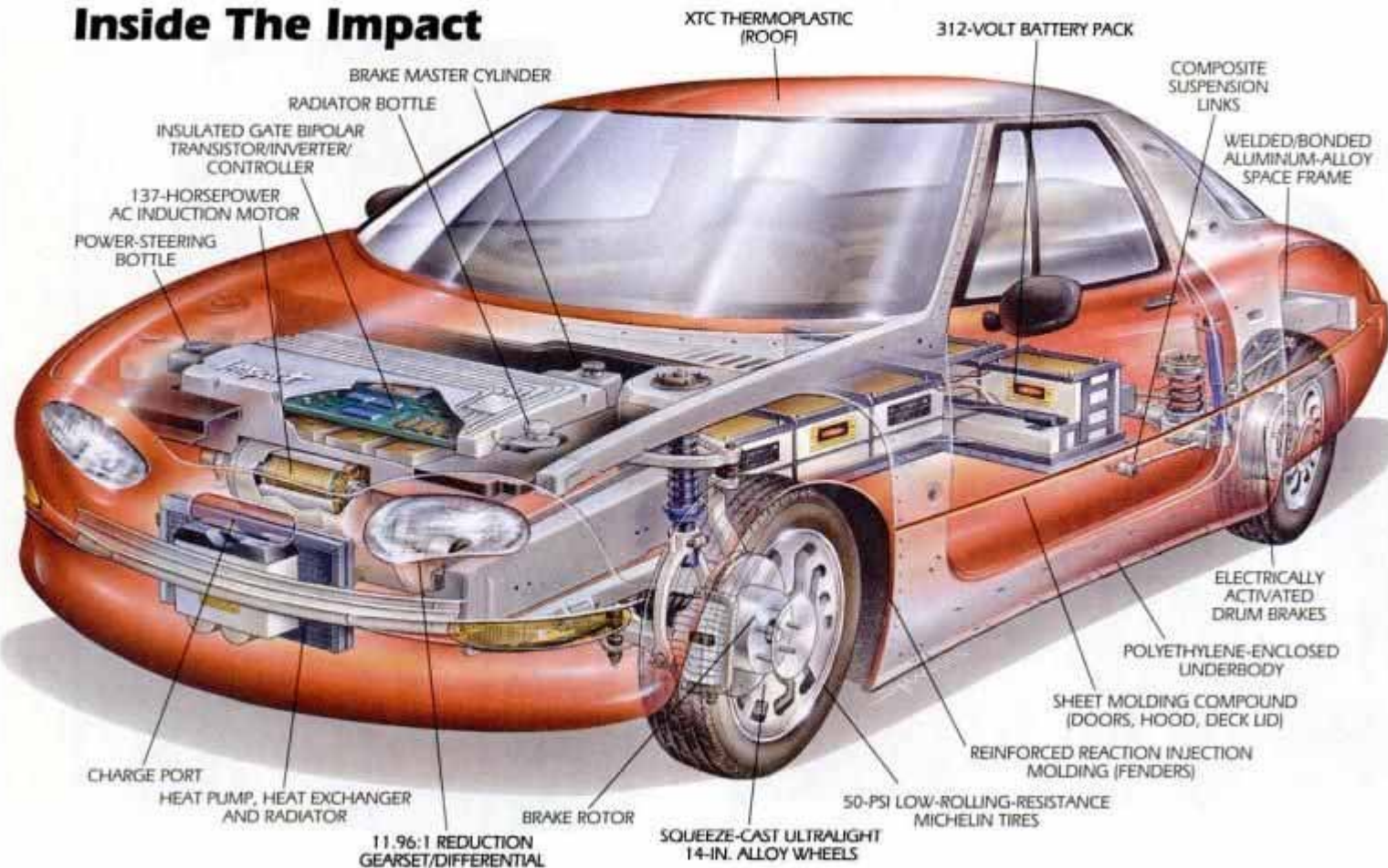
GM took a different tack, engineering a totally new super-efficient vehicle and advancing the art of electric propulsion to maximize performance and range. What they achieved with the Impact is a 2910-pound 2-seater that delivers brisk performance and a 90-mile highway range, 70 miles on the federal driving cycle. The 1100-

pound 312-volt battery pack (26 12-volt batteries, plus one for the accessories) can be recharged via a new-design inductive charging port. There are no exposed contacts, so no shock hazard. Charging takes 2 to 3 hours from a 220-volt (6.6-kw) source, 8 to 10 hours from a 110-volt (1.5-kw) source or 10 to 15 minutes from a 50-kw source. Acid-saturated matting between the plates eliminates free liquid acid inside the battery case. Battery life is estimated at 20,000 to 30,000 miles with a replacement cost of \$1500 to \$2000.

Impact is powered by an AC induction motor, which spins at a very high 20,000 rpm. Electric motors pro-

ELECTRIC CAR

Inside The Impact



Alloy space frame uses 168 parts compared to the Acura NSX's 300-piece space frame.



AC induction motor spins at 20,000 rpm to eliminate the need for a transmission.



Five-link rear suspension is first to use fiberglass links mated to aluminum alloy ends for strength and light weight.



Short/long-arm front suspension reduces ride harshness.

duce excellent low-speed torque and an almost-flat torque curve. Impact's high revs permit single-gear operation with an 11.96:1, 2-step helical-spur gear-reduction final drive, lubricated by an electrically driven oil pump. Shifting to REVERSE just changes the direction of the motor. Regenerative braking, where applying the brakes makes the motor function like a generator, contributes some 20% to the range.

AC induction motors, while very efficient, do require a complex control unit to change DC current to 3-phase AC. Impact uses six insulated gate bipolar transistors for power-switching units. They are able to handle high-current loads with efficiency and excellent reliability. The original Impact show car used MOSFET transistors to handle the current and required 288 of them. The new system has about

1000 times the reliability of the old.

The motor and its controller both are water-cooled, with waste heat going either to the radiator or heater core. The original Impact show car used an air-cooled motor, which was not as reliable, required more space and was noisier because it needed cooling fans to create a high rate of flow to move a low mass of air.

The total on-board battery power (16.8 kw) equals about the same energy potential contained in 1½ gallons of gasoline. Pushing that kind of reserve to an acceptable range, with speeds governed up to 80 mph, in a package loaded with all the power-sucking amenities—air conditioning, power windows, locks, brakes, steering and mirrors, plus 4-speaker premium sound system with CD, ABS, traction control, cruise control and dual airbags—took some innovative engineering.

To minimize weight, GM developed a 168-piece alloy space frame, which is 40% lighter than steel. This is the lightest and stiffest vehicle structure developed to date. Superlight magnesium was used for components such as seat frames and the steering-wheel core. Squeeze-cast 14-in. alloy wheels hold the lightweight title, barely tipping the scale at just 8 pounds.

Rolling resistance was cut 25%, compared to current all-season tires, with 50-psi self-sealing Michelin tires. Ride harshness is tuned out via a short/long-arm (SLA) front suspension and a 5-link rear suspension that uses unique fiberglass links mated to aluminum ends.

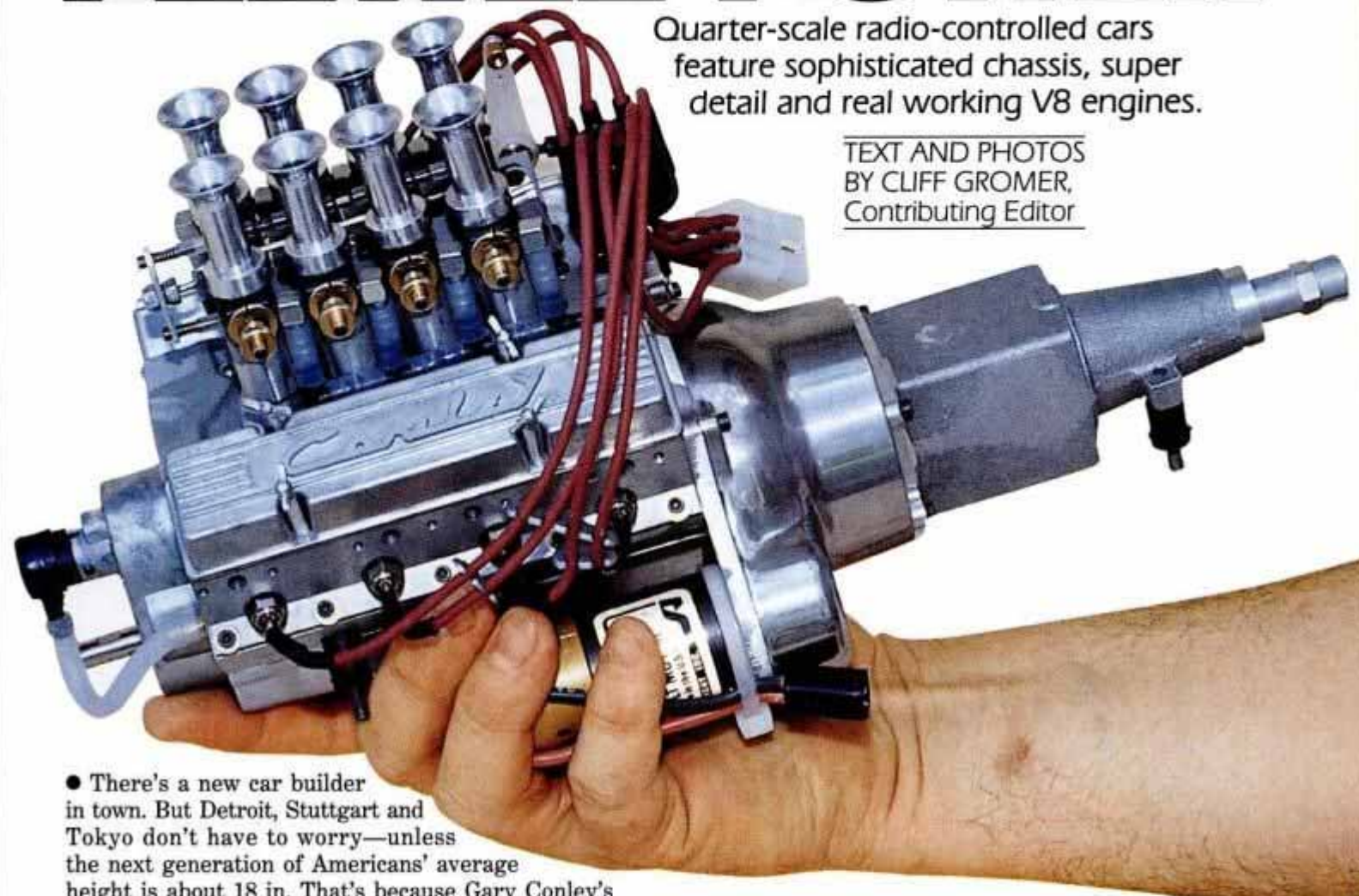
But the energy's biggest black hole is aero drag. At 50 mph, a full one-third of the watts produced are blown away in the breeze. A wind-cheating

(Please turn to page 103)

PEEWEE POWER

Quarter-scale radio-controlled cars feature sophisticated chassis, super detail and real working V8 engines.

TEXT AND PHOTOS
BY CLIFF GROMER,
Contributing Editor



● There's a new car builder in town. But Detroit, Stuttgart and Tokyo don't have to worry—unless the next generation of Americans' average height is about 18 in. That's because Gary Conley's cars—and the engines that power them—are sized down to quarter-scale. Sort of like a real-world, "Honey, I shrunk the car."

While quarter-scale radio-controlled cars—and racing—have been around for years, typical powerplants have been the off-the-shelf variety, 1.5-hp (at 8000 rpm) 23cc 2-stroke 1-cylinder weed wacker or chain saw engines. But Conley puts together the world's only production miniature operating V8 for quarter-scale cars. His engines put out 2.5 to 4.5 hp, depending on the induction system, from a 50cc water-cooled 4-stroke.

Conley got into the small time because he wanted a scale-size V8 for himself, and no one on the planet made one. So Conley tooled up to build his own. It's probably the most fascinating engine around. And just as fascinating are the painstakingly detailed cars he builds to put them in.

Peeking inside the 12-in.-

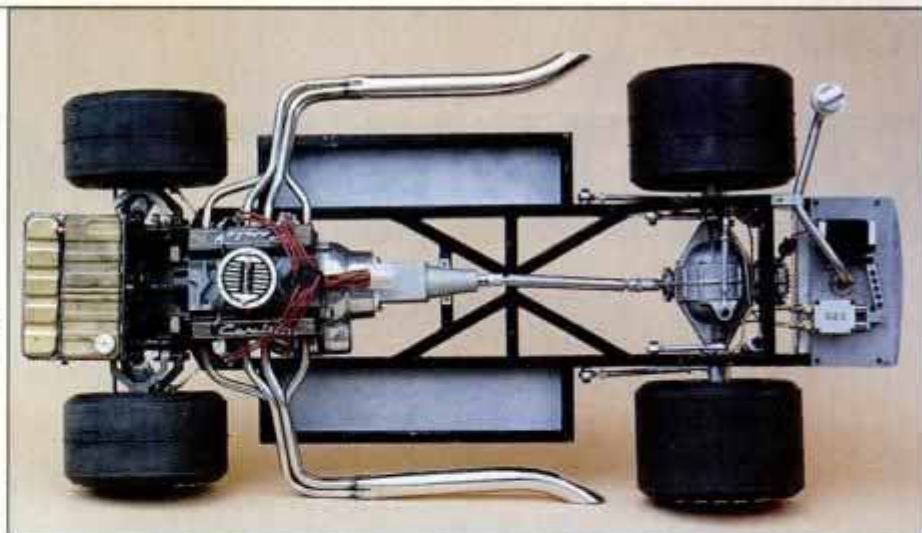
long, 9-pound V8 reveals a cast block with full wet liners, and a .875-in. bore and .625-in. stroke. The 3-in. displacement can be increased to 3.6 cubes via a stroker kit which increases the stroke to $\frac{3}{4}$ in., and uses the standard rod, but changes the height of the wrist pin in the piston.

The bottom end is plenty beefy with a balanced, investment-cast 4140 steel 5-main-roller-bearing crank. Billet rods connect to billet machined pistons which wear a single



Radio-controlled, quarter-scale Cobra has 100-mph potential and costs more than the real McCoy.

PEEWEE POWER



Cobra front A-arm suspension features adjustable shocks. Aluminum brake calliper grips with fiberglass pads (upper left). Rear suspension is 4-link setup. Rear disc brakes also are hydraulically activated (lower left). Cobra chassis shows fuel filler and dual master cylinders on rear platform (above).

ring. There is no oil in the oil pan, and the engine runs on model-airplane fuel which contains 15% nitromethane and a 20% oil base. Oil that isn't burned during combustion slides by the ring and lubes the entire lower end.

A mild small-block Corvette solid-lifter grind camshaft served as the pattern for Conley's case hardened, billet bumpstick, and he used a pantograph to accurately copy the configuration in scale. The real cam lifts the valves .600 in., while the scale version operates them at .060-in. lift.

Chevy-style heads (non-water cooled), with siamese ports, use O-ringed head bolts instead of a head gasket. The runner-style, cast and cored intake manifold likewise is O-ringed for sealing. Valvetrain features a shaft rocker-arm assembly with one-piece adjustable rocker arms that are set to .003-in. lifter clearance.

The real fun begins with intake options, where the choices run from milquetoast to mind boggling. Base engine feeding chores are handled by a single carburetor, with duals, tripower or an exotic Weber-style 8-carb setup. It's just a matter of swinging the

hinge on your wallet a little wider. Of course, if you want your real micro V8 to be different from everyone else's on your block, go for broke (literally) and opt for the functional scale replica GMC 6-71 supercharger mounted on twin carbs. Belt-driven from the crankshaft, the blower puts out 12-psi boost at 13,000 rpm, and produces the unmistakable whine that's music to the ears of hot-rodders everywhere. The supercharger's internals were designed in Sweden, while Conley designed the cases.

Modified model-airplane suction-feed carbs are pressurized with a 4.8-volt electric fuel pump and give an almost throttle-body-injection-like response. Low- and high-speed metering systems manage the mixture throughout the power range.

Fires are lit with glowplug ignition (also a model-plane engine item), making the engine work like a modified diesel. The distributor is just a dummy unit, but the 12-volt remote-controlled electric starter is for real. Push a button on your radio-controlled

transmitter, the starter cranks and the V8 rumbles to life. Cooling is handled by a water pump, a scale radiator with top and bottom tanks and a 22-tube, 18 fin/in. core.

A variety of exhaust options, including stainless-steel headers and cast ram's horn-style manifolds let you be creative in spewing out your gas. Sorry, Sierra Club, but no catalytic converters are planned at this time.

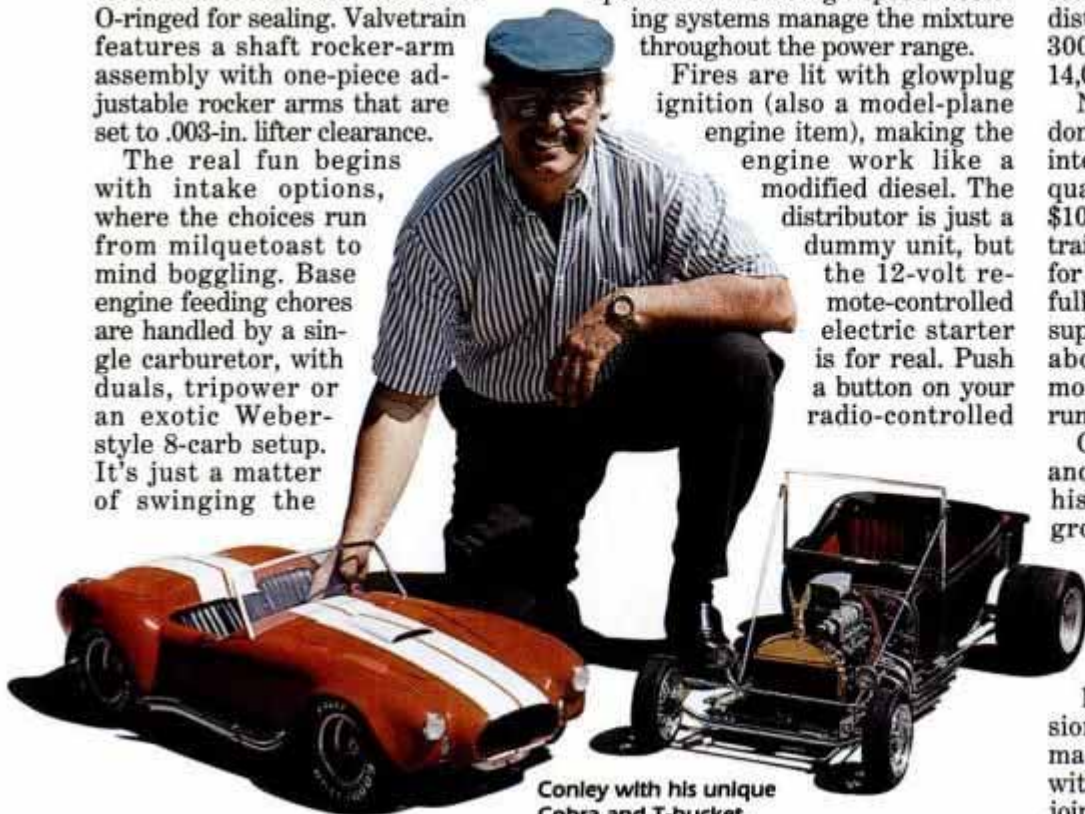
Aside from the striking detail of all those teeny-weensy parts, the really cool thing about this engine is that it captures the characteristic rumpety sound of a real V8—only with the volume turned down. It sounds like a real V8 engine that's running at some distance away. Idle speed is a brisk 3000 rpm, and the mill will rev to 14,000 rpm.

Not surprising, Conley engines don't come cheap. While you can get into a conventional radio-controlled quarter-scale package for less than \$1000 for a complete car and drivetrain, Conley's engines start at \$2495 for a base kit that you assemble. His fully assembled, tuned and test-run supercharged baby will set you back about \$4400. And for that kind of money, you don't even get a car to run it in.

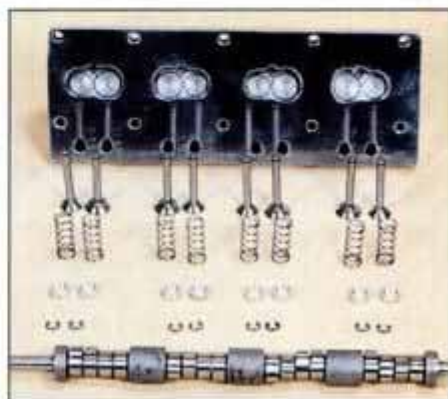
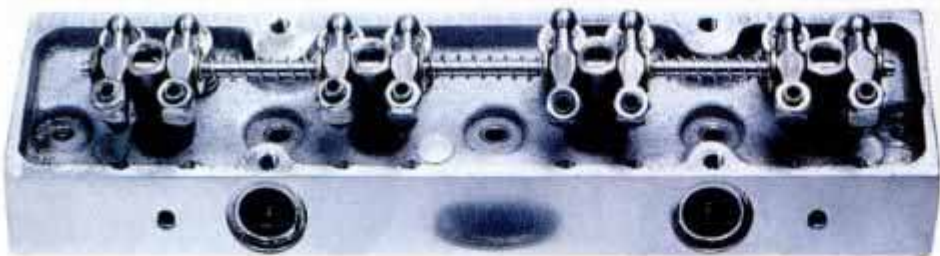
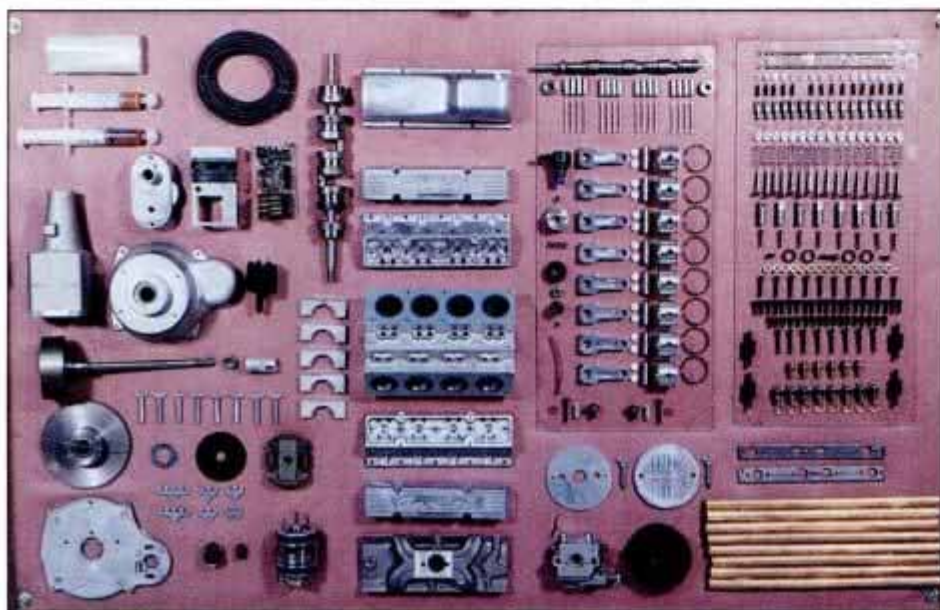
Conley's cars, both a '23 T-bucket and Shelby Cobra are as exotic as his engines and get power to the ground using a centrifugal clutch.

The 39-in.-long, 40-pound Cobra is his showpiece and comes set up for road or oval racing.

The Cobra sits on an X-member frame to which Conley adds his own independent front suspension using upper and lower A-arms machined from bar stock and fitted with his preloaded, greaseable ball joints. Toe, caster and camber are ful-



Conley with his unique Cobra and T-bucket.



ly adjustable, as are the coilover shocks. Rack-and-pinion steering turns reproduction Halibrand functional knock-off wheels.

The rear suspension uses an off-the-shelf quick-change Halibrand replica rear and a 4-link setup. Brakes are unique—a hydraulic 4-wheel disc setup with dual master cylinders, filled with silicone brake fluid, for separate front and rear circuits. Full-floating calipers, machined from billet aluminum use stainless-steel pistons and liners. Fiberglass brake pads grip aluminum rotors.

The T-bucket uses radius rods to support the front and rear ends. Up front is a traditional dropped axle with a transverse-mounted leaf spring. The rear wheels are Halibrand replicas, while the fronts use individual



wires that are hand-tuned by truing the wheel with a dial indicator. Goodies include functional headlights, leather interior and polished aluminum firewall.

How far will Conley go to achieve realism? Well, the Cobra's interior can be had with stitched carpeting and full leather seats and door panels. For gauges, Conley cut out pictures of real Cobra gauges from magazine photos, and mounted them in the dash using custom aluminum bezels and a punch and die to punch out the plastic lenses. Truly a man possessed.

Top speed on the Cobra, with stock rear-end gearing of 7.00 to 1 is about 45 to 50 mph. Ultimate speeds of about 100 mph are expected with 2.00-to-1 gearing and push-starting the car up to about 40 to 50 mph.

(Clockwise from bottom left): Dime shows scale of cylinder head. Parts that make these V8s tick. Basic engine comes with a choice of intake and exhaust. Cylinder head and cam are based on Chevy small-block. One-piece roller-bearing crank uses split races. Micro GMC 6-71 blower really works.

Prices for a complete Cobra kit start at about \$7000 and range up to \$9500 for a turnkey car with options.

Putting the whole thing into perspective, a real '66 Shelby Cobra costs about \$6500 new.

With truly unique cars and engines, Gary Conley hopes to make it big by staying small. **FM**

For more information, contact Gary Conley at Conley Precision Engines, 825 Duane St., Glen Ellyn, IL 60137; (708) 858-3160.

TELECOMMUNICATIONS

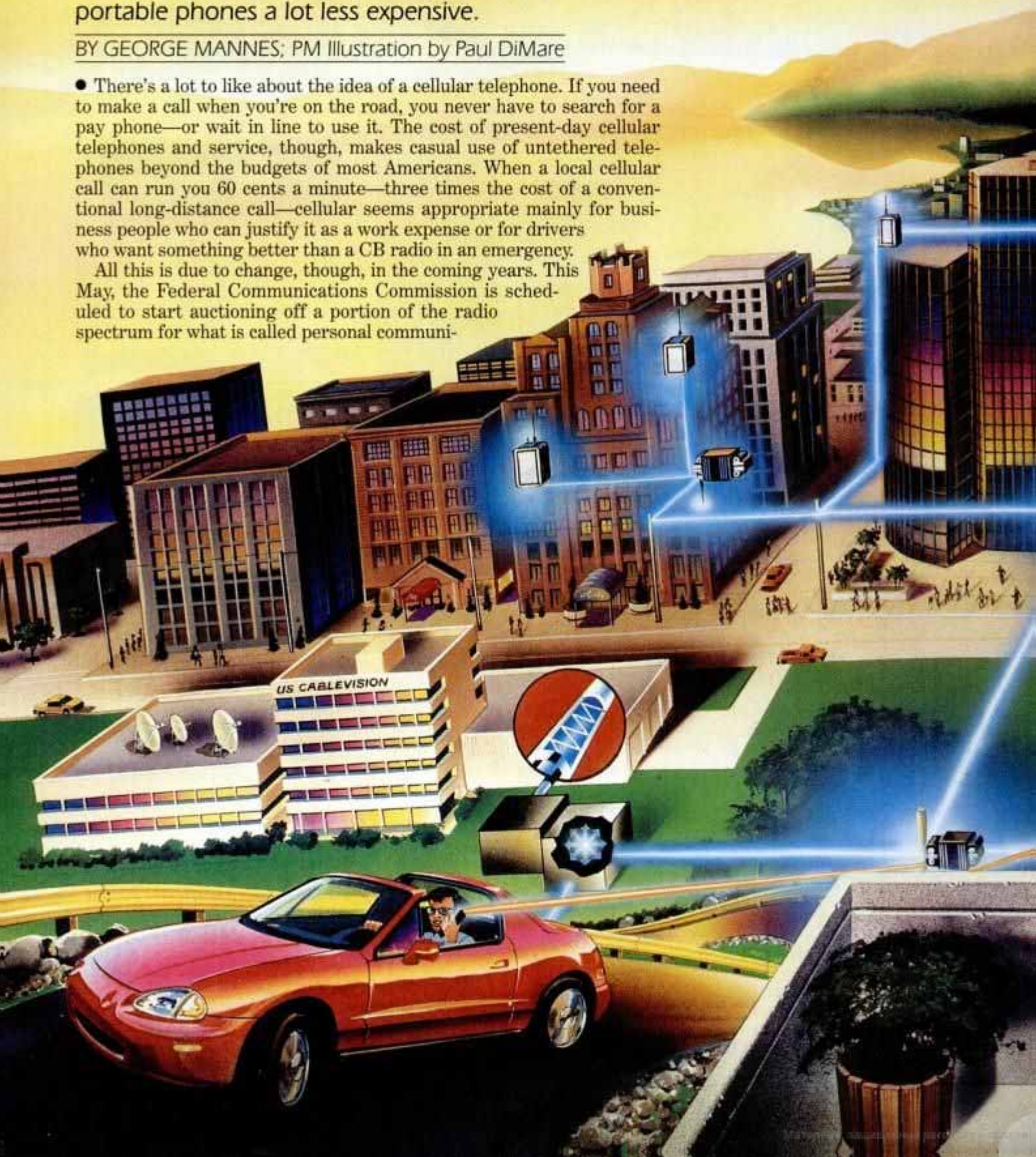
PORTABLE PHONES GET AFFORDABLE

A new communications system promises to make portable phones a lot less expensive.

BY GEORGE MANNES; PM Illustration by Paul DiMare

● There's a lot to like about the idea of a cellular telephone. If you need to make a call when you're on the road, you never have to search for a pay phone—or wait in line to use it. The cost of present-day cellular telephones and service, though, makes casual use of untethered telephones beyond the budgets of most Americans. When a local cellular call can run you 60 cents a minute—three times the cost of a conventional long-distance call—cellular seems appropriate mainly for business people who can justify it as a work expense or for drivers who want something better than a CB radio in an emergency.

All this is due to change, though, in the coming years. This May, the Federal Communications Commission is scheduled to start auctioning off a portion of the radio spectrum for what is called personal communi-

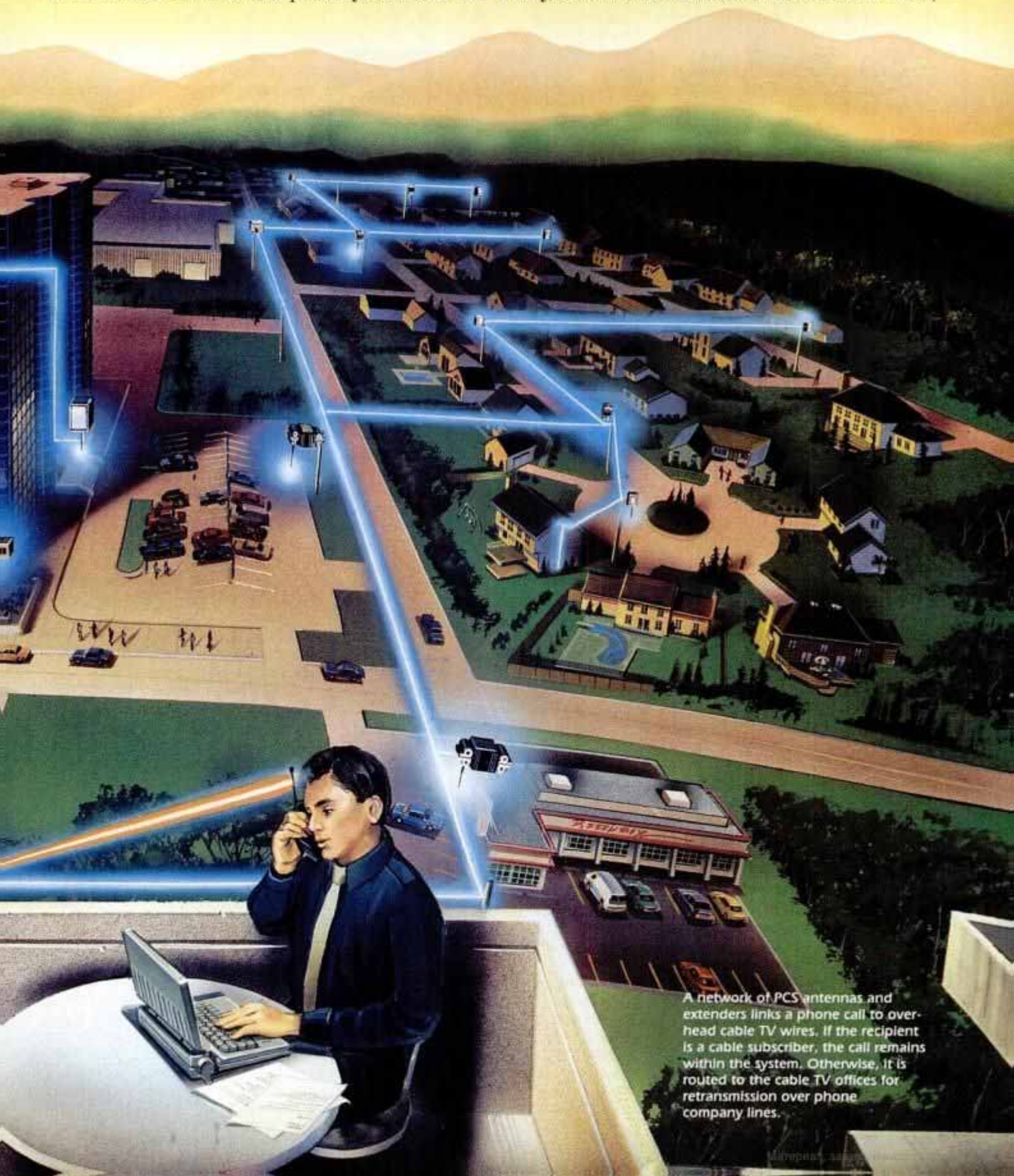


cations services (PCS). Meant to fulfill the idea of "anywhere, anytime" communication, the new PCS bandwidth—triple the space devoted to current cellular service—promises several new types of wireless communication at prices that won't bust your budget.

One of the new services expected to be offered by entrepreneurs could show up at your workplace. Companies or buildings that have a large wired phone network that feeds into the local phone system could re-

place it with a wireless system that operates within the building. Step away from your desk and you could still pick up your calls—all you have to do is answer the cordless phone that you're carrying around in your shirt pocket.

The PCS spectrum could also serve as a communications spectrum for personal digital assistants (PDAs)—palmtop computers like the Apple Newton and the Tandy/Casio Zoomer that can send and receive faxes,



A network of PCS antennas and extenders links a phone call to overhead cable TV wires. If the recipient is a cable subscriber, the call remains within the system. Otherwise, it is routed to the cable TV offices for retransmission over phone company lines.

PORTABLE PHONES

e-mail and other data. "You probably won't buy a laptop in a few years if it doesn't have a phone or a PCS service built into it," says Amy Stephan, director of personal communications services for Telocator, a PCS industry association.

But perhaps the most enticing service on the horizon is affordable, convenient wireless telephony—a phone that you could use around the house, around town and even across the country. Rather than using one phone number at the office, another at home and a variety of different phones at other locations, you could have one phone number—and a phone—that follows you wherever you go.

To that end, a number of companies are investigating the idea of setting up a seamless coast-to-coast telephone service in the newly authorized PCS band. Long-distance carrier MCI is spearheading one such effort, and has lined up an array of partners to offer service to 75% of the population of the United States and Puerto Rico. MCI's hope is that wireless mobile telephony, now used disproportionately for business, will enter the domain of everyday life.

"We don't really see any difference in a PCS world than we do in the regular landline [wired telephone] world," says Steven Zecola, MCI vice president of personal communications services. "Ninety percent of the customers today are residential. Ten percent are business. That will be what PCS is all about."

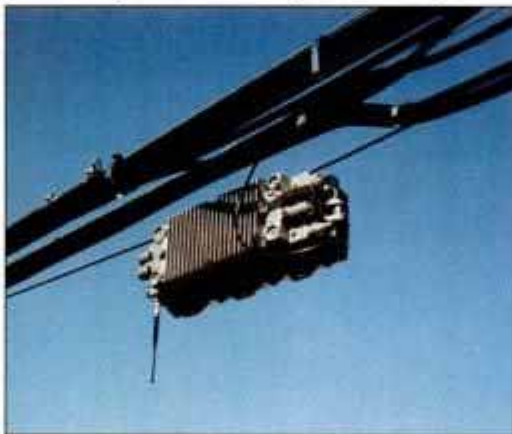
The price is right

How much will it cost to use PCS phones? Somewhat less than cellular phones and more than conventional wired ones, it's expected. In a market test that MCI and Alltel Mobile Communications are running in the Charlotte, North Carolina, area, the charge is a flat rate of \$28 per month, which includes unlimited calling in a user's "home cell"—equivalent to the service you'd get from carrying a non-cellular cordless telephone around your home. Local calls made or received outside of the home area are 30 cents a call, plus 15 cents per minute at peak hours (5 cents off-peak). Using the phone in another city—say, Raleigh—costs you 50 cents a call, plus 10 cents per minute. The cost to the service provider of phones would probably drop anywhere from \$275 to \$300 in the first year to \$100 in the fifth year of service, Zecola says.

To understand the value of the service, it's important to know that PCS could replace not only cellular service, but also the home phone that's wired for local service. A person's PCS bill

could be "easily 30% below those numbers," says Zecola, for today's combined local and long-distance cellular service.

Also part of MCI's national vision is ease of use. The system would automatically recognize whether the user is in his "home cell" and should be incurring no per-call charges. If you were to fly to another city, no special procedure would be required for making and receiving a call. All you



Antenna modules link PCS to the cable TV system, which is linked, in turn, to telephone wires.

would have to do is turn on the phone.

One obstacle to seamless, national PCS services, Zecola says, is the possibility that the industry would not settle on a single "air interface standard" for the wireless signaling between phones and the equipment that links the phones to wired networks. While all cellular carriers use the analog AMPS standard, more than a dozen analog and digital transmission systems have been proposed as standards, presenting the threat of a babel of systems across the United States.

Even if a national service isn't implemented, it seems fairly certain that PCS will enable some sort of traveling beyond the local grocery store. "Having these things usable in little islands of territory doesn't make it usable as a real service," says Wilt Hildenbrand, vice president of technology for the Long Island, New York-based cable company, Cablevision Systems Corp.

Cablevision has been testing a PCS system that links directly into its cable network. Lightweight antenna modules called platform repeaters hang from overhead cable wires at 1000-ft. intervals to provide coverage. Service in each cell area is augmented by microcell extenders designed to provide service to those buildings not wired for cable. A PCS phone call is then transmitted via coaxial cable back to Cablevision's offices. Here, at the "node," the signal is converted to a digital format for transmission over the telephone company's fiberoptic lines. If the recipient of the call is a Cablevision subscriber, then the call

can remain within the cable system.

While enabling people to keep in constant touch with the world, PCS phones will also permit them to keep their distance. It's likely that new phones will permit owners to selectively block incoming calls, identify important callers with special rings, and divert unanswered calls to an easily retrievable voice mailbox that would function like a mobile answering machine.

More talk time

Another important feature expected of PCS phones is longer battery life. While these days, you can expect to get about 1 hour of talk time on a cellular phone (along with 12 hours of standby to receive incoming calls), within a few years PCS phones should offer 5 hours of talking between charges, Zecola says. Lengthening battery time will be lower-power phones: the "absolute maximum" should be 0.1 watt for PCS phones, Hildenbrand says, as opposed to the 0.6-watt rating that's standard for handheld cellular phones.

While over 200 technical and marketing trials of PCS have been conducted over the last year, official services in the new PCS band probably won't be offered until next year. First comes the auction in May, in which 160 megahertz of spectrum between 1.85 and 2.2 megahertz will be parceled out in overlapping small-size and large-size batches. Current users of those frequencies will have to be moved to another spot on the spectrum. New license owners may end up overwhelming hardware suppliers with orders for equipment. It will take time for companies to install the cell antennas and other equipment necessary for wireless phone usage in a particular neighborhood. Zecola estimates that PCS won't be available before mid-1995 in the first cities where it will be offered. The FCC is requiring that operators offer service to at least one-third of the population in their market area five years after receiving their license, and to a full 90% within 10 years.

Observers predict a huge growth in wireless communications by the end of the decade, up from the 13 million people using cellular in the U.S. today.

The popularity of the idea of PCS is "fairly shocking," Zecola says. "You put this concept before customers: They can use their phone anytime or anyplace and have one single telephone number? And you give them the kind of prices that we talked about? What I found out is there is no reason why they wouldn't buy it. I mean, 75% of the public are saying they would buy it." **PM**



SHOP PROJECT

Fair Game

An elegant, yet practical, mahogany game table.

BY ROSARIO CAPOTOSTO, Contributing Editor

● Our fold-over game table is a well-bred piece of furniture with a history going back to 18th-century England. Tables of that period had a fold-over top that was supported by a swing-out leg. But our version follows the novel game-table design that evolved in the 19th century. It features an offset top that rotates a quarter turn so that both leaves of the table are supported

evenly on the fixed rectangular base.

The table is both functional and decorative, usually being displayed with its folding top resting against the wall. The table has a storage area beneath the top for playing cards, stationery or silverware, should you use it as a small dining table. In keeping with tradition, the table is built from solid mahogany and has



a lustrous hand-rubbed finish.

The table is a good project for a reasonably experienced hobbyist, in that it requires lathe work. Lacking a lathe, you can build it with gracefully tapered legs, rather than turned ones.

Color photo: J.R. Rost
Black-and-white photos: Rosario Capotosto
Technical art: Eugene Thompson
Photo stylist: Gabe Herrick

The Legs

Glue and clamp together a slab wide enough to make four legs. Rip leg blanks from the slab on the table saw.

Next, mark out the leg mortises. Then bore a series of overlapping holes to remove the bulk of the mortise. Pare the mortise to dimension using a chisel (Photos 1 and 2). Then draw a full-size paper pattern of the leg. Include the diameter sizing grooves at key locations, and hang the drawing behind the lathe.

Carefully center the turning blank on the lathe, because any error here will result in a lopsided shoulder where the square meets the round. To turn the shoulder from square to round, draw two guidelines around the square at $4\frac{3}{4}$ in. and $5\frac{1}{4}$ in. from the top. Hold the skew chisel vertically, toe down and heel up, and make a nicking cut at the upper mark (Photo 3). This prevents splintering. Next, run in a parting tool to cut the finished diameter of the flat band along the lower guideline.

Now, use the gouge to rough form the cylinder. Starting about 3 in. from the groove, feed the gouge toward the groove to form the round. Then reverse the feed direction from left to right, toward the tailstock to complete the rounding. Pass a wide skew chisel over the cylinder to smooth it.

Make pencil marks on the cylinder at the locations of the depth gauging grooves (Photo 4). These can be set off with a rule using the drawing for reference or, better yet, with a half-section pattern of the leg drawn on cardboard. This is held to the cylinder to transfer the marks.

Shape the curved shoulder with either the skew or spear-point chisels (Photo 5). The diameter gauging grooves are next. Use a caliper for checking the grooves, and run in the parting tool to within $\frac{1}{16}$ in. of the finished diameters at the designated locations (Photo 6). Adjust the caliper to the required setting directly on the drawing (Photos 7 and 8). Use the roundnose, spear-point skew chisels and gouge to form the contours (Photo 9). As the leg becomes thinner, it may chatter. To prevent this, use a steady rest (Photo 10).

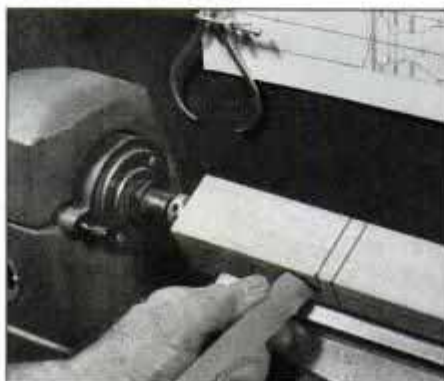
When the shaping has been completed, remove the toolrest, then turn up the lathe's speed to 1000 rpm for sanding. Start with 120-grit paper and work through 150-, 180- and 220-grit. Use strips of sandpaper to smooth the contoured areas, but use a felt-backed sanding block when sanding the taper (Photo 11).



1 Lay out the mortises in the legs. Remove the bulk of the mortise waste by boring holes with a drill press.



2 Clamp the legs to the bench. Using a razor-sharp chisel, pare the sides of the mortise parallel and the ends square.



3 Make a nick using a skew chisel where the square leg turns round. Note the leg pattern taped to the wall.



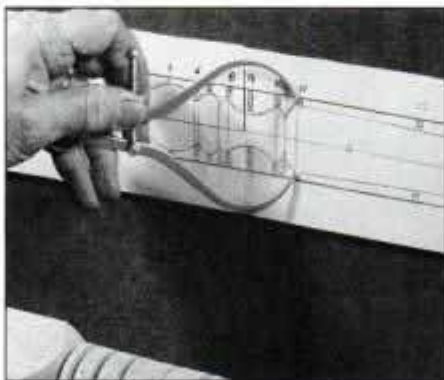
4 Use the half pattern of the leg to mark out the depth cuts that establish the diameters at key points.



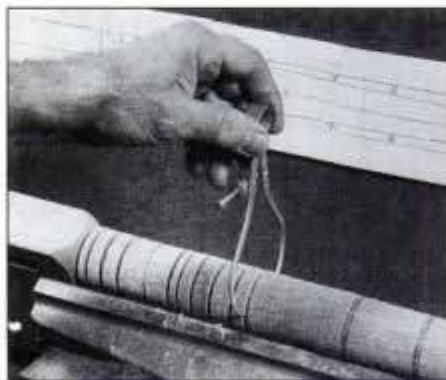
5 Use the skew chisel to turn the round shoulder on the leg. The nick cut made earlier prevents splintering.



6 Using the parting tool, make each of the depth cuts. Back off from the parting tool occasionally to let it cool.



7 Set the caliper to the finished diameter of the leg at a given depth groove. Note the groove number.

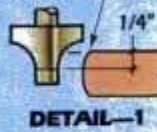


8 Measure the diameter of the leg at the corresponding depth groove. Cut the depth groove until the caliper fits.

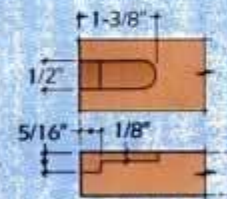
GAME TABLE

28-3/4" HIGH X 30" LONG
X 30" WIDE (15" CLOSED)

CUT EDGES WITH 1/2"-RAD.
CORNER ROUNDING BIT
IN ROUTER

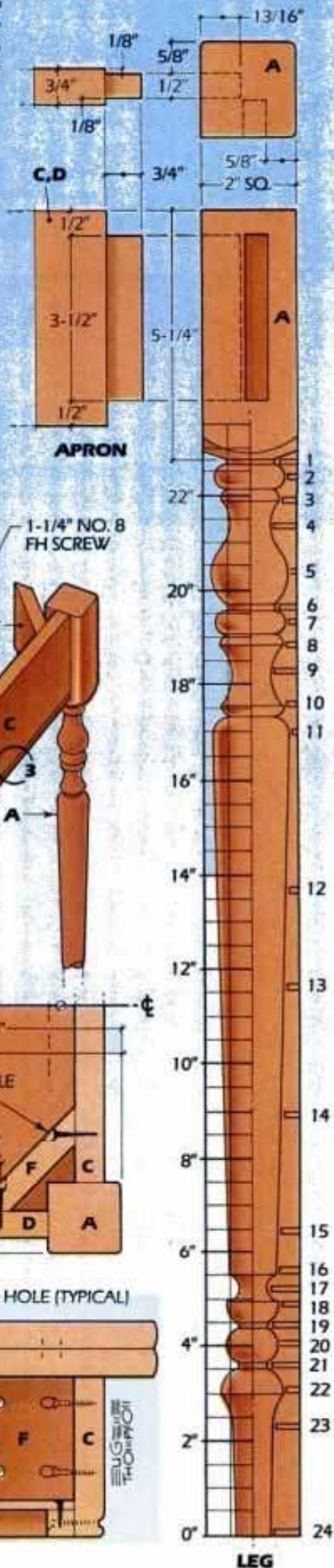
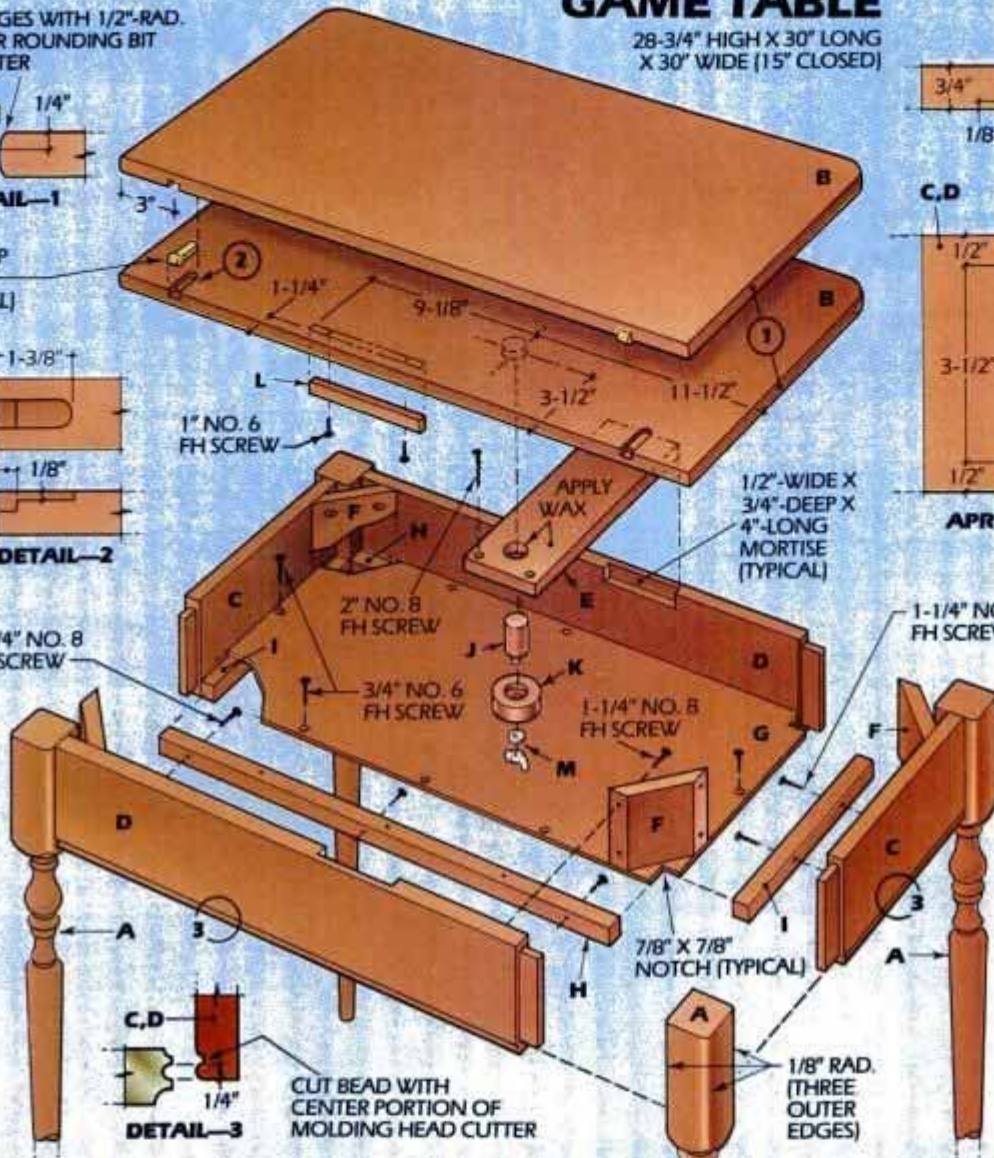


FLIP TOP
HINGE
(TYPICAL)



DETAIL-2

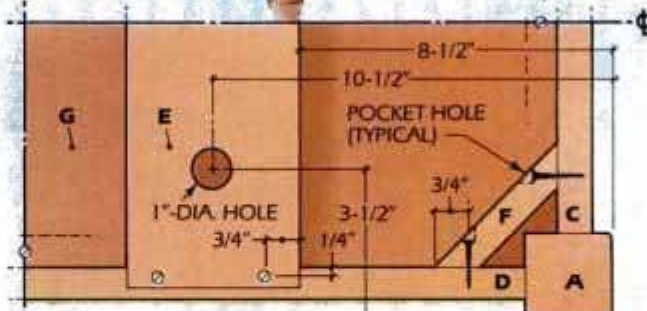
1-1/4" NO. 8
FH SCREW



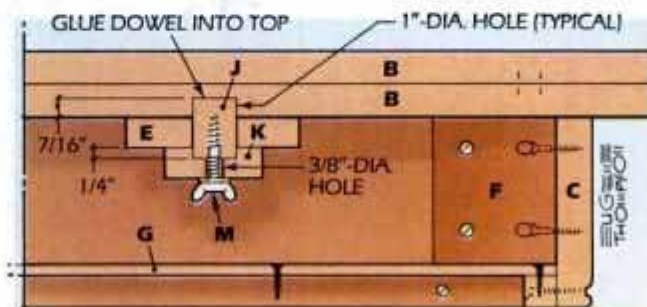
MATERIALS LIST—GAME TABLE

Key	No.	Size and description (use)
A	4	2 x 2 x 28" mahogany (leg)
B	2	3/4 x 15 x 30" mahogany (top)
C	2	3/4 x 4 1/2 x 11 1/2" mahogany (apron)
D	2	3/4 x 4 1/2 x 25 1/2" mahogany (apron)
E	1	3/4 x 4 x 12 1/2" mahogany (brace)
F	4	3/4 x 3 1/2 x 4" mahogany (brace)
G	1	3/4 x 11 1/2 x 25 1/2" mahogany (panel)
H	2	3/4 x 3/4 x 24" mahogany (cleat)
I	2	3/4 x 3/4 x 10" mahogany (cleat)
J	1	1"-dia. x 1 1/4" mahogany (pivot)
K	1	3/4 x 2 1/4"-dia. mahogany (cap)
L	1	3/4 x 1/2 x 7" mahogany (stop)
M	1	3/4 x 2" (bolt, washer, nut)

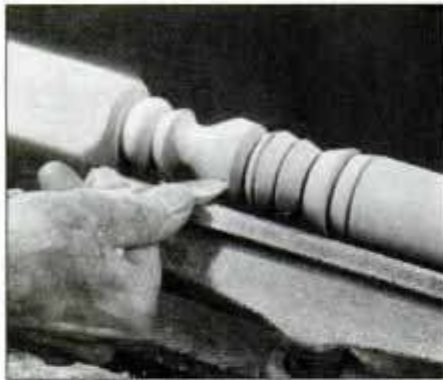
Misc.: No. 20 biscuits; sandpaper; yellow or hide glue; Behlen Solar Lux Stain (Medium Red Mahogany, Behlen product No. B5083A115), Solar Lux Retarder (Behlen product No. B500-00A25); stain and retarder available from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013; shellac; alcohol; paste wood filler; sanding sealer; Deft Gloss Clear Wood Finish; and flip-top hinge from Armor Products, P.O. Box 445, East Northport, NY 11731.



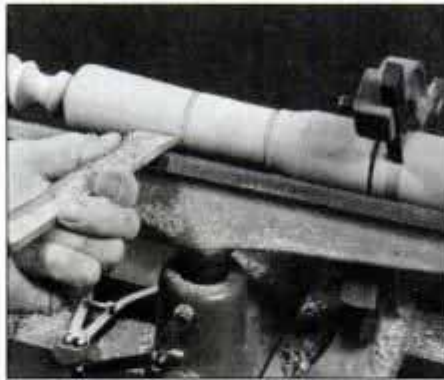
TOP VIEW



SECTION VIEW



9 Shape the remaining parts of the turned section using the gouge, skew and spear-point chisels.



10 The leg becomes thinner, and not as stiff, as it is turned down. Use a steady rest to prevent chattering.



11 Use a felt-pad sanding block and 220-grit paper to smooth the long, tapered portion of the turning.

The Top

Rip and crosscut the boards for the top slightly oversize, and joint their edges. Then group them for the most desirable appearance while arranging their annular rings alternately facing up and down.

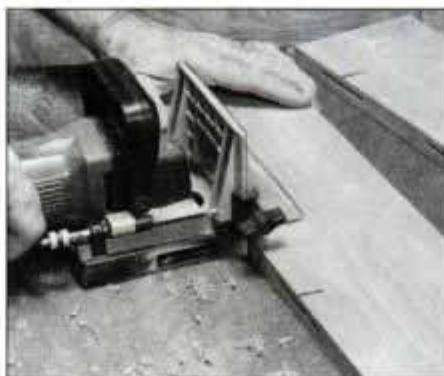
We used joining plates to join the boards together, but dowels can be used as well. To cut the plate slots, place the boards on a flat surface in the order in which they will be glued together. Mark the biscuit locations and cut the slots, holding the biscuit joiner and the board flat to the bench (Photo 12).

Glue and clamp the boards together (Photo 13). Prevent the panel from bowing under clamping pressure by using cauls. Wax the cauls' edges where they come in contact with the glue. This prevents the glue from sticking to the caul. After the glue has set, remove the dried glue and small differences in height between the boards using a cabinet scraper (Photo 14).

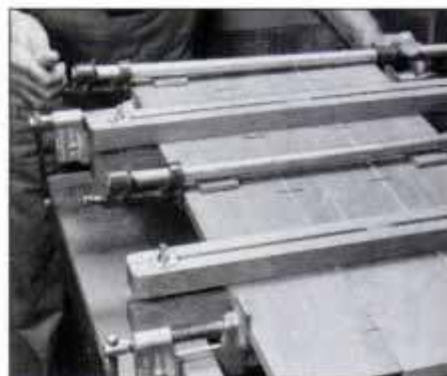
Cut the mortise for the flip-top hinge with a router and a 1/2-in.-dia. straight bit. Make a guide frame, and cut the mortises in both leaves at the same time (Photo 15). The frame is made with four strips of plywood 1/4 in. x 1 1/2 in. wide. The size of the frame opening is dictated by the size of your router base. After cutting the mortise, chisel out the notch for the hinge knuckle (Photo 16).

Cut the radii on the outside corners of the leaves using a sabre saw, then set up the router with a ball-bearing 1/2-in.-rad. corner rounding bit. In order to achieve the elliptical edge, adjust the bit so about half its cutting edge projects beyond the base. Shape the edge by making a pass from both sides (Photo 17).

Finally, use a 1-in.-dia. Forstner or spur bit to bore the flat-bottomed hole that seats the pivot dowel.



12 Use a plate joiner to join the boards for the top. Hold the workpiece and the joiner on a flat, clean surface.



13 Glue and clamp the top panels. Use cauls to keep the assembly from bowing. Waxed cauls will repel glue.



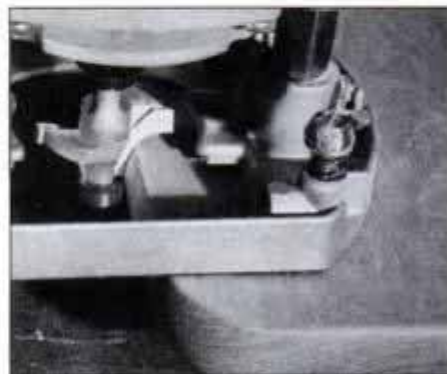
14 Push a cabinet scraper over the panels to remove the dried glue at the joints and to level the panels.



15 While cutting the hinge mortises, guide the router with a simple frame. Clamp and tack nail the frame in place.



16 Cut a notch for the hinge knuckle at the rear of the mortise. Each half of the mortise is notched to receive a knuckle.



17 Cut the ellipse on the edge of the top panels by raising the router bit up so it won't cut to full depth.

Aprons, Assembly And Finish

Rip and crosscut the apron stock. Use the miter gauge and an auxiliary fence with a stopblock to guide the aprons as you push them over the dado head in the table saw (Photo 18). To cut the decorative apron bead, use a molding head in the table saw (Photo 19).

Next, use a chisel to cut the pivot brace mortises on the inside of the aprons. Dry fit the legs and aprons, and bore pilot screwholes in the pivot brace and aprons. Glue and clamp the legs and aprons (Photo 20), then glue and clamp the pivot brace.

Cut the cleats and the bin's bottom panel to size. Temporarily attach the cleats with screws, then remove them. Cut the pivot dowel to size, then bore the pilot hole and install the hanger bolt in it. Cut a 2¼-in.-dia. disc for the pivot cap, then bore and counterbore the hole for the dowel and bolt. Temporarily install the pivot and the top (Photo 21). Check the hinge operation, and pivot the top around. Mark the position of the stop. Disassemble the pivot, stop and hinges to allow for finishing.

To obtain the deep rich mahogany color, we applied Behlen's Medium Red Mahogany Solar Lux Stain mixed at a ratio of 6 parts stain to 1 part retarder. The retarder helps you apply this fast-drying stain without leaving brush marks.

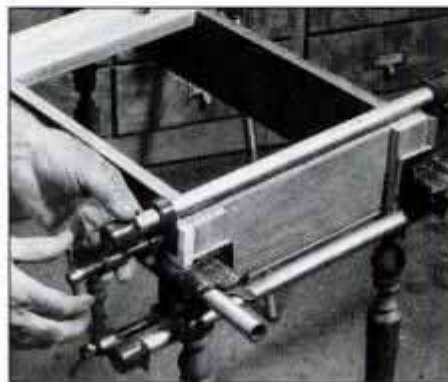
Apply the stain to one section at a time, then wipe off any excess with a soft cloth. Allow the stain to dry overnight, then seal it with a wash coat of shellac (6 parts alcohol to 1 part 3-pound cut shellac). Allow the sealer to dry at least 4 hours, and apply a mahogany-colored paste wood



18 Cut the apron tenons on the table saw using a dado head. Butt the apron against the stopblock to make the cut.



19 After the tenons are cut, shape the bead on the aprons with a molding head installed in the table saw.



20 Glue and clamp together the aprons and legs in one step. Use blocks under the clamp jaws to prevent marring.



21 Dry assemble the pivot, then position the top on the base to check for movement. Mark the pivot stop position.

filler. If you can't get mahogany-colored filler, use natural-colored filler and add burnt-umber Japan color to suit (available at art supply stores).

Apply the filler in the direction of the grain using a stiff brush. When the coating loses its wet look, wipe off the excess with a coarse cloth such as burlap. Wipe across the grain to remove the excess, then wipe with the grain using a soft cloth. Allow the filler to dry 24 hours, sand it lightly

with 220-grit paper to remove filler residue, then wipe off dust.

Apply a coat of sanding sealer, and again sand lightly. Wipe off the dust with a tack cloth, then apply three coats of Deft Gloss Clear Wood Finish. Allow 4 hours of drying between coats.

Apply sealer to the underside of the lower tabletop and the apron backs. Install the corner braces, and the project is complete. **FM**

REVIEW

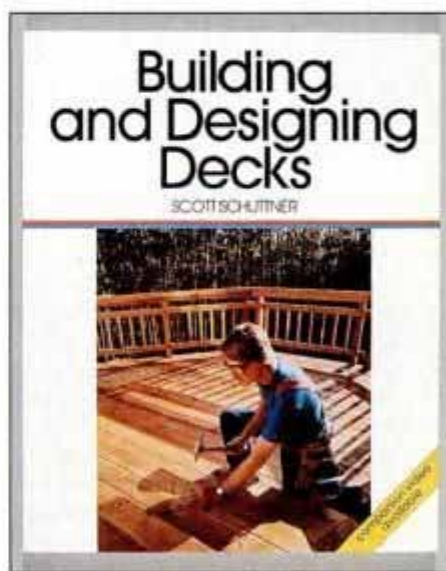
DECK-BUILDING BOOK AND VIDEOTAPE

Alaskan carpenter Scott Schuttner has written what may be the definitive book on wood-deck construction.

The book is thorough, but not ponderous, and it's loaded with neat tips like these: While laying out the foundation, Schuttner drops a plumb bob from a layout string to place the center of a footing. He takes a nail, pushes it through a piece of colored tape and presses the nail into the ground below the plumb bob tip. This way the spot is quickly marked and

highly visible. Also, he makes a 1 x 4 triangle measuring 3 ft. on one side, 4 ft. on the other and 5 ft. on the hypotenuse. He uses it to check large assemblies for square.

Costing about \$22, the book is a good buy considering the time, trouble and wasted materials it can save you. A companion videotape (also well done) costs about \$30 (postage extra). Write The Taunton Press, 63 S. Main St., P.O. Box 5506, Newtown, CT 06470.
—Roy Berendsohn



HOW IT WORKS

Washing Machine

BY STEVE TOTH, Contributing Editor; PM Illustrations by Eugene Thompson

● If you do laundry regularly, for yourself or your whole family, consider yourself lucky. That's right, lucky. Sure, you spend a few hours each week on the job, and maybe even chip away at the laundry hamper each day if your family is large. But if you think that your stint with the washing machine does less than enhance your life, take a look at the time-honored alternatives.

First, you could head down to the local stream, river or lake and pound your clothes against the rocks to get out the dirt—a marginal choice, if only because waterfront property is getting harder to come by. Or, you could buy a washtub and washboard and do the job right in your own home—a real step forward.

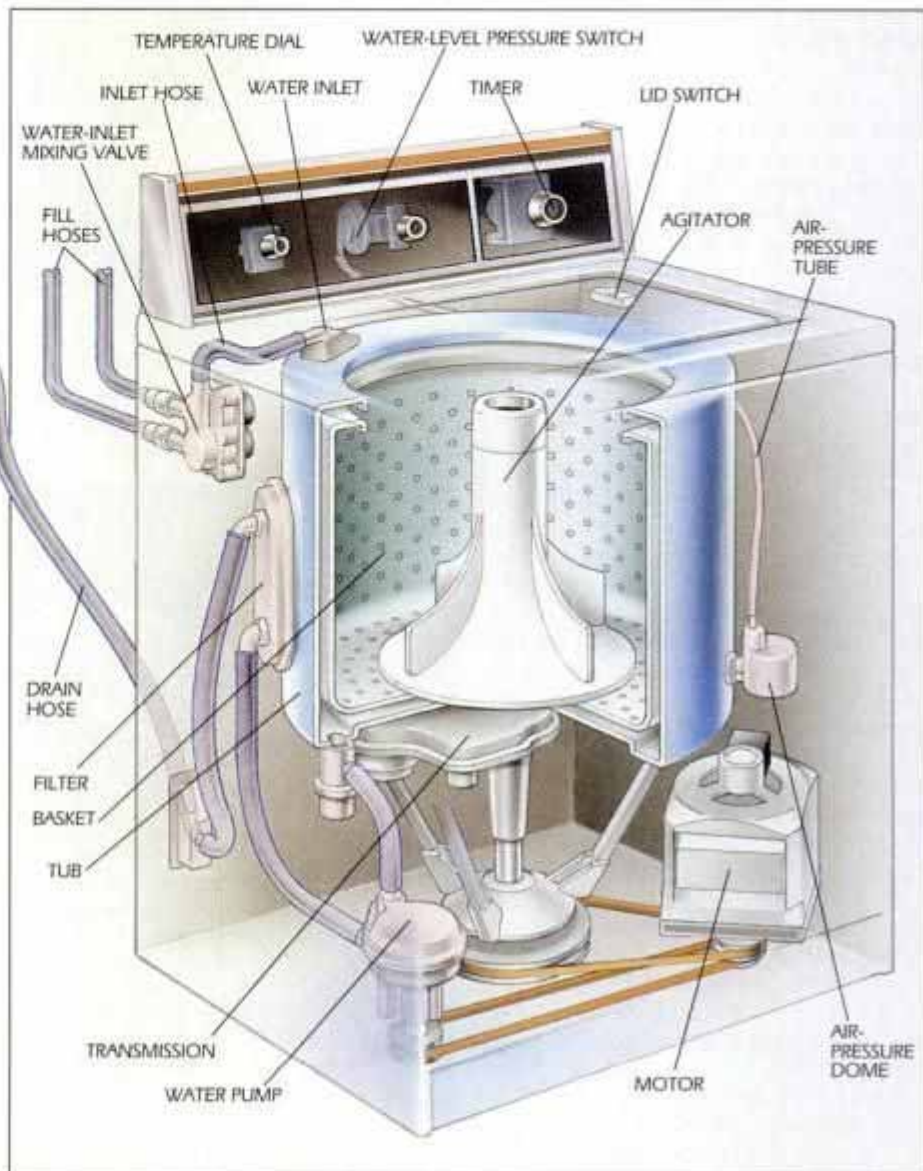
In the 18th century, the folks concerned with cleaner clothes and less work invented something called a dolly. This device consisted of a long wooden stick with a disc attached to the end. The underside of the disc held wooden pegs. After mixing the dirty clothes with soap and water, the dolly was inserted and moved around, up and down to agitate and clean the clothes.

Although the process became simpler, it wasn't until the acceptance of electrical power that things really started to take off. With a host of hand-powered mechanical devices on the forefront of domestic bliss, the general acceptance of the electric motor in the '20s proved to be the key to toil-free laundry.

Modern washing machine

Today's washing machine is a far cry from the early wooden-tub devices that began it all, but the principles are not that different. Along with a few improvements that automate the washing process, the basic washing machine remains an electrically powered mechanical device that agitates clothes, soap and water to remove the dirt.

There are two types of washing machines in use today—the top loader and the front loader. The front-loading machine features a horizontal tub.



The top-loading washer is the standard for most homes. A timer controls the program of cycles, and the transmission routes power from the motor to the agitator, basket and pump.

After the machine is loaded with clothes and detergent, and the door is closed and locked, water enters the drum and the drum starts to turn. Agitation occurs as the clothes lift out of the water and then fall back down while the tub rotates.

In the second type, the top loader, the tub is mounted vertically. Inside the tub is a basket, or perforated tub, and inside that is an agitator—a component with radial fins. In contrast to the front loader, the top loader cleans the wash through the back-and-forth rotation of the agitator. This type of design is the most popular washing machine found in homes today.

Washer automation

The brain of every automatic washing machine is its timer. This electro-mechanical device is powered by a small electric motor. Like a clock, the

timer motor turns a series of gears to move cams that activate switches. The switches, in turn, control the various functions—wash, spin and rinse, for examples—that make up the entire washing process.

In addition to controlling the various cycles by setting the timer, you set the water level to suit the size of the load at the water-level dial and control the water temperature—either hot, warm or cold—with the temperature dial.

The fill cycle

To start the machine, you first select a program of cycles, the wash time and the water temperature. Pressing the timer knob starts the timer motor and completes a circuit through the water-temperature selector switch and the water-inlet mixing valve. The temperature switch regulates the amount of

cold and hot water that passes through the water-inlet mixing valve. Once the mixing valve has opened, water flows into the tub from the hot and cold water valves attached to your home's plumbing system.

From here, the water fills the tub and the perforated basket that contains the dirty clothes and detergent. As the water level rises, it forces air into the air-pressure dome mounted on the side of the tub. A tube connected to the air-pressure dome carries the pressurized air to the water-level pressure switch in the console. When the air pressure reaches a point that corresponds to the water-level setting on the water-level dial, the switch shuts off the flow through the water-inlet mixing valve.

The wash cycle

Next, the timer signals the washer motor to start turning. The motor is connected to the agitator and basket through a series of gears, springs, cams and shafts that make up the transmission. Although transmission designs vary and have evolved over the years, the function of this assembly is the same: to convert the rotary motion of the motor shaft into the

back-and-forth motion of the agitator, and, at the appropriate time, stop agitation and engage the basket for the spin cycle.

In the wash phase, the fins on the agitator slosh the water and detergent through the clothes to remove the dirt. As the dirt is loosened from the clothes, it becomes suspended in the water.

At the same time that agitation begins, the water pump is engaged. The pump circulates water from the tub bottom to the top, and routes the water through a filter that catches lint and other particles.

Flushing the water

When the wash cycle is over, the motor stops momentarily and then starts in reverse. At this point, the agitator disengages and the pump moves the water in the opposite direction, flushing the filter and sending the dirty water out the drain hose.

Once the pump has removed most of the water, the timer advances to a spin cycle. The transmission now connects the motor to both the agitator and the basket, but disconnects the gears that control the agitation. As the rotating basket picks up speed,

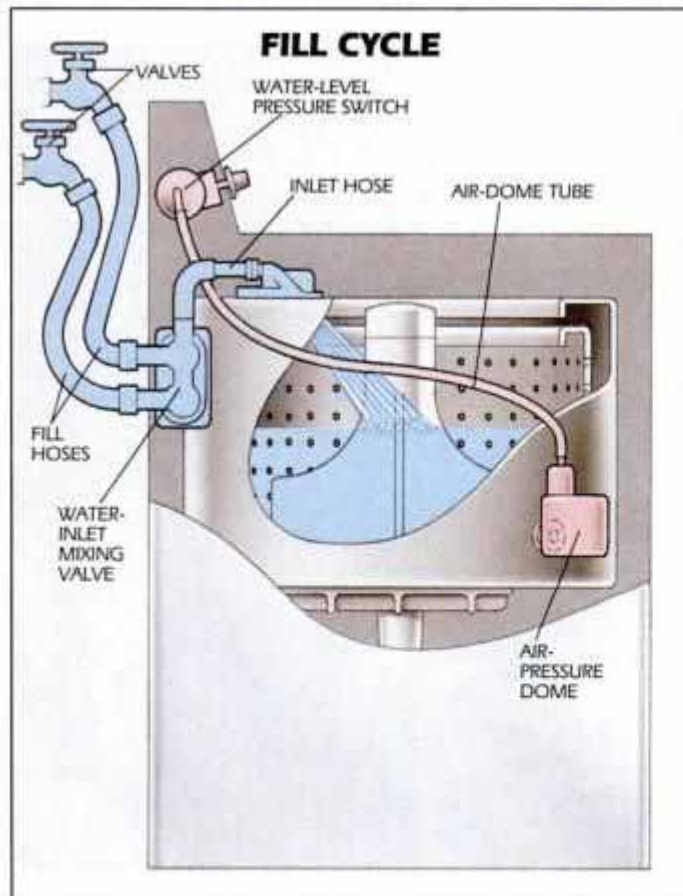
centrifugal force moves the water out of the clothes and through the basket perforations to the tub where it's pumped to the drain. As a safety feature, washers have a switch inside the lid that disconnects the motor if the lid is opened during the spin cycle.

Rinsing the clothes

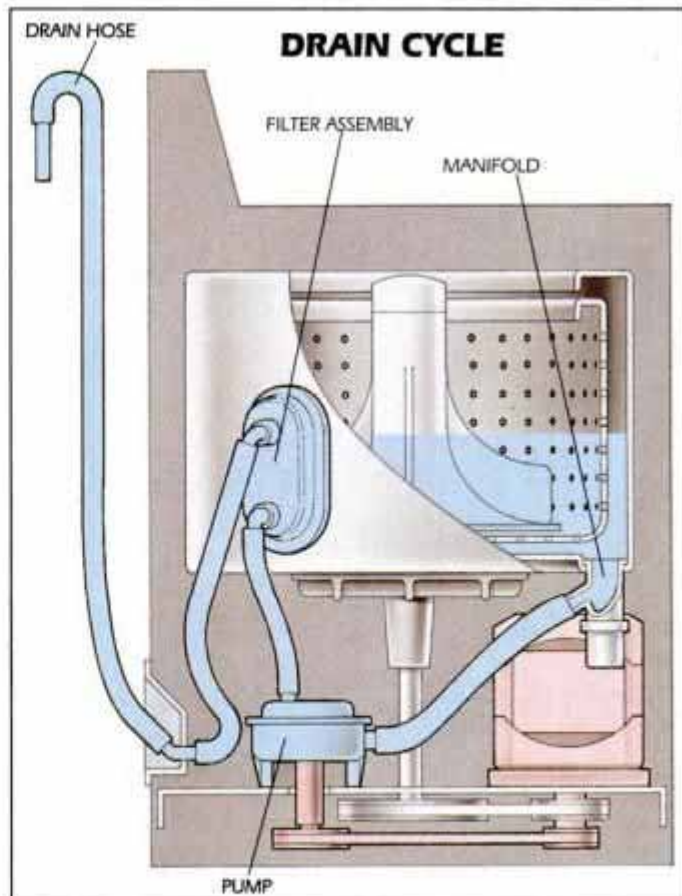
When the spin cycle is finished, the timer advances to the rinse cycle. During this phase, the tub again fills with water to the predetermined level and temperature. The timer then begins another short agitation cycle to remove any dirt and detergent that may remain in the clothes.

Following this agitation, the timer drains the tub and signals the motor and transmission to begin a high-speed spin that removes most of the water from the clothes.

During the final spin cycle, the timer opens and closes switches that control the water-inlet mixing valve. This sends bursts of water into the basket that are called spray rinses. The spray rinse helps remove any remaining dirt or detergent in the clothes. When the final spin cycle is complete, the timer stops the motor and shuts itself off. **PM**



In the fill cycle, the timer opens the water-inlet mixing valve to mix hot and cold water to desired temperature. The water-level switch senses water level through air pressure in an air dome.



In the drain cycle, the motor reverses and pumps water from the tub to the drain hose. Lint trapped in the filter is flushed away. Manifold catches larger particles. After draining, a spin cycle begins.

NEW PRODUCTS

Home Time

BY ROY BERENDSOHN, Assistant Home Improvement Editor



Pocket Size

This garage door opener is so small that it qualifies for the description pocket size—you can keep it on your key chain. The opener is powered by one A battery, and it works in conjunction with any post-1982 Stanley garage door opener. To program it, pry open its back hatch and set the 10 levers on its circuit board in the appropriate order. It costs about \$40 at hardware stores and home centers. For more information, write Stanley Door Systems, 1225 E. Maple Ave., Troy, MI 48083.

Zap It

A window box is something you plant flowers in, but this is a window box with a difference. The Caradco Zap-Pack contains two double-hung tilting sashes made from solid western pine and a vinyl window track. You can get the sash with optional Low-E glass, primed or clad with aluminum (in three colors—white, bronze or tan). The windows come in 120 standard sizes and are also available in custom sizes. ZapPacks range in price from \$106 for the smallest size in clear glass with primed wood to \$397 for the largest size with Low-E glass and aluminum cladding. To locate a Caradco supplier, write the company at 820 Lakeside Dr., Gurnee, IL 60031, or call (800) 238-1866.



Opening New Doors

Wing takes bi-fold doors in new directions, by making them nice enough for any passageway, closet or room. The product line contains, among others, La Door (left), a prehung and completely assembled French door (that comes with an installation video), and the Villa, an arch-topped door built of 1½-in.-thick Ponderosa pine and beveled glass. La Door costs from about \$230 to \$300, depending on size, and the Villa costs from \$140 to \$180. Both doors are sold at home centers. For more information, write Wing Industries Inc., P.O. Box 38347, Dallas, TX 75238.



Don't Get Irritated

With itching and irritation in mind, many people think of insulation as if it were bad-tasting medicine: They hate it, even though it's good for them. Owens-Corning has stepped in to make insulation easier to handle by introducing this polyethylene-wrapped product. The wrapping keeps irritating airborne fibers under control but is perforated to allow moisture vapor to escape. The 8-in. insulation has an R-25 rating, and is installed in the same manner as unfaced fiberglass. The 25-ft. rolls cost about \$10 to \$12 each, and come in 15-in. and 23-in. widths. They are sold at home centers and lumberyards. Write Owens-Corning, Fiberglas Tower, Toledo, OH 43659.



Looking Up

Suspended ceilings take a turn for the better with Armstrong's Prestige Collection. The embossed ceilings come in four types: raised panel (shown), scalloped, fluted and diagonal line for a more contemporary setting. We viewed the panels when Armstrong unveiled the line and found their support grid blends well with each panel design. The panels can also be installed with a dropped drywall border. Using this system, you can achieve a suspended ceiling without cutting the panels to width at the end of the run. In other respects, the panels are like ordinary dropped ceilings. You can remove the panels for access, and you can clean them with soap and water. The panels range in price from \$1.89 to \$2.29 per square foot. The 2-ft. x 2-ft. panels come six to the box. They are sold at home centers and lumberyards. For more information, write Armstrong World Industries Inc., Consumer Response Center, P.O. Box 3001, Lancaster, PA 17604.

Magic Pouch

You can't keep carpet from being soiled, but at least this pouch of carpet cleaner can help you keep the mark from becoming permanent. The cleaner consists of wood fibers impregnated with a broad-spectrum cleaner and deodorizer that handles—among other things—dirt, pet urine and grease. To use, just spread some of the product over the soiled area, then gently brush the cleaner into the stain. Let the cleaner dry, then vacuum it up. A 1-pound pouch costs about \$4 at hardware stores, carpet stores and rental centers. Write Host Consumer Division, Racine Industries Inc., P.O. Box 1648, Racine, WI 53401, or call (800) 558-9439.



Scald-Free Showers

You can guard against being scalded in the shower by installing this thermostat/pressure-balancing mixing valve. Dial the handle to any temperature in the 60° to 100° F dial setting (an override button allows hotter temperature settings). The device is available in chrome, gold, white and polished-brass finishes. It costs from about \$235 to \$515—depending on the finish and whether you opt for the model without thermostat capability—at plumbing supply houses and at kitchen and bath shops. Write to Grohe America Inc., 241 Covington Dr., Bloomington, IL 60108.



A Killer Exposed

This home warning device looks like a smoke detector and, with its 85-dBA siren, it sounds like one too. But it detects something more insidious than smoke—carbon monoxide. This odorless and colorless gas is a combustion byproduct and is present wherever there is a fuel-burning appliance or motor vehicle. Normally, it goes up a chimney, but it can leak into living areas if the chimney or appliance malfunctions or if the vehicle is left running in a closed garage. In the early stages of a carbon-monoxide leak, the gas causes headaches, but this detector sounds the alarm well before it gets to that level, its manufacturer says. The UL-listed device is powered by a combination 9-volt battery/chemical sensor. It costs about \$60 at hardware stores and home centers. Write First Alert Co., Q&A, 325 W. Huron, Rm. 315, Chicago, IL 60610.



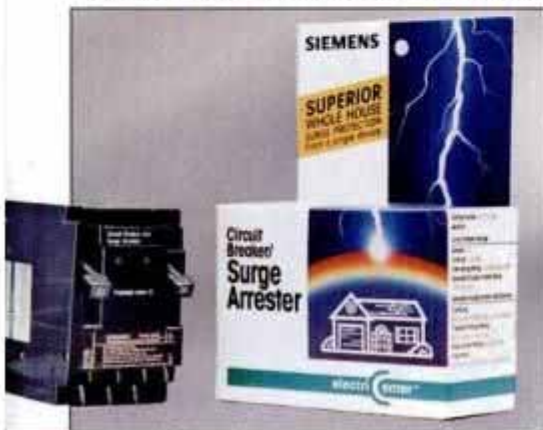
Classy Glass

For a manufactured product, these stained-glass windows are about as close to custom designed as you can get. The windows are available in seven styles in more than a hundred shapes and sizes. Each window consists of colored glass pieces held in soldered metal frames, framed in maple. The windows are installed in a new or existing Andersen window and are removable. Prices vary depending on style, shape and size. Transom lites, for example, cost \$325 to \$600. They are sold at Andersen dealers. For information, write Andersen Corp., 100 Fourth Ave., Bayport, MN 55003, or call (800) 426-4261.



Spike Protection

Lightning doesn't have to strike twice to damage your home—once is more than enough to ruin your computer and other electronic goods. To protect against these voltage spikes, and also those caused by utilities or even other appliances, you can wire this surge arrester/circuit breaker into your house's circuit panel. Siemens says the device provides more protection than plug-in surge arresters. Also, because it is wired into the circuit panel, it protects all the electronics plugged into that circuit. The UL-listed device comes in 15- and 20-amp sizes, and costs about \$75 at home improvement centers, hardware stores and computer/electronics stores. For more information, write Siemens, 3333 State Bridge Rd., Alpharetta, GA 30202, or call (800) 678-9888.



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If you're in a hurry, this is the concrete for you. It's a commercial-quality concrete that develops its strength early in the curing process (the commercial term for this is high early strength), and it delivers a 5000 psi rating in 28 days, or about an extra 1000 psi of strength compared to typical pavement concrete. You can walk on it in 10 to 12 hours, and its manufacturer says that it can be used in hot or cold weather applications. An 80-pound bag costs \$3.50 to \$4 at hardware stores and home centers. For more information, write Quikrete, 1790 Century Circle, Atlanta, GA 30345.

Wrap Around

Whether you build a box around it or just paint it, making a lally column look nice can be difficult, so here's a product to make the job easier. Pole-Wrap is a wraparound tambour made of 1/2-in.-wide oak slats on a cloth backing. It simply fits around the column and is attached with construction adhesive. It can be stained, painted or clear coated. It comes in 8-ft. lengths in 4-in., 7-in., 9 1/2-in., 11-in. and 12 1/2-in. widths. It costs about \$35 plus \$5 shipping from Pole Wrap, P.O. Box 1523, Troy, MI 48099.



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You're Surrounded

If you wanted a Corian shower and tub surround years ago, you had to be a professional installer or pay to have one installed—that's not true anymore. The solid surfacing material is now available as a 4-panel kit. Basically, you bore holes in one panel for the spout and handle, cut the trim pieces to size with a sabre saw and then install the panels using DuPont panel adhesive. The kit is available in several configurations and colors. The kits cost about \$800 at kitchen and bath dealers and home centers. For more information, write DuPont, Chestnut Run Plaza, No. 702, Wilmington, DE 19880.



Straight As An Arrow

Marvin says its new French door is the ultimate millwork product: warp free, weather tight and energy efficient. To prevent warping, the company made the door's stiles into a hollow assembly of clear white pine reinforced with a fiberglass composite channel. Even after the door is installed, it's fully adjustable to account for the building's settling.



And its steel hinges adjust $\frac{1}{16}$ in. horizontally or $\frac{1}{4}$ in. vertically. The hinges have recessed adjustment screws. To bring the door into position, you turn the screws with a Phillips screwdriver. It's available in a wide range of configurations and sizes. It costs from about \$1800 to \$5000 at Marvin dealers. Write Marvin Windows and Doors, P.O. Box 100, Warroad, MN 56763. **PM**



Take A Shine

Modern acrylics, other plastics and fiberglass are great building materials for vanities and tub/shower enclosures, but if they got scratched, there was little you could do to repair them—until now. Enter ultra micro-fine NicSand aluminum-oxide polishing gel, a material so fine it performs like 10,000-grit sandpaper. The water-based formula does not contain wax or silicone, the company says. You apply it by using the foam pad that comes with the material. Chuck the pad into an electric drill, squeeze some gel on the pad and polish away. An 8-ounce bottle and foam pad costs about \$15 at home centers. Two other gel kits with more aggressive grit are available. One is equal to 3000-grit paper, and the other equals 5000 grit. For more information, write NicSand Inc., P.O. Box 29480, Cleveland, OH 44129.

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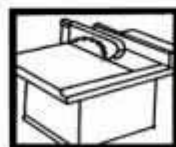


TABLE SAW, ROUTER & PLANER

Spray on surfaces of power tools to ease sliding of wood on table, resist rust and lubricates.



TOOLS

Spray on tools such as putty knives, paint trays, tin snips, etc. for smoother operation, protection and easier clean-up.



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Homeowners Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Water Heaters In Series

We have two 50-gallon electric water heaters connected in series, but we seldom use large amounts of hot water. If hot water is being dispensed one tank at a time, it seems that the water in the second heater in the series would rarely be dispensed. Could this standing water be a breeding ground for bacteria? How practical is it to turn off one via the breaker switch until large amounts of hot water are needed?

MARLENE PRENTICE
 LA PLATA, MD

Yes, standing water can be a breeding ground for the bacteria that are always present in water. However, in a municipal supply, the bacteria are normally not toxic, but they can cause smelly or rusty water. If your

water heaters are connected in series, you won't have standing water. As water is drawn from the first tank, makeup water will flow from the second tank into the first, and from the water supply into the second tank.

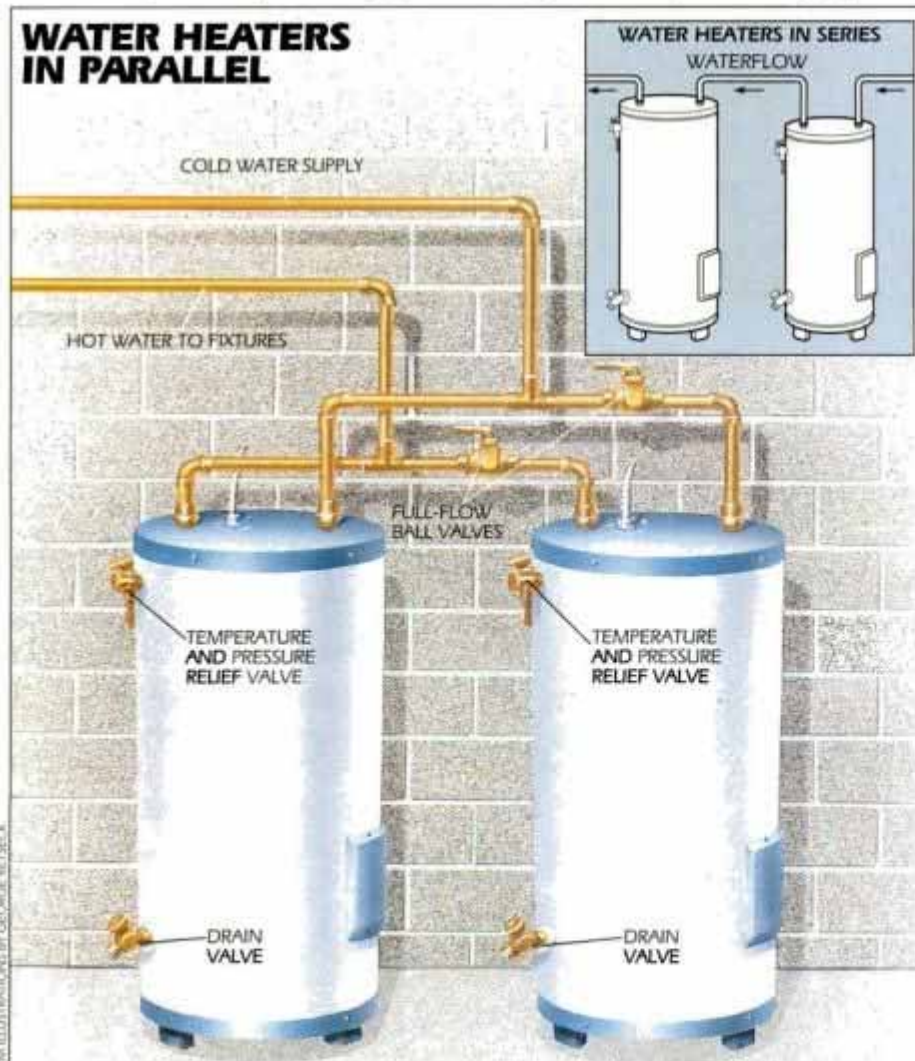
If you turn off the power to the second tank, that tank will function as a preheater by raising the water temperature to that approaching room temperature before it enters the first tank. This reduces your energy costs.

Readers who need more hot water should be advised that there are several ways to deal with the problem. For instance, a plumber may install the second water heater in parallel. Water heaters that are the same size and BTU input are usually installed this way—the advantage being that the system will provide large quanti-

ties of hot water at one time, since water is drawn from both tanks simultaneously. Also, this system allows you to shut off and drain one tank for periods where the extra hot water capacity is not needed.

Water heaters that are different sizes are often installed in series. The first and smaller tank functions as a preheater for the larger tank (see inset drawing below left).

Other options for homeowners to consider would be installing the water heaters individually (so each serves a group of fixtures), installing an instantaneous water heater (a small gas or electric water heater adjacent to a tub/shower or sink) or installing a single large water heater. Each installation has advantages and drawbacks, and you should discuss each of these with the contractor who will perform the installation.



Water heaters can be connected in series or in parallel. In series, one acts as a preheater. In parallel, both appliances supply hot water simultaneously.

Window Well Overflows

Please advise us on the problem of an overflowing window well. When there is heavy rain, the water builds up in the well, goes through the window frame and flows into the basement. How much crushed rock should be placed so the water will seep through?

M. FULLER
 EAU CLAIRE, WI

You should prevent the rain from entering the window well rather than let it seep through a gravel bed. You can buy clear plastic domes that fit over the window-well opening at home centers.

If your window well is an odd size, you can build the equivalent of a plastic dome. Buy a sheet of clear plastic, and cut it to size so that it overlaps the sides of the window well by about 6 in. Install a ledger board on the wall above the window well, and lay the plastic so it is inclined with the top resting on—and secured to—the ledger. The bottom of the plastic should overlap the outside edge of the window well by a few inches.

If the window well is filled with gravel, during a sustained rain, water will seep down through the gravel and accumulate around the base of the foundation, where it could seep into the basement via a crack in the foundation wall.

Hydronic Moaning

I have a 4-zone, gas-fired, forced hot-water heating system. The water heater has started making a low moaning noise intermittently, almost a groan. The system is 26 years old and has had minimal maintenance. How can I stop the noise?

BILL CONKLIN
TACOMA, WA

It sounds like the bearings are failing on the circulator pump. Over the years, the bearings wear—especially if they have not been adequately lubricated. Worn bearings get hot, overheat and develop a scraping noise, which is transmitted through the piping and can be heard in some sections of the house. If the sounds are coming from the circulator bearings, replace the circulator.

Circulator pump bearings should be lubricated at least once a year with motor oil, typically sold at hardware stores. Newer circulator pump motors, however, are usually permanently lubricated.

Shiny Finish On Laminate

Due to misuse and haphazardness, we have removed the shiny finish from parts of our Formica kitchen counter. The counter is still in good condition, but we'd like to know if we can restore the original finish.

GEORGE FUERTH
LAKEHURST, NJ

Unfortunately, there is no way to restore the shiny finish. The laminate is formed under heat and high pressure—conditions that are impossible to duplicate in the home. Once abraded, the finish can't be restored.

If you are unhappy with the finish of the countertop, you can resurface it with new laminate—provided the existing laminate is sound, well bonded and does not have deep texture.

You can call the Formica Corp. at (800) 367-6422 for an instructional sheet on resurfacing laminated assemblies. If you are interested in cleaning and maintaining Formica plastic laminates, ask for the free brochure Caring For Formica Brand Laminate Surfacing Material.

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

Worth Getting

Many homeowners hate installing or repairing drywall because it's difficult to get professional-quality results. You can improve your results by being well prepared before you begin, and these free pamphlets are a good place to start. They cover the basics of installation and finishing, and making large and small repairs. The pamphlets are well written and concise. Write to Gold Bond Build-



ing Products, 2001 Rexford Rd., Charlotte, NC 28211.

—Roy Berendsohn

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Hard-To-Find Parts For Plumbing And Windows

Equiparts, a company that specializes in hard-to-find plumbing hardware, started out selling plumbing and hardware to institutions and businesses. It is now expanding into residential components. The company says it can supply just about any plumbing part you need. Also, the company stocks electrical components, a variety of fasteners and window and door hardware.

Contact Equiparts, 817 Main St., Pittsburgh, PA 15215.

Blaine Window Repair Service boasts that it stocks more than 10,000 pieces of hardware for aluminum and wood doors and windows, whether they're obsolete or current. To be more specific, it handles parts for windows, patio doors, closet doors, storm windows and storm doors. These parts have been its stock in trade for 37 years. If the company doesn't have the part, it will try to find a source or have it made.

Contact Blaine Inc., Window Repair Service, 2410 Linden Ln., Silver Spring, MD 20910. —R.B.

Rusty Racks

• Repairing rusty dishwasher racks is easy, and it's a good way to prevent rust spots from forming on your dishes.

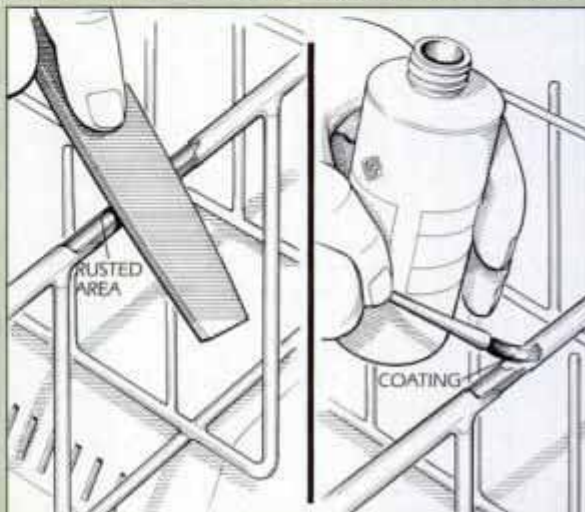
First, contact an appliance repair center to see if the manufacturer makes a repair kit. These kits are either a brush-applied coating or slip-over tips.

Before applying a coating, clean off any residue on the rack. Then, peel or cut back the rack coating. Next, file off the rust. Once you see clean metal, wipe off the area and apply several layers of the coating, allowing the material to dry for 30 to 45 minutes between coats. Let the coating dry for 24 hours before using the dishwasher.

If your dishwasher manufacturer does not offer a repair coating kit, contact Advanced Materials, 237 Senoia Rd., Peachtree City, GA 30269. The company's Dishwasher Rack Repair comes in five standard colors, in 1-ounce (\$6.95) or 2-ounce (\$9.95) bottles. Both prices include postage. —Steve Toth



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**HOME
 IMPROVEMENT**

**Making
 Cabinets:
 Part 1**

*First in a 2-part series
 on modern cabinet-
 making—traditional
 face-frame design.*

BY NEAL BARRETT
 PM Illustrations by
 George Retseck

● One of the cornerstones of the woodworker's craft is cabinetmaking. Whether the project is a utility tool cabinet, a kitchen cabinet or an entertainment unit, the skills and techniques are much the same. In contrast to the cabinetmaker of yesterday, today's woodworker uses a range of modern materials and tools that both speed construction and offer alternatives in design. One of the most popular styles is called the face-frame cabinet. Here, the door and drawer openings are defined by a rigid flat frame that adds structural integrity to the entire case.

Our updated interpretation is typical of modern face-frame design and you can modify it to suit your needs (see drawing on page 63). It features a hardwood frame-and-panel door, face frame and drawer front. The cabinet sides, back and the remaining drawer components are plywood.

When it comes to joinery, we chose simplified mortise-and-tenon joints for the frame and door, and rabbets and grooves to lock the drawer components together. To facilitate the plywood case construction, we opted for a plate joiner. You could also substitute dowels or build the case with dado joints, nails and glue.

While our drawing illustrates the components of a base cabinet, construction of an upper cabinet is similar. Simply omit the toeboard area and drawer-related components, and substitute a plywood panel for the base cabinet cleats that serve for fastening a countertop. Study the plans carefully so that you understand the construction. Then lay out a shop drawing of your cabinet. Make a list of all plywood parts and experiment with various cutting plans to get the best yield from your plywood.



Choosing materials

The materials for our face-frame cabinet are 3/4-in. veneer-core plywood for the sides and shelves, 1/2-in. plywood for the backs and 3/4-in.-thick hardwood for the face frames, doors and drawer faces. While 1/4-in.-thick plywood could be used for the backs to economize on materials, the 1/2-in.-thick stock provides more rigidity when securing the unit to the wall.

We used oak-veneer plywood for all case parts. If you wish, you can use a less-expensive birch or maple plywood for the parts that are hidden when the cabinet is closed.

You'll find hardware, such as hinges, pulls and drawer slides, at most building-supply outlets. Be sure to have your drawer slides on hand before you begin so that you can di-

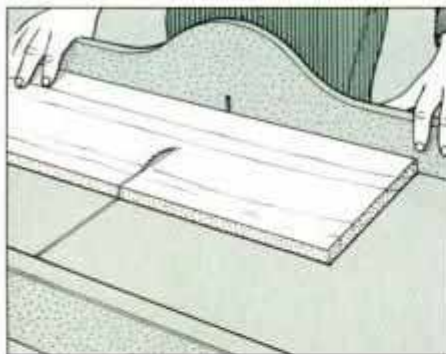
mension and position related components appropriately.

Starting construction

Use a circular saw and straightedge guide, clamped to the panel, to cut each 4 x 8 sheet into easily manageable pieces. Then use the table saw to rip and crosscut the parts to finished dimension (Fig. 1).

For base cabinets, lay out the toeboard notch at the bottom front corner of each case side and use a sabre saw to make the cutout (Fig. 2).

Lay out the location of joining-plate slots in all plywood parts. While we use joining plates alone, you can combine them with screws when the case side will be hidden against a wall or another cabinet. This technique eliminates the need for clamping and

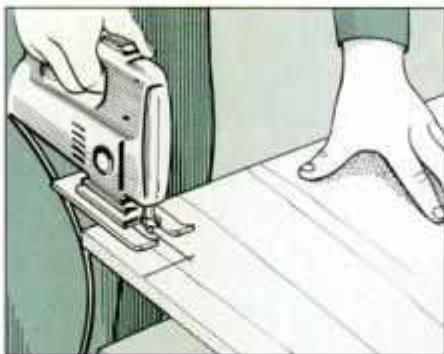


1 After cutting the stock slightly oversize with a circular saw, rip and crosscut to exact dimensions on a table saw.

speeds assembly. Cut the plate slots in the plywood pieces (Fig. 3). Note that it is faster to cut the slots for joining the face frame before you assemble the case (Fig. 4). Be sure to leave the layout marks visible so that you can transfer them to the face frame later.

Since the bottom edges of the upper cabinet sides will be visible, cover them with a preglued veneer edging (available from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, MN 55374). Cut a piece about $\frac{1}{2}$ in. oversize and apply with an iron (Fig. 5). Trim the veneer flush with a sharp chisel or utility knife.

Clamp each case side to your workbench to rout the rabbet that houses

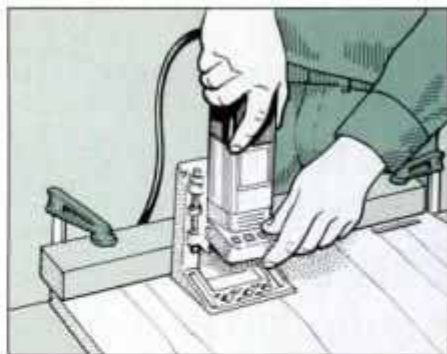


2 Use a square to lay out the toeboard notches on both side panels of a base cabinet. Cut the notch with a sabre saw.

the back panel. Use a straight bit and edge guide to make the cut (Fig. 6). When building upper cabinets, this rabbet stops short of the bottom edge of the side to align with a rabbet cut along the back edge of the case bottom. Rout to within $\frac{1}{16}$ in. of the stop mark, then use a sharp chisel to square the end of the cut (Fig. 7).

Make a template for the shelf pinholes to guarantee accurate spacing. Clamp the template to the front and back of each case inside face, and bore the shelf pinholes using a depth stop on the drill bit (Fig. 8).

Apply glue to plate slots for joining the top cleats and case bottom to the sides. Then, clamp or screw the parts together. If using clamps, place heavy

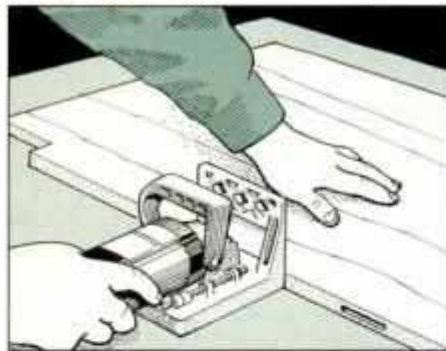


3 Cut plate-joint slots for joining the cabinet components. A board clamped to side positions plate joiner for case bottom slots.

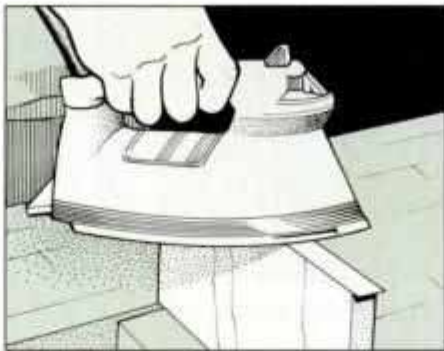
cauls across the joints to distribute the pressure evenly. Compare opposite diagonals to be sure that the assembly is square and adjust if required (Fig. 9). Cut the toeboard to exact size, and install it on the base cabinet by gluing it to the front edges of the case sides (Fig. 10).

Cut all parts for cabinet face frames from $\frac{3}{4}$ -in.-thick hardwood stock. Use a dado blade in the table saw to cut the tenons on rail ends. Mark the locations of the mortises in face-frame stiles, and use a router or drill press and chisel to cut them. Test fit each joint and adjust as required (Fig. 11).

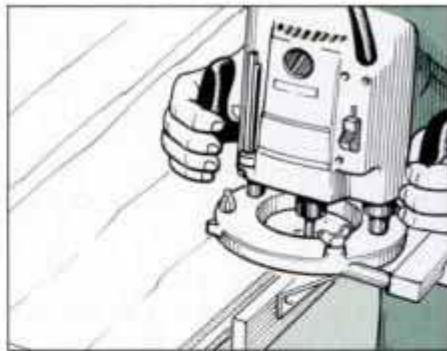
To assemble the face frame, apply glue to both mortises and tenons and



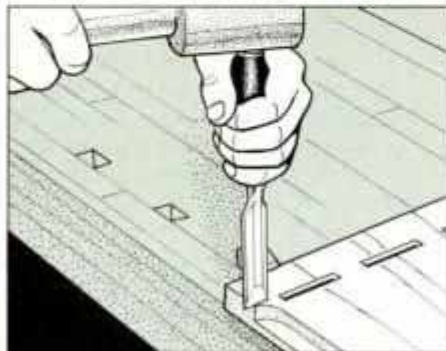
4 Use your workbench surface to position slots in component edges. Cut slots for joining face frame before assembling case.



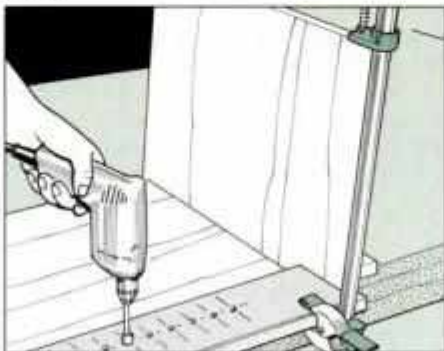
5 Use preglued veneer tape to cover bottom edges of upper cabinet side panels. Apply with an iron and then trim flush.



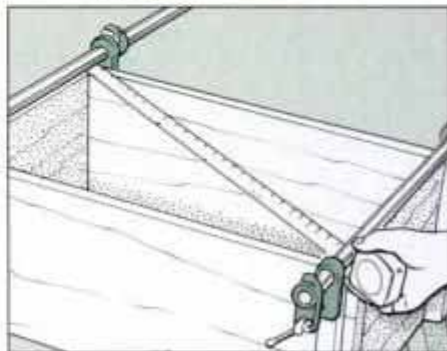
6 Rout the rabbet for the back panel in both cabinet sides. Use a straight bit and a router edge guide to make the cut.



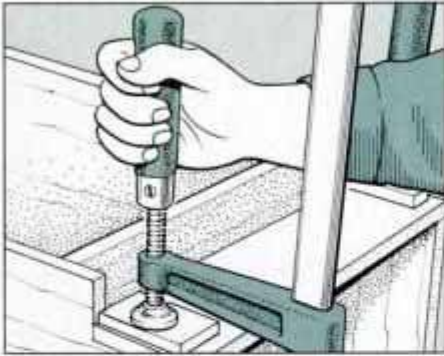
7 Cut a stopped rabbet for the upper cabinet back. After routing the rabbet, trim the end square with a sharp chisel.



8 Clamp case bottom in place and use a template to position holes for shelf pins. Reference template against case bottom.



9 Assemble sides, top and bottom. Use heavy cauls to distribute clamping pressure and measure diagonals to check for square.



10 Rip and crosscut the toeboard to exact size. Then, apply glue and clamp to the case sides until the glue sets.

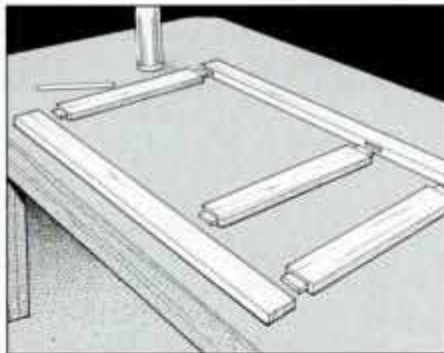
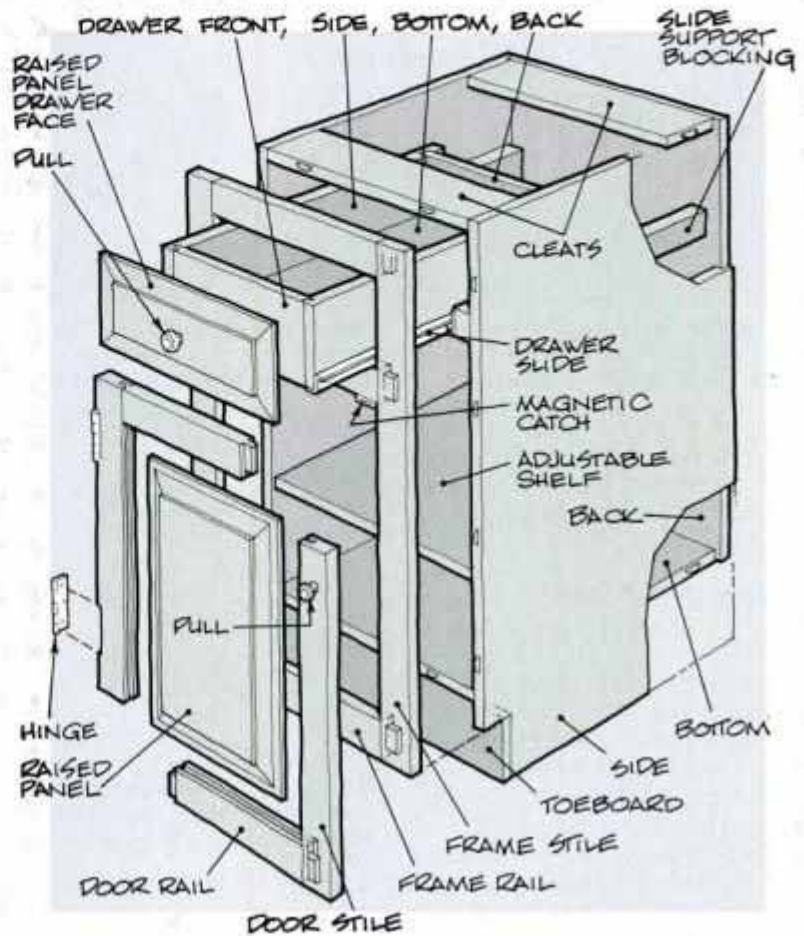
join the parts. Use bar clamps to bring the joints tight, and measure the diagonals to check that the frame is square (Fig. 12). Scrape off any excess glue after 20 to 30 minutes.

Place the face frame on your worktable and position the case over it, face side down. Transfer the plate location marks onto the back side of the face frame (Fig. 13). Cut the joining-plate slots in the face frame, using a shim underneath the plate joiner to properly position the slots (Fig. 14).

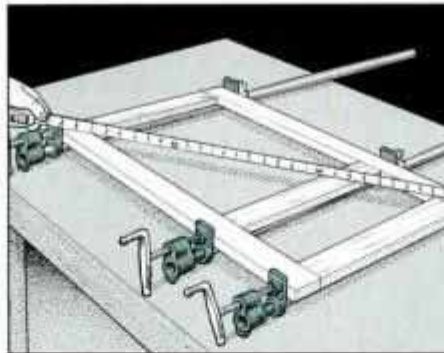
Apply glue to the plate slots and case-front edges and attach the face frame to the cabinet. Use clamps to bring the frame tight to the case, and let the glue set.

Cut mounting blocks for the drawer

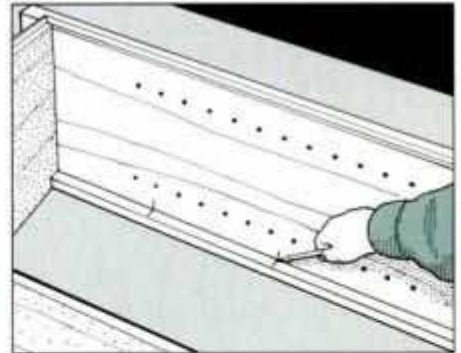
FACE-FRAME CABINET



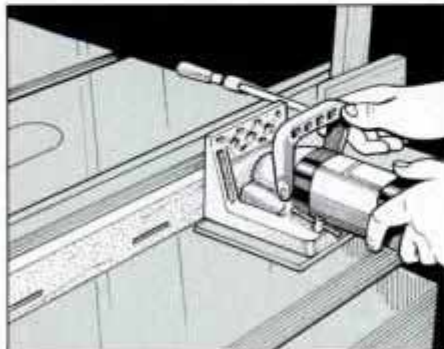
11 After cutting mortises and tenons in face-frame stock, test fit the components. Then, apply glue and assemble frame.



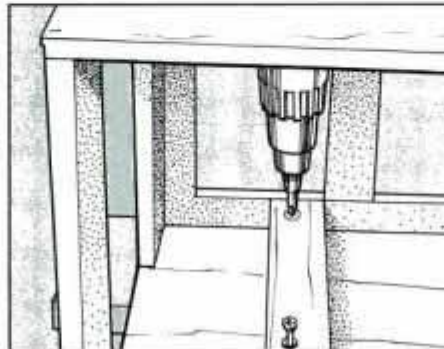
12 Clamp face-frame components together, and check that the diagonals are equal. Remove excess glue after it has set.



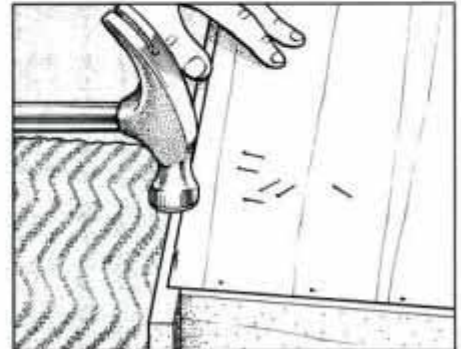
13 Lay case on top of face frame. Then, transfer plate-joint location marks from case sides to face frame for cutting slots.



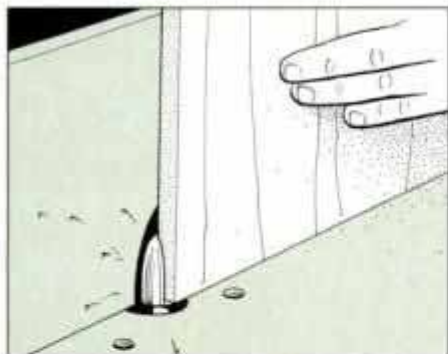
14 Shim base of plate joiner to accurately position plate-joint slots in face frame. Then, make a cut at every slot location.



15 Screw drawer slide blocking to the inside of each cabinet. Align blocking with upper edge of face-frame drawer rail.



16 Cut plywood cabinet back panel to fit. Then, apply a bead of glue to rabbets and install back with 1-in. brads.



17 Shape the raised door panel with a vertical-panel bit mounted in a router table. Use a high fence to support work.

slides from poplar, maple or birch, and then screw them in place (Fig. 15). Cut the cabinet back to exact size, and install in the rabbets using 1-in. brads and glue (Fig. 16).

Building the doors

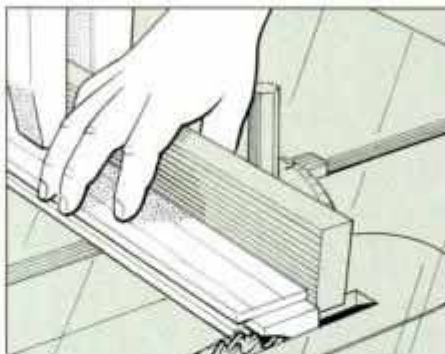
Measure the door opening and allow for a $\frac{1}{16}$ -in. gap on all sides. Then, compile a list of door parts with finished dimensions. The door utilizes a $\frac{1}{4} \times \frac{1}{2}$ -in.-deep dado along the edge of each stile and rail. This groove holds the panel and also acts as a mortise for the rail tenons. To compensate for dimensional changes due to variations in humidity, trim the panel width $\frac{1}{8}$ in. less than the space between the insides of the stile grooves.

We shaped the raised-panel edges with a Byrom Safety-Raiser router bit (No. 363-5802, available from Woodcraft, P.O. Box 1686, Parkersburg, WV 26102). Clamp a tall fence to the router table to support the panel, and make a series of cuts at increasing depths to achieve the profile (Fig. 17). Sand with 120- and 220-grit paper. Then use a dado blade in the table saw to cut the grooves in the rails and stiles, and the tenons on the rail ends (Fig. 18).

Assemble each door by applying glue to tenons and to those portions of the stile grooves that serve as mortises (Fig. 19). Avoid getting any glue in the rail grooves so that the panel will be free to expand and contract. Join all parts and clamp, cross-measuring to check that the door is square.

Lay out and cut the mortises for door hinges. Use a razor-sharp chisel to cut the mortises (Fig. 20). Bore pilot holes and mount the hinges to face-frame stiles.

Use $\frac{1}{16}$ -in. shims to position the door in the opening, and mark the hinge locations on the door stile with a sharp knife (Fig. 21). After cutting the hinge mortises in the door, bore pilot holes and hang the door. Then,



18 After cutting the grooves in the door frame pieces, use a dado blade to shape tenons. Rail tenons fit in stile grooves.



20 Lay out the mortises for the butt hinges on the inside of the cabinet face frame. Remove the waste with a razor-sharp chisel.

bore a pilot hole and mount the door pull, and finish by mounting a magnetic door catch.

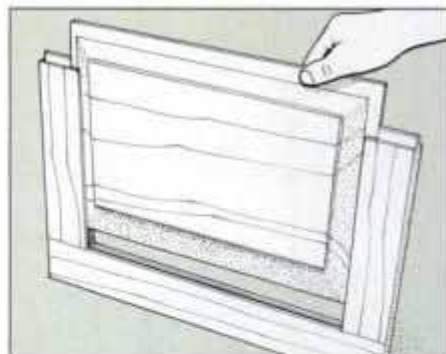
Drawer construction

We used $\frac{1}{2}$ -in. Baltic Birch plywood for the drawer sides, front and back and $\frac{1}{4}$ -in. birch plywood for the bottom. The drawer face is solid $\frac{3}{4}$ -in. oak. Shape the edges using the raised-panel bit, with the bit set lower in the router table than for the door panel. Trim the drawer face $\frac{1}{8}$ in. less than the drawer opening in length and width.

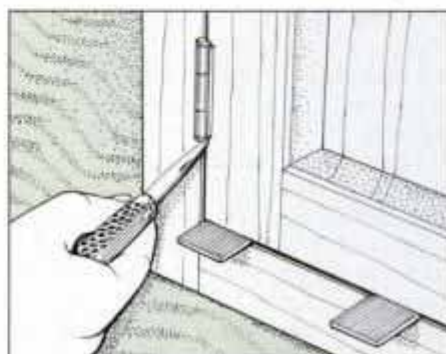
Use a dado blade to cut the grooves for the drawer bottom in the sides and front (the back is cut narrower and the bottom extends under it). Then



22 Use a table saw and dado blade to cut the grooves, dadoes and rabbets in the drawer sides, front and back.



19 Apply glue sparingly to the tenons and assemble the rails with one stile. Insert panel, add other stile and clamp.

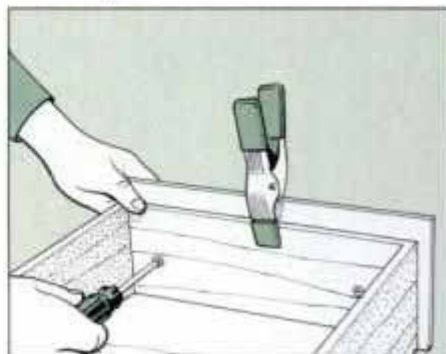


21 Install hinges on face frame and position door with $\frac{1}{16}$ -in. shims. Then, mark hinge locations on door with a knife.

cut the crossgrain dadoes in the sides for joining the front and back (Fig. 22). Finally, cut the rabbets in the drawer front and back. Assemble the boxes using 1-in. brads and glue. Slide the drawer bottom into place and fasten by screwing into the drawer back with No. 5 $\times \frac{5}{8}$ -in. flat-head screws. Drill pilot holes and mount the drawer face to the box with No. 8 \times 1-in. round-head screws (Fig. 23).

Mount the drawer slides and install the drawer. Then, mount the drawer pull. Cut and edgeband $\frac{3}{4}$ -in.-thick plywood for the adjustable shelf.

Remove all hardware and sand the cabinet with 120- and 220-grit paper. Dust off thoroughly, then apply the finish of your choice. **PM**



23 Clamp the drawer front panel to the assembled drawer box. Then attach the front panel with wood screws.

REVIEW

Affordable Log Homes

BY ROY BERENDSOHN,
Assistant Home Improvement
Editor

● If you've been pining for that hunting or fishing cabin or just a retreat in the woods, you might examine these six structures—log cabin vacation home kits, ranging in price from about \$6500 for a 224-sq.-ft. model to \$10,500 for one with 480 sq. ft. These prices don't include shipping.

The idea here is that an outdoors vacation involves simplifying things and roughing it a little. For example, the floor plans for three of the models don't show a bathroom, though there's no reason you can't install a toilet, shower stall and sink.

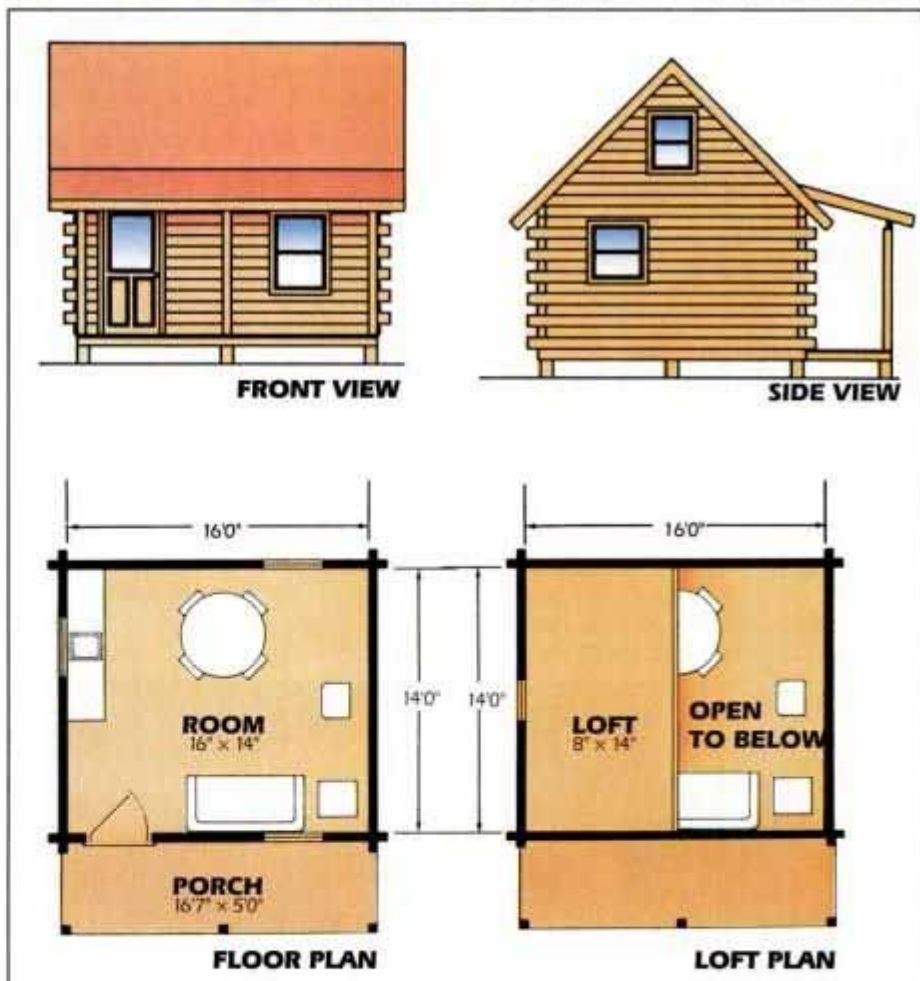
Each cabin is built from pre-cut and numbered Eastern White Pine D-shaped logs that are short enough for one or two people to handle, the company says. The log ends lock with a male/female joint that is protected with a gasket. The logs are butted together, stacked and fastened with 12-in.-long spiral-shank nails. A continuous gasket and caulking seals the joints between the logs.

With an eye toward reducing maintenance, the company has provided the cabins with insulated steel Peachtree doors and high-performance insulated Andersen windows (vinyl-clad outside, wood inside). The sills are pressure-treated 2 x 6s, as are the porch/deck joists. Porch and deck floors are pressure-treated Southern yellow pine.

The overhanging roof edge is protected with an 8-in.-wide galvanized-steel drip edge. Fiberglass shingles with a 25-year warranty are provided, as is 15-pound roof felt. The roof deck and floor are tongue-and-groove-oriented strand board. Conventional framing lumber, spaced 16 in. on center, is used for rafters and joists.

Homeowners provide the foundation or piers, interior partitions and doors, plumbing and electrical work, appliances, and a ladder and handrail for the loft.

The drawing at right shows the Hideaway, the least expensive model. Like all the models, it has a cathedral ceiling (all but one of the models have a loft). Note that the cabin's roof is



The Hideaway is one of six log cabin vacation homes in the Camp and Cabin Series. The smallest (shown here) costs \$6550, and the biggest is priced at \$10,495.

steeply pitched. Five of the six structures have this feature as a means to shed snow.

For more information on the Camp

and Cabin Series of log cabin vacation home kits, contact Northeastern Log Homes, P.O. Box 46R, Kenduskeag, ME 04450; (800) 624-2797. **PH**

TOOL TEST

**Skil
 Cordless
 Circular
 Saw**

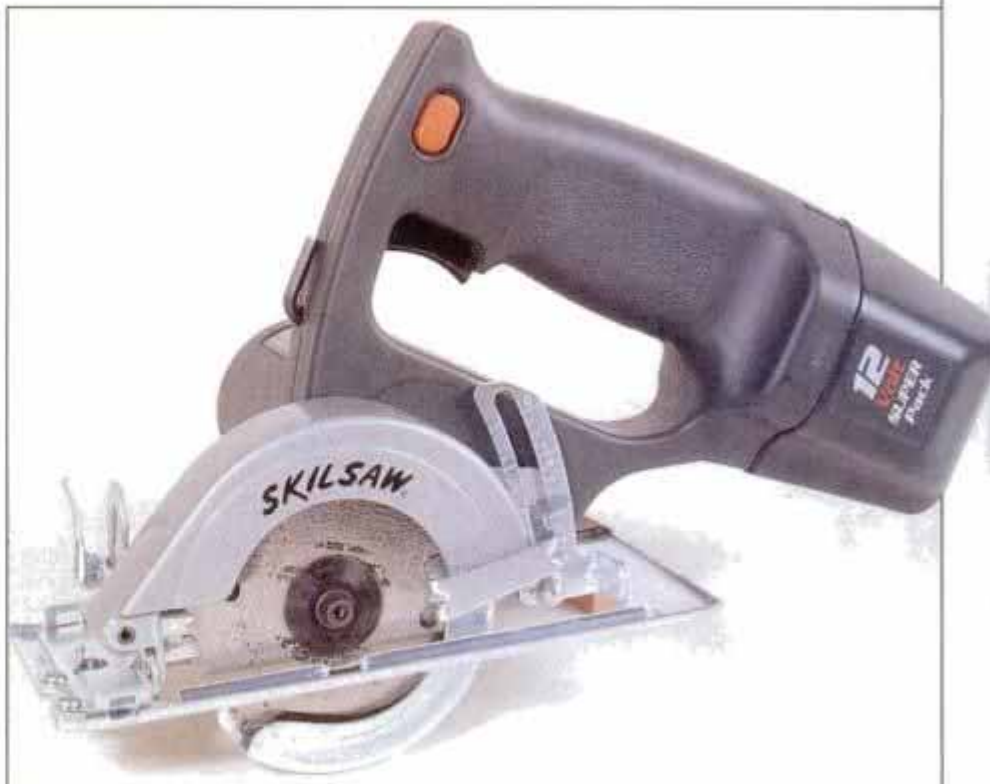
TEXT AND PHOTOS BY
 ROSARIO CAPOTOSTO,
 Contributing Editor

● You may remember when every tool in a typical home workshop was cordless—and quiet, too. Then came power. And it wasn't long before the old tools gathered more dust than they created. Now, the pendulum has swung back—with a hitch. Battery-powered tools combine the convenience and precision of corded tools with the freedom and flexibility of the old hand-powered versions.

We recently tested Skil's model 2977:02 12-volt cordless Skilsaw and found that, in terms of flexibility and convenience, this tool is worth serious consideration. At 4.5 pounds complete with battery, the new Skilsaw is a real lightweight and handles easily at an arm's length or in other awkward situations.

Designed specifically for light carpentry and trimwork, the saw features a smooth-cutting, but aggressive, 3³/₈-in.-dia. steel combination blade that turns at 1000 rpm. The maximum cut at 90° is 1⁵/₁₆ in., so it easily handles nominal 1-in. stock. And, you can adjust the bevel angle 5° beyond the standard 45° setting for out-of-square mitering. At 50°, the tool can handle 1/2-in.-thick work.

Other features include a comfortable handle with a lock-off button that prevents accidental starting. There's



The cordless 12-volt Skilsaw circular saw is designed for light-duty carpentry and trimwork. It has a 3³/₈-in.-dia. blade, and the removable battery recharges in 1 hour.

also a blade lock for easy and safe blade changing, and quick-acting levers lock blade angle and depth of cut. The base is solidly secured and includes an adjustable cutline indicator. Battery recharge time is 1 hour.

We first tried the new cordless Skilsaw on 3/4-in. particleboard. Equipped with a fully charged battery, the saw made fairly smooth cuts through 24 ft. of stock before the battery required recharging.

After a 1-hour recharge, and with the same slightly abused blade, we performed timed cuts through 3/4-in.-thick pine and oak stock. Ripping through 12 in. of the oak took 28 seconds and a 12-in. crosscut took 34 seconds. In pine, the same length rip

and crosscut took 12 and 15 seconds, respectively.

While these are by no means speed records when compared to big corded tools, the figures do indicate what you can expect. When used for the purpose that this saw was designed—making neat and accurate cuts in trim and light plywood paneling—speed of cut isn't a top priority.

The Skil model 2977:02 cordless Skilsaw comes in a kit that includes one battery, a charger, carrying case, combination blade and blade key. The suggested retail price is \$255, but you'll probably find it selling for around \$200. For more information, write to Skil Corp., 4300 W. Peterson Ave., Chicago, IL 60646. **PM**



Pushbutton shaft lock makes blade changing safe and convenient. The saw's base tilts up to 50° for bevel work.



Light plywood and panel cutting are typical chores for this cordless tool. A rip fence accessory is available.



With a maximum cutting depth of 1⁵/₁₆ in. at 90°, the 4.5-pound saw easily handles 3/4-in.-thick particleboard.

SPECIAL SECTION

Boating '94



HERE COME THE JETS

Invasion Of The Jet-
Powered Fun Boats

POWER AT SEA

New Engines Beefed Up
For Saltwater

GREAT GEAR

The Best New Equipment
And Accessories

PLUS

Test Drive Reports On The
Hottest Boats And Motors

Boating
'94

THE JET AGE

An explosion of minijets, advanced EFI systems and saltwater outboards are new for '94.

BY JIM YOUNGS



● It's a bit premature to say that this is the decade of the jet boat, but it's not a wild prediction. Jet boats have exploded onto the scene with a force rarely seen in boating. At last count, there were more than a dozen manufacturers offering minijets for 1994 and the number is increasing daily. But what's interesting about this trend is that it's actually a second coming of the jet age in boating.

The first arrived in the 1960s when high-performance jet dragsters, ski boats and river runners became the hot tickets in Southern California and other parts of the country. However, these boats were semi-custom, high-speed exotics that were never produced in mass numbers. For various reasons, their popularity has been on the wane since the 1970s.

However, there's a big difference between then and now, and that difference is in the engine compartment. Back in the '60s, jet boats used 4-stroke automotive engines that were heavy, bulky and costly. Today, the new jets are powered by 2-stroke motors, built by OMC and Mercury, that are lightweight, compact and affordable.

But as exciting as the minijets are, the coming boating season has several other reasons to consider '94 a banner year. EFI (electronic fuel injection) continues to move into stern-drive and outboard packages, ultrarugged features are being built into a new generation of saltwater outboards and innovative designs—flats boats, V-drive ski boats and party platforms—lead the way in new boat models.

The Jet Set

There's no doubt that the Mercury SportJet 90 deserves the lion's share of credit for igniting the current revolution in jet boats. Appearing in limited quantities last year, the SportJet employs a Force-based 2-stroke 90-hp outboard motor mated to a jet pump in a vertical orientation. Old jetdrives were horizontally configured and occupied a large chunk of on-board space.

The compactness of the SportJet gives designers a great deal of freedom to use the engines in small boats, where they prove to be an ideal match for hulls intended for wet fun, spinouts and shallow-water exploration—à la personal watercraft.



FOUR WINNS FLING

DRIVE REPORT

Regal Rush

● Part of the fun of building a jet boat is coming up with a snappy name. At Regal, an informal contest was won when an employee was overheard saying that the boat "felt like a rush." Truer words were never spoken.

I got my Rush on Lake Conway, in Regal's hometown of Orlando, Florida. That is to say I hopped into the little Regal, which is powered by a Merc SportJet 90, and found that it displayed head-snapping acceleration and a top speed of 42 mph.

I couldn't resist doing high-speed wheel-lock spinouts and



forward-to-reverse stops. Who can? The 14-ft. 6-in.-long and 7-ft. 2-in.-wide boat handled these with aplomb. I was especially impressed by how the 21° V hull cornered like it was on rails.

Equally impressive was the fit and finish, which was the best

I've seen in a minijet. Design notables include ski storage, a wide side console for passenger support and a nonskid sunpad. Overall, the Rush (\$8695) lives up to its Regal name and image, which has come to stand for quality and family fun. —Joe Skorupa



MASTERCRAFT MARISTAR 225 VRC



OMC TURBOJET

This year, OMC followed suit by introducing three versions of a 2-stroke jet package called TurboJet, available in 70-, 90- and 115-hp models. It, too, uses an outboard powerhead fitted to a jet pump in a vertical configuration.

With engine availability no longer a problem, the genie has been let out of the bottle, and an increasing number of boatbuilders are moving to capitalize on last year's successful launch of

the Bayliner Jazz, Sea Ray Rayder and the Boston Whaler Rage, which was the first of the new generation of minijets.

With names taken right out of the hipster's dictionary of slang, the new fleet of jet boats wear names like Blast (Baja), Fling (Four Winns), Rush (Regal) and Sizzler (Sunbird). Obviously, traditional boatbuilders see jet boats as a way of cashing in on the personal watercraft phenomenon and a way to get new blood into the boating ranks.

Regardless of what they're called, the new jet boats are plenty of fun. They're also interesting from a design standpoint. The Regal Rush, powered by a Merc SportJet, is a stylish sports sedan (see Drive Report on page 71), while the Four Winns Fling (\$8800) is built on the company's signature Stable-V hull and is powered by OMC's torquey 115-hp TurboJet.



MERCUISER 454 MAGNUM EFI

More EFI

One big advantage of EFI is the ability to just turn the key and go, much like in a car. No waiting for it to warm up, no fiddling with chokes and no engine dying at inopportune times. Other benefits include better fuel efficiency, cleaner emissions and instantaneous throttle response.

Despite the wealth of positive features, the emergence of EFI on stern-

DRIVE REPORT

Correct Craft Ski Nautique Paragon

• A true showstopper at the recent fall boat shows was Correct Craft's Ski Nautique Paragon, a classic wooden boat with fit and finish like a hand-built exotic automobile.

After climbing behind the wheel and hitting the throttle, I quickly found that the Paragon is not just another pretty face. It accelerates with authority and pulls button-hook turns at top speed. With its 351-cu.-in. V8 in-board, it accelerates to 30 mph in just over 5 seconds and hits top-end speeds in the mid-40s, which is fast enough for barefoot skiing. Overall, the Paragon exhibits the skiable qualities that make Correct Craft a top contender in competitive skiing.

Additionally, the boat has the warmth of real wood, glove-soft leather upholstery and hand-oiled



teak trim. The Honduras mahogany topsides are mounted with stainless screws and bunged with matching wood plugs. For high gloss and protection, the hull is covered with six coats of Spar varnish.

One last point: In addition to being able to effortlessly pull slalom skiers through a buoy course, the Paragon

can rock out with the best of them, thanks to its powerful stereo system complete with two 4-channel amps, multiple speakers and a 10-disc CD changer. Interested boaters should check out the Paragon quickly, since Correct Craft, which is based in Orlando, Florida, will build fewer than 30.

—J. Y.

drive engines has been painfully slow. High production costs have been cited as the culprit by manufacturers. Fortunately, 1994 seems to be the turning point. Several new stern-drive engines and outboards have been added to the EFI picture, and several more are on the horizon.

From a sheer excitement standpoint, the most notable EFI introduction is the MerCruiser 502 Magnum Blackhawk package. The new Blackhawk drive is a high-performance, twin-prop counterrotating surface drive that's designed for blazing single-engine installations. Because it represents a unique combination of complex technologies, the Blackhawk is a PM Design & Engineering Award winner for 1994. (See Drive Report on page 74.)

MerCruiser announced another EFI contender this year in the form of a 454 Magnum EFI inboard engine for cruisers, which is rated at 385 propshaft horsepower. Like the 502 Magnum engine, it's also fitted with the Cross Ram EFI system. The big-block 454 is available in a Tournament Ski inboard package, too.

OMC has a new EFI addition to its stern-drive lineup, the 351 HO model based on the Ford 5.8-liter V8 block. This new package is rated at 270 propshaft horsepower and has multiport EFI controlled by OMC's Spitfire management system.

OMC also has a new drive unit that's coupled to a series of Ford engines ranging from the 3.0-liter 4-cylinder to the 5.8-liter V8. The drive features the slim lower gearcase from



SUZUKI 200 EFI



VOLVO PENTA SX DRIVE



OMC COBRA OUTDRIVE

the King Cobra drive and a cone-clutch transmission, which precludes the need for an intermediate shift cable and a shift-interrupt switch.

In a related introduction, Volvo Penta has come out with a new series

of SX drives that feature its proven cone-clutch transmission and a new, slimmer lower gearcase. These drives, too, are coupled to Ford engines that range from the 3.0-liter 4-banger to the 5.8-liter V8. If the Volvo Penta

DRIVE REPORT

Cobalt 24X And Volvo Penta 820/DPX

● When the dark Canadian clouds moved in, the light drizzle turned to hail, but I was determined to finish my test of the new Cobalt 24X. The speedometer leveled out at 71 miles per hour, and with a stinging face, I headed for the shelter of a warm Toronto-area marina.

It wasn't the easiest test I've conducted, but it was worth the effort. The 23-ft. 10-in.-long and 8-ft.-wide 24X is a limited-edition, high-performance Cobalt that's equipped with Volvo Penta's new powerhouse, the 820/DPX engine—a match made in sport-boat heaven.

As most boaters know, Cobalt quality is second to none, and this is evident in the wood-grain dash, rich upholstery, full instrumentation and



Sony 10-disc cd player mounted on a floating suspension. Combine this with the 820/DPX stern-

drive and you've got 385 horses pushing this thoroughbred to a new level of performance—rocket-like hole shot and the smoothest cornering/handling in its class.

Check out this boat quickly. Cobalt, of Neodesha, Kansas, will build about 20 of the \$61,631 boats, and 10 have already been ordered. —J.S.



STRATOS 1700 FLATS



BAYLINER 1401 CAPRI

and OMC drives sound similar, it's because the companies made an agreement last year to share technology and production facilities.

In addition to the SX drives, Volvo Penta has two new EFI motors, and both are based on Ford blocks—the 5.0-liter and the 5.8-liter—which feature multiport fuel injection. The 5.0 Fi is rated at 215 propshaft horse-

power, while the 5.8 Fi pumps out 255 horsepower. OMC has similar engines.

Saltwater Outboards

Offshore anglers should be happy to learn that engine manufacturers have made saltwater outboards a top priority. The impressive new motors bristle with the latest corrosion protection

and are geared to produce the low-end grunt demanded by offshore skippers. Also, they pump out more electrical current than ever before to power a full boat's worth of navigation and fishing electronics.

Mercury has unveiled a new 3.0 Litre saltwater outboard in both Mercury and Mariner trim. The new engine is rated at 225 horsepower and features a 60° V, one-piece cowl and loop-charged induction. (See Drive Report on page 75.)

The Yamaha entry in this category is the Saltwater Series 225-hp V76X, which features a 76° block with an offset crankshaft and torsional damper for smooth operation. It also has a concave piston design for a boost in power and a Cross Induction Intake. To keep the electrical power charged, the new 225 is fitted with a 3-phase alternator that develops 35 amps at

DRIVE REPORT

MerCruiser 502 EFI Blackhawk

● We, the few brave members of the elite corps of professional boat testers, often find ourselves unwitting dupes as we climb into very fast boats at the hands of others. Imagine the trepidation, then, as we recently went for a spin in an exotic Eliminator 22 Daytona powered by a fire-breathing MerCruiser 502 (415-hp) EFI Blackhawk. On the first run on Lake Perris, in California, the boat easily hit 94 mph. On subsequent runs, it nudged the century mark before this intrepid tester's courage ran out.

It's easy to see why the Blackhawk drive, coupled to MerCruiser's 502-cu.-in. block with Cross Ram EFI, is one of the most exciting performance developments to come along in years. By itself, the surface-piercing Blackhawk reduces drag by a phenomenal 85% to 90%, and its



counterrotating props also cure chine walk and crabbing problems inherent in fast, single-engine boats.

Illustrating this point is the recent record set by an Archer Marine Scarab, driven by Nigel Hook, powered by a 468-cid Chevy/Blackhawk combination. The 26-ft. Scarab achieved 93.17



mph in Offshore Class A, and upped the previous record by 10 mph. This same boat was also the 1993 APBA Western Division Champion. —J.Y.

WOT, 25 amps at 1000 rpm and 20.5 amps at idle. Accompanying the new motor is a new fuel-flow management system, which is unique in the industry and is another 1994 PM Design & Engineering Award winner.

Though technically not tagged a saltwater or offshore motor, the new Suzuki 200 EFI fits nicely into this category. The 164.3-cid 60° V6 powerhead features an industry-leading digital electronic fuel-injection system and Suzuki's MicroLink computerized ignition.

Emerging Trends

The party platform design seems to be a natural metamorphosis of the pontoon boat. It's a very practical design, particularly for those who like to entertain but also like a little performance to cut loose.

Based on last year's success with the 220 Sonesta deck boat, Chaparral will soon introduce a 250 sterndrive Sonesta loaded with the kind of stuff party hosts demand. The 24-ft. 6-in.-long 250 is equipped with such live-aboard amenities as an enclosed head, freshwater supply, galley, cockpit table and bimini top. Fit the big party animal with a camper top and it can double as a floating condo.

One of the most interesting ski boats to come along in years is the MasterCraft MariStar 225 VRC (\$28,993), which is powered by an aft-mounted Indmar LT-1 EFI engine that delivers prop power through a V-drive transmission. Conventional inboard ski boats typically have a center-mounted V8 engine, which has desirable skiing attributes but limits interior room. MasterCraft designed the V-drive model to achieve the same ideal wake and low-spray characteristics but with a big boost in interior roominess.

With the introduction of the 1700 Flats, Stratos continues its move into the saltwater arena with a model aimed at the hottest category in fishing—the flats boat. Flats boats are shallow-water wonders that are sturdy enough to handle rough saltwater and versatile enough to work well in freshwater, too. The 16-ft. 4-in.-long and 6-ft. 10-in.-wide 1700 Flats (\$14,125) has a draft of only 10 in. and a weight of only 995 pounds. Standard features include a circular baitwell, pop-up cleats for a snag-free deck surface, compass, fish boxes, built-in rod lockers and plenty more. It's rated to handle up to 115 hp.

Entry-level boats are the primary beneficiaries of this year's emphasis on minijets and small flats boats. For those looking for a more traditional runabout, Bayliner has a new 1401 Capri (\$5995), which is a closed-deck



CHAPARRAL 250 SONESTA



YAMAHA 225 SALTWATER

sportboat with distinctive styling. The Capri is powered by a 50-hp Force outboard, and measures a shade more than 14 ft. long and slightly less than 6 ft. wide. It weighs only 960 pounds.

As you can see, it's a banner year for the marine industry. As opposed to the expensive flash and dash of previous years, 1994 is taking shape with innovative products aimed at making time on the water easier, more comfortable, safer, more efficient and, perhaps most important, more fun. **PM**

DRIVE REPORT

Mercury 3.0 Litre

● From behind the wheel, it's hard to tell the difference between an old 225-hp outboard and a new one—unless there's something new like EFI to change the mix. Under the cowling, it's a different story but, basically, 225 hp is 225 hp.

And yet when I throttled the new Mercury 3.0 Litre (185 cu. in.) forward, it popped the heavy Robalo 22-ft. walkaround on plane without noticeable effort. It also demonstrated surprising acceleration and a top speed in the low 50s.

For a few years, big Mercury V6 outboards lagged behind the competition, but with the 3.0 Litre (also available in Mariner trim) Merc has moved to the front again. Features include a 60° V design, loop charging and a one-piece bucket cowl. With a nod to the increasingly important saltwater market, 20-in., 25-in. and



30-in. shaft lengths are available.

Merc makes use of the lost-foam casting process in the 3.0 Litre to reduce bolted-on parts, and uses a low-copper aluminum alloy to reduce corrosion. The electronic engine management isn't quite EFI, but it's the next best thing. —J.S.

GREAT GEAR

The best of this year's hot new marine toys.

BY MARK WEINTZ

• Who needs virtual-reality games when real life is so spectacular, especially in boating? Taking real-life toys out for an adventure on the water generally beats anything you can do with high-tech games. For example, you can now buy a satellite-linked navigator—a GPS (Global Positioning System) unit—that tracks five satellites and fits in your shirt pocket. You can pull a suitcase-size boat out of the closet and go to the lake for a day of waterskiing. And you can fish selected bottom structure all over the lake without ever touching the trolling motor, thanks to a new unit that's programmable and robotically controlled.

What else? There are new pieces of equipment and accessories that make boating faster, safer, easier and more fun than ever before. So, as we head into the warmer months of spring, keep in mind there's nothing virtual about boating and let the real-life games begin.



Closet Boater

Forget dry-docks, trailers and other typical boat storage. Just fold the 105-pound Fastroller 380 Zodiac (\$3515) into the size of a suitcase and stash it in your closet. Inflated, the Fastroller 380 is 12 ft. 6 in. long and can accommodate a 25-hp outboard. To make the boat rigid for better performance, it has a unique high-pressure inflatable floor—an industry first. Contact Zodiac of North America, P.O. Box 400, Thompson Creek Rd., Stevensville, MD 21666.

One Belt Fits All

Until now, the only thing to do when an engine belt popped was to get out the toolkit, find a spare belt and dive into the motor compartment. No more. The SeaMaster Emergency Master Belt (\$29.95) is a multilink temporary repair belt that can be snapped quickly into place without tools or cutting. The SeaMaster belt is reusable, and is distributed by Nordic Marine, P.O. Box 611, Crompond, NY 10517.



Robo-Prop

There are fish suspended on a ledge below the surface. Problem is the 12-ft. ledge zigzags all over the lake. To stay on the depth mark, all you have to do is preset the Pinpoint TDP 3700 (\$1599) and it robotically follows the contours of choice. This smart trolling motor—made by Pinpoint, 910 Bern Ct., San Jose, CA 95112—has 50 pounds of thrust in its current freshwater configuration. A saltwater model is planned for '95.



Map In The Box

The Lowrance handheld Global Map Sport (\$699) is about the size of a Star Trek tricorder, yet the waterproof GPS navigator not only performs standard route plotting and tracking, but also displays map screens that geographically show you where you are. With the purchase of a Map-Link Cartridge, over 7000 highly detailed charts are available for display. Contact Lowrance Electronics, 12000 E. Skelly Dr., Tulsa, OK 74128.

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GREAT GEAR

Splash And Flash

WetJet, one of the pioneers of sit-down water bikes, is back with a new line of splashy minijets. Now a part of MasterCraft, the 1994 WetJet line begins with the Duo 200 (\$4595), which is equipped with a torquey 50-hp Brut engine—so it's not necessarily for beginners. Other models include the Duo 300 and the Duo 300 Kraze. A Trio 300 model is planned for next year. Contact WetJet, 869 Binfield Rd., Maryville, TN 37801.



Where's My Line?

When you rig the new Interline rod by Daiwa, you actually put the line inside the rod. The sleek, graphite composite rod has no rod guides, just an entrance channel that leads inside the hollow rod. The innovative design, which is intended for use with downriggers and dippy divers, ensures that the line moves in a perfect arc with no stress points and no way for the line to get tangled. Suggested retail is from \$139.95. Contact Daiwa Corp., 7421 Chapman Ave., Garden Grove, CA 92641.



Ready, Set, Go

All hell breaks loose when a fish hits bait. Amid the chaos, someone reaches for the rod, pulls it out of the holder and gets ready to fight. The new Pole Setter by Rupp (4761 Anchor Ave., Port Salerno, FL 34992) quickens this process by allowing the angler to pump the rod before lifting it. A spring-loaded hinge allows the rod to be pulled backward in place. This feature also alerts anglers that bait has been hit. Price for the new Pole Setter is \$199.95.

Bring 'Em Back Alive

Every fisherman, either those using live bait or those in catch-and-release tournaments, has experienced the belly-up syndrome during warm months. Fish are very sensitive to temperature changes, a problem Crestliner Boats has overcome with its Enviro-System, which chills baitwell water to about 50° F by pumping it through a radiator coil immersed in ice. It's available for \$275 on Crestliner Boats, 609 13th Ave. N.E., Little Falls, MN 56345.



New Highs And Lows For Sterndrives

Outboard owners have been using jack plates to lower the engine for solid prop bite and then raising it up for speedy top end. With Stern Jack (\$1245) by Land & Sea, MerCruiser Alpha Drive owners can now do the same. The unit adds 8 in. of setback while providing 2 in. of vertical travel. Tests indicate the unit adds significantly to top end and provides better control in turns. Contact Land & Sea, P.O. Box 96, North Salem, NH 03073.



Wild Thing, You Move Me

You've never seen an inflatable like the Wild Thing Explorer, which has an egg-shaped see-through hull and bulbous tailfins. Fitted with just a 15-hp outboard, the runabout can zip along at just under 30 mph and turn on a dime. It weighs 93 pounds, and is 11 ft. long and 6 ft. wide when inflated. It's rated to carry up to 1085 pounds. It comes with hand-grips, seat and foot pump for a suggested retail price of \$2699. Contact Wild Thing of North America, 3250 Army St., San Francisco, CA 94110.

CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Keeping A Constant Velocity

I just had my brakes worked on. The Pontiac dealership's mechanic says that one of the rubber covers over an axle joint has gone bad. He wants almost \$500 to fix it. This is on a 1988 Pontiac Lemans that is probably only worth a little more than twice that amount. Help!

The really sick part is that I paid more than \$200 to get these rubber things replaced only a couple of years ago.

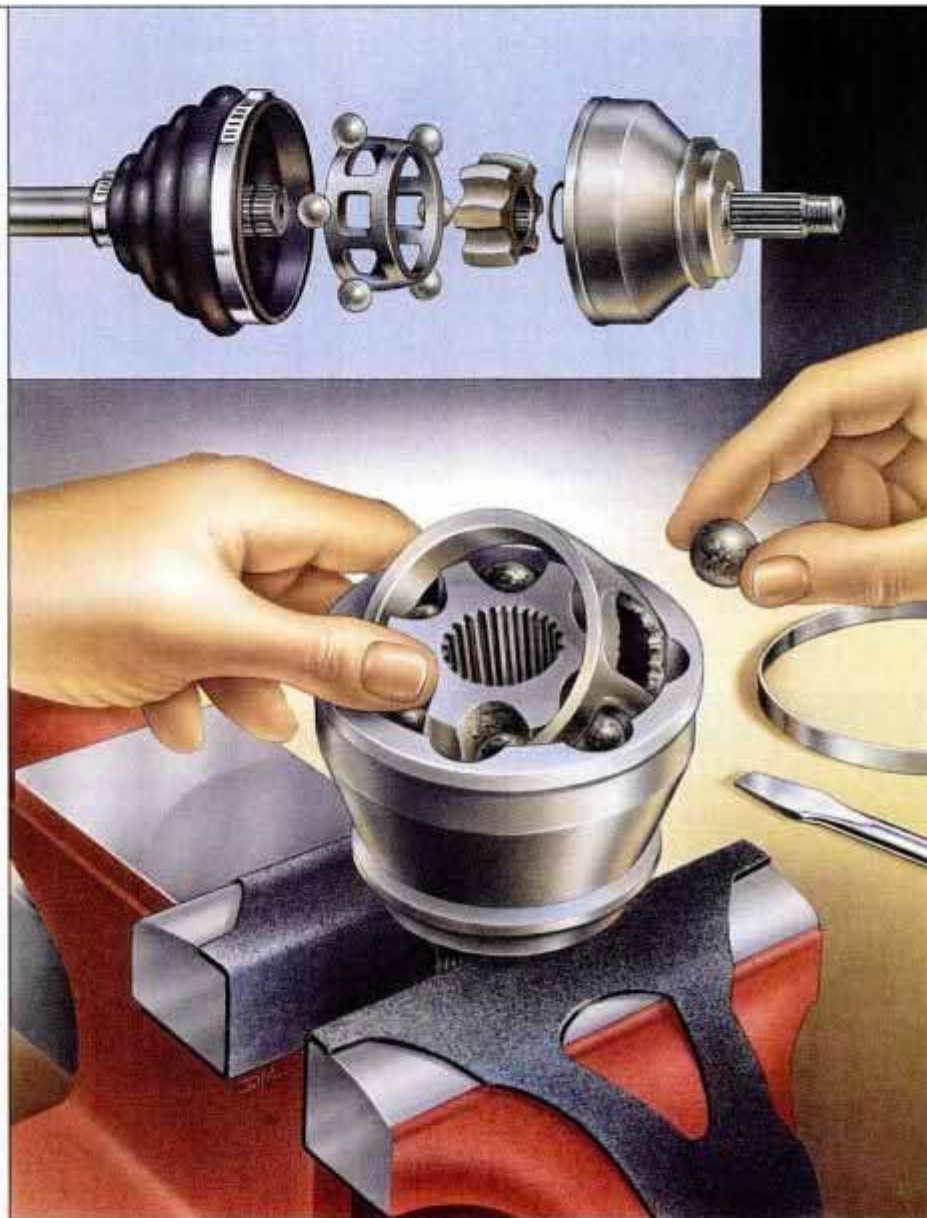
H. ANANE
PRINCETON, NJ

The mechanic, correctly, wants to replace not only the rubber boot, but also the constant-velocity joint inside of it. Judging by the symptoms you give in the unpublished part of your letter (a clicking noise from that corner of your car when negotiating tight corners), the joint has digested enough dirt from the road to be worn out.

CV joints are normally very long-lived items that don't need to be replaced for the life of the vehicle. But they do need occasional repacking with fresh grease. Their normal failure mode is when the rubber boot tears, letting the grease out and the rest of the world in.

Are you sure both axles had the boots replaced? Or perhaps the now-failed boot was damaged by debris from the pavement.

At any rate, it's time to replace the CV joint. The bad news is that Pontiac's prices for this part are enough to take your breath away. I show a list price at the dealership of \$386. That's about four times the price of a comparable part on most other cars. Chalk that up to the Korean-built Lemans, built for General Motors by a firm called Daewoo, which lacks any parts commonality with the rest of the GM product line. And you thought you were buying



an inexpensive, low-cost-of-ownership car, right?

All is not lost. I started checking around for you. Dana Corp. is a large remanufacturer of driveline components. They list a remanufactured axle—with both inner and outer CV joints, prelubricated and with boots installed—for about \$185. Several other companies also list remanufactured axles for this application, but only Dana seemed to actually be able to supply one.

The remanufacturing process involves remachining the grooves in

both the inner and outer housings and cage several thousandths of an inch deeper, and then reassembling with slightly larger ball bearings. It gives you a CV joint that is every bit as good as a new one. Your mechanic should be able to install an axle in less than an hour.

Those of you who care to work on your own cars take note: Do not disassemble CV joints while in the process of cleaning or inspecting them. It's tough to get them clean, I know. If you must remove the balls to inspect them, do so one at a time

CAR CARE

by tilting the cage just far enough to pry one out. If you do actually take the joint completely apart, you'll have a very tough time getting it back together. (Don't ask how I know this. But even my dog blushes when I use some of those words.)

ALLDATA

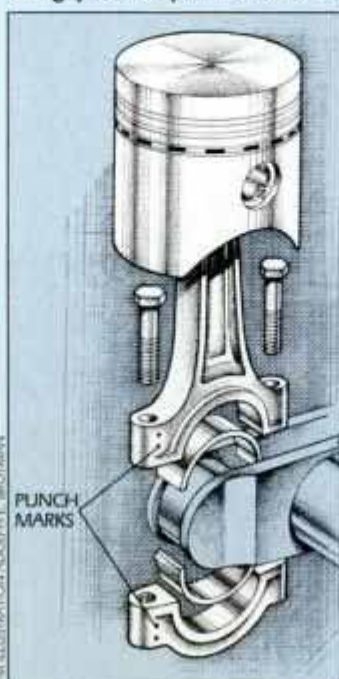
In the November '93 issue I mentioned a firm called ALLDATA, which maintains a database of service and repair information. They sell this information largely to independent repair shops on a CD-ROM database. They also have a dial-in service available by computer modem. I use ALLDATA extensively here to assist in writing this column and the rest of the maintenance and repair pages in PM. The phone number we printed in that column was incorrect, the correct number is (800) 829-8727, Ext. 3052. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

Tattoo, Anyone?

● Well, not a tattoo actually. But it's something just as permanent. I helped a friend re-



assemble an engine last week. Nice fellow, very methodical. He had carefully sorted all of the valvetrain pieces so he could reinstall all parts in their original positions. Ditto for the rods and pistons. This is important, because once a wear pattern has established between two parts, it must be maintained. If you reassemble parts in different positions, wear rates will be high until a new pattern is formed.

Back to my friend. He'd carefully marked all of the bottom-end pieces—with a felt pen. Sigh. Felt pen washes off in the hot tank, or even in the cleaning solvents.

We managed to get all the rod caps on the right rods, and all the main-bearing caps in order. But as to which rod went on which piston, and which hole the assembly went into...

Get a small punch or a numbered stamp and use it on some unstressed area of these components as you disassemble any engine—near the parting line of the rod or on the pin boss inside a piston.

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SATURDAY MECHANIC

SILENCING SQUEAKS AND RATTLES

BY DON CHAIKIN, Contributing Editor

● You slide the new Frank Sinatra *Duets* disc into your car's CD player and smile as you set the volume and balance while Luther Vandross and Frank modernize the lyrics of *The Lady Is A Tramp*. Then you carefully adjust the graphic equalizer to match the tone to your mood and get ready to head for work. As Ol' Blue Eyes and Aretha start tearing into *What Now My Love*, you start moving. But as soon as you hit 30

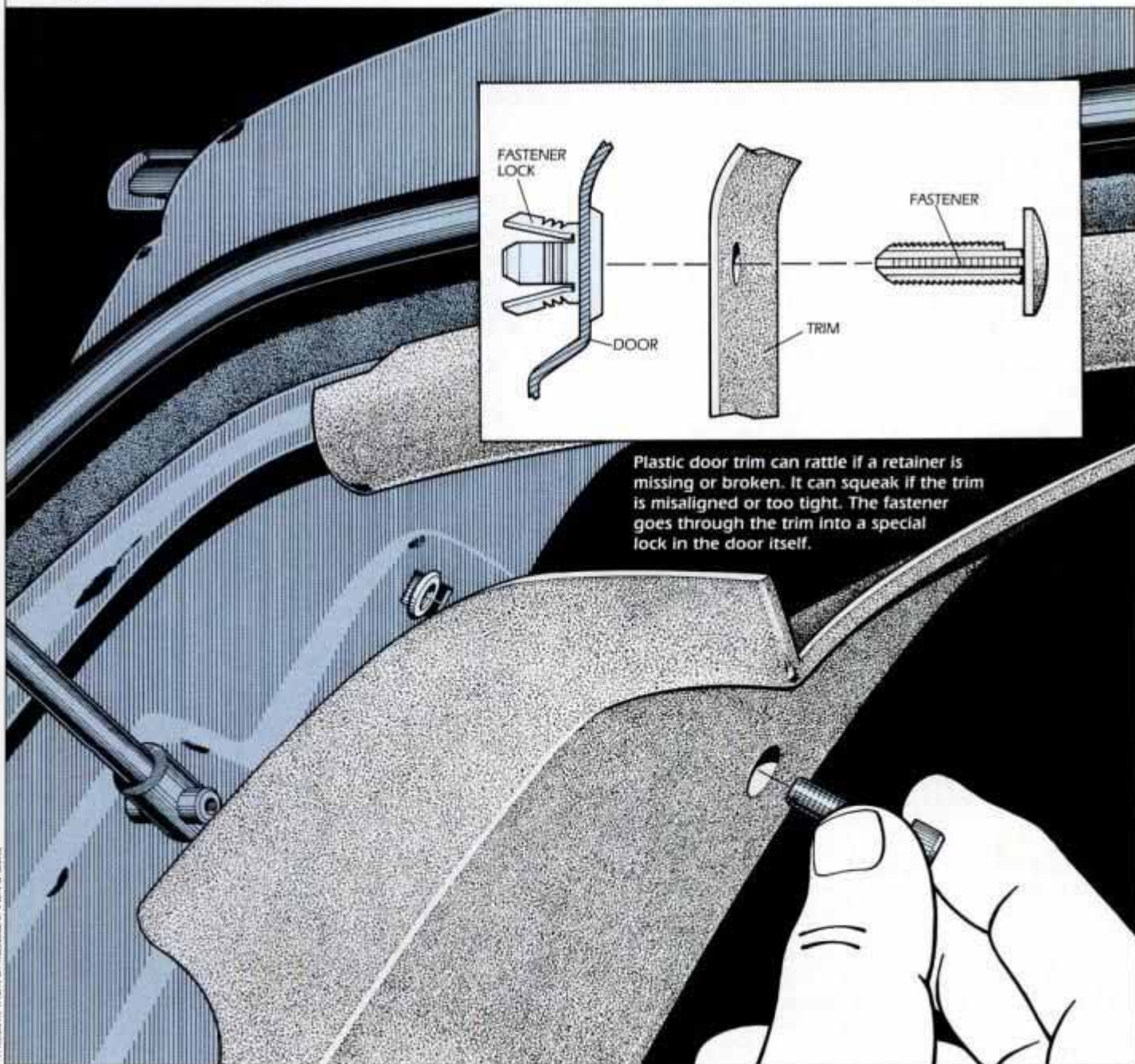
miles per hour, the delicate balance of vocals and instrumentals are shattered by an unremitting creaking and squeaking coming from somewhere inside the car.

Rattle while you roll

Sooner or later in the life of any car or truck, the toll of miles and hard work create a variety of annoying squeaks, rattles and groans. As irritating as these noises can be, however, tracking

down the source and eliminating it can be even more irksome. However, if you work methodically and logically, you will find that with diligence and time, you can return your car's anvil-like solidity and vault-like quiet.

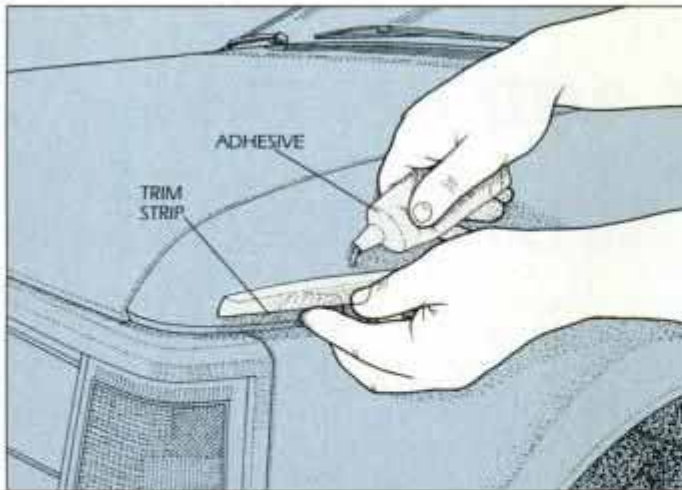
Due to minor inaccuracies or even sloppy mistakes that may occur during manufacture, some cars and trucks can come from the factory with an irritating squeak or hard-to-stop rattle. It's not beyond the ability of a



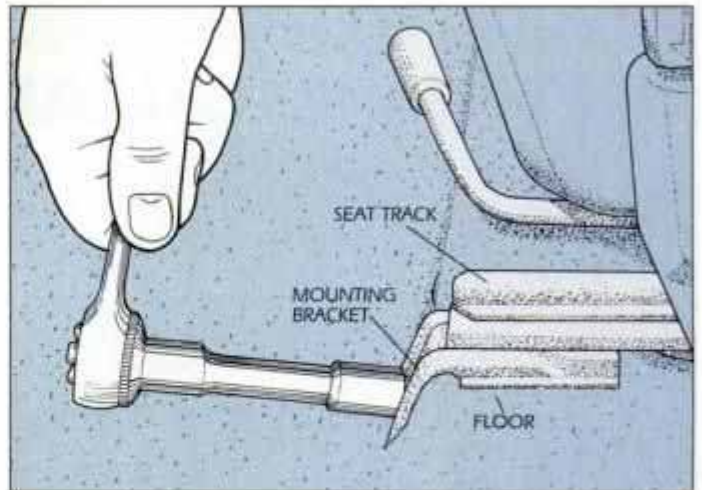
Plastic door trim can rattle if a retainer is missing or broken. It can squeak if the trim is misaligned or too tight. The fastener goes through the trim into a special lock in the door itself.

PH ILLUSTRATION BY BRUSSELL J. VON SAUBERS

CAR CARE



Reattach a loose trim strip using special trim adhesive. Apply the glue sparingly to the back side of the trim only.



Tighten the bolts that hold the seats to the car floor. Also check for slop between the seat track and the mounting bracket.

careful do-it-yourselfer to right what the factory may have done wrong.

Whether your vehicle's squeaks or rattles have developed just recently or have always been a part of your ownership experience, their elimination is the same. And the first step in quieting these unwanted noises is to determine which general area in the vehicle a particular noise is emanating from.

Is the noise from inside the passenger compartment proper? If so, is it from the front or the rear? Is the noise coming from within the structure of the vehicle—possibly a door or the cowl area? Is the sound coming from the cargo area or the trunk? Or is the noise coming from the exterior—somewhere on the sheetmetal itself?

Besides determining the source of the noise, you must also determine its cause. Squeaks are generally caused by pieces rubbing tightly together. Rattles are caused by something bouncing back and forth against another part.

Naturally, you can quickly pinpoint a noise from a specific component if you hear the noise only when that component is working. For example, a tight bearing in the heater fan or blower motor will only squeak or shriek when the blower fan is operating. Most irksome noises tend to prove somewhat more vexing to find, however.

Starting on the outside

If you hear a noise when you're driving with the windows open that you don't hear with the windows closed, there's a good chance the sound is coming from the outside of the car. Don't jump to conclusions, however, the sound can also be coming from inside the door—caused by the window

being down, inside the door.

To help verify that the sound is coming from the outside of the car, try driving past a helper who's standing on the curb listening for the noise.

Rattles that are heard coming from the car's exterior are almost always caused by a loose piece of trim. If your car or truck has side moldings, inspect the entire length of each piece of molding. Modern trim strips are attached to the car by adhesive. If you find that a section of molding has come loose and is flapping back and forth, simply reglue it to the sheetmetal.

On older models where the trim is held by retaining clips, get new clips at an auto-body supply parts store or the dealer's parts department. Remove the stub of the broken clip from the sheetmetal and the retaining tab from the trim strip. Slide the retainer into the trim strip, and then press it into place in the sheetmetal.

Other likely sources of an exterior rattle are the sections of a luggage rack—if your car is equipped with one—body-mounted sideview mirrors, trim bezels around lights, the grille and even license-plate brackets. Walk around the vehicle and gently tug and push on each exterior piece that might conceivably be loose and rattle as you drive.

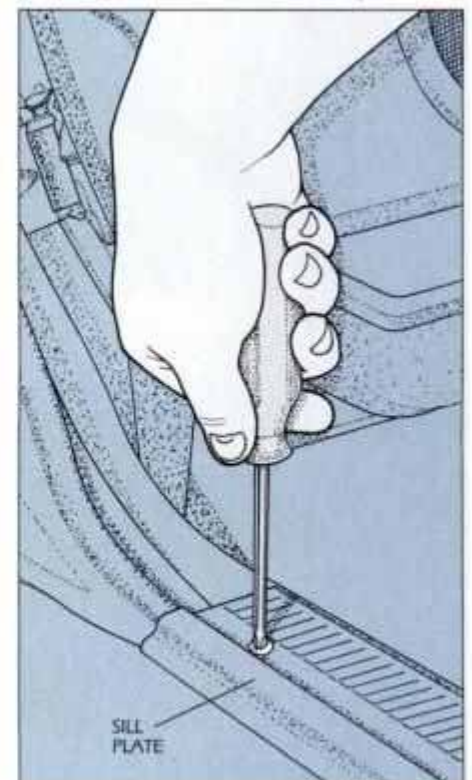
Speed-dependent noises

Some rattles and squeaks simply happen when they do, seemingly with their own frequency and regularity—or lack of it. Other noises, however, are clearly motion dependent. A rattle may increase in frequency as vehicle speed increases, for instance. Or a squeak may happen only when the springs are compressing or rebounding. Noises that occur or vary with

specific circumstances are easier to locate than those that seem to follow no logical pattern.

If there's a rattle that stops when the vehicle is at rest but gets faster as you drive faster, check each wheel. If your vehicle has wheel covers, remove each one to be sure that there is nothing loose inside the wheel cover—possibly a lugnut or even some pebbles or other misplaced debris.

If the wheel covers are empty, inspect the brakes and the bearing hubs. A loose spring, cotter pin or even a small rock that's loose inside a brake drum will rattle around as you drive. A wheel bearing that is



Tighten trim plates at the door sills, making sure any wires underneath are secure.

CAR CARE

beginning to fail will also rattle before it shrieks.

If the noise occurs while cornering hard or while going over bumps, try rocking each corner of the vehicle hard in turn and listening, or raise each corner of the vehicle, place it on safety stands and then try prying up hard on each wheel and tire using a long 2 x 4.

A loose shock-absorber mount or suspension bushing will rattle over bumps. Dry suspension bushings may squeak and creak as you drive—try lubricating a suspect bushing with some aerosol silicone and repeat the test. If the lubrication stops the noise, you've found the squeak.

Though a loose exhaust system

someone is sitting in the seat, check under the seat for something rolling around on the floor. Also check that any wiring clips—such as for the seat-belt sensor—are securely attached to the seat spring or frame.

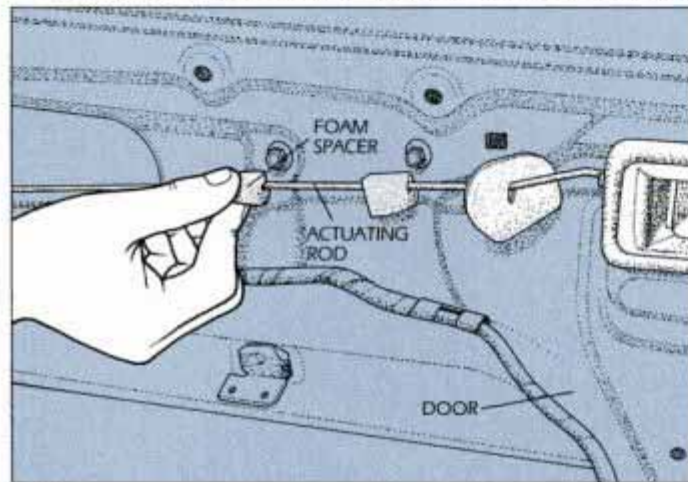
A rattle that sounds like it's coming from the bottom of the door may actually be from a loose door-sill plate or a loose wire retainer beneath the sill plate.

A rattle from a door or the rear parcel shelf may be due to a loose radio speaker or speaker cover grille. Simply tighten it.

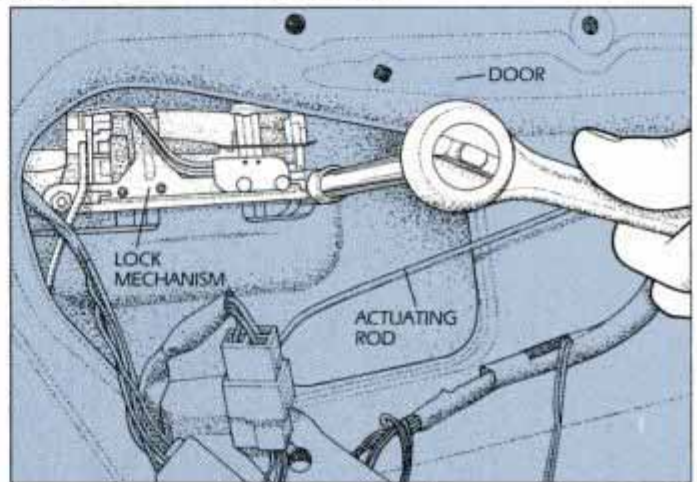
However, despite these easy-to-reach repair problems, it seems that many annoying noises are from within doors and behind the dash.

away any plastic vapor liner to gain access to the inside of the door.

Likely noisemakers inside the door include the door-lock actuating rod, the lock mechanism itself and the window-lift assembly. Use foam spacers to hold the actuating rod in place while allowing it to operate. Check the snugness of the lock- and window-lift assemblies. Tighten—without over-tightening—them. Also check in the bottom of the door for misplaced screws or washers left over from the car's assembly-line days. After you're certain that nothing inside the door is loose, replace the vapor liner and the trim panel. Be sure to securely reattach the trim panel, or it will cause a new rattle.



The door-latch actuating rod may be rattling inside the door. Small foam spacers on the rod keep the rod off the door's metal.



Tighten the door-lock mounting bolts from inside the door. Also check the window-lift mechanism and all wiring connectors.

tends to clunk more than rattle, don't overlook each muffler clamp and hanger. One loose bracket or clamp will rattle around on the otherwise tight exhaust pipe.

An engine-speed-related noise may indicate something loose in the engine compartment. Check that all mounting brackets for major engine-driven accessories and for small things like the throttle cable are all snug.

First-class cabin

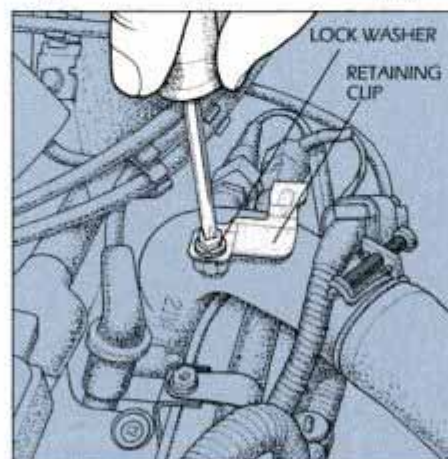
Noises inside the passenger compartment can prove to be more elusive to pinpoint and silence than those from outside. To help establish the source of a squeak or rattle inside the car, sit in each seat while someone else drives the car.

A rattle that seems to come from a seat, usually when the seat is empty, is probably caused by a loose seat mounting. Check the mounting bolts of the seat frame to the floor as well as the seat track to the mounting frame.

If the noise happens even when

Slam a door and listen for rattling or clunking from within the door as you close it. Try this with the window open as well as with it closed.

To quiet a rattle from inside a door, remove the door's inner trim panel—which may also mean removing the window crank arm, the armrest and maybe even a speaker. Carefully peel



Underhood retaining clips and accessory-mounting brackets may loosen and rattle.

Rattles behind the dash may be from loose mounting bolts, loose wire retainer clips or loose actuating rods from the heater controls. Check that the radio and all switches are tightly mounted.

Various and assorted squeaks inside the passenger compartment can be traced to loose or improperly installed plastic trim pieces. Hard plastic on the pillars, console and dash are held in place either by screws or push-through retaining clips. A missing, broken or loose retainer can allow the piece to rattle or squeak. An overly tight retainer can also cause a squeak. Check the gaps around all the trim—try holding a suspect piece of trim as you drive. If direct pressure in one spot stops the noise, try loosening the piece and placing a soft wedge—such as a small piece of foam-backed tape—between the trim pieces.

Don't overlook such obvious noisemakers as the glove compartment and center-console doors and their hinges, the ashtray, rearview mirror and even the sunvisors.

FM

MAINTENANCE BASICS

REPLACING A FUEL FILTER

BY DON CHAIKIN,
Contributing Editor

● One unfortunately placed miniscule piece of dirt can ruin your car's or truck's precision-made computer-controlled electronically timed sequential fuel-injection system forever. However, since the fuel filter on many newer vehicles is mounted away from the engine compartment—maybe even underneath the vehicle—it's often neglected. In fact, too many people just plain forget about it when maintenance time comes. This is a bad idea.

Regardless of where the filter is mounted, replace it every year, or 12,000 miles.

At filter-replacement time, check the entire fuel system for signs of wear and leakage.

● Start by relieving pressure in the fuel system. Fuel-injection systems operate under as much as 50 psi, even when the engine is not running. A shot of pressurized fuel can be dangerous.

● Locate the fuse for the fuel pump in the fuse block. Remove it.

● Use the ignition key to crank the engine several times. This will allow the injectors to spray the fuel into the engine, relieving pressure in the system.

Now locate the fuel filter. If it's not readily apparent in the engine compartment, check the underbody—possibly near the fuel tank, tucked away from harm.

● Place a clean container underneath the filter at the fuel-line connections.

● Use a clean rag to wipe the area around the fuel fittings before undoing them.

Depending on your vehicle and its fuel filter, the fuel lines may be attached in any one of a number of different ways.

● To loosen threaded hexhead fittings, use the correct-size socket, box or flare-nut wrench. Hold the fuel line with your other hand to keep it from turning as you loosen the fitting.

Threaded connectors have sealing washers—one on top of the connector



fitting under the hexhead, the other between the fitting and the filter. Do not damage or lose either one.

Spring-clamp connectors may be removed by squeezing the spring's tabs with a pair of pliers while sliding the clamp along the fuel line away from the fuel filter. Twist and tug on the fuel line to remove it from the filter.

Worm-drive clamp connectors are undone with a small screwdriver. Then remove the fuel line by twisting and tugging.

● Inspect the fuel line ends for hardening, cracking, swelling or other signs of damage. Replace suspicious fuel lines.

● Undo the filter's mounting clamp or

bolt, and remove the filter. Allow the gasoline to drain into the container.

● Install the new filter, noting the fuel-flow direction—from the fuel tank to the engine. The inlet and outlet will be labeled, or there will be an arrow showing the direction of flow.

● Reattach the fuel lines, taking care that any sealing washers are in place, and tighten the hexnut or clamps.

● Reinstall the fuel pump's fuse and crank the engine several times to repressurize the system.

● Start the engine and check the entire fuel system—from tank to filter to injectors and back to the tank—for leaks. If there are any, stop the engine and repair the leak.

PM

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Brave New World

BY GREGORY T. POPE, Contributing Editor

● When the news broke in a *New York Times* article last October, reality seemed to edge a little closer to science fiction's colder face. Two scientists announced that they had cloned human embryos. The report conjured up a question that has lurked for decades beneath the surface of medical research.

To what degree do we have the right to meddle with motherhood and rewrite the laws of human conception and childbirth? The issue tugs at the same emotions that flare in debates

over abortion and gene-splicing. Where will it all lead? "Down a tunnel of madness," according to the Vatican newspaper. "The dawn of the age of eugenics," is how biotechnology critic Jeremy Rifkin characterized the research. The announcement also spawned articles that painted scenarios such as twins born years apart, a team of quintuplet Michael Jordans and live embryos kept on ice in case a sibling needs bone marrow or a kidney.

But as the headlines fade, the facts—if viewed with clinical neutrali-



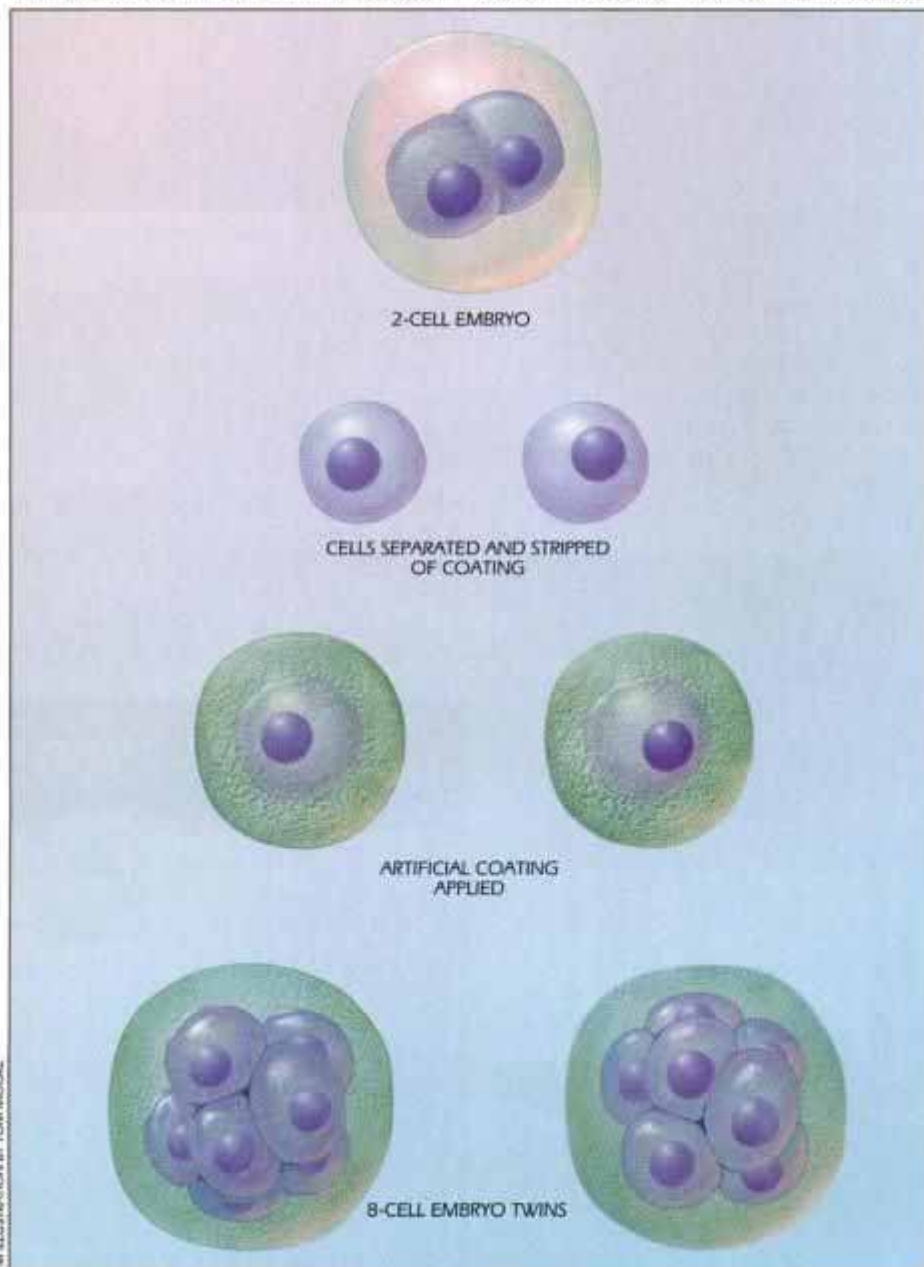
Egg cell bears clinging cells that can interfere with in-vitro fertilization.

ty—reveal how quickly and quietly a technology has evolved over the past 15 years. The brave new technology isn't genetic engineering, the way cloning is done in *Jurassic Park*, for example. Rather, it's in-vitro fertilization, or artificial conception, which has come a long way since Louise Joy Brown became the first test-tube baby in 1978.

Unlike, say, cancer treatment, in-vitro fertilization has matured without the financial incubation supplied by the National Institutes of Health. Instead, the research has been nurtured largely on grants from the pharmaceutical industry and fees from infertile couples who can afford the expensive procedure.

Despite impressive progress, however, in-vitro fertilization remains an infant technology. It still doesn't boast a fecund success rate. Up to 40% of all infertility cases, for example, stem from weak sperm cells that can't reach their target. Specialists have mustered an array of microtechnologies to try to help the sluggards along. These include lasers and minute needles to create pathways by which the sperm can wriggle through the egg cell's protective coating, and even direct microinjection of a single sperm into an egg. Such procedures, however, risk damage to chromosomes and the potential of fertilizing an egg with an abnormal sperm.

What's more, even if an in-vitro fertilization works in a test tube, the chances that it will then bear fruit in a successful pregnancy are only about 20%. Obstetricians have learned that the best way to beat these odds is to stack the deck, by fertilizing and implanting several embryos simultaneously. Typically, doctors have achieved this by giving the mother hormones that cause her to superovulate, or produce more than one



PH ILLUSTRATION BY TOM MOORE

Artificial coating to protect separated cells was breakthrough in human embryo cloning.

egg at a time. But hormone treatments harbor their own risks, including possible links to chromosomal damage and ovarian cancer.

All these drawbacks are what prompted the cloning experiment, performed by Jerry Hall and Robert Stillman of George Washington University's In-Vitro Fertilization and Andrology Laboratory. Their reasoning: Why tinker with cellular microsurgery, or drug a woman's body into producing too many eggs? Why not instead take a successfully fertilized egg cell and replicate it? The procedure, in theory, should supply multiple viable embryos with a reduced health risk to the mother.

Although agricultural researchers have cloned and implanted livestock embryos for a decade, their methods are not suitable for human embryos. The technique involves plucking a cell from an animal embryo and injecting it into an unfertilized egg cell that has had its own genetic material removed. But this method assumes the ready availability of spare egg cells. That's not the case with humans.

Instead, Hall and Stillman began with a fertilized egg cell and allowed it to divide into a multicellular embryo. They then dissolved away the embryo's coating and used micropipettes

to separate the uncoated cells. Then followed the key step. The researchers swaddled the cells with a synthetic coating concocted from algae. The cells subsequently divided again, developing into twin embryos.

Hall and Stillman worked with 17 original embryos, ranging from two to eight cells each, and found that the best results came from 2-cell embryos, which matured to the 32-cell stage. At that point, theoretically, they could be implanted.

But they weren't implanted. In fact, the embryos that the researchers duplicated were doomed from the outset. Having been fertilized by several sperm, they housed too many chromosome sets and wouldn't have survived in the womb.

The very inviability of the embryos is what swayed George Washington University's ethics review board to approve the experiments. But the same inviability also prevented Hall and Stillman from discovering whether the embryos would have hatched from the artificial coating and progressed further.

The researchers themselves say they have no plans to take that next critical step. Instead, they say they'll hold off until the American Fertility Society issues new guidelines that

cover the cloning of humans.

Expected this month, these guidelines—followed by institutions when granting their researchers permission for experimentation—would constitute the only set of regulations governing this area. Congress did establish a biomedical-ethics commission in the 1980s. But since that panel expired four years ago, lawmakers have remained leery of stirring up voters' emotions and haven't renewed the commission. By contrast, Japan, Britain and Germany either ban or tightly control experimentation on human embryos.

The Hall-Stillman experiments are likely to kindle a healthy ethical debate, even scientific backlash, for some time. "There are techniques that could improve markedly what we're doing. The trouble is, nobody wants to be the groundbreaker," notes Kaylen Silverberg, director of the in-vitro fertilization program at the University of Texas at San Antonio. At the same time, in-vitro fertilization is a lucrative procedure, and obstetricians estimate that one of every 10 American couples suffers from infertility. While mass-produced carbon-copy babies remain figments of fiction, there may be a brave new future for clones. **PM**

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PRESENT

THE NATIONAL AUTO QUIZ

1. This current production super sports car is the:



A) Ferrari 512 TR. B) Lamborghini Diablo. C) Lotus Esprit S4. D) Porsche 928 GTS.

2. The famous Chevrolet bowtie logo had its origins in:

A) An original drawing by Louis Chevrolet. B) A hotel room wallpaper pattern. C) A creation of the GM design studio. D) None of the above.

3. When did Cadillac ever outsell Chevrolet?

A) Never. B) 1909. C) 1943. D) 1959.

4. Piston damage is most likely to be caused by:

A) Abnormal combustion. B) Valves hitting the piston head. C) Lugging the engine. D) Continuous high engine RPM.

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224 W. 57th St.
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5. Engines powered by which of the following qualify as "zero emissions vehicles?"

A) Compressed natural gas. B) Propane. C) Electricity
D) All of the above.

6. What make automobile does Lt. Columbo drive in the popular TV series that bears his name?

A) Volvo. B) Ford. C) Renault. D) Peugeot.

7. What is the current quarter-mile drag strip speed record for a piston-driven engine?

A) 203 MPH. B) 286 MPH. C) 307 MPH. D) 349 MPH

8. What overseas car manufacturer was the first to build an assembly plant on U.S. soil?

A) Volkswagen. B) British-Leyland. C) Honda. D) Renault.

9. The first domestic subcompact with front-wheel-drive was the:

A) Chevy Citation. B) Plymouth Horizon/Dodge Omni.
C) Chevy Corvair. D) Cord.

10. Engine bearings (crankshaft and camshaft bearings) are also called:

A) Antifriction bearings. B) Needle bearings. C) Roller bearings. D) Sleeve bearings.

ANSWERS
1. B 2. B 3. C (502 to 56) 4. A 5. C 6. D 7. C
8. A 9. B 10. D



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New Cars



PHOTOS BY JIM DUNNE

Ford's Windstar Van

● Ford will make the most direct challenge to Chrysler's domination of the minivan market later this year when its Windstar model goes into dealer showrooms.

Windstar offers a completely new body style on a 120.7-in. wheelbase. However, its sleek body shape and flush window mountings place Windstar with the vanguard of future van designs.

To shoppers, Ford will emphasize the relatively quiet interior, fully fashioned passenger cabin and seating comfort. Passengers in the front and rear seats can converse without bellowing.

Right from the program startup, Windstar designers stressed a strong, rigid body set atop a road-controlling chassis. A test drive confirms their success. At highway speed, Windstar's tire slap disappears somewhere in the suspension without triggering body vibration.

For reliability, the 3.8-liter V6 engine and 4-speed electronically controlled automatic transmission found in the Ford Taurus will be the initial powertrain offering. Within the first year of production, Ford will of-

fer a 3.0-liter V6 as standard equipment, and make the 3.8-liter drivetrain an option. You can expect a real-world fuel-economy increase for the 3.0-liter engine over the projected 17 city/22.5 highway mpg of the 3.8-liter.

Zero-to-60-mph times for the 3.8-liter V6 are in the 11-to-12-second range—on a par with today's leading minivans. Trailer-towing limits are surprisingly high for this front-drive vehicle. Ford gives the standard Windstar a 2000-pound towing rating. With the optional towing package, the trailing weight goes up to 3500 pounds.

The Windstar has 4-wheel antilock brakes, gas-filled shock absorbers, 4-wheel coil springs and a twist-beam rear axle.

On the road, the assets of the Windstar's wide track and long wheelbase are a level ride with little lean in curves. For better handling and ride, the 15-in. wheels are set out to the

limits of the body corners.

Ford researchers found that minivan customers want: space, space and more space. Van owners expect to use the vehicles for family trips where passengers need stretch-out room and the cargo space behind the rear seat must be able to carry bulky loads. One notable result: Interior surfaces have a "shrink wrap" form that follows the bulges of door locks, heater vents and the wiring paths.

Sit behind the wheel of the Windstar and you know right away you're in something new. A wide, sweeping shelf extends from front door to front door. Gauges are centered for viewing through the steering wheel.

Radio and heater controls are almost too close to the driver's right hand. But window controls, locking systems and mirror adjuster are in lefthand locations that fall right at the driver's fingertips.

Inside, three rows of seats will handle seven passengers in comfort. The third seat will actually comfortably seat three adults and can be moved 7 in. fore and aft to vary the amount of legroom or stowage space. Both rear seats have adjustable backrests to provide a just-right comfort angle.

Safety was an important consideration throughout the minivan's development. Ford claims that the new vehicle meets all the same safety regulations that are required for passenger cars, including side-impact



Longer, wider, roomier and far more sophisticated than before, new Sonata is truly new.

protection, and front-end and rear-end crush acceptance.

Windstar options also include two child seats—the kind that fold out from the standard second-row seat.

Two versions will be built—the GL and LX. Prices, not available yet, should range all the way from an average out-the-door ticket at the \$18,000 level to more than \$20,000 for a fully equipped LX. —*Jim Dunne*

1995 Hyundai Sonata

One of the best values—indeed, one of the best 1995 cars overall—may turn out to be a Hyundai. Hyundai? Yes, Hyundai. The Hyundai Sonata. And after driving the car on its native soil in Korea, we came away impressed.

The new '95 Sonata is all new and should not be confused with the car that has been on sale during the past few months in Hyundai showrooms, nor with any other Hyundai ever built. Company executives are well aware of the quality shortcomings in some of their previous models and have been working diligently to correct the errors of their previous ways. The cars we inspected in Korea were a far cry from the Excels of 1985 in fit, finish and every other way. So forget everything you knew about Hyundais and check out the newest Sonata.

The '95 Sonata goes on sale in February 1994 and, in every way, it'll be head to head with tough competitors the Honda Accord, Toyota Camry, Ford Taurus, the coming Ford Contour, Nissan Altima and Pontiac Grand Am. It's a worthy entrant.

The new Sonata is bigger, wider and sits on a longer wheelbase than the car it replaces. This all translates into much more interior room. The new car already meets the 1997 federal side-impact regulations, and dual airbags are standard.

Under the hood, you can find an optional 3.0-liter V6 that's been carried over from the previous car, but with such refinements as roller-tipped rocker arms and needle bearings. There's also a new electronically controlled 4-speed automatic transmission with lockup converter. We can attest to the fact that this drivetrain moves the Sonata along at a very brisk clip. Zero-to-60 times were consistently under 10 seconds in our informal testing. For those buyers more inclined toward fuel mileage than performance, standard equipment lists a dual-overhead cam, dual-balance shaft 2.0-liter Four that is no slouch.

Among other optional equipment is a unique 4-channel antilock brake system that monitors and modulates each wheel individually. Most other systems have the rear wheels modulated

as one. The air-conditioning system uses R134a refrigerant, and all plastic parts are marked for recycling.

Hyundai is marketing the Sonata as a car with the comfort, roominess and functionality of a family sedan but

with the spirited performance of a sport sedan, all at a family-friendly price. Only a zillion other car companies have tried that formula before. Hyundai is one of the few to pull it off successfully. —*Joe Oldham*

Corvette-Based Super Car



With an estimated quarter-mile time of about 12 seconds and a top speed of more than 190 mph, the Marocco II should rank as one of the—if not the—fastest cars in the world. Based on a Corvette chassis, the Marocco II has a modified 5.7-liter V8 complete with a massive Paxton supercharger, which produces 400-plus hp. The distinctive bodywork clearly sets the Marocco II apart from any other Corvette derivative. The \$125,000 price sets it apart from other limited-production super cars.



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Detroit Spy Report

BY JIM DUNNE, Detroit Editor



Van Champ, 1996

With the coming of the new Ford front-wheel-drive Windstar minivan or not, Chrysler is still the undisputed sales leader in the minivan field, with sales totaling 50% of the market. And it intends to keep that position in the face of any and all newcomers. To help, Chrysler is planning an all newly styled van for 1996, a prototype of which is shown here. The windshield shows more angle than before, and there is more glass area overall. As for details, notice the different door handles and the absence of a visible slide bar for the rear door. The heavy disguise on this prototype includes the full-length cap at the rear and the glass frames from the front door rearward. You'll also note that the grille design is far from anything Chrysler has planned for 1996.

Is That An Import Car?

Just exactly what defines a car as an import or domestic model continues to be an elusive matter. Honda is the biggest exporter of American-built cars. Toyota builds more Camrys in the United States than anywhere else. Nissan and Mazda sell Ford-built vehicles. And now Mitsubishi plans to use Chrysler engines in its Eclipse sporty model. More than 90% of '95 model Eclipses will be powered by Chrysler's new 2.0-liter 145-hp 4-cylinder. It certainly seems that the term "import" refers only to the carmaker's home office address rather than where the car is built.

1995 Chevrolet Monte Carlo

This marks the return of the Chevy Monte Carlo, which gets thrown against Ford's Thunderbird later this year. Essentially, the Monte Carlo is



Chevrolet's Monte Carlo personal sporty coupe.

a 2-door Lumina with its own model name and unique appearance to support its challenge of the Ford sporty coupe. This undisguised prototype shows the base version of the Monte Carlo, identifiable by the chrome surround of the grille's air intake. The overall styling leans more to the mainline than to the radical, in keeping with the Lumina's and Monte Carlo's major market. However, look for a naturally aspirated 200-hp V6 engine to pull the Monte Carlo around.

'95 Chevy Astro/GMC Safari

GM is planning a major facelift for the Chevrolet Astro and GMC Safari rear-drive minivan twins for 1995. Though the changes—especially to the front end—may

appear minor, they are more drastic than first meets the eye. The fenders, hood, bumper, fascia, grille and turn signals all get replaced. The final look is going to be more rounded, similar to the styling trends worn by the vans' competitors. On the inside, look for airbags and new instrument panels. However, there are no planned changes to the front-seat passenger room and comfort.

Cobra Pace Car

Ford's Mustang Cobra is this year's Indianapolis 500 pace car. Track officials say that Mustang was selected as this year's pacer because, "it seemed like a natural selection." There is no testing of the car in the selection process. In fact, when the Cobra selection was announced, no Mustang Cobras had actually been built yet. Ford must now provide the track with three pace cars. They will build an additional 1000 "Cobra Pace Car" models to sell to the public.

Just Won't Quit

Cadillac is still pushing for an "entry-level" small car to compete with the BMW 3-series, Mercedes-Benz C-Class and the wide assortment of Japanese near-luxury models. "I'm never going to give up on this," says Cadillac General Manager John Grettenberger. "We're closer now than ever." He is awaiting the green light for the project from GM management. GM's hold-down on spending is the last obstacle ahead of this smaller "but it won't be inexpensive" Cadillac.

(Please turn to page 96)



New nose identifies the '95 GMC Safari.

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1995 GMC Jimmy

GMC's version of the small sport/utility vehicle holds few surprises. In lockstep with Chevy's changes to the S-Blazer, the new Jimmy adopts the S-Series pickup-truck cab styling up front. At the rear, sheetmetal and glass surfaces are smoother, more rounded to make the vehicle appear larger. The standard engine will be GM's 200-hp version of the seemingly ubiquitous and trustworthy 4.3-liter V6. As far as safety features, a driver's-side airbag is planned.

Getting Younger All The Time

One reason Cadillac wants a smaller car is to appeal to more youthful buyers. In fact, with every new car Cadillac introduces, its average buyer gets younger. From a high of 55 to 75 years old for Fleetwood buyers, the average age drops all the way down to 52 years for the Seville STS buyer. Younger buyers mean repeat customers for years to come.

1995 Ford Contour

Ford's venerable Tempo finally gets replaced later this year. The new car, the Ford Contour, is a compact sedan based on Ford's European Mondeo, with a few changes. One obvious difference lies in the car's front. The nose on the Contour follows the American Ford theme with an oval grille opening with a centered, blue Ford logo. Two engines will be offered, a 2.0-liter Four and a 2.5-liter 60° V6. The Contour's vital dimensions are larger than Tempo's. The Contour sits on a 106.5-in. wheelbase and has an overall length of 183.4 in. Fuel economy, depending on drivetrain, ranges between 29 and 34 mpg.

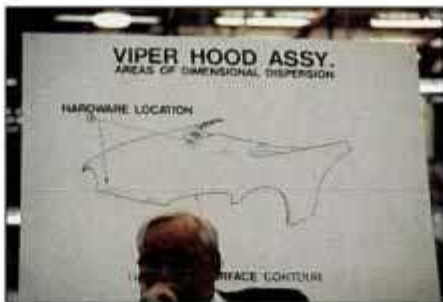
Hooded Viper

While you may not have noticed, Chrysler has. There are fewer Dodge Vipers on the road than Chrysler had originally planned. One reason for the low sales volume is quality, especially the fit and finish of the Viper's plastic



GMC's '95 Jimmy adopts S-Series pickup-truck cab styling up front.

hood. The large curvaceous hood is Chrysler's largest piece of plastic, and it's a tough part to mold with precision. Viper assemblers found that the location points in the hood did not align with the headlight surrounds.



Viper team attacks the car's ill-fitting hood.

When they bolted the hood in place, large gaps showed up in the headlight area. Chrysler has changed its supplier for the hood and hopes to get more of these domestic exotics on the road.

Pricey Wheels

While it's not something many people ponder, steering wheels can be costly. Chrysler broke down the costs of steering wheels between basic and luxury versions to see where savings might be made. The carmaker's prices for one wheel range from \$14.50 to \$60.75. That's cost, not the final price. A breakdown tells why you pay more. A painted wheel rim costs \$1. Wrap that with leather over a foam pad and the price skyrockets to \$25.75. A painted backshroud costs \$1.50. If you enclose it in leather, the

cost is \$10. A welded steel arm runs about \$5.50, while aluminum or magnesium can be as high as \$8. Next time you wonder about the higher prices of luxury cars, take a careful look at the details.

Tall And Lean

Have you noticed how the styling trend on many new cars features a high trunklid and narrow fenders? You know that it's for more than appearance alone. It is for improved aerodynamics. This design allows air to flow smoothly over the rear of the car, reducing both turbulence and backdraft. At highway speeds, the better aero means improved fuel economy. A prime example of this look is the Olds Aurora. Its rear styling helps the car slip through the wind tunnel with a Cd of 0.31—one of the best of any production car, no matter its size.

Lighting The Way

Think headlights are an inconsequential design and engineering concern for the carmakers? Well, think again. The GM design team, charged with bringing the Chevrolet S-Series and GMC Sonoma pickups to market, headed back to the computer and changed the headlights and the whole front end's styling after customers at clinics turned their collective thumbs down at the original look. The designers had developed flush-mounted composite headlamps for the small pickups. The look was right for the sleek styling of the trucks. But the folks who pay good cash for pickup trucks pointed out that pickup headlights get broken—often. At \$100 or so a pop, the pretty composite units are just too costly for a small-pickup owner to keep replacing.



Grille opening differentiates Contour from European versions.

Sounds Of Silence

BY REBECCA DAY

● When John Koss Sr. threw in a pair of headphones to try to push the company's Model 390 portable phonograph back in 1958, he had no idea that his marketing decoy would far outlive the product it was designed to push. Thirty-five years later, it's the headphone market that does a robust \$100-million-a-year business, cruising on the coattails of success stories like the Walkman, while the turntable has faded into the Jurassic Age of consumer electronics.

Now, the headphone is venturing into new territories—in ear, out of ear, electrostatic, wireless. There are probably more types than you know what to do with. The latest headphones have a double agenda. More than simply transforming an electrical signal into an audio waveform for personal listening, the headphone is taking on the outside world as well. Next on the retail shelf: active noise-cancellation headphones.

While the term might conjure up images of earplugs or cotton (generally considered passive noise cancellation), active noise-cancellation technology is an aural phenomenon used to cancel out low-frequency noise in the 30- to 1500-Hz bandwidth.

Sounds falling into that range include jet engines, which makes the headphones ideal for plane trips (except on takeoff and landing, in accordance with new airline regulations), vacuum cleaners, jack hammers, boat motors, leaf blowers and so on.

Noise-cancellation technology has two things going for it. First, it reduces annoying noise, which is reason in and of itself to don a set. Second, by reducing loud noise, it lets you listen to a personal stereo at reasonable and safe listening levels. Walk down a busy city street with your Walkman turned to an audible volume level. Don't change a thing and then take another listen in a quiet room, and you'll hear the abuse your ears can suffer from personal stereos.

Noise-cancellation technology uses "anti-noise" to cancel unwanted fre-



quencies. Anti-noise is a noise wave that's the mirror image of the noise wave being targeted for reduction.

Tiny microphones inside the headphones pick up surrounding noise and then transmit information about the noise to microprocessor circuitry located in the accompanying control case. Upon receiving the information, the microprocessor runs a series of algorithms to predict what the noise waveform will look like a millisecond before it reaches the phone. It then

introduces a signal that's 180° out of phase with the noise. These mirror-image signals are known as anti-waves, which are then relayed back to the headphones. When the waves and anti-waves meet, they counteract each other, thus reducing certain low-frequency noises.

Hitting the range

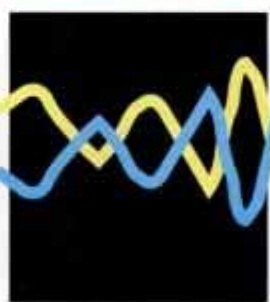
The process has different effects on different noises. If most of a particular noise's harmonics reside in the 30- to 1500-Hz range, the noise reduction will be greater. Other noises' harmonics fall outside of that range, so some noise will remain audible to users wearing the headphones. According to manufacturer Noise Cancellation Technologies, for example, aircraft cabin noise can be reduced up to 95% when you wear noise-cancellation headphones. Car noise is reduced by as much as 80%, trains and subways up to 70%. Lawnmowers are up to 60% quieter, and vacuum cleaners are as much as 40% quieter.

Because only the 30- to 1500-Hz range is affected (Koss says the range for its Quiet Zone system ranges from 30 to 1400 Hz), noise-cancellation headphones allow you to hear all the sounds above that range. Whereas earplugs block out all sounds, noise-cancellation systems let you hear sirens, telephone rings, conversation,

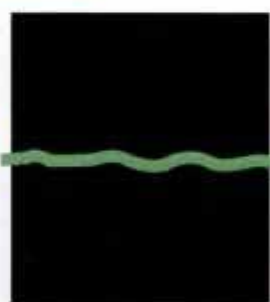
How Active Audio Works



A processor sends the image of an unwanted sound through a loudspeaker.



The two sound waves, mirror images of each other, collide and cancel each other instantly.



The result: Unwanted outside noise is reduced or eliminated, making the music more enjoyable.

PH ILLUSTRATIONS BY KURT HOVAK



In your ear: RDL Acoustics' Etymotic Canal Phones reduce low-frequency noise.

crying and, of course, music.

The concept isn't new. The military and airport ground personnel have been using noise-cancellation headphones for years but at a cost far beyond most consumers' means.

Pilots first

Sennheiser, Telex and Bose, for example, have been selling noise-cancellation products to pilots. In the past year, several noise-cancellation systems have been launched for consumer use.

This month, Koss Corp. will begin selling a set priced at \$299 that uses Koss headphones and noise-control circuitry developed by a Phoenix-based company called Active Noise and Vibration Technologies (ANVT). ANVT designs electronic noise-cancellation products for industrial use including aeronautics, mufflers and appliances, such as dishwashers and refrigerators. ANVT's NQ-100 system comes in at a much lower \$189.95, and is available via mail order and through catalogs. Michael Koss, president of Koss Corp., says the street price of the Koss system will fall around \$225. In addition, Stamford, Connecticut-based Noise Cancellation Technologies (NCT) recently began selling its own noise-cancellation system via direct mail for \$149.

Both systems (the Koss and ANVT products are identical except for logo) operate on the same principle, which means both have two parts—the headphones and the accompanying controller that houses the electronics. Used for noise cancellation only, the gear is no more unwieldy than a personal stereo and a set of headphones.

Add a personal stereo for music, though, and you've got two pieces of electronics, two wires and headphones. At that point, mobile activity like jogging or even walking becomes a little unrealistic.

The weight of the Koss system is given as 5 ounces for the control case (including the required pair of AA batteries) and another 5 ounces for the headset. Dimensions of the case are 4 x 2.5 x 1 in. The NCT model comes in slightly smaller at 2.8 x 3.2 x 1.1 in., weighs 7 ounces and operates off a 9-volt battery.

The Koss/ANVT systems boast noise reduction of up to 18 dB, while NCT claims a best-case reduction of 17 dB, with 15 being the norm.

In the ear

Another noise-reduction approach, this one based on passive theory, is an etymotic type. RDL Acoustics sells an in-ear phone, which the company claims reduces low-frequency noise (below 200 Hz) by 20 to 25 dB and



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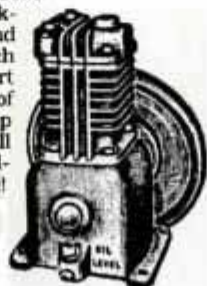
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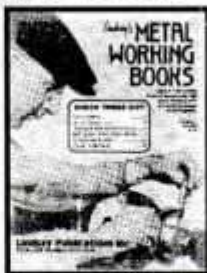
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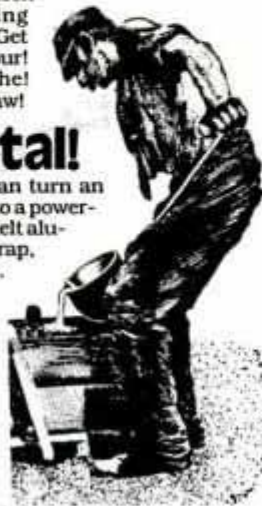


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higher frequencies by 30 to 35 dB. Instead of using noise cancellation, however, the phones fit well into the ear canal, creating a seal that isolates the listener from noise.

Called Etymotic Canal Phones, the earbuds were developed by Mead Killion, an adjunct professor of audiology at Northwestern University and founder of Etymotic Research. Killion originally developed the phones for audiology research. They subsequently wound up in the ears of an *Audio* magazine reviewer, who gave them rave reviews. Now the Etymotic phones sell to consumers for \$329 each. Two versions are available, Model ER-4S for conventional stereo listening and Model ER-4B for listening to binaural recordings. The set includes the phones, 1/8-in. and 1/4-in. adapters, extra rubber eartips, filters to protect the buds from earwax, a filter-changing tool, a carrying pouch and a storage case. Weight is less than an ounce.

The leaf-blower test

So, do they really work? I wrote this article in autumn from my office in a very wooded area of suburban New York, where throughout October and November I hear a constant serenade of leaf blowers. I tried out each of the active noise-cancellation headphones—from Koss, the equivalent ANVT set and NCT's NoiseBuster. None blocked out the noise completely from leaf blowers across the street. The whine still came through but at substantially reduced levels. The noise-cancellation technology effectively reduced certain sound frequencies caused by the blowers. However, at one point I was left with an annoying hum, which evidently was above the 1500-Hz range. But each time I switched off the noise cancellation, the difference was scary. I realized then how much noise bombards my ears every day.

Addressing the no-hands issue, ANVT and NCT both say one-piece noise-cancellation systems are on the drawing board. Koss says the real advances in active noise-cancellation technology will occur when they're fully digital systems. The current models are hybrid systems that still use an analog configuration. Nascent 3-volt digital signal-processing technology in the labs at companies including Texas Instrument and Motorola will lead to smaller, lighter and programmable noise-cancellation systems. Want to block out that car alarm? If all goes as planned, it should be a done deal in a couple of years.

Comfort levels

There are no major differences between the NCT and Koss/ANVT

camp as far as the products are concerned. Each comes with a small, handsize controller, which connects to the headphones via a flexible cord. The Koss and ANVT headphones were slightly more comfortable than the NoiseBuster model on the ear and head, aided by a cushion on the headpiece. The battery compartment on the NoiseBuster was much easier to open than on the Koss and ANVT models. The NoiseBuster runs on 9-volt, and the other two on AAs.

Both come with belt clips for those willing to wear them.

You get used to the engine and mo-

tor noise that surrounds you every day, and you're used to shouting on airplanes in order to be heard by the person next to you. When that noise is reduced, you perceive a dramatic difference. That difference may not be enough right now to drive you to buy noise-cancellation headphones and a controller, however. But keep an ear to what's going on in this area. Some day it's going to be active noise-cancellation headphones dramatically changing all that for the better. Whether you want to wire up to tune out is another issue altogether. **FM**

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In Search Of Eddie Bauer

BY JOE SKORUPA, Boating/Outdoors Editor

● The mission: Find Eddie Bauer. Determine if he's real, à la Howard Johnson, or a marketing construct, à la Betty Crocker. Is he a legendary giant, like the founders of Jim Beam, Jack Daniels (my personal favorite) and Oscar Mayer, or is he just another Pacific Northwest legend like Big Foot or Sasquatch?

To millions of Americans, Eddie Bauer is a familiar presence. He's in our mailboxes. He's in our shopping malls. He fills our closets with rugged outdoor clothing. But who is the man so widely promoted and yet so cautiously concealed beneath a cloak of goose down?

To find out, I teamed up with Ford Trucks and scoured Washington state for clues. I drove a thousand miles through Eddie Bauer country—the greater Seattle area, the North Cascades, the Olympic Peninsula and the Columbia River Valley. I examined a fleet of *genuine* Eddie Bauer edition Ford Explorers, Aerostars and Broncos. And along the way, I pursued classic Eddie Bauer activities—fishing, skeet shooting and hiking. In the end, I accomplished my mission. Here's the lowdown:

● First, there's nothing virtual about the reality of Eddie Bauer. He was born on Orcas Island in 1900, and died in Seattle in 1986.

● Second, he was a celebrated fisherman, hunter and marksman.

● Third, he was a pioneering retailer of sports equipment and rugged outdoor gear and clothing.

● Fourth, he opened his first outdoors/sporting goods store in 1920 after already becoming an outdoorsman of note in his teens.

● Fifth, he was an inventor of new sporting and outdoors equipment, several of which received patents. Chief among these is the down jacket, which proved to be the foundation of

his company's national success.

● Sixth, the company he founded grew far beyond his original concept. Today, it's a billion-dollar multinational operation that sells a minimum of E.B.-style sporting equipment and a maximum of upscale casual clothes.

● Seventh, the company is a unique combination of mail-order business and retail sales. Its network of stores now stands at 270. By 1995, it will be 350. Eddie Bauer dwarfs such competitors as L.L. Bean and Cabella's. For a fair comparison, consider such giants as Land's End and The Gap. Acquired by Spiegel in 1988, Eddie Bauer is responsible for 52% of its parent company's annual sales.

This is the core of my report, and as you can see E.B.'s accomplishments are impressive. However, there are a number of ancillary details associated with E.B. that are also quite interesting. These

include E.B.'s role in World War II, his fame with early aviators and his circuitous route into the clothing and mail-order businesses. But I'll get to these later.

First, there's a second mystery that needs to be cleared up. Exactly what is an Eddie Bauer edition Ford truck? Is it a real product of collaboration or just a superficial badging operation? Does Ford Trucks really need Eddie Bauer, and vice versa?

Fortunately, my trip to Seattle coincided with the 10th anniversary of the Ford/Eddie Bauer association, so I was in an ideal position to get the scoop.

The main point I discovered was that the corporate collaboration has proven to be far more successful than most people believed possible when it was launched in the 1984 model year. At that time, sales for the new Eddie Bauer edition Bronco II were projected to be about 400 a month. To date, the Eddie Bauer edition Bronco II has sold 96,000 units, or double the original estimate.

The same success story was repeated with the Eddie Bauer edition Ford

(Please turn to page 103)



The Eddie Bauer image not only includes a special-edition Ford Bronco, shown above, but a new Ford F-Series 1/2-ton pickup truck for '94.

teardrop-shape body—the rear track is 9 in. narrower than the front—and full belly pan cut Cd to an F-16 jet-fighter-like 0.19. That's 30% better than any current production car.

Another first is the heat pump for heating and air conditioning. Using a separate AC induction motor and inverter to drive the compressor, R134a refrigerant is pumped to a reversing valve, which controls the flow to either the front heat exchanger that is located ahead of the radiator or the rear heat exchanger that is located in a module underneath the dash on top of the tunnel. The system is able to provide 3000 watts cooling for 1000 watts of electrical input, and in the a/c mode, uses only 1000 to 1500 watts of power compared to 4000 to 5000 watts for conventional systems.

A unique preconditioning mode allows you to program the heating/ventilation/air-conditioning (HVAC) system, like you would a VCR or an alarm clock. While the car is being charged, you can have the heat or a/c come on at a preset time, so you can enter a toasty cabin on cold days and a cool car when outside thermometers are popping.

So what's it like to drive an Impact? Starting the car is a bit eerie, because it doesn't actually start. There's no ignition key. You punch in your special code via the console keypad, and a dash light reads READY. That's it. There's no sound, no vibration, no nothing. The electric motor plays dead until you hit the gas—er, watts.

Performance is unlike any other electric vehicle we've driven. Previous electrics have been downright slugs, but the Impact scoots and handles like a sports car. You can hammer down the road in confidence, and this 2-seater really responds. At one point, at the GM Proving Grounds, we drag raced a '93 Acura Integra up a steep incline test track and arrived at the top out in front by three car lengths.

Impacts will hit the road this spring as GM turns over 50 of them into the hands of more than 1000 motorists for 2- and 4-week test drives during a 2-year test-evaluation program. It gives everyone—including GM—a chance to get electric-car experience. As of yet, GM has not decided if it will go to market with Impact in 2- or 4-seat versions, or both. The 2-seater, with an expected price tag of \$25,000, may not have sufficient market appeal. But a 4-seater may be practical only if a more advanced (and affordable) battery is developed.

Who knows, the ubiquitous expression of "Fill 'er up," may become as obsolete as "Whoa, Dobbin," as Americans sing a new tune—"Watts up!" **PM**

Bronco (91,800 units since 1985), Aerostar (72,800 units since 1988) and Explorer (178,000 since 1991). To date, Eddie Bauer edition Ford trucks have sold a total of 438,600 vehicles.

Apparently Ford was right on target a decade ago when it realized that a large segment of buyers was no longer satisfied with lean-and-mean trucks. They wanted worklike utility, but carlike comfort. Typical cargo for these trucks isn't hardware and lumberyard supplies, it is fly rods, shotguns and backwoods gear.

This previously unrecognized segment of truckers was essentially Eddie Bauer people—both in the spirit of E.B. and the company he founded. Consequently, the Ford/Eddie Bauer alliance anticipated one of the major automotive trends of the 1990s—the emergence of upscale trucks as an alternative to cars.

With the truck culture now in full swing, Ford has decided to take it further by introducing an Eddie Bauer F-Series ½-ton pickup, which will be available in selected markets in 1994. While upscale pickup trucks seem a less likely match than upscale sport/utes or vans, market acceptance of the Ford/Eddie Bauer F-Series ½-ton will probably continue the string of success.

So, what exactly is an Eddie Bauer edition Ford truck? Basically, it's a vehicle that carries Eddie Bauer badging and offers upscale amenities and styling. These include cast-, forged- or deep-dish aluminum wheels, sport bucket seats or captain's chairs, leather upholstery, top-of-the-line electronic instrument clusters, luxury accessories, unique color treatments and complimentary garment and duffel bags, shipped directly from Eddie Bauer's headquarters in Redmond, Washington. This upscale treatment makes Eddie Bauer edition Ford trucks as equally at home with doctors and lawyers as with carpenters and masons.

While it seems natural today that trucks have become alternatives to midpriced luxury cars, 10 years ago it wasn't self-evident. In fact, it ran counter to decades of automotive buying patterns and marketing. To break the pattern, Ford came up with the idea of linking trucks with the upscale, outdoorsy Eddie Bauer image. This was a gamble for both companies, but it was considered much riskier for Eddie Bauer.

The early 1980s wasn't exactly a high point in quality control and customer satisfaction for Detroit. Yet, these were the precise areas where Eddie Bauer's reputation rested. Not only did the Eddie Bauer Co. design

and field-test all products, starting in 1920 with E.B. himself, but it stood 100% behind all purchases. The Eddie Bauer Creed and Guarantee, which was written by E.B., is the foundation of the company's customer relations. It assures buyers: "Every item we sell will give you complete satisfaction or you may return it for a full refund."

Eddie Bauer executives frankly admit they were apprehensive about teaming up with Ford in the bad old days of the previous decade. However, this was the time when Ford was introducing a campaign that would help turn its reputation around—Quality Is Job One.

In the end, Eddie Bauer's fears were unjustified, although it reportedly gets the occasional call from a customer asking if Eddie Bauer edition Ford trucks are covered under the full-refund guarantee. Did Eddie Bauer benefit from the alliance? During the past decade, its sales exploded and it emerged as the giant in its field. The company has apparently done several things right, in addition to teaming up with Ford.

Now, back to some interesting side details. It turns out that E.B.'s path into outdoor clothing was a bit circuitous. He started out stringing tennis and badminton rackets. Then, using high-quality feathers, he began producing dry flies and making tournament-quality badminton shuttlecocks. This eventually led him to using feathers as an insulating material for the world's first down jackets, coats and jumpsuits.

E.B. intended this clothing for outdoor sporting activities, such as hunting and fishing, but early aviators were among his most devoted customers. High-altitude temperatures were brutally cold and down insulation was the only thing that enabled the pilots to endure it. Charles Lindbergh, in fact, was one of E.B.'s strongest supporters.

When the United States was gearing up for the Second World War, E.B. was given a major contract to supply aviators with warm, high-altitude clothing. E.B. produced thousands of items for WWII and presciently stitched his label into each one. After the war, flyboys looked at the label and called E.B. for replacement gear. Seeing a flood of interest, E.B. asked the government for an address list of the men he clothed in WWII, and got it. Thus was born his mail-order business, and the rest is history.

This concludes my investigation into the mystery of Eddie Bauer. Now, if I can just get someone to assign me to get the scoop on the Kentucky genius Jack Daniels. **PM**

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PULLING POWER

(Continued from page 35)

The company calls its High-Q 6500 (\$60) the "downtown" antenna because it's optimized for urban and signal-rich conditions. No amp is needed, as signal strength is seldom a problem in and around cities. Quite the contrary, which is why the 6500 has a switch to reduce tuner overload.

The major reception problems in cities are interference from adjacent channels on the crowded airwaves and multipath distortion. Theoretically, FM stations in a given broadcast market are spaced 800 kilohertz (KHz) apart. This means the 105.9-megahertz (MHz) frequency shouldn't be flanked by anything closer than 105.1 and 106.7 MHz. In practice, though, the presence of broadcasters in suburbs and nearby cities means spacing is usually 400 KHz or under. In places like New York, you pick up more than one station on the same frequency. They're usually low-power stations, and the premise is that their signals won't overlap.

The High-Q 6500's strong point is its selectivity—the ability to reject adjacent-channel interference. The 9-in. square box conceals a folded, quarter-wave antenna and the so-called High-Q circuit, which makes its channel selectivity razor sharp. In other words, if you tune your radio to 102.7 MHz, it'll turn deaf ears to the neighbors at 102.5 and 102.9. A separate tuning dial on the 6500 aids in this process.

Multipath distortion occurs when an FM signal bounces off buildings, hills or mountains, and a jumble of these reflections arrive at your tuner along with the direct original signal. It's radio's version of TV's ghosts, and the result is anything from muddy sound to unrecognizable hash.

The High-Q 6500 can clean up the mess. Where multipath is so severe that your tuner can't identify and reject the false reflected signals, the otherwise omnidirectional High-Q 6500 can be turned on its side and rotated like a directional antenna until the best sound emerges.

For the record, with no antenna at all, the typical hi-fi receiver we used picked up 25 stations decently—good to slightly hissy stereo. A dipole ribbon hauled in 36, all listenable. Besides cleaning up the sound of the previously marginal stations, the High-Q 6500 brought in another 13.

Much of this was the result of

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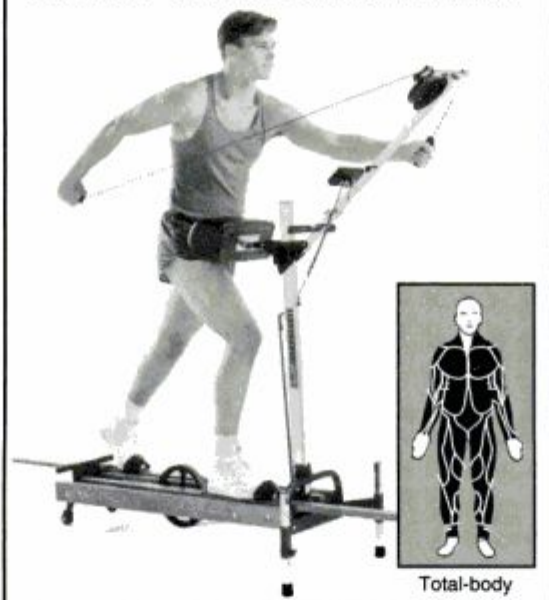


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bringing order to the riot between 88 and 92 MHz—the so-called education band where low-powered college stations and low-budget National Public Radio affiliates are crammed in just 200 KHz apart. The compact 6500 made them all listenable, but most remained noisy enough to warrant a switch to monaural—or a try with a different antenna. Compared to the big-wattage commercial stations, these small-fries carry some of radio's more interesting programming. AudioPrism's Model 7500 (\$190) and APPA-8500 (\$450) cleaned up all the jive on the airwaves, and even coaxed a few more riders from the storm. But at 7½ and 5½ ft. tall respectively, these columns might create some indoor static of a personal kind.

These aerials resemble organ pipes because they conceal unfolded half-wavelength antennas—three in the case of the APPA-8500. The more reception surface a radio signal sees, the better. And because antenna "gain" is a function of length, these models need no amplifiers. Issaquah, Washington-based AudioPrism, (206) 392-0399, contends that the amps that compensate for small element size in tiny antennas might feed noise to the tuner.

For all its height, the AudioPrism 7500's diameter is just 4 in. The black-cloth-covered tube sits on a hand-rubbed wood base. It weighs 9 pounds and actually is pretty attractive. Custom covering is available for this and the charcoal-wrapped APPA-8500.

The 7500 is an omnidirectional antenna, and best used where you want to haul in a lot of signal and distant signals, but where multipath isn't a concern. That's the APPA-8500's forte.

APPA means AudioPrism Phased Array. Inside the 12-in. tube are three half-wave elements spaced 120° apart. This makes it a directional antenna—the kind that rejects multipath reflections. Just sit back and use the supplied remote control to select the position that delivers the best sound—which may vary by station. The 24-pound APPA-8500 will also work as an omnidirectional model, with all three elements linked.

Besides the quantifiable benefit of additional stations, any of these antennas provide a qualitative improvement in FM listening—better stereo definition, quieter reception. This is particularly audible on stations that broadcast CDs, where silent passages remain just that.

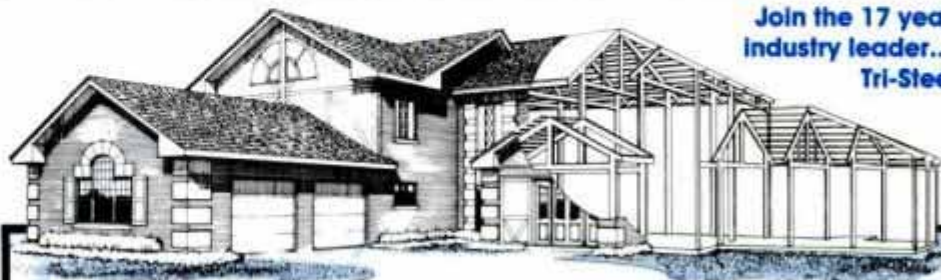
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Alternate Views

BY FRANK VIZARD, Electronics Editor

● It's worth a trip to Japan every year just to poke your head inside the annual Electronics Show held alternately in Tokyo and Osaka. The recent Tokyo show, though, was not the usual electronic humdinger. A recession has hit the Japanese electronics industry particularly hard, with most companies reporting declines in either sales or profits, or both.

Still, there were some interesting products and some interesting conclusions to be drawn. For instance, you can expect to see more 16:9 televisions coming from manufacturers like Sharp, a company that has gone as far as developing a prototype 16:9 TV/VCR featuring a 24-in. diagonal screen. Sharp officials believe the TV/VCR combination is the future and that the stand-alone VCR is doomed for extinction.

Interestingly, the VCR section contains a commercial-zapping feature that allows you to fast forward through commercials automatically. This feature works with stereo TV broadcasts, kicking in when it encounters a monaural commercial.

When these new 16:9 TVs will appear largely depends upon how long Japan's recession lasts. The simple truth is that the Japanese market is saturated with standard-size (4:3) TVs, and, thanks to the recession, Japanese consumers are not buying any new ones.

If Japanese TV manufacturing plants are to stay active, they will

have to make 16:9 models in a variety of sizes just to make the average Japanese part with his hard-won yen. Ultimately, these 16:9 models certainly will find their way to the United States.

Sharp, meanwhile, is also improving its LCD television technology. A new 14-in. monitor has a viewing angle of 80°—more than double the 35° of previous screens. This development makes LCD screens more viewable



Going wide: Sharp's 16:9 TV/VCR (top) and LCD TV.

from extreme off-center positions.

Another display technology with a different twist comes courtesy of Sanyo. The company demonstrated a prototype of a 40-in. 3D LCD projection television that can be watched



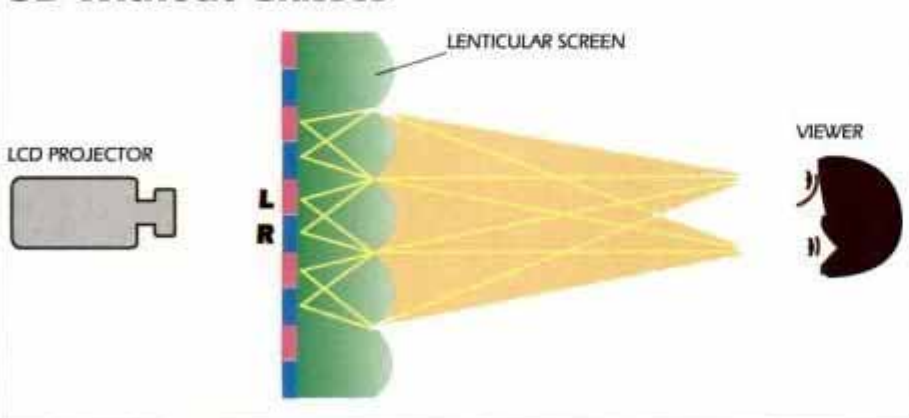
without the red- and blue-lensed glasses we're all familiar with from the movies. Multiplexed images are projected from the rear onto a lenticular screen, which acts to separate the images. Your right and left eyes see different images, creating the 3D effect. While an animated demonstration video looked good, the images were viewable only from a narrowly restricted position. Naturally, such a system would require special broadcasts and video source material, and this may limit any practical application.

Video for CD

Many show exhibitors were also making a concerted effort to get the fledgling Video CD format off the ground. Companies like Panasonic, Sharp, Sony, Hitachi and JVC demonstrated machines that could play audio-size CDs containing video. The video quality is said to be comparable to VHS-quality videotape. Most of these Video CD players were demonstrated as part of portable systems rather than as part of larger home entertainment systems. Details were sketchy, but more information should be available in coming months.

Another new format getting a lot of attention was the diminutive audio-only Mini-Disc. Sharp showed a combination Compact Disc/Mini-Disc tabletop machine, interesting in that it allows you to record a CD directly onto a Mini-Disc. Sharp also showed a tiny portable Mini-Disc model, operating with a lithium-ion battery, which can also record. Sony, meanwhile, debuted a Mini-Disc changer for in-dash car installation. A rectangular tray holds four Mini-Discs, and the tray is inserted into the player. **FM**

3D Without Glasses



Sanyo uses a lenticular screen to present different images to the left and right eyes.

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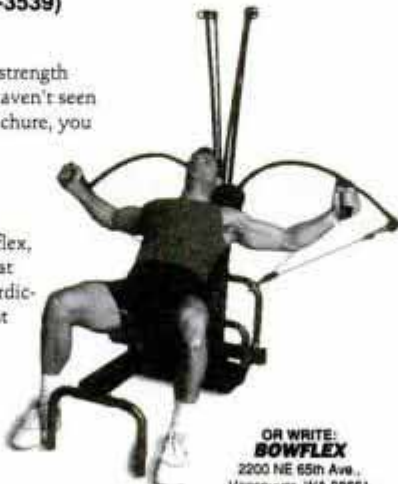
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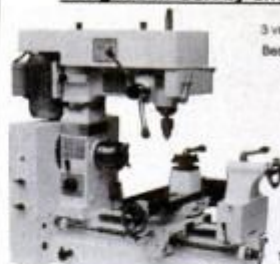
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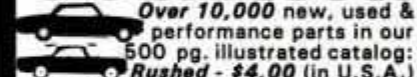
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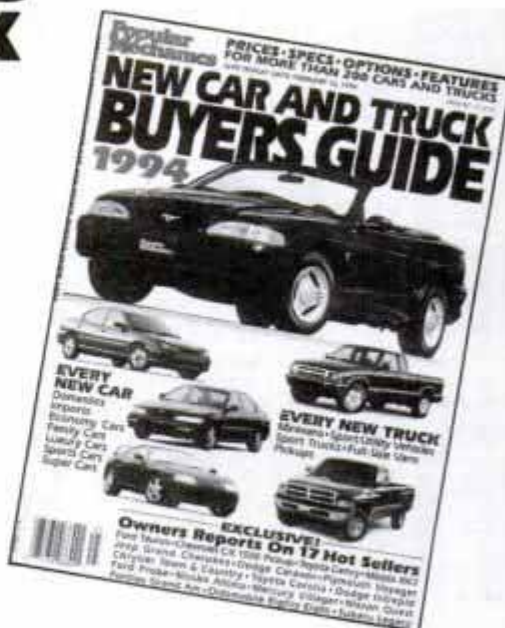
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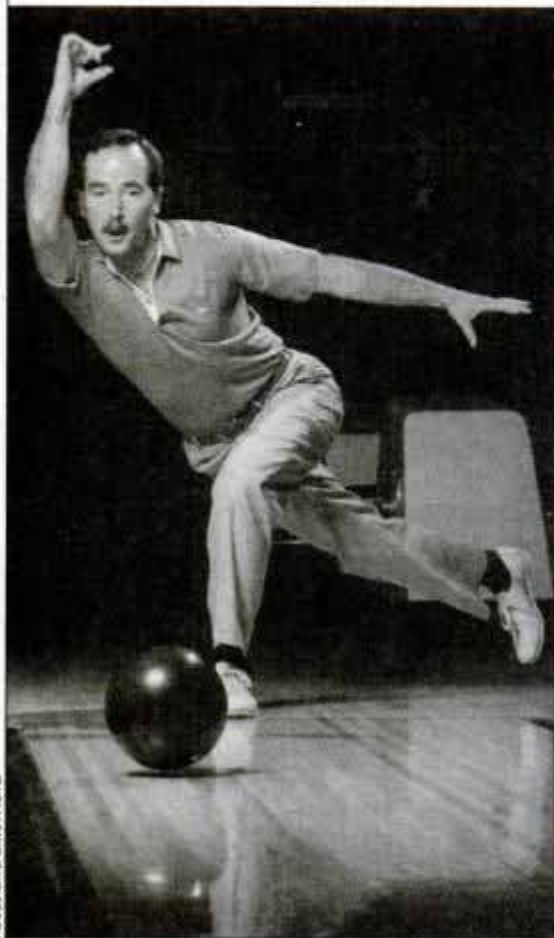
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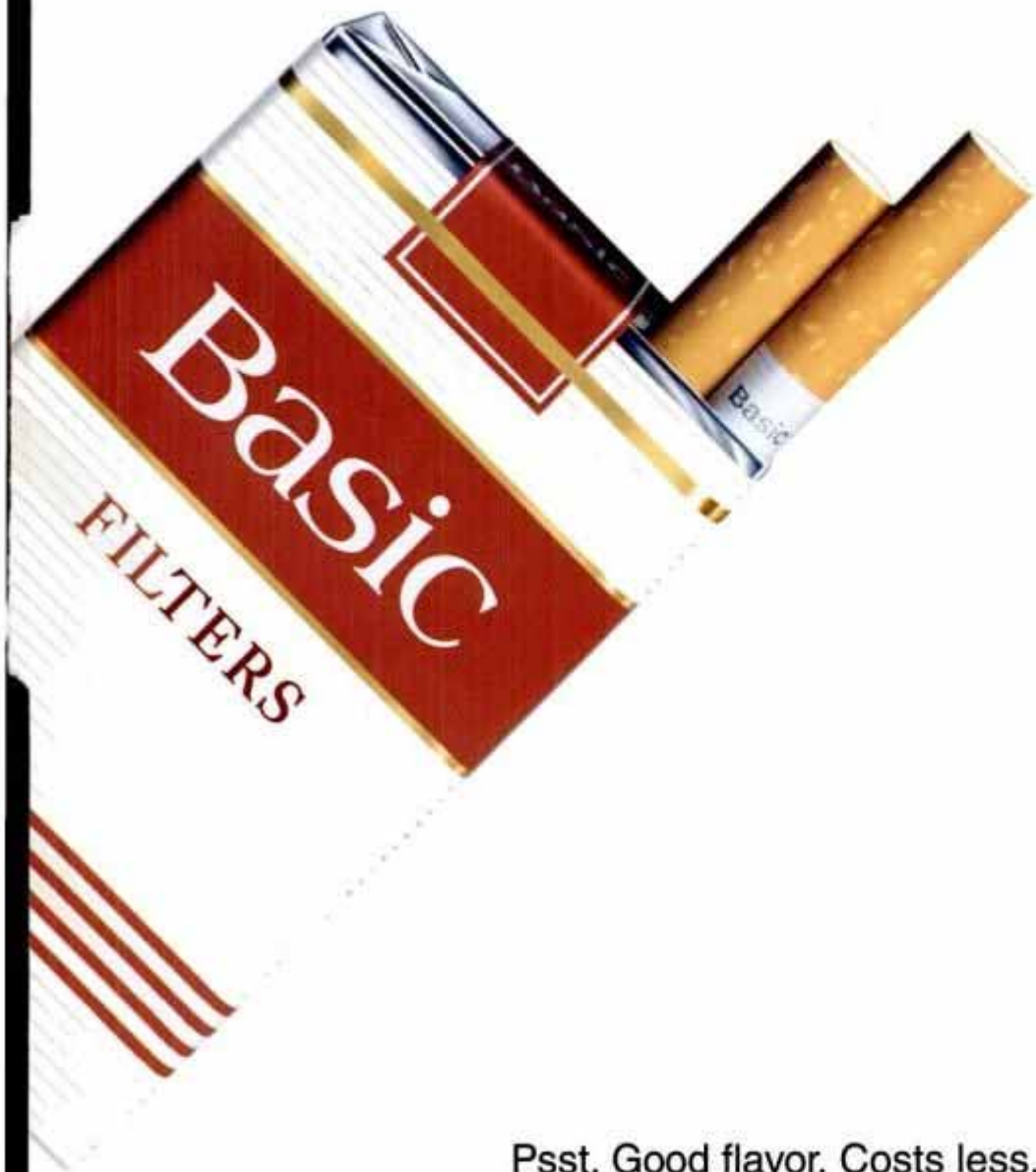
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