

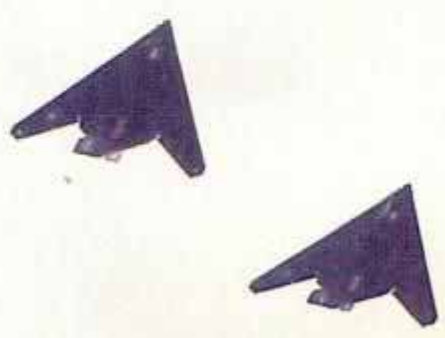
JULY 1990 \$2.50

# Popular Mechanics

**CHEVY vs. FORD**  
New Caprice Battles Crown Vic

## 'I FLY THE BLACK JET'

First Inside Look At  
The F-117A Stealth Fighter  
And The Men Who Fly  
America's Most  
Secret Aircraft



**SPECIAL SECTION**

**The Art Of  
DESK MAKING**

3 Classic Designs You  
Can Build To Enhance  
Your Home And Office

**CAR CD/TUNER  
TORTURE TEST**

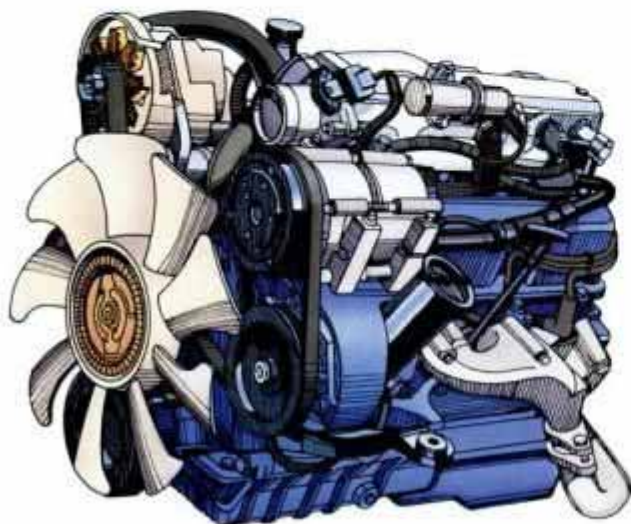
Lab-Rating 4  
Low-Priced Models



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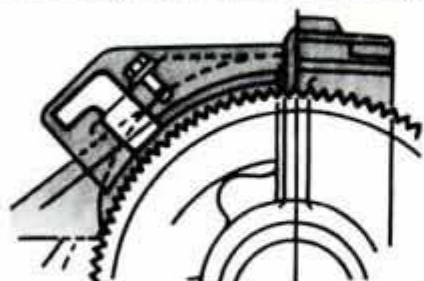
# Why Do Ford Trucks For Some Very Technical



*Advanced engine technology: Newly developed 4.0L multi-port electronic fuel-injected V-6 governed by Ford's advanced EEC-IV engine control computer.*



*A Ford exclusive: Electronic pushbutton four-wheel drive system. Shift on-the-fly from 2WD to 4WD-High and back at the touch of a button at any speed. Standard on Ranger 4x4s.*



*Computer-controlled anti-lock rear brakes for more controlled braking. Functions full-time in the 2WD Ranger and when the 4WD model is in 2-wheel drive.*



Buckle up—together we can save lives. Optional light bar shown not for occupant safety.

\*1990 Model Year Manufacturers' Reported Retail Deliveries by division vs. 1989.

\*\*Based on an average of consumer-reported problems in a series of surveys of all '81-'89 models designed and built in North America.

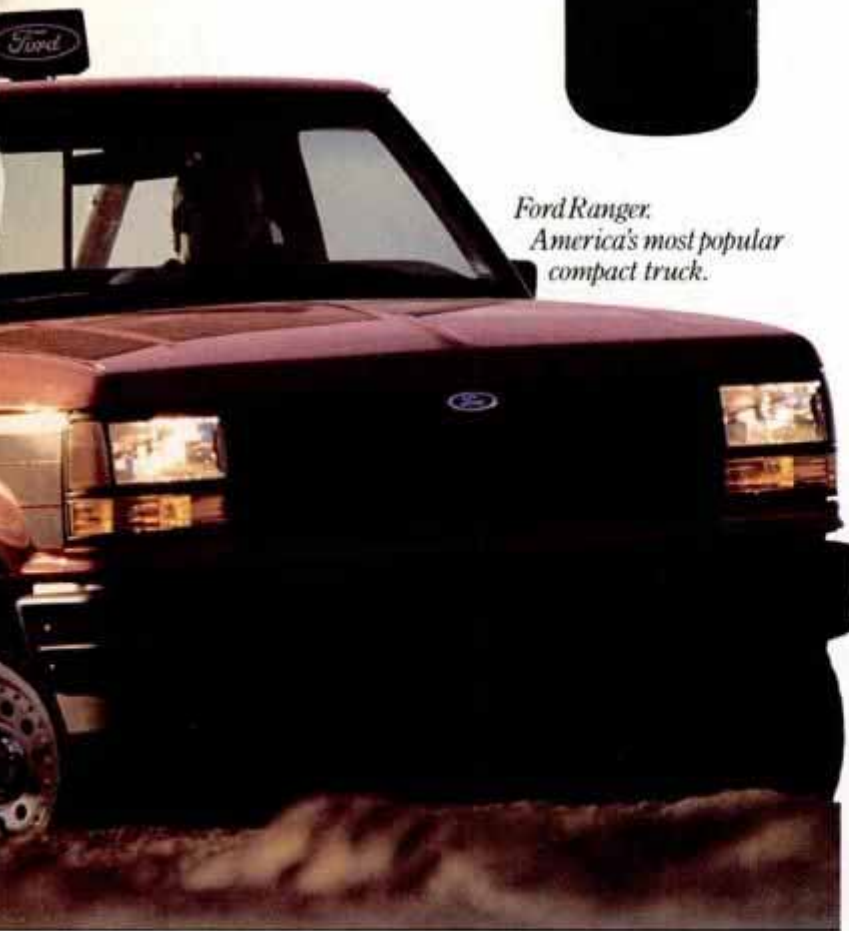


# Keep Widening The Gap? Reasons.

Another industry exclusive: 2WD Twin I-Beam and 4WD Twin Traction Beam front suspension systems with nitrogen gas shocks for a smooth, controlled ride.



*Ford Ranger.  
America's most popular  
compact truck.*



The sales gap is growing\*.

That's a good indication that our technical expertise is paying off.

But staying ahead of the competition means staying ahead of the times.

So we're going to continue to make

**Ford Trucks.  
The Best Never Rest.**

the kinds of advances we've made with Ford Ranger. It already has a technically advanced 4.0L engine and an exclusive pushbutton four-wheel drive system, but we're going to keep working to make Ranger better. The same goes for every truck we make.

Because we're determined to make the best-built,\*\* best-selling American trucks better and better. And watch the sales gap grow wider and wider.

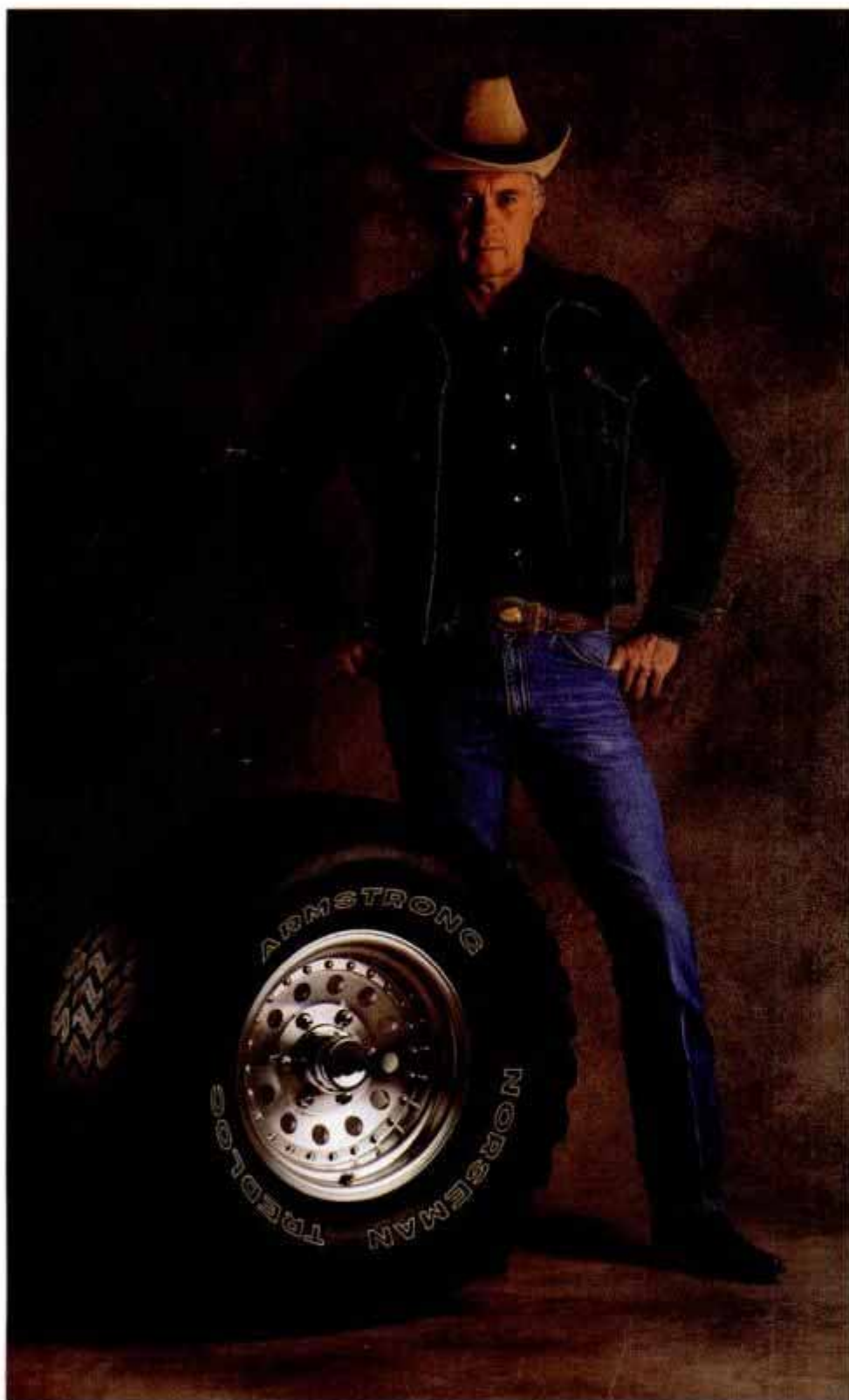


THE BEST-BUILT, BEST-SELLING AMERICAN TRUCKS  
ARE BUILT FORD TOUGH.



N1R0-BDE-XY3W

# Norseman® Tredloc®. Because Things Are Tough All Over.



The great outdoors isn't so great when you're in it up to your wheel wells. But since you're not about to change where you go, think about changing how you go. With Armstrong Norseman Tredloc Radials.

Instead of the usual criss-crossed layers of steel belts, Norsemans are wrapped with two continuous woven belts of DuPont Kevlar®. It's a process so unique, it's patented. Kevlar's lightweight, but pound-for-pound, it's five times stronger than steel—so you begin to get a pretty good idea about where the "strong" in Armstrong comes from.

Those Kevlar belts also let the tread flex more easily—so it contours itself to whatever off-road surface you subject it to. And, with low-inflation performance that's equally awesome, it's no mystery why *Off-Road Magazine*\* calls the Norseman Tredloc one of the best year-round, off-road tires on the market.

Hard to believe a tire so good at riding out tough times can feel so good on the road, but Norseman handling and steering response are nothing short of



excellent. Its bigger "footprint" comes from that woven belt construction to allow the entire tread to stay flat on the road.

No matter what you're driving, there's an Armstrong Norseman tread pattern and size to fit most 4WD and 2WD light trucks, vans and RV's.

So check it out now. Because when things are tough all over, your ride doesn't have to be.





# Popular<sup>®</sup> Mechanics

JULY 1990  
VOLUME 167  
NO. 7

ERIC SCHULZINGER/DENNY LOMBARDI/LOORHEED



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—PM cover photo by  
George Hall



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# EDITOR'S NOTES

IT SEEMS INCREDIBLE to me in this age of instant communication that the Air Force's F-117A Stealth Fighter could have been kept not only secret but actually *operational* since 1983. Yet, that is exactly the situation with this aircraft. The cover story we ran in January 1989 was the first real glimpse of the plane printed in any magazine. Some of the speculative information we published in that article proved to be correct, some not correct. Now, finally, the Air Force has taken off the wraps, at least partially, and we can bring you the first hard facts and clear photos of what has been America's most secret aircraft. The F-117A is, without doubt, the most bizarre-looking plane ever developed. Yet, it flies, and apparently very well,



At Nellis Air Force Base: Dane and the Black Jet.

according to the pilots Science/Tech- nology Editor Abe Dane interviewed at Nellis Air Force Base outside of Las Vegas. His story on "the Black Jet," as it is called around Nel- lis and Tonopah, and the men who fly it, is this month's cover story. . . . How do you get to be Tom Cruise? I mean, look at him. The guy is the hottest hunk in Hollywood, has ev- ery girl in the world after him, and gets to play the best parts in the best movies. And he's al- ways the best in his films. He was the best teenager in *Going All The Way*. He was the best naval aviator in *Top Gun*. He was the best bartender in *Cocktail*. He was the best brother in *Rain Man*. He was the best Vietnam veteran in *Born On The Fourth Of July*. And now, in *Days Of Thunder*, he's the best stock car race driver. I don't know if he really is a good flyer, brother or bartender. But I can tell you that he really is a pretty decent race driver. He's run the past few years, schedule permitting, as part of the Newman-Sharp Racing Team out of Wilton, Connecticut. That's Newman, as in Paul Newman; and Sharp, as in Bob Sharp. Cruise's racing experience apparently came in handy in the filming of *Days Of Thunder*. In his report, Contributor Cliff Gromer says that Cruise did just about all his own driving during the film- ing, resorting to stunt drivers only for the crash scenes. The film, which should be premiering nationwide about the time you read this, sounds like the definitive stock car racing movie. Any of you who remember *Fireball 500* with Frankie Avalon and Fabian will join me in welcoming *Days Of Thunder* to theaters this summer. . . . Most woodworking enthusiasts will tell you that they lay off for the summer. It's too hot in the shop and they'd rather be soaking up the rays at a pool or on a golf course. But there is a hard- core group of woodworkers who go at it year-round. To those hardcore en- thusiasts out there, or to those of you who want to plan ahead for a winter project, Home and Shop Editor Steve Willson and his staff of- fer a special section on Desk Making. Three different designs. Three different looks. All really neat. Till next time.

  
Joe Oldham

# Popular Mechanics

Editor-In-Chief Joe Oldham

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# Marlboro Lights



The spirit of Marlboro in a low tar cigarette.

© Philip Morris Inc. 1990

**SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.**

11 mg "tar," 0.8 mg nicotine av. per cigarette by FTC method.



# LETTERS

## The Last Word On Bathing Suits

**I**N YOUR May '90 Letters column, I was intrigued by your question, "What's wrong with this picture?" underneath the Boating '90 cover picture which shows a bikini-clad woman standing next to a boat. Here's my answer:

1. If I had a body like the girl on the cover, I would probably also wear that bikini boating.
2. You can be sure that my male companion would be wearing a string bikini too.

Please note that all the men in the article are wearing shorts or jeans with a T-shirt, etc. I am an avid fan of yours and demand equality.

SUSAN WOOD  
FRANKLIN, MA

In your May 1990 issue, you printed a letter from John Rodecker, of Cincinnati, Ohio. How does he know that a picture of a beautiful girl is embarrassing to women—has he had an operation? I hope he cancels his subscription, because I would not want to read a magazine that he finds enjoyable.

Let me know if he cancels, so that I can renew my subscription.

BILL SOLOMON  
MARGATE, FL

Please send me the address of John Rodecker and I will send him a copy of the swimsuit issue of *Sports Illustrated*, as well as the April '90 issue of *Hot Rod*. That should make him stamp his foot and throw a real tizzy. I have read and enjoyed your magazine for over 50 years. Keep up the good work.

BOB BRADFORD  
SEATTLE, WA

I feel that the use of semiclad models to pose for PM is contrary to its stated intention of providing newsworthy products, techniques, scientific and technological develop-



The great swimsuit controversy—still heating up.

ments. There is no technical benefit or advantage to the display of human flesh in front of, or riding as an ornament in, a fast-moving boat. It is offensive to some of your readers. I feel my subscription support of your magazine is being used to hire models to exhibit their bodies in an otherwise excellent technical journal.

JERRY JOHNS  
BALTIMORE, MD

There is nothing wrong with the picture! In fact, I rather enjoyed it, and it saves me the trouble of going to the beach in winter hoping to see such sights. If anything should cause me to cancel my subscription, it will *not* be some nonsense about what some model wore (or didn't wear). Wishing you continued success in offering a fine magazine.

CHARLES W. MILLER  
WINSTON-SALEM, NC

Your answer to Mr. Rodecker's letter was the last straw. He had a good point and you made fun of him. I hope he did in fact cancel his subscription.

I grew up reading *POPULAR MECHANICS*, but your problem is your magazine hasn't. You still have a '50s

mentality. Your boating article (May '90, page 60) pictures fully dressed males operating the boats and carefully posed near-nude females doing nothing but looking cold.

Please cancel my subscription, too.

TEDDY E. EWERS  
LEMON GROVE, CA

I agree wholeheartedly with John Rodecker. Your rebuttal to his letter indicated that you could not understand what he was saying. Perhaps this analysis of your boating article will help you understand:

■ 20 men and 17 women are shown in the article (no complaint about that).

■ 14 women and none of the men are shown in bathing suits.

■ 14 men and none of the women are shown driving the boats.

I will also cancel my subscription to PM if this sexism continues.

ALLAN BOMMER  
SEATTLE, WA

You ask "What's wrong with this picture?" I say, Nothing.

RUDY PUCCI  
OSHKOSH, WI

I was particularly appalled by your response to John Rodecker. He was simply trying to state that there should be some decency shown in your magazine, and he was publicly ridiculed for it. Unless I see a change in your policy of showing seminude women, I will not renew my subscription.

JAMES M. REYNOLDS  
CORVALLIS, OR

I applaud your reply to the totally silly letter by John Rodecker in his complaint about the bikini-clad women in the Boating '90 article. Keep up the good work.

ROBERT K. MOXON, M.D.  
COLUMBIA, CA

I also found the picture inappropriate, as well as distasteful and insulting. Why do you show all men in the boats wearing jeans and polo shirts while all the women are lounging around in bikinis? It looks to me like your editors are victims of the "sex sells" mentality. If I want to see attractive women posing in swimsuits, I'll get the swimsuit edition of *Sports Illustrated*. Please don't continue to subject our families to cheesecake shots when you're able to give us informative, factual, lively written insights and realistic visuals into the latest technological advances. By the way, I feel you owe John Rodecker an apology.

KASEY JONESREBANDT  
SAN DIEGO, CA

You ridiculed Mr. Rodecker because he objected to what the models were wearing—or rather, were not wearing. The male models were wearing shirts and shorts, but what the females "wore" amounted to little more than a couple of Band-Aids. If those "ladies" were to actually dive into the water, do you think they would still be wearing anything when they surfaced? I doubt it.

I think the clothes that women wear these days are nothing more than sexual harassment against men.

H.W. BARR  
ST. LOUIS, MO

In answer to Mr. Rodecker, who threatened to cancel his subscription because a *girl* appeared on your Boating '90 cover, I promise to *renew* my subscription if you continue to "run photos of this type!" I've been reading PM for so long (decade upon decade), I could not imagine life on this planet without my monthly issue of PM.

JERRY WINTER  
MT. SINAI, NY



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If you'd like to know more about Jack Daniel's, won't you drop us a line?

AT JACK DANIEL'S DISTILLERY, sturdy barrelmen and charred oak barrels are a big part of our whiskey's smoothness.

Actually, Jack Daniel's is uncommonly smooth before it goes into the oak. You see, every drop has been seeped through vats of hard maple charcoal prior to aging. Any rough edges are removed right here. Then, barrelmen make sure more smoothing occurs inside the wood. Naturally, the whole process takes a lot of time. And a lot of lifting. But, we believe, the results are worth all our barrelmen's efforts.

SMOOTH SIPPIN'  
TENNESSEE WHISKEY

Tennessee Whiskey • 40-43% alcohol by volume (80-86 proof) • Distilled and Bottled by Jack Daniel Distillery, Lem Motlow, Proprietor, Route 1, Lynchburg (Pop 361), Tennessee 37352





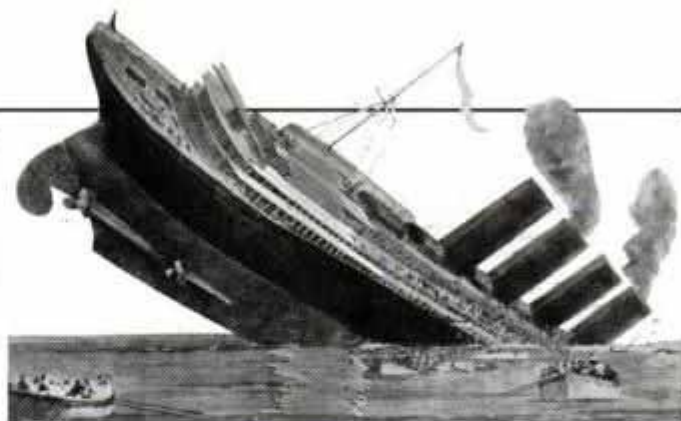
# TIME MACHINE

75 YEARS AGO: JULY 1915



## War Or Terrorism?

Shocking news was trickling back from the trenches of the European war. In open defiance of the Fourth Hague Convention, both sides had descended into the barbarous practice of gas warfare. Our editors described the French and German methods in detail, and condemned them roundly. They further pointed out that the techniques seemed to produce no advantage for either side. Rather, they merely forced both to adopt gas masks and other countermeasures.

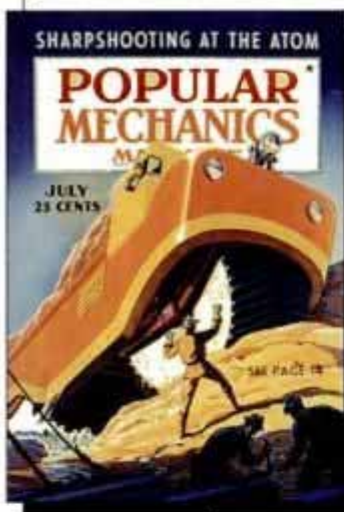


## Lusitania Sunk

Although the majority of Americans wanted no part of WWI, the sinking of the *Lusitania* by a German sub in May, 1915, eventually made neutrality impossible. With-

out making political judgments, PM gave a thorough analysis of the relevant technical factors, explaining how another supposedly unsinkable vessel went down in 20 minutes, taking 1198 lives.

50 YEARS AGO: JULY 1940



## Barging Over Land

North of the border, the vast Canadian wilderness beckoned with mines rich in ore, but the rugged terrain posed daunting obstacles to anyone wanting to haul it out. Two North Woods inventors patented one solution—a 20-ton amphibious barge. Capable of carrying an 18-ton load, it rolled on a 12-ft.-high x 6-ft.-wide watertight drum, and two smaller rear wheels. Power was transmitted from a 200-hp diesel engine via a generator and electric motors at each wheel.

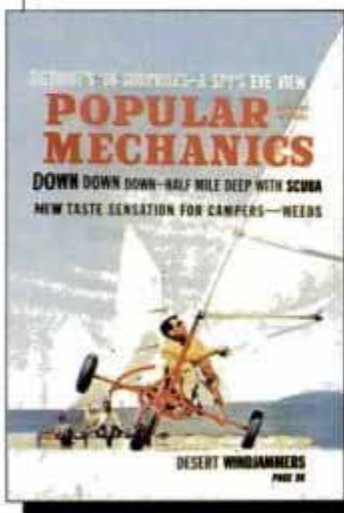
## Battling The Dust Bowl

It seemed as if the good earth was abandoning America. Throughout the '30s, wind and water scoured billions of tons of topsoil from farms

forcing families to abandon their ruined land. But by 1940, there was hope. PM told the story of how farmers reshaped their farms and farming methods to counter the scourge.



25 YEARS AGO: JULY 1965



## Sand Blasters

No less than today, thrill-seekers of a quarter-century ago looked to California as the breeding ground for new kicks. The latest? A lightweight sand sailer that could top 65 mph. Perfected over years of backyard tinkering, it consisted of little more than a bucket seat, a 3-wheeled frame and a sail. The nimble craft dashed over sand flats, with frequent spills. But thanks to good design, and lap belts, the seemingly breakneck sport had a perfect safety record.

## Super Scuba

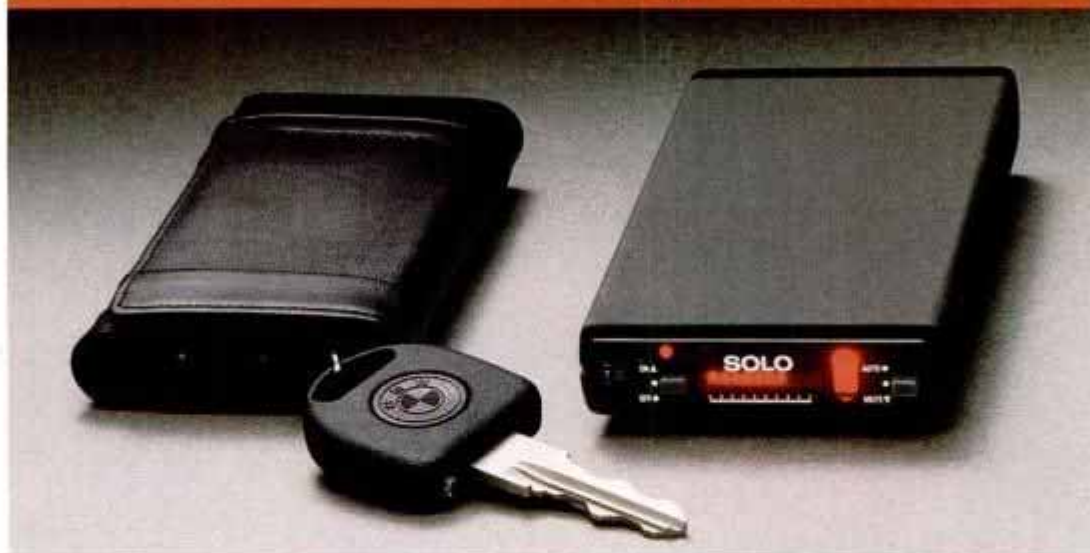
Designed for a less-forgiving environment, the Krasberg scubalung overcame the problems which kept divers

to shallow depths. Krasberg's unique oxygen sensor was the brains of a closed-circuit lung, which varied proportions of helium to prevent oxygen poisoning. **PM**





NEW! From the maker of Passport and Escort



Finally, a radar detector so advanced,  
you'll never be bothered with a power cord

## Self-powered SOLO

Until now, high performance radar detection required a messy power cord. Plugged into your car's lighter. Dangling across your dashboard. And tangling in your pocket.

Finally, there is a better way.

### No power cord

Solo is a totally new concept in long-range radar detection. All you do is clip Solo to your visor or windshield, and switch it on. It's that simple.



*Solo comes complete with all accessories, including visor and windshield mounts that instantly conform to any car, but fold flat for convenient carrying. Both designs are patented.*

You'll never need a power cord. Unlike any other radar detector, Solo has its own power source — inside its compact magnesium housing (Solo is 3/4" x 2 3/4" x 4 1/2" — just 5 1/2 ounces).

### How it works

After years of research, our engineers (who also designed Escort and Passport) developed circuitry fifty times more efficient than conventional detectors. This design provides long-range radar warning for 200 hours on a single 9 volt battery.

If you drive one hour a day, you won't need to replace Solo's battery for over six months. (Even if you drive two hours a day, you'll get over three months.)

### WHAT THE EXPERTS SAY

*"No other detector manufacturer has anything even close...Solo moves the state of the art to a bigger plane."*

BMW Roundel

*"The most user-friendly detector yet... we fell in love at first beep."*

AutoWeek

### No compromise performance

With Solo, you get long-range radar warning with no hassles. And you never have to worry about Solo's performance.

Solo maintains all of its radar warning capability over its entire battery life. Solo is even smart enough to turn itself off if you forget. When it's finally time to replace the battery, Solo will tell you five hours in advance.

Order today and try Solo  
for 30 days at no risk

Call toll-free 1-800-543-1608



\$345 Ohio add \$18.98 tax. Higher in Canada.



Cincinnati Microwave  
► Department 306870  
One Microwave Plaza  
Cincinnati, Ohio 45249

Then just drop in another lithium battery for 200 more hours (or use a standard alkaline to power Solo for 80 hours). Solo costs less than three cents per hour of use.

### Experience the freedom

You'll slip your Solo into its carrying case and carry it in your shirt pocket. In your car, just clip Solo to your visor and switch it on.

It's so easy, you'll never go without radar protection again. And now a special offer lets you try Solo for 30 days at no risk.



*Solo's super efficient design never needs a power cord. A 9 volt battery provides 200 hours of power — several months of radar protection for most drivers (at a cost of only three cents an hour).*

### We GUARANTEE your satisfaction

Solo is available from us only, and comes complete with our Digital Key anti-theft system, all mounts and accessories, two batteries, and a one year limited warranty.

Here's our offer. Try Solo. If for any reason you're not completely satisfied, just return Solo within 30 days. We'll refund all your money and even pay your return shipping cost. You can't lose.

Once you try self-powered radar protection, nothing else will do. Order today.





**May the road rise to meet you,  
May the sun shine warm upon your face,  
May the wind be always at your back,  
But when it's miserable,  
May you be driving a very dressy V-6, 4WD Montero.**

It's poetry in motion, and it knows no bounds.

Beneath this 4-door Montero's urbane, sophisticated exterior waits a 3.0-liter, 143 horsepower V-6 up to subduing the wild trails, swamps or dunes you're likely to run across.

Whether the rising road is paved or not, Montero's independent torsion bar front/3-link, coil spring rear suspension system assures very smooth going all around.

Automatic locking hubs, with a 2-speed transfer case, let you slip in and out of 4-wheel drive at will, right from the driver's seat. And whether you're wearing your oldest jeans or your Sunday best, you'll arrive looking like a million. As Motor Trend observed, "The

Montero is more reminiscent inside of a decked out luxury car than an off-road truck."

Considering the fact that Montero gives you nearly a third more cargo space inside than either Cherokee or Trooper II, that's a lot of luxury.

Priced from \$15,519 to \$19,499\* (LS model), you couldn't wish anything better upon a traveler than a new Montero.

Call 1-800-447-4700 for your nearest Mitsubishi Motors dealer.

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MONTERO** 

\*Mfr's sugg. retail prices exclude tax, lic., freight, dir. options and charges. Actual price set by dlr. LS model shown with optional alloy wheels, MSRP \$428.

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# TECH UPDATE

News Of Tomorrow's Technology Today



FM ILLUSTRATION BY ED VALJURSKY

## 150-Mph Train To Link Florida Cities

DEERFIELD BEACH, FL—The latest plan to install a high-speed rail line in the United States calls for an electrified route between Tampa, Orlando and Miami that would be traveled at up to 150 miles per hour.

A request for proposals from the Florida State Legislature brought two bids—one from the company building the French TGV, currently the world's fastest train, and another from a consortium of 29 international companies called the Florida High Speed Rail Corp. TGV has now withdrawn from the competition.

The FHSRC train would employ technologies from numerous existing rail lines

around the world. Locomotive design is based on a Swedish unit known as the X-2, which is powered by thyristor-controlled asynchronous motors supplied with electricity from overhead lines. Lightweight, aerodynamic stainless-steel carriages will carry seating in three classes, along with dining, lounge, and bilevel snack and observation areas.

The last hurdle before construction is approval from the Florida High-Speed Transportation Commission, which is expected in '91. Operation would follow in '95.

Editor: Abe Dane  
Assistant Editor: Gregory T. Pope  
Contributors: Mike Fillon, Robert Scheier, Andrew G. Roe

Traveling at 150 mph through Central Florida, FHSRC train would link population centers at speeds 25 mph faster than any other rail line in the U.S. Go-ahead for construction is expected in 1991.

### Highlights This Month

- **Crane With A Cranium**—Smart lifter outthinks dangerous loads.
- **Pegasus Flies**—Winged rocket soars into space history.
- **How To Fix The Space Station**—Maintenance hardware will be tested on upcoming Shuttle mission.
- **Call Me The Breeze**—Redesigned blades shave windpower generation costs.
- **Star Wars Strikes Back**—SDI testing continues quietly.
- **Knock, Knock**—Schwarzenegger plus special effects equal "Total Recall."

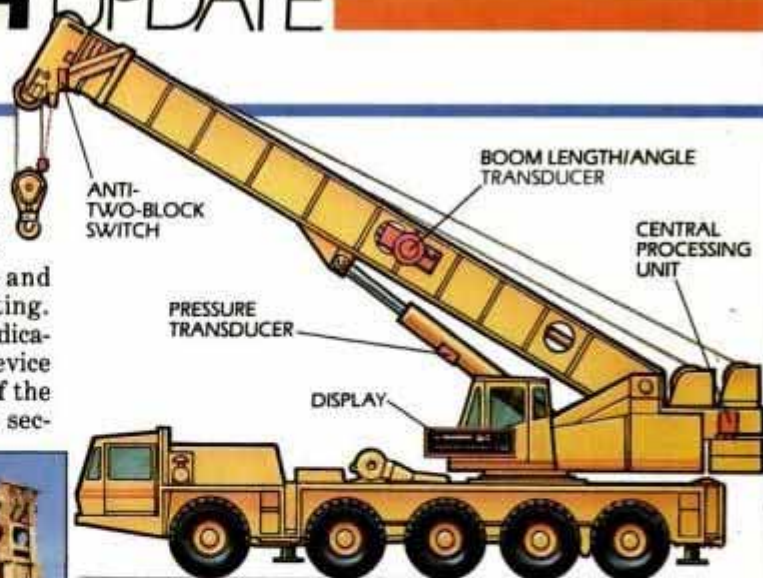


## Cross-Country Lifter

NEW YORK, NY—Despite its brutish image, heavy equipment has been getting smarter. Among the cleverest of these lumbering behemoths is a 132,000-pound, 10-wheeled crane intended for off-road use. With 8-wheel steering and 8-wheel drive, it maneuvers in tight spaces and clambers over obstacles. All 10 wheels are controlled by a hydrogas suspension system that positions them for work on uneven surfaces. A turbocharged diesel hustles the whole package along at up to 43 mph.



The most advanced feature, though, comes into play when the crane lowers its stabilizers and gets down to heavy lifting. Called a load moment indicator, the computerized device monitors the position of the boom's four telescoping sec-



Components of load moment indicator system monitor boom position and measure loads, so that crane can be kept steady.

tions, which extend to heights of 140 ft. By automatically warning the operator of unstable conditions, it spares him complex calcula-

tions that would normally distract him. Manufactured by Grove Coles, four of the cranes have so far gone into service in the United States.

## Pegasus Launches New Era

EDWARDS AFB, CA—With its near-perfect flight from a high-flying B-52 on April 5, the winged *Pegasus* booster became the first privately developed rocket ever to reach orbit, the first successful all-new launch vehicle produced in the United States since the Space Shuttle, and the first air-launched orbital rocket in history.



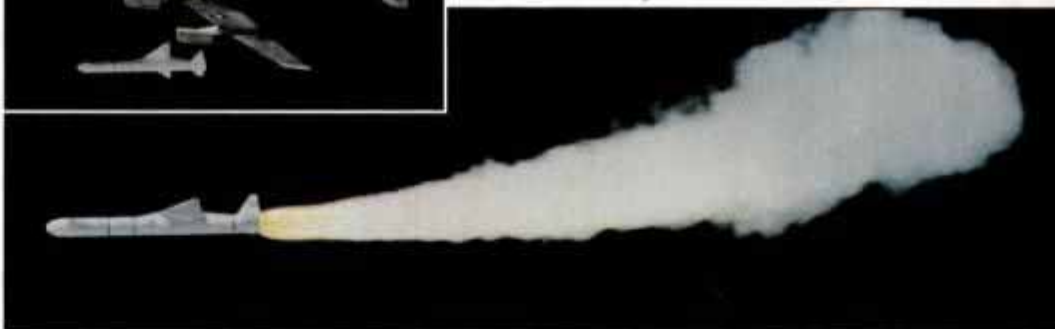
The radical craft was cut loose from the NASA B-52, flying at 43,000 ft. 60 miles southeast of Monterey at 12:10 pm. After dropping for 5 seconds while the bomber veered away, its solid-rocket first stage ignited, raising

*Pegasus's* speed from Mach .8 to Mach 8 in 78 seconds.

Onboard guidance systems directed the craft by activating movable tail fins equipped with small, solid-fueled rockets. The two subsequent

stages put the spacecraft's 422-pound payload in a 320-mile-high polar orbit.

Analysis of data from the heavily instrumented rocket's first flight will be completed within a month, clearing the way for another launch this fall.



Chase plane photos show *Pegasus* at release (top), and moments after ignition of first-stage rocket.



Astronauts ride aboard CETA in Johnson Space Flight Center's Weightless Environment Training Facility Pool.

## Space Repair Devices Tested

HOUSTON, TX—Amid furor stirred up by reports that Space Station *Freedom* would need far more maintenance than predicted, NASA is testing equipment that would help astronauts with their extravehicular chores. In preparation for Space Shuttle mission STS-37 scheduled for November, astronauts are practicing with Crew and Equipment Translation Aids (CETA), which they will be trying out in the orbiter's payload bay.

Intended to help the astro-

nauts travel along the truss that ties together the Station's modules, the CETA devices consist of small carriers that pull the astronauts along on rails. Among the prospective designs are an electrically propelled model powered by a hand-crank generator, and a manual device similar to an old-fashioned railway handcar that scoots along when the rider works a lever.

The 6-hour spacewalk will be the first for American astronauts in five years.

(More Tech Update on page 14)

GROVE COLES PHOTO

FM ILLUSTRATION BY PAT RUGGERO

AP PHOTOS

NASA PHOTO



# THE INCREDIBLE BURGLAR ALARM



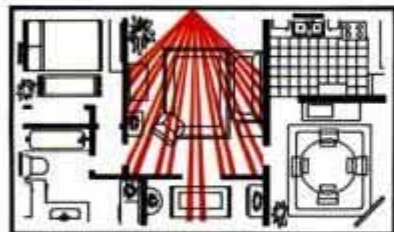
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One compact, self-contained instrument provides complete protection in an area 40 feet long by 25 feet wide. Supplied back-up battery assures at least four hours of continuous protection in case of a power failure. And every Homewatch 2000 comes with a videocassette and manual to help you set up and expand the system.

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#### Dual Detection/Protection System

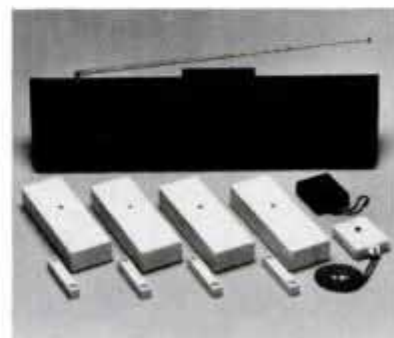
This incredible alarm bags burglars two ways. Two sensors, motion and heat, guard the space within your home. A passive infrared heat sensor and a microwave motion sensor work together for state-of-the-art protection reliability. And it's all housed in one compact table-top unit.

#### No False Alarms

The Homewatch 2000 has two sensors which must both be activated before the alarm sounds. Small pets, household appliances, or blowing curtains will not set off the device. Dual technology virtually eliminates irritating false alarms common in other systems and maximizes your protection.

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Homewatch 2000 gives you the safety and security of a technically sophisticated, commercial grade intrusion detection system at a price you can afford. Homewatch 2000 is as easy to own as it is to install. And the money you save will be your own. Your purchase is protected by a 30-day money-back guarantee and one year warranty.



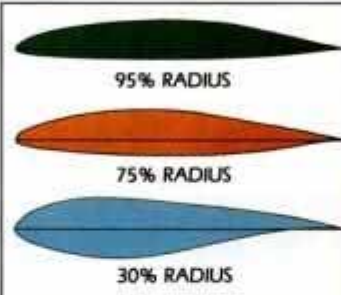
Wireless Perimeter Protection Package  
Protects Doors/Windows!



## Blade Cuts Windpower Costs

GOLDEN, CO—By subtle alterations of airfoil shape, size and structural properties, the Solar Energy Research Institute has produced a wind-generator blade 20 percent more efficient than earlier ones.

The gains were achieved partly by departing from the principles of aircraft propeller design, which earlier windmill blades had been based on. The two applications have very different requirements. For propellers, a very high lift coefficient is desirable to prevent stalling



Cross-section of SERI blades (being installed at right) is varied from root to tip (above).

under heavy loads. Windmill blades, however, *should* lose some of their grip in heavy winds, so that generating



equipment doesn't get overloaded. "We see a lot of burned-out generators and transmissions because of excessive power," says Jim Tangler, an investigator at SERI. The SERI blade's ability to stall in high winds will also let excess windpower spill past to leeward generators.

The new blades will be used to replace an older Danish design now in use on 3600 windmills on a large California wind farm, and are expected to lower electricity costs from between 8 and 13 cents per kilowatt-hour to between 7 and 10 cents.

NASA ILLUSTRATION; NASA PHOTO

## Beleaguered SDI Effort Continues To Advance

HUNTSVILLE, AL—Despite uncertainties about the ultimate shape of the system, or whether it will be deployed at all, research into the development of a shield against nuclear missiles continues unabated.

The latest plan for the earliest operational form of the system, called Phase I, includes one set of satellites to pick up and track missiles immediately after launch, another to follow them through space, and a ground-based sensing rocket that would be launched to follow the course of incoming warheads in the event of an attack. Interception of the missiles would be carried out by an orbiting flock of self-propelled space bullets called Brilliant Pebbles (see Tech Update, page 14, Oct. '90), and in the terminal phase by ground-launched rockets.

Although this scheme is drastically scaled back from the original one proposed by President Reagan in 1983, an aggressive testing program is still being pursued, as technology begins to move from the drawing board to early prototypes.

In January, the first



Left: Boeing engineer tests free electron laser to be fielded after Phase I. Center: HEDI testing at White Sands. Right: Martin Marietta Rapid Retargeting lab simulates high-speed beam aiming problems.

test firing was carried out to prove components of the High Endo Atmospheric Defense Interceptor (HEDI).

Designed to ram incoming missiles, HEDI rockets will form the final layer of the multitiered space shield. A

few weeks later, two satellites were launched from Cape Canaveral. Targeted by a ground-based laser, these satellites will help determine the feasibility of redirecting the beams toward missiles with mirrors. Most recently, a laser radar based near Boston was used to track a decoy warhead deployed from a sounding rocket. Even as SDI research continues, however, resistance to it is growing in Congress. And it's anybody's guess whether the program will survive until 1992, when President Bush is scheduled to decide whether to go ahead with full-scale deployment.



Phase I components of SDI (colored gold) will include only kinetic kill devices. Directed energy weapons, such as lasers, will be added later.

U.S. ARMY PHOTOS

FM ILLUSTRATION BY ADOLPH E. BROTMAN



Why wait?  
Do it today

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SLIPPERIER  
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# CHANGE YOUR OIL INTO A PATENTED ENGINE TREATMENT

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GOES TO INVENTOR OF TUFOIL

USE **Tufoil**<sup>®</sup>  
AND YOUR ENGINE  
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LAST...AND LAST!

NEWSFLASH!!!  
POPULAR SCIENCE  
DECEMBER ISSUE  
PAGES 34 - 37  
SUPERCONDUCTOR ARTICLE  
ABOUT US!

You've seen the price of new cars...they go up every year! Cars get flimsier...prices get higher...it never seems to end. There are lots of reasons to keep that nice car of yours on the road as long as possible.

Car sales are down and Tufoil sales are up. People are smart...they're taking the economical way out and what could be easier than Tufoil. Just add Tufoil to the crankcase. You don't have to shake the container or add an engine flush. Just pour it in and drive away.

Your throttle will get silky smooth...acceleration will improve. One customer said his car "takes off like a scared rabbit!"

Tufoil works wonders for all known engine oils. It's actually slipperier than Teflon (according to a famous U.S. Government laboratory).

You'll get astonishingly fast starts on cold mornings with both diesels and gas engines. The Canadian government tested Tufoil at it's cold regions lab. They showed faster cranking and significant fuel savings with Tufoil.

What about additives that claim to be a one-time treatment that will last the life of an engine? Well, I've been following the scientific literature on lubrication for a very long time. As far as I know, there isn't a shred of scientific evidence for such a claim. So don't believe it!



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TO ONE 8 OZ. BOTTLE OF  
TUFOIL FOR ONE OIL CHANGE

You'll notice quieter, smoother operation, quicker starting, snappy acceleration! If you don't, just send us proof of purchase with a note describing the year and make of your car. We'll refund your \$14.25 immediately.

Send for Tufoil today and prove to yourself the amazing increase in your car's performance. Fill in the coupon today or call TOLL-FREE any time, 24 hours a day.

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Stay in tune with your car!

Engines last longer with Tufoil. Our 1976 476 T-Bird is now at 190,000 miles and purring.

A bunch of customers' cars have now passed 250,000 miles.

Several months ago, a nice man I'd never seen before walked into my office, big smile on his face, sat down and said, "Would you believe 340,000 miles on a Tufoil engine?" He went on to rave about how well his engine has been running all these years. I couldn't get a word in edgewise.

Recently, a truck driver called in with over 1,000,000 miles on a diesel using Tufoil - WOW!

A customer from Vermont added 10% Tufoil to his sticky mechanical transmission, called in and said he couldn't believe it... "Shifting is like slicing butter now!" he said.

SAAB owners are writing letters praising Tufoil in their "NINES" magazine. They report spectacular improvements in their engines and transmissions!

Don't forget! Tufoil is the result of over 15 years of research and development. The U.S. government has awarded us 6 patents so far...so have Germany, England, France and Canada.

No other lubricant even comes close.

FREE... Products based on TUFOIL technology. Check one with each order of 2 bottles or a quart. Check 2 for each gallon order. Values range from \$3.98 to \$9.95.

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- 30 Questions/Answers about TUFOIL
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See NASA Tech Briefs for technical details, 1986, 1987 and 1988.

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rush my TUFOIL order:

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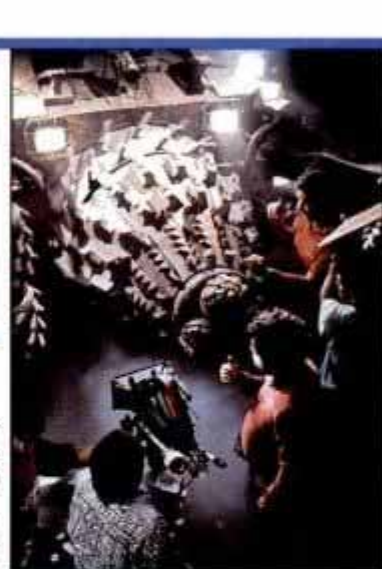
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## F/X Bonanza In 'Total Recall'

HOLLYWOOD, CA—Special-effects junkies may reach nirvana when "Total Recall" hits the screen this summer. Directed by Paul "Robocop" Verhoeven, and

starring Arnold Schwarzenegger, the film reportedly cost more than \$60 million to make.

The Los Angeles-based Dream Quest Images, which created the lush scenic effects of "Blade Runner" and "The Abyss", handled the film's optical effects. Filmmakers spent an unprecedented amount of time using real-time, motion-control camerawork. This allows a computer-controlled camera to pan across characters moving in front of a blue screen. Then the same motion-control program steers a

Computer-controlled Animatronix brought to life the cyborg driver of film's Johnny-cab (left). Other futuristic hardware includes a murderous mole machine (above).

camera panning over a matte background painting or miniature set. Parts of the movie are set on Mars, and the sets derive from NASA's concepts of human settlements on the red planet.



Schwarzenegger plays a construction worker of the year 2084.

CAROLCO PHOTOS

## Clash Of The Particle Colliders

ARGONNE, IL—As plans for the huge Superconducting Supercollider (SSC) wax ever more costly, a new accelerator has proved able to whip electrons up to speed over desktop distances.

Recently demonstrated at Argonne National Laboratories, the wakefield accelerator uses a technique reminiscent of racing cars "drafting" the car ahead.

In Argonne's apparatus, a driver beam, a pulse of electrons, is fired along a ceramic tube. As it travels, the beam induces in its wake a moving charge that races along the inside of the tube. This moving charge pulls a second group of particles launched a fraction of a second behind the driver beam.

Accelerating continuously, the energy level of the trailing beam builds quickly. Injectors feed fresh driver beams into the tube to replace driver beams whose energy is flagging. The timing of these injections—to the billionth of a second—is crucial to the accelerator's operation.

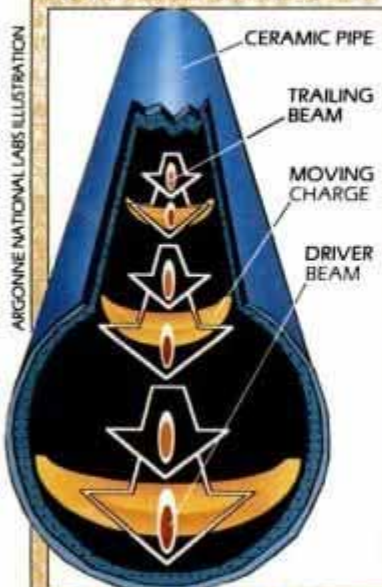
Scaled up, the existing apparatus could generate light-speed energy levels with a tube only 32 ft. long. A tube 2 miles long, configured for

heavier protons instead of electrons, could do the job the 55-mile-long SSC is expected to do.

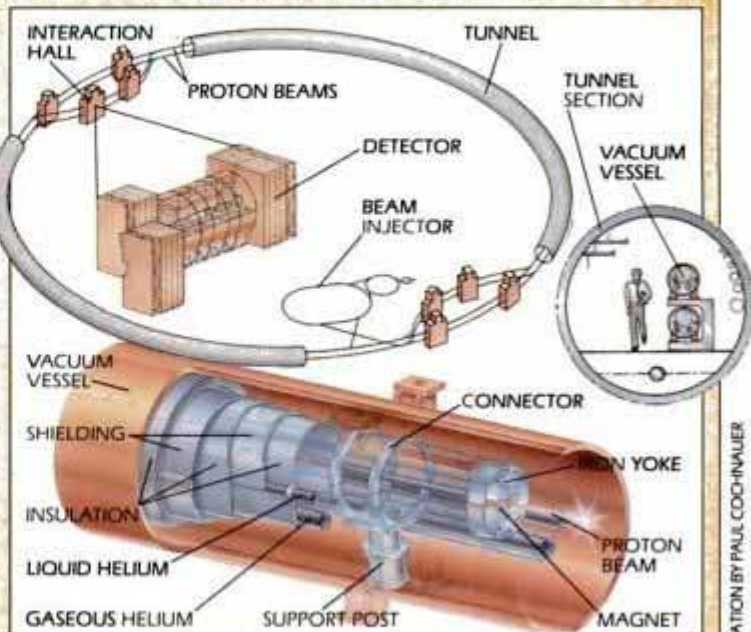
Meanwhile, the price tag for the SSC has jumped from \$5.9 billion to more than \$7

billion. Reason: The proton smasher will need a beam injector twice as powerful as originally planned, and a beam tube 1/2 in. wider. Ground has yet to be broken for the project.

ARGONNE NATIONAL LABS ILLUSTRATION



In wakefield accelerator, trailing beams ride on wake of driver beam. Wake shows up as moving charge on inside tube.



Latest plans for the SSC include a 2-trillion-electron-volt injector (top) and new cryostat (above) with a wider beam tube.

PM ILLUSTRATION BY PAUL COO-HAUER



# IMPORTS

BY RICK TITUS, West Coast Editor



Decontented Corrado will sell for about \$15,500.

Corrado's 158-hp, 1.8-liter supercharged 4-cylinder produces 166 lb.-ft. of torque at 4000 rpm, and though it never nails you to the back of the seat, it does pull the car toward its impressive 140-mph top speed in a hurry.

The biggest news regarding the Corrado isn't what's changed for 1990, but, more importantly, what will change for 1991.

The Corrado is currently base priced at \$17,900, a sizable sum, and a figure VW feels has hurt Corrado sales. In an effort to lower the base price, VW plans to decontent the car for '91 by removing a number of the currently standard features. These include the power windows and mirrors, the Heidelberg AM/FM auto-reverse cassette stereo with six amplified speakers, the 6-function trip computer, the standard

## VW Goes Back To Basics

**V**OLKSWAGEN USA is set to tackle that most difficult of all car biz challenges: the art of staging a corporate comeback. To do this, VW will put an end to rebates—a rather courageous move in the face of a soft market and consumers conditioned to believe that the only good deal includes money back.

Add to this a broadening of Volkswagen's product line, price rollbacks that in some cases go back to 1987 figures, plus a new management edict that requires unswerving attention to customer satisfaction, and you quickly get the sense that VW is going to bring about its recovery the old-fashioned way—by earning it.

### Passat

Leading Volkswagen's bid for an American-market renaissance is the all-new Passat, which will be available in two body styles—a 4-door notchback sedan and a 4-door wagon. Based on a front-wheel-drive platform, the Passat is powered by a 134-hp, 16-valve 2.0-liter 4-

cylinder engine that's reasonably snappy when it's mated to the 5-speed manual transmission (standard equipment), and just a tad sluggish when matched to the optional 4-speed automatic.

The Passat's two leading market strengths are its huge interior and trunk space, which should create instant appeal for owners with families, and its base-feature packaging. Base priced at \$14,770, the 5-speed Passat's equipped with air conditioning, height-adjustable steering column, automatic shoulder belts, height-adjustable front seats with adjustable thigh and lumbar supports, and individually adjustable fore/aft rear-seat cushions with 2-position backrests as standard features.

Options include the 4-speed automatic, power tilt/slide sunroof, antilock braking system (ABS), 15-in. alloy wheels, leather seats, cruise control, power windows and mirrors, central locking, an antitheft Heidelberg AM/FM auto-reverse cassette stereo with six am-

plified speakers, and a cold-climate option that features heated front seats with individual temperature controls and heated windshield washer nozzles. All of which, when paired with the Passat's attractive styling and tidy fit and finish, make



New Passat series heads VW lineup, beginning at \$14,770.

Volkswagen's new lineup leader look like an exceptionally solid value.

### Corrado

The Corrado bowed last year as the fastest production car VW has ever introduced, and is, by all accounts, an impressive sports car. Its slippery body is assembled by one of Europe's oldest and most respected custom coachbuilders—Wilhelm Karmann—and measures up to the firm's excellent reputation for quality assembly.

rear window washer/wiper, and the unique automatically activated rear wing.

The net savings should lower the Corrado base price by nearly \$2500. However, we think there'll also be a corresponding drop in resale value. The Corrado is a good sporting ride, and it's better with the items that are about to be classified as extras.

We'd have to say that Volkswagen is serious about making a comeback, and we think some very good buys will be the result. **PM**



**225 horses  
are bound to kick  
something.**

225 horsepower at 4200 rpm. 300 ft. lbs. of torque at 3200 rpm. Gas-pressurized struts up front. Quadra-Shock system in the rear. And four patches of extra fat rubber on the pavement. Mustang GT. Grab onto the five-speed and make your move. It's a kick in the tranny.



Buckle up—together we can save lives.

Mustang GT, защищенный литиевым стеклом



**Best-built American cars.**

The best-built American cars are built by Ford. This is based on an average of consumer-reported problems in a series of surveys of all Ford and competitive '81-'89 models designed and built in North America. At Ford, "Quality is Job 1."

All 1990 Mustangs are equipped with a driver air bag supplemental restraint system.

# Ford Mustang GT

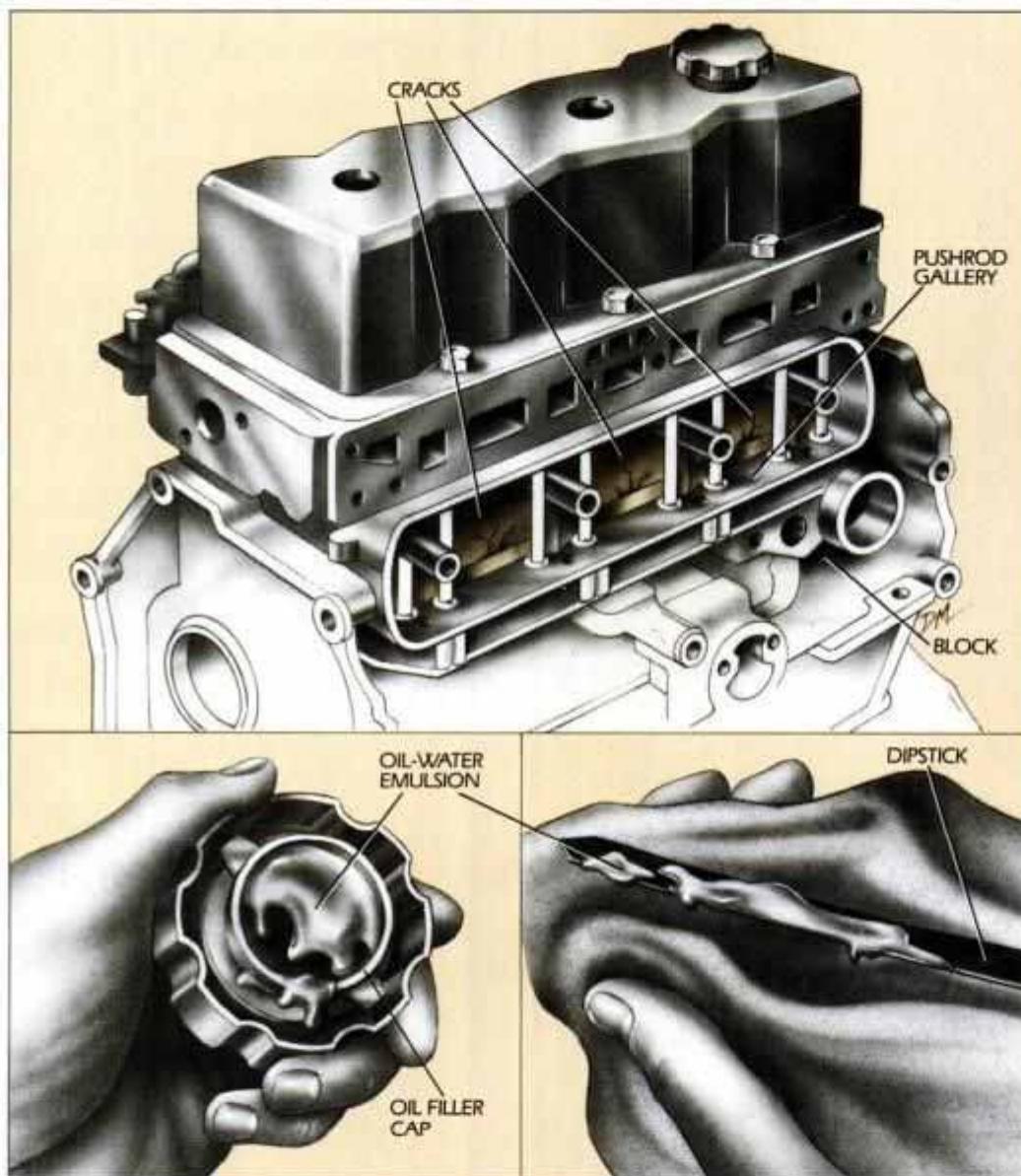
Have you driven a Ford...lately?





# CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



## Water, Water, Everywhere

**M**Y 1983 LYNX has been showing beads of moisture and a light brown froth on the dipstick. I'm concerned that this "condensation" is harmful to the engine. The mechanic says it's because of the paraffin-based oil I use, and that I should change brands.

CHARLES PURSEGLOVE  
LINCOLN, IL

I have a 1984 Fiero, and coolant seems to be getting into

the oil, because the oil gets yellow and milky. I've replaced the cylinder head and gasket. I've already fixed this problem twice, so I have to make sure by asking for your opinion.

TIEN NGUYEN  
COOKVILLE, CA

*I'm answering both these letters together because the symptoms are similar, at least at first glance.*

*Water, or coolant, in the oil*

*makes for a mayonnaise-like emulsion. High-paraffinic oils seem to be more prone to this than aromatic-based oils. Paraffinic oils are also supposed to be better lubricants. A certain amount of goo building up on the dipstick or inside the oil filler cap is normal, especially in colder weather on cars used for short trips, and is certainly not going to cause any engine damage.*

*Also, Ford has a TSB (85-16-7) for modifying the crankcase breather system to*

*reduce condensation, which is a problem on Lynxes of this vintage. So, Charles, continue to use your current brand of oil if you like, see the dealer about the TSB, and get a new mechanic.*

*But, Tien, you have big problems. Fieros of this vintage had major problems with cracked blocks.*

*Pontiac put the 2.5 Iron Duke motor through a mass-reduction program that year, and reduced the amount of cast iron, enough for cracks to appear in the pushrod gallery area of the block. Warranty was extended on these cars because of this, but your car is way, way past even this extended offer. You might try requesting that GM honor this warranty, but it's a long shot.*

*You'll have to replace the block, preferably with one from some other year of car.*

*How do you tell the difference between normal condensation and the dreaded Cracked Block Syndrome? In the case of the Fiero-type leak from the water jacket to the unpressurized pushrod gallery, you'll have to drain the oil and examine it. All of the oil will be emulsified with water, not just the cooler areas around the dipstick and oil filler cap.*

*And if the problem is subtle, oil analysis can detect even a few drops of coolant in the oil. Coolant, because of its anticorrosion additives, leaves trace contaminants that oil analysis spectrometers can detect.*

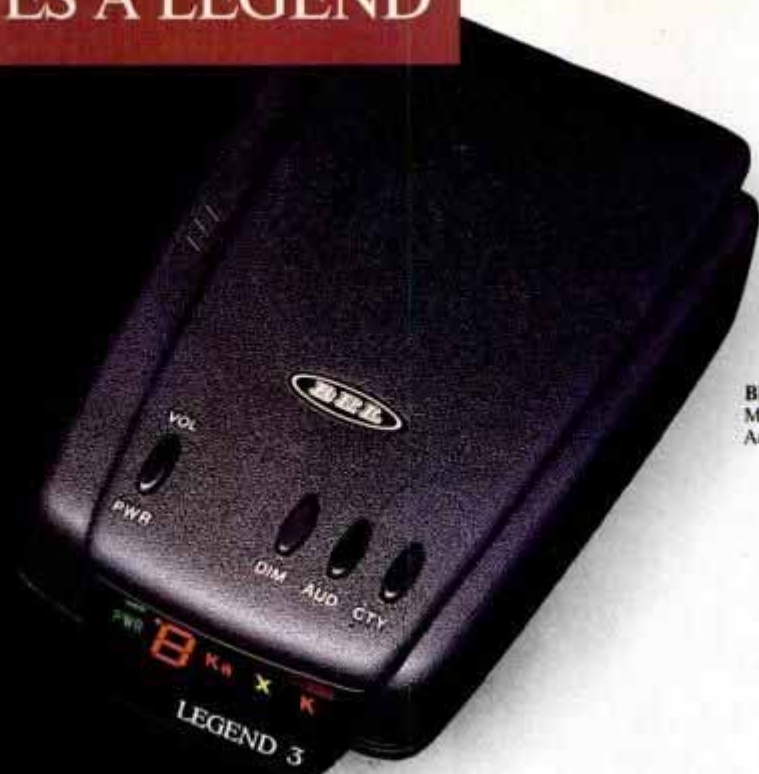
## Turn, Turn, Turn

My friends and I have a difference of opinion. They say that in a conventional ring-and-pinion differential, only one rear wheel is driven. I say that both are driven equally, until one starts to

*(Please turn to page 22)*



# BEL CREATES A LEGEND



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Actual Size

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## CAR CLINIC

(Continued from page 20)

spin. And that even in a turn, where the outside wheel must turn faster than the inside, both wheels are powered.

Most people agree with my friends, but who's really right?

MAURICE WILLIAMS  
BROOKPARK, OH

*You're almost right, Maurice. Even in an ordinary (not limited-slip) differential, both rear wheels normally carry equal amounts of power. When one wheel speeds up for a turn, there's still an equal amount of power. In fact, when one wheel is spinning crazily on a patch of ice or buried in a mudhole, they still carry equal amounts of power.*

*That's how differentials work. Before any physics professors out there start bringing their word processors to critical mass, power is a very specific term in this context, and not the appropriate term for the case at hand.*

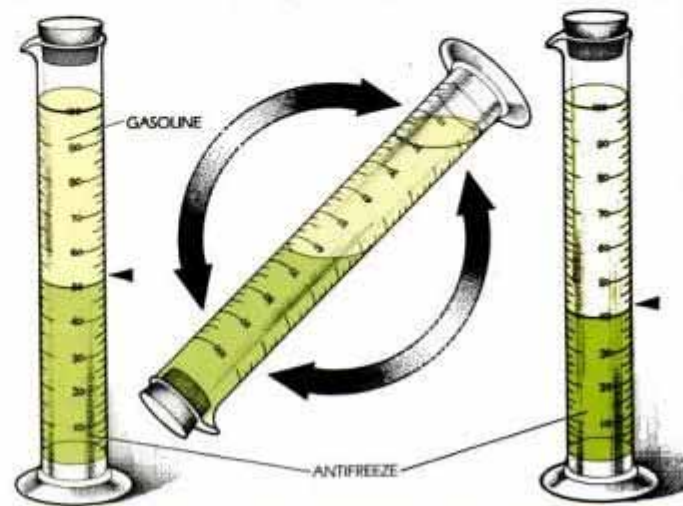
*Torque is really what we're talking about here. Torque is the amount of twist applied to a rotating object, and a differential will equally divide the torque between the wheels. When one wheel sees less resistance, it can speed up. But if the resistance at the wheel is so low that the torque overpowers the friction between the tire and the road, then the wheel will*

## 20-Proof Is The Limit

I've been getting a lot of complaints about driveability and fuel-system corrosion from readers. Apparently, there are a few unscrupulous individuals out there who are adulterating gasoline with excess amounts of alcohol.

Ten-percent additions of ethyl alcohol ("Gasohol") are acceptable, and represent a good way of extending nonrenewable resources with biomass-derived energy. But, today's cars aren't engineered to run properly on concentrations higher than 10 percent.

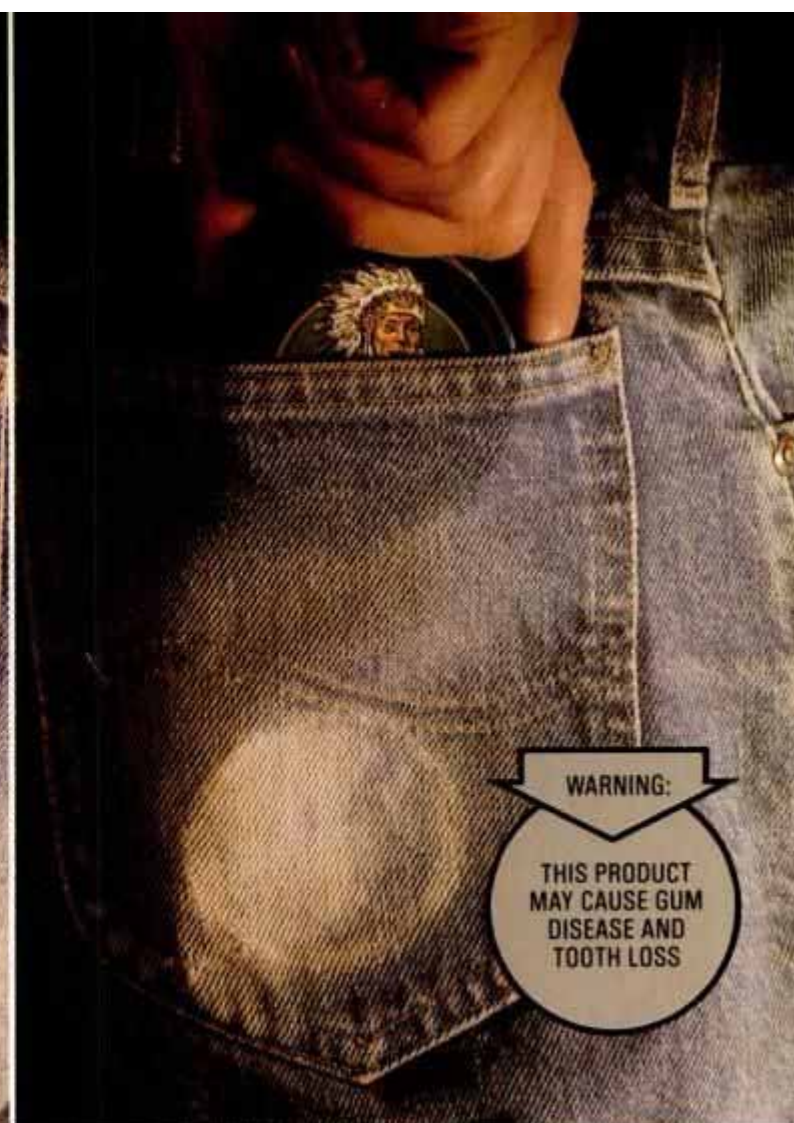
Problem is, how do you tell if you're getting higher concentrations? Take equal quantities of the suspect gasoline (an ounce or two is plenty) and pure, undiluted



antifreeze. Mix gently, by inverting the container a half-dozen times. The alcohol in the gas will move to the alcohol-based antifreeze, changing the proportions of the two volumes. If what started out as 50/50 gas/antifreeze is now 40/60, then the gas was 20-percent alcohol to start with.

PM ILLUSTRATION BY ADOLPHE BROTMANN





WARNING:

THIS PRODUCT  
MAY CAUSE GUM  
DISEASE AND  
TOOTH LOSS

spin—and only an identical amount of torque will be available at the other tire.

This amount of torque may not be enough to propel you out of the mudhole. Limited-slip differentials simply use friction clutches to limit the difference between the speeds of the two axles, making the transfer of power to the pavement (or mud) more uniform.

This phenomenon is also why lightly applying the parking brake may help when one wheel is spinning—even though both wheels are being braked, you've increased the torque to the high-traction wheel by the amount of braking torque you've added to the spinning wheel.

## Back End First

I began to have trouble with my rear brakes locking. Over the space of about three months, I installed new semimetallc pads in front and new brake shoes, turned the rotors and drums, installed a new proportioning valve, and pressure-bled the system completely—but the rear wheels on my '83 Riviera still slide first.

JOHN RUSH  
PITTSBURGH, PA

*You've installed semimetallc front pads where formerly an organic pad was in use. The friction characteristics of the metallics are different, and they require*

more pedal effort for the same braking effect. They will work better once they heat up, and should last longer than the OEM compound.

The organic rear shoes are getting the benefit of the extra effort, and locking up. Altering anything that will change front-to-rear brake bias is a crapshoot.

Replace the front pads with OEM organics. If you are towing, or feel you need longer-lived pads, or think you give your brakes particularly severe service, then leave in the semimetallc pads and change over the rears to a matching semimetallc compound.

## In Hot Water

Do you know of any detrimental effect that can be caused by engine-block or bottom radiator hose heaters, if they are properly installed?

I've been using these for years, and believe it has led to the long life of my cars' engines.

A local mechanic expresses the concern that reversing the normal heating process will confuse the new engine sensors on the computer-controlled vehicles. What do you say?

GEORGE DAY  
VOORHEESVILLE, NY

*The on-board computer has two basic modes: open loop and closed loop. It runs*

in open loop until the engine warms up to proper operating temperature, then drops into closed-loop mode.

In this mode, the O<sub>2</sub> sensor actually allows the computer to sense the lean/rich state of the exhaust, and adjust the fuel to achieve the best economy and most power.

The heaters you use are thermostatted well below the engine's operating temperature—at least 100° F below. They will not affect the normal warmup process—except to shorten it, which is good.

I don't, however, recommend dipstick-type oil heaters. They can overheat the oil locally, even though the engine has remained cool, something that will, at best, decrease the efficiency of the oil.

Best is the kind that replaces one of the soft plugs in the engine block. This will put the heat where it will do the most good—that is, in the cooling system. Easier to install, and still good, is the kind that goes into the lower radiator hose.

To conserve energy, use a timer to turn on the heater in the morning an hour or so before you need the car, rather than leaving it on all night.

## Exhausted

I'd like to change over the exhaust system on my '89 Grand Marquis to dual  
*(Please turn to page 24)*



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TOOTH LOSS

STRAIGHT  
FINE CUT



EXTRA  
WINTERGREEN  
FINE CUT



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## CAR CLINIC

*(Continued from page 23)*

pipes instead of only one. With these computers, I wonder if there will be some adverse effects.

I assume there will be some gain in power, and I actually have seen some late-model Mercurys with duals, so I assume it's possible.

RICHARD QUIXANO  
PALM HARBOR, FL

*It's certainly possible, Richard. Any muffler shop can do the job. The engine computer will be capable of handling the change, although it might need its calibration chip replaced.*

*But—you're voiding your warranty, which isn't a very good idea. Because some Marquis models come with duals, you probably won't have any trouble getting an inspection sticker.*

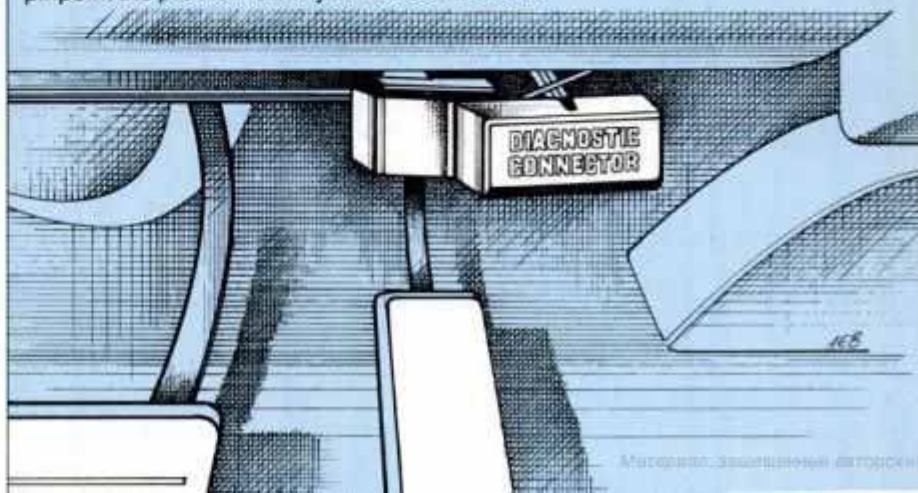
*Here's the hard part: You'll have to add a second catalytic converter, which will add considerably to the expense. Finally, there won't be more than a half-dozen extra ponies under your hood for the effort. Don't do it.*

## His Story Won't Hold Air

I have an almost-new steel-belted radial tire with a hole in the tread about 1/4 in

## Secrets Of The ALDL

The "diagnostic connector" under the dash of this car is typical of most modern cars with on-board computers. You can use it to access the trouble codes the computer stores when it finds a fault in its sensors or internal operation. Readers keep asking me to list the trouble codes in their car's on-board computer. I won't do that, for several reasons. First, the codes are extremely specific to make, year, model, engine and trans on your vehicle, and I don't want anybody to mistakenly use the wrong one, figuring their '87 is close enough to the '86 they read about in last month's Car Clinic. Second, you'll need to know much more than how to access the codes and what they mean. The factory shop manual will have the procedures you need to pinpoint the problem once you access the code.



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LONG CUT

ple of times, but a slow leak persists. In older days, it would have been a pretty simple puncture repair. But my tire dealer and the Buick shop manual say it's not possible.

What can I do? Can I patch it from the inside, or use a tube?

PAUL SCHNEIDER  
DANVERS, MA

*Don't use a tube. It'll make any tubeless tire run way too hot.*

*The recommendation about not plugging holes in steel radial tires near the edge is appropriate for two reasons.*

*First off, the steel belts tend to cut the plug through may cut the steel wire, precipitating a belt failure. If there is any evidence of cut steel wire, scrap the tire.*

*Secondly, reaming the hole to get the plug through may cut the steel wire, precipitating a belt failure. If there is any evidence of cut steel wire, scrap the tire.*

*I've had good luck patching radials. Demount the tire, and buff the area for 2 in. in diameter around the hole. Apply a tube-type rubber patch, according to the manufacturer's recommendations. When the hole is near the edge, this sometimes fails, as the constant flexing peels the patch off after a few hundred miles, but it's worth a try.*

*If you ever have this problem again, skip trying to plug the hole from the outside, and go straight to patching it from the inside.*

## Excuses, Excuses

I needed a jump start for my '82 Skyhawk, but a fellow in the office refused, because he said you can mess up a car with electronic ignition if you jump-start it.

Is this true, or is it just a convenient excuse?

DAVE HELMS  
MUNSTER, IN

*He was just ducking having to help you. There's no reason why cars with electronic ignitions shouldn't give or get a jump start.*

*Briefly, here's the correct procedure for a jump start: First, connect the two positive battery terminals together. Then, hook the second cable onto the negative terminal on the running car. Next, hook the cable onto the engine block of the stalled car. Wait a minute or three to put a little juice into the discharged battery. Then have someone hold the running car at high idle, while you crank the stalled car.*

*After the car starts, remove the negative cable to the block first.*

PM

## DO YOU HAVE A CAR PROBLEM?

*Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 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.*

## SERVICE TIPS

- Early-production 1990 DeVilles, Fleetwoods, 60 Specials, Eldos and Seviles may experience an engine stall when placed in gear immediately after an engine start. This may be caused by an improper PROM calibration. TSB T-90-2 covers the part numbers for the correct replacement PROM.
- Wheel vibration on some early Mitsubishi Eclipses that isn't attributable to wheel balance may be traced to interference between the chamfered edge of the rotor hitting the hub, preventing proper seating. This will make the rotors run out of true, causing a wobble that will be felt under light braking. Replacement rotors will fit correctly. TSB ATIN-88-05-001
- If you own a 1988 or '89 domestically manufactured Chrysler product with a nontilt steering wheel and the turn signal has stopped canceling after the steering wheel has been removed, check TSB 08-03-89. There is a pin in the wheel that must index with the turn signal switch.
- 1989 Honda Accords that have a rattling noise from the front wheel area when going over bumps, which is reduced when the brakes are applied, should have their front caliper brackets replaced with new parts.
- If you haven't seen the recall campaign, some '89 Ford 4x2 pickups with 133-in. wheelbases and manual transmissions may have been manufactured without a protective shield for the fuel tank.



# DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



## Ford Limits Caprice Response

**A**SIDE FROM rivals bearing other GM divisional nameplates, Chevrolet will still have the full-size wagon market all to itself when Ford brings out its 1992 Crown Victoria and Mercury Grand Marquis.

That's because Ford has no plans to build a replacement for its current full-size wagon. Instead, Dearborn will depend on the Taurus wagon and Aerostar van to meet the demand for carryall vehicles.

At least that's the plan for model year 1992, the new Crown Vic's first year.

Chevy, meanwhile, is planning a big splash for its full-size Caprice wagon, to be unveiled later this year.

Chevy may very well steal the big wagon market with the new Caprice. It looks like a larger version of the Taurus, just right for buyers who want the hauling space of a full-size wagon in a sleek, sedanlike package.

## Grand Prix Facelift

Smaller headlights and a squeezed-down grille opening distinguish this '91 Grand Prix from the '90 model.

The styling of this early production GP shows what can be improved when the size and position of headlights are altered. Freed of government restrictions that dictated a common headlight

shape and standard height, automakers are building lower hoodlines that offer better forward vision and improved aerodynamics.

The smaller lights also give the Grand Prix a customized appearance.



Like Crown Vic, '92 Grand Marquis will feature aero styling.

Look for all the GM-10 models, including Oldsmobile Cutlass Supreme and Buick Regal in 1991 and Lumina in 1992, to switch to the smaller headlights.

## Saturn Update

Insiders at GM expect that Saturn, scheduled to begin production late this summer, will eventually supply parts for other GM cars, and perhaps even sell to companies outside GM.

Saturn's 4-speed automat-

ic is one feature that outsiders are likely to covet. It will be a state-of-the-art electronically controlled gearbox, just the right size for compacts and subcompacts.

Also, Saturn's 1.9-liter aluminum engine promises to deliver the kind of power and economy with light weight that other GM divisions crave for their smaller models. Saturn officials say that the company may act the part of a supplier, but only after its own production is up to speed and running smoothly.

## Electronic Camshaft

The work of camshafts may be taken over by electronic systems within a few years. Siemens and other electronic firms report that valve timing may be regulated by electronic pulses instead of chain and gear drives.

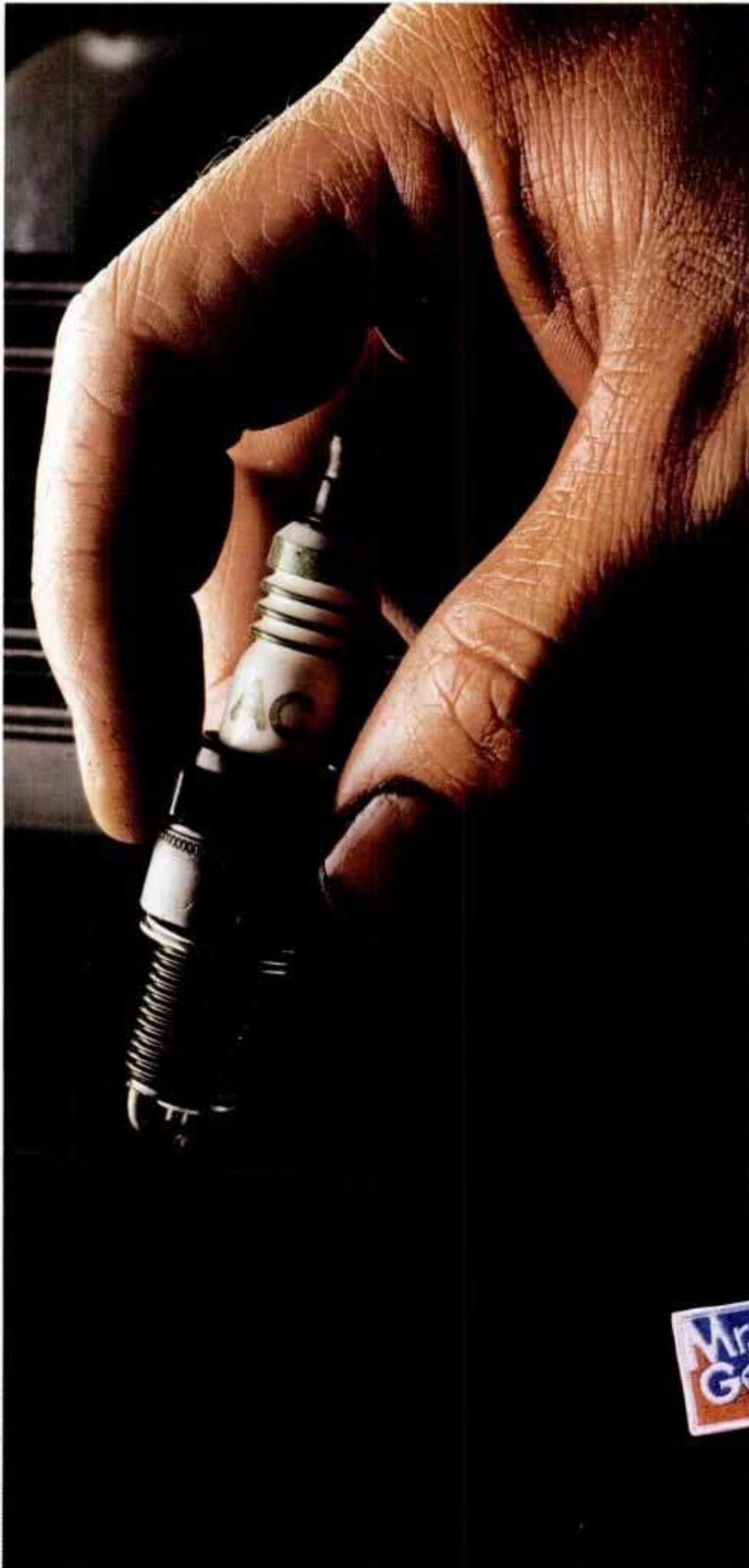


Grand Prix facelift for '91 entails smaller headlights, lower hoodline.

Valves would then open and close by magnetic force instead of cam lobes and springs. The electronic control system would open up all kinds of possibilities. Spark timing could be custom designed to fit different power demands put on the engine at all its speeds.

Camshaft timing in today's cars is set in hard metal, and every camshaft in production represents a compromise between fuel economy, emissions and performance. **FM**





## Power is being restored.

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# OLD HOUSE RESTORATION

BY BOB VILA, Contributing Editor



PM ILLUSTRATION BY EUGENE THOMPSON

Period garage plans that yield outbuildings, like this Colonial Revival Coach House from Lynch & Co., can help restoration enthusiasts design their own outbuildings.

remember is that for the building to be historically correct, the proportions of the design must be accurate. By this, I mean the size of the walls and the roof pitch must be right for the building's style. When the proper proportions are coupled with the right period detailing, the result is a historically appropriate structure.

## Today's plans

No matter what the age of your house, you should be able to find a period garage plan appropriate for this addition. A good source for outbuilding plans designed in the feel of those that adorned early American houses is Eli Townsend and Son, Inc., P.O. Box 351, Clinton, CT 06413. Its most popular plan, the "Carriage Shed," is a flexible early American design detailed with, among other things, strap-hinge barn doors and a cupola. The cost for a set of plans is \$15.

If you're interested in adding an outbuilding that will historically complement a Victorian house, Lynch & Company Ltd. (9205 W. Center, Milwaukee, WI 53222) offers a fine set of Victorian and post-Victorian garage plans in four styles: Italianate, Queen Anne, Eastlake and Colonial Revival. All follow the proper proportions of the period in question and have the right detailing to complement a home in each style.

For example, the company's pattern for the "Bracketed Coach House" features fancy roof brackets and a cupola—both popular elements of Italianate architecture. The "Queen Anne Coach House,"

## Period Garage Plans

**M**ANY old-house owners find, when all is said and done, that there is one thing missing from their property—a period garage.

Most of the original old outbuildings that accompanied and complemented their homes, like barns and carriage sheds, weren't maintained properly. As a result, they are long gone.

Re-creating a period garage today involves blending a bit of the past with the present. Namely, you'll want to build a structure with a period feel that complements your restored old house, but that will be used to house one or more automobiles.

Fortunately, there are companies that supply garage plans ideally suited to this market. These include plans for simple saltbox designed garages, barns and carriage sheds, along with those for outbuildings in Victorian and post-Victorian styles.

A brief look at the history of these structures, along with a discussion of today's plans, will help you choose an

appropriate addition to your property.

### Details and proportions are key

Today's garage is a product of evolution from the wagon or carriage barn. On early American farms there was often a separate barn used for storing wagons and carriages, along with the main one that housed animals and hay. Great expense may have been put into the house, but the quality of barns and sheds was often a function of the materials available and, in many cases, what was left over. Many times, outbuildings were constructed out of necessity and didn't do justice to the houses they neighbored.

Many of the better Victorian homes had a matching coach house, designed in the same style as the main structure. In cases where the homeowner couldn't afford to build what was, in essence, a *minihouse*, at least the roof pitch and the siding were usually the same as that of the main house. It wasn't until the

early 1900s, around 1910 to 1920, that houses began to be designed with a garage.

No matter what type of outbuilding you decide to add to your property, its degree of authenticity will depend on its level of detail.

Proper period detailing for a simple saltbox-style garage, for example, often includes design elements like beveled wood siding with a 4-in. exposure, good multipaned windows, a well-laid cedar-shingled roof and strap-hinged barn doors. If you're building a Victorian garage, this period detailing may include things like brackets, spindles and diagonal siding (depending, of course, on the style in question).

Most of the period garage plans I've seen aren't exact copies of existing buildings. Rather, they are adaptations of the best of a number of original outbuildings taken from old pattern books and then re-designed to accommodate our 20th-century needs.

Many plans can be adapted to construct a building to house one, two, three or more cars. The important thing to



in keeping with the style of that day, is detailed with textured materials, like routed bargeboard and diagonal siding, along with a hood that borders its windows and doors. The "Colonial Revival Coach House" has unmistakable Palladian features, while the "Eastlake Carriage Shed" sports the turned posts, wood spindles and fretwork common to this architecture. The cost for each plan is \$18.

Lynch & Co. also offers something I found rather unique: plans to *Victorianize* a modern garage. Assuming you have an existing utilitarian garage—a basic 21-ft. x 21-ft. unit with standard height walls and a hip roof—the proper replacement and addition of exterior elements can transform this plain structure into a Queen Anne-styled building. Some of the details the plan dictates include changing the siding, adding diagonal boarding and new trimwork.

### What's involved

There are a few different ways to approach a project like this. Some folks subcontract the cement work, like the footings and slab, along with the framing, then complete the siding and finish work themselves.

What you decide to do really depends on your level of expertise. Many of these plans were designed so that a skilled home-improvement expert (I imagine a good number of my readers fall into this category) could conceivably tackle this project from start to finish. Of course, time is always an important element to your planning, along with that all-important restoration budget.

No matter which route you choose, you will need a building permit and you must conform to your local building codes. So before putting a shovel in the ground, make sure that you are complying with all local regulations.

The plan you choose should include all the details necessary for the building's construction, including framing diagrams, foundation footings, sizes for door and window headers, and reinforcing rods. In addition, the details necessary to define the structure as one of a certain period should also be noted. These include things like the type of siding and its proper exposure, the recommended styles for both windows and doors, along with specifications for decorative elements like moldings and cupolas. If you plan to supply electrical and/or plumbing service to the building, however, you'll have to add these components to the plans yourself because mechanical systems are rarely specified on plans for any outbuilding.

No matter what type of garage you decide to add to your property, make sure its proportions and detailing are appropriate for the period of your house. When all is said and done, adding a period garage will enhance your total restoration efforts.

PM

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# OUTDOORS

BY JOE SKORUPA, Boating/Outdoors Editor



PHOTO BY DAVE HALL

## High-Tech War On Poachers

**T**HEY SHOOT poachers don't they? Not in the U.S. At least not yet, and probably not ever. But in Kenya, the Wildlife and Conservation Management Dept. shoots at poachers first, and then questions them later. It's Draconian, but the man who implements it, Richard E. Leakey, was recently named *Outside* magazine's Outsider Of The Year for 1989.

Leakey was forced to take these harsh measures for three reasons: 1. Wildlife species in his care, notably elephants, are on the brink of extinction, 2. Poachers kill conservation rangers, and 3. Time is running out.

In 1970, Kenya counted 140,000 elephants. Today, the number is 20,000. At the poacher's former rate of three kills per day, a United Nation's environmental report estimated the Kenyan elephant had 10 years to go before extinction.

But that was before Lea-

key. In the first year of his stewardship, the rate of illegal elephant kills is down to one a month. During that same period, 60 poachers died.

### Eco outlaws

Needless to say, Leakey's methods are controversial. Conservation supporters find it hard to justify a policy of armed confrontation. But Leakey's rangers are facing gun-toting outlaws, and shootouts are self-defense. Also, he's given Kenya a new reason to have hope for the future. Tourism is the impoverished country's most profitable industry, and the elephant is the industry's biggest asset.

Fortunately, poaching in America isn't as dangerous, or as potentially disastrous, as it is in Kenya. But it's still serious. So serious, in fact, that the U.S. Fish and Wildlife Service recently purchased a Bell Jet Ranger helicopter to help stamp out

the illegal slaughter of up to 4 million birds per year. And the Department of Justice recently built a \$3.5-million high-tech National Fish and Wildlife Forensics Laboratory to aid in the successful prosecution of black-market wildlife traffickers.

The story behind the purchase of the Fish and Wildlife's new chopper is a fascinating one, with plenty of white knights to share in the credit. Villains are plentiful, too.

Black-market trade in elk, bear, wolf, bobcat, sea lion, bald eagles and other coveted species is estimated to be between \$300 to \$400 million per year. During a recent undercover sting operation in Massachusetts, two law enforcement agents participated in transactions involving gall bladders from 374 black bears, 25 full bear carcasses and the heads, hides and paws from another 15 bears.

Why the tremendous demand for bear gall bladders? They're sold for use in folk medicine in the Orient. Kore-

an and Chinese dealers made the grisly purchases in the case cited above.

On a personal level, I can't understand the Oriental thirst for powdered animal horns and organs. Neither can I understand the disregard for life shown by a wealthy Texan of several years ago. He paid a guide \$5000 per shot at trophy elk out of season. He shot five and left four to rot. Why? Only one was big enough for the record books.

### Birds in the bayou

Gross wildlife poaching violations in the state of Louisiana go back a long way, according to recently discovered records at the Fish and Wildlife Service. Field agents documented their concerns about gross poaching in the early 1970s. But the problem goes back farther than that. It's woven into the social fabric of the Cajuns and other groups who live off Louisiana's wildlife-rich bayous. Ducks have always been an inexhaustible resource to these people and,



until recently, they weren't too far from being right.

About one-quarter of all North American ducks migrate to Louisiana for the winter. This swampy region is the cold-weather home to most of the birds traveling the Mississippi and Central flyways. Fifty years ago, the region hosted about 30 million ducks, a flock so immense that endangerment seemed inconceivable. Today, the number is about 10 million, and dropping. Endangerment is almost here.

During the 1987-1988 hunting season, special enforcement agents from the Fish and Wildlife Service in Louisiana made the following discoveries:

■ Three hunters were found with 168 ducks, 78 of which were shot the morning of the arrest.

■ Another three hunters were found with 71 ducks.

■ A solo hunter was found to have killed 53 ducks in a single outing.

■ One special agent placed 78 hunters under surveillance. Of these, 35 were tagged with grossly exceeding the daily limits, and between them possessed 574 ducks. Of the remaining 43 hunters, 26 were cited for other violations. It got to the point where the agent in charge began to wish for just one legal duck camp so he could sit down and enjoy a cup of coffee with some fellow outdoorsmen. It didn't happen that season.

Two points should be made about the above data. One is that it became clear to special agents in Louisiana that gross poaching isn't just a problem, but a way of life. And second, bad as it was, the gross excess used to be worse. Fifteen or so years ago, when there were more birds, reformed poachers claim that they didn't have a good day if they didn't return with 100 ducks per man.

### Eye in the sky

After a few drought years in the mid-1980s, it became obvious to wildlife managers and outdoorsmen that continental duck populations were lower than they'd ever been and at a crossroads. Blame for this was attributed to habitat loss and a huge increase in legal hunters. Both factors were genuine. But few people recognized the extent and effect of poaching. Fish and Wildlife agents knew, especially in Louisiana, but their input was unappreciated at the national level.

Everything changed in 1988 with the publication of a powerful, 4-part series in the *St. Paul Pioneer Press Dispatch* called "Empty Skies," written by Dennis Anderson. In words and photos, Anderson drove the point home that the North American duck population was being decimated, and that gross, illicit poaching in Louisiana was a large part of the problem.

Anderson's stories caused a firestorm

of national attention. To his credit, Anderson did more than expose a problem. He came up with a solution: Buy the Fish and Wildlife Service a helicopter. It's easy to spot a poacher illegally spreading corn (called baiting) from the air. Also, the chances of apprehension are greatly increased.

Anderson wrote about his helicopter idea in the *Pioneer Press Dispatch*, and it triggered a flood of donations. The Izaak Walton League of America enthusiastically joined the project and set up a helicopter fund in early 1988. In less than a year, enough money was contributed by conservationists, hunters, outdoorsmen and businesses to put a down payment on a \$650,000 Bell Jet Ranger helicopter. Ultimately, the Fish and Wildlife Service agreed to add the balance and Bell promised a year of free service. The helicopter officially went into operation on February 12, 1990.

Interestingly, so much money was raised during this effort, about \$300,000, that enough was left over to buy Louisiana enforcement agents two new airboats. Recently, these were also put into service.

Is the problem of poaching in Louisiana solved? According to Louisiana native Dave Hall, a Fish and Wildlife enforcement agent for 30 years, it's down by a large percentage, but not solved. "Most times," says Hall, "success of a program is measured by tickets written. But the truth is that we'll never catch even 1 percent of the violators. The only way we'll end poaching is to treat it as a social problem rather than a wildlife problem. It's the human animal we have to concentrate on."

Hall is currently working on a program dubbed "From Poachers To Preachers," where he uses reformed poachers to spread the message of wildlife awareness in a language that hunters and children can understand. The success of this program has convinced Hall that given education in ethics, hunters are willing to accept responsibility and to police themselves.

What can you do? First of all, strictly obey game laws and demand the same of your friends. Report violations. The National Parks and Conservation Association has established a toll-free poacher hotline: call (800) 448-6722. Encourage schools to offer conservation classes. Lobby for the judicial system to treat wildlife abuses as serious offenses. Support funding for enforcement budgets. And finally, treat your game warden with the respect he deserves.

Because of Dennis Anderson, the Izaak Walton League, concerned citizens, responsible hunters, Dave Hall and others, the U.S. doesn't need to institute a poaching policy like the one set up by Richard Leakey in Kenya. At least not yet, and, I hope, not ever. **PM**

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# SCIENCE

BY ABE DANE, Science/Technology Editor



NASA ILLUSTRATION

## Beyond The Planets

**W**HEN THE SUN has dwindled to just another speck in the blackness, and the last trace of its influence has been left behind, the great void of interstellar space begins. That point is called the heliopause. It marks the edge of the heliosphere—an envelope of gas, dust and radiation thrown off by the Sun that separates the solar system from what lies beyond. Exactly where this boundary lies no one knows. But at this moment, four hardy space probes—the most distant outposts of human perception in the universe—are racing to find out.

Their names are *Pioneer 10*, *Pioneer 11*, *Voyager 1* and *Voyager 2*. All are better known for earlier encounters with the planets closer to home, which is what they were intended for. But even as the flow of data from these overachieving spacecraft

slows, and the corps of scientists monitoring it thins, a few linger on hoping for more answers.

Among the most eminent of these is professor James Alfred Van Allen, discoverer of the globe-circling radiation belts that bear his name. I spoke to him about what the probes have found so far, and what is yet to be discovered.

### Distant envoy

Now farthest out of the probes is *Pioneer 10*, shown in the artist's concept above. Launched in 1972, it was the first man-made object to pass beyond the orbit of the most distant planet, and is now 4.4 billion miles away. Although built to last only 30 months, NASA believes they can nurse it along until the year 2000.

Whether or not that will be long enough to reach the heliopause is an open question.

Estimates of the boundary's distance from Earth commonly range between 50 and 100 astronomical units (one astronomical unit equals about 93 million miles). "That leaves quite a bit of uncertainty," says Van Allen. His best guess is that the heliopause lies somewhere between 85 and 100 astronomical units away. *Pioneer 10* is now just short of 50 astronomical units away, and will not reach 100 until 2010.

Van Allen's estimates of the distance to the heliopause are based on the rate at which cosmic rays increase as the craft moves out through the thinning heliosphere. Since cosmic rays might be affected by variations in solar activity, as well as by distance from the Sun, Van Allen has had to compare *Pioneer 10*'s measurements with ones from *Pioneer 11*, which is now about 2.8 billion miles out. So far, cosmic rays have been in-

creasing at about 2 percent for every astronomical unit the spacecraft travel, but, says Van Allen, "we don't know if it will continue." Matters are complicated by the fact that the heliosphere is probably not spherical at all, but rather molded into a teardrop shape by its movement through the interstellar medium. All in all, says Van Allen, "It's an intricate and fragile argument."

### Are we there yet?

Putting speculation aside, how will we know the probe has entered the interstellar medium? For one thing, says Van Allen, readings of "the cosmic ray intensity will be almost constant with time." The probe would also cease to sense solar flares, and would register a change in the movement of spaceborne plasma when solar wind gives way to stellar wind. These changes will probably not be sudden, however. "Most expect the heliopause to be a soft boundary," says Van Allen.

Even if *Pioneer 10* gives out before reaching that point, the odds are good that another of the four spacecraft now hurtling outward would find the boundary. Although it was the last to be launched, the speedy *Voyager 2* will actually overtake *Pioneer 10*, and reach 100 astronomical units first, arriving in 2007. More complex than the *Pioneers*, the *Voyagers* have a higher risk of mechanical failure, but could send back more detailed data if they make it.

But whether or not any of these most-distant man-made objects make it to the edge of the solar system, they will have extended the grasp of human curiosity farther than any explorers before them. **PM**



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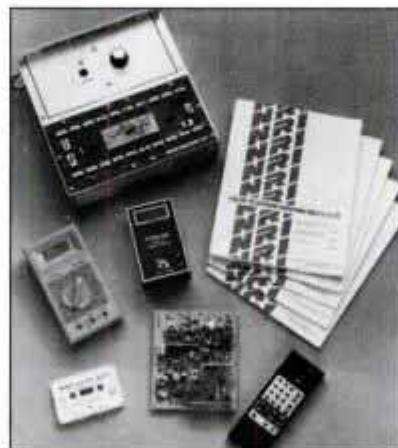
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# HOME FINANCE

BY DAVID ELIAS

## Workers' Compensation Insurance

**A** MAN I KNOW was proud of his new ranch-style, 3-bedroom house in Old Bridge, New Jersey, and the grounds that surrounded it. In fact, he paid a teenager to mow the front and back lawn every week during the summer. One Saturday, however, he had a different young man do the job. As fate would have it, that teenager cut more than the grass that day. As he was pulling the power mower backward, he tripped and yanked the machine over his foot, chopping off a toe.

My friend called the insurance company that wrote his homeowner's policy to notify them of the accident. They told him some pretty bad news: While he was covered for certain types of liability, this particular case fell under Workers' Compensation, and his policy didn't include that. The result? He was sued for \$2 million.

There's one great thing about doing all the work around the house yourself: If you get hurt and decide to sue, at least you'll be dealing with a reasonable person. But realistically, if you're a homeowner, it's likely that at some time or another you'll hire somebody to work on your home. And it's good to know whether or not you're covered. Do keep in mind that in terms of insurance coverage, degrees of responsibility vary from state to state. They also depend on what type of labor a homeowner might employ: domestic, casual or professional.

### Domestic labor

A domestic worker is a person hired to perform ordinary household duties in a domestic setting, such as preparing, serving and cleaning up after meals, cleaning windows, mopping

floors, making beds and doing laundry. Other examples of domestic work are a full-time companion to an invalid or sick person, a person hired as a nanny or governess, or a full-time, live-in maid.

Domestic workers are entitled to Workers' Compensation insurance in many states—New York, for example—if they work 40 or more hours per week. Depending on the state's laws, insurance is purchased by the employer or jointly by employer and employee. The coverage provides cash benefits and medical coverage for workers who become disabled due to an on-the-job injury or sickness. If death results, benefits are payable to the surviving spouse and dependents as defined by law.

In short, the law in such states treats domestic labor in the same way it treats employees in a factory.

When covered by Workers' Compensation insurance, an employee can't sue his or her employer, so it's a

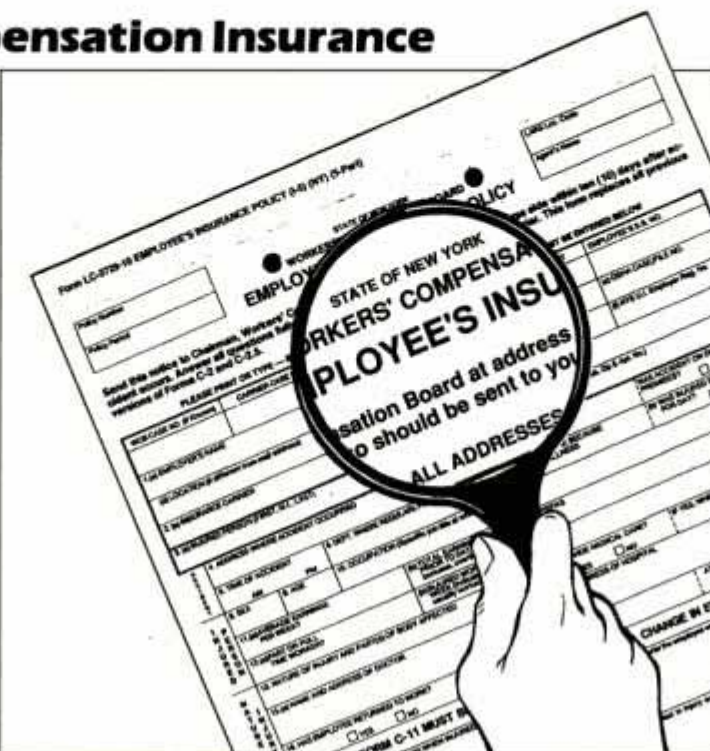
mutually beneficial system. Even before the Workers' Compensation Law, an employee rarely won a settlement from an employer. But when it did happen, the payoff was often astronomical—the stuff that headlines are made of.

The homeowner/employer is responsible for adhering to state Workers' Compensation laws.

In some states, there's a free market for this type of coverage, meaning you can shop different carriers and compare. In others, the system is a monopoly—only a select company, or sometimes a couple of companies, can sell it. In still others, it's not needed at all in a domestic situation.

In Texas, for example, domestic employees are included in the basic homeowner's policy.

In New York and other states, domestic employers are obligated to get Workers' Compensation insurance for themselves, and their employees.



### Casual labor

Casual labor refers to the people you pay to work around your house on an occasional basis. Such employees include babysitters age 17 and under, minors who might do odd jobs for you, or an adult hired to do repair work or painting on a part-time basis.

Federal law prohibits minors, depending on age, from doing certain types of work. This includes work that involves the use of power-driven machinery, like lawnmowers. So when you give a 15-year-old \$10 to cut your lawn, you're probably violating the Child Labor Law and inviting a liability nightmare.

Casual laborers are excluded from Workers' Compensation laws, but are covered on most standard homeowner's policies. If your policy doesn't include such part-time employees, contact your agent. The additional cost, if any, is minimal compared to the risk that's involved.

### Professional labor

Professional labor includes anyone a homeowner enters into written contract with to work on his or her property. Remodeling contractors, like carpenters, roofers or landscapers fit into this category. These workers should have their own insurance. In fact, in most states they can't be licensed without it.

But remember, it's still your responsibility to make sure these professionals are insured. Ask to see their certificate of insurance, and then make a call to the insurance company to double-check.

If any damage to property or personal injury should occur involving an uninsured professional on your proper-



ty, you are totally liable. This includes damage to your neighbor's property. The overwhelming consensus among insurance people is that you should forbid an uninsured professional from stepping on your property.

### Other liabilities

However, if a professional is using any of your equipment, you are liable for injury caused by any defect in that equipment. For example, if a professional painter suffers an injury due to a rung on your ladder giving way, you're liable. If he suffers the same injury falling from his own ladder, all you owe him is payment for the work he has done.

The lesson is clear: If you hire a professional, assume that it is his or her responsibility to be properly equipped. Do not offer them the use of your own personal property.

Assuming there's no negligence on your part—your pit bull gets loose, your kid starts taking human-target practice with an air rifle, your yard is mined with explosives—then the problem you'll most likely face isn't whether you're covered, but whether you're sufficiently covered.

With domestic labor, you're protected by Workers' Compensation. In the case of the professionals, they should have their own insurance.

### The gray area

The fuzzy gray area is with casual labor. They're probably covered under your homeowner's policy, but only up to a certain amount.

For example, if you employ an uninsured college student to paint your house, and he falls off a ladder and suffers permanent spinal damage, your \$50,000 liability isn't going to satisfy him or his attorney.

Before amateurs engage in high-risk work on your property, talk to your insurance agent. It may be to your benefit to buy extra insurance, since you can have your policy altered to include a specific individual. Or, it may be in your best interest to hire a professional to do the work.

Remember, when purchasing a homeowner's policy, you must disclose any hazards on your land, such as a hole or a pond. If you don't, you won't be covered in the event of an accident involving that hazard.

### Umbrella policy

If you're the type who has trouble sleeping, you might consider an umbrella liability policy.

"For about \$100," says Edward G. Wright, vice president of marketing for Exchange Insurance Co., Buffalo, New York, "a consumer can purchase

\$1,000,000 worth of protection, which covers him whether he's at home, at the office or playing golf. Where can you find a better deal than that?"

The umbrella policy goes above and beyond basic protection. It covers you for any number of potential lawsuits, such as slander, mental anguish, false arrest and malicious prosecution, as well as the *traditional* physical injury claims.

The umbrella liability policy would typically cover the gap between regular home or auto insurance, and a financial judgment against you.

For example, if that uninsured college painter wins a judgment against you for \$1,000,000, and all you carried on your homeowner's policy was \$100,000 worth of liability, the umbrella will pay the remaining \$900,000, thus saving you and your family from financial ruin.

An ounce of conscientious home maintenance, management and research can usually beat a pound of liability. Keep your home safe and in good repair: Nail down loose boards, replace burned-out light bulbs, repair loose carpeting and exposed wiring, chain unruly pets, fill or cover dangerous holes. The simplest, and often the quickest, household repairs can save you a lot of money and heartache in the long run. **PM**



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# ELECTRONICS

BY FRANK VIZARD, Electronics Editor



## Briefcase Entertainment

**I**F PORTABILITY is what you look for in home entertainment systems, then two new video and audio systems that fit into a briefcase should be added to your luggage. The video system comes from JVC, while the audio system is made by Cambridge Soundworks, Incorporated.

Called "Concept C" in its prototype stage, the SC-F007U system from JVC is a group of interchangeable modular video components that can be used separately, or all together. The heart of the system is a tiny Super VHS hi-fi videocassette recorder.

Other components in the SC-F007U system include a 3-in. color LCD monitor with a built-in speaker and a tiny CCD camera with microphone. All three components can be connected together in two ways: Both the camera and color monitor can be attached directly to the VCR, or cables can be used to make

the connections.

The small size of the camcorder makes live video recording potentially more interesting. The camera's small size means it can be clipped to the pole of a hang glider or onto the shoulder of a bicyclist. Having a color monitor on hand means footage can be viewed by all instantly. If there's one drawback, it's the lack of a zoom capability, an admittedly high expectation considering the camera's size.

Savvy video fans will also detect an immediate drawback to the use of SVHS-C videotape. SVHS-C blank videotape offers only 20 minutes of recording time in the standard play (SP) mode, or 60 minutes in the extended play (EP) mode.

List price for the SC-F007U system is \$2499. All of the components fit into a briefcase supplied by JVC.

Audio lovers seeking portability may become enamored of the Model Eleven

briefcase system from Cambridge Soundworks, Inc. While the Model Eleven won't suffice as a main listening system for the long term, it will offer the quick fix that is so often needed at a vacation house or other temporary housing.

All you add to the Model Eleven is the sound source. If the sound source is a personal Walkman-sized cassette or compact disc player,

there's already a compartment in the briefcase for it. Everything else is already packed.

What's in the briefcase? Power is supplied by a  $7 \times 5 \frac{1}{2} \times 3$ -in. amplifier offering a total of 36 watts. The amplifier packs more punch than its specifications and size would suggest. Audio pioneer and Cambridge Soundworks founder, Henry Kloss, uses a bi-amplification technique—meaning the bass frequencies are amplified separately from the upper frequencies—to boost output, while retaining the amplifier's small size. Bi-amplification works well in this case since the amplifiers can be tailored to fit the speakers, a known quantity with the Model Eleven. The amplifier includes three sets of inputs for tape, CD and auxiliary sound sources.

The Model Eleven is basically a 3-piece speaker system. The two milk-carton sized satellite speakers are actually each 2-way systems in their own right. Each satellite contains a 3-in. mid-range and a  $\frac{3}{4}$ -in. tweeter.

The third speaker is actually the briefcase itself. Inside the briefcase is a 7-in.



JVC's video [top] and Cambridge's audio gear fit in a briefcase.



woofer which fires bass frequencies through a grille on one side of the briefcase.

How well the Model Eleven sounds seems very dependent on the quality of the signal source. For example, in using the included Y-adaptor to plug in a common personal stereo, the resulting sound quality seemed fair to poor. When using a high-quality CD player as the signal source, the sound was much better. One can only conclude that the Model Eleven tends to amplify what might be previously inaudible flaws in the signal source. The Model Eleven amplifier has both a stereo and mono switch, the latter being particularly effective when using the system with a standard television. The Model Eleven could easily be used to upgrade a mono TV in a second bedroom, while it waited for its travel orders. With a list price of \$750, the Model Eleven is somewhat more expensive than the widely available portable boom box. The Model Eleven, though, sounds better than most boom boxes and offers more flexibility.

The Model Eleven, like all Cambridge products, is not available in stores. To order or ask for information, call Cambridge Soundworks toll-free at (800) 252-4434.

## Smart Televisions

The thinking man's television may be one that actually thinks for itself. Both JVC and Sony are introducing TVs that use fuzzy logic, or artificial intelligence (AI), to learn from past experience. Fuzzy logic is a term used to describe the technology that enables a computer to simulate the human judging and decision-making process regarding imprecise areas.

JVC and Sony, however, are applying this technology in different ways.

JVC uses fuzzy logic in four new models in two fashions. In the first instance, the JVC television monitors viewing habits to determine which three broadcasts are the most frequently viewed during the day and also at night. Depending upon the model, your favorite three stations are either displayed on a menu or on a multiscreen format for easy selection. It's like having your own Nielsen rating service at home.

In a second application, the JVC television can store data relating to the audio volume at different times of the day. The television then uses this data to automatically adjust the volume to your preference. The volume set for the evening news would be different than that for MTV late at night, for example.

Both these features are available this summer in a 27-in. and a 31-in. model listing for \$950 and \$1600, respectively. Two other models sporting artificial intelligence

**You can hold Sanyo's new camcorder as you would a pair of binoculars.**

are slated for the fall.

Sony, meanwhile, is using fuzzy logic to improve picture quality. Incorporated into the new 27-in. KV-27XBR50 and the 32-in. KV-32XBR50 is a fuzzy logic application called Active Signal Correction (ASC). In this application, 248 reference points on the screen are monitored 60 times per second for contrast, color, brightness and sharpness.

A perfect picture, of course, is often in the eye of the beholder. Sony uses a basic data base of 40 perfect pictures culled from high-definition laserdisc images. These new Sony TVs also take other factors into account as well. Additional data include any changes you've made to the preset levels for picture, color, brightness and sharpness.

ASC also considers the amount of extraneous signal



noise and the set's relative working condition. The ASC circuitry may work harder as the TV ages, for example, to compensate for a deteriorating picture tube. ASC is more evidently in use some times more than others.

The 27-in. Sony lists for \$1500, and the 32-in. lists for \$2700.

Fuzzy logic may not be the best term to use in connection with televisions, but this type of circuitry is destined for many video applications. Both Canon and Sanyo are using it in camcorders, for example. How is fuzzy logic applied in camcorders? Sanyo FVC-880 seems to keep an object in focus as it moves across the viewing plane, rather than just focusing on what's in the middle of the lens. The auto iris, meanwhile, seems able to quickly adjust itself to changing colors, even if the color of the object stays the same while the background changes.

The FVC-880 is also unique in other ways. The FVC-880 looks more like a pair of binoculars than a camcorder. The 2-handed design is meant to reduce the blurring caused by camera jitter and to allow quicker access to all controls.

The FVC-880 is also very light at 1.7 pounds, just a fraction less than the lauded Sony TR-5. List price for the FVC-880 is \$1300. Look for a more in-depth review in a future issue.

FM



This JVC television learns from past experience.



# FREEWHEELING

BY CLIFF GROMER



## Days Of Thunder, Hollywood Nights

**T**HE adrenalin starts pumping hard as the back end of the car lifts up straight off the pavement at a speed in excess of 175 mph.

There's no time to think, no time to react. And it's too late now to do anything about it anyway. From inside the strongly braced race car, the world goes into a slow-motion, dreamlike spin, although in this case, the dream is really a nightmare. The driver is aware of a jolting crash as the car smashes down hard on its roof, then goes into a disorienting series of somersaults.

Hitting the fence at the top of the track, the car rolls down sideways and comes to rest on its side in the middle of the circuit, drawing the pack to it like a giant magnet. There's split-second maneuvering, as the drivers bring all their nerve, skill and instinct to bear.

Fenders crunch, sheet-metal flies and cars spin out wildly in a mad effort to avoid brutal contact. But to no

avail. Lying on its side across the track, the lifeless hulk presents a target as big as a barn, and it takes the full brunt of a T-bone hit.

Cars pile up all over the place, ambulances scream to life, and a limp body is dragged from the brutalized wreck to be rushed to the infield hospital.

"Cut!"

The ambulance comes to a halt and the crumpled driver sits up and dusts himself off. For Tom Cruise, on location in *Days Of Thunder*, it's all in a day's work.

### Reality plus

For sheer realism, *Days Of Thunder* makes other films on motorsports pale by comparison. You won't see any wild special effects or video fireworks. "This isn't a science-fiction film," says executive producer Gerry Molen.

What you *will* see is an actual *Days Of Thunder* camera car (46) actually ran in Winston Cup events to collect authentic racing footage.

most documentary honesty that cuts to the heart of what big-time American stock car racing is all about. And of course, spectacular crash scenes come with your price of admission.

Staging these crashes uses tried-and-true technology developed over the years by stunt and special-effects crews. The first step is to choreograph the crash,

Producers shunned video technology in favor of conventional 35mm movie cameras.

breaking it down into its component sequences.

The initial phase of the stunt may have the car doing a series of end-overs. Then it may progress into side rolls and other autobatics.

Initially, the car is literally blasted into the air. A cannon built into the undercarriage is packed with gunpowder and armed with a short length of telephone pole. The charge is triggered by the driver in an adjacent car. The pole is fired into the ground, which launches the car into an endo or side roll, depending on the cannon's position.

A complete crash sequence may consist of scores of separate filmings spliced together in the editing room for one smooth-flowing thrill show.

All of the high-risk work, of course, is handled by stunt drivers, and not the actors themselves.

### Panavision preferred

While some films and your Sunday afternoon motorsports TV show may use the latest high-tech race-cam video cameras, *Days Of*





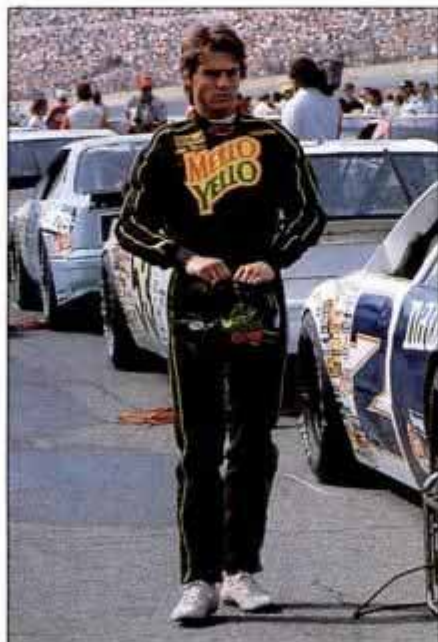
*Thunder* relies on conventional 35mm reel-to-reel Panavision movie cameras. According to the production company, video just can't duplicate the "feel" of 35mm film and does not work effectively with Panavision.

The cameras themselves are mounted inside the car and in a special crashproof housing built in the headlight area behind the grille. Rear-mounted cameras ride low in the trunk area with the lens projecting through the bumper.

Expect to see a lot of low camera angles, for dramatic effect, from both car- and track-mounted cameras. The latter, operated by remote control, were so close to the action that a couple got crunched in the course of filming the wilder scenes.

### Cruise credit

The idea for *Days Of Thunder* originated with Tom Cruise, himself a credible race driver. Introduced to the sport by Paul Newman, when they were filming *The Color Of Money*, Cruise took racing seriously, and also took the concept for a serious race film to Paramount. The studio was interested



Cruise brings racing experience to his role.

and reunited producers Don Simpson and Jerry Bruckheimer and director Tony Scott, who put together the very successful *Top Gun*.

"Cruise can really drive," relates Jimmy Johnson, a spokesman for Rick Hendrick, who is the NASCAR team's owner and a race consultant on the film. "He came down to Daytona, jumped in one of our cars, and cut some hot laps in the 185-mph

range." Hendrick supplied cars and drivers, and obtained complete NASCAR cooperation, without which the film would not have been possible.

To get the realism needed for the film, the entire crew immersed themselves in racing by attending events like the Firecracker 400 at Daytona. Director Scott also spent hours reviewing real racing footage to make his crash scenes look authentic. But the script makes it all come together. Hendrick

set up interviews for screenwriter Robert Towne, who spent four weeks talking to drivers like Rusty Wallace, Darrel Waltrip, Dale Earnhardt and a half-dozen other big names in the business. Towne did his homework, asked all the right questions and taped the conversations. He also spent weeks in the Hendrick race shop watching and listening as the crew tore down the cars and put them

back together again.

Tapes were made of radio conversations between drivers and pit crews during actual races, dialogues that had to be toned down for the film because in their unedited state, according to Jimmy Johnson, they "were a little too colorful."

### Camera qualifying

Most of the racing footage was done under real competition conditions. Hendrick had to qualify the camera cars, the same as everyone else, in the races they ran at Phoenix, Darlington and Daytona. The camera cars received no preferential treatment. They had to be fast to qualify and 100-percent NASCAR legal.

Under special arrangement with NASCAR, they were not running for points, but started at the back of the pack and retired from the races after they shot the footage they needed.

Cruise himself needed little help or coaching when it came to the driving sequences. When racing is in your blood and you've got a natural talent for it, who needs to act? **PM**





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# BLACK JET

Forbidden even to whisper the word "stealth," pilots called it the Black Jet, and for years this nearly invisible plane has shrouded their lives in secrecy.

BY ABE DANE, Science/Technology Editor

**I**T BEGINS at 1 pm on Monday. A chartered 727 appears over the mountains and touches down on a 12,000-ft. desert landing strip shimmering in the midday heat. The plane taxis to a stop, and drops a group of handpicked pilots on the tarmac.

For the next four days, they will sleep by day, and fly by night in an aircraft that appears no larger than a bird to hostile radar, but carries in its bomb bay 2000 pounds of laser-guided high explosive. Their mission: To hunt alone in radio silence and total darkness, strike with pinpoint accuracy, and return.

So it has gone week-in, week-out for the last seven years at the Tonopah Test Range deep in the Nevada desert. There, the Lockheed F-117A



Nighthawk insignia symbolizes the mission of the 37th, which is charged with stealing up on its quarry in the F-117A Stealth Fighter, then striking with leading-edge avionics and ordnance.

Stealth Fighter, also known as the Nighthawk, roosts in the custody of the 37th Tactical Fighter Wing. But until recently, the pilots were not even allowed to tell their families the full story.

Although the existence of the plane was acknowledged in November of 1988, and it has now made its first public appearances, operations at Tonopah have remained mysterious. Dormant by day, the base's 47 hangars would slide open only under cover of darkness, and were securely buttoned up before first light.

In recent months, however, the Air Force has begun to loosen the strict code of secrecy. Now, for the first time, the men who fly the Black Jet are beginning to give accounts of life



## BLACK JET

at Tonopah, and of the invisible plane that draws them there. POPULAR MECHANICS was granted the first exclusive interview with one of these elite pilots—Capt. Philip McDaniel of the 416th Squadron. Our story is based on his comments, along with those of other pilots present at the F-117A's debut before the press.

### On the tip of a spear

To anyone looking at the aerodynamically improbable contours of the F-117A, the question that immediately comes to mind is: How does it fly? Despite rumors of skittish handling, which inspired pilots to nickname the plane "The Wobbly Goblin," those I spoke to reported nothing but affection for the plane's in-flight behavior.

Capt. Joseph Salata, who has been flying the F-117A for two years, positively bristled when I mentioned the Goblin nickname to him. "Actually the pilots who fly the airplane are kind of offended by that comment," he said. Capt. McDaniel described the sensation in more enthusiastic tones. Because of the pilot's position high above the plane's short nose, he said, "It feels like you're on the tip of a spear."

While it might not seem surprising that pilots handpicked by the Air Force to appear before the media would praise the plane's handling, others less constrained have done so as well. William C. Park, a recently retired Lockheed test pilot who was nearly killed in an F-117A crash, told the *Los Angeles Times*: "It flew great. It flew like a fighter should fly. It had nice response to the controls."

Whatever basis there might be for the rumors of handling problems probably lies in an aerodynamic flaw that plagued the early Lockheed prototypes. The planes tended to drop suddenly and slam onto the runway as they made their final approach for landing.

The problem has apparently been solved, and Col. Tony Tolin, a veteran fighter pilot and commander of the 37th, now says: "I have talked to virtually every pilot who has ever flown the airplane, and I can find no pilot who has ever referred to the aircraft as the Wobbly Goblin." He points to the plane's digital fly-by-wire flight control system, lifted almost unaltered from the F-16, as one reason for the plane's well-mannered flight.

### Secrets of stealth

In fact, as more is learned about the F-117A, it becomes clear that it is the advent of these computerized flight controls that has done more than anything else to make stealth possible. Getting an aircraft to fly straight has become as much a matter of electron-

ics as one of aerodynamics, allowing designers to shape a plane with radar foremost in their minds.

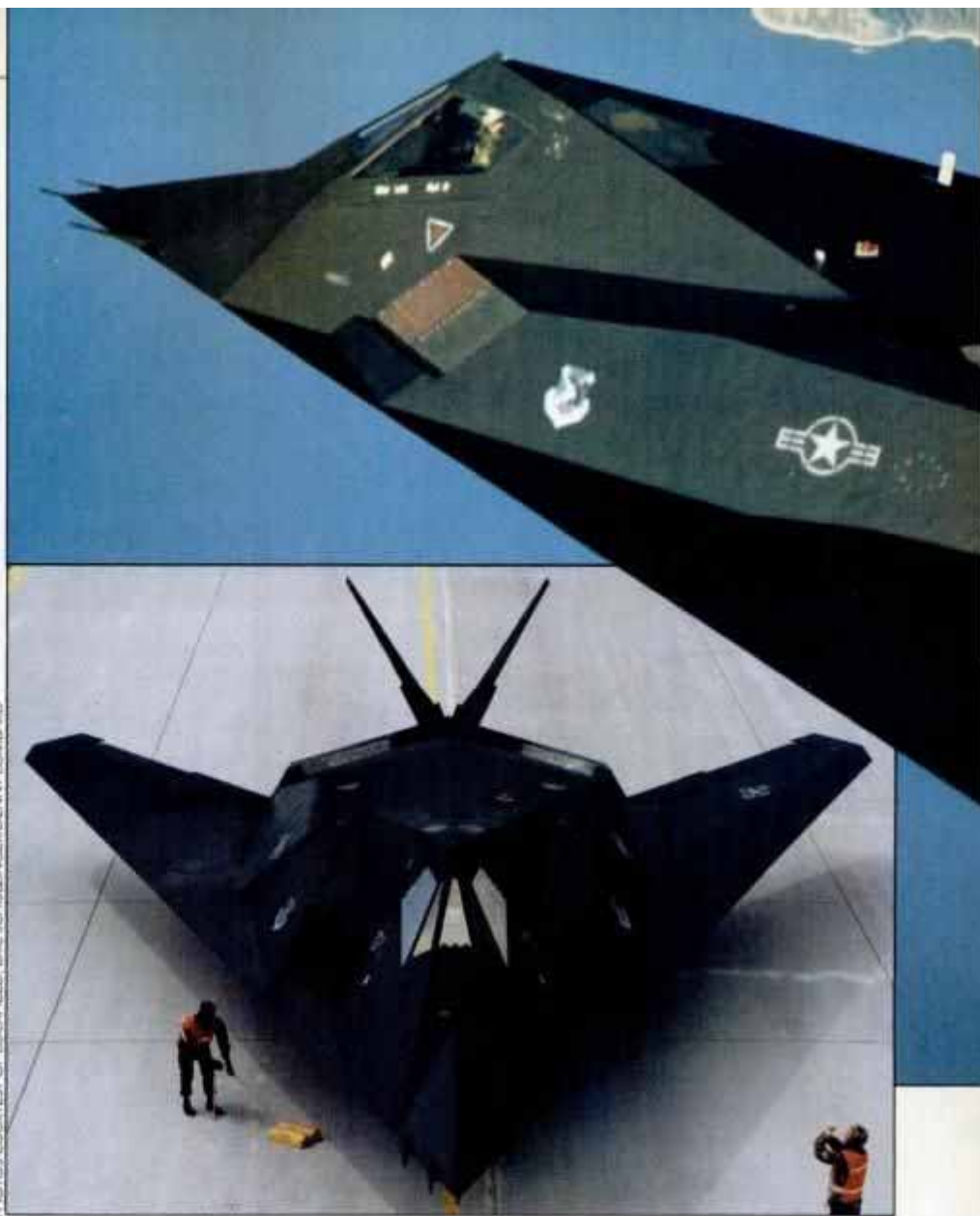
Although much has been made of the composite radar absorbing material (RAM) that sheathes the plane's aluminum airframe, it is in fact the careful arrangement of the F-117A's faceted panels that contributes most to its ability to fly undetected. Since radar is unlikely to view the plane from more than 30° above or below, the panels are all canted at more than 30° from vertical. This causes radar energy to be deflected either up or down, rather than bouncing straight back toward the receiver.

To further baffle tracking attempts, whatever radiation does return is focused into a few narrow beams. These beams appear to a radar receiver the same way that light glinting off a cut gemstone would appear to the eye, and are much more difficult to lock onto than would be a steady but weak return. The glinting effect is accomplished by aligning as many of the panels parallel to each other as possible. For example, the

leading edges of the wings, normally strong reflectors, face in the same direction within a horizontal plane, as the top edge of the fuselage and the faces of the engine inlets.

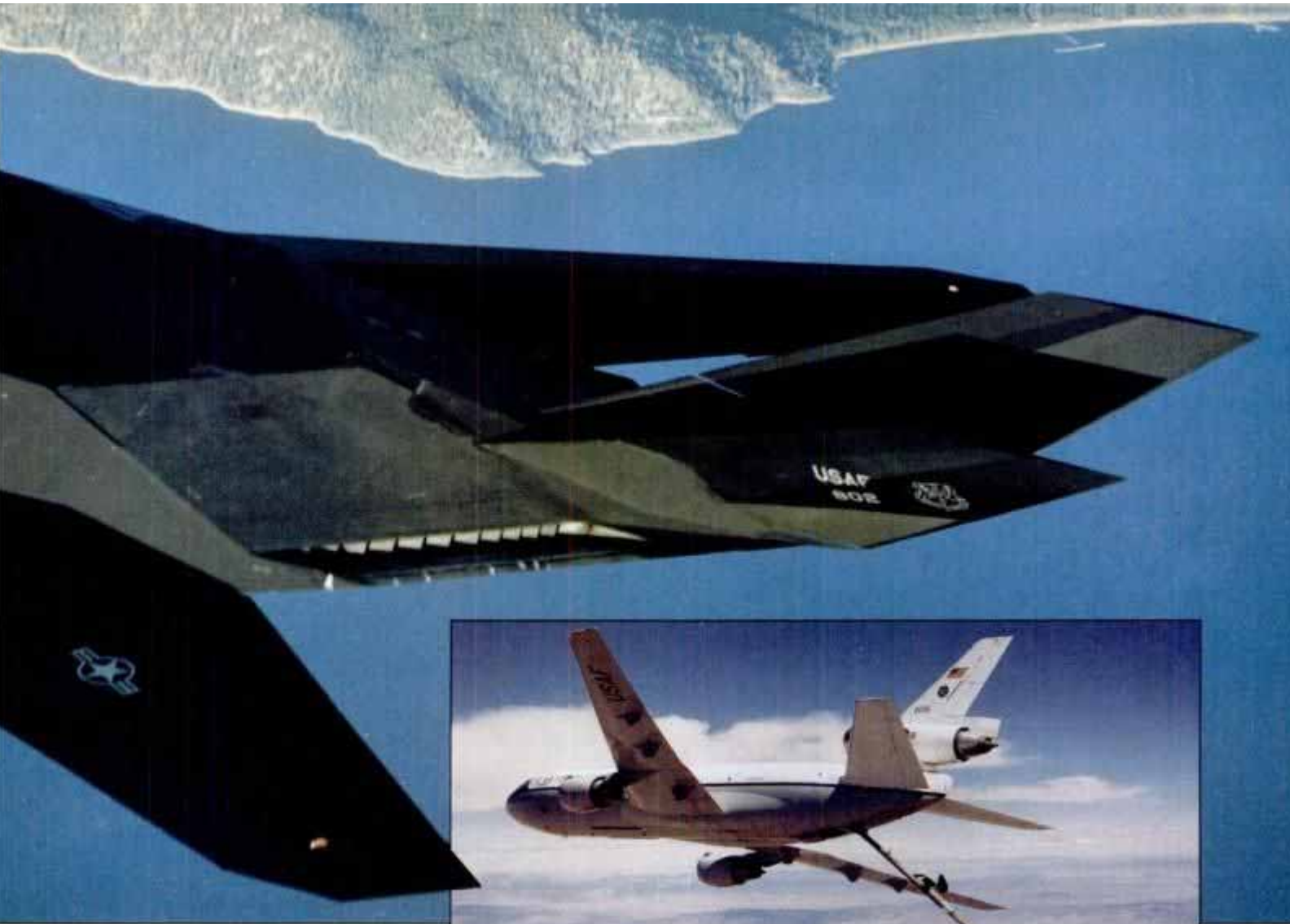
Scrupulous attention to stealth is evident in numerous other details. Serrated trim, angled to follow the beam paths, overlays the joint between canopy and fuselage. Openings for Forward Looking Infrared (FLIR) turrets used for night vision are surrounded with the same trim, and covered with a radar-absorptive mesh. A heavier mesh covers the jet intakes, masking the highly reflective turbine disks. Wing and tail airfoils are prism-shaped, with knifelike leading edges presenting minimum frontal surface area. So small is the resulting radar cross section that if the canopy windows were not coated with radar-deflecting material, the pilot's helmet alone would be more visible on radar than the entire plane.

Radar is not the only hazard the Stealth plane must evade, however. Most anti-aircraft missiles use infrared seekers to home in on the heat of



PHOTOS COURTESY OF LOCKHEED; ERIC SCHULZINGER/DENNY LOHMEYER





Looking different from every angle, the F-117A Stealth Fighter cools its jets through flat, shielded nozzles visible above. A pop-up receptacle facilitates in-flight refueling (right).



aircraft exhausts. So the F-117A's twin GE 404 turbofans vent through thin, horizontal nozzles that spread out the heat. A final measure of protection comes from a narrow ducktail heat shield along the bottom of the exhaust openings that blocks the view of them from even a few feet below.

### Making of a Stealth pilot

Although it might seem a simple matter to penetrate enemy defenses with

a plane this difficult to detect, selection and training of the Stealth pilots has been exacting. Only those with 1000 hours of jet fighter flying time were even considered, meaning the entire 37th consists of captains and above.

When the F-117A was at its most secret, training usually began in A-7D Corsair IIs. This was not so much because of any similarity between the two planes, but because it provided a

convenient cover story. When first selected for Stealth duty, pilots were typically told they were being assigned to do avionics testing on the Corsair. Their real mission was not revealed to them until about a month into training.

Transition to the F-117A was a daunting task. Since there is no 2-seat trainer version of the plane, every pilot's first flight in it is a solo. Until recently, this was complicated by the fact that the need for secrecy kept the planes hangared until half an hour after sunset. No matter how good the preparation, one can imagine how the pilots felt making that first launch into the inky sky over Tonopah in a plane that didn't even look like it could fly. And indeed, most of the pilots I spoke to cited this as their scariest moment in the cockpit of the F-117A.

By the time Capt. McDaniel entered the program in 1989, it was a different story. He says he was more "apprehensive" than scared before his first flight, since by then daytime flying was possible. "It was just a matter of how pretty it was going to



PHOTO BY RICH COX



# BLACK JET

PM PHOTOS BY RICH COX



PM PHOTO BY GEORGE HALL



Cover pilot unmasked: Capt. McDaniel (above) stands with his plane. F-117A with canopy up (right) shows heads-up display borrowed from an F/A-18. All-movable V-tail, and trailing edge flaperons are the plane's only control surfaces (top).



be," he says. For McDaniel, the trickiest stage of training was the initiation into night flying. Formerly an F-111 pilot, he was accustomed to having a copilot by his side, and found he missed the extra pair of hands. Although the plane is well instrumented, he says, "I had to learn to organize myself in the cockpit, so I know where each and every thing is."

After about two months of flight training, pilots are qualified in the aircraft, and from here, practice consists of doing exactly what the F-117A was designed for. Operational details are still secret, but the Air Force has declared the plane's purpose to be precision night attack of high-value

targets. To carry out this mission, the pilots must be proficient in the use of three critical systems aboard the aircraft. A highly precise inertial navigator provides guidance in the search for distant targets. FLIR turrets, located just below the windscreen, and next to the nosegear on the aircraft's flat bottom, serve as eyes for close-in work. And once the plane's laser designator is locked on target, a 2000-pound, low-level laser-guided bomb homes in for the kill.

The mission demands a lot from a pilot, and the combination of night flying, fatigue and aggressive new tactics designed to make the most of the plane's invisibility have apparently taken their toll. In two fatal crashes, experienced pilots appear to have simply flown into the ground. Accident reports found the planes to have

been functioning properly, and the pilots made no attempt to eject.

Still, with only three crashes in nine years, Col. Tolin says, "The F-117A has the best safety record of any modern fighter." He attributes this in part to precautions against fatigue that include locking up the pilots' blackout-curtained dorms until 1 pm to prevent disturbances, and limiting them to a single brief flight on their first night after arrival at Tonopah.

Now, as the plane moves out of the black, life is becoming safer, not to mention simpler, for the men of the 37th. There's no need for new Stealth pilots to make their first flights in complete darkness. Ground crews needn't rush to get the planes under cover before daylight. And the 37th will probably be moved to a less desolate location in the next few years, eliminating the weekly 200-mile commute from homes in Las Vegas.

## End of an enigma

As would seem almost inevitable when an aircraft at the heart of so much speculation was brought to light at last, the F-117A is both more and less than we might have expected. On the one hand, it is unprecedented—a fully operational attack plane designed and built in complete secrecy to foil radar-detection techniques that have been the nemesis of airmen since the Battle of Britain 50 years ago.

On the other hand, the F-117A is already out of date. Operational since 1983, it relies on the stealth technology of 12 years ago, and it borrows major components from such workaday warplanes as the F/A-18, the F-16 and even the C-130 transport. Incapable of supersonic speeds, and carrying only a modest bomb load, the F-117A clearly represents an effort to get first-generation stealth technology flying as quickly as possible.

But if the Air Force has been flying such a plane since 1983, and we didn't learn of it until a little more than a year ago, one has to wonder what sort of aircraft might take the Black Jet's place when it vacates those 47 tightly shuttered hangars in Tonopah. **PM**



PM PHOTO BY RICH COX





# DODGE DAKOTA

Considered average by some, loved by others.

BY MICHAEL LAMM,  
Contributing Editor

**C**HRYSLER HAS established itself as the niche-marketing champion among the domestic automakers, and the Dodge Dakota midsize pickup is one proof that the title is in the right hands.

Surveying the burgeoning pickup market in the early '80s, Chrysler product planners saw an opportunity for a truck scaled midway between minipickups like the Mitsubishi-built Power Ram 50 and full-sized models like the big Dodge D-W150 series.

Inching into the marketplace with a package slightly bigger than Ford's Ranger and the GM S-10/S-15 twins, the Dakota quickly established itself as an idea whose time had come, and Dodge marketers have been broadening the Dakota's appeal ever since.

Today, prices range from \$7995 for the S model to \$17,000 for the Sport convertible and there are now 12 models to choose from.

That's because in 1989 Dodge scooped the industry by adding a factory convertible to the Dakota line, creating a niche within a niche. And

this year, there's also a Club Cab version on a 131-in. chassis.

According to Dodge, Dakota owners tend to be slightly younger than buyers of full-size pickups, and they also earn more, with a median income of \$35,000. We found that the Dakota appeals mostly to men ages 30 to 50 and that it doesn't attract many wom-



en drivers (only 9.4 percent).

The Dakota's market share has grown every year since its introduction, starting at 2.1 percent for 1987 and currently at 7.7 percent. For 1988, Dodge sold a total of 93,396 Dakotas, an impressive showing for a new truck. The only real competitor in the Dakota's size class remains the Jeep Comanche pickup, a sibling since

Chrysler's acquisition of AMC.

However, the Dakota still has this niche pretty much to itself, and its success has been due partly to a long option list and also to a wide range of body styles, bed lengths and power-train choices. This is definitely not your average pickup.

Yet we found through our questionnaires that owners view the Dakota as no better than average in several important categories. Almost a quarter of our respondents, for example, reported mechanical problems of some nature, with a rough-shifting automatic transmission and a noisy 5-speed topping the list. We also recorded a number of electrical glitches, engine hesitation and so forth.

Dealer repairs ranked average, too, with just over half of the owners in our survey rating the backshop good and only a third deeming dealer service excellent. The Japanese would not be pleased with those marks. Fortunately, most repairs were made under Chrysler's 7/70 warranty, but even so, a number of owners grumbled about downtime and mentioned that dealers put customer-paid repairs ahead of warranty work.



# DODGE DAKOTA



Workmanship turned out to be another area of definite averageness. Just over half the owners we queried rated workmanship good, while 46.2 percent gave it a mark of excellent. The Dodge Dynasty, built under the same corporate roof, managed an extra 10 percentage points in the excellent workmanship column, and even that's not prize-winning.

No one mentioned pep, power and performance among the Dakota's best-liked features. However, 17.4 percent of our owners did have good words for fuel economy. On the other hand, a nearly identical number—



Dakota's handling pleased most owners, scoring second on best-liked list. Interior drew complaints for marginal comfort and too much noise. Many owners felt need for V8 power. 15.7 percent—told us they'd expected more miles per gallon, and were disappointed by the 16/20 mpg they were getting from their 3.9-liter V6s, especially with the 4-speed overdrive automatic. (For the record, the EPA

## SUMMARY OF 1990 DODGE DAKOTA OWNERS REPORTS\*

<b>Total miles driven</b>	1,136,608	8-ft. bed	25.5	Make a larger engine available	8.7	Engine hesitation after deceleration	8.2
<b>Average miles per gallon:</b>		<b>Engine selection:</b>		Larger glovebox	7.2	Speedometer registers high	8.2
With 2.5-liter Four		3.9-liter V6	82.3%	Make seats softer	7.2	Oil leaks	6.6
In town	21.9	2.5-liter Four	17.7	Higher horsepower	7.2	Hard to shift into reverse	6.6
On the highway	26.3	<b>Transmission selection:</b>		Reposition window-lift switch	7.2	<b>Did you repair it yourself?</b>	
With 3.9-liter V6		4-speed automatic	70.6%	<b>How much did you pay?</b>		No	87.9%
In town	16.2	5-speed manual	29.4	Average	\$12,962	Yes	12.1
On the highway	20.4	<b>2- and 4-wheel-drive selection:</b>		Range	\$7615-\$17,461	<b>Dealer repairs satisfactory?</b>	
With 5-speed manual transmission		2-wheel drive	87.4%	<b>Workmanship opinion:</b>		Yes	69.1%
In town	19.6	4-wheel drive	12.6	Excellent	46.2%	No	30.9
On the highway	23.9	<b>Major options chosen:</b>		Good	51.0	<b>Dealer service opinion:</b>	
With 4-speed automatic		Air conditioning	71.0%	Average	2.4	Excellent	32.6%
In town	16.1	Optional sound system	66.5	Poor	0.4	Good	50.3
On the highway	20.3	22-gallon fuel tank	47.5	<b>Comfort opinion:</b>		Average	11.6
<b>Why did you choose Dakota?</b>		Alloy wheels	39.7	Front seats:		Poor	5.5
Liked the size	36.8%	Limited-slip differential	37.9	Excellent	53.5%	<b>Number of vehicles owned:</b>	
Liked the styling	28.1	Trailer towing package	29.9	Good	41.4	This pickup only	19.0%
Price was right	17.8	<b>Specific overall likes:</b>		Average	3.9	Two vehicles	52.0
Owned Dakotas before	14.0	Exterior styling	39.9%	Poor	1.2	Three vehicles	20.6
Wanted the Club Cab	11.2	Handling	33.8	Rear seats:		Four or more vehicles	8.4
Liked the warranty	5.4	Riding qualities	31.5	Excellent	17.5%	<b>Would you buy a Dakota again?</b>	
Roominess and carrying capacity	5.4	Comfort	30.0	Good	48.5	Yes	68.8%
<b>Series chosen:</b>		Size	23.0	Average	26.2	Maybe	26.3
Base Dakota	42.8%	Economy	17.4	Poor	7.8	No	4.9
Dakota S	38.6	<b>Specific dislikes:</b>		<b>Had any mechanical trouble?</b>		<b>Would you buy Chrysler again?</b>	
Dakota Sport	11.0	No complaints	15.7%	No	76.2%	Maybe	50.2%
Dakota LE	6.4	Low fuel mileage	15.7	Yes	23.8	Yes	31.0
<b>Body styles chosen:</b>		Rattles and noises	10.3	<b>What type of trouble?</b>		No	18.8
Regular Cab	60.4%	Comfort level	7.0	Rough automatic and noisy manual trans	18.0%	<b>Age distribution of owners:</b>	
Club Cab	39.6	Engine not powerful enough	5.4	Electrical gremlins	8.2	Under 29 years	16.0%
<b>Bed lengths chosen:</b>		Riding qualities	5.4			30-49 years	48.6
6-ft. bed	74.5%	<b>What changes would you like?</b>				50-plus	35.5
		Greater fuel mileage	13.8%				

\* Percentages might not equal 100 percent due to rounding or insufficient data.



forecast was for 15/20 mpg.)

Owners of 4-cylinder Dakotas were considerably happier with their 22/26 mpg averages (the Four is available with 5-speed only).

On that topic, for 1989, Carroll Shelby converted a limited number of Dakotas to V8 power by dropping 318s into 2wd versions. These weren't catalogued as production vehicles and were sold only by Shelby. In our survey, a few Dakota owners suggested that the 318 V8 be made available from the factory, and 8.7 percent suggested that some sort of larger engine, V8 or otherwise, should be made available. As it turns out, according to Dodge, that engine will become available as a 1991 option.

### Handling draws high praise

One area of performance that did draw a noteworthy response was handling, cited by almost 34 percent as something they particularly liked about their Dakotas. This ranked second on the best-liked list behind styling, which won the hearts of almost 40 percent of our Dakota buyers.

However, Dakota's size scored ahead of styling as the primary reason for buying, vindicating the product planners. Price was also an important consideration, and it was interesting to see that 14 percent of our owners had owned a Dakota prior to their current one. Of these, a hefty percentage opted for the extra space afforded by the new Club Cab edition.

In fact, almost 40 percent of the group owned Club Cab models.

The Dakota's standard 2-wheel antilock braking system (ABS) came in for a fair amount of unsolicited praise. One gentleman in Louisiana told us that without ABS, he would have "bought the farm" after a freak cold snap left glare ice on local roads.

Ride comfort also met with hearty approval. The Club Cab option sold a lot of Dakotas, but most owners agreed that the Club Cab's rear seats were only good for children and pets.

### Affection versus data

In summary, even though the Dakota's scoring was essentially so-so—fewer than 70 percent said they'd buy this truck if they had it to do over again—we did hear a lot of "I really love it" and "best truck I've ever owned" from many of our survey respondents. Admiration and enthusiasm for this midsize pickup seemed to be much greater than the sum of its data.

The bottom line seems to be that the Dakota has a lot of personality, and, even though it's far from perfect, it endears itself to many of those who live with it. **PM**



Dakota's dimensions, which are slightly larger than Ford Ranger and Chevy S-10/GMC S-15 competitors, was main factor in 36.8 percent of Dakota purchases. Styling ranked second.

## EDITORS REPORT

### The Realities Of Compromise

**A**SIDE FROM the availability of a convertible top, size is the Dakota's chief claim to fame. It's the biggest small pickup truck you can buy.

But being biggest in a group of smalls can be a mixed blessing. People tend to expect the best of both worlds, and, as a consequence, may slide behind Dakota steering wheels with unreasonably high expectations.

Take fuel economy as an example. The Dakota gets better gas mileage than a full-sized V8 might—but not a lot, especially in the 4x4 version. If you expect super economy, you're going to be disappointed, just as some of our owners were.

Similarly, don't expect to sit three adults in the cab. Even with a bench seat, there won't be enough hip or shoulder room. Same for the cargo box—the traditional 4x8 plywood sheet won't make it.

The interior is fine for one or two, although we did whack heads against the roof hot-dogging for the pictures you see here. Steering was devoid of serious kickback jumping ruts in the sand pit, and at the same time not overly boosted on the freeway.

Engine power is adequate, but if you go for the 4x4, we strongly recommend staying away from the automatic transmission—there's not enough

horsepower to comfortably coexist with traffic. With the stick, shifting is precise, but won't be hurried.

Ride was trucklike, which means firm, well-damped and with too much spring rate in the rear. Like any pickup, Dakota rides best when it's carrying something in the box. But it's not as ponderous as a full-sized truck.

Fit and finish of the high-end truck shown here was excellent—for a truck. How well the tape graphics will last after a few seasons of brush-busting remains to be seen, but the body panels were straight, and the paint relatively shiny and deep.

Body panel fit was average, with large but consistent gaps. There's a good reason for this. Like most pickups, the Dakota rides on a separate ladder-type chassis, which grades out low for torsional rigidity. Low torsional rigidity eliminates close tolerances between panels—the truck twists too much over rough surfaces.

We have several acquaintances who own Dakotas, including one contractor who has owned several. And with the abuse they see in that kind of service, we're happy to report that they seem to hold up extremely well.

The Dakota may not get rave reviews from all its owners, but it's not afraid of hard work. —Mike Allen



## COMPARISON TEST

# POCKET CRUISERS

Four trailerable 25-footers that have it all.

BY JOE SKORUPA, BOATING EDITOR; PM Photos by Skip Gandy

**S**PACE IS THE ultimate luxury. When you're dreaming about moving up to something better, it invariably means something bigger. Boaters who dream this dream usually envision something with enough deck area and seating space to entertain a van load of guests, *plus* a cabin fitted with enough accommodations to feed and sleep the crew for a weekend cruise.

I'm not talking about a miniyacht, here. I'm talking about a sporty boat that can be legally trailered. I'm talking about a 25-footer that's less than 8 ft. 6 in. wide, which has room enough for a complete galley, full head with shower, and a midship sleeping berth. In other words, I'm talking about a pocket cruiser.

Admittedly, these boats aren't cheap. But for those who dream bigger-is-better dreams, the boats in our test fleet impressively fill the bill. Each was powered by a MerCruiser 5.7-liter sterndrive, and put through its paces off of Florida's west coast. They take different approaches to the basic midcabin and raised-helm design, but scoring was close overall.

### 2651 Ciera Sunbridge

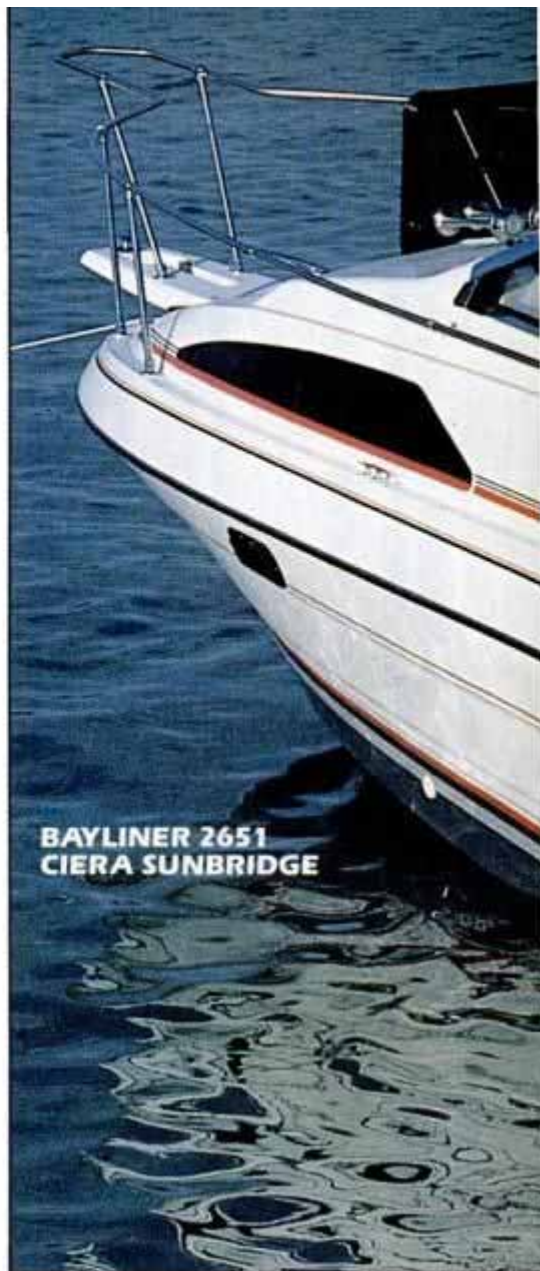
Midsized cruisers have been a bread-and-butter boat for giant Bayliner

since the mid-1970s, so it's not surprising that the 2651 Ciera Sunbridge was considered the boat to beat. Nobody did. The 2651 scored firsts in four of eight ranked categories, and easily emerged the overall winner.

Dreamers looking to trade up to a boat with plenty of room will find it here. The 2651 led the fleet in total deck space and sleeping pad area. Other fleet-leading scores were in hole shot (0 to 25 mph) and overall handling, which encompasses cornering, big-water ride, low-speed maneuvering and backing down. It was the only boat without a last-place score and came in third only in top speed at a respectable 40.5 mph.

Topside layout features a bilevel deck with a large L-shaped lounge in the raised bridge and a wide bench seat aft. Both areas have pedestal mounts to accommodate a dinette table. A walkthrough windscreen allows access to foredeck during docking, and is an alternate route to the narrow walkaround side deck.

Numerous hatches provide excellent lighting and ventilation below. Ash wood trim and superb joinery highlight the fine job of fit and finish in the fore cabin, although not everyone will appreciate several exposed through-bolts. The upholstery and



BAYLINER 2651  
CIERA SUNBRIDGE

carpeting on the 2651 are topnotch.

Features of note include: gas lifts for the engine cover, compass, VHF radio, depth sounder, electric refrigerator, a standup head with macerator, sink and handheld shower, and many more.

For overall comfort, performance and affordability, the 2651 ranks among the best in its class.



LARSON  
SAN MARINO 250





### Larson San Marino 250

Bold and creative leap to mind when describing boats by Larson, and the San Marino 250 doesn't disappoint. This is the first nonyacht we've seen with remote-control sensors for the radio/cassette player and a unique asymmetrical cabin layout that looks and functions like a complete kitchen.

Marching to the beat of a different

drummer has helped Minnesota-based Larson to move up among the nation's top-10 builders. Basics, however, haven't been overlooked. The San Marino, like the Bayliner, also scored four firsts out of eight ranked categories. These were in total stowage, superb handling (due to the patented Delta Conic hull), comfort factor—which ranks design features

and use of space—and fit and finish.

As noted, the San Marino's forward cabin is impressive. The entire galley and head are placed on the starboard side, leaving a large area to port that serves as a comfortable eating nook. The cooking area, which features copious countertop space, actually has overhead cabinets and pull-out drawers appropriate for any home kitchen.



**RINKER  
250 FIESTA VEE**



# POCKET CRUISERS



**CRUISERS HOLIDAY 2570**

A minor drawback to the innovative design is that it cuts into other areas. The boat has the fleet's smallest deck space and sleeping pads, although neither are cramped. Also, its low, racy profile comes at the expense of headroom (33 in.) in the midship berth.

However, a long list of features and equipment more than compensate. These include: aft lounge area that assembles into a sundeck, plush bucket seat at helm, electric refrigerator hidden in a cabinet, 4-in. walkaround side decks, generous ports and hatch-

es, compass, windshield wiper, depth sounder and radio with weatherband and equalizer, to name a few.

The look of the 1990s is still evolving, but the design of the San Marino may well be leading the way.

## Cruisers Holiday 2570

Unlike the other builders, Wisconsin-based Cruisers is a large-boat specialist, and the Holiday 2570 is actually one of its smallest boats. It's not surprising, then, that the 2570 has a sturdy, big-boat feel.

The 2570 finished a solid second in five categories. High marks for total deck area, comfort factor and fit and finish weren't unexpected. The surprising scores were in handling and top speed (41.5 mph), especially when considering this is the fleet's heaviest boat at 5300 pounds.

Outstanding features are: a dual-battery isolator system that seeks out the weaker battery and charges it, balsa (end-grain) reinforced hull, hidden through-bolts backed with aluminum plates, compass, tilt steering

### TEST PARAMETERS

Boats were propped and tuned by technicians at Mercury Marine's MerCabo Test Base, in Placida, Florida. Speed and timing data are result of averaging four test runs with two adults aboard and matched fuel loads. All boats equipped with 13x17 stainless-steel props, except for the Bayliner, which comes standard with an aluminum 16x16. Sleeping pad figure is total of forward and midship berth. The bold numbers at the beginning of the line indicate ranking in fleet.



MAKE/MODEL	1. BAYLINER 2651 CIERA SUNBRIDGE	2. LARSON SAN MARINO 250
LOA/Beam/Weight/Fuel Capacity	25'7"/8'/4400 lb./55 gal.	25'1"/8'6"/4900 lb./80 gal.
Top End	3. 40.5 mph, plenty fast for family fun	4. 38.0 mph, fast enough for a cruiser
Acceleration 0-25 mph	1. 6.41 sec., unique prop helped it blast off	2. 8.37 sec., leaps up on plane like a runabout
Deck Area	1. 44.53 sq. ft., immense bilevel areas	4. 32.5 sq. ft., single-level deck arrangement is roomy
Sleeping Pads Forward/Aft	1. 42.6 sq. ft./33.25 sq. ft., midberth height 46 in.	4. 23.44 sq. ft./28.1 sq. ft., midberth height 33.5 in.
Stowage Space	2. 38.09 cu. ft., generous compartments	1. 40.41 cu. ft., no opportunity missed
Handling	1. (tied) Best of fleet in cornering, superb overall	1. (tied) Bow-down hole shot, great cornering
Comfort Factor	2. (tied) Superior lighting, ventilation, roominess	1. Outstanding galley, creative design and features
Fit and Finish	2. (tied) Excellent carpeting, upholstery, styling	1. Plush appointments, craftsmanlike detailing
Price	\$29,070	\$38,435
Address	Bayliner Marine, P.O. Box 24467, Seattle, WA 98124, (800) 443-9119	Larson Boats, Paul Larson Memorial Dr., Little Falls, MN 56345, (612) 632-5481



Boats equipped with 5.7-liter, 230-hp Mercs.

Ash trim, light colors and numerous port lights make interior bright. Table drops for large V berth.



Eating nook to port and kitchenlike galley starboard. Refrigerator hidden. Curtain encloses V berth.







**LARSON  
SAN MARINO 250**

**CRUISERS  
HOLIDAY 2570**

**RINKER 250  
FIESTA VEE**

wheel, transom shower and a ski eye for towing kneeboarders.

Some items are successful, but represent compromises. The formica counters and joinery in the galley are plush, but squared top and bottom edges make bumping into them pain-

ful. The standup head is roomy, but there's no sink, and ventilation is restricted. The forward cabin is spacious, but there's no sidedeck outside. To reach the anchor, boaters must climb up through a cabin hatch.

These items will impact on the way

most boaters use a pocket cruiser, but they're not glitches. They're trade-offs. And the 2570, like its bigger brothers, is a well-built boat.

### Rinker 250 Fiesta Vee

The 250 Fiesta Vee is the second biggest in the Rinker fleet and embodies the Indiana builder's simple philosophy: Design a boat that's right for the market, and make it affordable.

The Fiesta Vee is a sprightly, straightahead performer, and came in with a fleet-leading top speed (43.5 mph) and a third place in hole shot. During fast wheel-lock turns, however, we discovered some prop ventilation, and some side-to-side bow steering at low rpm. Experimenting with props might help.

The boat's clean design keeps the cabin area uncluttered. It's roomy enough, in fact, to fit the fleet's second largest sleeping pads.

Upholstery, rugs, helm, galley and head are Spartan, compared to the other boats, but fit and finish is sound. A 3-step swim ladder, transom shower, microwave, hidden through-bolts, stout hardware and tasteful teak trim are among many noteworthy features. Everything is standard.

Rinker is one of the longtime, family-owned builders in boating, and the Fiesta Vee is designed to be a longtime, family-owned boat.

Space may be the ultimate luxury to buyers, but it's the ultimate challenge to designers. Each boat in our fleet met the challenge by providing a sporty platform with truly comfortable accommodations. Without question, these pocket cruisers have hefty price tags. For many of us, this is why space is also a final frontier. **PM**



#### 3. CRUISERS HOLIDAY 2570

25'7"/8'/5300 lb./80 gal.
2. 41.5 mph, quick for fleet's heaviest boat
4. 16.0 sec., hull weight held it back
2. 39.13 sq. ft., fleet's most expansive seating
3. 36.23 sq. ft./25.8 sq. ft., midberth height 42.5 in.
3. 32.57 cu. ft., adequate for most uses
2. Well-behaved, big-boat feel, not trim sensitive
2. (tied) Good overall, but some compromises
2. (tied) Craftsmanlike throughout
<b>\$38,133</b>
Cruisers, Inc., 804 Pecor St., Oconto, WI 54153, (414) 834-2211

Formica counters and cabinetry. More port lights would help. Only boat with support strut that doubles as handle.



#### 4. RINKER 250 FIESTA VEE

28"/8'6"/4800 lb./65 gal.
1. 43.5 mph, makes rest of fleet look slow
3. 10.86 sec., adequate for a cruiser
3. 38.99 sq. ft., sound bilevel layout
2. 42.57 sq. ft./29.56 sq. ft., midberth height 43 in.
4. 30.55 cu. ft., can use berths when necessary
3. Propping might help minor misbehavior
3. Spacious cabin, but low on creativity
3. Although Spartan, many superb touches
<b>\$28,995</b>
Rinker Boats, 207 Chicago St., Syracuse, IN 46567, (219) 457-5731

Clean design approach gives spacious feeling. Somewhat spare compared to other boats. Bright and airy.



\* Includes fleet's only integrated bow pulpit.



# INTRODUCING THE



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\*Excluding other GM products.

\*\*J.D. Power and Associates 1989 Compact Truck Sales Satisfaction Index,™ rating salesperson performance, delivery activities and initial product quality.

†Retained value percentage is figured on a sales weighted average of all the vehicles sold by a truck marketer based upon the MSRP of three-, four-, and five-year-old comparably equipped vehicles produced domestically during the model years 1975-'86, compared to the average wholesale auction price of vehicles as reported in the January 1980-'89 issues of the National Automotive Research Black Book. The independent certified public accounting firm of Deloitte & Touche has compiled these retained value percentages.



GMC TRUCK  
SMARTLEASE  
by GMC

anymore. GMC TRUCK.





**F**ORGET APPLES and oranges. In this test of perceptions, we're comparing bricks and jellybeans. Over the past few years, the automotive industry has been teaching us to think that cars with boxy styling are old-fashioned and inefficient, while cars that are rounded and aerodynamic are efficient and modern.

As America embraced aero, Chevrolet was forced to conclude that the Caprice—an old-fashioned brick introduced in 1977—needed to be transformed into a modern jellybean.

And so we have the 1991 Caprice. Thanks to all-new bodywork, the coefficient of drag has been improved dramatically, from a barnlike 0.41 to 0.33. But underneath, the chassis is virtually unchanged, with the important exception of standard antilock braking.

Compared to the old Caprice, the new one is 2 in. longer, 2 in. wider—and 250 pounds heavier.

This sets up an interesting contrast between the relative effect of aerodynamic efficiency versus weight on fuel economy. After a redesign that must have cost GM a bundle, the EPA city cycle rating for the new Caprice is exactly the same as the old Caprice—17 mpg. Net gain: zero.

The previous Caprice was introduced 14 years ago, and it took Ford two years to respond with the current LTD Crown Victoria. It looks like history will repeat itself on this score. The bricklike LTD, with its  $C_d$  rating of 0.42, will be around until late next year, when a Taurus-shaped successor will be introduced.

Like the new Caprice, the forthcoming Crown Vic will be built on the same rear-drive chassis, with no significant changes—which is not a bad thing. Body-on-frame construction, the basic technique for both cars, tends to be more durable, one of the big reasons these two cars have been favorites in taxi fleets over the years.

There is one curious footnote. Ford plans to drop its Crown Vic wagon in the next iteration, while Chevrolet is readying a new Caprice wagon for fall that looks for all the world like an oversize Taurus wagon.

But back to the brick versus the jellybean. The two cars are so similar on the specifications page that they could very well have been built on the same assembly line. The LTD wheelbase is 1.6 in. shorter, the body shorter by 3 in. It weighs about 100 pounds less than the Chevy, but EPA city cycle ratings are identical.

Both cars are powered by solidly established over-





## COMPARISON TEST

# CIVIL WAR II

Brick versus slick: Chevy's new Caprice versus Ford's old Crown Vic in a battle of shapes.

BY RICH TAYLOR, Contributing Editor, PM Photos by Ron Hussey

head-valve V8 engines, and both can tow 5000 pounds. Ford's 5.0-liter V8 makes 10 hp less than Chevy's, but produces 25 lb.-ft. more torque.

Similarly equipped, the two cars cost within \$150 of one another—which adds up to more than \$20,000 either way.

In objective measurements, the brick and the jelly-bean continue to be remarkably similar. The Crown Vic's edge in torque gives it slightly better acceleration at all speed ranges, but only by a tick. And compared to other cars, both these behemoths are slow, among the slower large passenger cars on the market, although breathtaking acceleration isn't a requirement in this class.

On the other hand, both cars have excellent brakes. As the data panel indicates, the Caprice, with ABS, took an extra car length to stop from 60 mph, but it's important to remember that antilock braking doesn't necessarily improve braking performance on dry pavement. On any other surface, however, it will optimize braking efficiency beyond the capabilities of almost any driver and, most important of all, allow the driver to retain directional control.

We congratulate Chevrolet for making this impor-

tant safety feature standard equipment, and expect Ford will follow suit when the new Crown Vic rolls out.

A 2-ton traditional sedan with a 9.5-ft. wheelbase is never going to be perceived as nimble. Nevertheless, both cars performed well in our slalom test, all things considered.

The Caprice, equipped with an optional FE2 heavy-duty suspension package (recommended, particularly if you plan to tow) has much better turn-in and much less body roll than the Ford.

The Crown Vic, equipped with a standard suspension setup, was a good deal softer, with correspondingly more body roll in hard cornering. This produces pronounced weight transfer, which in turn reduces the car's ability to respond to rapid directional changes. This is nothing, if not traditional American sedan suspension, and we think it's one link with the past that could easily be abandoned.

Both cars were unexpectedly competent on the skidpad, where performance was limited mostly by their tires. Bolt on a set of high-performance Goodyear Eagle GT+4 tires, and the Caprice could easily exceed .8 G.

The Ford, meanwhile, has such a flabby suspension it heels over on the skidpad until it settles on the bump



## CIVIL WAR II



Caprice's optional FE2 suspension gave a winning edge in slalom (above). New aero exterior is at odds with traditional instrumentation and veteran workhorse small-block V8 engine (right).

stops, whereupon it plows around quite quickly, hiking its inside rear wheel in the air. Both cars could benefit from some suspension work, but the Caprice has the most potential. Naturally, this also applies to the millions of post-1977 Caprices still rolling out there, since new, as it applies to the Caprice, goes only skin deep.

One thing that helped give the Caprice an edge in handling versus the Crown Vic was its optional FE2 suspension package. This is what you get in the trailer towing package—it's stiffer than the basic Caprice suspension—and we strongly recommend it over the standard setup.

Inside, both the Caprice and Crown Vic are *very* traditional. If you're accustomed to big American sedans, you'll feel right at home in either car. The Crown Vic is the same plush-lined box that Ford has been selling for decades.

And while the Caprice may look like 2001 on the outside, from the driver's



seat the view is strictly 1977 rent-a-car, right down to the simulated woodgrain on the dashboard and the horizontal speedometer. What's particularly interesting about the Caprice's interior treatment is that it represents a redesign. Chevy's new Caprice dashboard and instrument panel faithfully preserve the look of the old one, and it's obvious that clinic

and focus groups had their say in the product development process.

Our test cars both had velour bench seats with virtually no support—expect a backache after 2 hours in either car. Both of these full-size family sedans from Ford and Chevy could use a strong dose of the Taurus' functional interior design.

It doesn't take more than 15 min-

### SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (lb.-ft.)	ENGINE DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in.)	LENGTH OVERALL (in.)	WIDTH OVERALL (in.)	TRACK FRONT/REAR (in.)
Chevrolet Caprice	\$17,370	V8 OHV	170 @ 4300 rpm / 170	front	4-speed	115.9	214.1	77.0	61.8/60.7





utes with the new Caprice to see that all the research and development money was spent on wind-tunnel time. This has produced an interesting set of mixed signals. The shape says modern aero, but a standup hood ornament rides the end of the sloping nose, and a formal Cadillac-style egg-

From certain angles, the Caprice is very awkward-looking, particularly from the rear. The rear wheels are set well in from the fenders, to accommodate the skirting that covers the upper part of the wheels, giving the going-away view an old-fashioned look.

The trunk is fairly large, but its

**Flabby suspension held back Ford's Crown Victoria in handling tests (above). Instrument panel is pure oldtime Americana. Ford 5.0-liter V8 provided a slight edge in the acceleration runs (left).**

legroom is still on the skimpy side for a car that's nearly 18 ft. long. The Ford wins in both these categories.

We certainly give the Caprice the edge in styling, even though we think the styling isn't entirely successful. Our Crown Vic tester, replete with vinyl roof, clearly belongs to another design era.

But with the important exception of standard ABS braking, the 1991 Caprice is not a better car than the one it replaces. It just looks different. Whether you think it looks better or worse depends on whether you favor bricks or jellybeans.

The new aerodynamic shape is expected to appeal to younger buyers, although Chevy is obviously anxious to avoid alienating its current Caprice owners. But the big question isn't bricks and jellybeans. It's whether younger buyers, most of whom were raised on small front-drive cars, will







# IN-DASH CD PLAYERS

Lab and road testing the first of a new breed of inexpensive CD/tuners that slide into your dashboard.

**C**OMPACT DISCS are already a musical staple in many homes, but their presence in automobiles is still relatively rare. The reason is obvious to anyone who has ever shopped for one: CD/tuners cost too much money.

All this is changing. Models incorporating both a CD player and an AM/FM tuner are beginning to come down in price. This year, manufacturers are determined to offer machines with list prices of \$500 or less in an effort to spark sales.

Besides the potential benefit of pristine digital sound offered by home CD players, a car CD player is also a time and money saver. It'll be no longer necessary to copy your CDs onto cassette tapes for car playback.

CD/tuners are destined to replace cassette receivers as the signal source of choice for the music fan on the road. The only question at this point concerns the performance of these lower-priced CD/tuners. To answer this question, POPULAR MECHANICS decided to test four units that are already part of the low-priced vanguard.

PM's partner in this test was the Advanced Product Evaluation Laboratory (APEL), a facility we've used

## CD/TUNER

### SONY CDX-6020

Serial No. 20482

PRICE: \$450

OVERSAMPLING RATE: 4x

This unit is rated tops overall, but was the worst in its ability to correct for defects in the CD itself.

BY FRANK VIZARD,  
Electronics Editor, and  
FRANK C. BARR, President,  
Advanced Product  
Evaluation Laboratories

in previous product tests. Our cutoff list price was \$500, a figure that has long been the target of manufacturers looking to sell CD/tuners in mass quantities. Generally speaking, real-world retail prices should be somewhat less than the list price. The models selected for this test included the Alpine 7904 listing for \$500, the Sanyo ECD4000 listing for \$429, the Sparkomatic SR600 listing for \$399, and the Sony CDX-6020 listing for \$450.

## Vibration tests

While APEL did check both the tuner and CD sections for performance, we felt from the start that the environmental tests would be the most important. Unlike the home, the car is a very hostile environment for sound systems. The car interior is not only subject to temperature extremes, but also to shocks and vibrations—all of which can seriously hamper a CD player's performance.

All four models were placed in an environmental test chamber at -10° F for 24 hours and then measured for the effect of cold temperature upon performance. After 12 hours at room temperature, all four models were then subjected to 165° F and 95-percent humidity for another 24 hours, after which they were tested again.

After the temperature test, the units were secured to a specially designed vibration

platform that mimics the amount of vibration a CD/tuner could conceivably encounter in an automobile over an extended period of time. The amount of displacement was 0.05 in. and the frequency was 20 Hz. Each unit was tested in the X, Y and Z planes for 10 minutes each, for a total

## CD/TUNER

### SANYO ECD4000

Serial No. 09201440

PRICE: \$429

OVERSAMPLING RATE: 4x

Shake, rattle and roll is not this unit's favorite type of dancing. It did not stand up well to simulated road conditions.



of 30 minutes overall. If any of the samples had loose connections or poor solder joints, the vibration tests would uncover them.

All four samples passed the temperature and humidity tests with flying colors. Upon retesting after the vibration test, however, the Sanyo ECD4000 was worse for wear. While both the tuner- and CD-section modes were operational, the distortion and frequency response figures were dramatically poorer than those found for the unit prior to the vibration tests. The other three models showed no change.

A second Sanyo ECD4000 sample was used to lab test the unit's CD player and tuner performance. Performance tests on the other three models were done using the original samples.

In the lab, all four models performed well in many aspects of the test. Still, APEL found enough differ-





# IN-DASH CD PLAYERS

ences in certain areas to come up with a ranking for the four.

## Key criteria

While all four models were subjected to a battery of tests, some measurements are more significant than others. Among the key measurements are:

■ **Frequency response**—A measure of the unit's ability to reproduce a signal accurately over the audio bandwidth.

■ **Output level**—A measure of how strong a signal the unit can produce.

■ **Signal-to-Noise ratio (S/N)**—The difference in decibels between the reference output level and the inherent noise the machine makes while it's operating.

■ **Linearity**—A measure of the amount of distortion evident in a CD

player's reproduction of low-level signals, often a weak area in CD player performance.

■ **Dropout corrections**—A measure of the CD player's ability to correct for defects or variations in the disc itself. The larger the number, the greater a defect the player can compensate for.

## ■ Total Harmonic Distortion

(THD) — The amount of distortion (preferably under 1 percent) introduced in the handling of the signal by the component.

## PM's rankings

Of the four units tested, APPEL ranked the Sony CDX-6020 as the best overall. It finished first in output level, frequency response, S/N ratio and THD. Linearity was a tie for first with the Alpine 7904. The CDX-6020 was not a model of perfection, however. The unit's ability to correct for dropouts was the worst of all the units tested, though it's in the range of acceptable performance.

APPEL ranked the Alpine 7904 second of the four. In most instances, the Alpine 7904 measured very close to the Sony CDX-6020. Linearity, in fact, was the best of all four models that we evaluated. THD, though, at 1KHz and at 31 Hz was third best.

The Sanyo ECD4000 ranked third best in the lab, but the failure of our

## CD/TUNER

### SPARKOMATIC SR600

Serial No. 077174

PRICE: \$399

OVERSAMPLING RATE: 2x

What it lacks in CD performance, it makes up for in the FM-tuner section. It's a good all-around performer.



## CD/TUNER

### ALPINE 7904

Serial No. B91211201

PRICE: \$500

OVERSAMPLING RATE: 8x

Linearity is this model's strong suit, as it tested top in this area. A strong second place.



sample in the vibration test puts it squarely in fourth place overall. In the lab, the Sanyo ECD4000 tested third, but its ability to correct for dropouts was superior to all. The S/N ratio is just slightly better than the Alpine 7904. Linearity, though, was worse than the Sparkomatic SR600. Linearity for both the Sparkomatic SR600 and Sanyo ECD4000 was substantially poorer than the Alpine 7904 and the Sony CDX-6020.

APPEL ranked the Sparkomatic SR600 fourth in performance but, again, the failure of the Sanyo model gives it a real-world ranking of third. On paper, the output voltage of the SR600 is the highest, but this advantage is nullified by the lowest S/N ratio in the group. Test results for different criteria sometimes have to be viewed in relation to one another. The SR600's ability to correct for dropouts was identical to the Alpine.

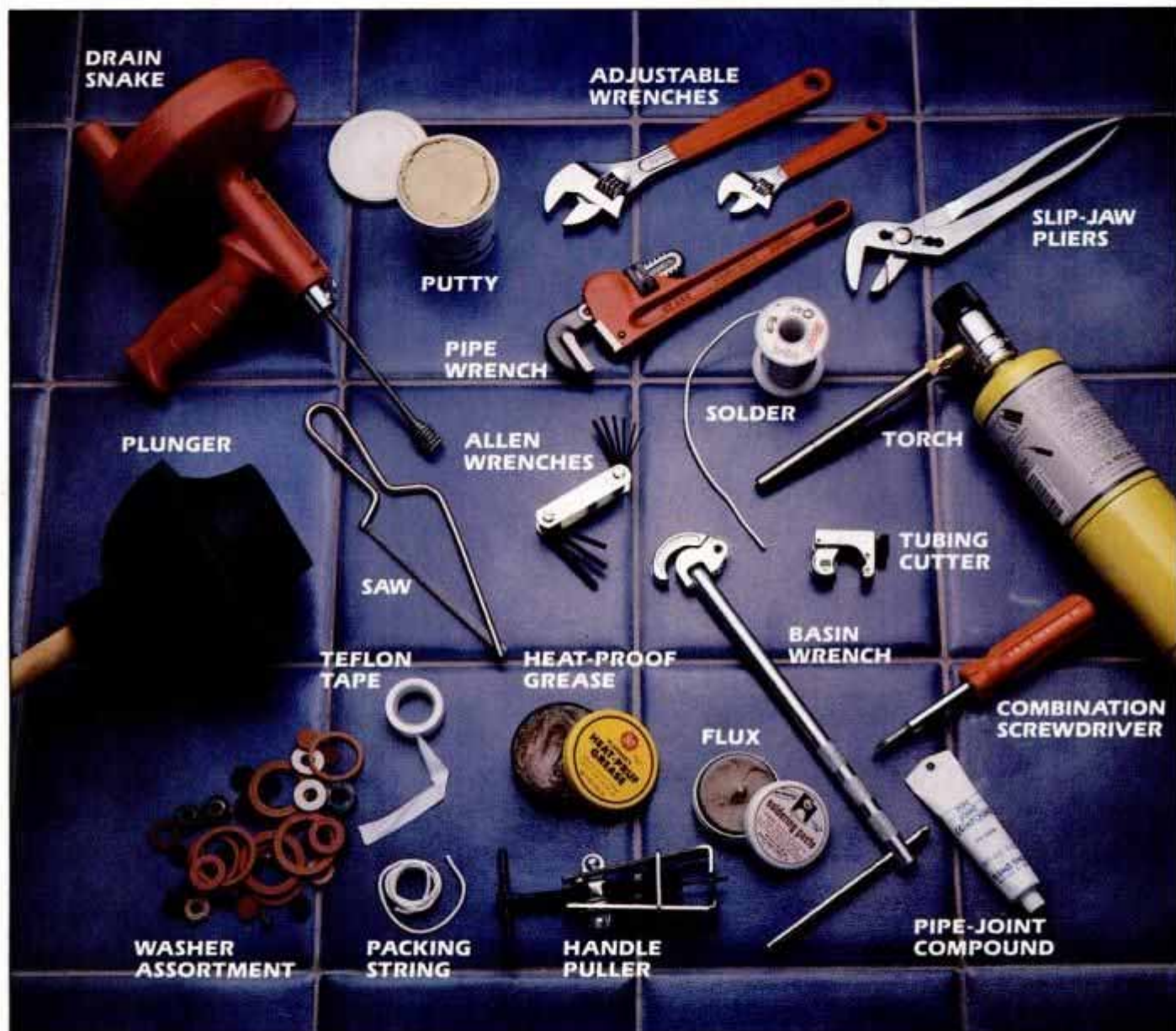
(Please turn to page 94)

## LAB TESTS

	ALPINE 7904	SANYO ECD4000	SONY CDX-6020	SPARKOMATIC SR600
<b>CD SECTION</b>				
Output Voltage	1.57	1.95	2.03	2.10
Frequency Response (20 Hz to 15KHz)	+0.42dB to -0.33dB	+0.63dB to -0.45dB	+0.07dB to -0.42dB	+0.58dB to -1.09dB
Signal/Noise Ratio (@ weighted) in dB	93.1	93.4	94.5	90.4
Channel Separation, 0dB, 1KHz Left/Right	-75.6/ -81.2	-74.1/ -70.6	-87.4/ -87.1	-71.9/ -71.5
Linearity Error, Worst Case (@ -90dB)	+0.97	+8.84	-1.02	+8.35
Phase Difference Between Channels @ 20KHz (degrees)	+1.2	-41.3	-17.1	-40.3
Dropouts (1 per track, 0.05 to 4.0mm)	1.3	2.4	1.0	1.3
Dropouts (2 per track, 2 x 0.1 to 2 x 3.0mm)	2 x 1.5	2 x 2.4	2 x 1.0	2 x 1.5
<b>FM SECTION</b>				
Mono Sensitivity (uV/Ohms)	3.2/75	2.6/75	2.7/75	2.5/75
Capture Ratio (dB)	2.2	2.5	1.8	2.5
Signal/Noise Ratio (dB)	68	64	68	69
Total Harmonic Distortion (percent)	0.68	0.30	0.38	0.21
Stereo Separation (1KHz)	36	38	38	35
DIMENSIONS (in.)	2 x 7 x 7 1/4	2 x 6 15/16 x 7 1/2	2 x 7 x 6 1/4	7 1/2 x 2 1/2 x 2 1/2



# JOURNAL



## TOOLS

# BASIC PLUMBING TOOLKIT

TEXT AND PHOTOS  
BY MERLE HENKENIUS

**E**VERY PLUMBING system acts up occasionally. And, while some problems simply require routine maintenance, others are less predictable and may require special tools to get the job done. Because labor costs on service calls to correct minor prob-

lems can amount to over 90 percent of the bill, a basic household plumbing kit will pay for itself in short order.

The trick is in knowing which tools you'll need to own and which are better rented or left to the pros. The following kit is one that will serve most households well. There will be variations, of course, but we'll address these as we go along.

**Plunger**—Every household should have a good plunger for unclogging sinks, tubs, toilets and floor drains. The important consideration is the depth of the cup. Because plungers push and pull air and water to break clogs, the greater the volume of air in the cup, the greater the force.

The plunger shown has a deep cup and a collapsible funnel. When the

funnel is folded in, it can be used on standard basin fixtures. When extended, it has the power to clear partially clogged toilets. Avoid smaller plungers. While they're easy to store, you'll get little clog-busting force.

**Drain snake**—You'll find a variety of drain snakes on the market, from simple coils to heavy-duty closet augers. The model featured here, with its handle, housing and crank, is the most versatile and powerful for the money. While some auger manufacturers suggest snaking directly through sink strainers, you'll get much better results by removing the trap and snaking into the drain line. Snaking a clogged line is only part of the job. Always follow with a thorough plunging and plenty of hot water.





To use a handle puller, insert the stem of the puller into the handle's screw hole and clamp the sides around the handle. Then, thread the puller handle inward to gently draw the faucet handle from the stem.

**Adjustable wrench**—A 6- and a 10-in. adjustable wrench will handle most plumbing needs. Use the smaller one whenever possible. Many plumbing nuts such as compression fittings and stool bolts can be overtightened, and you'll be able to feel the resistance of the nut with a small wrench easier than with a larger one. Of course, these two wrenches will be useful in other projects as well.

**Pipe wrench**—A pipe wrench may not be necessary if you live in a fairly new home with plastic and copper piping. If, however, you'll be working on threaded-iron piping, pipe wrenches are a must. In fact, you'll need two: one for the fittings and another for backholding the pipes, thus preventing a leak elsewhere. A 10- or 12-in. wrench will suit most residential piping.

**Slip-jaw pliers**—Slip-jaw pliers are a good substitute for pipe wrenches in a modern home. They are adjustable in size and can be used to loosen P-traps, tighten packing nuts, change disposers and replace faucets. Most have toothed jaws for a better grip, but some have smooth jaws that won't damage chrome fittings. You might substitute a smooth-jawed version for the larger, adjustable wrench to get greater versatility and spanning width for about the same money.

**Allen wrench**—You'll find that a few plumbing fixtures have Allen-screw fasteners. These are often used on faucet handles and on some tub spouts. Allen wrenches can be bought in assortment packages or individually and come in handy for other jobs around the house and shop. The wrenches shown fold into a single handle to reduce the chance of one or more being lost.



When using a drain snake to clear a clogged tub drain, first remove the cover on the overflow opening and take out the tripwaste mechanism. Then snake through this opening. Follow with hot water and plunging.

**Basin wrench**—Basin wrenches are designed for changing faucets in existing sinks. Their long handles and flip-over jaws allow you to reach up behind the sink to loosen and tighten fastening nuts and supply-riser nuts.

A basin wrench also comes in handy for replacing elements in an electric water heater, where the metal cabinet prevents a normal wrench from reaching the element nut.

**Miniature hacksaw**—Too often, you simply won't be able to fit a large hacksaw into the cramped spaces associated with many repairs. In these cases, the miniature version can be a lifesaver. It's available with a packet of long-lasting replacement blades



Use a basin wrench to turn difficult-to-reach faucet nuts. Its long handle easily fits between the sink basin and wall. Wrench jaws flip from one side to the other for either loosening or tightening nuts.

and can be used to saw through stripped toilet-seat bolts, stuck drain-strainer nuts, recessed closet bolts, copper, iron or plastic pipes within joist spaces, and other difficult situations.

**Screwdriver**—Of course, an assortment of screwdrivers is essential in plumbing, as in most household repairs. Two sizes of Phillips and two sizes of standard screwdrivers will do fine. For added convenience, you might choose a combination screwdriver. The 4 In One model shown has four sturdy driving tips. While one is in use, the remaining three are tucked away inside the stem.

**Tubing cutter**—Wheeled tubing cutters are the best way to cut copper

## SPECIAL TOOLS

**T**HE KINDS OF fixtures and components that you have in your home, and the demands that you or your family place on the plumbing system, may influence your tool choices. If, for example, you live in a fairly new home, where drain clogs are not likely to accumulate for years, then you may not need to own a drain snake at all. On the other hand, if you have small children who like to flush foreign objects down your toilet, then even an ordinary drain snake might not be up to the job. A better choice would be a closet auger. A closet auger is a snake designed only for toilets. Its cable is encased in a hook-shaped tube that forces the cable over the toilet trap. It is much more effective on toilets than ordinary snakes.

If most of your faucets are of the compression variety that use replaceable valve washers, you may want to invest in an inexpensive valve seat-removal tool. If a faucet drips soon

after replacing its seat washers, suspect a defective seat. A seat with a channel cut across its rim will chew up washers in a few weeks' time. By replacing the defective seat, you can expect to get years more service out of your older faucet. —M.H.



Damaged faucet-valve seats can ruin washers. To repair the faucet, unthread the seat from the faucet body with a seat-removal tool. Then, install an exact replacement seat and fit appropriate valve washers.



and plastic pipes because they leave uniform edges.

Most cutters, however, are too big for the tight spaces common to many plumbing jobs. The best solution is to choose a miniature tubing cutter, commonly called a *thumb* cutter. To use this tool, simply tighten the cutter around the pipe, rotate it, and then repeat until the pipe is cut through. Unless you'll be installing lots of new water piping, where speed becomes an issue, a small thumb cutter is a far better choice.

**Handle puller**—A handle puller is essential with some kinds of faucets and completely unnecessary with others. If all your faucets have plastic handles or are of the single-lever variety, you shouldn't have trouble removing a handle. If, on the other hand, your faucets have metal handles that slide directly over brass stems, corrosion can literally fuse the handles to the stems. In this case, only a handle puller will break a handle free without damage. The advantage of a handle puller is that it exerts steady, even pressure until the corrosion bond is broken.

**Torch, solder and flux**—If some of your plumbing improvements will require soldered joints, don't be intimidated. Buy a small propane or MAPP gas torch with replaceable tanks, a small tin of flux and a roll of lead-free solder. (The EPA has prohibited the use of high-lead solders in plumbing since June of 1986.)

Many torch kits come with soldering instructions. Read the instructions and practice with a few fittings and some copper pipe. If you buy a self-cleaning flux, you won't even need to sand the pipe and fittings.

Gas torches are also useful in breaking loose stubborn iron fittings. Simply apply heat to the fitting side of the joint. The heat will expand the fitting and loosen the corrosion bond.

**Plumber's putty**—Putty is used primarily in fixture drains—where drain spuds pass through fixture openings. In these cases, roll the putty into a ropelike string about 8 in. long. Then, press it around the drain flange before inserting the drain through its fixture opening. As you tighten the drain, the putty will flatten out, filling any voids in the joint. Trim the excess putty from the flange.

**Pipe-joint compound and Teflon tape**—Use pipe-joint compound on threaded joints, trap washers and on all compression joints in the water system. It serves as a lubricant when tightening a fitting and also fills voids within the joint. A Teflon-base compound is more versatile, because it will not damage plastics, as will petroleum-base compounds.

Teflon sealant also comes in tape form for use on threaded fittings. The primary advantage of Teflon tape is that it withstands the heat of a soldering torch. This allows you to solder pipe to adapter fittings after the system is assembled.

**Heat-proof grease**—If you'll be doing any faucet repair, especially on compression-style faucets, heat-proof grease will be important. As its name implies, it is resistant to heat and will not dissolve from the hot side of a faucet. Heat-proof grease will substantially increase the longevity of a faucet repair and should be applied to the washers and moving parts of every faucet and valve you repair.

**Washers and packing string**—If you own cartridge-style faucets, you'll simply replace the cartridges to make a repair. If you plan to work on compression faucets and valves that have renewable washers and seals, then you'll need an assortment of faucet washers, washer screws and some packing string. The washers and screws are usually included in the same packet, while packing string must be bought separately. The assortment shown here also includes flat washers for chrome P-traps.

When replacing faucet washers, feel around the faucet seat to determine whether a flat or beveled washer is in order. If the seat has a raised rim, use a flat washer. If the seat is recessed, use a beveled washer.

Packing leaks appear around the handles of the faucet when the faucet is turned on. By raising the packing nut and wrapping packing string around the stem beneath the nut, the problem is solved. As the packing nut is tightened, the string is compressed against the stem and fills the voids. **PM**

## BOOK REVIEW

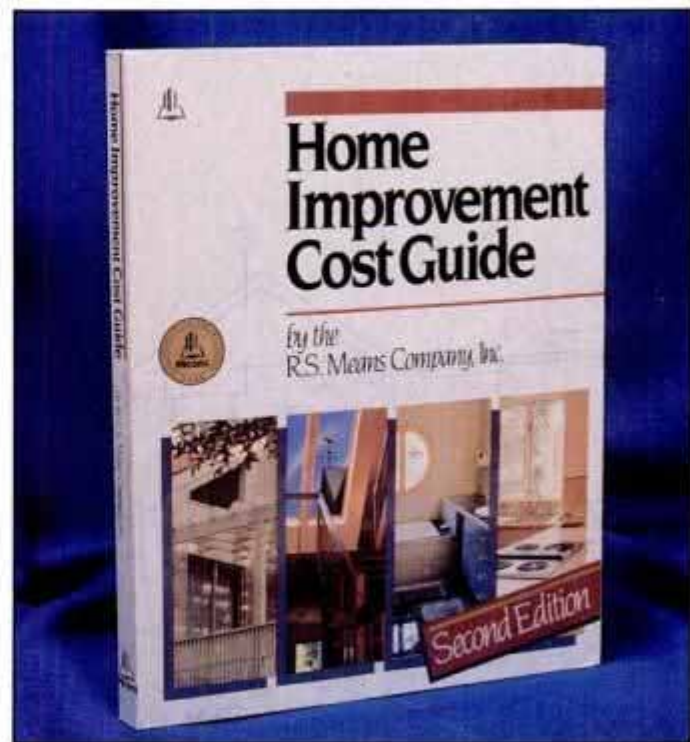
**I**F YOU'RE a homeowner contemplating a home-improvement or renovation project, the *Home Improvement Cost Guide* is a must-have reference.

This book will prove indispensable in helping you determine the cost of projects ranging from kitchens and baths, to additions, decks and garages. Whether you'll do all the work yourself, hire a contractor for the difficult chores, or even have a pro handle the entire job, the information will give you an idea of the bottom line—before the work starts. The book even contains cost tables that reflect contractor fee variations around the country.

The *Home Improvement Cost Guide* presents 74 projects, both interior and exterior. It not only details the materials required, but supplies estimated man-hours to completion for three do-it-yourself skill levels: beginner, handyman and expert. Also included are construction procedures, helpful tips, precautions and assessments of difficulty for the various operations involved.

Each project is headed by a clear illustration showing typical design and construction. The data that follows is presented in a neat, easy-to-follow format. Priced at \$29.95, this paperback is available at bookstores or directly from R.S. Means Co., Inc., 100 Construction Plaza, Box 800, Kingston, MA 02364.

—Rosario Capotosto



PM PHOTO BY ROSARIO CAPOTOSTO



# HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

## Attic Heat

I have a 3-year-old, Chalet-style house with about 2400 sq. ft. of living space. About 1000 sq. ft. of that space is attic. The rest is divided between floor-level and loft-living space. The attic gets extremely hot in the summertime.

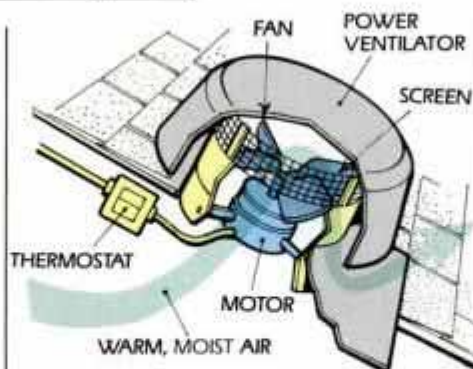
What's the best way to reduce the heat in the attic? Should I use a ridge vent, an attic fan or a roof-mounted ventilator?

Any help you could give would be appreciated.

TOM EGBERT  
CARMEL, IN

*The two items of concern regarding attic ventilation are moisture control in the winter and heat removal in the summer. Without ventilation, an attic's summertime temperature can easily build to over 140° F. Since removing heat requires more air movement than removing moisture, the venting system should be designed for summer conditions.*

*From an energy conservation point of view, a ridge vent with continuous soffit vents is the most efficient, since it relies only on air convection. However, if your main concern is to reduce the heat buildup, then you might try a thermostatically controlled roof-mounted ventilator. The thermostat is set to the temperature at which you want the fan to start, usually around 95° F. Although I haven't done a scientific survey, my experience from inspecting thousands of attics during the summer is that attics with power vents were not as hot as those with ridge vents.*



Power ventilator is an effective means of removing hot, moist air from an attic.

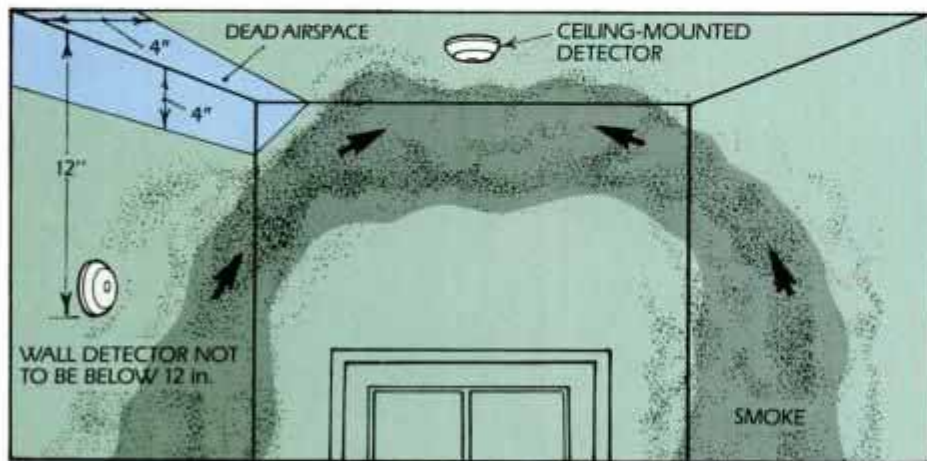
## Smoke Detector Location

To afford the earliest possible warning in a fire, it's important that a smoke detector be located properly on a wall or ceiling.

Smoke is lighter than air and rises with convection currents, but not as a stratified layer. Smoke will bounce off the walls as it rises, leaving a dead airspace about 4 in. wide and deep at the corner of the walls and ceiling. A smoke detector placed in the space may not detect smoke until the room is filled with smoke, precluding the possibility of an early warning and a safe escape.

Ceiling-mounted smoke detectors should be mounted outside the dead airspace. Wall-mounted smoke detectors should be mounted below it, but not more than 12 in. below the ceiling.

Neither wall- nor ceiling-mounted detectors should be placed near a light fixture or a ventilation grille that could block smoke from reaching the detector.



Position smoke detectors away from dead airspace at corner of ceiling and wall.

## Lighten Up Dark Siding

I recently purchased a raised ranch with cedar clapboard siding that was painted with a dark brown, semi-transparent stain (Cabot's Cordovan Brown). How can I lighten the color of the siding?

CHRIS LYPIDES  
NEW FAIRFIELD, CT

*I contacted Samuel Cabot, Inc. to answer your question, and I learned that they have three types of stain in terms of pigment content. The thinnest, and the one that absorbs into wood the most, is semitransparent. The next thickest stain is semisolid, and the thickest, solid.*

*Because semitransparent has the least pigment in it, the less likely it is to hide a darker color. They recommend you apply a couple of coats of semisolid or solid stain. They suggest you try a beige.*

*The company makes three free samples available, if you would like to try out one of the colors on an inconspicuous piece of siding. For more information, write to Customer Service Department, Samuel Cabot, Inc., 100 Hale St., Newburyport, MA 01950.*

PM

## Service Tip

The American Society of Home Inspectors (ASHI) has published a 4-page, illustrated brochure titled, "The Facts About Exterior Walls." The brochure can help homeowners who are planning to re-side their house. It explains the difference between exterior wall surfaces, which include stucco, stone, cement, asbestos shingles, wood shingles, aluminum, vinyl, steel and asphalt composition siding. It contains a comparison fact chart of the various wall surfaces with regard to maintenance, installation, initial cost and lifespan. The brochure also has a section on maintenance and inspection.

For your copy, send \$1 and a self-addressed, stamped envelope to ASHI Brochures, 7th Floor, 3299 K St. N.W., Washington, D.C. 20007.

## 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. For more home-repair and maintenance help, get PM's Home Care Guide, \$5.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.



## PRODUCT TEST

# NEW VACUUM CLEANER

TEXT AND PHOTOS BY  
THOMAS KLENCK,  
Associate Home and  
Shop Editor

**I**T WASHES carpets and upholstery, mops and dries floors, cleans up standing water, and dry vacuums with a strength usually found in only heavy-duty shop vacuums. It's called Vax, and it's the latest and one of the most complete approaches to home cleaning.

Vax isn't exactly one machine that does many things, but rather a basic, 8.4-amp vacuuming unit that can be converted from dry to wet operation. For dry vacuuming, a dust bag is installed in the tank over which a filter section is fitted. At the end of the 3-piece, stainless-steel wand, you can mount the usual accessories, including a novel carpet vacuuming head with an air-driven, rotating brush.

For vacuuming liquids into the 8½-qt.-capacity tank, you remove the dust bag and replace the filter section



More of a cleaning system than a simple vacuum cleaner, Vax comes with a full range of vacuuming and washing components, including detergents. Assembled Vax (right) is shown with standard floor attachment for use on hard floors and carpets.

with the reservoir section. To wash carpets, floors and upholstery, the reservoir is filled with hot water and Vax detergent. A plastic tube clipped to the wand siphons the solution to the cleaning nozzle. Although the system is simple, it doesn't work when the nozzle is higher than the detergent level in the tank—you have to raise the machine to handle most upholstery chores.

For hard floors, the mop accessory

has a foam applicator on one side, and a vacuuming head on the other side for removing dirty water and drying the floor.

Vax is effective and comes with everything you need, including detergents. About the only thing it lacks is a storage rack for holding the accessories and components. It's available at Sears Brand Central for about \$400. Contact Vax Appliances, Inc., 30400 Solon Rd., Solon, OH 44139. **FM**



For dry vacuuming, reusable dust bag fits in tank, and filter section is placed on top. Additional filter under motor cleans air.



Rather than using a separate motor, Vax rotary-brush carpet attachment is powered by airflow and internal impeller.



To wash carpets, dust bag and filter are replaced by reservoir. Plastic tube carries solution from reservoir to washing head.



Detergent solution feed is controlled at handle. It can be set for continuous washing, or operated intermittently with trigger.



Carpet washing head circulates detergent in fibers while drawing dirty water into tank. After washing, suction dries carpet.



Mop attachment carries detergent in foam pad. Opposite side of attachment serves as vacuum head for removing dirty water.



## APPLIANCE CLINIC

BY STEVE TOTH,  
Contributing Editor

### Basket Case

I have a Sears Kenmore washing machine model 110.S7004610W00, serial No. C04172538. I want to remove the basket. I've removed all parts including the locknut, but I am still unable to loosen the basket.

What can I do?

GLEN C. JOHNSON  
OTIS ORCHARDS, WA

Over the years, water, detergent and dirt have probably gotten between the aluminum drive block and the washer basket and have begun to eat away at the drive block. This corrosion is probably causing the basket to stick to the block making the basket difficult to remove. To free the basket, pour a little penetrant, such as WD-40 or Rust Buster, into the flange opening at the top of the drive block, and let it soak in.

Then, reach into the basket with both hands and grab the inside flange at the top. Using your palms, push down on one side then the other, rocking the basket up and down. Rotate the basket 90°, and again force the basket up and down. Continue doing this until the basket breaks free from the drive block. Lift the basket out of the machine. Then, remove the drive block by spreading the slot in the block with a screwdriver blade and lift it off the shaft. Wipe the basket surfaces clean. Replace the block and reinstall the tub.

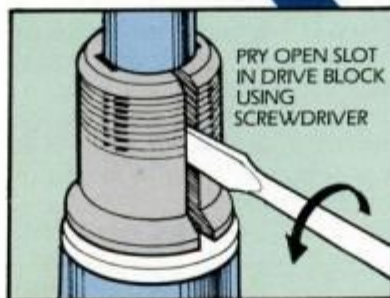
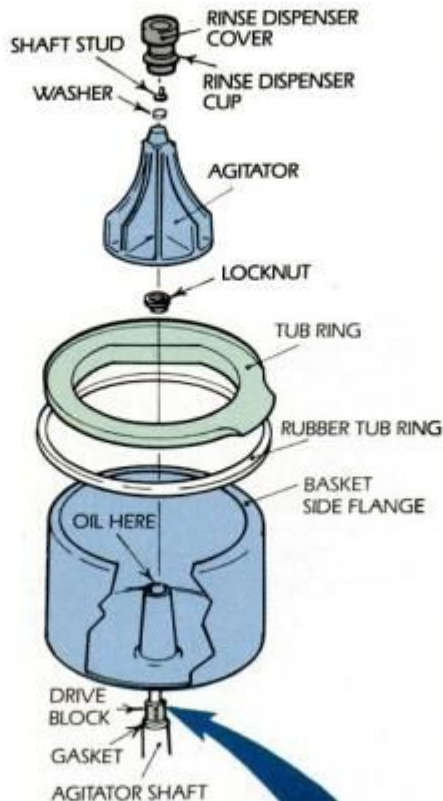
### Needs A Book

I enjoy working on appliances as a hobby and need a book that covers a wide range of repairs on different appliances.

Any information you can give would be greatly appreciated.

JAKE WHISNANT  
BOILING SPRINGS, NC

Your local library should prove to be a good source of information on appliance repair. Check in the Home Repair section. There, among the many books offered, you should find the Popular Mechanics Home Appliance Repair Manual. This manual, though now out of print, has a lot of step-by-step procedures to help you diagnose and repair appliances.



A washer basket is difficult to remove when the drive block sticks to it. Use a small amount of penetrant and work the basket loose. Pry open the drive block with a screwdriver and replace it.

### Beater Banter

I am inquiring about beaters for a Sunbeam Hand Mixer Model J.C., 100 volts, 65 watts. Does anyone make or have beaters available?

ROMAN COLLING  
SPENCER, IA

To get a replacement set of beaters for your approximately 20-year-old mixer, either contact your local Sunbeam parts dealer, or call the company's parts order center at (800) 227-7449. The beaters for your vintage mixer are still available under part No. 2187 and cost \$3.50 each, plus \$2 postage, from Better Brands, 3611 Prospect Ave., Cleveland, OH 44115.

### Old Stove Switch

We own a G.E. electric range model J405W1M2, serial No. OM2159A,

which has given us faithful service for many years. One of the pushbutton switches has finally given out and must be replaced.

Our local serviceman says the range is so old, he can't find a parts list microfilm on it, much less order a replacement part. It seems a shame to replace a fine stove just because one part has failed.

Can you please advise us on how to obtain a replacement pushbutton switch?

HUGH G.J. AITKEN  
AMHERST, MA

I suggest you contact South Eastern Range Parts Manufacturing Co., Gastonia, North Carolina. There is a good chance they can help you get a replacement switch for your vintage range.

First, remove the old switch from the range and jot down any numbers you find on it, as well as the number of buttons and electrical terminals on it. Then, call the company at (800) 438-8364 and provide them with this information.

They'll check to see if the part is in stock or if the old numbers have changed to new numbers. If they have the part, they'll quote you a price over the phone. If they can't match the numbers with a stock part, they may ask you to send them the old switch, so they can match it to a similar or aftermarket switch.

There is a good chance that they can help you extend the life of your range.

PM

### Service Tip

Here's a tip sent in by Gregory Funke of Polson, Montana. Clean the sediment off the bottom of an electric water heater using a wet/dry vacuum. First, shut off the heater's power supply, and remove its access panel. Then, remove the lower heating element.

Now, cut down an old funnel or a cutoff plastic engine oil container and secure it to the vacuum's corrugated hose with electrical tape. Then, tape a cutoff section of garden hose to the funnel's end. Poke the garden hose into the heater element hole and vacuum up the sediment.

**DO YOU HAVE AN APPLIANCE PROBLEM?** Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance 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.



MAINTENANCE

POWER EQUIPMENT  
FUEL AND OIL

BY GUS G. SHEPHERD  
PM Illustrations  
by Don Mannes

**I**F YOU'VE recently upgraded your lawnmower, tiller or other piece of gas-powered outdoor equipment with one of the latest models, you may have noticed that small-engine manufacturers are no longer content to produce the same stodgy engine design year after year. And, unless you've been utilizing horsepower of the 4-legged variety for the past 20 years or so, you've probably seen a few changes in the kinds of oils and gasolines available at the corner service station.

Combine both of these developments, and you have a recipe for confusion—at least when it comes to maintaining and operating your outdoor power equipment. Knowing which oils to use and what gas to buy not only help to ensure that your equipment will function properly, but could actually save you money.

**The new engines**

After generations of lagging behind contemporary automotive designs, outdoor power equipment engines are rapidly being modernized. Traditional valve-in-block, L-head engines—common to nearly every piece of outdoor power equipment up until a few years ago—are now being superseded by compact, high-efficiency overhead-valve (OHV) powerplants.

For many, the new generation of engines may seem like a needless complication. However, these new powerplants can be built lighter and more compact, making the equipment they drive easier to handle. And, they run cooler, control oil consumption better, and can be designed to require very little maintenance.

As engines become more sophisticated, however, their fuel and lubrication requirements change. For example, some new equipment is less tolerant of modern, alcohol-blend fuels because of the plastic components in the fuel system. The makeup of today's gasoline dispensed at the pump often includes alcohol to increase the octane rating. And, alcohol



has an affinity for water. Although this is a minimal problem for cars that are driven regularly, it can cause balky starting in outdoor equipment that's used infrequently.

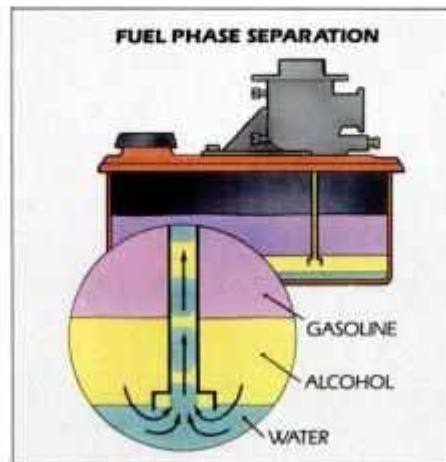
Alcohol-blend gasolines have become more prevalent in recent years, and up to 10 percent (by volume) of ethyl alcohol is allowed by EPA standards. These blends are common in areas where poor air quality dictates gasoline formulations that include oxygen-bearing additives to reduce carbon monoxide emissions.

While design sophistication may bring with it some fuel problems, OHV engines can simplify your maintenance schedule. Because the valve mechanisms require continuous lubrication, these engines commonly use an oil pump and an automotive-style filter. Full filtration of the oil means that the oil-change interval can be longer. But always check your owner's manual for the correct information on your specific engine.

**Gasoline requirements**

Every major supplier of small engines—two cycle or four—recommends the use of regular-grade, unleaded gasoline, regardless of how old your engine is. The principal reason for this is that unleaded fuels form far fewer deposits on the piston and in the combustion chamber. Spark plug fouling is less likely with unleaded fuels, too.

Before unleaded gas was in widespread use, removal of the cylinder head at regular intervals was required to remove combustion deposits. The combination of unleaded fuels and OHV engine design makes this procedure a far less frequent chore. Valve seat deterioration with unleaded fuels has not proven to be a problem because outdoor power equipment rarely runs under the constant high loads of a car engine.



Alcohol, used to increase the octane rating, absorbs moisture from air that can then collect in fuel system. Alcohol and water separate from gas after about 30-days storage.



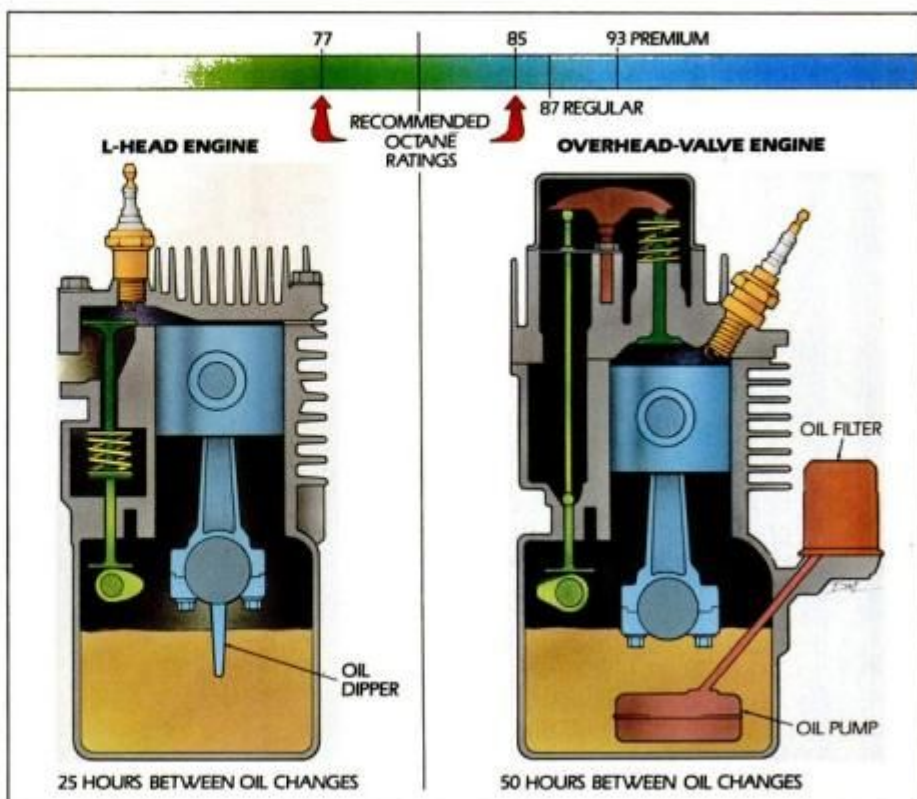
The latest OHV engines do, however, require a higher-octane gas than the older L-head (also called side-valve or flathead) designs. Briggs & Stratton, for example, calls for 85-octane gas in its Vanguard OHV engines, whereas 77-octane fuel will suffice for the older L-head engines. If you stick with 87-octane gas or better, you'll have no trouble, although there's no advantage in buying a premium-grade gasoline.

For long storage periods, it's a good idea to drain the fuel tank and run the engine until the carburetor is dry. This is even more important if you're using an alcohol-blend fuel. Any gas containing alcohol will undergo phase separation after about 30 days storage, dividing the fuel into three layers—water at the bottom, alcohol in the middle, and stale fuel at the top. One way to counteract this problem is to use a fuel stabilizer, such as Briggs & Stratton Fuel Additive. This product also contains detergents and rust inhibitors. Avoid using fuel system dryer additives not expressly designed for small engines, especially 2-stroke engines. These additives may contain compounds that are incompatible with magnesium and other light-metal components.

Two-stroke engines are particularly sensitive to alcohol content because of the need to keep the oil portion of the fuel mix from settling out. Buy name-brand gas from a reputable dealer and, by all means, avoid gas that contains methanol rather than ethanol. Two-stroke engines that utilize an oil-injection system rather than oil/gas premix are less affected by alcohol content.

## Oils and changes

To circulate the oil through the valve mechanism, most OHV engines incorporate a gear-driven, positive-displacement pressure pump. This replaces the old connecting rod dipper that simply splashed crankcase oil to internal parts. The constant flow of lubricant in the new design helps to cool the engine and, by including a filter, the oil-change intervals have been lengthened. Briggs & Stratton, for example, now calls for changes after 50 hours of use on filter-equipped engines as opposed to a 25-hour limit on the old L-head models. Kohler calls for a 100-hour oil-change interval on their OHV engines. When an engine is rebuilt, or a new short block is installed, the first oil change should occur after 5 hours of operation. Always check your manual for



Manufacturers recommend a higher-octane gas, and allow longer time between oil changes, with pressure-lube, filter-equipped OHV engines. Data shown is typical for Briggs & Stratton engines. Check your owner's manual for your engine's requirements.

specific oil-change information.

Another benefit of the new OHV engines is a greater tolerance for multigrade oils. Most manufacturers call for 10W-30 oil at temperatures above 32° F, and 5W-20 below that temp. There are widely differing opinions on the use of 10W-40 oil because of the viscosity-improving additives needed to span that wide range of grades that have been blamed for harmful thickening of the lubricant—especially in air-cooled engines.

Multigrade oil will make cold starting easier in winter. Use an oil marked with an API (American Petroleum Institute) Service Class of SF or SG. Winter starting may also be easier with synthetic oil. Most manufacturers consider synthetics acceptable substitutes, though they offer little advantage in warm weather and have high initial cost.

Although you can use multigrade oil in the crankcase of your traditional L-head engine, manufacturers have generally recommended single-grade oil, claiming that less oil is consumed.

All small-engine manufacturers warn against the use of supplementary oil additives, pointing out that the relatively high operating temperatures of air-cooled engines may cause the additives to thicken and actually impede lubrication. Also, the

small oil capacity of these engines means that an extra additive simply displaces vital lubricant.

Two-stroke engines require special oil, whether they use an oil/gas premix or are equipped with a separate oil-injection system. These oils are specially formulated to stay in suspension for a long period of time in a premix application. Because they only pass through the engine briefly (they're burned with the gas), 2-stroke oils contain fewer additives and detergents.

The critical attribute of these special oils is a low ash content. This keeps spark plug fouling to a minimum and reduces carbon deposits in the exhaust ports. A certification stamp from the National Marine Manufacturers Association (NMMA) is your best guide to 2-stroke oil quality. For extreme cold-weather duty, you may want to use special snowmobile 2-stroke oil.

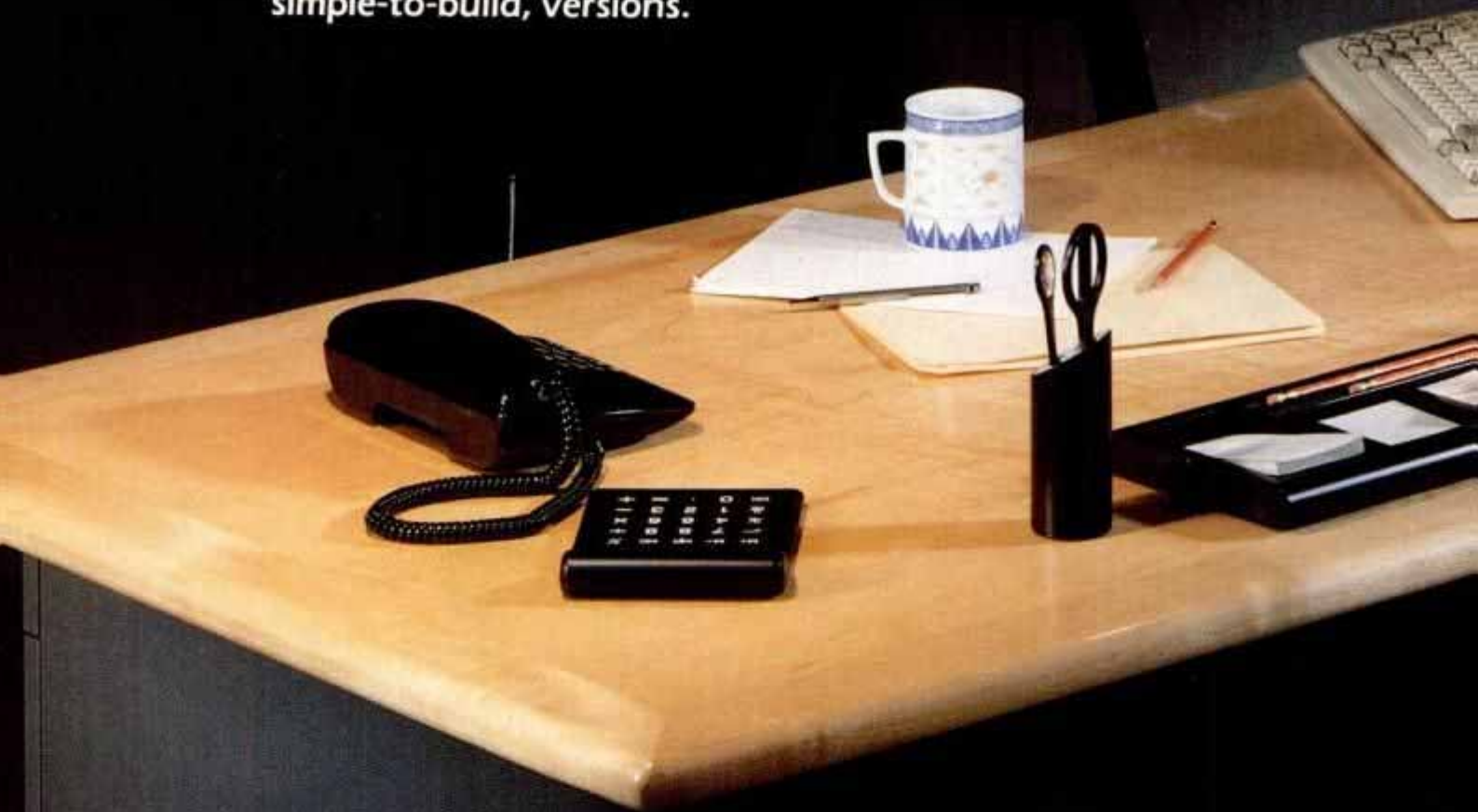
Not only does progress in engine design affect your choice of fuels and lubricants, but new formulations do as well. The best way to ensure long service is to change the oil regularly using quality products. Keep your gas supply fresh by storing a minimal amount and always buy from a reliable source that offers low-alcohol-content gasoline.

PM



# DESK MAKING

It's the heart of a home office. Sometimes, when space is limited, it's the office itself. Either way, a functional and attractive desk is a great addition to your home. Here are three eye-catching, but simple-to-build, versions.



PM PHOTO BY J. R. ROST



# These Piranhas Can Devour A Cow In Just 3½ Minutes.



## Wait'll You See What Ours Can Do.



Black & Decker's® carbide-tipped Piranha® circular saw blades will eat just about anything, and fast. Because these blades combine the durability of carbide with the cutting speed of steel. And their patented, curved teeth are razor sharp, allowing Piranha blades to cut faster and easier than ordinary carbide-tipped blades.

Moreover, Piranha blades last up to 50 times longer than steel blades,

which makes them extremely ferocious for an extremely long time. And they're even resharpenable.

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Available in either 7¼" or 10" sizes, Piranha Teflon® coated blades are ideal

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## Ebonized Writing Table

An elegant 2-tone writing table that's surprisingly simple to build.

BY NEAL BARRETT

POPULAR MECHANICS • JULY 1990

**T**HIS WRITING table is constructed with two of the most elegant hardwoods available, cherry and mahogany. Both have been prized by generations of woodworkers for their beauty and dimensional stability. The top panel is mahogany plywood edge banded with solid mahogany strips that are mitered at their corners and secured to the panel with splines. Using

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



# DESK MAKING

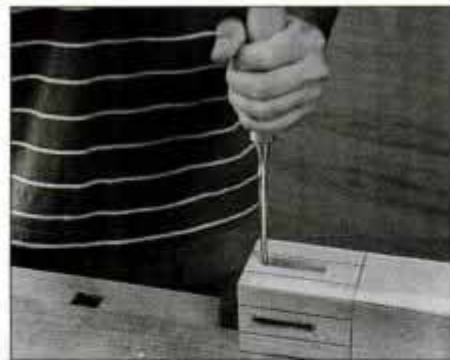
plywood, as opposed to solid wood, makes the top relatively simple to make.

The base is ebonized cherry. An ebonized finish is one in which the wood is considerably darkened, to look like ebony, while still allowing its grain and character to be evident. The top is stained with an aniline dye to bring out the mahogany's warm red tones, and then given a traditional brushed varnish finish. This gives the top a satisfying sheen and adequate protection against the abrasion that results from books, picture frames and, of course, writing, whether on a blotter or on the surface itself.

We hope that the result of our combining tones and textures achieves a quiet elegance that belies the table's simple, but sturdy, construction.

## Legs

For the table legs, use either 3-in.-thick cherry, or glue up thinner stock. If gluing up the legs, start with slightly oversized stock and cut the workpieces to dimension after the glue has set. Use a radial-arm saw or table saw to crosscut the leg blanks. Clamp a stop to the radial-arm saw fence, or on an extension to the miter gauge, to ensure the legs are crosscut to the same length.



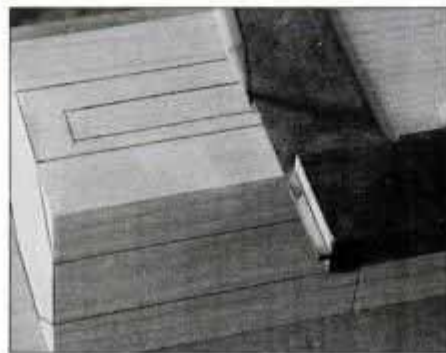
**3** With leg secured between bench dogs, use a sharp chisel and mallet to square the ends and smooth walls of mortise.



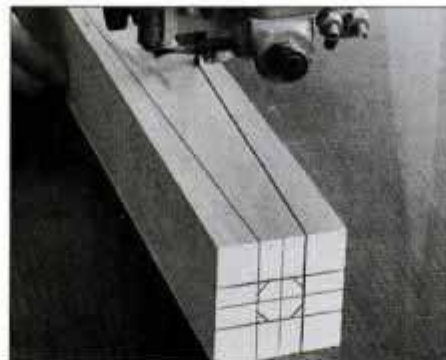
**6** After the leg has been smoothed, connect the marks at the top of the leg to those on the bottom to draw remaining facets.

Lay out the octagon shape of the legs on both top and bottom ends of each leg blank. Note that the legs begin to taper 4 in. down from the top, and they measure 1 in. across at the bottom.

Mark a line around each leg about 4 in. down from the top to indicate the start of the taper (Photo 1). Extend the octagon corner marks down the face of the legs. Then mark the position of the apron mortises on the leg faces. Next, clamp a fence on the drill press table, to help position the work, and use a 1/2-in.-dia. drill bit to bore overlapping holes. Remove most of the waste from each mortise (Photo 2). Then, use a sharp chisel and mallet to square the ends and smooth the



**1** Draw line around leg to mark where it starts to taper, and extend taper lines down leg. Mark for the apron mortises.



**4** Cut the leg tapers on a band saw. Feed the leg smoothly into the blade, and cut just to the waste side of the taper line.



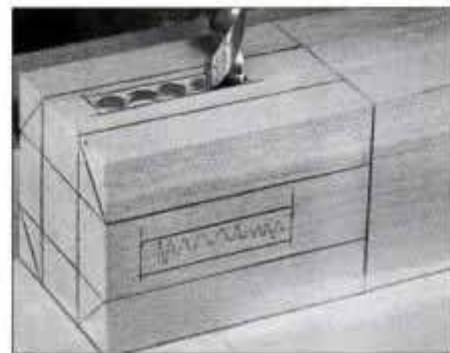
**7** Use a chamfer bit in a router to rough out remaining leg facets. Each chamfer should be about 3/8 in. wide.

walls of the mortise (Photo 3).

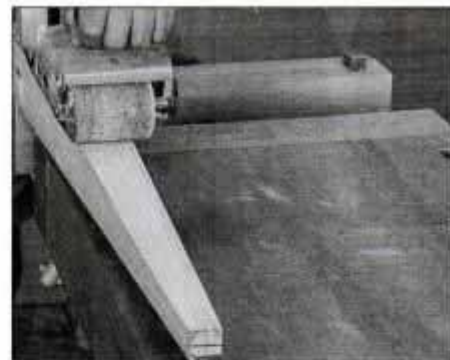
Next, use a band saw or sabre saw to make the taper cuts (Photo 4). Cut on the waste side of the line. Then clamp the leg to the workbench, and use a belt sander to remove saw marks and bring the taper right to the line (Photo 5).

Mark the taper for the remaining sides on the newly cut surface, and saw the next tapers. Again, smooth the tapers with the belt sander working down to the layout line.

Mark the lines for the remaining leg facets (Photo 6). Rough out these facets with a 3/8-in. chamfer bit (Photo 7). Clamp the leg to the workbench, and finish shaping the leg with a hand plane (Photo 8).



**2** To clear mortises, butt leg against fence clamped to drill press table and bore overlapping holes with 1/2-in.-dia. bit.



**5** Use a belt sander to remove the saw marks and refine leg taper. Be sure that the workpiece is firmly held to the bench.

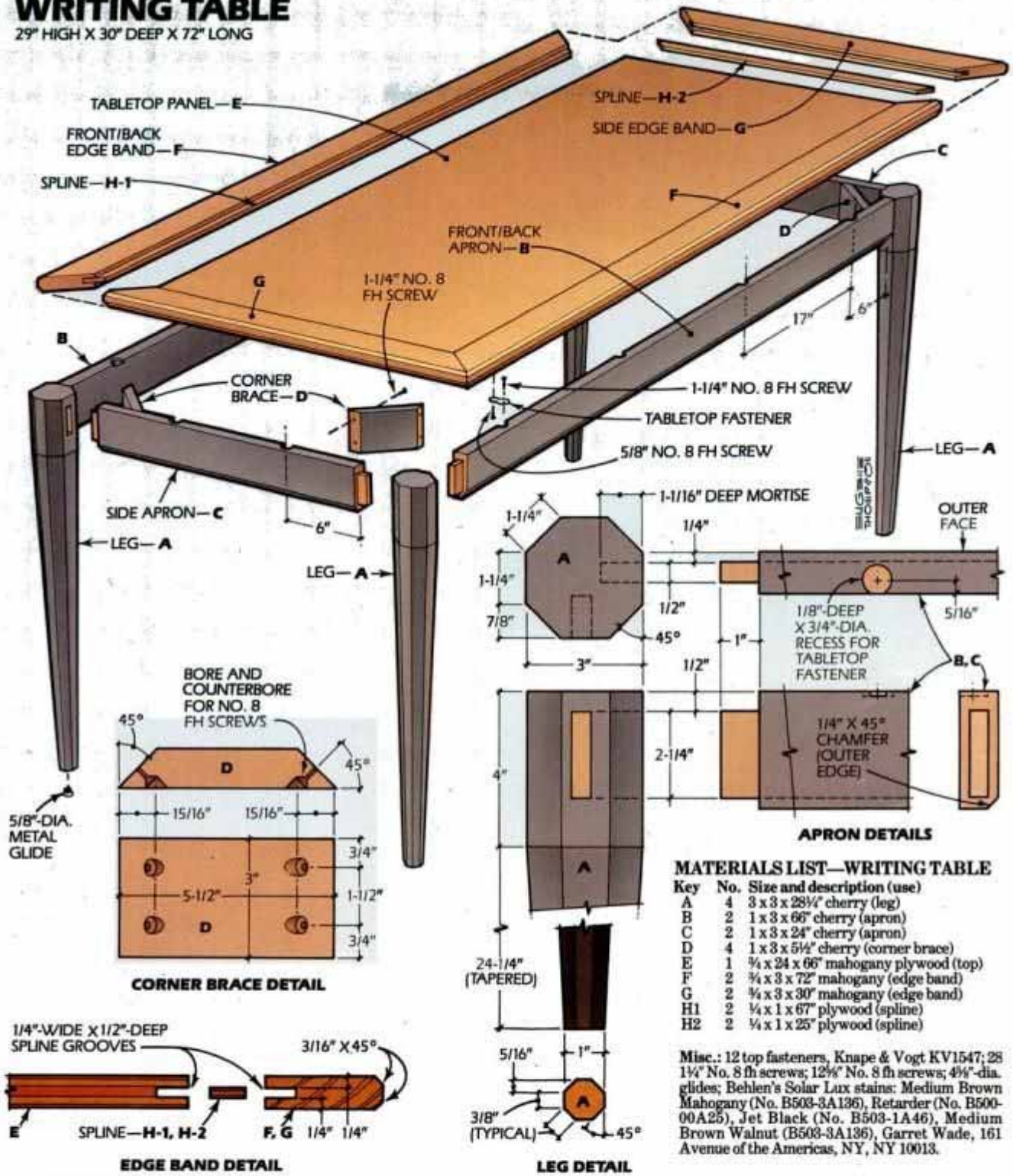


**8** Finish shaping the legs with a hand plane. Work in direction of grain. If used against grain, plane will tear out wood.



# WRITING TABLE

29" HIGH X 30" DEEP X 72" LONG



### APRON DETAILS

**MATERIALS LIST—WRITING TABLE**

Key	No.	Size and description (use)
A	4	3 x 3 x 28 3/4" cherry (leg)
B	2	1 x 3 x 66" cherry (apron)
C	2	1 x 3 x 24" cherry (apron)
D	4	1 x 3 x 5 1/2" cherry (corner brace)
E	1	3/4 x 24 x 66" mahogany plywood (top)
F	2	3/4 x 3 x 72" mahogany (edge band)
G	2	3/4 x 3 x 30" mahogany (edge band)
H1	2	1/4 x 1 x 67" plywood (spline)
H2	2	1/4 x 1 x 25" plywood (spline)

Misc.: 12 top fasteners, Knap & Vogt KV1547; 28 1 1/4" No. 8 fh screws; 12 3/8" No. 8 fh screws; 4 3/4"-dia. glides; Behlen's Solar Lux stains: Medium Brown Mahogany (No. B503-3A136), Retarder (No. B500-00A25), Jet Black (No. B503-1A46), Medium Brown Walnut (B503-3A136), Garret Wade, 161 Avenue of the Americas, NY, NY 10013.

## Aprons/Base Assembly

Rip and crosscut the 1-in.-thick stock for table aprons. Use a stopblock while crosscutting to ensure that the aprons are the same length.

Lay out the apron tenons. Using the dado blades in the table saw, make the cheek cut for the tenons (Photo 9). You can leave the blade height in the same position to cut the shoulder at the apron's bottom edge (Photo 10), but then raise the blade to cut the shoulder at the apron's top edge. Cut the tenons a hair large. Then hold the



9 Cut tenon cheeks on aprons using dado blades in table saw. Butt apron against fence, and use miter gauge to guide cut.

apron in a bench hook and pare away the ridges left by the dado blades using a sharp chisel.

Test fit each mortise and tenon joint. The joints should be snug, but should not require great force to bring together. Finish shaping the aprons by using the chamfer bit in the router to cut the chamfer on the bottom edge of apron members.

Mark the locations of the tabletop fasteners along the aprons' top edges, and use a 3/4-in.-dia. multispur or Forstner bit in the drill press to cut each fastener's recess (Photo 11).



# DESK MAKING

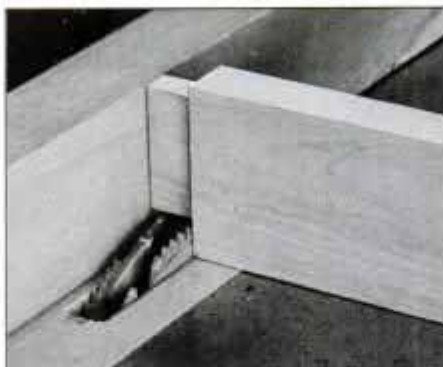
Clamp a fence to the drill press table to keep the apron aligned under the bit.

Begin the base assembly by joining two legs to each long apron. Apply glue to both mortise walls and the tenons, and use long bar clamps to bring the joints tight. To maintain equal spacing at the top and bottom of the leg, clamp a scrap board reaching from the foot of one leg to the other (Photo 12). Cross measure the diagonals to check for square, adjust the clamps if necessary, and let the assembly dry.

Complete the base assembly by joining the short aprons to each side (Photo 13). Carry out this assembly on a flat surface to avoid imparting any twist to the base. Again, cross measure to check for squareness, adjust if necessary, and let set.

Next, cut the corner braces for the base as shown in the plan. Use the table saw, radial-arm saw or a miterbox to cut the 45° angles at each end. Bore and countersink pilot holes for the screws that attach the brace to the apron. Install the braces at each corner using 1¼-in.-long No. 8 fh screws.

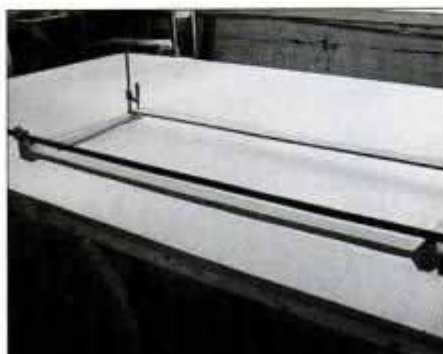
Invert the base and install the ¾-in.-dia. glides on each leg bottom.



**10** Tip the apron on its side to cut the bottom tenon shoulder. Lower the blade height to cut the top tenon shoulder.



**11** Butt apron to a fence clamped to the drill press table. Use multispur or Forstner bit to bore recess for tabletop fasteners.



**12** Glue and clamp a pair of legs with an apron. Clamp a temporary support at the foot of the legs to maintain proper spacing.



**13** Glue and clamp together subassemblies with short aprons. Cut corner braces to span long and short aprons, and install.

## Tabletop

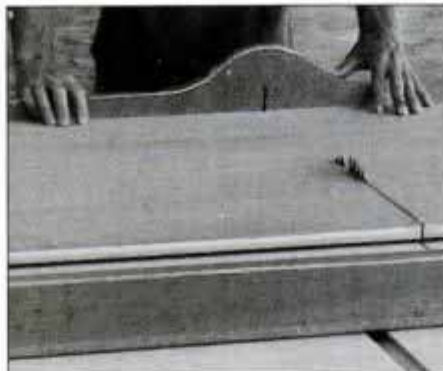
Cut a piece of mahogany plywood to size for the tabletop. Although we used lumber-core plywood, other core types also work (veneer or flake core, and medium-density fiberboard, known as MDF). Use a table saw and crosscut jig, or a circular saw and a guide clamped to the panel (Photo 14).

Rip ¾-in.-thick stock for the top edge banding. Use the miter gauge on the table saw to cut the 45° angles at their ends (Photo 15). Next, use a slotting cutter and router to cut the spline grooves in the panel and edge bands (Photo 16).

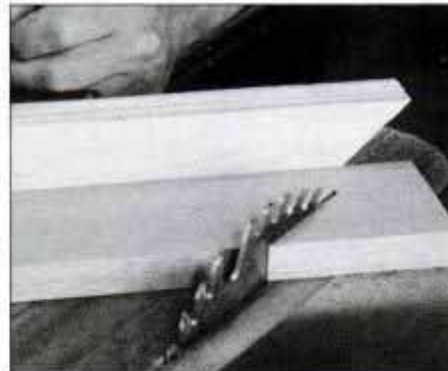
Cut the splines from ¼-in.-thick plywood or solid wood. Check that plywood fits snugly in the groove, as often ¼-in.-thick plywood is less than ¼ in. thick. If the spline is loose, it won't accurately align the panel and edge band.

Glue and clamp the end edge bands to the panel (Photo 17). Spread glue on the panel and edge band and in the spline grooves. Clamp until the glue sets. Apply glue to the mitered surfaces, and apply the remaining two edge bands.

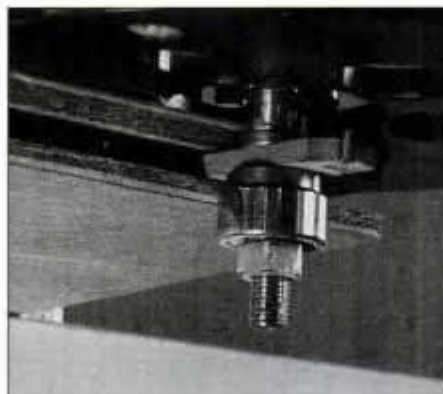
Use the chamfer bit in the router to cut the edge profile along the top and bottom edges of the tabletop.



**14** Cut plywood panel for tabletop. Here, a sliding table jig is used on the table saw, but a handheld circular saw works too.



**15** Cut mitered edge band on table saw. The edge band is cut to length, and inside edge of the saw blade bisects corner.



**16** Use a slot cutter in the router to make a spline groove in panel and in edge band. Cut spline so it fits snugly in groove.



**17** Clamp end edge bands in place first. Prevent clamps from coming in contact with glue by supporting them on strips.



## Finishing

Sand the base and top with 120- and 220-grit sandpaper. Be careful throughout the sanding process not to sand through the panel's face veneer. Sand the underside of the tabletop first, to get the feel of sanding mahogany veneer, which is relatively soft and easily removed by sanding. Vacuum off the dust and wipe clean with a tack cloth before proceeding.

The top was stained with Behlen's Medium Brown Mahogany aniline dye. We added retarder to this to prevent it from drying too rapidly and leaving lap marks. The order number of the dyes used and the retarder are contained in the Materials List on page 75. Let the stain dry 2 hours before applying the top coat.

We used several heavy applications of aniline dye to ebonize the base (Photo 18). The proportions are two parts Jet Black, four parts Medium Brown Walnut and two parts Medium Brown Mahogany.

Mix the stains and apply the mixture with a cloth, brush or spray. If you apply the stain with a cloth or a brush, add retarder to prevent leaving lap marks. Let the stain dry 1 hour, and apply a second coat. Let that coat dry, and apply a third coat, if you want the darkest color possible. When aniline stains dry, they appear considerably lighter than they will under the top coat. The color of the wet stain is closer to the finished color.

Next, we brushed on two coats of McClosky's Heirloom Satin Varnish to all parts, front and back. Let it dry overnight, and sand between coats with 600-grit, wet-or-dry paper. As with all varnish finishes, you can apply more coats for greater protection and a "deeper" looking finish. Because this is a satin varnish, however, adding more coats will not increase its glossiness. If you desire a high-gloss finish, then apply a gloss varnish. A



**18** Apply the ebonizing stain with a rag, brush or by spray. Wear gloves and use organic filter cartridges in the respirator.

high-gloss varnish requires more work to rub out dust specks and other imperfections, such as lap marks.

With a high-gloss finish, follow the finish manufacturer's directions, as explained on the can label. With the 2-coat finish, use the tack cloth to wipe up the varnish dust. Use 4/0 steel wool to remove dust marks from the second coat and apply a light coat of wax.

When the finish is dry, attach the

tabletop fasteners to the aprons with 1½-in.-long No. 8 flathead screws. Invert the tabletop on a padded surface, and invert the base over it. Check for uniform overhang on all sides. Then attach the top to the base using ½-in. No. 8 flathead screws. When preboring the top for these screws, use a stop collar on the bit, or mark the bit with a piece of masking tape. This should prevent you from boring through the top. **PM**

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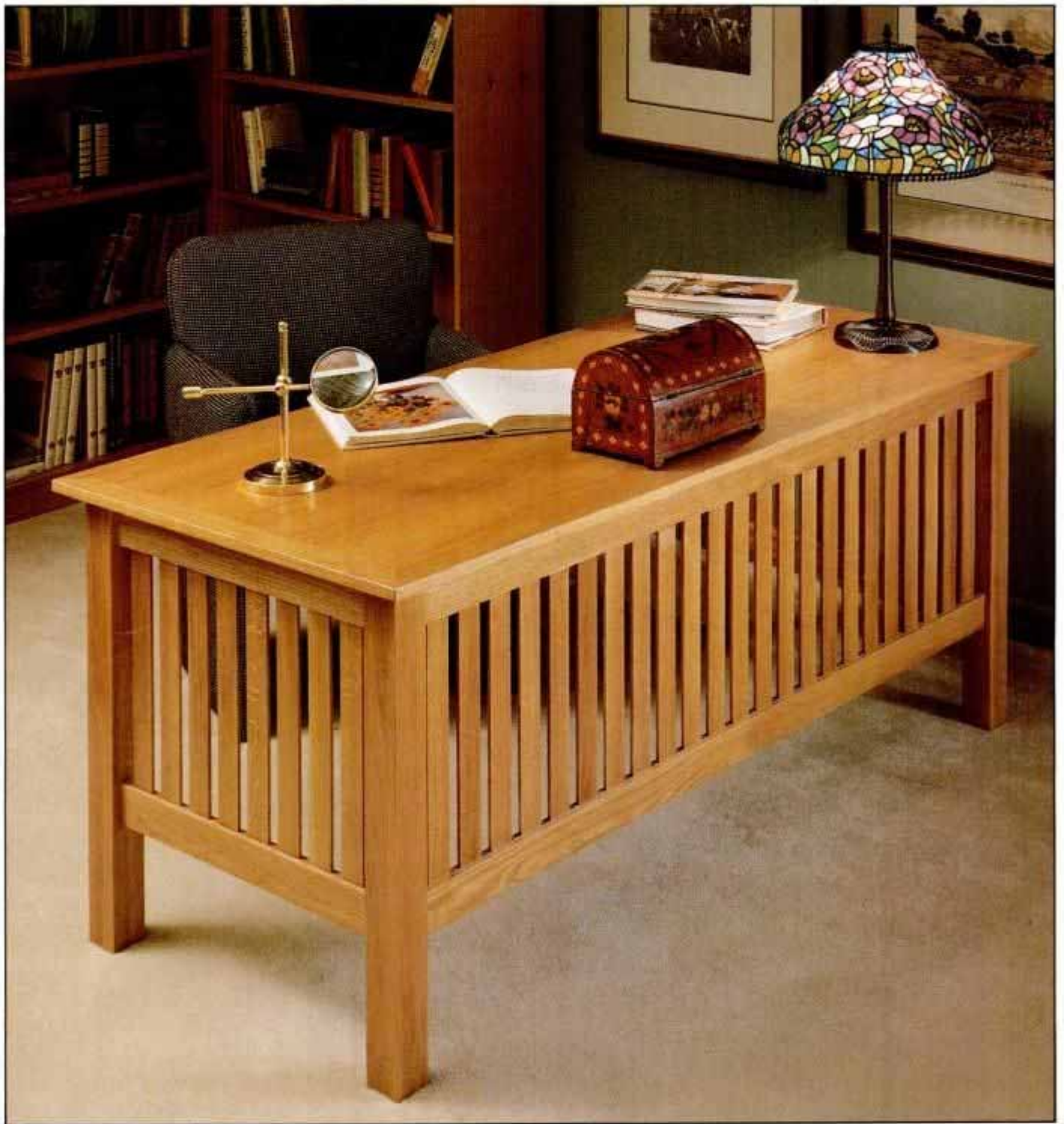
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## An Oak Writing Desk

This Mission-style desk is made from white oak.

BY NEAL BARRETT

**T**HE DESIGN of this white oak writing desk is derived from the Mission furniture style that was popular in the early part of the 20th century. While conveying a feeling of solidity and substance, its slats lighten its appearance, so it can fit into nearly any room without overpowering the decor. With two drawers to keep paper and writing

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



implements handy, it may be just the thing to encourage writing those letters so long overdue.

Its construction is straightforward. The top panel is white oak plywood

banded by four pieces of solid white oak. The base consists of four legs, three aprons and matching stretchers with decorative slats in between.

Three coats of Waterlox Transpar-

ent Finish complete the project. Unlike heavy-film finishes, this tung oil-based finish is tolerant of dusty shop atmospheres. Apply it with a brush, a rag or with a sprayer.

## Legs

Begin by gluing up stock for the leg blanks. Use two pieces of  $\frac{3}{4}$ " stock for each leg (Photo 1), or glue up the leg blanks from thinner material. The blanks should be slightly oversize. Clean off the glue squeeze-out while it's still rubbery, using an old chisel. Then, rip the blanks and plane off the saw marks. Crosscut the legs using a stopblock to ensure the legs are the same length (Photo 2).

Lay out the apron mortises as shown in the drawing. Note that two legs have four mortises, while the other two have only two mortises each.

Next, use a  $\frac{3}{8}$ -in.-dia. bit in the drill press to bore overlapping holes to remove the waste from each mortise (Photo 3). Clamp a fence to the drill press table and butt the workpiece up to it when boring the holes.

Finish the mortises by paring with a sharp chisel, to square the ends of each mortise and smooth its sides (Photo 4). The tenon should fit the mortise snugly, so be careful not to pare beyond the lines.



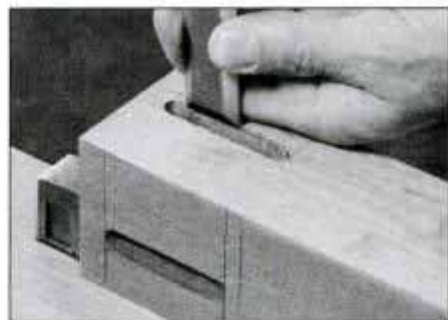
**1** Glue up slightly oversize leg blanks. When the glue is dry, rip and crosscut the blanks to the finished dimension.



**2** During crosscutting, butt legs against clamp or stopblock on miter gauge. This ensures the legs will be the same length.



**3** Mark the mortise position on legs and remove waste by boring overlapping holes with  $\frac{3}{8}$ -in.-dia. bit in drill press.



**4** Hold leg securely to bench. Use a sharp chisel to square the ends of mortise and to finish smoothing the mortise walls.

## Aprons And Stretchers

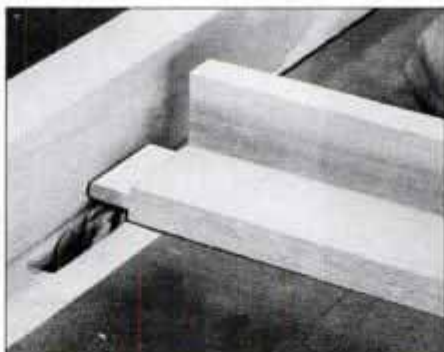
Rip and crosscut the aprons and stretchers. Using dado blades in the table saw, make two passes to cut one cheek of each tenon. Clamp a stop to the table saw or use the rip fence as a stop to make the cuts (Photo 5).

Leave the dado blades at this height and cut the  $\frac{1}{4}$ -in. shoulder on both aprons and stretchers. Then raise the blades to  $\frac{1}{2}$  in. high and cut the top shoulder (Photo 6). Since the dado blades leave small ridges on the tenon, cut the tenons a little large and pare them to size with a chisel.

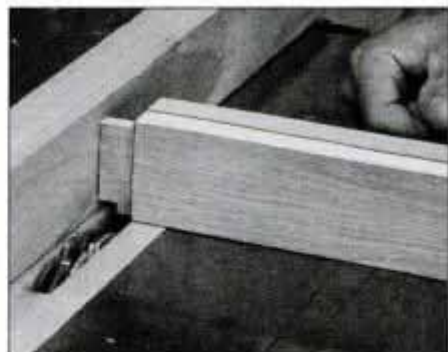
Test each mortise and tenon joint for proper fit. The tenons should be snug in the mortise, but should not require great force to bring tight. If the joint is too tight, pare the tenon. If too loose, glue some veneer to the tenon.

Use a router and a slotting cutter (Bosch No. 85520) with a  $1\frac{1}{8}$ -in.-dia. bearing to cut the  $\frac{1}{4}$ -in.  $\times$   $\frac{1}{4}$ -in.-deep grooves in the apron edges and stretchers (Photo 7).

Use a  $\frac{3}{4}$ -in.-dia. multispur or Forstner bit in the drill press to bore the recesses for tabletop fasteners on the apron's top edge (Photo 8).



**5** Use dado blades in table saw, with stopblock or fence as guide, to cut the tenon cheeks on aprons and stretchers.



**6** Cut the bottom apron shoulder with dado blades at  $\frac{1}{4}$ -in. height. Raise the blades to  $\frac{1}{2}$  in. high to cut the top shoulder.



**7** Use the slotting cutter in the router to cut the slat groove in apron and stretcher edges. Dado blades can also be used.



**8** Use a  $\frac{3}{4}$ -in. multispur or Forstner bit in the drill press to bore recess for tabletop fasteners in apron's top edge.



# DESK MAKING

## Slats/Base

Crosscut some 1 $\frac{3}{4}$ -in.-thick stock to 15 $\frac{1}{4}$  in. long, and rip that stock into strips to form slats (Photo 9). Cut several extra slats as a hedge against defects in any of the pieces and to make the small filler blocks for in between the slats. Finish plane the slats to  $\frac{1}{4}$  in. thick.

Rip several  $\frac{1}{4}$ -in.  $\times$   $\frac{1}{4}$ -in. strips out of the extra slats. Set up a stopblock on the table saw and crosscut the strips to  $\frac{7}{8}$  in. long (Photo 10). It's important that the strips be clear of the stopblock once they move into the blade. Otherwise, an offcut block could jam between the stopblock and the blade and shoot back at you.

To begin the base assembly, secure a side stretcher to the workbench with grooved edge facing up. Apply glue to the groove and place the first filler block at the end of the groove (Photo 11). Place the first slat next to the block and keep alternating block and slats until the groove is filled.

Next, apply glue to the apron groove and fit it over the slat ends (Photo 12). Turn over the assembly and fill in between the slats with filler blocks. Use pipe clamps to pull the assembly together. Compare opposite diagonal measurements to see if the assembly is square. Adjust the clamps if necessary to obtain square, then let the glue set up. Repeat this on the other side and the front.

Now, place a leg on the bench with the mortises facing up. Apply glue to the leg mortises and to the apron and stretcher tenons. Insert the tenons into the mortises, and use pipe clamps to pull the joints tight. Check the diagonals for square, and let the glue set (Photo 13). Repeat the process to join the front assembly to the side legs, using long pipe clamps to pull the joints together (Photo 14).

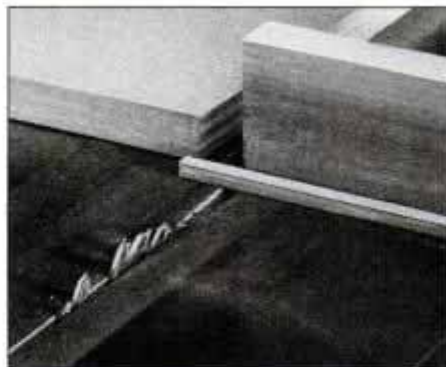
## Top

Using either the table saw or a circular saw and straightedge, cut the plywood panel for the desk top. Rip  $\frac{3}{4}$ -in.-thick solid stock to width for the edge banding and carefully joint the edge that meets the panel. Butt the edge banding to the panel and mark the inside corners of the miters. Miter the edge banding on a table saw or miterbox (Photo 15).

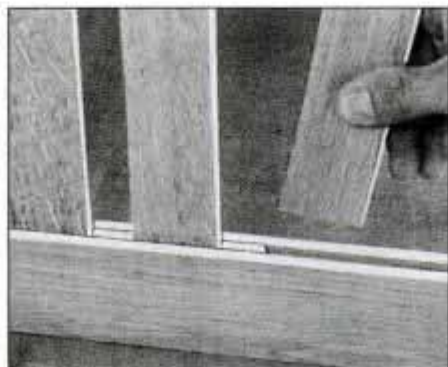
For this project, we used joining plates as a registration device between the plywood panel and the edge banding. The plates should be spaced 6 in. to 8 in. on center. If you don't own



**9** Rip slats slightly oversized from 1 $\frac{3}{4}$ -in.-thick stock. Then plane them to finished thickness to remove the saw marks.



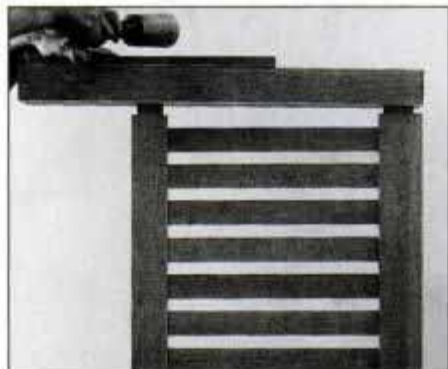
**10** Rip  $\frac{1}{4}$ -in.  $\times$   $\frac{1}{4}$ -in. strips, then use the miter gauge with a stopblock on table to cut the filler blocks for between slats.



**11** Apply glue to stretcher groove and position the filler blocks and slats. Slat and blocks should fit snugly in groove.



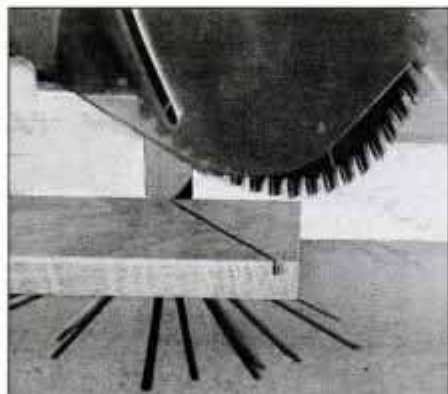
**12** Next, apply glue to the groove in the apron and position over slat ends. Then, position filler blocks in between slats.



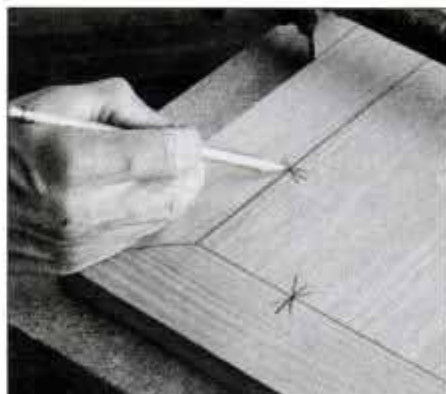
**13** Join the legs to apron-stretcher sub-assemblies with glue. Tap tenons into mortises, and clamp to bring joints tight.



**14** Use long pipe clamps to hold the front to side assemblies until glue sets. Pads under clamp heads prevent marring work.



**15** Cut the edge band miters in the miterbox or table saw with miter gauge. Extreme accuracy is needed for tight joints.

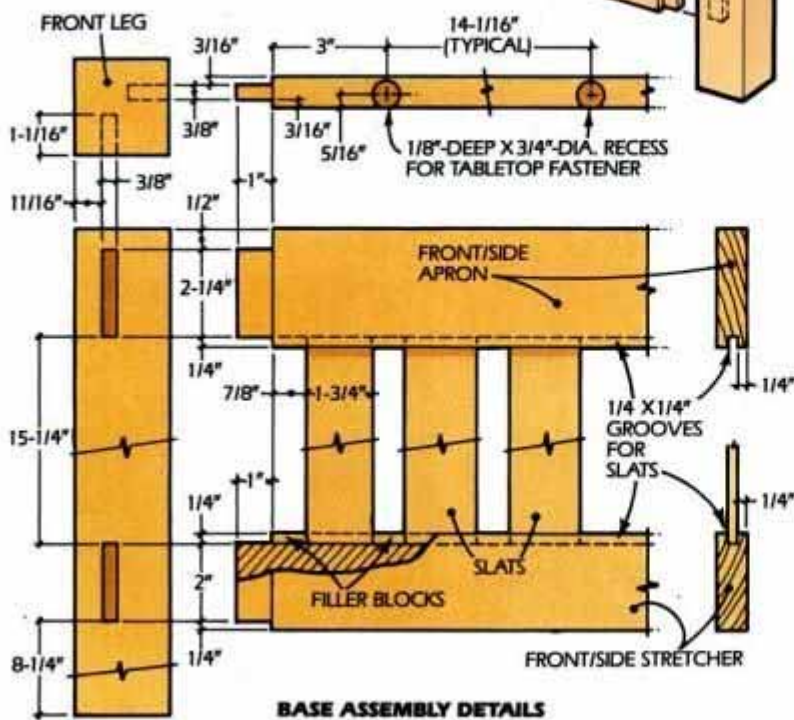
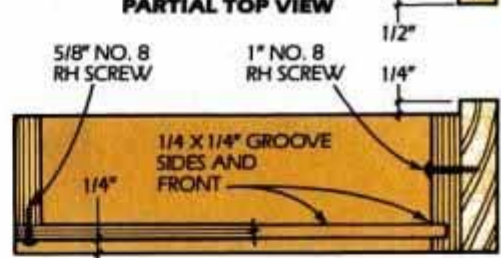
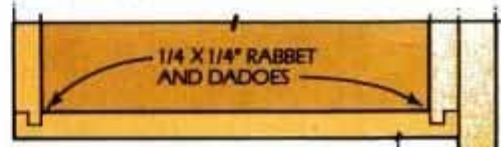
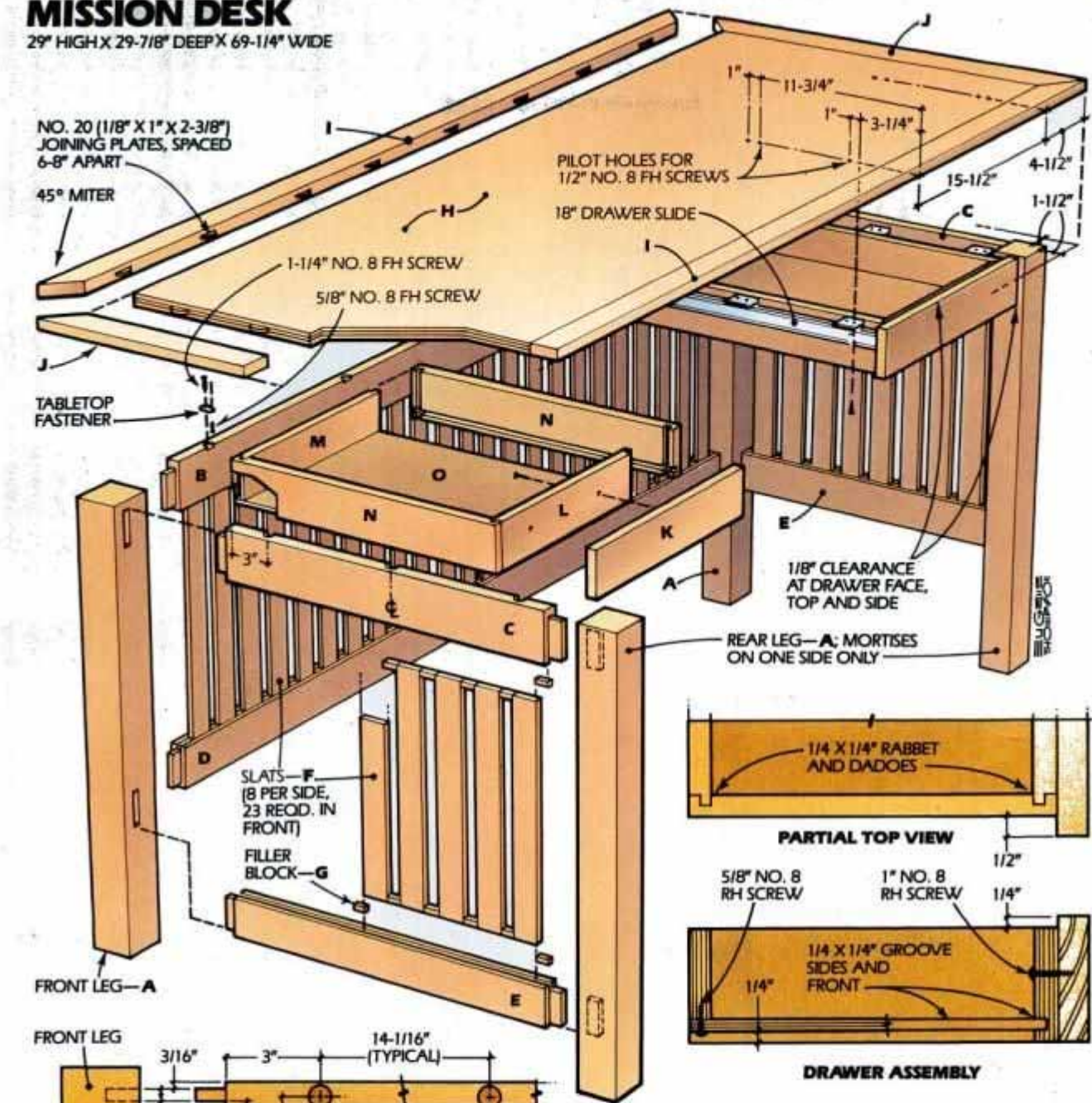


**16** Temporarily clamp edge band to the panel. Mark edge band and panel for joining plates centered every 6 in. to 8 in.



# MISSION DESK

29" HIGH X 29-7/8" DEEP X 69-1/4" WIDE



## MATERIALS LIST—MISSION DESK

Key	No.	Size and description (use)
A	4	2 1/2 x 2 1/2 x 28 1/4" oak (leg)
B	1	3/4 x 3 x 63 1/4" oak (front apron)
C	2	3/4 x 3 x 23 1/8" oak (side apron)
D	1	3/4 x 2 1/2 x 69 1/4" oak (front stretcher)
E	2	3/4 x 2 1/2 x 23 1/8" oak (side stretcher)
F	39	1/4 x 1 1/4 x 15 1/4" oak (slats)
G	84	1/4 x 1/4 x 1/8" oak (filler blocks)
H	1	3/4 x 25 1/4 x 65 1/4" oak plywood (tabletop)
I	2	3/4 x 2 x 69 1/4" oak (front/back edge band)
J	2	3/4 x 2 x 29 1/8" oak (side edge band)
K	2	3/4 x 2 1/2 x 16 1/2" oak (drawer face)
L	2	1/2 x 2 1/2 x 15" birch plywood (drawer front)
M	2	1/2 x 2 1/2 x 15" birch plywood (drawer back)
N	4	1/2 x 2 1/2 x 18" birch plywood (drawer side)
O	2	1/4 x 15 x 17 1/4" lauan plywood (drawer bottom)

Misc.: 11 tabletop fasteners, Knape & Vogt 1547; 11 1/4" No. 8 fh screws; 11 3/8" No. 8 fh screws; 4 1" No. 8 fh screws; 16 1/2" No. 8 fh screws; 6 1/2" rh screws; 2 sets C2006 Accuride pencil drawer slides (18-in. slide length), Order No. D7553, available from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, MN 55374; Waterlox Transparent Finish, Waterlox Chemical and Coatings Corp., 9808 Meech Ave., Cleveland, OH 44105.



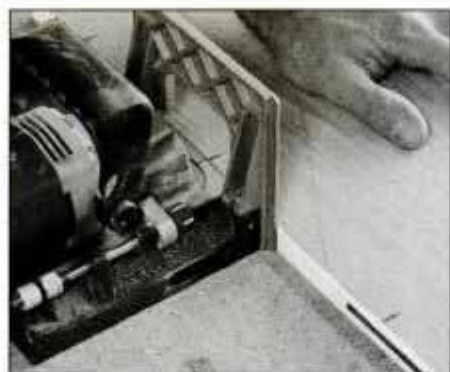
# DESK MAKING

a plate joiner, a spline joint will work just as well.

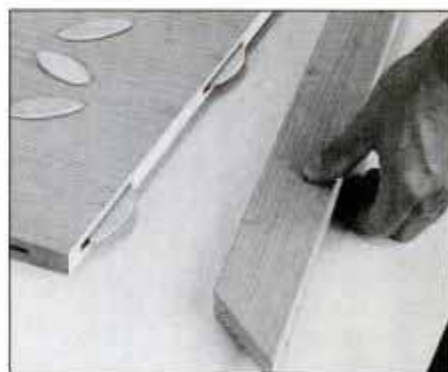
Place the panel and edge band on a broad, flat surface. Clamp the edge banding to the panel and mark the plate locations on the panel and banding (Photo 16). Hold the plate joiner and the workpiece firmly against the surface. Cut the plate housings in the panel and edge bands (Photo 17).

Test fit the edge band to the panel (Photo 18). Then, spread glue on the edge banding, the panel and the plate housings (slots). Clamp the end edge bands in place, and support the pipe clamps above the panel with thin wood strips (Photo 19). After 15 to 20 minutes, remove the clamps and apply the remaining two edge bands, spreading adequate glue on the miters. Scrape off glue squeeze-out after 30 to 40 minutes.

Sand the base and top with 120- and 220-grit sandpaper. Attach the tabletop fasteners (see Materials List on page 81) to the aprons using 1 1/4-in. No. 8 fh screws. Invert the top on a padded surface and place the base over it. Locate the base with 1 1/2-in. overhang of top on all edges. Attach the top to the base with 5/8-in. No. 8 fh screws (Photo 20).



**17** Position the plate joiner on a flat surface when cutting plate slots. Align mark on joiner with that on workpiece.



**18** With panel and edge band on flat surface, dry fit pieces with joining plates before gluing and clamping them in place.



**19** With top on sawhorses, use long pipe clamps to hold edge band to panel. Spread glue on joining plates and on edge band.



**20** Screw tabletop fasteners to the apron edges. Then invert base on top, and attach, leaving 1 1/2-in. overhang on all sides.

## Drawers And Finish

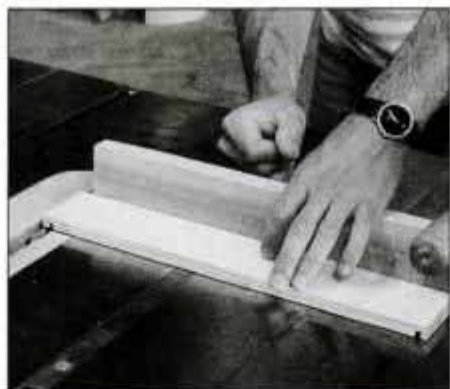
Make the drawer parts from 1/2-in.-thick birch plywood. Cut the dados and rabbets in the drawer sides and back using dado blades. Use a stop on the miter gauge to ensure uniform cuts (Photo 21). Cut the drawer bottom groove in the front and sides. Make a pair of plywood drawer bottoms. Sand interior drawer surfaces.

Assemble the drawer boxes with glue and brads. Slide in the bottoms and screw them to the drawer back with four 5/8-in. No. 5 rh screws.

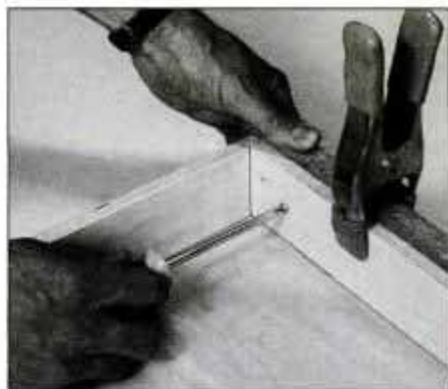
Rip, crosscut and sand the drawer faces. Clamp each face to the drawer box and attach it with two 1-in. No. 8 rh screws (Photo 22).

Attach the drawer slides to the drawers using the slotted holes (Photo 23). Assemble the drawer slides, place the drawer upside down on the inverted desk top, and mark the position of the mounting tabs. Bore on the marks, and screw the slides to the desk with 1/2-in. No. 8 rh screws. Install the drawers (Photo 24).

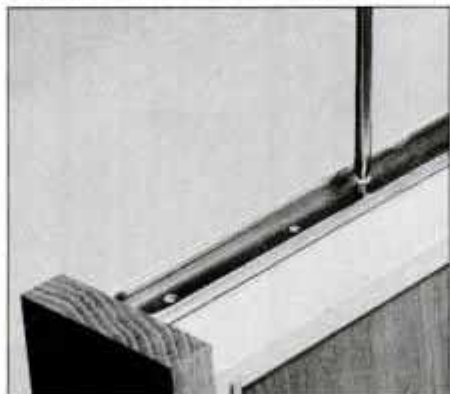
To complete the desk, apply three coats of Waterlox Transparent Finish. Allow each coat to dry overnight, and sand lightly between coats with 220-grit sandpaper. Buff out the final coat with 4/0 steel wool. **PM**



**21** Cut dados in the drawer sides using table saw. Use stopblock or clamp on miter gauge to ensure accurate cutting.



**22** Assemble the drawer box with glue and brads and attach the oak drawer face to it using a pair of 1-in. No. 8 rh screws.



**23** Drive screws through the slotted holes in the drawer slides. Install the remaining screws after slides are adjusted.



**24** Position drawers over inverted desk top and mark position of mounting tabs. Attach drawers, and adjust as necessary.





## Home Office Desk

A pedestal desk with a contemporary flair.

BY NEAL BARRETT

**I**N DESIGNING and building this desk, we took the concept of the traditional double-pedestal desk and added some new twists to give it a clean, contemporary look.

We made the pedestals more interesting by departing from a predictably boxy shape. To do this, we attached a preformed plywood half round to the front of each pedestal. Next, we painted the base and applied

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



# DESK MAKING

clear satin varnish to the top. The natural wood tones and the colorful base are an eye-catching combination.

The desk is also designed to meet workday demands by providing plen-

ty of work surface and as much drawer space as you're likely to need. The lower drawers are extra deep and have slotted sides to accept hanging files.

It is a straightforward project to build, since it's constructed almost entirely of plywood. If you can cut a rabbet and a miter, you should be able to build this desk.

## Pedestals

Cut the panels for pedestal sides, tops and bottoms slightly oversized from  $\frac{3}{4}$ -in. maple or birch plywood. Rip strips for edge banding from  $\frac{1}{4}$  maple, poplar or birch. (Normally,  $\frac{1}{4}$  stock is  $\frac{13}{16}$  in. thick, and this is perfect for edge banding.) Glue and clamp the edge banding to the back edges of the side and top panels (Photo 1). Scrape off any glue squeeze-out before it completely hardens, and use a sharp plane to trim the banding flush to the panel surface after the glue has dried (Photo 2). Be careful not to accidentally plane through the face veneer.

Use a table saw or a circular saw and straightedge guide to rip and crosscut the pedestal sides, tops, backs and bottoms to finished dimensions.

Mark the position of the notches for a toeboard on the pedestal sides and use either a band saw or a handheld jigsaw to make the cuts (Photo 3).

With a fence attached to a router, cut the  $\frac{3}{8}$ -in.-deep rabbets at the top and front edge of the case sides using a  $\frac{1}{4}$ -in.-dia. straight bit (Photo 4). Use a straightedge clamped to the workpiece to guide the router in making the bottom dados (Photo 5).

To assemble the pedestals, apply glue to the rabbets and dados on the sides, top and bottom. Use clamps to bring the parts together, and check for square by comparing diagonal measurements. If one diagonal is longer than the other, shift the clamps on one side so they bear diagonally on the pedestal and retighten them. If the diagonal measurement is worse than before, or shows no improvement, slant the clamps in the opposite direction or try adjusting the clamps on the opposite side of the pedestal. Regardless of how you get the pedestals square, it's important that you do so. If the pedestals are not square, you'll have a difficult time getting the drawers to fit properly and getting the half rounds to meet the pedestal evenly.

You can use finish nails in addition to the clamps, to prevent racking during assembly. You can fill the nail holes later, since the pedestal will be painted (Photos 6 and 7).

Install the back on the pedestal by



**1** Clamp the maple edge bands to plywood panel edges. Note that edge bands are clamped only to a panel's front edge.



**2** Plane edge band flush to the panel's edge with a sharp block plane. Be careful not to plane into the panel's face veneer.



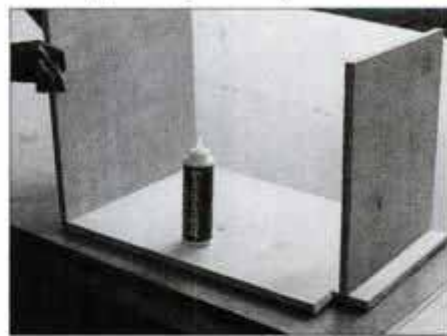
**3** Saw out the notch for toeboard on the band saw. Fence and stop clamped to the saw table ensure precise, straight cut.



**4** Use a  $\frac{1}{4}$ -in.-dia. straight bit in the router with a fence guide to cut rabbet on top and back edge of the pedestal panel.



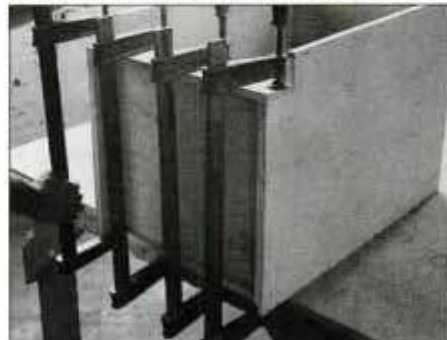
**5** Cut a dado across the pedestal panel to accept plywood bottom. Clamp a fence across the panel to guide the router.



**6** Assemble portion of pedestals that carry drawers. Spread glue in rabbets and dados, and nail the components together.



**7** Clamp up assembly and measure diagonals to check for square. If measurements differ, shift clamps to achieve squareness.

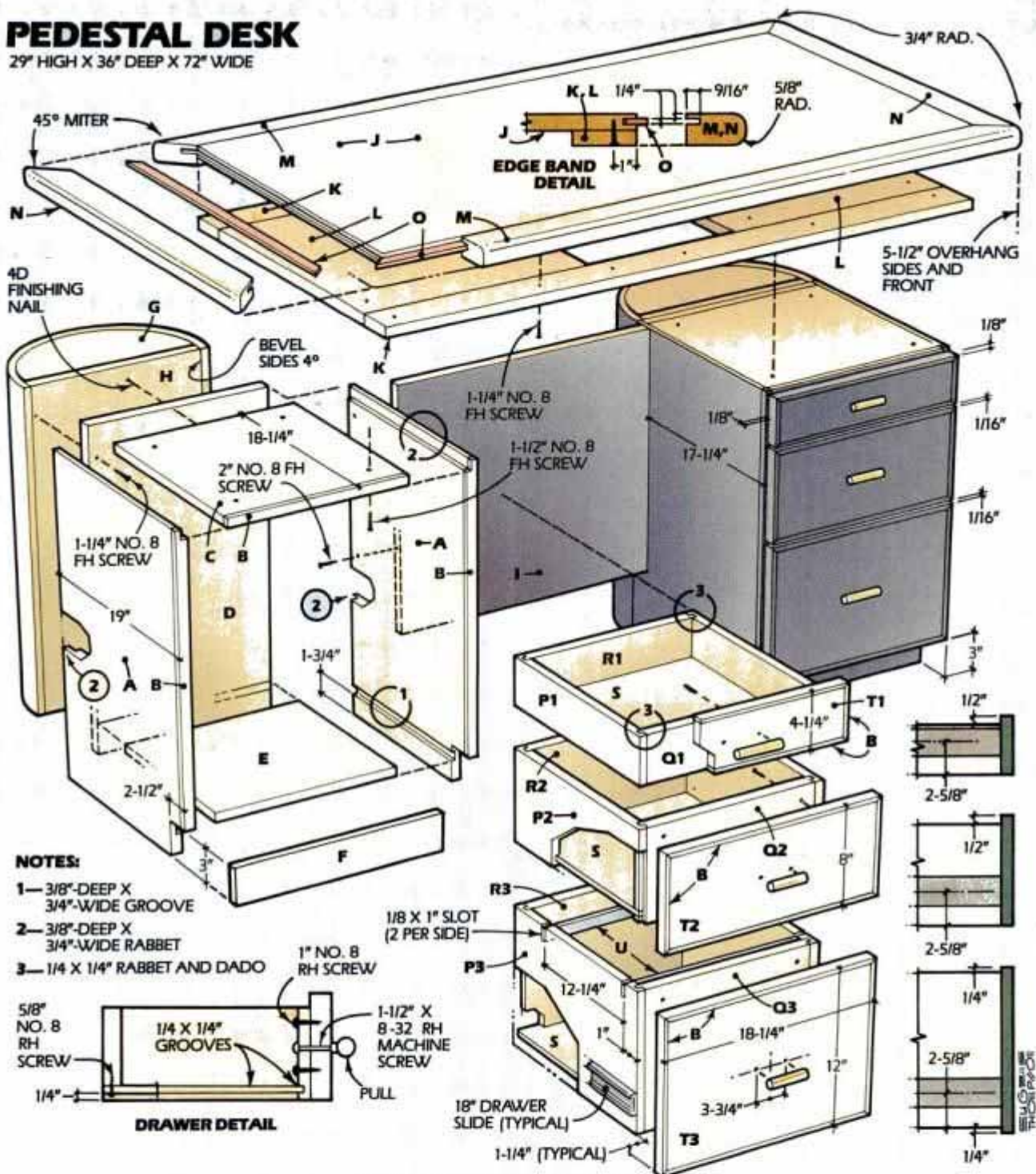


**8** Glue and clamp the toeboard to the front of the pedestals. Pare off the glue squeeze-out before it hardens.



# PEDESTAL DESK

29" HIGH X 36" DEEP X 72" WIDE



## NOTES:

1—3/8"-DEEP X 3/4"-WIDE GROOVE

2—3/8"-DEEP X 3/4"-WIDE RABBET

3—1/4 X 1/4" RABBET AND DADO

5/8" NO. 8 RH SCREW



## DRAWER DETAIL

## MATERIALS LIST—PEDESTAL DESK

Key	No.	Size and description (use)
A*	4	3/4 x 18 1/2 x 27 1/2" birch plywood (sides)
B	40'	3/4 x 1 1/2" maple (edge band)
C	2	3/4 x 17 1/2 x 17 1/2" birch plywood (top)
D	2	3/4 x 17 1/2 x 27 1/2" birch plywood (back)
E	2	3/4 x 15 1/4 x 17 1/2" birch plywood (bottom)
F	2	1/2 x 3 x 18 1/4" birch plywood (toeboard)
G	2	9/8 x 18 1/4 x 27 1/2" maple plywood (pedestal)
H	2	3/4 x 17 x 17 1/2" birch plywood (blocking)
I	1	3/4 x 21 1/2 x 24 1/2" birch plywood (modesty panel)
J	1	3/4 x 31 1/2 x 66 1/2" birch plywood (tabletop panel)
K	2	3/4 x 3 x 66 1/2" birch plywood (tabletop buildup)
L	2	3/4 x 21 x 24 1/2" birch plywood (tabletop buildup)
M	2	1 1/2 x 2 3/4 x 72" maple (edge band)

N	2	1 1/2 x 2 3/4 x 36" maple (edge band)
O	20'	3/4 x 1" plywood (spline)
P1	4	1/2 x 3 3/4 x 18" birch plywood (drawer sides)
P2	4	1/2 x 7 1/2 x 18" birch plywood (drawer sides)
P3	4	1/2 x 11 1/2 x 18" birch plywood (drawer sides)
Q1	2	1/2 x 3 3/4 x 15 1/4" birch plywood (drawer front)
Q2	2	1/2 x 7 1/2 x 15 1/4" birch plywood (drawer front)
Q3	2	1/2 x 11 1/2 x 15 1/4" birch plywood (drawer front)
R1	2	1/2 x 3 3/4 x 15 1/4" birch plywood (drawer back)
R2	2	1/2 x 7 x 15 1/4" birch plywood (drawer back)
R3	2	1/2 x 11 x 15 1/4" birch plywood (drawer back)
S	6	3/4 x 17 1/4 x 15 1/4" birch plywood (drawer bottom)

T1*	2	3/4 x 3 3/4 x 17 1/2" birch plywood (drawer face)
T2*	2	3/4 x 7 1/4 x 17 1/2" birch plywood (drawer face)
T3*	2	3/4 x 11 1/4 x 17 1/2" birch plywood (drawer face)
U	2	1/8 x 1 x 15 1/4" steel (bar)

**Misc.:** 6 sets of 18" Accuride drawer slides No. 3037, available from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, MN 55374; 1 1/2" No. 8 fh screws; 2" No. 8 fh screws; 1" No. 8 rh screws; 1/2" No. 8 rh screws; 6 1/2" X 8-32 machine screws; 4d finishing nails; glue; epoxy; varnish; Glidden Paints: Spred Lustre Semi-Gloss Enamel (4600 series) Drawbridge No. 64974, Wooden Undercoater #310. For information, write to The Glidden Co., 925 Euclid Ave., Cleveland, OH 44115. Plywood half rounds available from Roberts Plywood Co., 150 Rodeo Dr., Brentwood, NY 11717.

\* Dimensions do not include banding.



# DESK MAKING

gluing and nailing it to the sides with 4d finish nails. Then cut a pair of pieces for the toeboard. Glue and clamp these pieces in place (Photo 8).

The plywood half rounds used here were once available only to industrial woodworkers, but are now widely available. They come in a variety of sizes and shapes. I used a section that was  $\frac{5}{8}$  in. thick, had an outside diameter of  $18\frac{1}{4}$  in. and was 72 in. long. (The supplier is listed at the end of the Materials List on page 85.)

Use a framing square to check the half round's end for square, and adjust it if necessary (Photo 9). Measure and mark the pedestal length at two points. Take a scrap piece of  $\frac{1}{8}$ -in.-thick plywood with a straightedge and clamp it along the curve, aligning the edge with the marks. Mark a cutting line along the guide (Photo 10). Be sure and mark on the correct side of the scrap straightedge, otherwise the measurement will be off by the width of the guide. One way to avoid this is to make your measurement, mark an X on the scrap side of the line and then place the guide so the X is visible.

Crosscut the half round with a jigsaw (Photo 11). First, pivot the half round so the cutting line is off the bench. Once the cut is well established, you can slide the half round back over the bench. Pivot the half round again toward the end of the cut so the jigsaw's shoe will clear the bench. Be sure the portion of the half round that has already been cut remains on the bench to prevent the cut-off section from falling free.

Next, rip and crosscut the blocking that fits in the half round. These must be made very accurately. If they are too large or too small, they'll change the shape of the half round, by either pulling it in or pushing it out. This makes it impossible to get a smooth joint where the pedestal and half round meet. Also, each of the blocking's long edges should be beveled  $4^\circ$  to fit the half round.

Apply glue to the blocking's edges and on the half round where the blocking will meet it. Pin the blocking to the half round with 4d finish nails and bring the joint tight with pipe clamps. Set them aside and let the glue set. Set the head of the finish nails and fill the holes.

We used epoxy as the adhesive to hold the half round to the pedestal. Epoxy is strong and when mixed with microfibers, made of fine cotton, it has excellent gap-filling properties. The epoxy and microfibers are available from Gougeon Bros., Inc. (P.O.

Box X908, Bay City, MI 48707). You could also hold the half round to the pedestal with wood glue and fill in any gaps between the half round and pedestal with wood filler. Whether you use glue or epoxy, scrape off the adhesive that has squeezed out of the joint before it begins to harden.

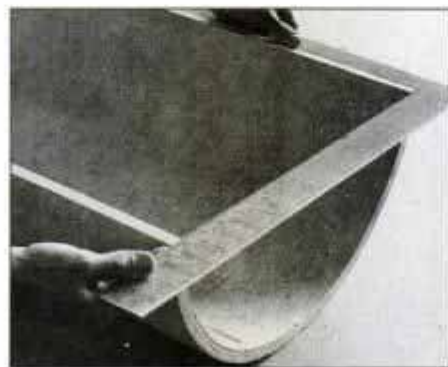
To assemble the pedestal, clamp the half round, curved side down, on the bench. Apply glue or epoxy to the half round's edges and to the pedestal. Clamp the parts together, check that all outside edges are flush. Then, screw from the half round into the pedestal backing (Photo 13), and set it

aside until the glue or epoxy has hardened.

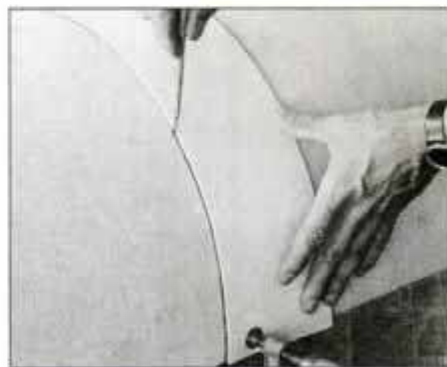
After the adhesive has hardened, remove the pedestal from the clamps and use an orbital sander with 100-grit paper to smooth the surface. Aim for a smooth transition of flat to curved surfaces.

Mark and bore countersunk pilot holes in the pedestals for the modesty panel (Photo 14). Rip and crosscut the panel from  $\frac{3}{4}$ -in.-thick plywood. Assemble the desk base by attaching the modesty panel between pedestals using 2-in. No. 8 fh screws.

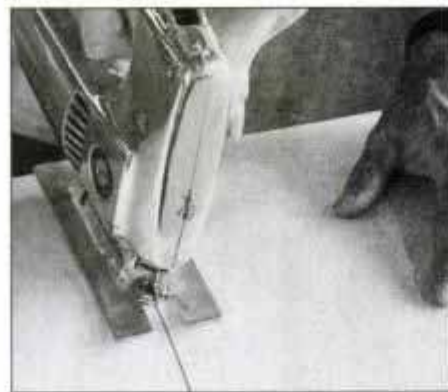
*(Please turn to page 88)*



**9** Check that the end of the half round is square. Use a belt sander or a block plane to bring it square, if necessary.



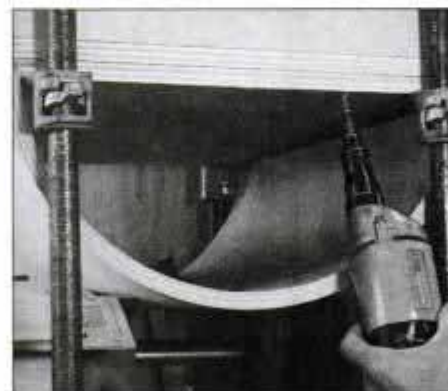
**10** Bend a thin sheet of plywood around the half round and clamp it. Be sure to mark on the correct side of straightedge.



**11** Support half round on bench and use a jigsaw to cut to length. Pivot pedestal at start and end of cut to clear jigsaw.



**12** Glue and nail the blocking inside curved pedestal. Glue and clamp the half round to pedestal using gap-filling epoxy.



**13** Fasten the half round to the front of the pedestal with screws driven through the blocking into the pedestal's back.



**14** Bore pilot holes for screws that will attach modesty panel to pedestal. Be sure to bore the inside face of pedestal.





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# DESK MAKING

## Desktop

Rip and crosscut the top. Cut the pieces for the buildup and apply them flush to the panel's edges (Photo 15). Keep screws 1 in. from the edge to avoid hitting them with spline cutter.

Rip the edge banding to width, and miter the pieces. With the slotting cutter in the router, cut grooves for splines in the edge of the panel and edge banding (Photo 16). Cut splines

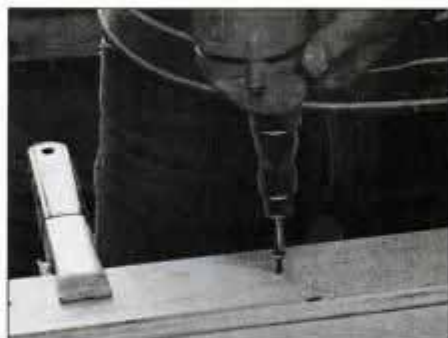
from 1/4-in.-thick plywood, making sure the spline fits snugly in its groove.

Spread glue on the ends of the top panel, on the edge banding in the spline groove and on the spline. Clamp the edge bands to the ends of the top first (Photo 17). Support the pipe clamps on thin wood strips. Spread glue on the miter joints and clamp the edge bands on the long side.

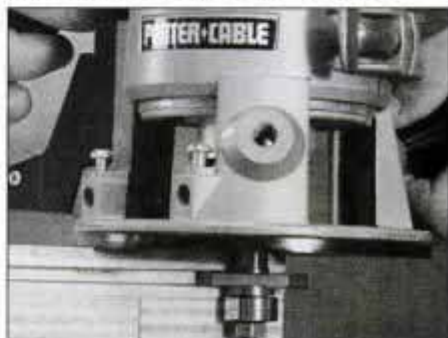
Mark a 3/4-in. radius on the top corners and use a jigsaw to cut the curve.

Round off the top and bottom edges of the edge banding with a 5/8-in.-rad. rounding-over bit with ball-bearing pilot (Photo 18). Sand the top with 120-, followed by 220-grit sandpaper.

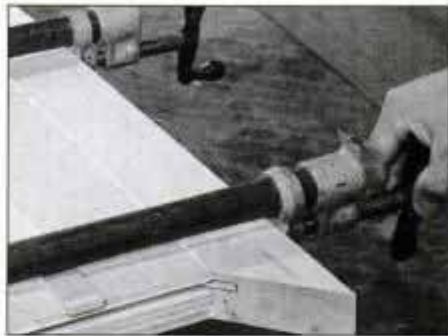
*(Please turn to page 90)*



**15** Glue and screw buildup to desktop. Keep buildup flush to edge of desktop, and keep the screws back 1 in. from edge.



**16** Use a slotting cutter in a router to cut groove for the spline strip in edge of plywood desktop and in edge banding.



**17** Glue and clamp the end edge banding to the top first. Support the clamps above the tabletop with thin strips of wood.



**18** Use 5/8-in.-dia. rounding-over bit to mold corners of edge banding. Rout bottom edge first, then rout top edge.

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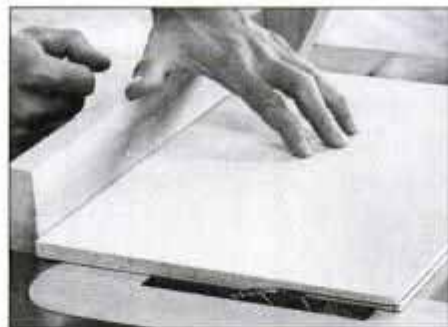
### Drawers

Rip and crosscut the parts for the drawer boxes from ½-in.-thick Baltic or Scandia birch plywood. Use dado blades in the table saw to cut the dados in the drawer sides to accept the tongue formed by the rabbet on the front and back (Photo 19). Use the miter gauge while cutting these dados, and butt the workpiece against the fence or a stopblock to ensure consistency among cuts. Move the fence or stopblock over ¼ in. to cut the rabbet on the front and back of drawer box.

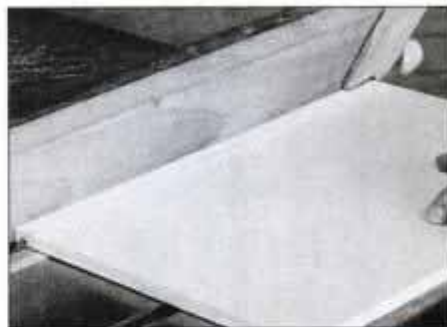
Use the rip fence and dado blades to cut the ¼-in.-wide groove in the drawer sides and drawer front (Photo 20). There is no groove in the drawer back, since the drawer bottom slides underneath it. This makes the drawer easier to assemble and square up, but also allows the bottom to be slid out in case the drawer box needs to be repaired someday.

With a crosscut blade in the table saw, use the miter gauge to cut the 1-in. deep slots in the top edges of the file drawer (Photo 21). These slots ac-

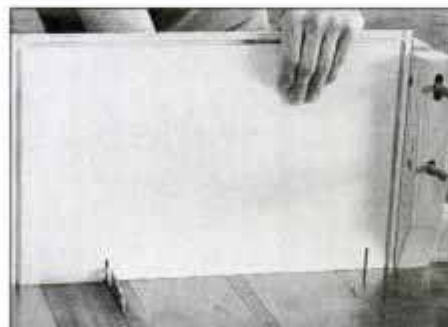
*(Please turn to page 92)*



**19** Use dado blades in table saw to cut rabbets on edges of drawer parts. The clamp acts as stop to ensure precise cuts.



**20** Dado blades in table saw are used with a rip fence to cut grooves in drawer sides and front. Drawer bottom fits in groove.



**21** Use a single blade to cut the slot for a steel bar that suspends hanging file. The clamp acts as a stop for precise cut.



**22** Assemble drawer box front, back and sides. Screw the drawer slide to side of box. Screw through slotted holes only.



# Cocaine lies.

After nearly a decade of being America's glamour drug, researchers are starting to uncover the truth about cocaine.

It's emerging as a very dangerous substance.

No one thinks the things described here will ever happen to them. But you can never be certain. Whenever and however you use cocaine, you're playing Russian roulette.

---

## You can't get addicted to cocaine.

Cocaine was once thought to be non-addictive, because users don't have the severe *physical* withdrawal symptoms of heroin—delirium, muscle-cramps, and convulsions.

However, cocaine is intensely addicting *psychologically*.

In animal studies, monkeys with unlimited access to cocaine self-administer until they die. One monkey pressed a bar 12,800 times to obtain a single dose of cocaine. Rhesus monkeys won't smoke tobacco or marijuana, but 100% will smoke cocaine, preferring it to sex and to food—even when starving.

Like monkey, like man.

If you take cocaine, you run a 10% chance of addiction. The

risk is higher the younger you are, and may be as high as 50% for those who smoke cocaine. (Some crack users say they felt addicted from the *first time* they smoked.)

When you're addicted, all you think about is getting and using cocaine. Family, friends, job, home, possessions, and health become unimportant.

Because cocaine is expensive, you end up doing what all addicts do. You steal, cheat, lie, deal, sell anything and everything, including yourself. All the while you risk imprisonment. Because, never forget, cocaine is illegal.

There's no way to tell who'll become addicted. But one thing is certain.

No one who is an addict, set out to become one.

---

## C'mon, just once can't hurt you.

Cocaine hits your heart before it hits your head. Your pulse rate rockets and your blood pressure soars. Even if you're only 15, you become a prime candidate for a heart attack, a stroke, or an epileptic-type fit.

In the brain, cocaine mainly affects a primitive part where the emotions are seated. Unfortunately, this part of the brain also controls your heart and lungs.

A big hit or a cumulative overdose may interrupt the electrical signal to your heart and lungs. They simply stop.

That's how basketball player Len Bias died.

If you're unlucky the first time you do coke, your body will lack a chemical that breaks down the drug. In which case, you'll be a first time O.D. Two lines will kill you.

---

## Sex with coke is amazing.

Cocaine's powers as a sexual stimulant have never been proved or disproved. However, the evidence seems to suggest that the drug's reputation alone serves to heighten sexual feelings. (The same thing happens in Africa, where natives swear by powdered rhinoceros horn as an aphrodisiac.)

What is certain is that continued use of cocaine leads to impotence and finally complete loss of interest in sex.

---

## It'll make you feel great.

Cocaine makes you feel like a new man, the joke goes. The only trouble is, the first thing the new man wants is more cocaine.

It's true. After the high wears off, you may feel a little anxious, irritable, or depressed. You've got the coke blues. But fortunately, they're easy to fix, with a few more lines or another hit on the pipe.

Of course, sooner or later you have to stop. Then—for days at a time—you may feel lethargic, depressed, even suicidal.

Says Dr. Arnold Washton, one of the country's leading cocaine experts: "It's impossible for the nonuser to imagine the deep, vicious depression that a cocaine addict suffers from."

Partnership for a Drug-Free America



# DESK MAKING

cept the steel bar supports that the file folders hang from.

Rip and crosscut the drawer bottoms from 1/4-in.-thick plywood. Pre-sand all interior drawer surfaces before assembly. Then assemble the drawer boxes using glue and brads. Slide the bottoms into place, and check the assembly for square. Fasten the bottom to the drawer back with five 3/8-in. No. 8 roundhead screws. Sand the outside of all drawer surfaces with 120-grit sandpaper.

Rip and crosscut 3/4-in.-thick plywood for the drawer faces and edge band all the sides with 3/8-in.-thick strips of maple, birch or poplar.

Attach the drawer members of the slides to the drawer boxes, driving the screws through the slotted adjustment holes only (Photo 22). This allows adjustment of drawers for proper spacing.

Clamp the faces to the drawers and attach the face to the box using 1-in. No. 8 roundhead screws (Photo 23).

Mark carefully and bore pilots for the drawer pulls (No. DP1-3, polished brass finish, from Doug Mockett & Co., P.O. Box 3333, Manhattan

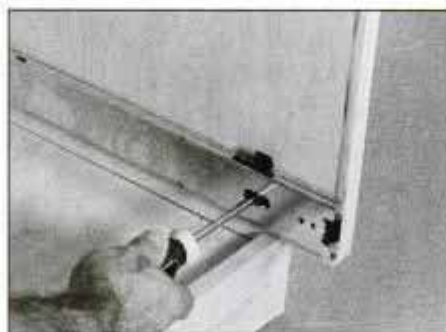
Beach, CA 90266). Then mount the pulls after finishing.

Crosscut the steel bars to length with a hacksaw and file the ends smooth to remove the burr left from cutting them. Then, attach the drawer slides to the pedestal base (Photo 24). Install the drawers and adjust them for proper operation and uniform spacing (Photo 25).

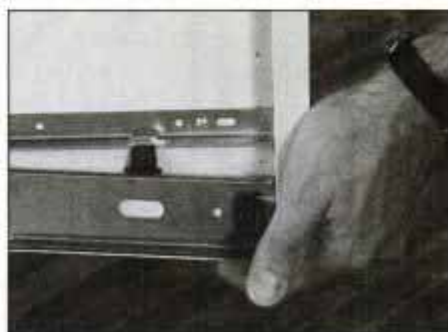
Remove the drawer faces and number each of them for reassembly. Sand the faces with 220-grit sandpaper, dust them off and wipe them with a tack cloth.



**23** Clamp the finished drawer front to the drawer box. Attach the drawer front to the drawer box with a pair of screws.



**24** Attach the drawer slides to pedestal with screws provided. Front of slides should be flush with front of the pedestal.



**25** Slide in drawers, and lower them onto locking clips. Adjust the drawers for uniform spacing and smooth operation.

# SCATTER.





## Finishing

Finish the desktop and the drawer boxes with three coats of McClosky's Heirloom Varnish, Satin finish. Allow each coat to dry overnight and sand between coats with 220-grit sandpaper, removing the dust between coats with a tack cloth.

Using a brush, airless or compressed-air sprayer, prime the pedestals, modesty panel and drawer faces with Glidden Wood Undercoater (see Misc. section of Materials List on page 85). No matter how you apply



**26** Primer and top coat can be brushed or sprayed. Wear respirator with cartridge rated for a naphtha-thinned finish.

the primer, work in a well-ventilated area. If you are using a fan for ventilation, it should have an explosion-proof motor, designed for venting solvent-based finishes. Also, wear a respirator with an organic vapor cartridge (Photo 26).

Allow the primer to dry overnight, and sand it with 220- or 320-grit sandpaper. Dust thoroughly and wipe surfaces with a tack cloth (Photos 27 and 28).

For our top coat, we used Glidden Spred Lustre Semi-Gloss enamel, in a color called Drawbridge. This can be

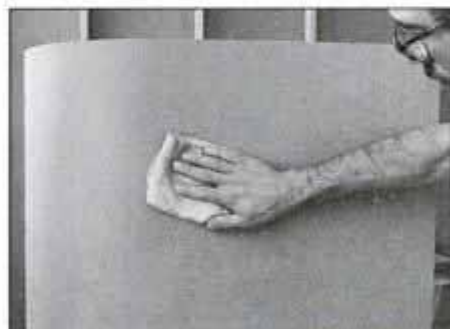


**27** Sand primer with 220-grit sandpaper. Note that glue line between half round and pedestal disappears under primer.

brushed or sprayed. To spray it, thin it at a ratio of 5-parts paint, 1-part thinner using VM&P (Varnish Maker and Painter's) naphtha, a common solvent at paint stores.

Apply two coats, allowing each coat to dry 24 hours. Lightly scuff sand between coats to ensure a good bond and remove dust with a tack cloth.

Reassemble the pedestals and modesty panel. Reattach drawer faces to the drawer boxes, and attach drawer pulls with 1½-in. No. 8 roundhead machine screws. Reinstall drawers, and the desk is complete. **PM**



**28** To remove sanding dust, wipe down surfaces with a tack cloth immediately prior to applying next coat of finish.

# BRAIN.



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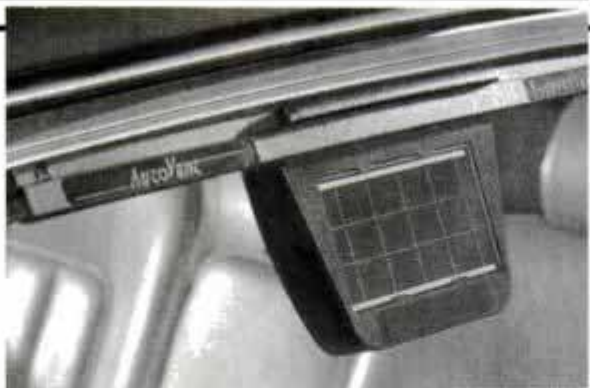
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## IN-DASH CD PLAYERS

(Continued from page 62)

### Tuner section

In addition to the CD section, APEL performed some key tests on the FM mode of the tuner. Interestingly, an examination of the figures seems to suggest that CD performance came at the cost of the tuning section. In capture ratio (a measurement of the tuner's ability to reject a weaker signal), S/N ratio and THD, the Sparkomatic SR600 fared best, and the Sanyo ECD4000 made a strong showing at the expense of the Sony and Alpine samples.

Additional considerations can also affect any buying decision, of course. The Sparkomatic SR600 is the only one of the four tested to include an amplifier. The amplifier is a separate unit connected via a 9-pin cable and it offers 13.7 watts per channel at 1-percent THD.

Convenience features are similar to that on home players. One of the most popular convenience features is SHUFFLE PLAY. Activating the SHUFFLE PLAY button causes the unit to randomly select songs from the CD for playback in no particular order. In a CD changer, this same function will randomly select songs from all the discs available. It's like having a jukebox in your car.

### Special features

Other features that are available on CD/tuners are not as common. Sony, for example, allows you to program the tuner to turn on at a specific frequency at a desired time. Alpine includes an audio-mute mode for use with a cellular phone. The phone rings and the audio system is muted automatically.

In the final analysis, judging sound quality can be a very subjective experience. What sounds good to one person may not to another. Keep in mind also that when you are listening to a CD/tuner in a store, you are listening to it in an artificial environment. CD/tuners, and for that matter any other car audio component, are likely to sound very different in a car as compared to a demonstration room in a store.

You may ask, as well, how do car CD players stack up against home CD players? In general, pretty well, although the specifications for home players are just a bit better. Frequency response and the ability to correct for dropouts seem to be comparable, however.

All in all, it looks as if the compact disc player is making the transition from the home to the car pretty smoothly. **FM**



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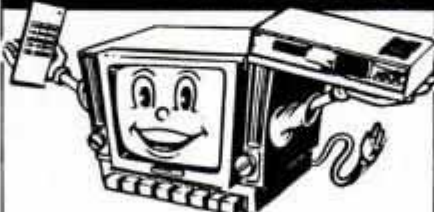
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A one quart treatment of Slick 50 will bond slippery "poly" to your engine for a minimum of 50,000 miles. Unlike some temporary products on the market, Slick 50 does not need to be added every time you change your oil. By reducing engine friction, Slick 50 increases gas mileage and horsepower and it reduces wear, defraying costly overhauls.

## Slick 50's Credentials are Impressive

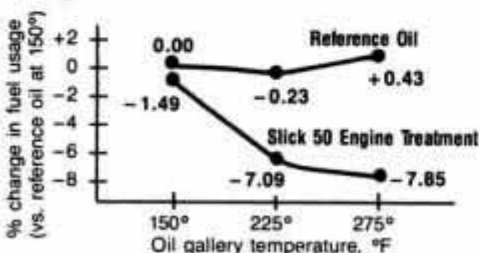
"Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicated that it will improve gas mileage by about two or three miles per gallon . . . Slick 50 does exactly what Petrolon claims it does." *Consumer Digest* (Mar/Apr 1982, p. 35)

In 1989, the premiere engine and lubricant testing lab in the U.S. tested Slick 50. This EPA recognized lab conducted a strictly controlled experiment using industry standard ASTM procedures. Results showed Slick 50, compared to a standard reference oil, reduces engine wear by more than 50%. Be cautious of those Poly treatments that cannot back up their claims with such solid evidence.

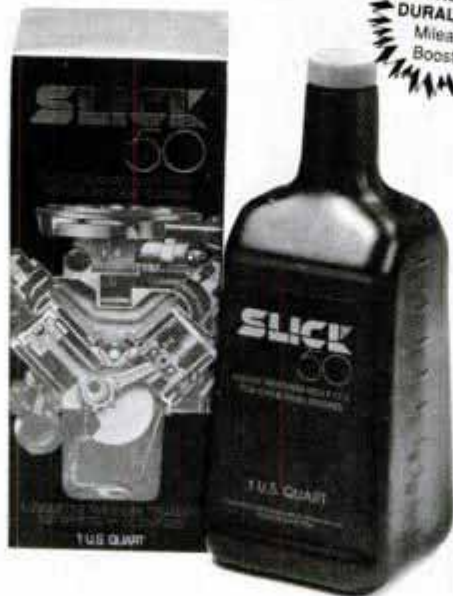
In a fuel usage test conducted by this same prestigious lab, results showed that Slick 50 (compared to a standard reference oil at 150°) reduced fuel consumption in the test engine by 7.09% at an oil temperature of 225° and 7.85% at 275°. Once warmed up, most cars operate within the range of 225° to 275°.

Especially interesting is the fact that fuel usage with just the reference oil increased (see graph) as the oil got hotter than 225°. This is due to the well known fact that oil gets thinner at higher temperatures, causing increased friction (and wear) in your engine. However with Slick 50, fuel usage actually decreased, showing that Slick 50 produces its greatest friction reducing benefits at higher temperatures, which is exactly when your engine needs it the most.

As with any lab test, these results may not translate exactly the same percentagewise for every engine under every type of driving condition in the "real world." However, the conclusion for these test cases is clearly that Slick 50 does reduce engine wear and does increase gas mileage.



The Federal Aviation Administration has fully accepted a similar product—Slick 50 Aircraft Treatment (F.A.R. #33.49).



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start them, before the oil has a chance to circulate. Up to 90% of engine wear can be caused by this starvation. You receive all these benefits for less than the cost of two tanks of gas (\$39.95).

## Will Slick 50 Harm my Engine or Affect my Warranty?

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TUV, a prestigious German testing laboratory, tested Slick 50 and found substantial increases in both gas mileage and horsepower. The Space Shuttle Columbia uses the chemical "Poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

The Cranfield Institute, known worldwide for its work in tribology (the study of friction), concluded a five-year study on Slick 50 in 1989. Results showed Slick 50 does indeed coat metal surfaces, dramatically reducing friction and extending the life of metal.

Perhaps the most dramatic of all is the torture test seen by thousands of viewers on NBC TV station KPRC. A Lincoln Town Car was treated with Slick 50. During the broadcast, the oil was drained and the car was driven without the oil plug for about 30 minutes. The water temperature never rose and the engine sustained no apparent damage.

## It's Easy to Treat Your Engine

Change oil and filter and substitute one quart of Slick 50 for the last quart of oil. (Add two quarts for engines with oil capacities of seven quarts or more.) Slick 50 is excellent for turbo-charged engines, aluminum block engines and rotary engines.

Slick 50 will work with all petroleum based oils and synthetics compatible with petroleum based oils.

## What are the Benefits of Slick 50?

By reducing friction, Slick 50 does all of the following:

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2. Increase horsepower (small economy cars and large RV's really need this)
3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine
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5. Easier starting (important in cold weather)
6. Since lubricating lead is being removed from gas, and unleaded gas is poor in lubricating qualities, this extra lubrication of Slick 50 on valve systems and guides is a real bonus.
7. Slick 50 eliminates the "lubrication starvation" that all cars experience when you first

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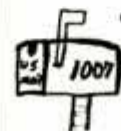
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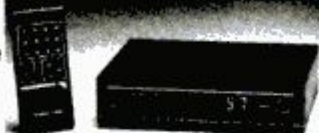




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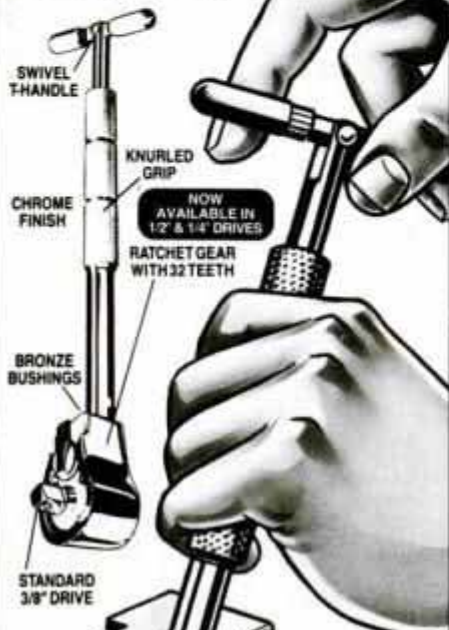
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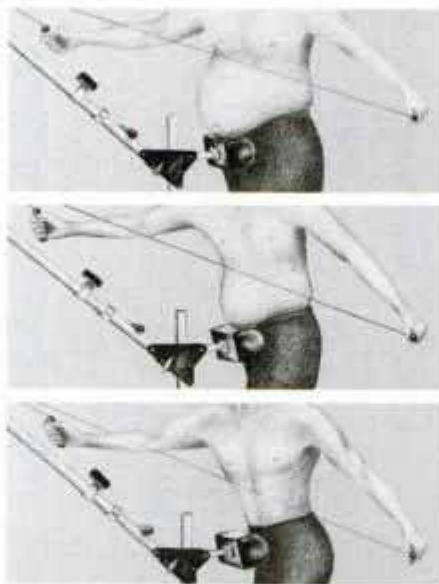
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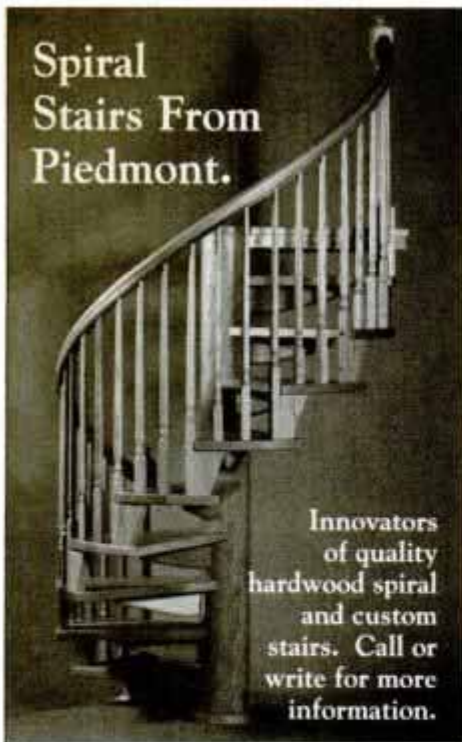
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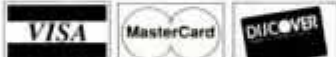
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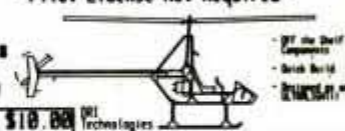
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# HOW TO REBUILD BRAKE CALIPERS

BY PAUL STENQUIST; PM Illustrations by Fred Wolff

**Y**OU'RE CLIPPING along at the speed limit. Several hundred feet down the road, a truck lazily pulls out from an adjoining highway. You stomp on the binders and your foot goes to the floor. Frantically, you pump the brake pedal. Pressure builds with maddening slowness, the brakes begin to apply, and, gradually, you come to a halt.

As you wipe the sweat from your brow, you vow to do something about those mushy brakes. No more procrastinating.

Mushy brakes are the result of air in the hydraulic system—air that's not supposed to be there. When you apply the brakes, the air compresses where hydraulic fluid would not—and the brake caliper's piston doesn't move.

Where does the air come from? Well, usually it's air that has replaced leaking brake fluid. And the most common cause of a brake fluid leak on disc brake systems is a leaking caliper.

## Checking for brake fluid leaks

Your brake system could be leaking fluid without you knowing it.

To check, just run the engine at

*Hone the interior walls of the caliper bore lightly with fine stones (or polish uniformly with crocus cloth) to remove any stains or discoloration.*

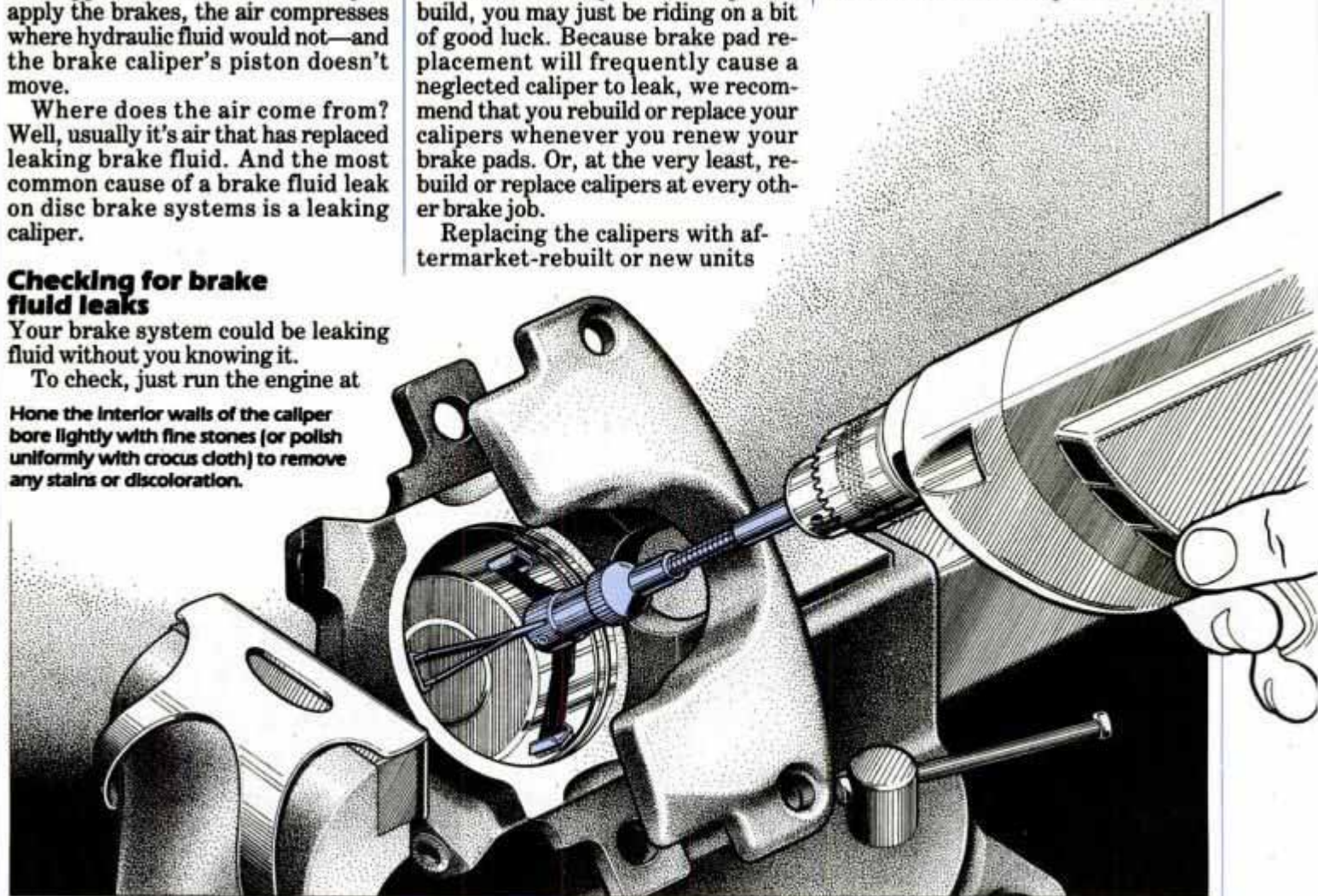
idle with the transmission in neutral. Then push on the brake pedal, holding constant pressure. If the pedal gradually drops, the hydraulic system is leaking. A few minutes on the creeper can confirm a leaking caliper. If the back of a tire is streaked with brake fluid, or if there's a strong brake fluid smell near a wheel, you can bet that you've got a leaker on your hands. If a caliper isn't the source of the hydraulic leak, trace all lines back toward the master cylinder until you find the offender.

If your calipers don't leak fluid and your car has more than 30,000 miles on the clock since your last caliper rebuild, you may just be riding on a bit of good luck. Because brake pad replacement will frequently cause a neglected caliper to leak, we recommend that you rebuild or replace your calipers whenever you renew your brake pads. Or, at the very least, rebuild or replace calipers at every other brake job.

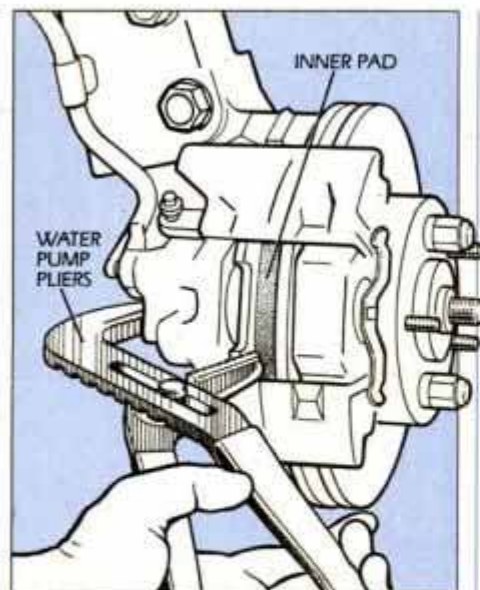
Replacing the calipers with aftermarket-rebuilt or new units

can be costly. And, since the rebuild procedure is somewhat easy, it's a job that you probably will want to do yourself. In the following sections, we'll show you how. You'll need a few basic tools and a rebuilding kit for each caliper that you intend to service. You can purchase the rebuild kit at your auto parts store. You should have a supply of compressed air as well, but you can get along without it, if necessary.

Most cars with 4-wheel disc brakes combine a parking-brake mechanism with the rear calipers. These vary widely in basic design and can be difficult to rebuild. For specific instruc-







**1** Before you can dislodge the caliper, you'll have to retract the piston in one direction or the other for clearance.

tions on the rebuilding of rear calipers with integral parking-brake mechanisms, consult your factory service manual.

## Caliper removal

Before you even think about removing the caliper, you'll have to siphon about two-thirds of the brake fluid from the master cylinder, so that it won't overflow when you retract the pistons. A turkey baster comes in handy here. Discard the old fluid, and keep it away from the paint, as it's an excellent paint remover. It's also toxic if ingested.

Raise the car securely on jackstands, following the manufacturer's vehicle-support recommendations. Then mark the relationship of the wheel to the axle with a grease crayon

or chalk. Remove the wheel and tire, and on front-drive cars reinstall a pair of lugnuts so the discs don't flop around.

Next, you'll need a C-clamp (7 in. or larger) or a pair of 12-in. adjustable water pump pliers to retract the pistons. What you have to do here is squeeze the piston back into the caliper until there's enough clearance between the pads and the rotor to remove the caliper (Fig. 1). On some applications, the C-clamp will work better. On others, the pliers will be more useful.

If you're using the C-clamp, position it so that the jackscrew rests against the inboard pad and the top of the clamp rests against the back of the caliper. Turn the jackscrew to retract the piston. If you opt for the pliers, just position them over the inboard brake shoe tab and the back of the caliper housing, and squeeze.

Next, disconnect the brake hose. On many calipers, you'll find that a bolt secures the inlet fitting to the caliper. By unscrewing this bolt, the hose and inlet fitting can be disconnected from the caliper. Once the hose is off the caliper, plug the end of it with a plastic cap, or something similar.

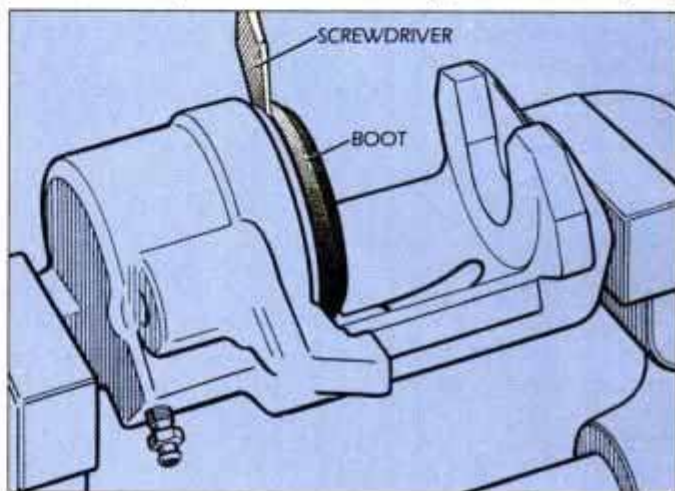
At this point, you should carefully examine the brake hose. If it shows any signs of cracking, rubbing or other deterioration, it must be replaced.

There used to be a whole grab bag of schemes for attaching the common single-piston floating brake caliper to the car. Fortunately, most makers have adapted a single strategy: pins that extend through bushings on the caliper and thread into the caliper mount (Fig. 2). But older cars may employ other means of attachment, so we'll cover several of the most common here.

## Threaded-pin calipers

Threaded-pin calipers are found on almost all late-model cars and most GM cars with disc brakes, including the older models. On most early GM cars and many other late-model cars of other makes, a 3/8-in. hex key (Allen wrench) tightens or loosens the pins. You also might find a conventional capscrew head on some pins. The latest GM calipers are secured with internal Torx drive pins. You'll need a Torx drive key to remove them. Some tool companies package the specific driver you need and sell it as a brake tool. You should be able to find it at an auto parts store.

After removing the threaded pins,



**3** Carefully pry the old dust boot from the caliper housing without nicking the edge of the caliper bore.

lift the caliper from the rotor. If necessary, you can use a screwdriver to pry it away from the rotor.

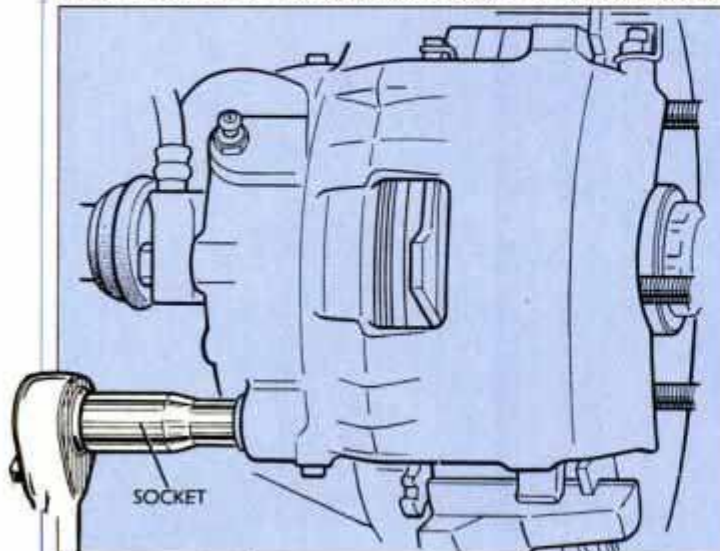
## Machined-way calipers

Early Ford calipers slide on a machined surface and are retained by a key. A locking screw holds the key in place. To disengage the caliper, remove the locking screw and use a hammer and drift to drive the retaining key out of the caliper mount.

Some early Chrysler calipers slide on machined guides, or ways, and are retained by clips. These can be removed by disengaging the clips.

Up until a few years ago, most import calipers moved on machined guides, and were retained by pins and clips, or pins and pin bolts. These are removed by disengaging the clip or pin bolt from the pins.

On some early imports, you'll find machined metal pieces that fit between the guides and the machined surfaces of the caliper. Take note of their position as you remove the caliper. If you get confused, refer to your factory service manual. You may find



**2** Most calipers are mounted to the suspension by means of threaded pins that are easily removed.



that the caliper pins have corroded to the point where you have to cut through the pins to remove the calipers. In such cases, the calipers must be replaced.

## Caliper disassembly

Once the calipers are off the car, remove the outer and inner pads and any support retaining springs.

On most threaded-pin calipers, you'll find sleeves on the inboard ears of the calipers and O-rings inside the caliper ears. Remove them.

On the pins of retainer-pin calipers, you'll find dust seals and rubber seals. Remove these as well.

On all calipers, any soft bushings or O-rings should be replaced with new parts at rebuild time.

Examine the retainer pins or threaded pins as well. If they show wear, corrosion or galling, they should be replaced. Don't attempt to polish away corrosion, as it will only come back.

To remove the piston, position the caliper on the floor and place rags in position between the piston (which is covered by the dust boot) and the rear pad support of the caliper. Then *gradually* apply air pressure to the caliper inlet to force the piston out of the caliper bore. *Don't* try to catch the piston in your hand!

If you don't have an air compressor, you may have to ask your neighborhood mechanic or parts store counter-man to give you a hand here. But, you also might use a portable air tank and air-gun attachment, as only a short blast of compressed air is needed.

A third alternative: Leave the brake line connected to the caliper, and suspend the caliper



4 Use a plastic or wooden probe to lift the seal from its groove in the caliper bore.

from the steering knuckle with a piece of wire coat hanger. After removing the pads, stuff some rags behind the piston and gently push on the brake pedal until the piston pops out of its bore. This is the recommended procedure when removing the phenolic (plastic) pistons, which might be damaged if they're expelled aggressively with air pressure.

Some phenolic pistons have been known to stick in their bores and have defied all attempts to remove them. If this proves to be the case, you'll have to replace the caliper assembly.

Use a screwdriver to pry the dust boot off of the caliper bore. But be very careful not to damage the caliper bore surface (Fig. 3).

Use a plastic toothpick or pointed wooden probe to remove the seal from the groove in the caliper bore (Fig. 4).

## Cleanup and Inspection

Wash all the metal caliper parts in brake cleaner or alcohol. Blow them

off with air, if possible. But make sure the air supply is free of water or oil. You want to steadfastly avoid contaminating any brake parts with moisture, as the brake fluid will quickly absorb moisture, leading to serious problems later on.

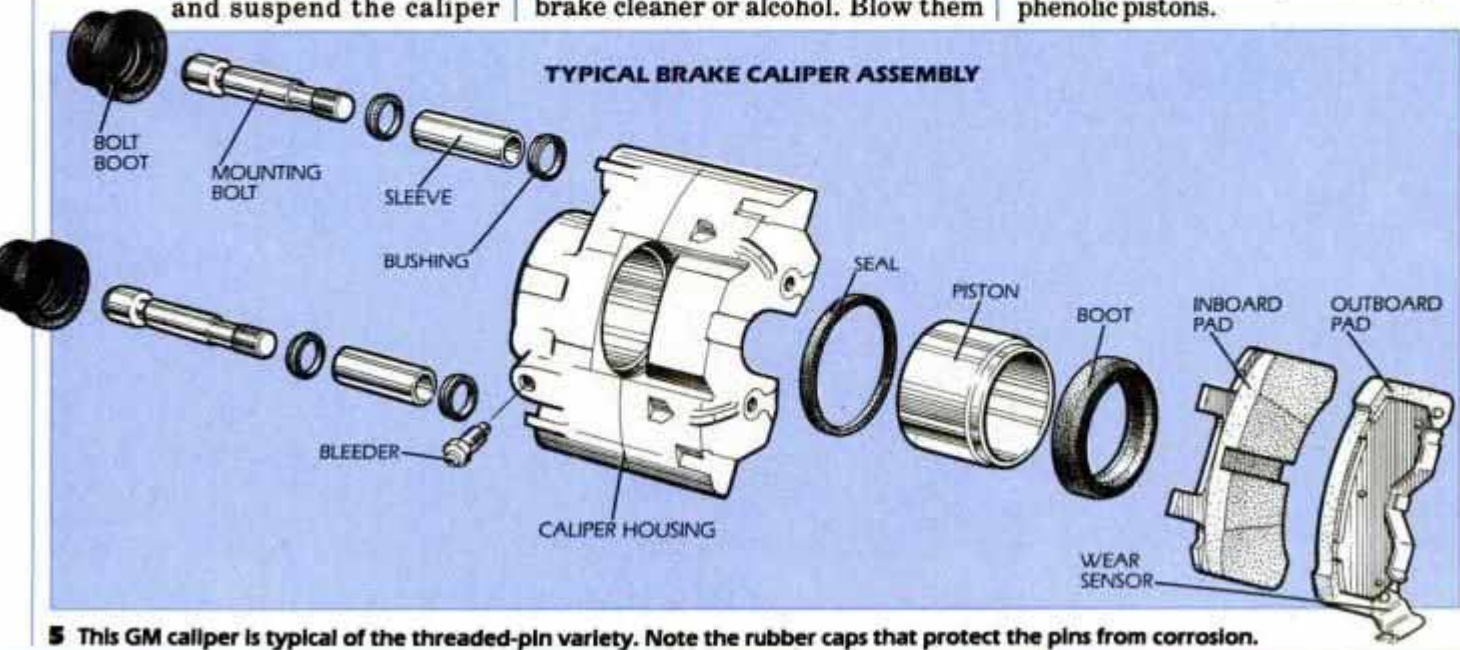
Carefully examine the caliper bore, the groove in the caliper bore and all the passages in the bore for any lingering moisture.

Check the caliper bore for nicks, pitting or scoring. If you find any metal distress, the caliper should be replaced. Pay particular attention to the seal groove. This is the business end of things. If the seal doesn't hold pressure, the caliper won't work.

If the caliper bore is stained or discolored, you can clean it up with a light honing or with a bit of crocus cloth. Take care not to overdo it with a hone, and make sure the stones don't clog by lubing liberally with a light machine oil.

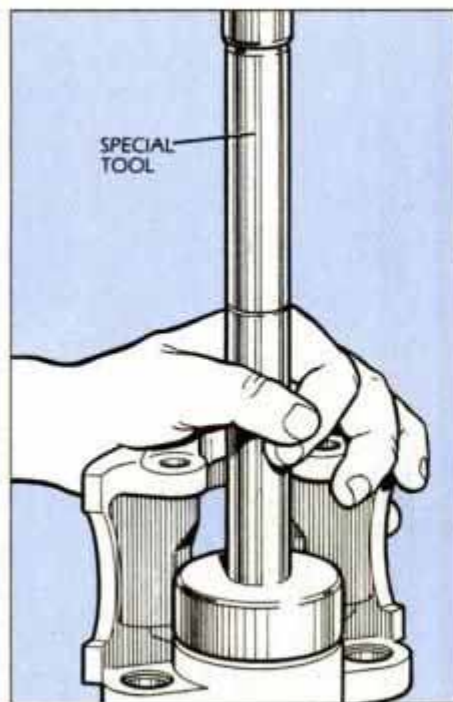
Carefully check the piston for scoring, pitting, nicks, corrosion and worn or damaged plating. If the piston is the least bit flawed, it *must* be replaced.

Phenolic pistons should only be reused if they are in perfect condition and were easily removed from the bore of calipers that weren't leaking. In every other case, replace them. Some mechanics automatically replace the phenolic pistons with steel pistons. But, this practice is questionable, as the steel piston transfers more heat to the brake fluid than a phenolic piston does. If a phenolic piston has given you good service to date, replace it with another phenolic one. Don't try to file or sandpaper phenolic pistons.



5 This GM caliper is typical of the threaded-pin variety. Note the rubber caps that protect the pins from corrosion.





6 Install steel-ringed dust boots with a driver that pushes on the edge of the seal.

## Caliper reassembly

To reassemble a caliper, lubricate the cylinder bore and the piston seal with clean brake fluid (Fig. 5). The fluid must come from a new, freshly opened can.

Lube the outside surface of the piston with clean brake fluid and slip the dust boot over the end of the piston. Then, smoothly push down the piston to the bottom of the bore.

Don't force the piston. Use hand pressure only. If it won't move past the seal, the seal was inserted incorrectly or you have the wrong piston.

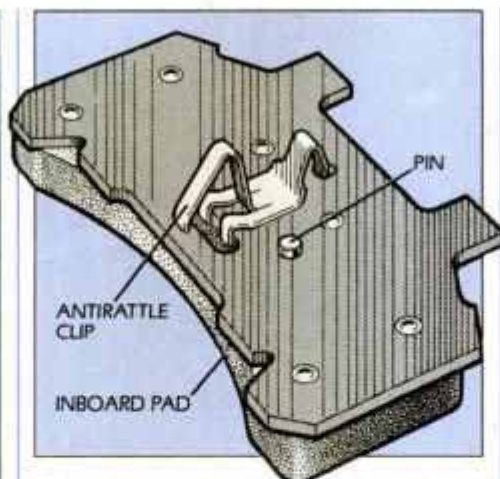
If the dust boot has a steel rim, tap it in place with a driver that aligns with the outer edge of the rim (Fig. 6). An old brake piston will work on some applications.

If the dust boot is solid rubber, use the flat side of a screwdriver or other blunt tool to press the boot into its groove. If you damage the boot, you'll have to get another one and try again. Make sure the boot seats fully in its groove.

Where applicable, apply a small amount of antiseize compound to the caliper pin bores between the bushings. Then install new bushings and O-rings in the caliper ears or pin bores.

## Bolting everything back together

Of course, we're assuming here that you've completed the rest of the brake job, checking all other



7 Avoid squealing brakes by installing all antirattle clips on the inboard pads.

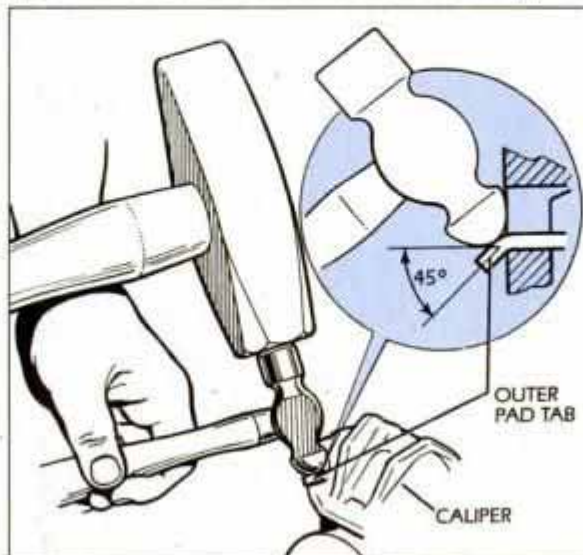
hydraulic components for leakage and examining and servicing the brake rotors as required.

If so, reinstall the new pads in the calipers with any antirattle springs or clips (Fig. 7). Check for possible left and right side designation on antirattle clips. Apply a narrow strip of noise-suppression compound to the center of the inboard pad, and a large round patch of the compound to each end of the outboard pad. Then install the pads in the caliper.

To reinstall a threaded-pin caliper, position the caliper on the rotor so that the holes in the caliper ears line up with the holes in the anchor. Insert the caliper pins, making sure they pass under the retaining ears on the inner plate. Then tighten the threaded pins to 25 to 35 lb.-ft.

Reattach the brake hose and torque the retaining bolt to 30 lb.-ft.

**Note:** On brake pads equipped with tabs that fit over the caliper, you'll have to clinch the tabs after bleeding



8 Have a helper depress the brake pedal while you clinch the pad tabs against the caliper body.

the brakes. On calipers with machined guides, use silicone grease sparingly to lube the guides. Locate the caliper in position and reinstall the pins or clips.

## Out with the bad air

Refill the master cylinder reservoirs with clean, fresh brake fluid. Make sure they remain at least half-full throughout the bleeding operation. Top off as necessary. If you find that the master cylinder is empty, you'll have to bleed it before proceeding. Check your service manual.

To bleed the calipers, find a box wrench that fits the bleeder valve and hang it from the valve. Connect a transparent tube to the bleeder valve of the right-rear caliper (or wheel cylinder if your car has drum brakes in the rear). Submerge the other end of the tube in a glass jar of brake fluid.

Have a helper push the brake slowly to the floor and hold it. Then loosen the bleeder valve and allow air and brake fluid to escape from the caliper's cylinder. Tighten the bleeder valve and slowly release the brake pedal. Wait at least 15 seconds, then repeat the process. Continue to repeat the entire sequence, including the 15-second wait, until you stop getting bubbles. Don't let the fluid level get too low.

After bleeding the right rear, continue with the left front, left rear and right front. When you've finished, there should be no hint of sponginess in the brake pedal, and the brake warning light should, of course, be off. If not, repeat the process.

If you have compressed air, a power bleeder will make this a faster, one-man job. Some auto parts stores and rental outfits have power bleeders for rent.

## Clinching the tabs

On many cars with threaded-pin calipers, including most GM models, you'll have to clinch the tabs of the brake pad backing plates onto the caliper after bleeding the system.

To do this, apply heavy pressure to the brake pedal (about 175 pounds) three times in a row. Then have a helper hold down the brake pedal with about 150 pounds of force. While he's holding the pedal, use two hammers to bend the tabs of the outboard shoe around the caliper body (Fig. 8). Never hit a steel hammer with a steel hammer—use a brass, lead or plastic mallet. **PM**



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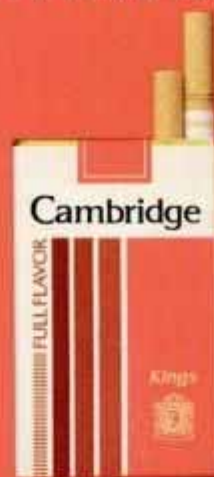
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