

OCTOBER 1989 \$1.95

Popular Mechanics

1990 NEW CAR REPORTS

STEALTH STRIKE FORCE

B-2 Stealth Bomber Adds A Knockout Punch To The Air Force's Attack Strategy



With the B-2, the B-1B and B-52, the Strategic Air Command has created an integrated bomber fleet to keep the peace into the 21st century.

HOME & SHOP JOURNAL

- Blade-To-Blade Comparison Test Of 11 Top Sabre Saws
- Easy-Build Classic Shaker Table Project

SPECIAL SECTION

NEW HOME ELECTRONICS

We Pick The Best In

- Videogame Accessories
- Computer Enhancements
- Surround Sound Stereo And More!



0 754744 1

T IS US.

comes standard on all Ranger and Bronco II 4x4s, and is available as an option on all Broncos.

This year, Ford is introducing a more powerful V-6 engine that will be available on Ranger††

6/60 POWERTRAIN WARRANTY.

All Ford light trucks come with it. And it covers you and future owners with no transfer fee, on major powertrain components for 6 yrs./60,000 miles. Ask your Ford Dealer for a copy of this limited warranty.

BEST-BUILT AMERICAN TRUCKS.

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

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And why the toughest competition we have is ourselves.

*Based on latest available 1989 model year manufacturers' reported retail deliveries by division. **Based on calendar year manufacturers' reported retail deliveries through 1988. †Based on 1988 New Car and Truck Buyer Study. ††See your dealer for availability.



FORD TRUCKS BUILT FORD TOUGH



Buckle up—*together we can save lives.*

**FORD
TRUCKS.
WE HAVE MET
THE
COMPETITION...**



AND I'

THE TOUGHEST COMPETITION WE HAVE IS OURSELVES.

When you make the best-selling trucks in America,* you're everybody's competition.

Including your own.
That's why at Ford we

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And the result is, not only have we made the best-selling pickup for the past 12 years** and the best-selling compact truck for the past two,** we have more repeat buyers than any full line of light trucks†

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Ford trucks beat all others in 43 areas, like the longest deepest cargo box, the biggest standard engine, the most available maximum payload and the most standard torque among half-ton pickups.

And Ford makes the only trucks that let you shift into four-wheel drive at the touch of a button. A feature that





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Foldout slip-sheet



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1. Follow instructions on the other side

Back

6bsl1pback-0018



Inverted Back

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Take this simple IQ test:

For the same price, would you buy an ordinary camera which only gives you this?



Or would you buy the Pentax IQZoom 60 which gives you



this



this,



this,



and this.



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See how easy it is to raise your IQ? The Pentax IQZoom 60, with its motorized zoom lens, gives you multiple choices. From wide angle to telephoto and everything in between. Even macro for close-up details. And of course the IQZoom 60 is smart

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PENTAX IQZoom 60



For best results use Kodacolor Gold. ©1989 Pentax Corp.

NOTICE TO PM READERS



Have you seen any of the artwork that has appeared on PM covers?

Whatever happened to the working model of this plane?

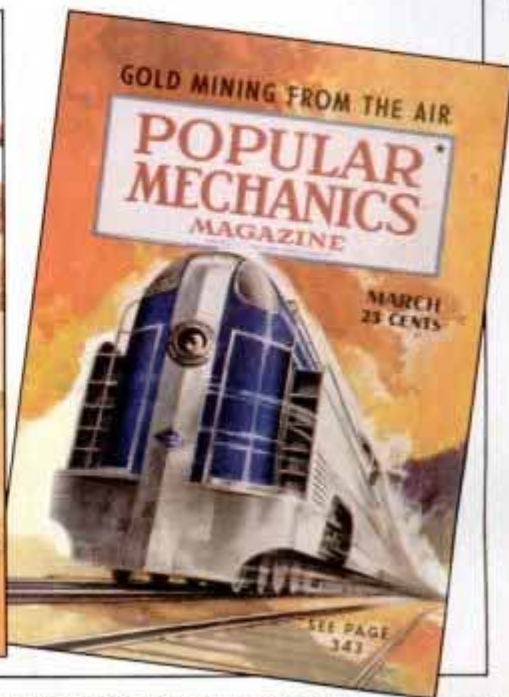
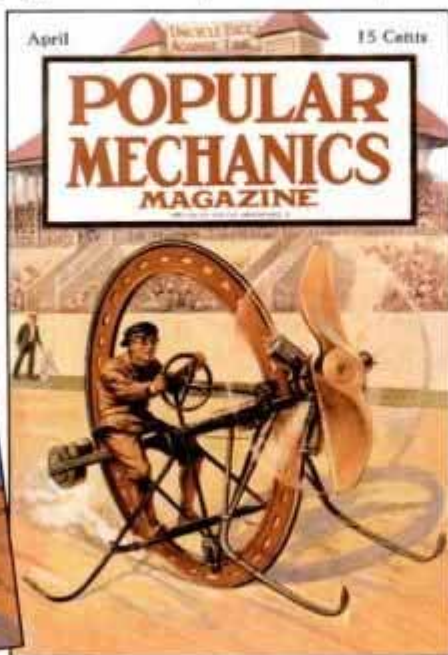
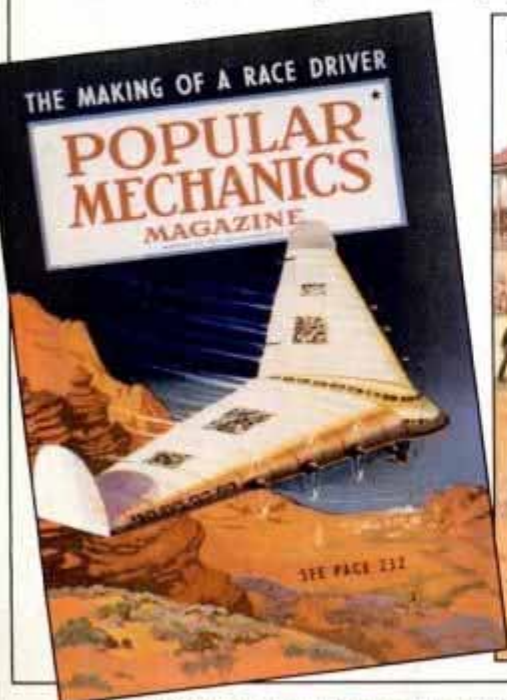


We need your help. To commemorate the 90th anniversary of POPULAR MECHANICS, the Henry Ford Museum & Greenfield Village and PM are assembling an exhibit on the history of American mechanical ingenuity, as chronicled in the pages of POPULAR MECHANICS. PM has played an important role in bringing an understanding of the industrial revolution to its readers. The history of our magazine reflects deep and lasting American traditions of self-reliance, ingenuity and inquisitiveness. We would like to bring these same qualities to this exhibit.

We need your help in identifying inventions,

artifacts, projects, models, cover artwork and illustrations that appeared in the countless features that have filled the pages of POPULAR MECHANICS for the past 87 years. We are interested in both those things that never came to pass, and also those things which have become part of the fabric of everyday living. Please help us locate these objects, inventions and artwork so that we can create a timely and exciting historical exhibit.

Please send any information you think would be helpful to POPULAR MECHANICS, 224 West 57 Street, New York, NY 10019.



NOTE: Thank you, but we are *not* interested in back issues of POPULAR MECHANICS. We already have a complete set.



59 COVER STORY

The \$530 million B-2 Stealth bomber joins the B-52 and the B-1 in a penetrating force that will deter potential aggressors.
—PM illustration by Attila Hejja



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EDITOR'S NOTES

EVEN ON A 25-in. TV screen, the great black flying wing looked awesome as it took off on its maiden flight. I wondered what the B-2 Stealth bomber would look like in person. Deadly, probably. That's what a bomber that rains certain death on an enemy is supposed to look like. What a bomber is supposed to cost is something else. Depending on who is talking, the price of each B-2 will be anywhere from \$270 million to \$500 million. Not exactly Tic Tac money. Meanwhile, those individuals responsible for our nation's defense have already set a strategy whereby the B-2 would form the third side of a triangle of aerial force along with the B-1B and B-52, a triangle that would, we hope, present a deterrence to any enemy well into the 21st century. Three bombers, each with different capabilities, each with a different mission. "It's a fascinating idea if it works," says Science/Technology/Aerospace Editor Tim Cole



Klenck and Willson in the shop.

who wrote this month's cover story (page 59). Cole has already observed missions in a B-1B and a B-52G. He's anxiously awaiting his ride in a B-2. . . . So it's a comparison test of 11 different sabre saws (Home And Shop Journal, page 79). What's the big deal? The big deal is that Home and Shop Editor Steven Willson and Associate Home and Shop Editor Tom Klenck spent five grueling 12-hour days in the shop using the saws, performing tests, collecting data and forming opinions before they even sat down to write the article you see in this issue. But how else could we tell you what works and what doesn't? No wonder not many other magazines present this kind of article to their readers. . . . Our Detroit Editor, Jim Dunne, is something of a legend in his own time (Editor's Notes, Oct. '87, page 4). He has been considered the dean of Detroit automotive journalists for some time and he practically invented the whole new-car spy photo industry. Whenever you see spy photos of next year's or the year after's cars in PM, in other car magazines, in *USA Today* or even on public television's "Motorweek" show, check the photo credits. Chances are, our Jim Dunne took them. Because Dunne is the master spy photographer in Detroit, we thought it appropriate that we change the name of his monthly column to reflect the true nature of his business. So beginning in this issue, Inside Detroit is now Detroit Spy Report. . . . Speaking of Detroit, if you're in the market for a new car or if you're just like me and look forward to the new car introductions each fall because you love cars, this is your month. Thirteen pages of 1990 new cars—photos, tech information, photos of new models, technical changes, and, just as importantly, insight into where the new models fit into the marketplace give you the big picture as far as 1990 domestic cars are concerned. . . . If electronics are more your bag, this month's special section should get your juices flowing—videogame goodies, laser videodiscs, computer enhancements and more. The only trouble with a section like this is that I want to buy everything in it. Till next time.


Joe Oldham

Popular Mechanics

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LETTERS

Mustang: 25 Years And Counting

I ENJOYED your Mustang article "Past And Present" in the August issue ("Happy Birthday Mustang," page 56). The gorgeous 1964½ convertible is intriguing. But my information says that the GT Equipment Group and the Interior Decor Group were introduced in April 1965. Also, one way to distinguish 1964½s from 1965s is that the former use a generator and the latter an alternator. In the photo of the engine on page 64, it looks like the convertible has a generator. Could it be that somebody added the GT equipment and Pony interior? Let me add that I just recently drove a new '89 V8 Mustang LX convertible with automatic transmission and it was slower than my A-engined '65 4-speed and maybe about equal to my son's C-engined (289-2V) '66 with auto. The much more common 225-hp A engine would've given your '89 a real scare in that drag race.

DONALD C. WOOD
CARPINTERIA, CA

To be an authentic GT, your cover car would have had to have been built after the GT package release date, well into the '65 model year. My affection for Mustangs goes back to a '68, 6-cylinder coupe I drove in college and currently rests with a '65 convertible that has provided many hours of enjoyment the past six years. I enjoy your magazine and especially appreciated the 25th anniversary Mustang salute.

RICK LOWE
WOOSTER, OH

I would first like to thank you for your wonderful magazine and especially your great tribute to the 25th anniversary of the Mustang. The arti-



Response to August special section proves that PM readers really know their Mustangs.

cles were very enjoyable, however, the GT Equipment Package didn't come out until April 17, 1965.

I hate to be critical, but when you love these cars as much as I do it is easy to get totally carried away.

I own a fully restored 1965 K GT Fastback. My wife and I enjoy the car very much and plan to go to the Grand Nationals in September.

KEVIN KELLY
STAFFORD, VA

I picked up a couple of innocent mistakes in your Mustang section, but still loved your birthday salute. I may be only 16 years old, but I am a whiz on the early Mustangs. I own two Mustangs myself, a 1965 hardtop with a 1968 302 4-barrel carburetor, and the other one is a 1978 Mustang II with a 2.3-liter 4-cylinder.

Your articles in this section were terrific. Keep up the good work.

JEFF SPORRE
EAST BETHEL, MN

I was very interested in your articles on the 25th anniversary of the Mustang. However, I would guess the cover car is actually a '64½ convertible that has had the GT op-

tions and the Interior Decor Group options added on.

LARRY SCHWARZ
SANTA CLARA, CA

You're all right. According to our cover car's owner, this is indeed a 1964½ Mustang. The additional 1965 items were added after delivery by the dealer who sold the car.

PM Printouts

FROM: Captain B 367

TO: The PM Staff

DATE: 07-13-89 23:49:16

SUBJECT: Kudos

Just wanted to offer a hearty well done! (Bravo Zulu in Navy parlance) to everyone at PM who worked on the Aug. '89 issue. Once again you've done a swell job.

FROM: Mark 520

TO: Captain B 367

DATE: 07-19-89 01:10:48

SUBJECT: Mustangs

I found the August PM to be my all-time favorite issue. The Mustang poster is proudly displayed and now I have found it most imperative that I get the '65 coupe I've had my eye on.

Some readers like Mark 520 use the bulletin board feature of PM's Hotlines to share thoughts with other readers. You can call the PM computer any day between 6 pm and 8 am (only) EDT. The number is (212) 582-8369. Once you're on line, you can leave messages for specific editors or a specific department.

New users will get an identification number and password that allow them to access the system. Simply set your communications software to 8 bits, no parity and one stop bit (8-N-1), and set the baud at 300 or 1200.

First Rearview

I have read for years that the invention of the rearview

mirror is credited to Ray Harroun on his race car driven in the 1911 Indianapolis 500.

Awhile back I was looking through some old copies of PM and I found a very interesting article which predates the 1911 date by some time. It ran in your August 1908 issue, page 492.

NEWELL KELLY
EVERETT, WA

It seems that Ray Harroun only popularized the rearview mirror. We've seen them listed in motor equipment catalogs prior to 1911.

In the 1908 POPULAR MECHANICS article, another benefit of these safety devices was emphasized:

"One of the numerous ways by which autoists succeed in foiling the attempts of the police to catch them exceeding the speed limit is a large reflector fastened to the dashboard of the automobile. In catching the time of a speeding car, the police usually set their trap along a stretch of straight road, and as the automobile passes, one policeman steps out into the road and waves his arms to signal the next officer. This action can be seen in the reflector and if the autoist is cautious he immediately slackens speed and slowly rolls past the other end of the trap in triumph."

PM



"Seeing without turning" was caption for 1908 PM illustration.

Popular Mechanics

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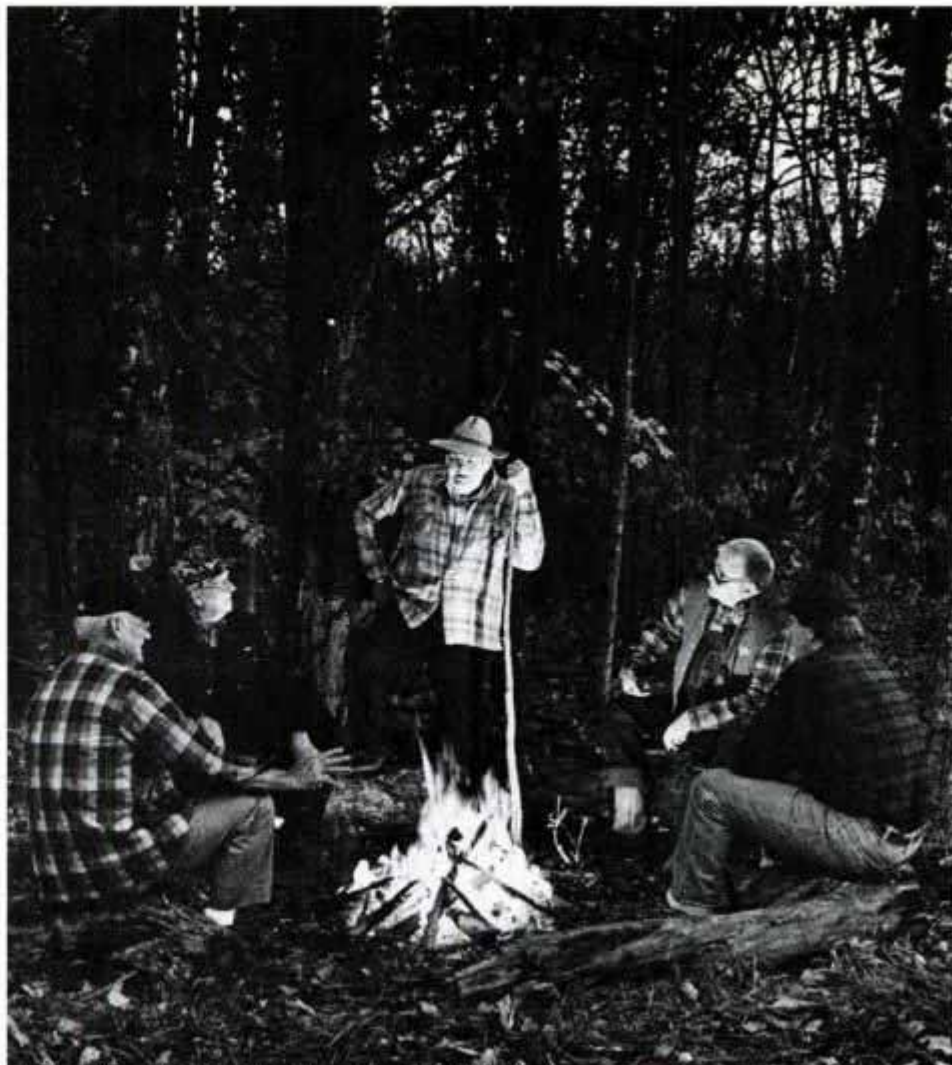
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Ask any bartender about the Tennessee Wyoooter. He can give you the whole story, too.

OCTOBER IN TENNESSEE is when the hills grow darker and the stories taller.

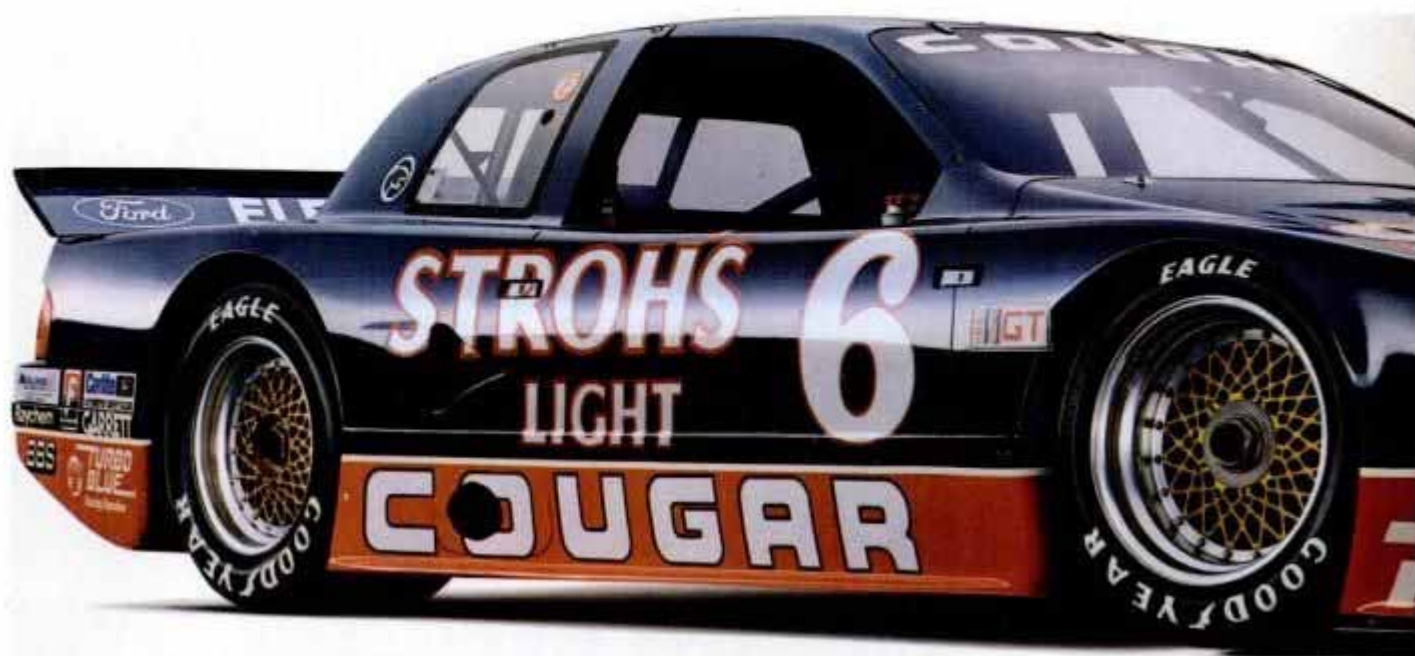
The man in the wide-brimmed hat has a good one about the Tennessee Wyoooter, a barn-big critter who roams these hills under October moons. And though there are those who question his story, he'll have you hanging on every word. Of course, these same old hills are legitimately famed for good whiskey. Drinkers call Jack Daniel's the smoothest there is. And, after a sip, there aren't any questions about that.

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



O N L Y O N



*The race-winning IMSA GTO Mercury Cougar XR7.
Exclusive tires: Goodyear Eagle racing radials.*



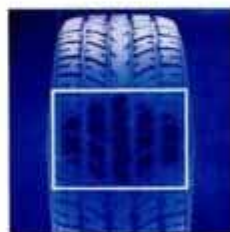
*The 1989 supercharged Mercury Cougar XR7.
Exclusive factory-specified tires: Goodyear Eagle street radials.*

E A G L E S .



Other makes of tires may fit these top-performing Cougars. But only one make was chosen: Goodyear Eagles.

As the engineers at Lincoln-Mercury and Roush Racing know, there really is a difference in performance tires.



A Goodyear Eagle "contact patch." Where an Eagle demonstrates its superiority.

It is a difference that ultimately shows itself in the "contact patches" of your tires, where your car meets, grips and responds to the road. Or, to the track.

Which explains why Goodyear Eagle racing radials are the exclusive tires chosen for Roush Racing's race-winning IMSA GTO Cougar XR7s.

And why Goodyear Eagle performance street radials are the exclusive tires chosen by Lincoln-Mercury for the Cougar XR7.

In fact, more major racing teams choose Goodyear racing Eagles, and more performance car makers choose Goodyear Eagle street radials, than any other make of tires.

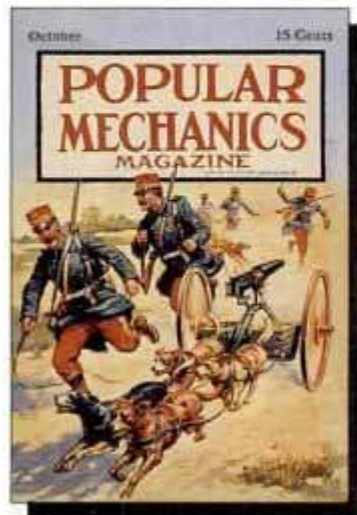
Because Goodyear makes better high-performance tires. For the track. For the street. For virtually every performance car.

Like you, performance car makers have a number of tires to choose from. And like them, you can choose the world's best-selling performance tires: Goodyear Eagles.

GOODYEAR
BECAUSE THERE REALLY IS A DIFFERENCE.

TIME MACHINE

75 YEARS AGO: OCTOBER 1914



The Horror Of War

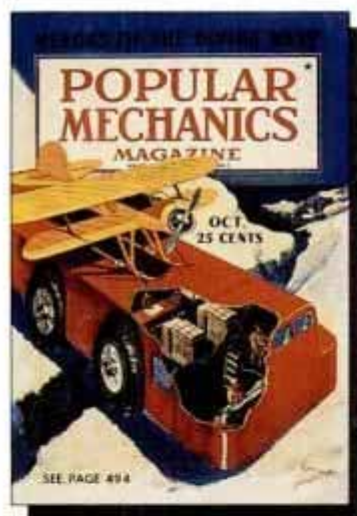
The First World War, depicted on our October cover, showed the destructive power of technology. Grim new instruments of death, including machine guns, poison gas, military aircraft and tanks, forever changed the face of conflict, stripping away the ancient mask of chivalry, and bringing about unprecedented carnage. The war to end all wars didn't, but it did bring a new sense of the responsibility that technology's terrible killing power places on us.

A Tacky Idea

Although advertising has evolved somewhat, the key then as now was to get your message where people could see it. To this end, a rifle was developed that could post signs on objects up to 50 ft. away, and 30 ft. high. The signs were wrapped around a heavy stick with a tack fastened by string to the top. Launched like a dart by heavy springs, the roll came undone on impact, and the sign fell into place.



50 YEARS AGO: OCTOBER 1939



Antarctic Explorer

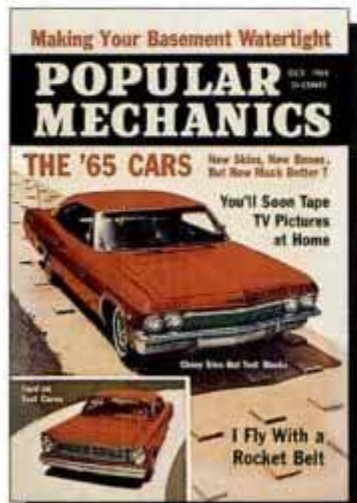
With the country at peace, scientists at the Armour Institute of Technology turned their ingenuity to the building of a 55-ft. snow cruiser for a trek across the bottom of the world. Powered by diesel generators running electric motors on each wheel, the vehicle could cross 15-ft. crevasses, and had work and living spaces for five men. The mapping was to be performed by a camera-equipped ski-plane, which could be slid off the roof and launched in less than 10 minutes.

Sub Rescue

The 19th test dive of the *Squalus*, one of the world's largest subs, was her last. PM told the dramatic story of Navy divers who raced to the scene and miraculously brought 33 of the sunken sub's crew to the surface alive. Key to the mission was Cmdr. Charles B. Momsen's rescue bell, which the divers guided down 240 ft. and fixed to the sub's hatch. With the rescue complete, the divers moved on to the perilous work of raising *Squalus* itself.



25 YEARS AGO: OCTOBER 1964

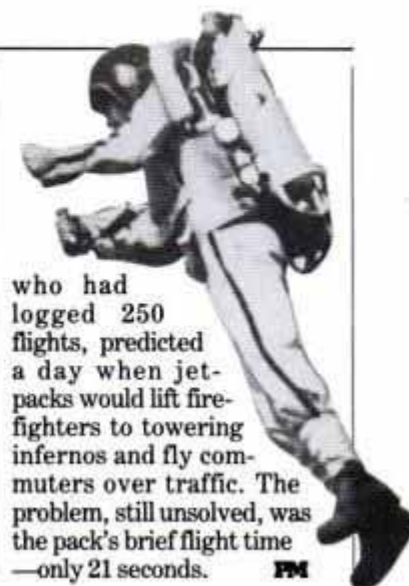


Extra Whoa-Power

With the introduction of Detroit's '65 models, the horsepower race was in full swing, but the feature that most impressed PM editors was fade-resistant stopping power, courtesy of disc brakes. Earlier thought strong enough only for lightweight foreign cars, discs were at last refined to where they could reign in 4000 pounds of Detroit iron. By '65, all the U.S. makers had at least one model with them. Perimeter frames and bigger engines were also noteworthy.

Vaulting Ambition

Jetpacks, an idea whose time still hasn't come, were the cause of much excitement at the '64 World's Fair. A version developed by Bell Aerospace used hydrogen peroxide fuel to reach heights of 60 ft., and speeds of 60 mph. With fuel pressurized by bottled nitrogen, the operator's right hand controlled thrust and left hand controlled left/right movement by vectoring the pack's nozzles. Moving the arms up and down controlled altitude. Rocketman Robert Courter,



who had logged 250 flights, predicted a day when jetpacks would lift firefighters to towering infernos and fly commuters over traffic. The problem, still unsolved, was the pack's brief flight time—only 21 seconds. **PM**

MAGNA

Good Smoke. Great Price.



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Acura Integra LS	\$14,628	Ferrari Testarossa	\$140,700	Oldsmobile 88 Royale	\$15,295
Acura Legend Coupe LS	30,840	Ford Escort GT	10,003	Oldsmobile 98 Regency Brougham	20,495
Alfa Romeo Veloce	21,195	Ford Tempo LX	10,944	Peugeot 505-STX	25,895
Aston Martin Lagonda	187,500	Ford Mustang GT	14,060	Pontiac Sunbird GT	12,074
Audi 80 Quattro	22,700	Ford Taurus LX	15,282	Pontiac Grand Am SE	14,474
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Audi 200 Quattro	36,355	Ford Thunderbird Turbo Coupe	17,146	Pontiac 6000 STE	22,599
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BMW 535i	43,600	Honda Prelude Si	16,965	Porsche 944	36,360
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Buick Regal Limited	14,739	Lincoln Town Car	25,562	Saab 900	17,515
Buick LeSabre Estate Wagon	16,770	Lincoln Mark VII LSC	27,569	Saab 9000 Turbo	30,795
Buick Electra	20,460	Lotus Esprit	67,500	Sterling 825-SL	26,983
Buick Reatta	26,700	Mercedes-Benz 190-E	31,590	Subaru GL-10	16,401
Cadillac DeVille	25,435	Mercedes-Benz 300-E	44,850	Subaru XT-6	17,111
Cadillac Allante	57,183	Mercedes-Benz 560-SEC	79,840	Toyota Camry Deluxe	14,433
Chevrolet Beretta	11,325	Mercury Topaz LS	11,818	Toyota Cressida	21,498
Chevrolet Camaro IROC-Z	14,920	Mercury Sable LS	15,094	Toyota MR2	16,063
Chevrolet Celebrity	12,270	Mercury Cougar XR-7	16,157	Toyota Celica GT-S	16,533
Chevrolet Caprice Brougham	16,835	Merkur Scorpio	25,052	Toyota Supra Turbo	25,720
Chevrolet Corvette	31,545	Nissan Sentra SE Coupe	12,719	Volkswagen GTI	14,455
Chrysler LeBaron	13,495	Nissan Pulsar NX SE	13,794	Volkswagen Jetta GLI	15,575
Chrysler Fifth Avenue	18,345	Nissan Maxima SE	17,999	Volkswagen Scirocco 16V	15,235
Dodge Daytona Shelby Z	13,295	Nissan 300-ZX Turbo	24,699	Volkswagen Quantum GL	17,975
Dodge Lancer ES	13,695	Oldsmobile Cutlass Calais SL	11,995	Volvo 240-DL	17,250
Eagle Premier ES	16,089	Oldsmobile Cutlass Supreme SL	15,195	Volvo 780	37,790

Source: Automotive News 12/5/88, "Pricing the '89 Models"



Isn't your car worth the extra protection?

Mobil 1. The winning oil at the 1989 Indy 500.

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TECH UPDATE

News Of Tomorrow's Technology Today

Batmobile Combines Stealth Bomber With '68 Chevy



DC COMICS PHOTOS

Batmobile achieves its forbidding appearance with jet-engine and dragster parts sculpted into its composite skin. Small-block Chevy mechanicals are good for 92.7 mph.

PINEWOOD, ENGLAND—The uncanny resemblance between the new Batmobile and the Stealth bomber is more than coincidental. Among the eclectic sources of inspiration drawn on by "Batman" production designer Anton Furst were the B-2, the SR-71 Blackbird spyplane, and Salt-Flats speedsters of the 1930s.

Furst's creation plays the role of a fictional turbojet-powered vehicle capable of 0-60 mph in 3.7 seconds, and equipped with retractable armor, concealed machine guns, voice-activated controls, electronic tracking devices and a pair of explosive charges launched from the wheel hubs. Its actual capabilities, however, are more modest.

The two Batmobiles built for the film began as '68 Chevrolet Impalas with 327-cu.-in. V8s. Under the guid-

ance of special-effects supervisor John Evans, the cars' frames were widened by 2 ft. and stretched 30 in., bringing their total length to 20 ft. Engines were dropped 12 in.

From here on, efforts focused on making the cars look as scary as possible. Voluptuous black bodies were fabricated from Kevlar by John Lovell, a builder of Group C race cars. To simulate a jet intake, a fan from a Harrier Jump Jet was set into the hood, with a hub from a Rolls-Royce Olympus Spey engine at its center. Flaming exhaust was produced by igniting a pressurized mix of air and kerosene.

A pair of inoperative, but nonetheless real, machine guns were mounted on hy-

draulic rams to pop on and off the fenders. Other rams launched simulated explosives from the wheel hubs.

Inside, a combination of Ferrari gauges and Harrier

instruments are arranged to simulate the effect of a jet cockpit.

Despite the cosmetic additions, the Batmobile is still more than a parade float. Top speeds of 92.7 mph were measured, and the old Chevy chassis reportedly handled well enough for chase scenes.

Editor: Tim Cole
Assistant Editor: Abe Danc
Contributors: Mike Fillon,
Frank Seitzer, Jim Dunne

Highlights This Month

- **Strategic Defense Initiative**—The Brilliant Pebbles breakthrough.
- **Superconductors**—Fabricating 1-2-3 oxides into usable wiring.
- **Composites**—New testing methods advance graphite/epoxy structures.
- **In The Army Now**—Technology to aid America's fighting forces.
- **Electronic Shades**—Switching on tomorrow's sunglasses.
- **Police Technology**—Video cameras and fingerprint readers take a bite out of crime.
- **Alternative Fuels**—Will your next car burn methanol? Or will mixed fuels power the cars of the 21st Century?



NIST PHOTOS

New Way To Test Composites

GAITHERSBURG, MD—Increased reliance on graphite/epoxy compounds in the construction of aircraft, rockets and submarines has prompted the National Institute of Standards and Technology (NIST) to come up with innovative techniques for testing and evaluating

composites. Using high-speed super computers, mathematical modeling and high-density computer graphics, NIST engineers are able to simulate stress and sound waves as they propagate in composite structures, and then view the waves in three dimen-

sions. The breakthrough technique will allow designers to better understand the composites' various properties.

So far, NIST has observed two distinct wave patterns during tests—one in shear and the other longitudinal—with a third unpredicted wave moving in yet another direction.

Deciphering the inner secrets locked in composite structures will allow engineers to find new potential in these vital building blocks.



New engineering tool: A 3-D computer graphic of wave propagation in composite structures.

Easy As 1-2-3

ARGONNE, IL—To overcome problems in shaping brittle high-temperature superconductors, researchers have fused the ceramic metal oxide "1-2-3"—mixed with fine silver powder—to a continuous ribbon of silver.

When very tiny, current-inhibiting cracks emerge in the superconductor, the silver carries the current past the break and thus maintains the superconducting current.

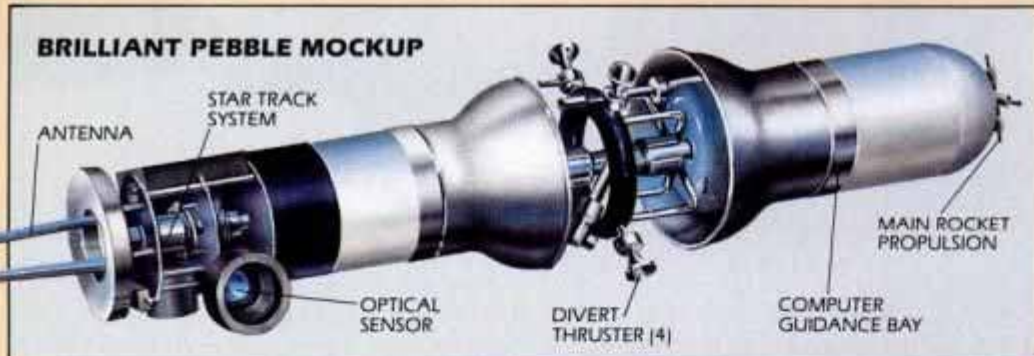


ARGONNE PHOTO

Ten times normal household current in a tiny band of silver and ceramic oxide.

Brilliant Pebbles Shines In Phase One SDI Test

PM ILLUSTRATION BY DON MANNES



WASHINGTON, DC—Advancements in computing power, sensors and rocket thrust have increased the potential for a relatively inexpensive and reliable defense against intercontinental ballistic missiles, according to SDIO officials.

The most recent hardware breakthrough for a proposed

Phase One SDI deployment comes in the form of Brilliant Pebbles, a high-tech kinetic-kill machine.

Officials envision a constellation of the tiny rocket-powered devices—each 3 ft. long and weighing less than 100 pounds—that would independently detect, track and neutralize incoming mis-

siles. Tiny supercomputers and tennis-ball-sized inertial measurement units are key to Phase One's development.

Each Pebble would be housed in a triangular-shaped shelter that would double as a solar-power generator and sensing platform. Once an ICBM's exhaust plume is detected, Brilliant

Simple all-axes divert thrusters and optical sensors form the heart of Brilliant Pebbles (left).



A recent SDIO experiment tested Brilliant Pebbles' stability in full-thrust mode.

SDIO PHOTO



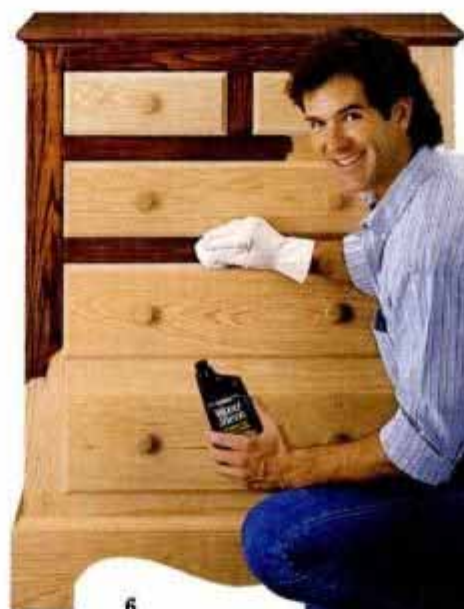
Brilliant Pebbles deploys from its life jacket and homes in on ICBMs picked up by an orbiting BSTS satellite (right).



Pebbles would be dispatched to destroy it using on-board optical sensors and unique high-power divert thrusters that would maneuver the device in all axes for the kill.

Another key to Phase One deployment will be the Boost Surveillance Tracking System (BSTS), an infrared detection satellite that would hand off target data to other SDI elements.

PM ILLUSTRATIONS BY DON MANNES



Minwax has more ways to make you a snappy dresser.

Minwax makes it easy to express yourself beautifully, with a variety of attractive wood finishes that add style and beauty to any home. Choose from our wide range of traditional stains. Fast-drying, durable topcoats. And one-step finishes that save you hours... Minwax has them all.



Which is why Minwax is the only name to look for, when you're looking for beautiful wood.

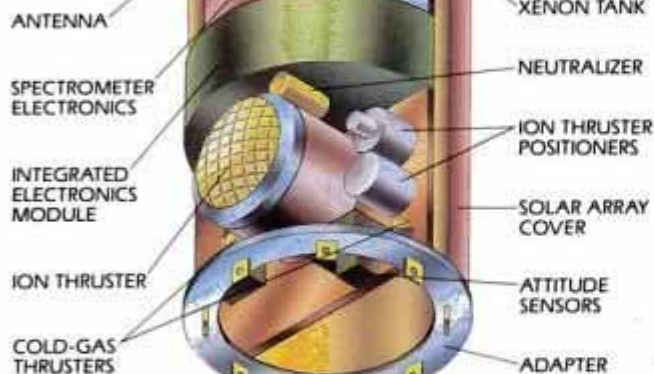
For additional suggestions and projects, send for our FREE brochure, *Tips on Wood Finishing*. Write: Minwax, Dept. PM109 Box 426, Little Falls, NJ 07424



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TOMORROW'S MOON PROBE



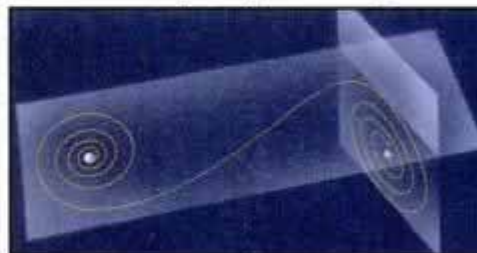
Low-Budget Moon Probe

PRINCETON, NJ—Princeton's Space Studies Institute is developing a spacecraft to seek out resources that could sustain future lunar colonies.

Scheduled for launch in 1991 aboard either the Space Shuttle or an expendable rocket, *Lunar Prospector* will orbit the Moon with a

gamma-ray spectrometer to detect water in the form of ice, and an electron reflectometer to look for ores and Helium 3 which could fuel fusion power generators.

Using low-thrust ion rockets, the 100-pound craft will reach the Moon on spiraling trajectory in about 2 years.



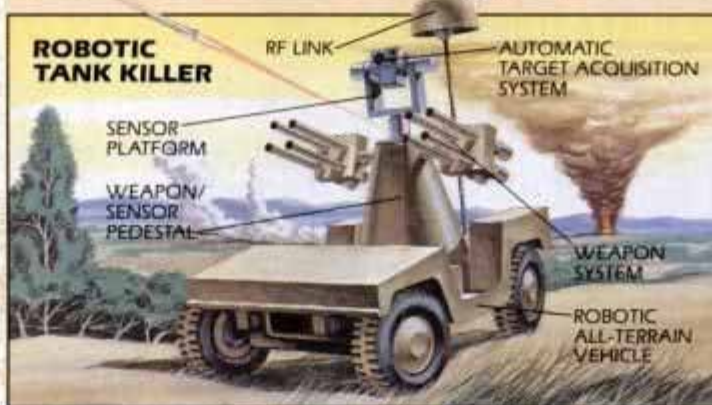
Among designs being considered for *Prospector* is the one above, with instruments configured for launch from the Shuttle. Lazy, spiral trajectory (far right) would bring the craft into lunar orbit (right).

PM ILLUSTRATION BY MARIO FERRO

(LEFT) SSI SIMULATION; PM ILLUSTRATION BY MARIO FERRO

LABCOM Presents Latest Army Field Technologies

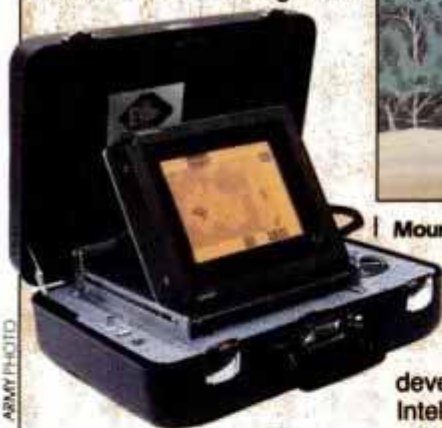
ADELPHI, MD—The seven laboratories of the U.S. Army Laboratory Command recently showcased a range of exotic technologies adapted to the rugged conditions of combat. To solve logistical



Armored vehicles could also benefit from the properties of composites, but problems in fabricating them to the required thicknesses have stood in the way. Now, a fiberglass-hulled version of the Bradley Fighting Vehicle has been created that protects the crew against lethal spall, and allows for a 25-percent weight reduction.

It also has superior resistance to structural fatigue and corrosion.

A more futuristic vehicle



CID (above) has removable electroluminescent display for remote operation. Binocular radio (below) permits secure communications with 1-km range.

Mounted on a robotic vehicle, ATA finds and fires on enemy armor.

and strategic problems, the Electronics Technology and Devices Laboratory has developed the Commander's Intelligent Display. Based on a 32-bit microprocessor, the CID is sealed against moisture and temperature extremes, and has a detachable, touch-sensitive electroluminescent monitor that allows use of a variety of software without a keyboard. In one test, an optical disk-equipped unit gave soldiers access to data that enabled them to disarm unexploded ordnance far faster than conventional field manuals. Microcircuitry is also key to an inexpensive millimeter-wave radio built into a pair of binoculars. Designed to permit secure,

short-range communications, its highly directional beam goes only where binoculars are pointed.

To lighten the infantryman's load, the Materials Technology Laboratory is ex-



Spectra helmet (above) is designed to withstand fragment impacts, which account for most battle casualties. Bradley's fiberglass hull (left) tests fabrication for future armored vehicles.

perimenting with composite helmets using a new type of reinforcing fiber called Spectra. Similar in strength to Kevlar now used in standard issue headgear, Spectra allows helmet weight to be cut from 3 pounds to 2.2 pounds.

concept, the automatic target acquisition (ATA) system would use lasers and infrared sensors to seek out and fire upon tanks in areas too dangerous for humans. The battlefield of tomorrow gets more technical—and far more lethal.

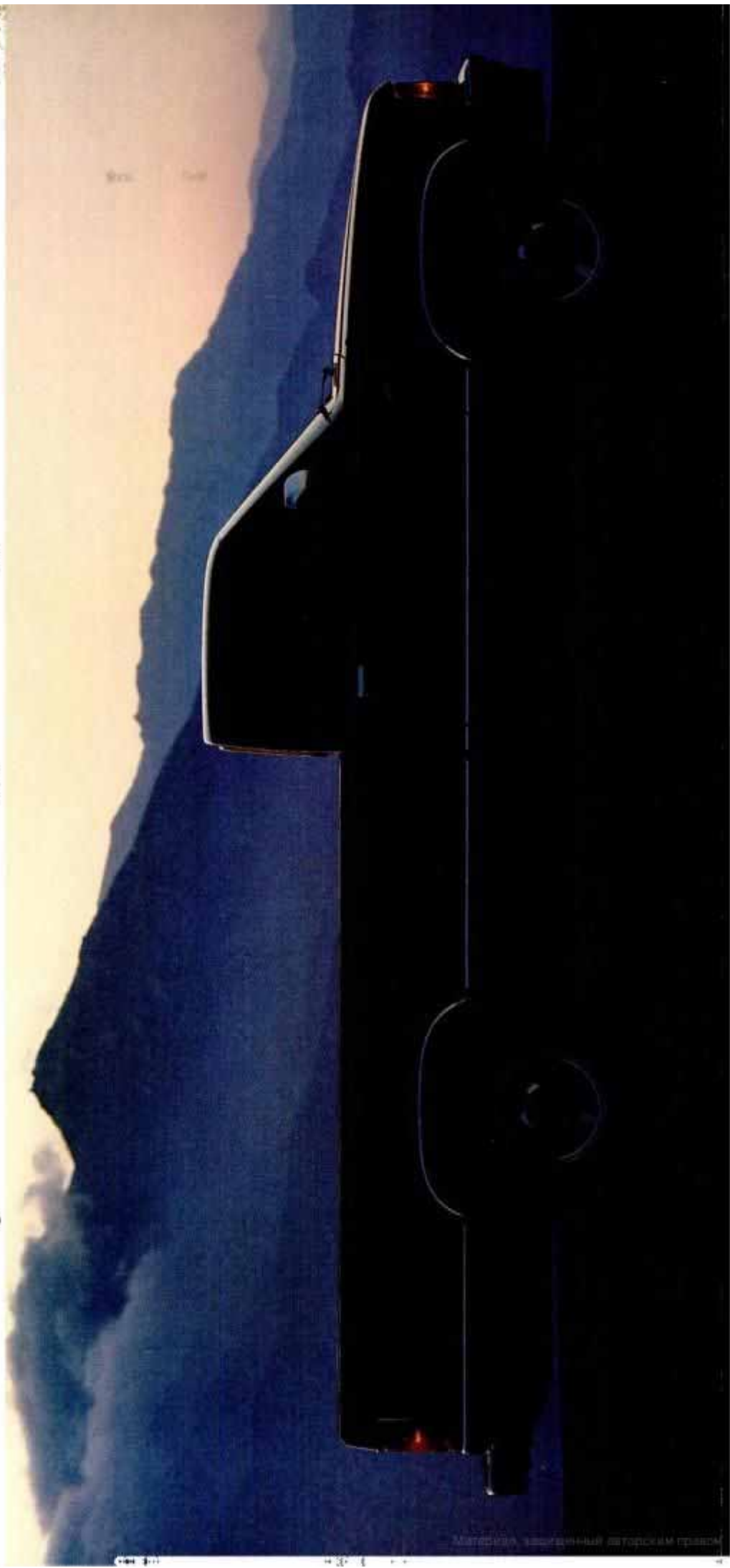
ARMY PHOTO

ARMY PHOTO

PM ILLUSTRATION BY ADOLPHE BROTMAN

ARMY PHOTO

The complete, unabridged guide
to every mid-size pickup in America.



Материал, защищенный авторским правом

Every mid-size 4x2.

Dakota 4x2 Maybe it's our pioneer spirit. Or, maybe it's just pure stubbornness. But out here in Dakota Territory, we've got our own way of doing things. And our Dodge Dakota 4x2 pickup is a prime example.

It's the first and only mid-size pickup around. Big enough to tote most anything that needs toting. Small enough to zip through traffic on a Saturday night. And since it seats three, roomy enough for you, a close friend of the opposite sex and a large furry animal.

For big jobs, we can even fix you up with an eight-foot bed. Up to 2,550 lbs. of payload capacity. 5,900 lbs. of available pull for towing. Plus a fuel-injected V6. And every Dodge Dakota comes standard with anti-lock rear brakes and our unbeatable 7/70 protection plan.*

We think you'll like our Dakota 4x2. And chances are so will your close friend of the opposite sex. Now as for the critter, we make no guarantees.

*See our powertrain limited warranty and its restrictions at your dealer.



Every mid-size 4x4.

Dakota 4x4 Living in Dakota Territory sure has its ups and downs. And with so much of the real estate being vertical, we just naturally had to go out and invent the Dodge Dakota 4x4 pickup.

Being the first and only mid-size 4x4 anywhere, our Dakota slips in and out of tight spots that would leave some of those full-sized pickups in a real bind. And with all four wheels churning, this Dakota is just the thing to get you to where the roads don't go and the air smells good.

Getting up and over is easy, thanks to standard fuel-injected V-6 power, big 15"

wheels and two-to four-wheel shift-on-the-fly. And with room for three,* you can bring along plenty of help for all those life-in-the-wilds chores you hate. Like setting up the tent. Building a fire. And plugging your TV into the portable generator.

Yes, life in Dakota Territory sure has its ups and downs. And our Dakota is definitely one of the ups. But with four-wheel drive, even the down part is a whole lot of fun.

*Dakota Sport models, as shown below, are equipped with bucket seats.



Every mid-size convertible.

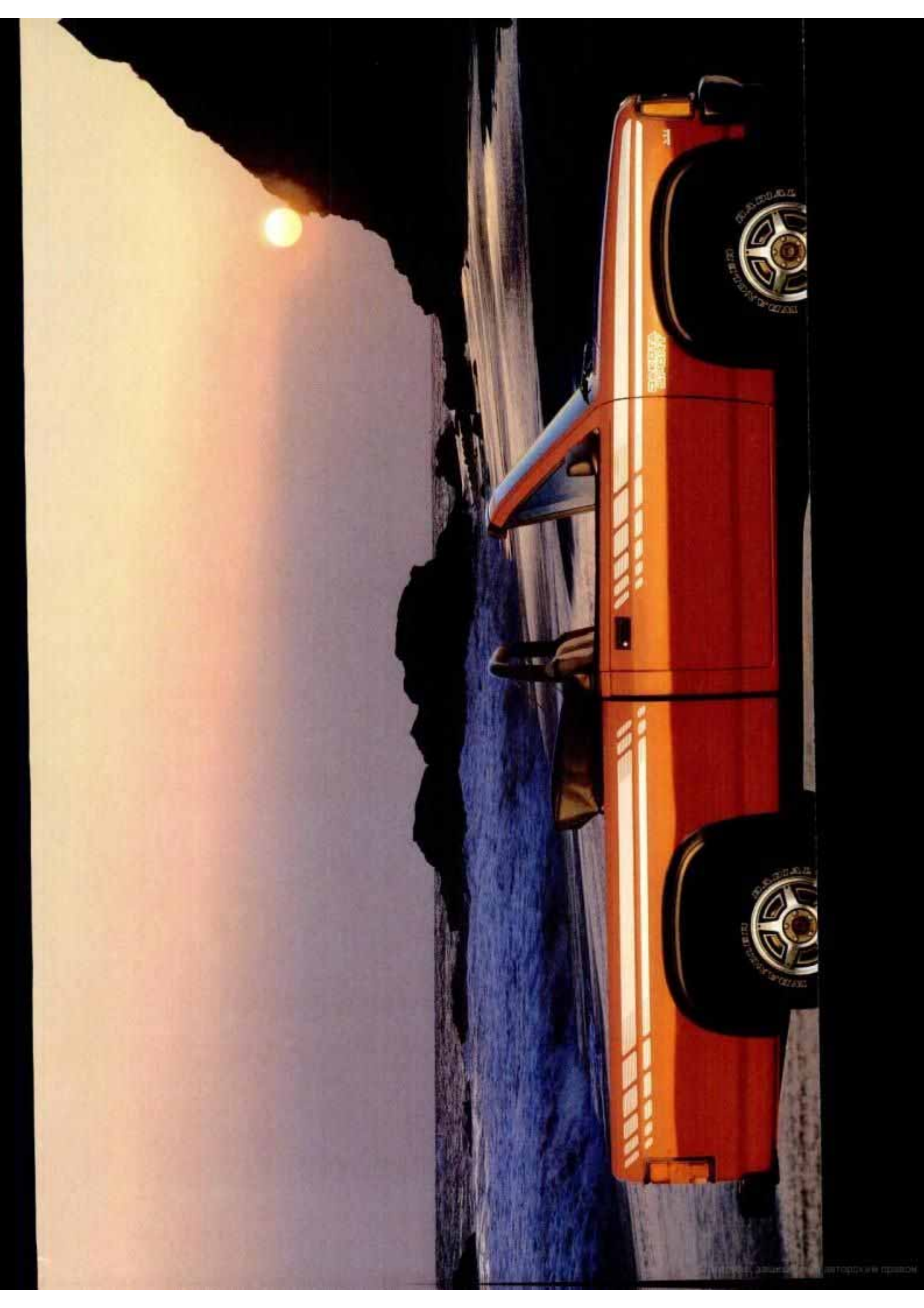
Dakota Convertible The sun always shines in Dakota Territory. And if that isn't cause for celebration, then we don't know what is.

Well, one day we got so carried away celebrating the sun, that we sliced the top off a Dodge Dakota pickup and came up with one of the slickest convertibles you ever saw. And we liked it so much, we decided to build a few more for our fellow sun worshipers.

Don't think because we took the roof off that this Dakota Sport is any less a truck.

It's still the same one-of-a-kind mid-size pickup it always was. It comes rigged with a fuel-injected V-6. A five speed gearbox. Anti-lock rear brakes. And a bunch of power stuff like steering, windows and door locks. You can even order a 4x4 version for top down mountain climbing.

Now, some might say we got carried away with our celebrating. And that a truck with a soft top breaks all the rules. But then, what are rules for anyway?



Every mid-size V-8

Dakota Shelby Not long ago, a Texan came visiting Dakota Territory.

Said his name was Carroll Shelby and that he wanted to "play around" with one of our '89 Dakota pickups. We knew he'd built some pretty hot cars. So we couldn't wait to see what he'd do with one of our trucks.

Well, the first thing he did was bolt in a big 5.2 liter V-8 and a sophisticated 4-speed automatic. Stuck on special wheels and big fat Eagle GT-4 radials. Tricked it up with a slick light bar and graphics. And called it the Shelby Dakota. Needless to

say, it moved us. After all, it's the only mid-size V-8 pickup around.

Now the good news is you can get one just like it at Dodge/Shelby dealers.*

The bad news, it's not easy. Seems Mr. Shelby only likes to build a few. But once he gets going, look out. Because he loves to create monsters.

(Confidentially, we think it has something to do with his parents naming him Carroll).

*Dodge's limited warranties do not apply to parts modified by Shelby Automobiles, Inc. See your Shelby dealer for all restrictions and details.



Every mid-size club cab.

Dakota Club Cab Out here in Dakota Territory we're very proud of our wide open spaces. That's why we decided to put a whole lot of it into our Dodge Dakota Pickup. But you know how some people are. They want more of everything. Including space.

So we just put more distance between the front seat and the back window and created the only mid-sized extended cab pickup around. The new Dakota Club Cab. You can use the extra room to lock things inside that might do a disappearing

act if you left them in the bed. Or fill it with family and bring the kids along.*

Our exclusive Club boasts rear anti-lock brakes, a five speed gearbox and an AM stereo/FM stereo radio as members in good standing. And the available fuel-injected V-6 and 4-speed automatic put the space under the hood to very good use.

But it's the extra space inside our new Dakota Club Cab you'll love the most.

Especially if you've got kids. Or something to hide.

*Choose an SE or LE Club Cab and your rear seat is standard equipment.



The mid-size Dodge Dakota. It covers a lot of territory.

Well, there you have it. Your personal guide to Dakota Territory. And to every mid-size pickup in America. Every one of them special in its own right, every one of them backed by our unbeatable 7/70 protection plan, and every last one of them built by Dodge.* So if you're looking for

something out of the ordinary in a truck, Dakota is the place you want to be. But be prepared for just about all the fun you can handle. It comes with the territory.

*With one powerful exception: Mr. Shelby's Dakota. And our powertrain limited warranty and its restrictions (which you can see at your Dodge dealer) do not apply to parts modified by Shelby Automobiles, Inc. So see your Shelby dealer for their restrictions and details.





SUPER SHADES

Switch-operated prototype has mini battery and AC inverter.

Instant-Response Electroshades

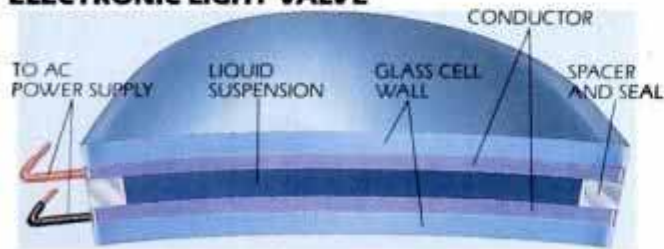
WOODBURY, NY—Research Frontiers, Inc., has demonstrated proprietary light-valve technology in a pair of sunglasses that darken at the flip of a switch. The key to the system is a 1/1000-in.-thick suspension

of needle-shaped light-absorbing particles sandwiched by layers of glass. Normally, the particles float randomly in suspension, partly blocking the passage of light. But when AC current is applied through an indium-tin-oxide conductor lining the glass, the particles are aligned so that the suspension becomes transparent. The same technology could be applied to windows and car sunroofs.

Nonprescription versions of the glasses should be marketed in two years.

Future models could be made to respond to varying light levels automatically by replacing the switch with a photo cell.

ELECTRONIC LIGHT VALVE



Scope Mirrors



Machinist checks aspheric, grazing-incidence UV mirror.

LIVERMORE, CA—New technology has enabled the Lawrence Livermore Lab to make telescope mirrors for the Extreme Ultraviolet Explorer satellite, scheduled for launch in 1991. Machined from aluminum, then coated with nickel, the optics are polished with diamond-dust pitch and lapped to 13-angstrom smoothness.

High-Speed ID Technology Closes In On Fugitives



NEW YORK, NY—Advances in computers, communications, and video technology are going into systems to provide lawmen in the field with rapid, positive identification of criminals, missing persons and stolen vehicles.

Officers pulling over cars for minor infractions now routinely run a check against wanted persons and stolen car files in computers at the FBI's National Crime Information Center (NCIC). The results are often uncertain, however, because names and descriptions may be falsified, or may match by coincidence.

To solve this problem, the FBI has built a working proto-

type of a system that sends and receives fingerprints and mug shots from a squad car.

A typical scenario: After going back to his car with a motorist's license and registration, an officer radios a description in to NCIC. An inconclusive response prompts him to follow up by bringing the motorist back to the squad car, and sending an electronic scan of his fingerprint. This

Concealed TV camera sends license-plate images to PC. Processing software compares with list of stolen cars.

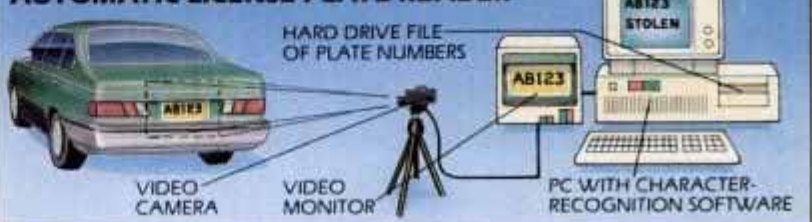
time, automatic matching turns up an outstanding warrant, which is sent back along with a mug shot and criminal record. With the present system, the first, inconclusive response leaves the officer to decide on instinct whether an arrest is justified.

To catch criminals on the move, Geospace Systems

Equipment in car (left) transmits images via network (middle), which sends back prints and mug shots (right).

has programmed a PC to read license-plate images fed to it by a video camera. The computer compares numbers to a list of stolen vehicle plates, and alerts police when a match is found.

AUTOMATIC LICENSE PLATE READER



Methanol Rally Tests New Fuel



GM PHOTOS

Methanol Marathoners make a pit stop (top). Engines (inset and right) were designed to consume a mixture of 85-percent methanol, 15-percent gas.

DETROIT, MI—The 1990's imperative for cleaner air has spurred carmakers to develop alternative fuels.

GM-sponsored an 1100-mile rally in which college engineering students ran Chevrolet Corsicas they had converted to methanol, mixed with 15-percent gaso-

METHANOL CONVERSION KIT

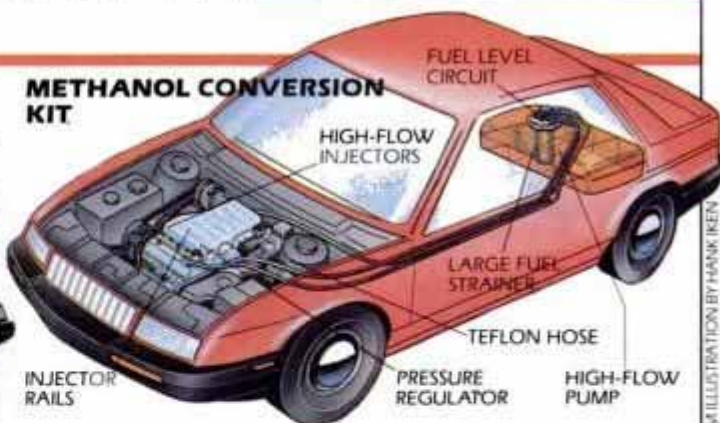


PHOTO ILLUSTRATION BY HANK IREIN

line to improve fuel delivery and combustion.

Each team was issued a conversion kit consisting of a stainless-steel fuel tank, high-flow fuel pumps, special fuel injectors and fuel rails. Fuel-efficiency winners won a \$20,000 prize.

Ford and Chrysler are also

pursuing alternative fuels. Chrysler's Gasoline Tolerant Methanol Vehicle places an emphasis on high-grade materials designed to combat the corrosive effects of methanol. Ford's converted flexible fuel Taurus is designed to run on methanol, ethanol or gasoline.

Steady Improvements In Head-Up Technology

NEW YORK, NY—The science of simplifying fighter pilot workload in combat continues to tax avionics engineers. Recent trends point toward enhanced look-and-shoot capability in helmet-mounted displays that liberate the pilot from traditional war-fighting chores. Already, combination raster and stroke technologies—and the far-off potential for voice commands—hint of a more intimate interface between man and machine.

Kaiser Electronics' Agile Eye Plus leads off with an improved version of its groundbreaking Agile Eye. The Plus features a wider field of view—20° instead of 12°—and the addition of a raster display that works in synergy with the system's stroke display. The raster technolo-

gy—akin to the linear construction of a television screen—is best suited for tactical TV and FLIR images. Stroke images are brighter and crisper and can be viewed in daylight, making them suitable for characters and symbols. Used in combination, raster and stroke displays provide vibrant, high-impact imagery that aids pilot cognition in highly dangerous combat situations. Physiological stress associated with flying a fighter to the extremes of the flight envelope can be mitigated somewhat with instrumenta-



Kaiser's Agile Eye Plus (above) outperforms current helmet-mounted displays. Tomorrow's prototype (right) will provide improved displays.



KAISER ELECTRONICS PHOTO

tion that's easier to grasp.

W.W. Gaertner Research Inc. is on the cutting edge of stroke technology, producing a stroke generator that can provide over 16 million colors and load the screen with 2.6 million points of light per frame.

Over the horizon, researchers at the Aeronautical Systems Division of Wright-Patterson Air Force Base are using MAGIC to explore the next-gen-

eration electronic cockpit. Microprocessor Application of Graphics with Interactive Communications (MAGIC) is being used to evaluate the pictorial formats to be used in future cockpits that will work in concert with helmet-mounted displays. While targeting and flight information will be imprinted on tomorrow's helmet visors, less critical information will be printed on wide-format touch-sensitive screens.

The efforts come as microchips assume an even greater role in the fighter cockpits of tomorrow.



The Air Force's MAGIC simulator (left) assesses cockpit symbology. The W.W. Gaertner stroke generator (right) offers vivid characters in a multitude of colors.

AIR FORCE PHOTO, (RIGHT) GAERTNER RESEARCH INC. PHOTO

Car owners!

"TUFOIL®
SLIPPERIER
THAN
TEFLON®"

WHY BUY A NEW CAR WHEN YOU DON'T HAVE TO?

Use **Tufoil**® and your engine will last

...and last
...and last!

The next time you change your oil, **REALLY** change it...into the engine treatment it could be, it should be!

TUFOIL IS EASY TO USE!

It's easy to make your engine run better, last longer. Just add 8 ounces of Tufoil to the crankcase. After that, add 4 ounces each time you change your oil. You don't have to shake the container or add an engine flush. Just pour it in and drive away.

SILKY SMOOTH ACCELERATION

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 US government laboratory.)

FAST STARTS - HOT OR COLD

You'll get astonishingly fast starts on cold mornings with both diesels and gas engines. The Canadian government tested TUFOIL at its cold regions lab. They showed faster cranking and significant fuel savings with TUFOIL. Better on desert like hot days too.

MORE POWER - BETTER RESPONSE

Owners of very expensive German diesels call in wanting to buy stock in our company. They say their diesels are accelerating like nothing they've ever seen before. One said he doesn't have to down shift any more on an annoying hill in his area.

Your car can have more power like that too!

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 our offices, 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!

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SAAB owners are writing letters praising TUFOIL in their "NINES" magazine. They report spectacular improvements in their engines and manual 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. One customer put it nicely when he said, "You can hear it...you can feel it", after adding Tufoil to his engine!

PS--Our loyal customers wrote this ad for us. Its full of their comments!

Thanks!



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See NASA Tech Briefs for technical details, 1986, 1987 and 1988.

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DETROIT SPY REPORT

BY JIM DUNNE

1991 Oldsmobile Wagon

THE PROTOTYPE of the 1991 General Motors full-size station wagon that we spotted recently has a split personality. One side of the vehicle is trimmed with Buick parts, the other with items that make it an Oldsmobile.

The grille, however, is taken right from Buick's future parts bin.

Taillights are the most noticeable difference in the rear. The Buick's are fatter and wrap around the rear corner. Olds uses its familiar vertical lens.

The roof is unique for a Detroit wagon. A tinted glass skylight over the rear seat area rises up 4 in. above the roof level. Aft of the skylight is a bed for a roof rack.

Chevrolet will also produce a station wagon built with this new bodyshell.

All three wagons are being developed under the GM 300 code designation.

The practice of building 2-sided prototypes to explore the effects of two different trim styles is an old one in the auto industry, and obviously is intended to save money by cutting in half the number of expensive prototype bodies that are required for styling development.

Turbo Lumina

Chevrolet plans to heat up its new Lumina family next year



Prototype 1991 GM wagon is either a Buick or an Oldsmobile, depending on how you look at it.

with a turbo version of the Coupe.

The prototype we photographed was undergoing high-speed testing on the track of one of GM's test facilities. The turbo is distinguished from the Lumina Euro Coupe by functional air intakes on the hood, plus sporty lower body trim.

Set up much the same as the Pontiac Grand Prix Turbo, the Lumina Coupe will use GM's 3.1-liter V6, which generates about 205 hp in turbo trim.

Chevy product planners still haven't decided what to call the Lumina hot rod. One group is pushing for a simple Lumina SS, while another wants to revive the Monte Carlo name.

Marquis Masquerade

Like its sister from Ford Division, the Crown Victoria,

Mercury's Grand Marquis is due for a 1991 facelift.

The prototype we observed wears the '91 front end bolted to a current body, to test the cooling characteristics of the new styling treatment. Besides the fresh grillework, the Grand Marquis mounts a new 1-piece

these cars—the body part called fascia by the industry. Pontiac will stick with the split grille opening, but the nose will scoop forward at the bottom more dramatically than in today's models.

Chevy will also have a forward-thrusting grille opening below the main bumper



Mercury's Grand Marquis will get new front-end styling in '91.

plastic-clad bumper.

Changes to the Crown Vic and Grand Marquis are expected to be limited almost entirely to front-end facelifts, and the rear-drive Panther platform, which is also shared by the Lincoln Town Car, will remain untouched.

F-Car Facelift

Look for General Motors' F-Cars, the Chevy Camaro and Pontiac Firebird, to get new front-end styling when the 1991 models roll out next fall.

Major changes will show up in the plastic noses of

bar, but without the vertical center divider.

Odds On Orbital

Ford and GM are betting on 2-stroke engine technology. Each has signed up to get Orbital Engine Co. know-how in designing a small 2-stroke for automobiles.

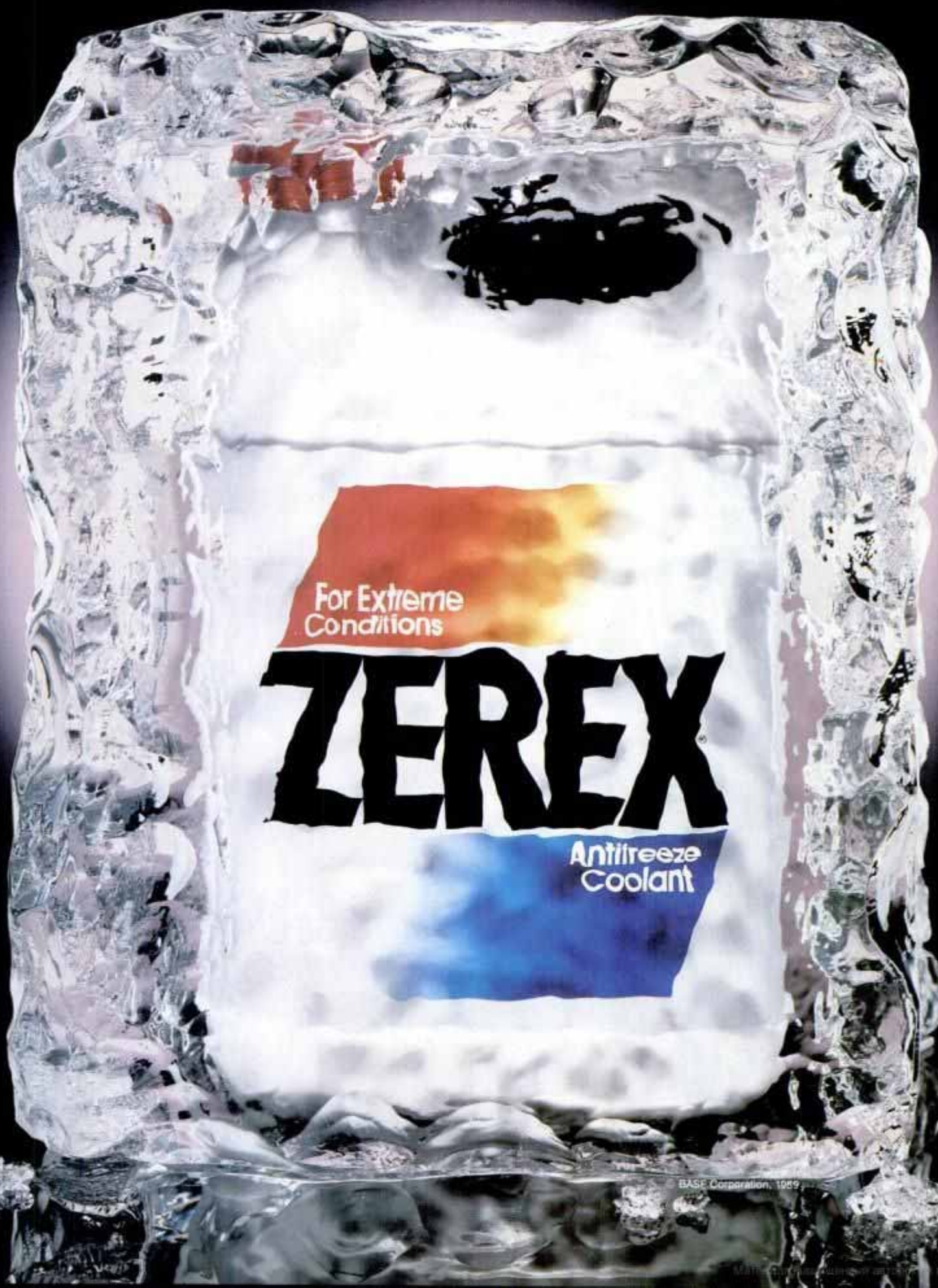
Ford apparently is way ahead of GM in its 2-stroke plans, and may have a mini-sedan powered by the engine on the road in Europe within four years. Two-stroke engines get a power stroke with each turn of the crankshaft,

(Please turn to page 34)



Hot-rod Chevy Lumina Coupe with turbo V6 will roll out next year.

EXTREME CONDITIONS DEMAND EXTREME PROTECTION.



BAE Corporation, 1989

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while a 4-stroke engine gets a power stroke with every two turns. This results in the same power from two cylinders as a 4-stroke engine produces with four cylinders. Two-stroke engines are not new. But excess emissions have held them back from wide use in modern cars. Now, with the Orbital Engine development, 2-stroke engines can meet emissions standards, at least in smaller displacement sizes.

Key to the Orbital system is premixing of fuel and pressurized air that allows more complete burning in the combustion chamber.

Frame Games

That old design argument is cropping up once again. Which is better—traditional body and frame assemblies or unitbody?

In recent years everything's been unitbody. All the Japanese cars are built that way, and all of the newer U.S. designs, too.

Unitbody designs are built with the body and frame in one piece, eliminating the separate frame under the car body that holds the suspension and drivetrain in place. The weight savings from this design are substantial.

But new thinking is that carmakers can change the shape of the body—restyle the body panels—more easily and

quickly if the car is built atop a separate frame. That would allow automakers to make more frequent styling changes—say every two years instead of the three to five years commonly required by Detroit today.

It is a relatively simple job to replace outside body panels, and keep the same frame and suspension intact.

Lightweight cars with unitized bodies can have big suspension problems when rough pavement is an everyday part of the driving. The unitbodies can flex when the suspension is put under heavy stress.

After a time, as body parts weaken, flexing becomes more pronounced. That's when trouble crops up—doors fit loosely, suspensions betray their ride and handling mission, and the car begins to feel old all at once.

The deterioration doesn't happen on all unitized cars. Some are built with stronger bodies, but they pay the penalty of heavier weight and a much lower fuel economy.

Don't look for a massive swing back to body and frame right away. Virtually the whole industry, from first design to final assembly line, is set up to build unitized construction.

But the persistence of certain body and frame models in taxi work—New

York City's yellow Chevy Caprices and Ford Crown Vics, for example—underscore the basic strength of this technique.

T-Bird Diet

That's what Ford executives are calling for after seeing the T-Bird and Cougar scaling in at 4000 pounds each. Given their choice, the management at Ford would like to see these cars at 3500 pounds or even below.

There are two reasons for this concern, and both are vital for Ford.

First, the added 500 pounds of avoirdupois mean higher costs, even just for the extra materials. More costs add up to less profits.

Then there is the problem of fuel economy. While the Federal government is tightening the demands for improvement in fuel usage, the T-Bird and Cougar are not making big improvements.

Additionally, there is the competition. Grand Prix and similar GM coupes weigh in at some 700 to 800 pounds less than Ford's personal luxury duo. In Detroit-think that advantage will eventually weigh heavily—in fuel economy, company profits and perhaps even in customer choice—in General Motors' favor. **PM**

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From this big can comes the best there is. With an advanced cleaning formula that cuts through engine dirt and grease *better* than anything you've ever used.

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MOTORSPORTS

BY TONY SWAN

A Long Day At Nelson Ledges

WHAT A DIFFERENCE a year makes. In 1988 we took our PM cop car Mustang to the Nelson Ledges 24-hour race with modest expectations and wound up first overall. This year we made the same trip with higher expectations and wound up limping home well off the pace. So it goes.

June marked the tenth renewal of this showroom stock classic, and the hard work of race chairperson Anne McHugh showed to particular advantage with the best field in the past five years. Thirty-seven cars took the green flag, including an excellent group of contenders in the Prototype class.

Our Saleen Mustang held the fourth grid position, while the Archers' Eagles, the Phoenix Racing G-lader Golf and Roger Marble's Team Dayton Camaro, last year's runnerup, ranged behind.

Our driver corps had a couple of new faces—P.D. Cunningham, a young Wisconsin hotshoe who's definitely going places, and Rick Titus, a Saleen Escort Endurance Series regular and 1987 co-champion. In addition to his ability to get from start to finish in impressively short periods of time, Rick gave us a special Mustang anniversary presence. His father, Jerry Titus, another jour-



Mid-race stop for rain tires was one of many that made Nelson Ledges a real Longest Day.

Included under this heading were two Eagle Talon TSi All-Wheel Drive entries fielded by the formidable Archer Brothers team, a 4wd Golf powered by VW's new supercharged G-lader engine, shortly to debut in the Corrado sports coupe, plus a trio of the limited-production Consulier sports cars we first encountered last year.

Our own car was a fairly exotic Mustang 5.0-liter, painted up in original Shelby G.T. 350 colors to commemorate the Mustang's 25th anniversary (see our Mustang anniversary section, page 56, Aug. '89). Since the car was a little more than showroom stock in suspension and horsepower, thanks to the ministrations of Saleen Autosport, we too were entered in the Prototype class.

This year's event was strongly reminiscent of 1988. The Consulier team was again fastest in practice and qualifying, this time claiming the top three spots on the grid.

nalist who doubled in racing, won the first SCCA title for Mustang, driving a G.T. 350 back in 1965.

Rick started the race, and by the end of the first hour was a lap up on the rest of the field. But as it turned out, that was the high point of the event for PM Racing. When Rick made his first pit stop, he complained of rear suspension problems and high operating temperatures, and these ominous symptoms turned out to be portents of much worse to come.

The rear suspension allowed the back of the car to work up and down excessively, and the driveshaft to rub against the top of its tunnel.

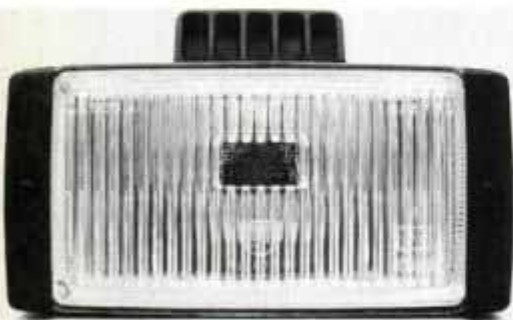
Breakable brakes

At some point fairly early in the proceedings, the unsynopated gyrations of driveshaft and bodywork allowed the rear brake line to become embroiled with the shaft, which left us without

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rear brakes for the balance of the event. Not long after that, the left front wheel bearing went away.

Even so, when darkness fell, we were still contending, swapping the lead with the G-lader Golf, which was being driven very steadily by Bill Pate, Phil Pate, Al Oag, Al Salerno and Herm Johnson, and one of the Talons (Mac DeMere, Mitch Wright, Paul Brand and Don Knowles). But the darker it got, the more apparent it became that our lighting scheme, which we hadn't been able to test before the race, was just a little south of inadequate.

A little past midnight, a torrential rainstorm sent the Mustang slithering off the track where it languished for several laps, helpless on a surface of slick grass and mud.

Although the rain let up about 3:30 am, our lighting situation went from inadequate to impossible, as the lenses got covered with mud thrown up from the verges of the track. Between stops to restore the meager output of our lights, the driving became positively nightmarish.

Dawn of hope

For all this, when dawn solved the lighting situation we found ourselves in third place and running a good two seconds quicker than any car in the race. Hope flowered. But a short time later we experienced the first of two total brake failures. A front brake line had come adrift, necessitating another long stop for repairs.

From this point on, the rear suspension began asserting itself, and we drifted backward through the field. We found later that every bushing in the rear suspension had disappeared, which gave the rear end some very intriguing moves during cornering.

Complicating this was a return of the high-temperature problems we'd had early in the race—it turned out a head gasket was going bad—and a steady loss of braking power thanks to a cracked front rotor and general abuse.

While we were doing all this character-building, the race for first place overall was a real cliff-hanger, with the VW and the Talon nose-to-tail through the 23rd hour. The issue was finally resolved in favor of the Talon when the Phoenix Racing car got embroiled with a back marker and was forced to limp home in second place.

The PM Mustang wound up eighth, a position we hope to improve in future Escort Endurance outings. Meanwhile, we wish to acknowledge our sponsors—Polyshield car care products, General Tire, Walker Dynomax exhaust systems, Saleen Autosport, Monroe shock absorbers, Warner gear, Motul motor oil and, of course, the Ford Motor Company. **PM**

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CAR CLINIC

BY MIKE ALLEN

Fiery Fiero

MY 1984 2M4 FIERO has had the engine replaced under warranty three times. I use this car for a daily commute of about 185 miles, all of it on high-speed expressways. Yesterday, the oil light blinked a couple of times as I was backing out of the driveway, and again at the corner, so I stopped and checked the oil. It was at the full mark, so I continued, carefully. The oil light blinked again in less than a block. I returned home and changed the oil. I've always changed the oil regularly at 2500 mile intervals, and wasn't due to do so for another 1000 or so, but something had to be wrong! I fully expected to see oil mixed with coolant—like the past three times.

Imagine my surprise when no oil at all drained out—I stuck a screwdriver into the drain plug and something about the consistency of road tar clung to it, so I removed the oil pan.

There was plenty of thick black oil, no evidence of coolant, and no evidence of abnormal wear when I pulled a connecting rod cap to look at a bearing. I cleaned the pan, changed the filter and added fresh oil. It's running fine—but what happened?

LESTER HAMMOND
COLDWATER, MI

Your engine, at least occasionally, is running way too hot. This will oxidize the oil, and turn it into the gelatinous goo you scraped out of your oil pan.

Ignore the stock temp gauge on your dash, and get a better aftermarket gauge that's calibrated meaningfully. Backstop that with an oil temp gauge. Coolant temps consistently above 220°, or oil temp above 200°, are causes for concern.

Start looking for a clogged or otherwise compromised radiator, a collapsing radiator hose, faulty electric fan, bad water pump or some other cooling system aberration.

When you can't find anything wrong, look at getting an oil cooler. That 2.5-liter motor turns mighty fast at freeway speeds, and you just might be asking too much doing it 3 hours a day.

Don't be surprised if, in spite of the fact that your rod bearings look okay, there's a certain amount of internal damage. Piston skirts and cylinder bores don't take kindly to this sort of abuse.

Clutching At Straws

My 1980 Ford F-150 Pickup has had five new clutches installed, and one transmission overhaul in 52,000 miles. I live in flat countryside, and never haul anything heavier than groceries. One mechanic claimed that Fords of this vintage have this problem. The local Ford dealer doesn't have the foggiest clue as to what's wrong.

CHARLES ALLEN
MIAMI, FL

I think there's some misalignment between the back of the block, the bellhousing or the transmission. Either the crank is off-center from the transmission input shaft, or the centerlines aren't parallel—or both.

Either way there will be a lot of premature clutch disc wear, as well as a lot of strain on the bearings on the trans-

mission. You'll need to use a dial indicator to measure runout at the transmission mating surface and at the circumference of the transmission mating hole.

If the centers are out-of-line, you can use offset dowels to line up the bellhousing with the rear of the block. If the transmission is cocked at an angle, you'll need shims. It might be simpler to change bellhousings, especially if you can identify your present housing as the culprit.

If the block is improperly machined, you're stuck using shims and dowels.

Squeaky Stoppers

I have a 1988½ Chevy C-10 extended cab pickup. The brakes squeak. The dealer showed me a service bulletin that states in part that it's normal brake noise. What can I do?

TERRY GOODMAN
MINERAL RIDGE, OH

You may not like what I'm going to say. Disc brakes squeal sometimes.

If your brakes have been examined by a competent brake technician who feels that everything is fine, and the brakes seem to function correctly, then you should count your blessings.

There are some things to try. Gluing the pads to the pistons with weatherstrip adhesive will work for a while, by preventing the pistons from chattering. Heat and corrosion tend to break down the glue, so this doesn't last long.

I've never tried it, but coating the back of the pads where they contact the pistons with antiseize compound may help sometimes. This apparently lubricates the area where the squeak originates.

(Please turn to page 40)

Technical Service Bulletins

Ever wonder if there are any Technical Service Bulletins issued by the manufacturer of your car? Or considered buying a used car and thought about checking to see if there were any TSBs issued, and whether the appropriate service was performed?

For \$50 a year (or \$35 for APAA members), you can subscribe to the Auto



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APAA TECH SERVICE Report

October '88

SUBARU

OBJECT: 1988-1989

APPLICATION: 1988-1989

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“Just another brake job? Not to the guy who owns this car. Not to me, either.”

“You learn real fast in a GM dealership, behind every brake job there’s a person. Someone who depends on these wheels to get around town, go on vacations, take the kids to school. And that person brought their car to this dealership because they wanted these brakes done right. With genuine GM parts. The kind this General Motors car was designed to use.

“Just another brake job? There’s no such thing in my book.”

Stephen V. Thompson

Stephen Thompson
Mr. Goodwrench Service Technician
Sycamore Chevrolet, Terre Haute, Indiana

Talk to Mr. Goodwrench and you learn very quickly, he’s a career technician. He takes pride in his GM factory training and the skills he brings to the job. So when you’ve got Mr. Goodwrench taking care of your car, you’ve got the freedom to go anywhere, anytime. And isn’t that what owning a car or truck is all about? Whether you drive a Chevrolet, Pontiac, Oldsmobile, Buick, Cadillac or GMC Truck, bring it to the man who knows it best...Mr. Goodwrench.



Mr. Goodwrench

It's not just a car...it's your freedom.

As a last resort, try chamfering the leading edge of the pad about 15°, so the disc doesn't meet the pad surface at a right angle. This will last until you wear past the chamfer.

Just remember that brake pad dust contains a lot of asbestos, so be careful not to breathe or ingest the dust.

Get The Lead Out

I have a 1978 half-ton Chevy pickup—80,000 miles, good shape. I can't find leaded gas around here any more. I can't afford a new vehicle, and I'd like to know if I can add a small amount of diesel fuel to the gas to restore the lost lubrication in the unleaded gas.

BOB GRAY
TAMPA, FL

I can tell where leaded fuel is being phased out of the market in various parts of the country by the return addresses on letters like this one.

Bob, don't add diesel fuel to your gasoline. It won't add any real lubrication to the areas where it's needed—the valve seats. The lead, used as an octane booster for generations, poisons the catalytic converters, and leaves lead in the atmosphere. Lead has been legislated out of gasoline for sound environmental reasons.

One side effect of the octane boost was to lubricate the narrow seat where the exhaust valve contacts the cylinder head. The exhaust valve is normally very hot, and in the absence of lead, can leave

traces of itself welded to the seat, and traces of the seat welded to the valve. Eventually, the valve and seat wear to the point where there is no longer a proper seal, compression suffers and

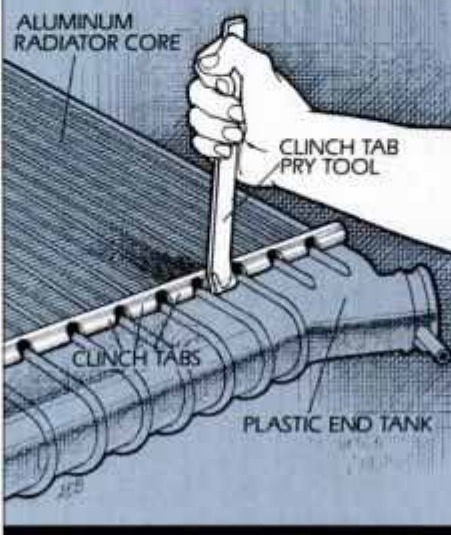
In The Clinches

Aluminum-and-plastic radiators are a marvelous combination of light weight and efficiency. They're also more difficult to repair, as you can't just solder up a hole. But you can replace a cracked or leaky end tank, or service a leaky transmission cooler



buried inside. Start by using the tool shown here, or, very carefully, a screwdriver, to pry open the clinch tabs holding on the end tank. You can now separate the tank from the core, clean the sealing surface, replace the gasket and squeeze the clinch tabs shut again. There's a special tool for squeezing the tabs, but Vise-Grips work fine.

Don't break any tabs. If you do, and there are no more than three broken on the same side of the radiator, and none of them are next to each other, you'll probably still have a serviceable assembly for your car.



Flushing With Water Just Doesn't Wash.

eventually the valve head can break off. Lead substantially reduces this metal transfer.

There are a number of lead substitutes on the market, to be added to the tank along with unleaded gas, but the expense and inconvenience is considerable.

If your truck is used in light-duty service, you'll probably see only a little premature valve seat wear from a steady diet of unleaded.

On the other hand, if you tow a trailer, or haul heavy loads up long hills, it's a different story. People with motorhomes are in the same boat—the rate of valve seat recession is heavy when the engine works hard.

You can either use a lead substitute, or have the cylinder heads pulled and heavy-duty, unleaded-gas-rated valve seats and valves installed. In your case, you'll probably be better off just driving it until valve problems show up—which might be a long time.

Extra Wires

How can I connect the lights on my old boat trailer to the rear lights of my 1987 Nissan Pulsar? The trailer has one wire for the running lights, one each for the turn signals and a ground. The brake lights are just the turn signals both on at the same time.

The Nissan uses a separate bulb for the brake lights. Can I modify the car's wiring so that it will work the same way as the trailer?

F.M. GAMER
SALINA, KS

Most domestic cars are wired like the trailer, with one lamp used for both the brake and turn signal. Imports usually use a separate circuit for each function.

I wouldn't try to rewire the Nissan. You might add a separate pair of lamps to the trailer, adjacent to the ones already there, to be used as brake lights. This is an arrangement that will let you tow the trailer with either a domestic or foreign car or truck.

For roughly the same kind of money you'll spend on a pair of extra taillight fixtures—about \$25—you can get a converter box that converts domestic to foreign. The three wires for turn signals and brake lights go into the converter, and two wires come out. Try looking for one of these gadgets at an auto parts store or RV dealer. **PM**

DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

■ Some '87 Camaros may have hard contact between the a/c compressor screw and the radiator hose. TSB 87-200-6B recommends twisting the hose 5° to 10° at thermostat housing.

■ Some Peugeots with 6-cylinder engines may experience oil leaks when operated under severe or short-trip conditions. Moisture may be blocking the PCV system, and Peugeot recommends (TSB 232-1/60) changing the oil and filter more often, inspecting and cleaning the oil trap in the PCV recirculation tube, inspecting and cleaning the PCV orifice and PCV hoses.

■ Some '83-'85 rwd Brougham and '85 fwd deVille and Fleetwood Cadillacs may exhibit no-crank conditions because of a burr built up on the inner diameter of the front shift collar in the starter motor. Be sure to check for the usual causes of no-crank conditions first. TSB 87-111-6D

■ '87-'89 Omni and Horizons may fill the a/c recirculation housing with water during periods of rain. Drilling holes into the housing will allow the water to drain into the evaporator housing instead of the footwell when the a/c is turned off. TSB 24-04-89

Prestone Super Flush does.



Deposits removed using Super Flush



Deposits removed using water alone

Super Flush your cooling system. Because Prestone® Super Flush cuts through 53% more oil, dirt and rust than draining and flushing with water alone. Super Flush power-cleans the clogged radiator passages that could destroy your cooling system and lead to possible engine breakdown.

And there's nothing to it. Just pour the Super Flush directly into your radiator. Simply run your engine and drain it. In no time, you'll have a clean cooling system that'll keep your engine humming.

And if you flush with Prestone Super Flush, refill your system with Prestone® Advanced Formula Anti Freeze and register, we'll guarantee your radiator for a full year.

So when it's time to flush, remember the right way to flush. Prestone Super Flush.

B FIRST BRANDS



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SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy.

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Kings: 8 mg "tar," 0.6 mg nicotine
av. per cigarette by FTC method.

It's sort of like the Theory of Relativity.

With relativity, it's like this: If you go fast enough,
time slows down. With Enriched Flavor,[™] it's like this: The taste
stays just as rich as you like even though the tar goes down.

What could be simpler?

Enriched Flavor,[™] low tar. A solution with Merit.



OUTDOORS

BY JOE SKORUPA

Debunking Hemingway's Marlin Theories

WE WERE having a fine time 20 miles out in the Pacific. "Pesky fish haven't bothered us all day," remarked my good-natured friend, Ken Grissom. It was noon and time to crack a cold Costa Rican *cerveza*. Suddenly our guide, Roberto, yelled, "Marlin!" and throttled the diesel down.

I looked astern at the artificial lures and there swimming in our wake, with its mouth open and its bill high out of the water, was a marlin about to strike.

I quickly picked up a rod and prepared to battle a fish several times larger than the rating of the 50-pound line on my heavy-duty Penn ocean-trolling reel.

But the wily marlin wasn't ready to pounce. I tried jerking the tip of the rod from side to side. No luck. My heart started to pound. I was just about to flip the reel into freespool, when he closed in and I felt a tug on the line. My heart shifted into overdrive.

Instead of waiting a few moments longer, I jerked back on the rod trying to set the hook. I felt resistance, so I jerked again. But when I started reeling in line, I learned the truth. No fight, no pressure, no fish.

Old man and the sea

This brief adventure was our boat's only chance for glory that day. It came during a week-long fishing trip, sponsored by Mako Boats, at the Golfito Sailfish Rancho, in southwest Costa Rica.

Naturally, one could do worse than spend a sunny day trolling the blue Pacific in a 26-ft., center-console Mako. Ernest Hemingway, outdoorsman and occasional writer, knew all about slow days on the water.

"While you wait there is plenty of time to think," he



Bringing a marlin to boat, one of the biggest thrills in sport, makes up for slow-action dog days.

observed without irony. And while I was waiting, I couldn't help but think of a story Hemingway wrote in 1934 titled, *Out In The Stream: A Cuban Letter*. The subject was marlin.

Offshore fishing was in its infancy 55 years ago and little hard data were had about inhabitants of the deep. Hemingway picked up as much information as he could from crusty commercial fishermen, who had a vested interest in keeping knowledge to themselves. Then he spent several years doing research in the field—fishing at least 100 days a year. During one 2-year stretch he caught 91 marlin and developed a number of theories about his adversary. He laid out these theories in *Out In The Stream* and ended the story with this challenge: "Now you prove me wrong."

Rising to Hemingway's challenge, I called the Billfish Foundation, in Miami, and spoke with Bruce Henderson. I told him of Hemingway's 55-year-old theories and asked him how they

stack up against modern research.

Latest data

Hemingway's marlin theories were based on a grand and erroneous assumption. He thought all species of marlin were "sexual and age variations of the same fish." For example, he mused, "Aren't the white marlin, top limit in weight from 125 to 150 pounds, the young fish of both sexes of all marlin?" The short answer is no, according to Henderson. White, blue, black and striped marlin are all distinct species.

Another theory: "At around 70 pounds, the male white marlin begins to show pronounced and fairly wide stripes, which fade when the fish dies. Aren't these adolescent striped marlin?" Again, no. Stripes are pronounced or faint depending on the state of the fish. They change all the time.

Aren't all striped marlin males? No. Aren't all black marlin females? No. Aren't all large marlin the final, oldest stage of a marlin's life,

and don't they gradually change sex to female as they grow older? Yes and no.

Hemingway hit on something here. While marlin are definitely not gender benders (they don't change sex as they grow older), they are characterized by sexual dimorphism, which means that nature allows the females to dominate—grow larger and stronger than males—to ensure ample supply of offspring to continue the species.

How could Hemingway and the experienced fishermen he knew have been so wrong? As the author admitted, "You can't do everything...and [research] should be done by a scientist." He also pointed out, "I would be glad to have any one disprove [my theories] as what we want is knowledge, not the pride of proving something to be true."

Hemingway, then, should be glad I had so much time to think in Costa Rica between big-fish sightings, small-fish catches and a cooler of ice-cold *cerveza*. **PM**

PHOTO BY RICHARD GIBSON

Tools For Astronomy's New Generation

MULTIPLY 100 billion stars per galaxy times 100 billion potential galaxies and you come away with an appreciation for the task facing today's stargazers. Never before has a changing, changeless sky demanded so much of astronomers and the technology they employ to fix our position in the cosmos.

Consider the arduous task of lens grinding, a vexsome chore that has raised the ire—and the callouses—of astronomers since Galileo. At the Optical Science Laboratory of London's University College, researchers are simplifying the job through the use of a 30-ton grinding and polishing machine capable of making mirrors and lenses with diameters up to 2.5 meters. Laser measurement devices and computer controls allow scientists to cut telescope blanks to within 1 micrometer.

On the analysis side, studying the output of photographic sky surveys—once a tedious job of inspecting photographic plates on a light box with a loupe—is now performed by an Automatic Plate Measuring System (APM) at the University of Cambridge. The device scans each photograph with a laser, and uses a microdensitometer to digitize the information. One plate may contain four gigabytes of information—equivalent to 100 sets of Shakespeare's complete works.

The image analysis software at the heart of APM also has applications in the fields of fluid dynamics and archeological mapping. One firm is using analysis techniques to investigate blood proteins.

These techniques may one day confirm that we're not alone in this ocean of stars.



Lasers and computers perfect the craft of grinding telescope lenses.

Magnetic Stimulation

While the mechanical man has long been a focus of fantasy in the science fiction realm, researchers have continued to make progress in restoring function to disabled people. Machines have been developed that communicate with the blind and deaf, or provide mobility for people who can't walk.

Researchers at MIT's Francis Bitter National Magnet Laboratory are at the forefront of a new technology that may one day restore movement to nerve-damaged limbs with magnets instead of painful electrical stimulation.

According to MIT's Dr. David Cohen, a neurological reflex can be obtained when a noninvasive and quite harmless magnetic field is applied outside the body, inducing a small electrical current in the underlying nerve tissue.

To improve efficiency and practicality, Cohen and his colleagues are trying to develop a highly focused mag-

netic stimulator to excite nerve paths and ultimately the brain. They're working on a pulsed external magnet with a concentrated field of about 17 Tesla—or 340,000 times that of the Earth's ambient magnetic field at the surface—for a few hundred millionths of a second. The team must face significant material stresses, and delivering the large intermittent current in the electromagnet's coil could prove troublesome.

But if all goes well, the next small step in using magnetic fields on the human anatomy will be a transcutaneous neural stimulator that will assist surgeons in establishing the extent of neurological damage.

Personal Robotics

As industry's enchantment with shopfloor robotics continues to wane, it's difficult to discern in what direction the much-vaunted robotics business is headed. But entrepreneurs continue to hold out hope for enough consum-

er demand to support a market for machines that will serve dinner, house sit—even tutor your children.

SynPet of Boise, Idaho, (208-376-0303) has produced an engaging little R2D2 called Newton that—according to the press release—can learn the floorplan of your home, autonomously find and dock with its own power charger, understand voice commands, sense intruders or smoke, even access on-line databases to help your kids with their homework.

A 20-meg hard drive and a 720K floppy inside the equivalent of an IBM PC XT forms Newton's brain.

Another personal robot produced by Droid Systems Corp. (607-257-1661) comes with a manipulator arm that will permit it to serve drinks at your next soiree.

Whether these machines will make the leap from upscale plaything to crucial domestic tool is certainly arguable, but at least they synthesize a lot of intriguing technologies. **FM**

The personal robot: high-tech plaything or useful tool?



OLD HOUSE RESTORATION

BY BOB VILA

Period Furniture

THE RIGHT furnishings can really show off a period home. After all the hours of sweat most of us spend bringing our homes back to the way they once were, it's a shame not to take restoration this one step further.

The obvious answer to the old-house furniture question is antiques. But some folks don't have the time or the inclination (not to mention the cash) to hunt down that *just-right* piece.

Although rooms full of mass-produced furnishings in the style of a certain era are perfectly fine for many people, some old-house restorers demand more. Fortunately for them, furniture—like so many other things I talk about here each month—has entered the realm of reproduction. There are some pretty good pieces available, patterned after the originals, that would do justice to any old house. Some even come in kit form. And, for a price, custom reproduction is also an option.

Furniture today

Today's new furniture orientation is looking backward. With the furniture market in a conservative phase, furnishings that capture the feel of a certain period are pretty easy to find. Walk into just about any furniture showroom today and you'll see what I mean. Victorian and Country French furniture, for example, are currently enjoying a revival. And simple Shaker style pieces, although always out there, are very popular now particularly in the Northeast.

Most of the furniture you'll see has been adapted for 20th

Contributing Editor Bob Vila is host of public television's "This Old House."



Kit furniture, like this stylish highboy, offers excellent reproductions at reasonable prices.

century use. In many cases, this means a scaling down of the larger pieces, like European reproductions of the 18th century, to fit into today's rooms. Remember, too, that people were smaller a century or two ago. So some seating pieces would be uncomfortable to us today if they weren't scaled up a bit.

In the name of progress (or comfort) there has been a

drifting away from reproduction or authenticity in many of these mass-produced pieces. We've become accustomed to overstuffed matching chairs and sofas. These deviations from original period furnishings won't matter much to most consumers. But, as I said above, for those who want to extend the restoration of their home to its furnishings, there are

some alternatives that may be more appropriate.

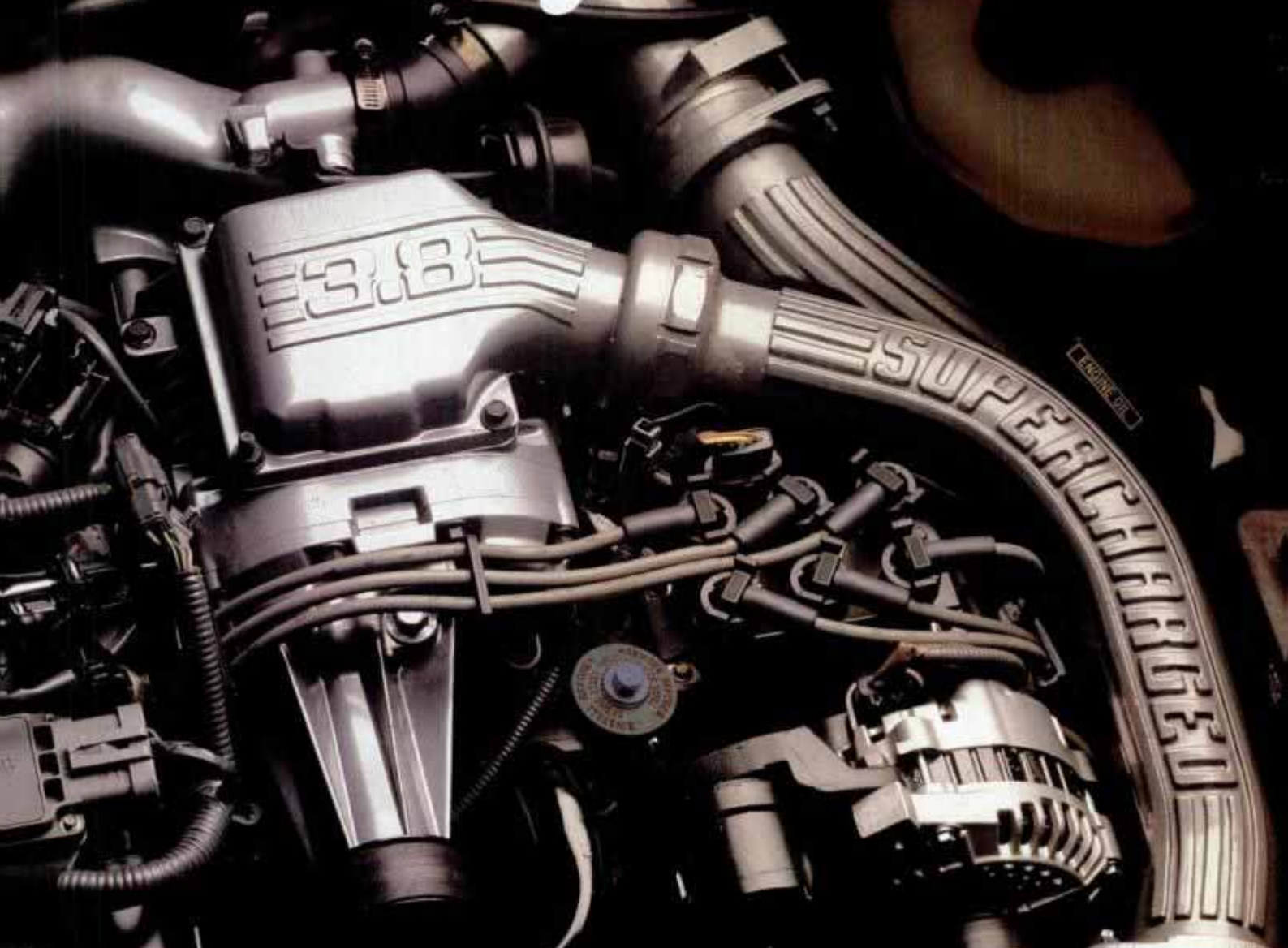
New old furniture

Is it new *old* furniture or old *new* furniture?

No matter which way you say it, the end product is the same, what I call reproduction furniture. Although there are some variables within this category, repro-

(Please turn to page 48)

Quality is Job 1.



**Profile in quality #10:
Engineering.**

Shown here is the 3.8 Liter Supercharged engine. It represents sophisticated high performance engineering. The Supercharged engine, available in the Ford Thunderbird Super Coupe and Mercury Cougar XR-7, is one example of Ford's constant exploration and development of new technologies. When quality is job 1—you don't do it any other way.

**Ford, Mercury, Lincoln, Ford Trucks.
Our goal is to build the highest quality cars
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Light wood, dark wood, all wood, it's the right glue for super-strength performance. It grabs fast, sets fast and dries to a heat- and water-resistant bond that's perfect for finishing. And right now, it's a great deal. Quantities are limited.

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OLD HOUSE (Continued from page 46)

duction furniture is often handcrafted and patterned after an original old piece. Although it may not be an exact copy, a reproduction piece will have the same form as its prototype. It's really an intangible sort of thing—a period piece looks and sits right and has the proper proportions.

At the high end of the spectrum are custom reproductions. One of the most expensive period furnishing alternatives, a custom reproduction is usually a line-by-line replica of an old piece that just can't be bought today. For example, a custom cabinetmaker may be hired to copy an antique on museum display for an old-house owner who desires that exact piece. Or perhaps a long-lost family heirloom is copied from an old photograph. This choice, of course, is usually reserved for furniture aficionados with unlimited budgets.

More common are the shops that specialize in reproducing particular pieces. Often sold direct by catalog, some of the period pieces available include Windsor chairs, Queen Anne highboys, candle stands, wing chairs, camelback country sofas, drop-leaf tables and pencil post beds. Many of the details of the old originals are carried through to these reproductions. Some are relatively easy to spot, like wide-board tabletops and wing chairs with 11-in.-high authentic turned legs. Others may be more subtle, like hand-doweled frames, dovetailed and mortise-and-tenon joints. Some of the high-end furniture feature hand-filed hardware and hand-rubbed finishes. Hand-carved detailing, an extremely time-consuming task, can also be found on some of these pieces.

Making it yourself

Reproduction furniture has also entered the realm of kit furniture. For a price that's significantly less than that of an assembled and finished piece, you can make some pretty nice looking period pieces yourself. Roll-top oak desks, bowback Windsor armchairs, Queen Anne highboys, harvest tables, Shaker rockers and fourposter canopy beds are only a few of the things offered by mail at substantial savings. Some of these, patterned after the original, are actual museum reproductions.

Most kit furniture is easy to assemble and can be done by someone with a minimum of woodworking skills. Pieces are usually precut and sometimes sanded. One manufacturer claims that, from the time you open the box to the time the piece is complete (minus the finishing), it should take less than an hour to assemble a chair, 2½ hours to make a bed, and 4½ to 5 hours to put together a complete chest of drawers. Another alternative is seeking out books that include

(Please turn to page 51)

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PEOPLE WRITE TO PENNZOIL®

Straight answers from the automotive experts.



20W-50: Is It The Right Oil?

Q. A friend of mine recently had a new 2.8 litre V-6 short block engine installed in his 1984 Chevy S-10 Blazer. His mechanic recommended and installed 20W-50 motor oil in his new engine. I strongly urged my friend not to use any oil with that heavy a viscosity in his new engine.

I also warned my friend that considerable damage or short engine life could arise from using a heavy viscosity oil in his vehicle. Who's right? Thank you,

W.H., East Lansing, MI

A. If you placed a bet with your friend, congratulations. He owes you. General Motors recommends 5W-30 for winter, and 10W-30 for summer.

It's true that prior to 1980, 20W-50 motor oils were generally recommended for temperatures above 40°F. But engines have changed dramatically. So have manufacturers' recommendations.

And today, General Motors, Ford and Chrysler *do not* recommend 20W-50 for any new car or light truck.

If your friend continues to use 20W-50 in cold Michigan weather, he's headed for a shorter engine life, and even costly repairs. That's because 20W-50 *can't flow fast enough* to adequately protect the engine. And as winter gets closer, it's vital he uses the right weight of oil.

The Right "Pumpability"

How well an oil flows through an



By Don Johnson

*Vice President, Product Engineering
Pennzoil Products Company*

engine to protect its vital parts is known as "pumpability."

Thicker oils, like 20W-50, have "poorer pumpability", and in cold weather, can't flow fast enough to protect vital engine parts. When oils can't flow fast enough to reach vital areas needing lubrication, metal-to-metal contact can occur, damaging the engine. This is why 20W-50 isn't recommended by U.S. auto manufacturers.

Oils like 5W-30 and 10W-30 have the "right pumpability", so they flow faster, and reach vital engine parts quicker for *complete* lubrication.

The Small Car Myth

Some people still mistakenly recommend 20W-50 for today's smaller, higher-revving engines because they believe it provides better protection

against engine wear. This, however, isn't true.

Numerous industry tests prove that Pennzoil 5W-30 and 10W-30 provide *the same* protection against engine wear as 20W-50. And because 5W-30 and 10W-30 flow faster, *and* provide quicker lubrication, all U.S. manufacturers recommend them for today's engines.

When To Use 20W-50

20W-50 can be used in high-performance racing engines, or modified engines built to accommodate a heavier weight oil. And, some European car manufacturers still allow the use of 20W-50 in warmer climates. In *every* case, always check your owner's manual. And then, choose quality Pennzoil in the weight recommended by the manufacturer.

Every weight of Pennzoil Motor Oil exceeds the API's highest standards (API SG/CD) for car engine protection. So no matter what you drive, there's a Pennzoil Motor Oil that can protect it. In any temperature, or any driving condition.

We're Open To Questions

about your motor oils, lubricants and engines. However, you can tell us a few things, too. Maybe you've discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Don Johnson, Pennzoil Products Company, P.O. Box 2967, Houston, TX 77252-2967.



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ROBERT BARROW PHOTO

Custom-made furniture, like this handcrafted Windsor chair, is available from local woodworkers around the country.

plans for building any number of reproduction pieces. Magazines can also be a good source of build-it-yourself furniture plans. A good case in point is this issue of POPULAR MECHANICS that shows you how to build a Shaker end table. The story starts on page 85.

So, you have lots of choices. Aside from taking the antique route, you can order authentic or close to authentic period furnishings to complement your home from one of the shops that specialize in re-creating original old pieces. If you've got the cash, you can have a cabinetmaker re-create a period piece exclusively for you. If you've got the time, tools and skill you can build something for yourself. Or you can save lots of money and assemble and finish a piece of kit furniture yourself. **PM**

Source List

- Here's a list of kit furniture manufacturers:
- Adams Wood Products, Inc., 974 Forest Dr., Morristown, TN 37814, 615-587-2942
 - The Bartley Collection, Ltd., 3 Airpark Dr., Easton, MD 21601, 800-227-8539
 - Cohasset Colonials, 519 IX Ship St., Cohasset, MA 02025, 800-288-2389; Catalog \$3
 - Craftsman's Corner Woodcraft Collection, 4012 N.E. 14th St., P.O. Box AP, Des Moines, IA 50302, 515-265-3239
 - Emperor Clock Co., Emperor Industrial Park, Fairhope, AL 36532, 205-928-2316; Catalog \$1
 - Shaker Workshops, P.O. Box 1028, Concord, MA 01742, 617-646-8985; Catalog \$1
 - Yield House, Route 16, North Conway, NH 03860, 800-258-4720



Since radar displays only one number, the operator has the responsibility to decide which vehicle is being clocked.

Why radar makes mistakes. How to protect yourself.

It's hard to believe, but traffic radar does not identify which vehicle is responsible for the speed displayed. It shows only a speed number. The radar operator must decide who to blame.

How radar works

The radar gun is aimed at traffic and it transmits a beam of invisible radar waves. Moving objects reflect these waves back to the radar gun. Using the Doppler principle, the radar calculates speed from the reflected waves. But there's a problem.

The best guess

Remember, these reflections are invisible. And truck reflections can be ten times stronger than car reflections. How can the operator know for sure which vehicle is responsible for the number?

The truth is, in many cases he can't be sure. The result? You can be ticketed for somebody else's reflection.

The only way to defend yourself against these wrongful tickets is to know when radar is operating near you.



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ELECTRONICS

BY STEPHEN A. BOOTH

Have Phone, Will Travel

IF YOU'VE got a pocket big enough for a wallet, you've got a pocket big enough for a cellular telephone. Long the darling of car-bound demon dialers, cellular phones are now becoming more portable and mobile than ever.

What's more, prices are actually coming down—making radiotelephone communication more accessible to more people.

Leading the way in putting a phone in everyone's pocket is Motorola. The company's new Micro TAC is the first of what is being called a new class of personal telephones. The Micro TAC weighs 12.3 ounces and is only 15.8 cu. in.

in size, including battery. A slimmer battery, available as an option, reduces the weight to 10.7 ounces and the size to 13.5 cu. in. Continuous talk time is 75 minutes with the standard battery and 30 minutes with the slim battery. Battery recharging takes about 1 hour.

The Motorola Micro TAC operates in a manner reminiscent of the planet-to-starship communicator used in the old "Star Trek" television series. When not in use the mouthpiece flips up so that the entire phone is only about 5½ in. long. To operate the phone, you simply flip out the mouthpiece, extending the phone's length to about 7½



Motorola's pocket-size cellular radio-telephone (shown about half its actual size) resembles a "Star Trek" communicator.

in., and get a dial tone. Dialing is done with the now-revealed keypad, which can call up to 120 phone numbers stored in memory for easy retrieval.

The retrieved number is displayed on an LED screen for visual confirmation. To

hang up, just flip the mouthpiece closed.

The Motorola Micro TAC packs a lot of features into its tiny body. It offers call screening, a call message for when you're away, a micro-

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Winston

FILTERS

W I N N I N G

phone mute function to keep off-line conversations private, automatic redial, speed dialing, a call timer, a locking function and call-usage restrictions to prevent unauthorized calls and a theft alarm when used with the vehicle-mounting option. Micro TAC costs \$2995, but as with many cellular phones, the street price can be much less than the retail price. Bulkier portable phones are available for as low as \$699. About 15 companies now market portable cellular phones.

Like other portables, the Motorola Micro TAC has a 0.6-watt power rating, in contrast to the 3-watt rating for other cellular phones. This means that you might experience some reception problems in fringe areas or in places with tall buildings. As system coverage improves, reception problems for portables are expected to diminish. For in-car use, most manufacturers offer a booster that upgrades a portable to a 3-watt unit.

Expanded service

Portables have also gotten a boost from the recent Federal Communications Commission decision to increase channel capacity. In each market area, the FCC permits two cellular services to operate. Each carrier constructs its own network of cells, each cell having its own low-power transmitter/receiver. As you pass from cell to cell, your call is handed off from one to the other for uninterrupted service. Thanks to the recent expansion, each of the two carriers in an area can now handle up to 416 conversations per cell simultaneously—up from 333. Newer 832-channel phones allow you to subscribe to both carriers' services.

Even more channel capacity is expected when cellular carriers begin switching from analog to digital processing late next year. Digitization will enable carriers to compress the signal so that many more messages can share the same band. The

quality of the digitized signal is expected to be better also.

Those truly concerned about power capability may opt for a transportable cellular phone. Transportables are typically mounted in a car, but the handset and the battery pack may be removed and carried anywhere. They have a 3-watt power rating but the battery pack generally makes them bulky and heavy. Transportables can weigh as much as 7 pounds, making you feel like the radioman in "The Battle Of The Bulge."

Transportables are easily transferred from car to car, and easily removed for safe-keeping. Manufacturers may be inclined to let you decide on how you want to use the phone. For example, the Audiovox CTX-5000 (\$1995) can be used in-car, as a transportable or as a portable.

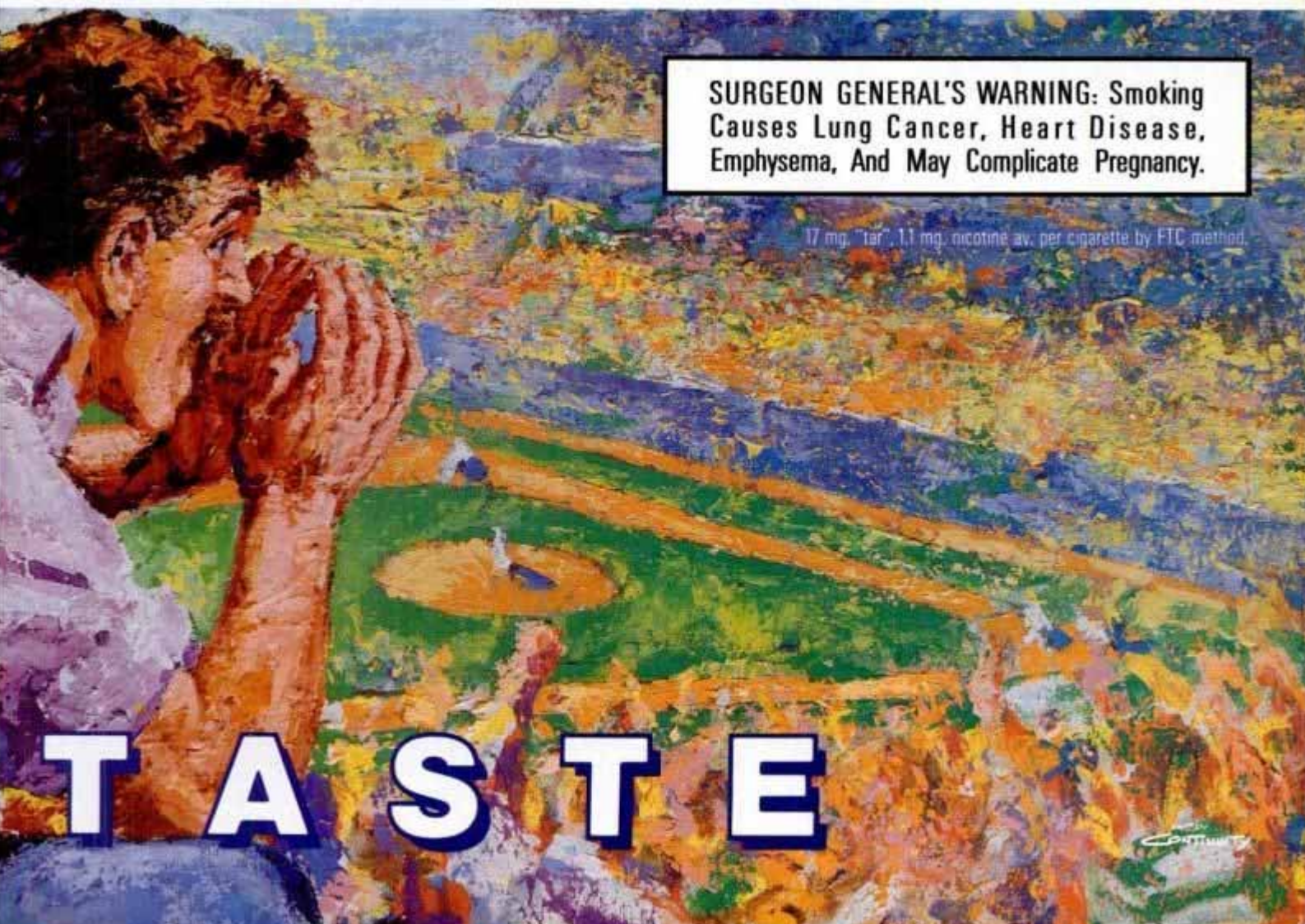
Falling prices

Cellular telephone service now is available in 300 U.S. cities and is used by more

than 2 million subscribers. Monthly bills average about \$130 but service packages vary. For example, low monthly rates with a high charge per call is available for those interested in using cellular phones only for emergencies, rather than routine calls.

While versatile portables and transportables are expected to be big sellers over the next few years, standard in-car cellular phones should become the most affordable mobile phone option. Street prices already have dropped to \$400 for a basic model.

Manufacturers are making in-car models easy to use while driving. Most cellular phones can be converted to hands-free use with the addition of a microphone and a speaker. Communication is even easier with a voice-activation feature like that found on the Audiovox CTX-4000 (\$1495). By simply saying "Call Joe" you can reach your boss at the office—or at his car phone. **FM**



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TASTE

Report From Paris

BY FRED MACKERODT, Contributing Editor

THERE WAS no formal competition for top participant in the 1989 Paris Air Show. But if there had been one, the Russians would have won it hands down. The Soviets would have triumphed, not only for the gobs of interesting flying machines and displays they brought to Paris, but also for the sheer showmanship they exhibited at this, the 38th running of the world's premier air show.

The Russian revolution kicked off with the arrival of the 6-month-old, Antonov



An-225 and the shuttle *Buran* on the Le Bourget tarmac.



MiG-29 hits the dirt as pilot ejects.

An-225 *Mriya* (*Dream*). Weighing in at 600 tons in maximum takeoff configuration, it is the world's largest and heaviest aircraft. The *Dream* arrived in Paris with a flourish. With its six 51,000-pound-thrust engines screaming and its caterpillar-like landing gear deployed, the huge aircraft made three circuits of Le Bourget punctuated by a window-rattling low pass over the flight line. On its back it carried the space shuttle orbiter *Buran* (*Snow Storm*), the first time this particular piece of Soviet equipment has been put on

public display. The first day's flight displays were captured by the Soviet's two fighter aircraft, the MiG-29 *Fulcrum* and the Sukhoi Su-27 *Flanker*. The air work by these two flying machines was nothing short of spectacular. Tail-slides, hammerhead stalls, plus high alpha and rising knife-edge passes, kept the audience agog.

Bail out

But then an unplanned event happened. The MiG-29 slogged down the flight line 580 ft. above the ground in a low-speed, high-angle-of-attack pass designed to display its docile, slow-speed handling. At the end of the runway, the 39,600-pound jet arced gracefully over in a maneuver that looked like it could have been part of its repertoire, but wasn't. A

small explosion was the first sign that anything was really amiss. The ejection seat hurled test pilot Anatoly Kvotchur free of the airplane barely a few hundred feet from the ground and the needle-nosed fighter plummeted to earth, burying its first eight feet in the rain-softened Le Bourget turf before disappearing in a giant ball of fire. The lucky test pilot landed mere yards from the inferno, his chute opening just in time to break his fall. He sustained only minor injuries in the process.

Kvotchur admitted at a later press conference to ejecting a few seconds later than he should have, adding, in what has to be the aviation understatement of the year: "The height was much lower than recommended in the manual."

And a chopper too

About the most popular individual at the 1989 Paris Air Show was Sergei Sikorsky, the 64-year-old son of Igor,

inventor of the first practical helicopter. Sergei, a vice president of special projects for United Technologies' Sikorsky Aircraft, speaks Russian, and he's made a lot of friends in the Soviet delegation since he began coming to the show with his father in 1952. At this show, everybody—and I mean everybody—was after Sergei to take them over to the Soviet exhibits to interview the Russian designers and pilots. We accompanied Sergei and a group from Westland, the British helicopter manufacturer, to see the Mil Design Bureau's prototype Mi-28 attack helicopter, code named *Havoc* by NATO. Sergei's comments about the Russians: "They've very steadily been nibbling away at any technological lead the West may have, particularly in their mastery of aerodynamics. They're using the Paris Air Show to explore as never before the potential for international cooperation." **FM**



Sergei Sikorsky (right) and Soviet helicopter experts.

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"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guinness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer...plus it reduces metal wear, defraying costly overhauls.

Years of Testing and Use Have Proved it True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decrease fuel consumption in tests done at the university."

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.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "Poly" between the parts where it is burnished into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
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.
4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

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FIRSTHAND DRIVE REPORT



ACURA INTEGRA

WHEN HONDA began its great Acura experiment three years ago, the Integra sport coupes and sedans were essentially supporting players for the new Legend luxury cars, with a lot of Honda Civic assembled beneath the relatively anonymous exterior.

Nevertheless, through competitive pricing and clever market positioning—Integra was portrayed as a direct beneficiary of Honda's all-conquering Formula One racing program—this new car became a solid player in the Acura stable.

For 1990, the Integra gets its first major makeover, becoming less Civic and more Acura in the process—bigger, stronger and, at first glance, better than the first edition.

Scaling up

Increased size is a key element in putting the second-generation Integra more squarely in the Acura luxury camp. Save for height, which is down 0.7 in., every exterior dimension is increased. The 2-door hatchback pictured here is 172.9 in. long, 4.4 in. more than the old car. Wheelbase has been increased from 96.5 to 100.4 in., and width from 65.6 to 67.4.

As usual, Honda has passed along these exterior increases as interior volume gains, offsetting the reduced roof height by dropping the floorpan. The car feels bigger inside, and interior appointments have been substantially upgraded.

As you might expect, bigger also equates with heavier, some 300

pounds from last year's coupe to the new one. However, the gain has less to do with dimensional increases than it does with vastly improved chassis rigidity. This is a much stiffer platform than its predecessor, which pays off in crisper handling.

Displacement of the original 1.6-liter double-overhead-cam 16-valve Four has been increased to 1.8 liters, with a corresponding bump in horsepower (130 versus 118) and torque (121 lb.-ft. versus 103).

With similar power-to-weight numbers—19.7 pounds per hp for the old Integra, 20.3 for the new—we don't anticipate much difference in all-out acceleration. The original Integra could get to 60 mph in 9 seconds, and we expect the new car to do the same.

However, the new car feels more responsive off the line, and isn't as buzzy as its predecessor. The key is a big improvement in the torque curve, which is a good deal flatter than the 1.6, and comes on lower in the band.

At the wheel

The new torque curve enhances the driving experience in two ways. You don't have to drive the car like you're mad at it to get it to perform, and on-going operations seem quieter than in the original. About the only critical observation we might offer is that the bottom end of the power band, though improved, can still use some bolstering.

As before, two transmission options are offered, a 4-speed automatic and a 5-speed manual. We view the

latter as exemplary, one of the best front-drive 5-speeds in the business.

To go with the chassis stiffening, Honda has given the Integra new suspension pieces, installing its double-wishbone control arms at all four corners, à la Legend. Another new touch is the availability of antilock braking.

All these elements add up to a sporty sedan that feels more precise than its predecessor—which is saying something, since the original Integra wasn't exactly deficient in the handling department.

The design goal

Honda's exterior designers wanted to make sure that everyone would understand that this was a new car, and succeeded. With its expanded glass area, flush-mounted headlamps (replacing the old pop-ups) and lower body detailing, Integra 2's exterior can't be confused with the understated lines of the old one. Nor can it be confused with either the Honda Prelude or Accord, a stated design goal.

On the other hand, it *could* be confused with some others. From certain angles one sees a diminutive Ford Thunderbird or Mazda MX-6.

But we don't think this genetic anonymity will slow the new Integra's sales pace a bit. The original Integra stood right there in the front rank of all-time Honda winners. Although the price has climbed a bit—to the \$12,000 to \$16,500 range—we expect this new Integra to run up the same kind of score. —Tony Swan

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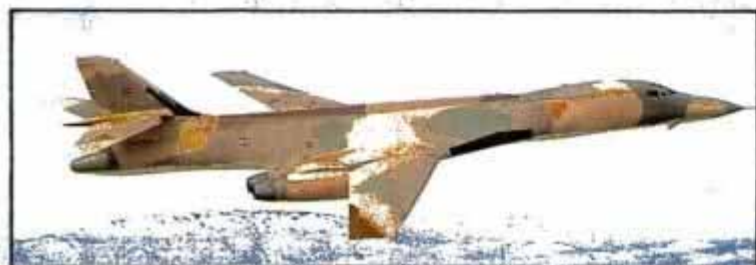
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B-2 Stealth bomber—flanked by B-1, lower left, and B-52, top right—takes to the air over Edwards Air Force Base on its first flight.

IRRESISTIBLE FORCE

The \$530 million B-2 Stealth bomber joins the B-52 and the B-1 in forming a Strategic Air Command capable of defeating diverse threats. But the American public must decide if the price is just too high.

BY TIM COLE, Science/Technology/Aerospace Editor

BRIEFERS AT Strategic Air Command headquarters in Omaha, Nebraska, are starting to call it an "integrated force package." But the marriage of flight-weary B-52s, as yet unfinished B-1Bs and politically explosive B-2s looks more and more like "something old, something new."

Nonetheless, as controversy and debate swirl and eddy around the air-

breathing leg of America's nuclear deterrent, Air Force leaders continue the task of modernizing SAC's bomber platforms—crucial, they say, to the process of waging peace. Who's to argue? Like it or not, the strength of America's bomber force has helped prevent global conflict for more than four decades—in a game of brutal logic that only makes nuclear war all the more unimaginable.

The current doctrine? Aging but still viable B-52s, capable but cantankerous B-1Bs and revolutionary but hugely expensive B-2s will work in concert to knock out key targets in the event of a nuclear strike—and to assume a conventional role in times of low-intensity conflict. Each brings unique attributes to SAC's power mix, forming a new weapons suite that, with hope and skill, can stand up to an evolving Soviet threat for another 40 years and beyond. Vast expense and technological uncertainty casts a pretty tall shadow on this otherwise optimistic outlook.

To understand the changes taking place in America's Strategic Air Command, POPULAR MECHANICS interviewed senior military leaders like SAC Commander-in-Chief General John T. Chain, and attended the B-2 rollout, meeting with engineers and officers of Northrop Corp. We also flew in the B-1B, making PM one of

IRRESISTIBLE FORCE

the few publications to place a representative aboard America's low-level penetrator (see "Fail Safe '88," page 54, Jan. '88). And on our recent ride on a low-level B-52 mission through America's heartland we observed the simulated release of air-launched cruise missiles, a new role for the mighty Stratofortress. Our interviews, technical briefings and flight time have given us a comprehensive understanding of where SAC is headed. B-52s and B-1Bs already stand alert. But significant hurdles must be overcome before the B-52, B-1B and B-2 can coalesce into an interdependent force of devastating destructive potential—a potential that, ironically, may be the key to a lasting peace.

A look back

While the Northrop B-2 Stealth bomber was capturing headlines, keeping the B-52 flying and fighting despite its increasingly geriatric airframe was the preoccupation of flight crews at scattered SAC bases.

Improved East Bloc surface-to-air missiles and the B-52's immense radar cross section have turned America's oldest bomber (it was first manufac-

ured by Boeing in 1952) into a superb delivery vehicle for air-launched cruise missiles. These weapons upgrades in the face of a significantly greater threat have transformed the B-52 into a logical platform for eliminating certain targets—particularly early-warning sensing devices—at standoff ranges.

But the Strategic Air Command is also formulating plans to turn part of the B-52 fleet into a low-level attack bomber in a conventional scenario. SAC planners foresee the need for deep interdiction of enemy troops and supplies in time of theater conflict. Upgrades in night-vision and terrain-avoidance gear will allow conventionally armed B-52s to fly to long-range targets in any weather. Just a handful of bases around the world—from Diego Garcia in the Indian Ocean to Keflavik in Iceland—gives the B-52 virtually global coverage.

The B-52's offensive avionics have been upgraded, and the ALQ-172 electronic countermeasures system has proven successful. Other conventional warfighting equipment include the GPS global positioning system for precision navigation (soon to become

fully operational), an infrared night vision system and head-up display (a highly unusual technology transfer from the fighter community) and an offensive avionics system (OAS). Similar to ground-attack systems found in F-16s and F/A-18s, the B-52's OAS senses altitude, barometric pressure, inertial navigation plot and other factors, evaluates target data, and adjusts the plane's inbound course and weapons release.

Equipped with Harpoon antiship missiles and mines, the B-52 can easily convert to sea patrol plane, adhering to a concept SAC planners call MASS, or Maritime Air Sea Surveillance. MASS calls for protection of shipping lanes in the event of an East Bloc attack on Western Europe.

Fast forward

While the future of the B-52—assisted by avionics upgrades and careful airframe monitoring for signs of stress—has never appeared brighter, it's been anything but smooth sailing for the Rockwell B-1B. Failure of the Eaton Corp. ALQ-161 electronic countermeasures system to perform according to manufacturer's claims



TOMORROW'S SAC BOMBER MISSION

In a greatly condensed artist's view of the future strategic battle space, B-52s lead a strike using air-launched cruise missiles to knock out enemy sensing platforms and airfields. B-1Bs firing short-range attack missiles and dropping gravity bombs strike fixed missile silos and SAM sites. The B-2 penetrates heavier defenses to eliminate hardened or mobile missile sites.

has been a lightning rod for criticism of the \$275 million swing-wing bomber. Crashes due to bird strikes and pilot error haven't helped the B-1B's reputation, nor have pesky but persistent anomalies like fuel leaks.

But the world's first low-level strategic penetrator has earned high praise from air crews, who fly the B-1B through the world's roughest terrain. "Fighting" the B-1B is tough physical and mental work, as I discovered on that training flight out of Dyess Air Force Base in Abilene, Texas. It takes some pretty aggressive flying to execute terrain-masking tactics through densely wooded mountain passes. The low-level rationale becomes immediately clear when you're clearing ridge lines by 100 ft. at 550 knots. While chaff, flares, radar location and warning systems and terrain-following radar give the B-1B some potent (though still not perfect) capabilities, its real strength is this ability to fly low at high subsonic speeds, often within the crags and chasms of the topography, to foil enemy detection methods. Indeed, the smaller, faster, more agile B-1B carries greater payload than the B-52

and drops it with greater accuracy.

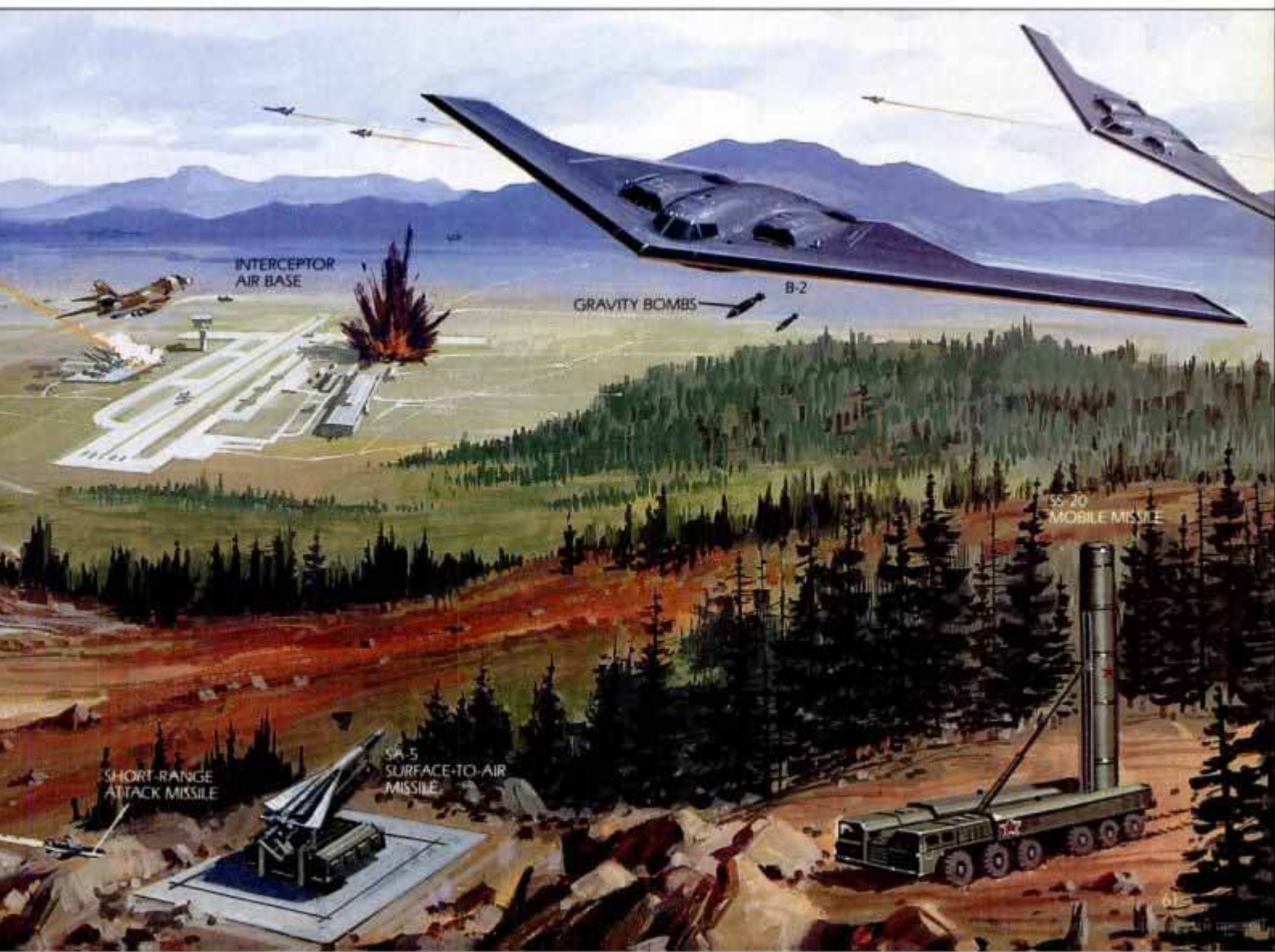
Despite its shortcomings, SAC must depend on the B-1B more and more as time passes, not only as a means of penetrating Soviet air space with gravity bombs, but as a standoff platform for advanced cruise missiles as the Soviet threat evolves. The B-1B also has on its side one very sobering and incontrovertible fact. The B-2 is several years from full production, if it ever passes Congressional budget scrutiny, making the decision to buy the B-1B all the more astute.

The new technology

As with any expensive, complex weapons system, the B-2 is hardly without criticism. Detractors charge that the latest generation of ground, spaced-based and bistatic radars, not to mention advanced optical and infrared sensors, will detect the B-2 as it penetrates Soviet air space to strike hardened or mobile targets. They say that billions in stealth technology can not protect B-2 from easy interception once detected, and that standoff cruise missiles will perform the mission more accurately at less risk. They also point out that the B-2 mis-

sion of finding and eliminating relocatable ICBM launchers depends too heavily on satellite reconnaissance, which will be eliminated in the first phase of a general nuclear exchange. General Bernard P. Randolph, commander of Air Force Systems Command which is developing the B-2, forcefully disagrees, ticking off B-2's advantages. A 6000-mile unrefueled range and an effective 50,000 pound internal weapons load of short-range attack missiles, nuclear gravity bombs or conventional ordnance give B-2 a formidable punch in a variety of mission scenarios. B-2s flying from just four bases—two in the states and two overseas—could cover most of the world's hot-spots with just one refueling.

The B-2's flying-wing platform, first proposed by Jack Northrop for the YB-49 back in the late 40s, is thought by the Air Force to embody the proper combination of load carrying, flight efficiency and low observability. If a B-1B has a radar cross-section $\frac{1}{100}$ th that of a B-52, the radar cross-section of a B-2 is said to be $\frac{1}{10}$ th that of a B-1B—giving the B-2 the appearance of a bird on an enemy



IRRESISTIBLE FORCE

radar. Passive stealth characteristics also extend to B-2's infrared signature. The intakes for the aircraft's General Electric F-118 engines are shielded, as are the exhausts. Additionally, placing the engines well within the airframe reduces the B-2's acoustic signature.

The B-2 is controlled by huge trailing-edge ailerons, flaperons and other articulating surfaces that provide directional control and flight stability. As an inherently unstable structure, B-2 remains aloft by relying on computer actuation of the control surfaces. Steering by a process of differential drag, the B-2's outboard surfaces are split—suggesting dual aileron and spoiler functions.

With the aircraft's F-118 engines embedded in the B-2's composite airframe, augmenting inlet air obviously became an issue. Northrop engineers addressed this problem by installing two square doors on the top of each 2-engine nacelle. The doors were open during most of the first flight. Tiny doors for auxiliary power unit exhaust and other functions, along with a centerline yaw indicator, round out B-2's revolutionary profile.

The primary criticism of the B-2 centers on its tremendous cost—\$530 million in current dollars. Congressional leaders are naturally balking at this huge expense as America's budget deficit continues to squeeze federal coffers. Air Force leaders like Chief of Staff General Larry D. Welch counter that the B-2's \$530 million pricetag includes the cost of ground-support facilities and research and development that will be amortized among future stealth programs like

the advanced technology fighter. The cost of the B-2 comes closer to \$270 million per plane on a "flyaway" basis, according to the Air Force, and becomes even more attractive when you consider the cost per target covered.

Mission scenarios

Three bombers. Three distinct weapons loads. Three separate scenarios for penetrating and overwhelming an enemy's defenses. But how will B-52, B-1B and B-2 work together?

Air Force planners suggest a target selection based on each airplane's unique capabilities. Priority will be given, according to General Chain, to knocking out Soviet radar installations, airfields and command and control installations for space-based reconnaissance assets. Eliminating the enemy's "eyes" and ability to intercept will greatly improve the chances for follow-on strikes. Cruise missiles launched from B-52s would be the logical choice for this crucial element in the SAC mission, with large, vulnerable B-52s continuing on to drop their load of gravity bombs on less heavily defended targets like bridge- and railheads.

With the enemy's ability to detect, track and intercept SAC's bombers thus degraded, B-1B's carrying short-range attack missiles (SRAMs), additional cruise missiles on external hardpoints, or its internal weapons load of B-28 or B-61 freefall nuclear bombs, could focus unhindered on hardened ICBM silos. The Air Force considers the silos to be worthy targets even though weapons inside them may already be launched in a first strike. The Soviet Union, un-

like the U.S., can quickly reload.

That leaves the task of finding and eliminating SS-20, SS-24 or SS-25 mobile ballistic missile launchers, as well as rail-garrison ICBMs, to the B-2—a task Air Force planners concede will be extremely difficult. The B-2 would also rely on its passive and active stealth characteristics to penetrate an enemy's heaviest defenses to strike hardened, high-value targets like command posts.

Can it all work according to the experts? Much depends on adequate intelligence and sufficient warning so that SAC bombers can escape incoming warheads. Indeed, "escape time" is addressed in the Air Force's techniques for "quick starting" and launching these huge machines. But the question of SAC's ability to perform its mission, to hold Soviet targets at risk, is intertwined with the issue of deterrence—and insuring a more stable world.

Many critics insist that cruise missiles can perform SAC's mission with far less cost and far less risk. "Cruise missiles are good. Bombers are better," in General Chain's view. Manned aircraft carrying gravity bombs can be regenerated, redirected and recalled. They can be dispatched and held in position to demonstrate resolve. They contribute to a potential aggressor's targeting and air defense problem because they aren't fixed in a silo—which makes an easy target—or far at sea in a submarine—where communication links suffer. Manned bombers therefore give an enemy pause—precisely the impulse one needs to engender when preventing Armageddon. **PM**



The B-2 Weathers Congressional Budget Storms

JUST AFTER the Northrop B-2 Stealth bomber achieved aviation history July 17 during its first flight, the House and Senate voted to continue the program—but greatly reduce spending. Lawmakers are urging B-2 program managers to fully test the aircraft's flight envelope—as well as its all-important ability to evade radar detection—before committing full funding. "We've hardly tested this plane," according to House Armed Services Committee Chairman Les

Aspin. "What this amendment does is say slow down the program and do the research and development." A less expensive B-2 program is being sought that would reduce the total purchase to far less than the 132 airplanes the Air Force says it needs to maintain a credible deterrence. The B-2 also figures pivotally in strategic arms reduction talks. Between performance milestones and federal budget fights, the story of stealth is far from over.

—Tim Cole

DETROIT 1990

CARS FOR A NEW DECADE

Motown opens the '90s with more doors and more room.

PONTIAC
TRANS
SPORT

BY TONY SWAN, Automotive Editor
and JIM DUNNE, Detroit Editor

SUDDENLY IT'S a new decade. We're six years downstream from George Orwell's vision of a grim future and motoring confidently toward the threshold of the year 2000.

It's safe to say that these 10-year milestones mean more to us than the men and women who conceive, design and build our new cars. As we're assembling this report on Detroit's new cars for 1990, the planners are close to finalizing the '95s, and concepts for the turn of the century have already begun to take shape.

As a result, the new cars rolling out of Detroit for 1990 represent the same relationship to their predecessors as the '89s and the '88s and so on—no revolutionary breakthroughs, but noteworthy improvements across the board.

If there's a single, prominent theme to the cars of the new decade, it's easier access and more space. GM leads the way with its dramatic new



OLDSMOBILE
SILHOUETTE



CHEVROLET
LUMINA APV



CHEVROLET BERETTA GTZ

minivans—the Chevrolet APV, Pontiac Trans Sport and Oldsmobile Silhouette—plus 4-door sedan versions of the Olds Cutlass Supreme, Pontiac Grand Prix and the Chevy Lumina. Chrysler is also emphasizing space with its new flagship, the Imperial, and Ford has a re-skinned edition of its perennial upper-crust hauler, the Lincoln Town Car.

In the pages that follow, we'll detail all the changes, great and small, as well as the engineering innovations that separate the new decade from the old.

General Motors

Any time the General conjures up a new car it almost always acquires high visibility, simply through sheer strength of numbers. That's because any new domestically produced GM bodyshell that comes along will very likely get promotional backing from more than one division.

But in the case of GM's swoopy new minivans, visibility seems to be built-in, with the most arresting shapes to come out of Detroit this year.

The new vehicles will be offered with three different brand names—Chevrolet, Pontiac and Oldsmobile—but will differ only in trim levels, which are detailed in the sections that follow devoted to each division. Aside from the divisional variations, all the new vans ride on a 190.8-in. wheelbase with an overall length just over 194 in. This is roughly similar in length to the stretched ver-



CHEVROLET BERETTA CONVERTIBLE

sions of the current Ford Aerostar and Chrysler minivans, and, at 65.2 in., about the same height as the Dodge Caravan/Plymouth Voyager.

All three divisional variations share the same powertrain—GM's corporate 3.1-liter V6 mated to a 3-speed automatic transmission. Fuel economy is expected to be 18 mpg

city, 22 highway, while 0-to-60 is pegged at a leisurely 13 seconds.

Besides their dramatic shapes, and attendant aerodynamic efficiency (0.30 C_d), two unique features distinguish the new GM minivans from their competitors.

First is the construction technique, which utilizes composite body panels, instead of sheet steel, bonded to a steel subframe. Most of the body consists of four major panels, to limit the number of seams.

Second is the clever modular seating design. Seats can be folded down, to create more cargo space or for use as tables, and they're also equipped with quick-release fasteners, to tailor interior volume to the user's needs. Each of the basic seats weighs only 34 pounds, and the vans can be ordered in 5-, 6- or 7-passenger configuration.



New Corvette Instrumentation is first change since '84.



CHEVROLET LUMINA SEDAN

Chevrolet

Chevy's version of the new minivan is called the Lumina APV, and it's available in both station wagon and cargo van editions. Chevy is the only division to offer a commercial version of the APV, and as a result, Chevrolet will get the bulk of annual production.

Chevy isn't confining the Lumina name to its minivan, of course. The Lumina Sedan, Chevy's version of the GM-10 platform (Pontiac Grand Prix, Olds Cutlass Supreme, Buick Regal) has been on the scene for several months now, rolling out quietly in rental fleets before finding its way into the showrooms. A Coupe version joins the mix for this fall's new car introductions.

Both the Coupe and Sedan are available in base and upscale Euro editions. The standard powerplant is the evergreen Iron Duke 2.5-liter Four, tweaked to produce a respectable 110 hp for 1990. Lumina pricing begins at a competitive \$11,883 for the basic Sedan.

The Beretta lineup has been expanded with two new models—a Convertible and the feisty GTZ. The Convertible is farmed out for final assembly to C&C (formerly Cars and Concepts), in Brighton, Michigan. Other distinguishing touches include rocker panel extensions, wheel arches, front and rear airdams, stiffer suspension, 16-in. cast-alloy wheels and a solid rear boot.

The heart of the GTZ, which replaces the paper tiger GTU model, is the 180-hp high-output version of GM's 16-valve Quad 4 engine. With high-performance suspension—GM's



CHEVROLET LUMINA EURO COUPE

deflected-disc gas shocks, front and rear antiroll bars and 205/55 Eagle GT tires on 16-in. body-colored alloy wheels—the GTZ rates as the hottest small-car Chevy.

Buick

Buick's three Rs—Riviera, Regal, Reatta—are the focus of change in the 1990 lineup, with the two luxury coupes getting new interiors, and the Regal line offering a 4-door sedan to team up with its coupe. While the changes aren't spectacular, the moves add up to a filling out of an important gap in the Buick lineup.

Regal's 4-door, which will compete directly against Ford's Taurus and Sable, shares its 6-window greenhouse with the Pontiac Grand Prix 4-door. The front-end styling follows Buick's tradition of bright metal grille with a vertical bar theme. Also in keeping with the Buick image, bright metal is used liberally in exterior trim, especially in bumpers, rub strips and greenhouse outlines.

Regal will have the 3.8-liter V6 engine available as an option over the standard 3.1-liter V6.

All members of the Regal family offer 4-wheel disc brakes, air conditioning and automatic transmission as standard equipment. For at least the 1990 model year, Buick will sell the Regal lines alongside the Century, its other midsize sedans.

Reatta finally has its long-awaited convertible model as a stablemate to the 2-seat coupe. Both models have a new Reatta/Riviera instrument panel that does away with the controversial video control screen, replacing it with high-tech vacuum-fluorescent read-outs.

The manually operated top on the convertible is easier to swing forward and/or stow than Cadillac's Allanté system, and has a hard cover that fits flush with the rear deck.

Other changes to the Buick line include a moderate facelift to the LeSabre sedans and the dropping of the Skyhawk series. LeSabres have new



BUICK REATTA CONVERTIBLE

bright-finished grilles, composite headlights, body-colored protective trim in front, and newly designed full-width taillights.

Pontiac

Consistent with its successful image-building of the past few years, Pontiac's version of the new GM minivan, the Trans Sport, will be the sportiest of the three.

Tops in the sporty department is the Trans Sport SE, which is decked out in a monochrome paint scheme with matching lower body cladding and 15-in. alloy wheels mated to Goodyear Eagle GT+4 tires.

Like Buick, Olds and Chevy, Pontiac has its own version of the new GM-10 4-door sedan, available with either the new 3.1-liter V6 or the 2.0-liter dohc 16-valve Quad 4 in 160-hp tune.

Pontiac will call its top-line version of the 4-door the Grand Prix STE, shifting the designation from the old A-body lineup. However, all-wheel-drive capability continues to be available only in the 6000 series, at least for model year 1990.

As with the original STE series, the Grand Prix STE will be issued essentially as a fully equipped car with almost no options. However, a more modestly equipped version of the new sedan, the LE, will also be available.

Oldsmobile

After years of taking a back seat to other GM divisions, Oldsmobile

strikes out in its own direction with several new models for 1990. No more look-alike styling for Olds. The Toronado and Cutlass Supreme Sedan, both with new sheetmetal for 1990, have individual styling that successfully separates them from other GM cars sharing the same platforms.

Stablemate to the Cutlass Supreme coupe, the new 4-door shares all of the coupe's chassis and mechanical features, but differs considerably in exterior styling. Wraparound glass for the rear window, a unique grille and a

an option. Both drive through a 3-speed automatic transmission. Standard on the SL is GM's new 3.1-liter 135-hp V6 and 4-speed automatic. This powertrain is optional on the other models.

Olds' famous 442 performance coupe is reborn in the Calais line for 1990. The Quad 442 package features the high-output Quad 4 engine and a Getrag 5-speed transmission, as well as performance-oriented suspension upgrades. With 180 hp, a 2500-pound curb weight and manual transmis-



PONTIAC GRAND PRIX STE

more conservative design are the major cues that set the new 4-door apart.

Engine lineup for the Cutlass Supreme line is complicated. The 180-hp high-output version of the Quad 4 engine is standard on all models except the SL. The milder 160-hp Quad 4 is

Olds is claiming 0-to-60 times in the 7.5-second range.

In an attempt to revive slumping sales, Olds has made a number of major changes designed to reestablish the Toronado as a large car. While the wheelbase has remained unchanged at 108 in., the overall length is stretched 12.4 in. to 200.3 in. overall.

Virtually every exterior panel except for the hood is new. Most of the extra length is in the rear of the car where 11 in. were added. Interior room is unchanged, but trunk space has been expanded by 2.5 cu. ft.

Inside the Toro, the instrument panel has a new shape, and a new array of analog instruments. You can still get digital electronic readouts but they are now carried as an option. All



BUICK REGAL LIMITED SEDAN

OLDSMOBILE CUTLASS SUPREME



Toronados have a driver-side airbag in the steering wheel hub.

Olds also picks up its own upscale version of the APV, the Silhouette, first van for the division.

Cadillac

Styling themes are familiar on Cadillac's six car lines for 1990, but significant changes are featured under the sheetmetal. The most noteworthy of these is the industry's first front-wheel-drive traction-control system, which debuts in the Allanté.

In addition, there is more power for the mainline cars—deVille, Fleetwood, Seville and Eldorado—and a more muscular V8 for the Brougham.

By increasing the compression ratio and installing sequential fuel injection on the 4.5-liter V8 used in the front-drive models, horsepower has been boosted to 180, an increase of 25 horsepower over last year.

Engine power in the Brougham, Cadillac's rear-drive sedan, has been boosted by the addition of the 5.7-liter V8 as an option over the 5.0-liter V8. Horsepower of the 5.7-liter is 185 versus the 140 of the standard 5.0 liter.

For passenger safety, Cadillac will have airbags in the steering wheel



OLDSMOBILE CUTLASS SUPREME SEDAN

hubs of all its front-drive models, while Brougham will stick with the 3-point passive belts.

Chrysler Corp.

After a decade of recovery and product programs done with mirrors, the

rolling out of the company's factories.

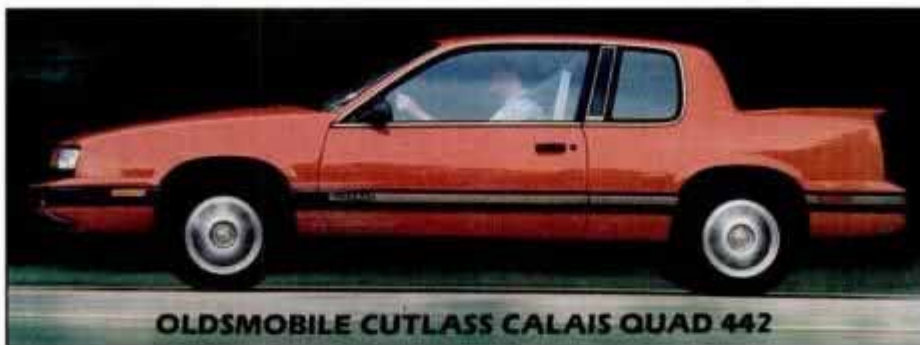
Chrysler Division

After a couple years of rumors, Chrysler has at last revived its flagship Imperial series, waiting until the new corporate 3.3-liter V6 engine was available before making the introduction.

Like two other new Chrysler nameplates, the New Yorker Fifth Avenue and the Salon, the Imperial rides on a front-wheel-drive New Yorker/Dodge Dynasty chassis. The wheelbase for the

Fifth Avenue and the Imperials is 109.3 in., 5 in. longer than the basic New Yorker platform, but the Imperial's overall length of 203.0 in. makes it the biggest in the fleet—by 4.4 in.

This dimension is roughly comparable to the Lincoln Continental, as is



OLDSMOBILE CUTLASS CALAIS QUAD 442

winds of change are blowing resolutely at Chrysler. Although Mr. Iaccoca is still solidly in charge, new faces are appearing in Chrysler's upper management circles, and truly new cars—as distinct from the years of repackaged K-Car chassis—are now



New touch-screen information center is Toronado/Troféo option.



OLDSMOBILE TROFÉO



CHRYSLER IMPERIAL

the curb weight—3570 pounds. The presentation is typical of Chrysler formal sedans—angular and chrome-frosted, with the familiar waterfall grille and vinyl half-roof.

It's interesting to find analog instruments in a car like this, and even more interesting to find driver-side airbags—as well as 3-point rear seatbelts—in this and other members of the Chrysler family. Chrysler will offer airbags in 16 car lines for 1990.

Optional equipment for the Imperial includes a self-adjusting air suspension package.

Aimed at the perceived gap between the Imperial and the standard New Yorker, the Fifth Avenue is a trifle shorter than the flagship but offers virtually identical interior dimensions—as well as the new 3.3 mated to a 4-speed automatic.

The slightly smaller Salon, on the other hand, is positioned just below the New Yorker as the range's value vehicle. Base engine here is the Mitsubishi-supplied 141-hp 3.0-liter V6, though the 3.3 is available.

Like many of the bigger Chrysler cars, the new LeBaron Sedan, due in

showrooms by January, is aimed at a more mature market, with formal sedan styling and Chrysler traditional luxury cues. The same can be said for the latest revival of the Town and Country nameplate, which has been attached in this iteration to a stretched version of the corporate minivan replete with woodgrain trim, leather upholstery and the 3.3 V6.

One other noteworthy update in the divisional lineup is a complete redesign of the LeBaron Coupe and Convertible interiors. This welcome change includes instrument panels,



EAGLE TALON TSI AWD



DODGE DAYTONA ES V6



CHRYSLER LE BARON SEDAN



seats, door trim and overhead consoles on the two cars.

Dodge

Much of Dodge Division's new product news for the coming year will come along midway through the 1990 selling season. Included in this plan is a revival of the Monaco nameplate and Shadow convertible.

Meanwhile, Dodge's major news for this fall is an expansion of the Daytona line to include a model powered by the smooth and mannerly Mitsubishi 3.0-liter V6. Dodge has also expanded availability of the potent (174-hp) 2.2-liter Variable Nozzle Turbo (VNT) to the Shadow and Daytona.

Both the V6 and the 2.2 VNT mate to Chrysler's slick new corporate 5-speed transaxle, and the Daytona interior has been given the same sort of redesign as the LeBaron Coupe.

Plymouth

Plymouth's major 1990 new-product announcement, made earlier this year, was the Laser sport coupe, built at the new Mitsubishi-Chrysler joint venture Diamond Star plant at Normal, Illinois.

Already rated as one of the best performance buys in the small sports coupe class, the Laser is available with three engine options—a 92-hp 1.8-liter sohc Four, a 135-hp 2.0-liter 16-valve dohc Four, and a turbocharged version of the 2.0-liter twin cam that makes 190 hp.

Eagle

Perhaps the single most exciting car offered by any Chrysler division this year is the Eagle Talon TSi AWD. Although the Talon is identical to the Laser in most respects, it's the only version of the car in the Chrysler stable that offers 4-wheel drive.



LINCOLN TOWN CAR

The Talon is available with both the normally aspirated and turbocharged versions of the 16-valve engine. However, the All-Wheel Drive system, which adds only 150 pounds to the car's curb weight, is available only with the turbo motor.

Ford Motor Co.

After four years of blockbuster new-product introductions, Ford is taking a bit of a breather for 1990.

Lincoln-Mercury

Ford's new Lincoln Town Car is the star of the Dearborn lineup for 1990. The big Lincoln sedan has an entirely new look, inside and out, plus chassis changes that upgrade its proven frame and body design.

Styling differences in the Town Car are better told in pictures, but it is obvious that the boxy, angular look of past Town Cars has been modified in favor of smoother surfaces and a more rounded appearance overall. Still, the styling flavor of past Town Cars has not been abandoned. Trunks are still among the biggest on the road, and the trademark opera window is carried over almost unchanged.

New styling touches include bumpers, now plastic covered, that wrap around to the wheel well openings, and door frames cut up into the roof, imparting a limousine aura. The familiar rectangular grille is changed, with edges that are more rounded.

Inside, the conservative, rectangular lines of the instrument panel surround colorful digital gauges. Airbags for both driver and passenger are carefully hidden in the steering wheel hub and just above the glove compartment. And the famous retracting quarter windows have been eliminated, replaced by a single sheet of window glass in the door.

Major dimensions of Town Car are virtually unchanged from those of the 1989 model. The greatest difference is

in the 1.2-in.-longer overall length.

Antilock brakes are now optional on all Town Cars while air springs were added to the rear suspension to smooth out the slightly firmer ride in the 1990 model. The big Lincolns also feature a speed-sensitive, variable-effort steering system similar to the one introduced on the '89 Continental.

Ford's workhorse 5.0-liter V8 engine is the sole powerplant in the Town Car lineup. Two versions are of-

pealing engine for many drivers.

The V6 can be teamed either with a 5-speed manual or 4-speed automatic transmission.

The 1990 Probe also gets some exterior trim tweaks, including new front-end styling, revised aluminum wheels and new taillights.

Aerostar will offer a 4-wheel-drive system on all models for 1990. The system includes a new 4.9-liter V6 engine and 4-speed automatic transmis-



FORD PROBE LX V6

ferred, a 150-horsepower standard engine, and a 160-horsepower dual exhaust option. Both power the rear wheels through a 4-speed automatic overdrive transmission.

Ford Division

One of the smoothest and most responsive small sporty coupes in the 1990 lineup is the Ford Probe LX equipped with a V6 engine, a new powerplant in this car. Ford rates the port-injected 3.0-liter V6, the same engine used in the Taurus and Sable sedans, at 140 hp, only 5 hp less than the 2.2-liter turbocharged 4-cylinder engine in the GT Probe. However, the constant torque output of the V6 in all speed ranges may make it a more ap-

sion plus a new front suspension that is specially designed to accept the new front-end differential. It is also fully compatible with the Aerostar's new antilock rear-wheel brake system, which is standard on all models.

In appearance, the 4-wheel-drive Aerostar is almost indistinguishable from the standard rear-drive vehicle, except for a 1/2-in. greater ride height and a badge on the tailgate.

Ford is also upping the horsepower ante, with a new optional 160-hp 4.0-liter V6 for the Aerostar. The V6, a larger version of the German Ford-built 60° 2.9-liter V6 currently offered in several light truck platforms, is only available with a 4-speed overdrive automatic transmission. **FM**

FINE TUNING

The many refinements in Detroit's '90 cars are subtle and high-tech.

ALTHOUGH there's a new engine at Chrysler and new systems like traction control, Detroit's 1990 engineering story has more to do with refinements to existing hardware. Here's what's going on beneath the skin.

Ford

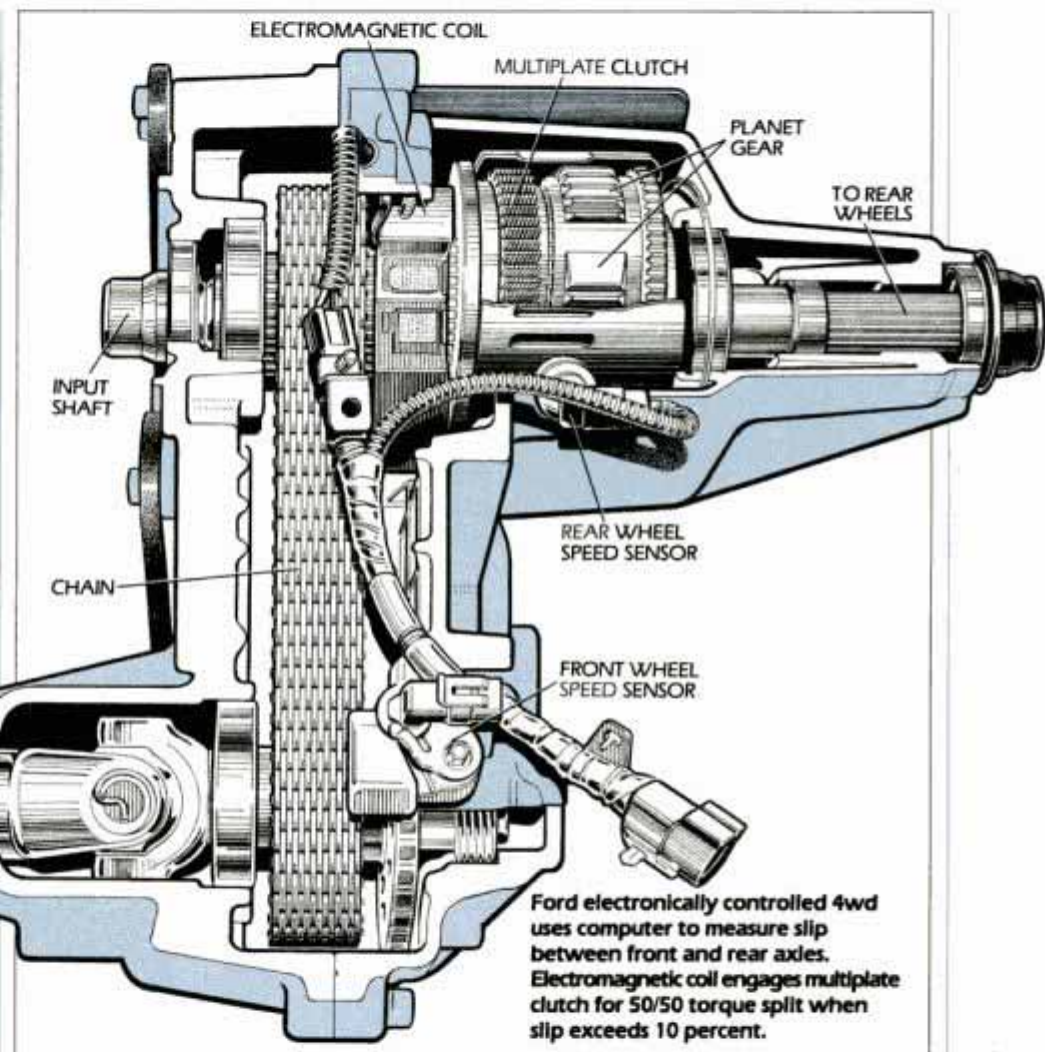
The dividing line between domestic and imported cars gets a further blurring on the 1990 Ford engine lineup. A 4.0-liter V6 built by Ford in West Germany will be installed in the Aerostar van, Ranger and Bronco II. And a domestic 3.0-liter V6 will be installed in the Probe built for Ford by Mazda in its U.S. plant.

Ford needs a high-torque V6 for its light trucks, particularly for the 4-door Bronco it is introducing next spring, to compete with the 224 lb.-ft. of torque (and 177 horses) of the 4.0-liter in-line Six in the Jeep Cherokee.

The 60° 2.9-liter V6 Ford builds in West Germany has generous distances between bores (along with a stroker crank) so Ford was able to make a whopping increase in bore (93 to 100 mm) and stroke (72 to 84 mm) to raise displacement to 4.0 liters.

The 60° 4.0 V6 has similar exterior dimensions to the 2.9 (much smaller than the 90° 3.8) so naturally it's an easy fit into Ranger and Bronco II, in which the 2.9 continues to be a standard or optional engine. Horsepower of the Ford multipoint fuel-injection 4.0-liter V6 is 172, just a whisker under the Cherokee, but the torque is 242 lb.-ft.

The 4.0 V6 gets all of Ford's latest low-friction technology, including novel hydraulic lifters. They have a roller recessed in the base, to reduce friction against the camshaft lobe, plus a roller in the side that fits into a groove in the lifter bore. This posi-



tively locates the lifter and permits running with tight clearances between lifter and bore. Result: Any tendency of the lifter to cock in its bore is virtually eliminated, reducing lifter-to-bore friction.

The 4.0 V6 gets a structural aluminum oil pan, which Ford has been using to replace the simple stamped steel design. The aluminum pan contributes to the overall rigidity of the block for reduced vibration.

The 4.0 V6 also gets distributorless ignition and an engine calibration that eliminates Exhaust Gas Recirculation, which contributes to smoothness. Putting a V6 into the Mazda-

built Ford Probe was a step planned from the beginning, and the engine compartment was generously sized to accommodate one. However, the decision to use the 3.0-liter V6 that also goes into the Taurus/Sable was Ford's. Mazda will not offer it in the MX-6, the Mazda model that comes off the same Flat Rock, Michigan, assembly line.

The 140-hp 3.0 V6 gives the Probe a reasonably powered alternative to the 110-hp 2.2-liter Four or the 145-hp 2.2 with the intercooled turbo. Ford has not been enchanted with the pricey turbos, so the V6 offering is more in line with its powertrain philosophy.

Electronic 4wd

Ford 1990 drivetrain changes also include the first U.S.-built electronically controlled 4-wheel drive, an option for the rear-drive Aerostar. Instead of the silicone-filled viscous coupling other makers use (including the Chevy Astro van), Ford has an electromagnetic multiplate clutch in the transfer case. The electronic system computer can automatically lock front and rear axles together when there is excessive slippage.

The 4-wheel-drive system, available on models with automatic transmission, is full-time, with a planetary gearset in the transfer case serving as the center differential. The transmission output shaft drives the planet carrier, which transfers power to the ring gear (output to the rear wheels) and to the sun gear (which drives the chain to transfer power to the front wheels).

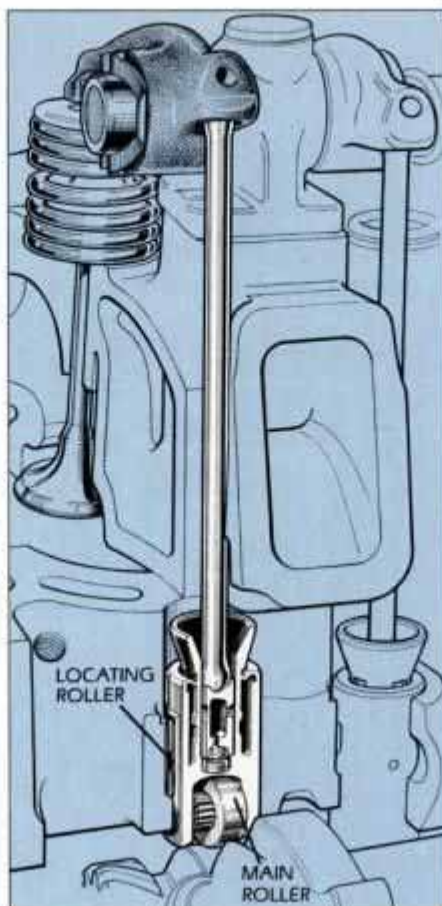
The transfer case has built-in wheel-speed sensors for front and rear, and when they transmit signals that vary by more than 10 percent, that's an indication of excessive slippage. The computer immediately completes the circuit for the electromagnet. The electromagnet locks a multiplate clutch. Half the plates in this clutch are splined to the sun gear, half to the ring gear, so the front and rear axles are locked together and the torque split is 50/50.

The computer holds the system in lockup for 3 seconds, then unlocks the clutch, rechecks for excessive slippage and if it finds any, reengages the clutch. The recheck takes only 0.4 second.

Aero Town Car

The Lincoln Town Car has long been Ford's luxury image leader—a very square body on a traditional frame, lots of interior room and a marshmallow ride and handling package. It's truly the essence of the American dinosaur. However, it's long suffered from wind noise and any attempt to add such a basic amenity as a drip rail around the doors just added to the problem. Although the owner and passengers would get a splash of water if they opened the doors in a heavy rain, they seemed to tolerate the nuisance because the car has sold well.

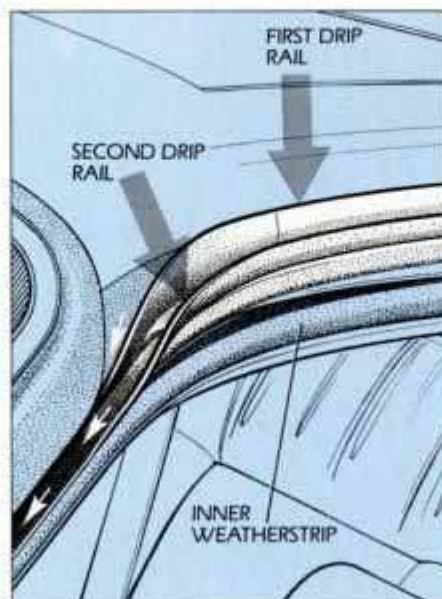
Tampering with success is always risky, but Ford reskinned the Town Car, giving an aero look. The coefficient of drag on the new model is a respectable 0.36, reducing wind noise. Because the doors are cut partly into the roof, it permits the addition of a drip rail. In fact, there's a double drip



On Ford 4.0 V6, side roller indexes tappet, permits closer tolerances, reduces friction.

rail, which also seals against wind noise, and a third layer of weatherstripping further inboard.

Ford also installed sandwiches of vibration-absorbing insulation covered by steel against key areas of the body, including part of the floorpan, and hopes to promote the Town Car as the quietest model in its class.



Lincoln Town Car's multilip weatherstrip forms drip rail to keep interior dry.

General Motors

The industry's first traction control system on a front-drive car—the Cadillac Allanté—joins the long-delayed introduction of the 385-hp Corvette V8 to be the leading lights in General Motors 1990 technical arsenal.

Traction control is antilock braking in reverse, and more, so the wheel speed sensors that signal locked brakes also can be used to detect wheelspin when the car loses traction. An antilock braking computer triggers solenoid-activated valves that limit or bleed off brake line pressures to free up a locked wheel; the traction control system applies the brakes at one or both drive wheels to stop wheelspin.

When slippage at one front wheel is 10 percent greater than another, a computer triggers a solenoid in the traction control unit, opening a valve so brake fluid under high pressure (typically about 500 psi) flows from a pump-fed reservoir to a piston in a cylinder. The fluid pushes the piston, producing pressure in the line to one of the front-wheel brakes.

The computer also can sense if both front wheels are slipping, by comparing their speed with vehicle speed, and if the slippage is more than 10 percent, the computer opens solenoid valves to the traction control units' two front-wheel pistons, applying the brakes to both front wheels.

The computer pulses the front brakes 10 times per second and continuously checks the front-wheel speeds. If the wheelspin rates drop to less than 10 percent, the computer allows the solenoid valves to close completely, relieving all pressure on the brakes. However, if the application of the brakes doesn't do the job within 3 seconds, the engine computer disables up to four fuel injectors, one at a time at 3-second intervals.

Although traction control hasn't come to any other GM model yet, the rear-drive Chevy Astro van does become the first van with both 4-wheel-drive and 4-wheel antilock brakes. The 4 and 4 system, which uses a viscous coupling in the center differential, is similar to that available on Jeep since last year.

Fluidic Defroster

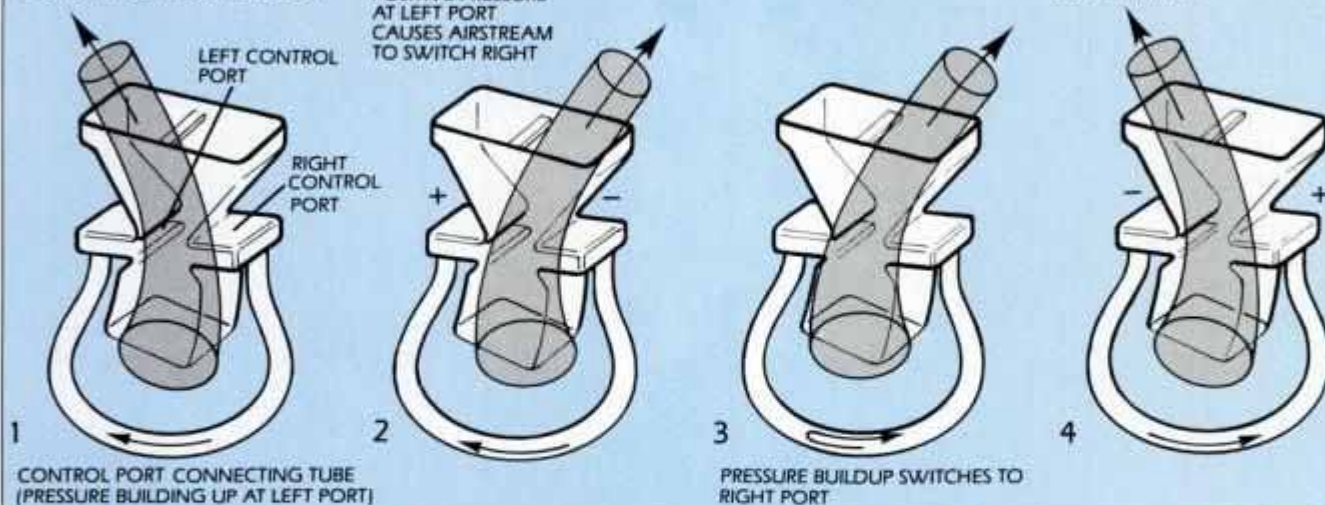
The huge windshields on GM's new aero vans (Chevy Lumina APV, Pontiac Trans Sports and Olds Silhouette) get fluidic defroster ducts, which have no moving parts, yet which produce narrow-fan airflows that imperceptibly sweep side to side to defog the windshield. This eliminates the

FLUIDIC DEFROSTER CYCLE

AIRSTREAM PAST LEFT CONTROL PORT CAUSES PRESSURE BUILDUP

POSITIVE PRESSURE AT LEFT PORT CAUSES AIRSTREAM TO SWITCH RIGHT

POSITIVE PRESSURE AT RIGHT PORT CAUSES AIRSTREAM TO SWITCH LEFT



Fluidic defroster vent sweeps General Motors' minivans' huge windshield with oscillating airstream without any moving parts (see text).

need for a huge blower motor.

The vans have two fluidic defroster nozzles. Here's how they work. There's a main fan-shaped opening with air necks at each side of the narrow part of the fan. A tube connects the necks, called control ports. The nozzle is shaped so that when the blower is first turned on, windshield airflow begins at one side. As the windshield air flows past one control port, it draws air through the connecting tube and pressure builds up in the port. When the control port pressure is just slightly greater than at the opposite port, it causes the windshield airflow to deflect to the other side. At the opposite side, the pressure in its control port remains lower than the other until after the windshield airflow causes the airflow in the control port tubing to reverse direction. The control port pressures soon reverse, and the airflow is pushed to the opposite side.

The fluidic defroster takes less space, delivers more heat to the windshield and therefore reflects less back into the faces of the front-seat occupants.

Dual A/C

His 'n' hers dual air conditioning will be available on the 1990 Buick Regal, a first on domestic cars. Buick has divided part of the heater-a/c case in two, and installed a separate temperature door (operated by an electric motor) for each side of the car. So if he likes it cold and she likes it hot, they can both have it their way.

A split case is not a simple matter. It takes careful design to avoid airflow restrictions as well as excess noise.

Body, Chassis Changes

In the interests of quiet—primarily a creak-free car—General Motors made major structure changes in the chassis of 1990 C-H cars (Pontiac Bonneville, Buick LeSabre and Electra, Olds 88 and 98 and Cadillac deVille/Fleetwood) plus the Caddy Eldorado/Seville and Allanté. Using computer analysis developed for the Regal-Cutlass-Lumina cars, GM reshaped panels and beams for more stiffness and reinforced several joints.

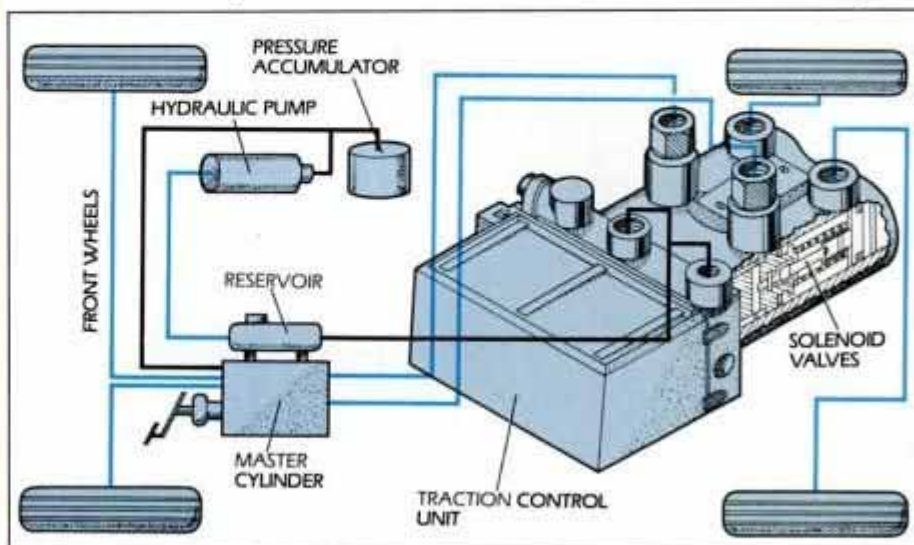
GM took advantage of experience gained on both the Corvette and the Fiero to produce the frame and body for the new aero vans. Like Fiero, they have welded space frames with body panel locating pads, but unlike Fiero use only a few screws to hold the panels, which then are secured with 2000 in. of beads of glue.

GM also is learning a few things about soft tops, and applying them to the new Buick Reatta convertible. The top stows under a metal panel, and when the top is up, the top's lower back must attach to the metal panel. To avoid hard-to-use snaps and the like, Buick is using an easy-aim giant screw at each side of the top's lower back, and electric screwdrivers with female bits on the underside of the metal panel to pull down the screws and bed the lower back of the top.

'90 Engines

Although there are no new engines in GM's 1990 lineup, there's a laundry list of changes.

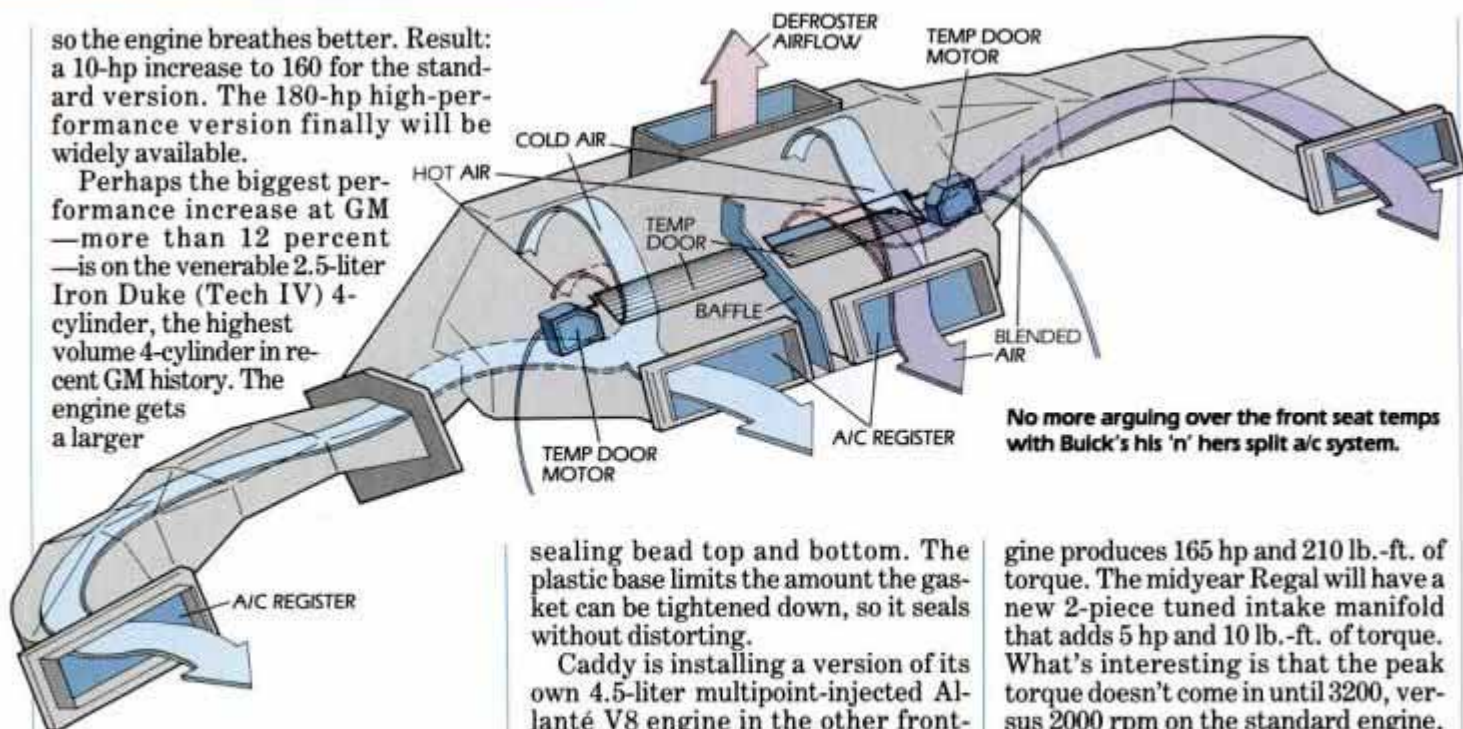
The Quad 4 4-valve 4-banger's timing chain and sprockets have been reworked to sharply reduce high-speed noise. The cylinder heads have bigger intake and exhaust valves and ports



Allanté traction control unit pulses brakes to prevent wheelspin when traction is marginal.

so the engine breathes better. Result: a 10-hp increase to 160 for the standard version. The 180-hp high-performance version finally will be widely available.

Perhaps the biggest performance increase at GM—more than 12 percent—is on the venerable 2.5-liter Iron Duke (Tech IV) 4-cylinder, the highest volume 4-cylinder in recent GM history. The engine gets a larger



No more arguing over the front seat temps with Buick's his 'n' hers split a/c system.

throttle body and a new intake manifold, but the main reason for a horsepower increase from 98 to 110 is quality. John Deere is now casting the cylinder heads and it has a molding process that is more accurate and results in less airflow-obstructing casting flash than anything from GM's own foundry.

Owners and prospective buyers, however, will be more interested in a pair of other changes. The version of the engine that's installed in the Pontiac Grand Am, Buick Skylark and Olds Cutlass Calais goes from a gear-driven camshaft to the more costly chain drive. GM has tried all kinds of things to quiet the noisy gear drive, including a plastic camshaft gear. All it got for its trouble were early plastic gear failures.

As long as it was making the switch in that area, GM widened the timing cover gasket surface (the all-metal gears take less space even with the chain around them and a spring tensioner in the cavity). It also reshaped the bottom of the front of the engine so the front side gasket surface now is a half-circle, distributing oil pan screw clamping loads more evenly.

The 4-bangers in the J-cars (Cavalier and Sunbird) get modest improvements. The Cavalier's pushrod 4-cylinder goes from 2.0 to 2.2 liters via a stroke increase from 80 mm to 88 mm, raising horsepower from 90 to 95 and torque from 110 to 120 lb.-ft. The 2.0-liter overhead cammer in the Sunbird gets a new cam cover gasket to eliminate oil leaks. The gasket is a flexible but hard plastic with a rubber

sealing bead top and bottom. The plastic base limits the amount the gasket can be tightened down, so it seals without distorting.

Caddy is installing a version of its own 4.5-liter multipoint-injected Allanté V8 engine in the other front-drive Cadillacs, dropping the dual throttle-body fuel-injection system. This 4.5 is less aggressively tuned (180 versus 200 horses of the Allanté) but still reduces 0-60 times from 10 to 9 seconds, only 0.7 second slower than the Allanté.

A sophisticated intake manifold sealing system, introduced as a running change on the '89 Allanté, is installed across the board for all 1990 4.5 V8s. It includes silicone rubber side seals with a neat offset waffle pattern that can take twice the compression of a conventional silicone gasket, plus a graphite material gasket on a metal core, and bolts with three disc spring washers. For 1990 the 175-hp 5.7-liter (350-cu.-in.) Chevy small block with multipoint fuel injection is an option for the rwd Brougham that cuts 0-60 from 14 to under 10 seconds.

The standard Corvette 5.7-liter V8 gets a modest power boost for 1990, although at 245 hp, it still will be about 140 horses short of the 32-valve V8 in the ZR-1.

A midyear version of the Buick Regal will get a modestly more powerful version of the 3800 V6. The Job 1 en-

gine produces 165 hp and 210 lb.-ft. of torque. The midyear Regal will have a new 2-piece tuned intake manifold that adds 5 hp and 10 lb.-ft. of torque. What's interesting is that the peak torque doesn't come in until 3200, versus 2000 rpm on the standard engine, to improve highway passing.

GM has been able to produce a power steering gear valve that provides a smoother feel as the driver steers off-center, even though the amount of on-center road feel has been increased. As a result, many 1990 GM cars will have better on-center feel.

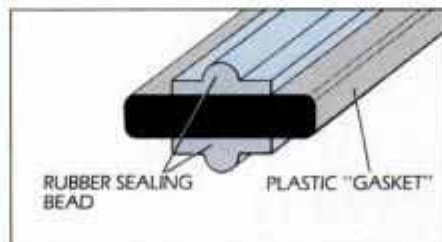
Chrysler

Everyone wants V6s and Chrysler is introducing a new multipoint-fuel-injected 3.3-liter (201-cu.-in.) V6 for 1990. However, as you might expect from the people who gave us the Slant Six, it's a basic pushrod design with two valves per cylinder, and produces a modest 147 horsepower and 183 lb.-ft. of torque.

The 349-pound engine, which has a cast-iron block and aluminum heads, is a 60° V, an inherently balanced, compact design. The bore is big enough to accommodate a 4-valve overhead-cam head and Chrysler has a 3.5-liter version in the works.

For openers, however, the idea is to produce a simple, smooth powerplant. Although the engine is tuned to run on unleaded regular, it has a knock sensor so the computer can retard timing at the first sign of ping. The cast-iron block has an extended skirt for vibration-resistant rigidity. The ignition system is distributorless, which eliminates the timing variations that can disturb idle.

All belt-driven accessories are mounted on the aluminum front cover, so vibration control can be centered on one part. In addition, the a/c compressor is close-mounted to the engine as a further aid.



In Pontiac 2.0-liter Four, plastic rail with rubber sealing beads replaces cork gasket.

Similar effort was expended to quiet the 3.3. The inside of both the oil pan and rocker covers contain the sandwich dampers (a layer of plastic against the pan topped by a layer of steel), introduced last year on the 4-cylinder engines. The air cleaner contains a venturi-shaped tuning tube that works something like a reverse megaphone to reduce the induction noise (in the 2000-3800 rpm range) caused by fluctuations in air pressure (from the opening and closing of intake valves). The fuel-injection rail has a spring-loaded damper to quiet fuel-pumping pulsations.

The 3.3 has oversquare cylinders (93 mm bore x 81 mm stroke), so large valves fit and that helps produce good low-end torque. The intake manifold is mildly tuned, which extends peak torque to 3600 rpm. Amazingly, 90 percent of that 183 lb.-ft. is available at just 1600 rpm.

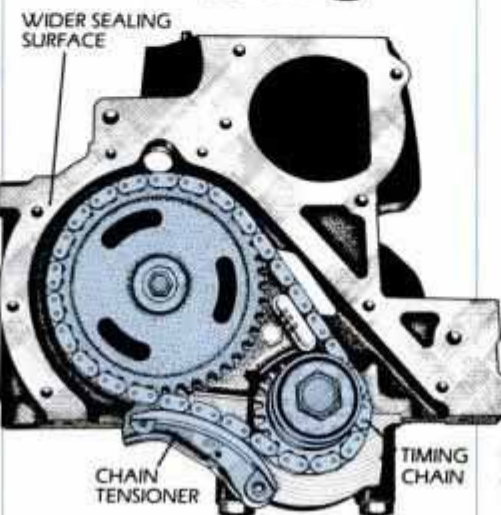
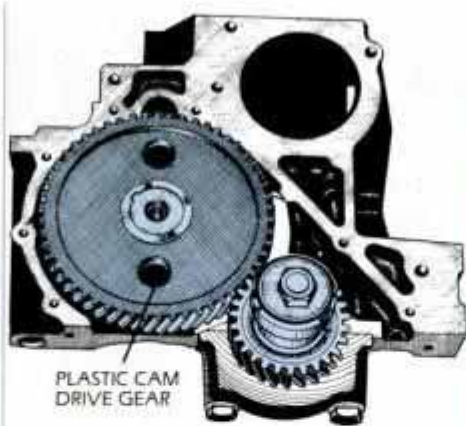
Variable-Nozzle Turbo

Chrysler has made a quantum improvement on its 2.2 intercooled Turbo II, incorporating computer-controlled vanes in its turbine wheel to virtually eliminate turbo lag on acceleration. The design, labeled Turbo IV, is called a Variable Nozzle Turbo. Tested last year on Shelby-built models, it has 12 vanes on pivots. When the driver hits the gas pedal, the vanes pivot to restrict exhaust flow, so the exhaust gas velocity increases and spins the turbo up to boost speed almost instantly. The computer operates a bank of solenoid valves to apply manifold vacuum or pressure (whichever is available) to a dual chamber diaphragm assembly to pivot the vanes. Once the turbo is up to speed, or when the engine is at idle, the diaphragm assembly pivots the vanes to the open position.

Horsepower of the Turbo IV engine is unchanged from Turbo II (174), but peak torque is up from 200 to 210 and it hits at 2400 instead of the previous 3200 rpm. All key acceleration times are better, and if you floor the pedal from a stop on Turbo IV, you'll not only take off better but reach full boost in 2.2 seconds, compared with 4.5 seconds on the Turbo II.

5-Speed Shift Quality

Chrysler put in extensive work to improve shift quality of its 1990 5-speed. Reverse is now opposite Fifth instead of to the left of First, so the reverse lockout ring was eliminated. Inside the transaxle, a fourth shift rail was added, so Fifth and Reverse now have their own. Instead of movable shift



General Motors' Iron Duke plastic timing gear is replaced by a conventional timing chain and tensioner.

forks, which have a tendency to cock and bind, the forks now are pinned to the rails, which slide through Teflon bushings. It's better than '89, but it still needs shorter throws, less effort and more crispness to be a truly satisfying gearbox.

Air Suspension

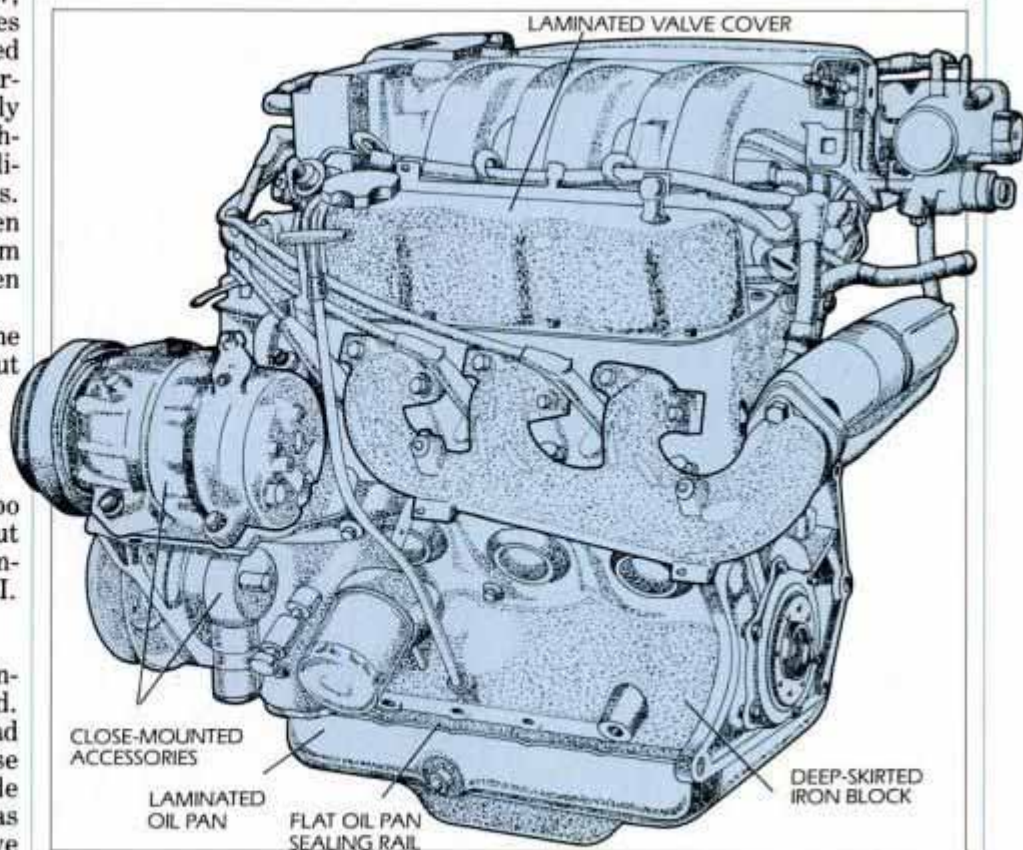
Chrysler finally is offering its versions of electronic suspensions used by other makers. A front-drive suspension with air struts in front and air springs in the rear, somewhat similar to what Ford introduced on the rear-drive Continental in 1988, will be an option on the 1990 Chrysler Imperial. A driver-adjustable electronic shock absorber system will be optional on the 1990 Daytona Shelby and LeBaron coupe and convertible.

Budget 5-mph Bumper

A low-cost 5-mph bumper will be used on LeBarons, Sundance/Shadow and Spirit/Acclaim. Instead of the costly hydraulic shock-absorber type, there's a simple plastic sleeve that compresses in an accident, then recovers. A coil spring compensates for any compression set the sleeve may take.

This may be the year that Chrysler tries to sell safety. In addition to the bumpers, it will have airbags across the board.

PM



First new Chrysler-designed and built powerplant in a generation is the 147-hp, 60° 3.3 V6.

OUTDOORS

SHARPSHOOTERS

We test four hyperaccurate match air rifles to find out why they're the top guns in world-class competition.

BY JIM BASHLINE; PM Photos by Brian Kossoff



THINK OF air guns and the first image that comes to mind is the Daisy Red Ryder BB gun that kids, and kids at heart, have elevated to the status of cultural icon for the past 50 years. More than 7 million of these lever-action guns have become prized possessions of adolescent boys and girls since they were introduced in 1938.

But the BB gun's popularity in the U.S. isn't shared in other parts of the world, particularly Europe. There, notably in Germany, air guns are regarded as serious, adult toys designed to fire pellets instead of BBs, and,

from an accuracy standpoint, there's really no comparison.

An accurate BB gun, charitably, is one that will group projectiles in a 2-in. circle at 15 ft. A sophisticated match-level air rifle firing standard .177 caliber pellets, can fire projectile after projectile into the same hole at that distance or at 10 meters (the prescribed Olympic shooting distance).

Of course, you move up in price as you go from BB guns to competition-quality rifles and the top performers cost more than \$1000. But what you get, in addition to masterly wood and metal craftsmanship, is a marvel of

high-tech design—ergonomically adjustable stocks, electronic triggers, adjustable micrometer sights and digital chamber-pressure readouts.

Four of the leading manufacturers were invited to ship us their most sophisticated rifles and when the boxes were opened we discovered all models weighed approximately 10.5 pounds and were a minimum of 43 in. long. Hands-on testing was done at a target range and all rifles were fired from a bench rest, using heavy sandbags for stability, at targets 10 meters away. Projectiles used were Haendler & Natermann .177 caliber pellets.



CROSMAN MODEL 84



ANSCHUTZ 2001



BEEMAN/FEINWERKBAU 601





Beeman/Feinwerkbau 601

Traditionally, German manufacturers have made the finest match air rifles in the world and competitors using the Beeman/FWB 601, along with the Anschutz 2001, have often swept all medals at international events.

At first glance, the 601 is a refined-looking rifle with a laminated stock made from alternate strips of light and dark hardwoods. The strips are bonded with hard rubber and the result is a highly stable stock virtually impervious to moisture.

Unlike the other rifles, the 601 has a short 16.6-in. barrel with a screw-on

extension that increases the rifle's length to 25.5 in. The extension is merely a hollow tube through which the pellet floats. The theory here is that a compressed-air-powered pellet achieves top speed (about 600 fps) a microsecond after the air pressure strikes its base. Powder-propelled bullets, on the other hand, must burn progressively during the entire length of the barrel.

According to this theory, a long barrel with spiral grooves increases risk of introducing flaws in trajectory.

The trigger on the 601 is nothing short of superb. It's fully adjustable and snaps wonderfully from shot to shot. Most unusual is a knurled knob inset in the stock that changes trigger weight without use of tools. A protruding chamber makes this a very easy gun to load.

As noted, the laminated stock is stunning, but it's finished so smoothly that the pistol grip has a slippery surface. This is easy to correct, however, with a little sanding and rasping.

Equally as impressive as the 601 is the Nickel running-target telescope (also made in Germany) that comes with it. The objective lens on the Nickel scope (about \$1700) measures more than 2.5 in. across and gathers so much light that it's like looking through a spotlight. Twin post reticles appear in the brilliant image area and they can be adjusted with elevation and windage knobs. (Note: The 601 was tested both with the Nickel scope and without it.)

There's little doubt the 601 (about

\$1200) will cut the heart out of a 10-ring target all day long, even in the hands of a nonOlympian.

Anschutz 2001

The black-and-birch colored stock and racy, slanted fore end give the 2001 high marks for styling. Aside from space-age looks, the 2001 shares a number of features with the Beeman/FWB 601. Chief among these is an almost infinitely adjustable stock. The length of pull, height of comb and positioning of buttplate can all be arranged to accommodate any shooter's stance and physique.

Apparently, Anschutz sets the



Propellant pressure is monitored on the Crosman Model 84's LCD display. The rifle also has an electronic trigger and two refillable CO₂ cylinders.

standard for competition-quality micrometer sights (all four models in the test featured them), and those on the 2001 are superb. So is the trigger, which felt fully as crisp as that of the Beeman/FWB 601. The stippling on the pistol grip and the ribbed rubber buttplate also felt like winners under shooting conditions.

As with the 601, anyone who couldn't shoot one-hole groups with the 2001 (approx. \$1350) from a bench rest should visit an optometrist.

Crosman Model 84

This is the only rifle tested that uses CO₂ as a propellant. Instead of pumping a lever for each shot, the shooter merely pulls back on the cocking ears and a new charge of gas is bled into the chamber. The Crosman Model 84 comes with two refillable CO₂ cylinders that provide up to 100 shots at adjustable velocities up to 720 fps.

Other high-tech features include an electronic trigger, which must be reset between each shot, and a digital LCD gas-pressure readout. Unlike most gas-powered guns, Model 84 is pressure regulated for consistency.

In addition, it also allows the shooter to adjust shooting pressure to vary muzzle velocity to a maximum of 720 fps. This can be done by twisting a knob. Once the gas has filled the chamber, the shooter can then check its pressure (up to 750 psi) by pressing a button to activate the readout.

The pistol grip and adjustable comb and rubber buttplate are extremely comfortable. Some shooters may miss the crisp snap of a mechanical trigger, but we found the electronic trigger worked well after it was broken in.

The only nit to pick is the bright chrome finish on the barrel, which can easily reflect light into the eyes of a shooter or nearby competitors. Aside from this easily corrected problem, the Model 84 (about \$1300) can shoot a 5-shot pattern about as small as the zero in its LCD display.

Daisy Gamo 128

The same company that brought us the Red Ryder BB Gun has joined the elite world of match-level competition with a true international rifle, the Gamo 128, which utilizes a Lothar Walther barrel, an Anschutz rear sight, a Spanish assembly, a European walnut stock and Daisy engineering.

Interestingly, the Gamo 128's cocking lever swings from front to back, the reverse of the two

German guns, which worked well and seemed to require less effort than the others. Like the Beeman/FWB 601, the 128's pistol grip was unadorned by any checkering or stippling.

The first few shots revealed the trigger had a slight catch to it, but tinkering with the adjustment screws and further breaking in eventually solved the problem. By the end of the day, the 128 (about \$500) was shooting patterns as tight as the renowned German rifles.

All four of these match-level air rifles, the most accurate in the world, are capable of shooting one-hole groups. This means that each time a pellet is shot, the hole on the target expands by half a pellet diameter or less. Those of us who are better than country-fair shooters pick up these space-age rifles, fire off a few tight, 5-shot patterns and think, "If I can shoot this well, how well do Olympic shooters have to shoot to win?"

The answer is very well indeed. It's the human factor that makes the difference, because today's pellets, barrels, sights and triggers are about as accurate as they're going to get. **PM**

HOME AND SHOP JOURNAL

COMPARISON TEST

SABRE SAWS

Any sabre saw will cut,
but some are a cut above.

BY THOMAS KLENCK,
Associate Home and Shop Editor
PM Photos by Brian Kosoff



IF YOU WANT to produce fast, straight rips in stock up to 2 in. thick, crosscut with speed and accuracy at bevel angles from 90° to 45°, or cut plywood straight and square, then go buy a circular saw. However, if you're willing to trade off some speed and accuracy for the ability to follow curved or straight lines, cut totally enclosed holes of any shape—and have metal-cutting capability, you're in the market for a sabre saw.

Sabre saws range from around \$30 for occasional-use versions, to well

over \$200 for professional models. Most of the inexpensive units feature trigger-controlled variable speed. On more expensive models, variable speed is either trigger controlled or set on a separate speed dial. The professional trigger-controlled tools have a speed dial on the trigger that allows you to set and hold blade speed at a specific rate.

Many models are available with electronic speed control that monitors the cutting load and maintains a constant speed. If you're cutting through

stock that varies in thickness, it may help. Otherwise, simply setting an appropriate speed and adjusting the cut rate by feel should work fine.

Sabre saws come in two basic designs. The standard top handle configuration is the most common and permits easy one-handed operation. Some pros prefer the barrel-grip design—one hand holds the motor housing while the other grips a knob mounted over the front of the tool. While this method offers increased control for curve cutting, choosing



HITACHI CJ 65V



SKIL 4580



MAKITA 4301BV



BOSCH 1581 VS

one or the other is a matter of personal preference.

Other than heavier construction and longer life, choosing a more expensive tool offers only one truly significant feature—orbital action. Here, the end of the blade moves in and out in line with the cut as it travels up and down. Cutting speed increases and with it the ability to easily handle thick stock. However, accuracy in terms of a square cut and the quality of the cut diminishes. All tools with orbital action allow you to adjust the degree to which the blade moves in and out—usually in four steps, from no orbit to maximum orbit.

Because sabre saw performance is so closely related to the material being cut and the blade that's installed, the best way to compare the actual tools is by using one type of blade and one material throughout. We performed all our tests with similar taper-ground, wood-cutting blades.

Unfortunately, the blade-holding system of each machine is far from standard and some tools can only be fitted with one type of blade. The most common blade type—straight shank with a semicircular notch at the top and a hole in the side—can't be installed in the Bosch and Porter-Cable tools. And, although it can be fitted in the Freud unit, it's not recommended by the manufacturer.

The Bosch-type blade is becoming increasingly popular. It has two small protrusions near the top and is offered as standard equipment with the Makita and Hitachi tools. The Porter-Cable blade features a hook design and only fits sabre saws made by this manufacturer. (See specification chart on page 82.)

Most sabre saws can be fitted with a T-shaped fence for sawing parallel to the stock edge. Making the system work properly depends not only on the condition of the blade and the uniformity of the material being cut, but on the precise alignment of the blade with the base. A slight misalignment will cause the blade to gradually bend, producing a twisted kerf. If the blade bends far enough, the tool will no longer track against a straightedge and the cut veers. Some tools are so severely misaligned that the saw can not be held against a straight guide strip at all. (See tracking chart on page 83.)

Our comparison test focuses on full-featured professional tools. They're expensive, but generally worth the price if used fairly often. Don't take the list prices too seriously, however. Many of these tools are heavily discounted by mail-order and industrial suppliers. We also take a close look at three of the more consumer-oriented saws. (See sidebar on page 84.)

AEG BSPE 100

The AEG tool has a unique, hollow plunger that allows you to match the blade depth to the stock thickness. As the teeth dull, you can simply expose more of the blade and, thereby, use it more efficiently.

This saw ranked at the top for speed of cut. It also produced square cuts at each orbit position and was easy to keep on the line during our contour cutting trials.

The single Allen wrench required to adjust the base and loosen the blade is neatly stored in a clip on the base. However, the blade-locking screw is under a protective guard and the plunger often needs to be pried up or down slightly to make the screw accessible.

The tilting base features sturdy, positive notches for locking at the most common bevel angles. To help reduce tearout, the tool comes with a plastic antisplintering shield that fits in the mouth opening. In terms of comfort and handling, the tool fares well—its oversize trigger-lock button is an especially nice touch. And, the tool is light—a real plus for cutting in awkward situations.

We were really beginning to like this tool until we checked it for tracking. It's impossible to guide this tool along a straight fence—the cut immediately curves away from parallel.



RYOBI JSE-60



AEG BSPE 100



FREUD CA 60 PEM



**PORTER-CABLE
7548**



SEARS 17210



MILWAUKEE 6256



**BLACK & DECKER
3158K**

Black & Decker 3158K

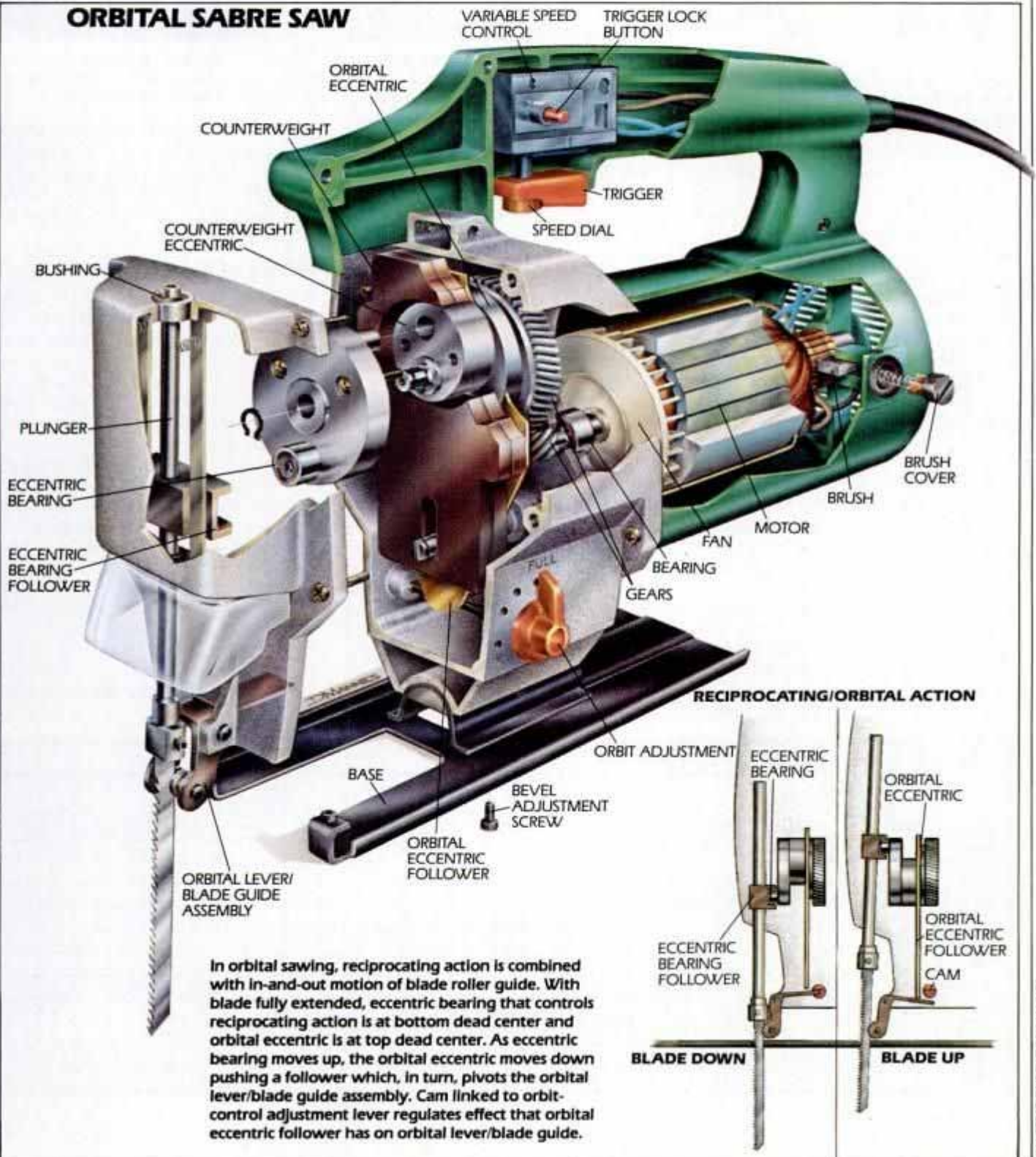
The B&D features a trigger-mounted speed dial with clear graphics on the trigger side indicating the set speed. Its unique orbit-selection control is a seesaw affair that's easily accessible from both sides of the tool. Unfortunately, the switch is very uncertain in feel and it's difficult to know which position it's in. Although the tool has a

large base, its effectiveness is reduced by heavily rounded edges. And, the base must be turned end-for-end to change from the narrow mouth to the wide mouth necessary for beveling. It must be completely removed and the Allen screw repositioned through the base in a second hole—an annoying operation at best.

While most other sabre saws have a

round plunger, B&D uses a rectangular-sectioned shaft that shows excessive side-to-side play. The saw cuts square on straight passes, but goes off square slightly and tears out more on the curves. It doesn't blow away the dust at slow speed. However, at any speed, the saw easily follows the line. It's loud but faster than most and follows a straight fence fairly well.

ORBITAL SABRE SAW



In orbital sawing, reciprocating action is combined with in-and-out motion of blade roller guide. With blade fully extended, eccentric bearing that controls reciprocating action is at bottom dead center and orbital eccentric is at top dead center. As eccentric bearing moves up, the orbital eccentric moves down pushing a follower which, in turn, pivots the orbital lever/blade guide assembly. Cam linked to orbit-control adjustment lever regulates effect that orbital eccentric follower has on orbital lever/blade guide.

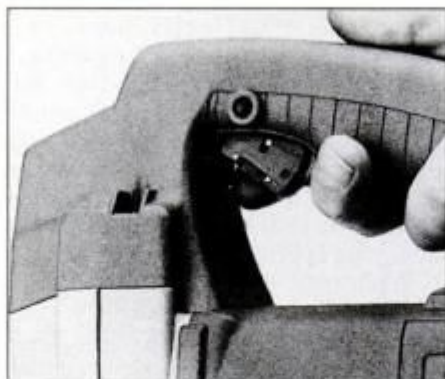


Loosening screw unlocks base to adjust for bevels. AEG, Freud and Bosch (shown) feature notches that engage at common angles.

Bosch 1581 VS

With a little common sense in matching the tool to the job, you could buy virtually any sabre saw and probably be satisfied with it—until you tried the Bosch 1581 VS. This saw is quiet—no mean feat in light of the mechanical linkages required to produce an orbiting and reciprocating blade. While it ranked just behind the front-runners for speed of cut, it's the easiest tool for following a curved or straight line and produces a very smooth cut. It also tracks fairly well. For slow cuts, you can activate a blower that keeps the cutline clear of dust.

The base locks at 90° and 45° through a carefully made tapered pin that engages notches on the base. Blade securing is unorthodox, but positive and solid. Only Bosch-style blades can be used and you need a long, thin, flat-tipped screwdriver—supplied with the tool—for the job. Bevel adjustments are made with an Allen wrench stored in the base. For fine work, a plastic antisplintering shield can be installed in the mouth



Milwaukee, Makita, Sears and Skill tools vary speed at trigger. Trigger-mounted dial sets maximum speed trigger can be locked at.

opening. The tool is very comfortable and scores high on fit and finish.

On the downside, the tool has a relatively short (6½-ft.) power cord and there's no simple way to access the brushes. And, although the speed dial works well, we'd rather see it on the top, front of the handle rather than on the side where it's harder to reach.

Freud CA 60 PEM

The Freud tool resembles the AEG in its sensible, oversize trigger-lock button and annoying shroud over the plunger end that interferes with accessing the blade screw. The Freud also performs unacceptably when guided along a straightedge—the blade is visibly misaligned with the base of the saw.

Our cutting trials exhibited lackluster performance. The cuts were slightly out of square—even with the orbiting action off. Tear-out was on the heavy side and the quality of the cut was relatively rough. This tool was incapable of blowing the dust off the cutting line at any speed.

However, it's fairly comfortable to



Trigger on saws with separate speed dial simply acts as ON/OFF switch. Cutting speed can only be varied by adjusting dial.

use and the Allen wrench holder is one of the best. The base features a notched bevel-lock system similar to AEG. This tool comes complete with a very good fence. The only question is: What do you do with it?

Hitachi CJ 65V

This Hitachi tool is clearly the most comfortable to hold and ranks just behind the Bosch for quiet, smooth-running operation. The trigger and speed dial are well designed, but the dial is placed at the back of the tool—you can't operate it with the hand that holds the tool.

This saw produces very smooth cuts with orbital action off—both tear-out and squareness deteriorate at any orbit position. One small Allen wrench adjusts the base and locks the blade. However, it's metric. In this country, at least, if you lose it, it may take you awhile to find another. The tool is very workmanlike in design and construction with provision for easily changing the motor brushes. It comes with a rip fence and circle-cutting guide.

SABRE SAW SPECIFICATIONS

MANUFACTURER	MODEL	PRICE ²	AMPS	STROKE	STROKES PER MINUTE ⁴	ELECTRONIC CONTROL	ORBITS ⁵	BLADE ⁶ TYPE	CAPACITY ⁷ WOOD (MILD STEEL)	WEIGHT (LBS.)
AEG	BSPE 100 ¹	\$250 ³	4.6	1"	450-3200	yes	3	A,B	2½" (¼")	4.5
Black & Decker	3158K	\$208 ³	4.5	1"	0-3100	no	3	A	2½" (¼")	6.25
Bosch	1581 VS ¹	\$239	4.8	1"	500-3100	no	3	B	2½" (¾")	5.75
Freud	CA 60 PEM ¹	\$218 ³	5	1"	500-3000	yes	3	A	2½" (¼")	5.4
Hitachi	CJ 65V ¹	\$239	3.7	1"	700-3200	yes	3	A,B	2½" (¼")	5.5
Makita	4301BV	\$274 ³	3.5	1"	0-3100	no	3	A,B	2" (¼")	6
Milwaukee	6256	\$217	3.8	1"	0-3100	no	0	A	2½" (¾")	5.75
Porter-Cable	7548 ¹	\$230	4.8	1"	500-3200	yes	3	C	2½" (¼")	6.5
Ryobi	JSE-60	\$234	3.5	1"	1000-2700	yes	3	A	2½" (¼")	5.5
Sears	17210	\$65	2.5	¾"	0-3000	no	0	A	1½" (¾/16")	5.6
Skill	4580	\$140	3.5	13/16"	0-3200	no	6	A,B	2" (¾/16")	5.6

1. Available in a barrel-grip version. 2. Suggested list price. 3. Price includes case. 4. Saws that range from 0 strokes per minute have trigger speed control. All others have separate dial speed control. 5. Orbit positions in addition to standard action. 6. A: standard straight-shank blade. B: Bosch-style blade. C: Porter-Cable blade. (Note: AEG offers long blades designed for hollow plunger.) 7. As stated by manufacturer.

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Side-mounted, 4-position orbital adjustment lever is common to Makita, Hitachi, Bosch, Freud and AEG tools tested.



Porter-Cable sabre saw features orbit selection dial behind housing. Ryobi control is similar but mounted in housing.



Black & Decker orbital adjustment lever is mounted behind housing and pivots at center. It can be operated from either side.

Makita 4301BV

This is the most compact tool of the group. While that's a plus, it also has one of the most uncomfortable grips. Its trigger-mounted speed dial is too small to adjust easily and there's nothing that indicates which way it increases or decreases speed. This tool does nothing for the noise-pollution problem—it's loud.

However, it produced acceptable square cuts with a noticeable deterioration in smoothness as the orbit increased. It blows the cutline clear, even at low speeds, and is easy to control. The tool is a fairly fast cutter and displayed the least deviation when guided against a straightedge at the zero orbit position.

The motor brushes are accessible for maintenance, and the single metric Allen wrench is stored in a plastic clip on the cord.

Milwaukee 6256

Although it lacks orbital action, the 6256 typifies the robust and no-nonsense nature of a tool designed for work. The saw easily follows a cutline

with excellent visibility. It produces square cuts on a straight run with slight problems through the turns. The cuts are smooth and the tool is relatively quiet.

We didn't like the awkward trigger-mounted speed dial. And, while the base can be shifted forward for narrow and back for wide-mouth options, the wide-mouth position, necessary for beveling, leaves too little base for proper support in front of the blade.

With no orbit capability, the tool ranks low in speed of cut. However, it still features a roller guide to support the blade which helps prevent breakage. Both the base and blade screw are simple slot-head screws and the rear section of housing can be easily removed to replace the brushes or cord.

Porter-Cable 7548

Porter-Cable seems to be pretty serious about this tool and apparently feels that real sabre saw users never cut bevels: The massive base is simply screwed to the front housing. The

blade guide, normally a simple, grooved-roller affair, is comprised of three ball bearings—one at the back to take the thrust, and one at each side to prevent blade deflection. And, a substantial metal antisplintering shield is supplied with the tool.

Appearances, though, can be misleading. While the saw did produce square, straight cuts at all orbits, the cuts went slightly out of square on curves. The quality of cut was rougher and showed more tear-out than expected—the saw seemed to lurch through the wood.

The problem seems to be with those nifty ball-bearing guides. The two on the side are nowhere near the blade. And, P-C uses a square-section plunger that not only appears similar to the B&D system, but shows the same excessive side play. Running the saw free exhibits considerable blade whip.

However, this tool felt very stable and offered exceptional blade visibility. Like the Bosch, a blower can be activated to clear the cutline of dust at slow speeds. The orbit control works well and, at maximum orbit, the tool

PERFORMANCE COMPARISON CHART

MAKE & MODEL	CUTTING SPEED ¹		NOISE LEVEL ²		TRACKING ³	
	SLOW	FAST	QUIET	LOUD	TWISTING KERF	VEERING FROM FENCE
AEG BSPE 100	██████████	██████████	██████████	██████████	██████████	██████████
Black & Decker 3158K	██████████	██████████	██████████	██████████	██████████	██████████
Bosch 1581 VS	██████████	██████████	██████████	██████████	██████████	██████████
Freud CA 60 PEM	██████████	██████████	██████████	██████████	██████████	██████████
Hitachi CJ 65V	██████████	██████████	██████████	██████████	██████████	██████████
Makita 4301BV	██████████	██████████	██████████	██████████	██████████	██████████
Milwaukee 6256	██████████	██████████	██████████	██████████	██████████	██████████
Porter-Cable 7548	██████████	██████████	██████████	██████████	██████████	██████████
Ryobi JSE-60	██████████	██████████	██████████	██████████	██████████	██████████
Sears 17210	██████████	██████████	██████████	██████████	██████████	██████████
Skil 4580	██████████	██████████	██████████	██████████	██████████	██████████

1. Comparative speed as determined by cutting through 2x10 stock with taper-ground blade at maximum orbit (where applicable). 2. Relative noise level of free-running tools as measured on dbA scale. 3. Length of bar indicates inability to cut straight when guided by a straight fence during ripping and crosscutting operations over 8 in. All tools showed a varying tendency to produce twisted kerfs. Severely misaligned tools immediately veered from fence.

ity to cut straight when guided by a straight fence during ripping and crosscutting operations over 8 in. All tools showed a varying tendency to produce twisted kerfs. Severely misaligned tools immediately veered from fence.

cuts very fast. The speed dial can be easily reached with one hand while holding the tool normally. While the tool tracks fairly well, there's no provision for a fence.

Ryobi JSE-60

The base on this tool is reversible—one end has a wide mouth for beveling and the other a narrow mouth to reduce tear-out on 90° cuts. Our suggestion is to use only the wide mouth. Not only is it a nuisance to change back and forth, but the blade on our saw actually rubbed against the base when the narrow mouth was used.

In freehand work, the Ryobi tool cut squarely, but the quality was rough and it cut on the slow side. The tool vibrated more than average and felt like it was laboring through the work. It was impossible to guide this saw against a straightedge. The controls had a flavor of cost-cutting about them—a feeling that, unfortunately, permeated the whole tool.

Sears 17210

Sears doesn't offer a saw with orbital action. Its top-of-the-line model does have an additional feature though—a pivoting blade for facilitating tight scroll work. Instead of turning the whole saw, you just turn the blade while moving the saw in the desired direction. While some may find this a handy feature, for run-of-the-mill cutting, it's just as easy to turn the saw.

We found that the clear plastic blade guard had to be removed to make the cutline visible. Even then, the blade is so far behind the blade clamp, you'll have to lean well over the front of the tool to get close to see what you're doing. Of course, then you'll need ear protection—this tool is noisy.

The Sears tool produces acceptable square cuts at all speeds on straight and curved profiles and tracks well. The lack of orbital action limits the tool to light-duty cutting. It comes with a fence and circle guide.

Skil 4580

Skil calls its orbiting capacity Vari-Orbit. It features no less than six orbit positions including normal action. The Skil tool achieves its orbiting action unlike any of the other tools—invisibly in the front housing at the plunger top rather than at a guide roller near the base. The manual indicates that the orbital action isn't apparent unless the tool is actually cutting. Perhaps we lacked the necessary sensitivity. No matter what or-

bit position was set, cutting speed seemed about the same. However, we did notice slightly more splintering at any orbital position than at standard cutting.

The Skil sabre saw has a very large, stable base, follows the cutline well and uses sensible slot-head screws for securing the blade and adjusting the base. Simply loosening the screw allows the base to be shifted forward or backward for wide- or narrow-mouth options. The trigger-mounted speed dial, however, isn't so handy. It's too small and should be marked to indicate speed adjustment.

The Bottom Line

A good sabre saw doesn't just cut well, it must be both easy to handle and comfortable so you're free to concentrate on the job at hand. It should also be made with the same care and attention to detail that you'd strive for in your finest work. Of the tools

that we tested, one comes closest to these ideals—the Bosch 1581 VS.

The Hitachi CJ 65V and Makita 4301BV are our next choices. While the Hitachi has a definite edge in terms of comfort and handling, the Makita shows more aggressive, straight-tracking performance.

Although sabre saws are used mostly for freehand cutting, guiding the saw along a straightedge or with a fence is clearly an option that manufacturers are featuring to enhance their product. And, it isn't unreasonable to expect that, before any frills are added, the blade clamp of the tool should be engineered so that the blade will be accurately aligned with the base. While none of our test saws tracked with circular-saw accuracy, the AEG, Freud and Ryobi units that we tested were so blatantly misaligned that guided cuts were absolutely impossible. Of these three, the AEG was the better saw. **PM**

Occasional-Use Sabre Saws

YOU DON'T HAVE to spend \$200 for a sabre saw. In fact, some manufacturers offer a wide selection of models and prices designed to ensure that there will be one saw that matches the money in your pocket.

The medium- to low-priced tools are smaller, lighter and generally have a life expectancy to match. They often have sleeve bearings, lack a roller blade guide, and the quality control can be lower. However, for occasional use in nothing heavier than ¾-in.-thick plywood, they'll do the job.

The **Black & Decker 7548** (about \$57) was the quietest of the three inexpensive saws we tried—well below the expensive group average. It easily followed a cutline, producing smooth, splinter-free results. Unfortunately, the cuts were slightly out of square and the sliding variable-speed switch is sticky—unable to progress uniformly through the speed range.

It features a novel blade and screwdriver holder that slips in the cavity between the base and housing. This seemed like a great idea until the blades fell out during a cut. And, although the unusual housing design makes this unit look more like a kitchen appliance than a tool, the saw is compact, light and generally easy to handle.

In many respects, we consider the Sears

1070 a better tool than the top-of-the-line model from the same company. It's quieter, more comfortable to hold, and offers slightly better cutline visibility although the blade is still set too far back in the blade clamp. It takes two screws to hold the blade in place—one in line with the blade to resist forward thrust and the other on the blade side. Both screws are the slot-head type. Unlike the B&D saw, you can't lock the variable speed at any setting but high speed. This tool comes with a rip fence/circle-cutting attachment and it costs about \$43.

Of the three inexpensive saws, the **Skil 4235** is the poorest tracker—unusable when guided by a straightedge. However, freehand cutting is easy at all speeds and the straight cuts are square. Curved cuts, though, are significantly out of square. The tool is comfortable to hold although a little noisy.

The Allen wrench that adjusts the base and tightens the blade is securely stored in a recess in the housing. A little too securely, though—you'll need a pair of pliers or screwdriver to pry it out. Like the Sears tool above, the 4235 may be a better choice than its more expensive cousin. You'll have to forgo the ball and roller bearings, but, at less than half the price, it will do much the same work. This model costs about \$56.





HOME AND SHOP PROJECT

SHAKER END TABLE

An elegant end table you can use in any room of your home.

BY NEAL BARRETT

THE SIMPLE LINES and crisp details of this small table were inspired by the Shaker furniture tradition. The Shakers were known for

their lean, well-balanced designs, many of which, not surprisingly, fit in as well today as when they were built. We think this table is just as adaptable. Whether it's used as a living room side table or as a bedroom night stand, it will prove a tasteful addition to almost any decor.

Our side table is built of solid maple and uses traditional joinery. Like the Shaker tables on which it was modeled, it will give years of service.

Construction

Begin by ripping and crosscutting $\frac{3}{4}$ -in.-thick boards, slightly oversized, for the tabletop. Square the edges of the stock on a jointer or with a hand plane. Spread glue on the boards' edges and clamp them together. Alternate the clamps above and below the panel to apply pressure evenly (photo 1).

Wait until the glue is rubbery, not hard, to scrape it off the panel with a chisel. When the glue has dried,

Lead color photo: J.R. Rost
Step-by-step photos: Neal Barrett
Technical Art: Eugene Thompson
Stylist: Gabe Henck

clamp the top down and, with a hand plane, smooth and flatten the top. Plane diagonally, then straight across the top (photo 2). Rip and crosscut the top to the finished dimensions.

Rip and crosscut stock for the legs. If you cannot get stock thick enough for the 1½-in.-sq. legs, glue and clamp together two boards. Lay out the mortise positions as shown on the drawing. Use a sharp pencil, knife or, better yet, a mortise marking gauge to mark the layout lines.

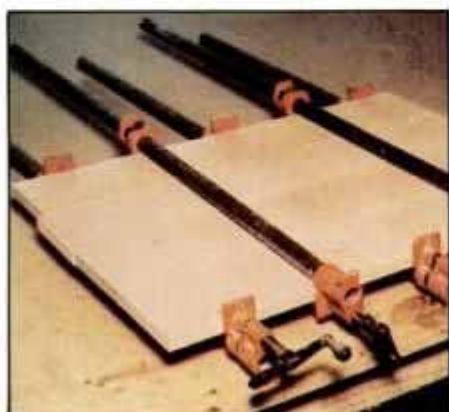
Clamp a fence to the drill press table to position the legs for boring.

Bore a series of overlapping ⅜-in.-dia. holes, 1⅜ in. deep for the mortise. The mortise is ⅜ in. deeper than the tenon to allow for glue squeeze out. Clamp the legs to the bench and, using a chisel, pare the walls of the mortise flat and square to one another. If the tenon fits the mortise too tightly, it's easier to adjust it, rather than the mortise.

Next, measure 5½ in. down from the top of each leg and cut a ⅜-in.-deep kerf around the leg's perimeter on the table saw (photo 5). The kerf prevents tear-out during turning.

Mount the legs on the lathe and turn them to shape using a ¾-in. or 1-in. gouge. Shape the small cove at the leg's top with a ⅜-in. gouge. Check the diameter of the legs as you turn them using a pair of calipers (photo 7). Finish sand the legs with 100-, 120- and 220-grit sandpaper. I like to use old sander belts for this job.

Rip and crosscut the ¾-in.-thick stock for the drawer rails and aprons. Using dado blades and a miter gauge, cut the aprons' tenons on the table saw. A parallel jaw clamp fastened to the miter gauge acts as a stop to posi-



1 Glue and clamp panel alternating clamps above and below to apply pressure evenly. Panel should be slightly oversize.



2 Use a sharp bench plane to smooth and flatten panel's top. First, plane diagonally across the panel, then with the grain.



3 With scrap wood fence clamped to the drill press table, use ⅜-in. drill bit to bore overlapping mortise holes.



4 Pare walls of mortise flat with chisel, working carefully to mortise lines. If tenon is too tight, pare it, not mortise.



5 Cut ⅜-in.-deep kerf around leg blanks to prevent chip-out when turning. Extend miter gauge with scrap piece.



6 Use ¾-in. or 1-in. gouge to turn tapered portion of legs. Use ⅜-in. gouge to shape small cove at top of leg.



7 Check large and small diameters with calipers. Smooth leg progressively with 100-, 120- and 220-grit sandpaper.



8 Cut tenon on table saw using dado blades and miter gauge. Parallel jaw clamp acts as stop for positioning workpiece.



9 Remove ridges left from dado blades by carefully pushing chisel across tenon. Hold chisel flat against workpiece.

tion the rails and aprons during the cut (photo 8). Pare down the ridges left from the dado blades using a sharp chisel (photo 9). Keep the chisel flat against the tenon.

Switch back to the drill press and bore the holes in the aprons and front drawer rail for the tabletop fasteners. Again, use a fence to position the workpiece (photo 10).

Apply glue to the front rail tenons and the mortises on the front legs and clamp them together. Measure diagonally across the drawer opening to check that the assembly is square

(photo 11). Glue and clamp together the rear legs and apron. Complete the leg-apron assembly by gluing and clamping the side aprons to the front and back legs (photo 12). Work on a flat surface to avoid putting a twist into the assembly during clamping. Measure diagonally across the assembly's top to check for square, adjust the clamps as necessary.

Cut the pieces for the side and bottom drawer runners to dimension. Bore and countersink the holes for No. 8 flathead screws that hold them in place. Fasten the runners to the

leg-apron assembly with the 1/4-in.-long screws (photo 13). The runners will have to be removed, so don't glue them in place.

Now, cut the drawer parts to dimension. Use a dado blade in the table saw to cut the rabbets on the drawer front and the dados in the drawer sides that hold them back. Use a thinner dado blade set up to cut the groove in the drawer front and sides. Bore pilot holes through the sides into the drawer front for the nails that attach the sides to it. Nail and glue together the drawer parts (photo 14). Use

SIDE TABLE

25-3/4" HIGH X
28" WIDE X
21" DEEP

DETAIL 1
E, F
3/16"-DIA. PILOT HOLES, COUNTERSUNK

TABLETOP FASTENER (12 REED.)
5/8" NO. 8 FH SCREW (24 REED.)

1-1/4" NO. 8 FH SCREW (20 REED.)

3/4" NO. 5 RH SCREW (5 REED.)

3/4"-DIA. RECESS FOR TABLETOP FASTENER

4d FINISHING NAIL (TYPICAL)

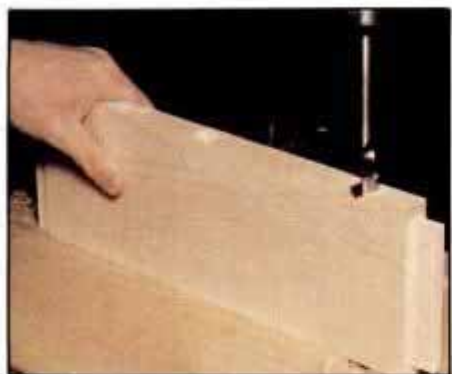
KNOB

MATERIALS LIST—SIDE TABLE

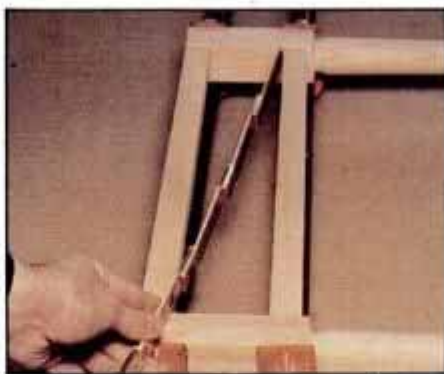
Key	No.	Size and description (use)
A	4	1 1/2 x 1 1/2 x 25" maple (leg)
B	1	3/4 x 5 x 21 1/2" maple (back apron)
C	2	3/4 x 5 x 17 3/4" maple (side apron)
D	2	3/4 x 1 x 21 1/2" maple (front rails)
E	2	3/4 x 3 x 16 1/2" maple (side runner)
F	2	3/4 x 1 x 17 3/4" maple (bottom runner)
G	1	3/4 x 21 x 28" maple (tabletop)
H	1	3/4 x 3 x 20" maple (drawer face)
I	2	1/2 x 3 x 18 1/2" pine (drawer side)
J	1	1/2 x 2 1/2 x 19 1/2" pine (drawer back)
K	1	1/4 x 14 3/4 x 19 1/2" birch plywood (drawer bottom)

Misc.: 1 drawer pull, 12 tabletop fasteners (Knap & Vogt No. 1547), 24 5/8" No. 8 fh screws, 20 1/4" No. 8 fh screws, 5 3/4" No. 5 rh screws, 4d finish nails, glue, 120-, 220-, 320-grit sandpaper, 4/0 steel wool, wax Waterlox Transparent finish, Waterlox Chemical and Coatings Corp., 9808 Meech Ave., Cleveland, OH 44105.

FRONT RAIL DETAILS
LEGS DETAIL
APRONS DETAIL



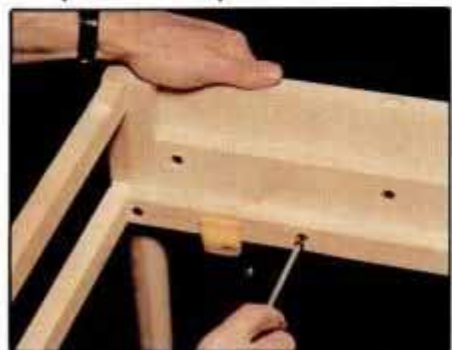
10 Bore holes for tabletop fasteners on drill press. Hold workpiece against fence clamped across drill press table.



11 Glue and clamp front rail and leg assembly. Check that drawer opening is square by comparing diagonal lengths.



12 Complete leg-apron assembly by gluing and clamping side rails to legs. Measure opposite diagonals for square.



13 Bore and countersink holes for screws in drawer runners. Lubricate screws with wax. Hold runners in place with clamps.

screws to hold the bottom to the drawer back. Check that the drawer is square and let the glue dry. Test fit the drawer. Sand or plane its sides if it fits too tightly. Attach the tabletop fasteners (photo 15).

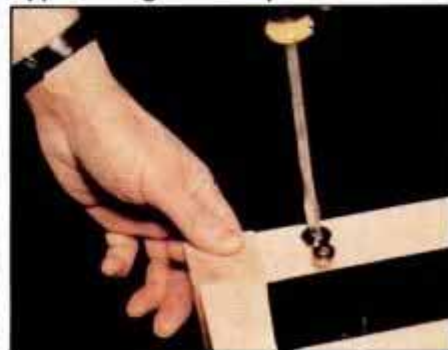
Sand the table with 120- and 220-grit sandpaper. Dust it off, and wipe it



14 Assemble drawer with glue and nails. Check diagonals for square and adjust as necessary. Sand front before attaching.

with a tack cloth. I finished the table inside and out with three coats of Waterlox Transparent. Sand lightly between the outside coats (don't bother sanding inside) with 320-grit sandpaper. Rub down the last coat with 4/0 steel wool.

The first step in attaching the top is



15 Install tabletop fasteners. Apply finish outside and inside table. Invert table on padded workbench and fasten top.

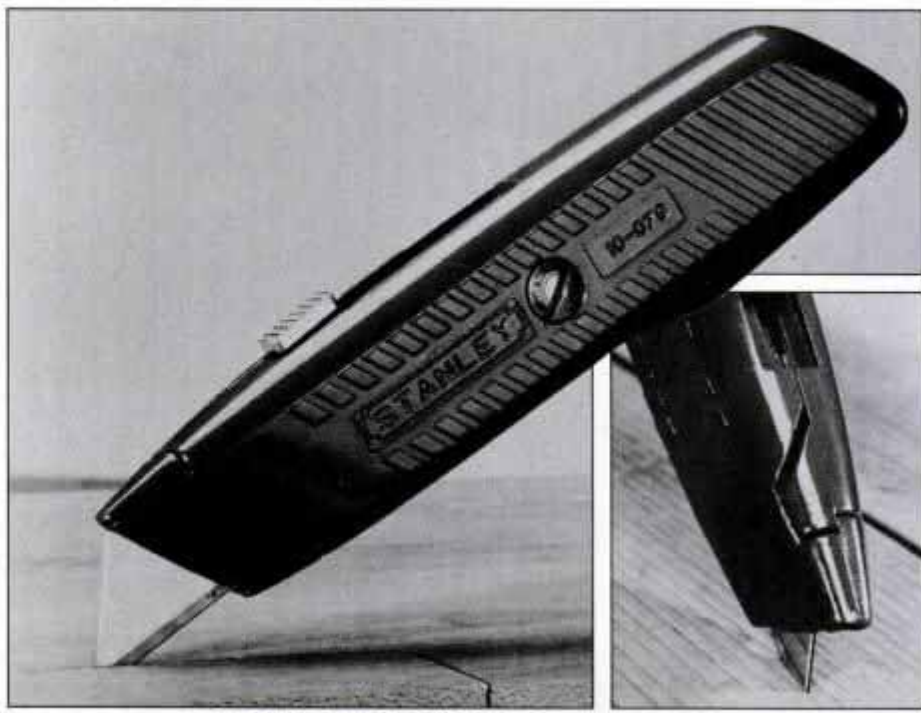
to remove the drawer runners. Cover the workbench top with a blanket to protect the top. Lay down the top, invert the table over it. Screw the top in place with the correct overhang around the perimeter.

Finish the job by reattaching the drawer runners. **FM**

NEW TOOL UTILITY KNIFE

HOPING TO improve on its time-tested retractable utility knife, Stanley has introduced the model 10-079. Compared to the old 10-099, the new knife has grips cast into its sides and an ergonomic shape to improve handling. It also has a new interlocking nose that prevents the blade from slipping between the body halves. Like its predecessor, the new model has blade storage in the body.

The new knife will cost about \$5 at hardware stores and home centers. For information, write Stanley Tools, Division of The Stanley Works, 600 Myrtle St., New Britain, CT 06050. **FM**



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It's a new approach to a tough old problem. And, part of the 3M Wood Refinishing System. From stripping and surface preparation, to finishing and right on through cleanup, 3M has the right tools and products to make the job go better and the project look better.

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FREE SAMPLE KIT

WOOD REFINISHING SYSTEM



IN OUR MAY '89 issue (page 148) we reviewed 3M's new paint and varnish remover called Safest Stripper. We put the product through its paces and concluded it was a wonderful new concoction. It's nonflammable, won't irritate your skin, and gives off no harmful fumes. Because it has a thick, semipaste consistency, it works equally well on vertical and horizontal surfaces. Safest Stripper cleans up with water and has an open time of up to 30 hours.

Because we thought a lot of you would like to try out this product, we

made an exclusive arrangement with 3M to provide you with a free sample kit. The kit features 3M's stripper, innovative Scotchgard Wipe-On Poly finish, two wood samples—one stained, the other painted—and two stripping pads, one coarse- and one fine-grit.

If you'd like to receive a free kit for your own hands-on test, just write to: PM/3M Refinishing Kit Giveaway, POPULAR MECHANICS, P.O. Box 1409, New York, NY 10101. The offer is on a first-come, first-serve basis and supplies are limited. **PM**

NEW PRODUCT

ALL-PURPOSE CLEANER

LIFT OFF is a new all-purpose spray solvent and cleaner for hard surfaces and fabrics. It's formulated to soften chewing gum, cut through engine grease and dissolve adhesive residue left from labels and stickers. Also, it can be used as a prewash treatment: Spray it on a stained garment, let it sit for 1 minute and launder as usual.

It's available in three different sizes: 1 ounce, \$2.79, 5 ounce, \$3.49 and 9.5 ounce, \$4.39. It's sold at hardware stores and home centers. For more information, write Loctite Corp., 4450 Cranwood Court, Cleveland, Ohio 44128. **PM**





**WHEN YOU DEPEND ON TOOLS,
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How To Install A CLOSET ORGANIZER

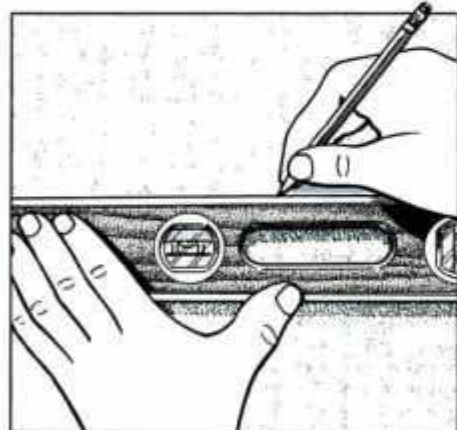
HOUSES TODAY have more closets than those built a few decades ago, and closets are bigger, too. But still, most of us seem to have more stuff than can be kept neatly in any closet. It seems like our clutter simply cannot be contained by a single rod and shelf.

Closet organizers, really wire-framed racks and baskets, were designed to make life easier. They allow for neat storage, easy access and ventilation. Their segmented design helps you stay organized because everything has a place.

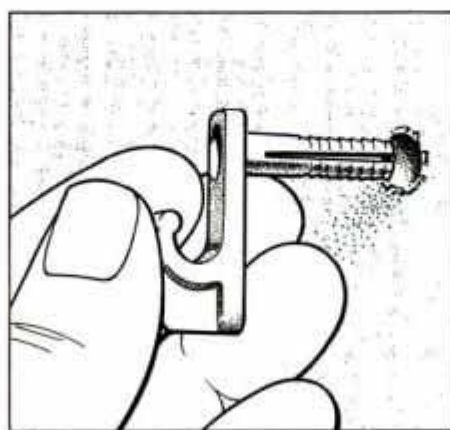
Most organizers can be installed in the same way we show here. Begin by measuring the height, depth and width of a closet. You now have two choices. Some home centers sell closet organizer components that you assemble into your own system. Or, you can take your measurements to a closet organizer dealer. The dealer will help design your organizer, so all you do is install it.

Installation

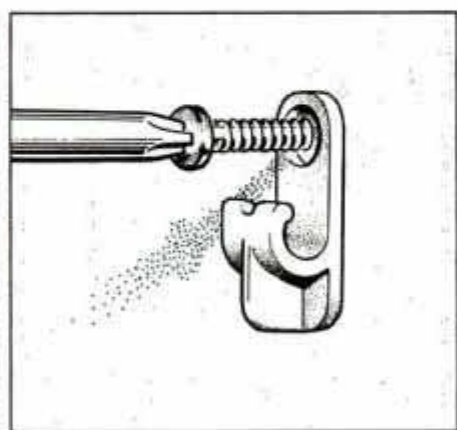
Measure the height of the organizer's highest shelf against the back wall. Using a level, draw a line from the mark completely across the back wall



1 Mark for the organizer's highest shelf and butt a level up to the mark. Draw a level line across the closet's back wall.



2 Bore $\frac{3}{16}$ -in. holes for shelf hooks 2 in. in from ends of level line and every 12 in. in between. Insert hooks facing up.



3 Fasten hook to wall with No. 6 panhead screw. Built-in drywall anchor holds hook to wall regardless of void behind it.

(Fig. 1). Next, bore a $\frac{3}{16}$ -in.-dia. hole 2 in. in from each end of the line and every 12 in. in between. Insert a shelf hook, facing up, into each hole (Fig. 2). Fasten the hooks to the wall using a No. 6 panhead screw. These hooks have built-in wall anchors.

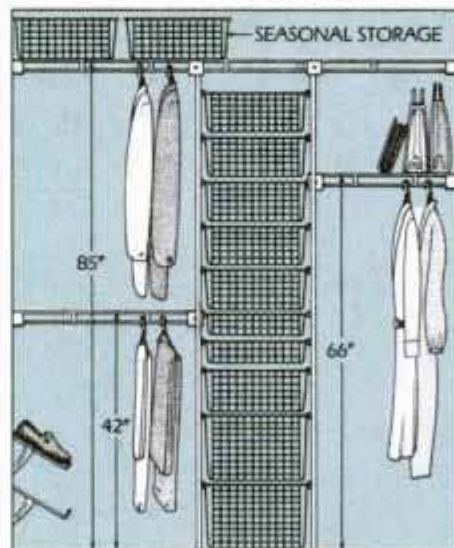
Hang the shelf on the hooks. Next to each hook, bore a hole. Insert a wall anchor in the hole and screw in a hook facing down (Fig. 4). These stop the shelf from pivoting off the hooks that are facing up.

Next, slide an end bracket over the shelf's support rail. Level the shelf and mark for the bracket's screw-holes. Bore the holes and insert wall anchors. Lift the shelf above the holes before screwing in the brackets because the brackets will prevent this afterward (Fig. 5).

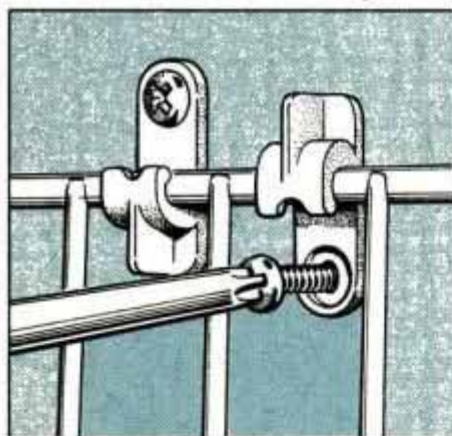
Install the first shelf brace at mid-span. Snap a plastic plate over the support rail. Position a brace behind the plate and bolt the two together (Fig. 6). Mark where the other end of the brace falls, for the screw-hole, and move the brace out of the way. Bore

the screw-hole, insert a wall anchor, and screw the brace to the wall. Install other braces every 40 in. from the center outward.

TYPICAL CLOSET LAYOUT



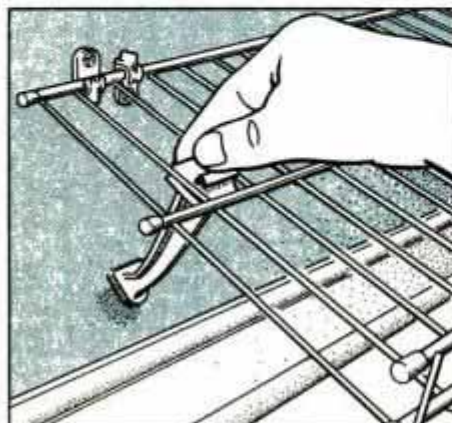
Completed organizer is divided for suits, dresses, pants and miscellany. Top shelf holds baskets of out-of-season garments.



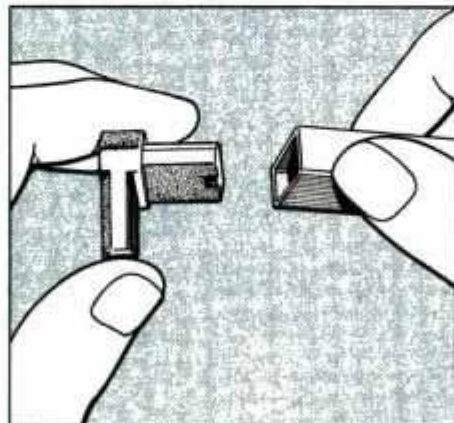
4 Snap shelf into hooks facing up; pivot it against wall. Slip matching hooks face down over shelf's rail. Screw in place.



5 Pivot shelf away from back wall and place side-wall bracket over end of rail. Level shelf and screw bracket to wall.



7 Attach shoe racks with hooks as was done with top shelf. Snap on two braces to center rail, one at each end of rack.



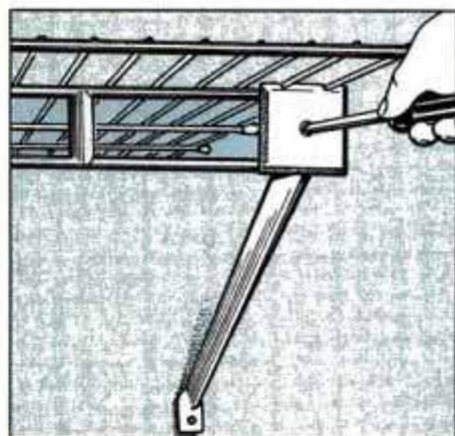
8 Begin assembly of rectangular tubing frames for wire drawers by pushing L-shaped connectors into ends of cross bars.

Follow the same procedure for the shorter shelves and shoe racks. The first shoe rack is installed 12 in. above the floor. Subsequent racks are installed every 9 in. above that. The racks are supported, at an angle, by a snap-on brace at each end that butts against the wall (Fig. 7).

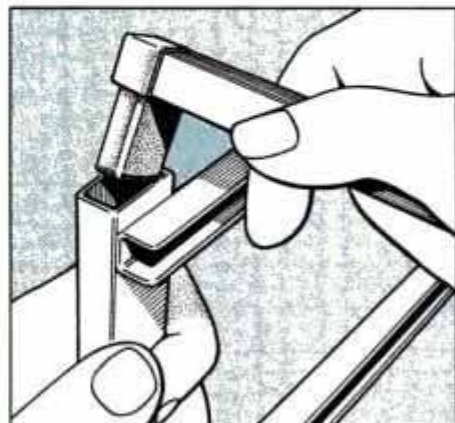
Now you're ready to construct the wire basket assembly. These are free-standing and consist of side frames connected by cross braces. Both are made of rectangular tubing. The baskets slide into U-channels welded to the side frames.

The assembly is fastened together with L-shaped and T-shaped connectors. Both fit into the ends of the cross braces (Fig. 8). Tap them in place with a hammer. Fit the cross brace and connector into the end of the side frame (Fig. 9). The L-shaped connectors are used as cross braces. The T-shaped connectors are used at the midpoints and base. The head of the T connects two pieces of vertical tubing at the midpoint and forms feet at the base.

FM

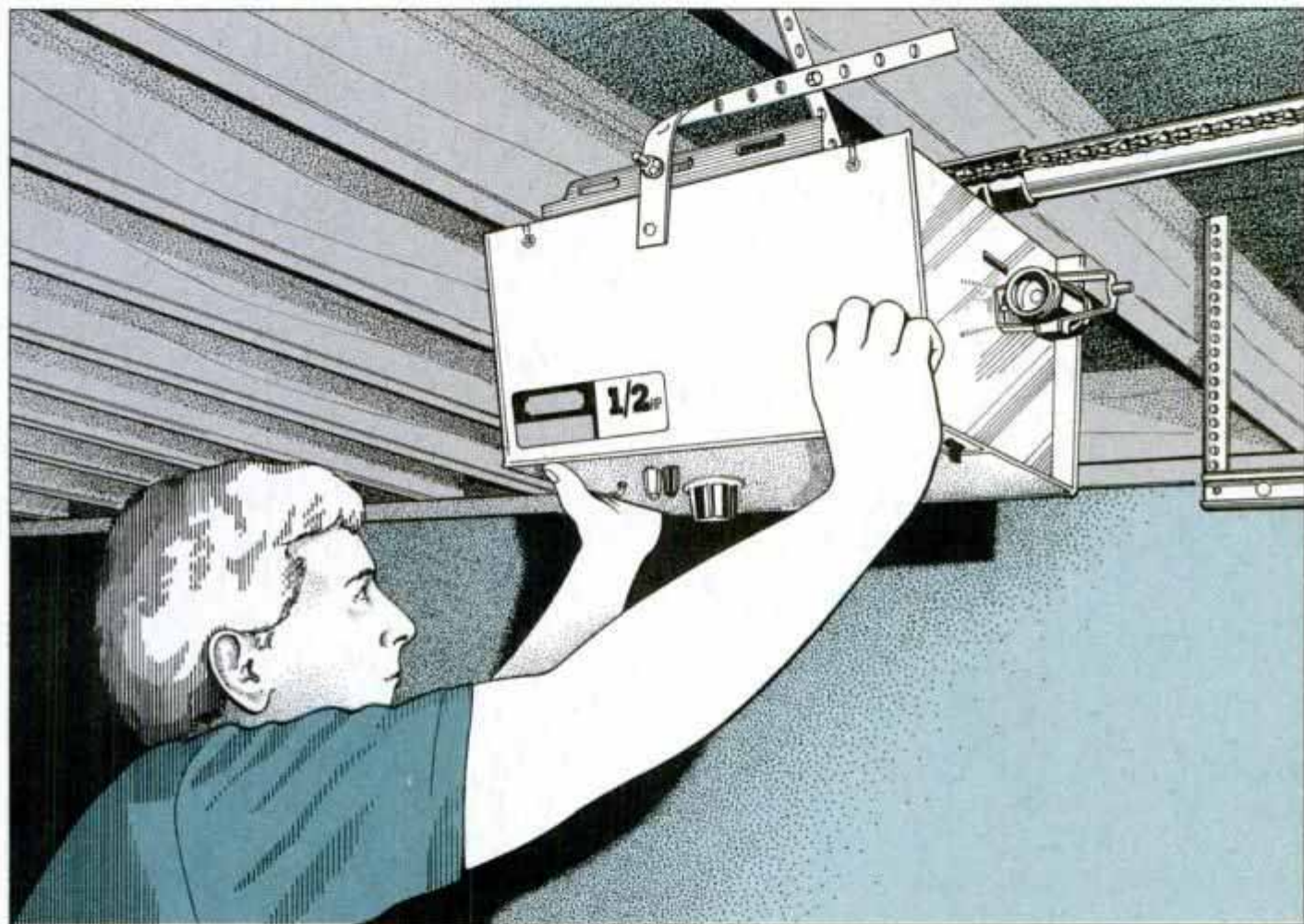


6 Snap plate over rail. Bolt shelf brace to plate with machine screw. Screw support brace to wall using wall anchor.



9 Connect cross bars to frames that have drawer rails. Again, push end of L-shaped connector into opening in end of tubing.

How To Install A GARAGE DOOR OPENER



IF YOU'VE LIVED for years without a garage door opener, your attitude toward installing one is probably pretty typical: Sure it would be convenient, but it's just not a necessity. Still, it seems that everyone who has a garage door opener swears he couldn't live without it. So, with visions of the door gliding open at the push of a button, you might reconsider the installation of an automatic garage door opener.

There are basically three types of home garage door openers: chain driven, screw driven and those raised by a nylon tape. All three are capable of opening a standard garage door. For our installation we opted for a Stanley model 3500 chain-driven

opener based on its reputation for durability, safety and ease of installation. The Premier model 3500 costs about \$150, while the range of six other models cost from \$95 to \$165. For information, write to Stanley Home Automation, 41700 Gardenbrook, Novi, MI 48050.

(Note: Other garage door openers are installed in a similar manner. Of course, follow the manufacturer's directions for your particular model.)

Powered by a ½-hp motor, the opener can lift a door up to 7½ ft. high × 18 ft. wide. This extra power is more than enough to open a typical 1-car garage door that measures 7½ ft. high × 9 ft. wide. It also opens sectional doors and 1-piece, tilt-up doors.

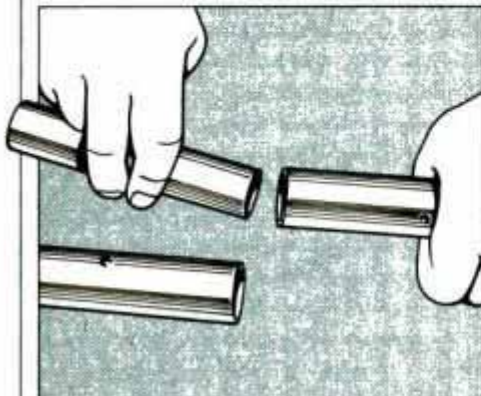
The Premier model 3500's other features include a time-delay light that stays on 4½ minutes after the door is activated, an ON/OFF pull cord that lets you use the light as an overhead worklight, programmable transmitter codes that have 1024 changeable combinations, a vacation switch that shuts off the opener while you're away, and an exclusive security feature called Signal Block.

The battery-powered handheld transmitter has two pushbuttons. One of the pushbuttons opens and closes the door, the other activates the Signal Block feature that prevents stray radio signals from opening the door—a problem with many older openers.

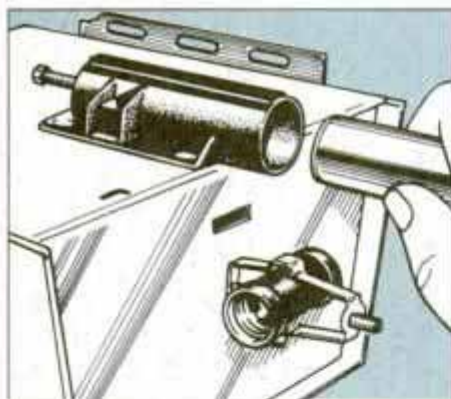
Installing the unit requires no special tools and takes about 3 hours to complete. A 23-page owner's manual provides clear instructions and plenty of helpful illustrations. A how-to videotape is included with the opener to show an actual installation. And if you still run into trouble, call the company's toll-free hotline: (800) 521-5262.

Assembly

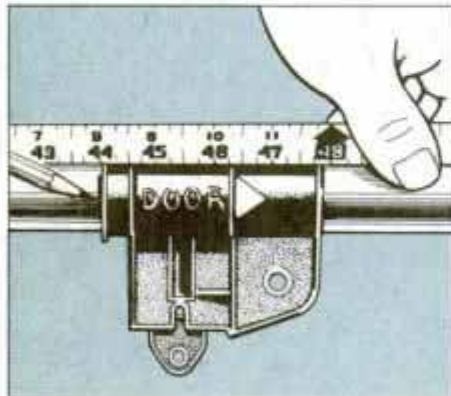
Begin by joining the four sections of steel tubing with the 6-in.-long in-



1 The first step is to join together the sections of 1 1/4-in.-dia. steel tubing using the 6-in.-long insert tubes.



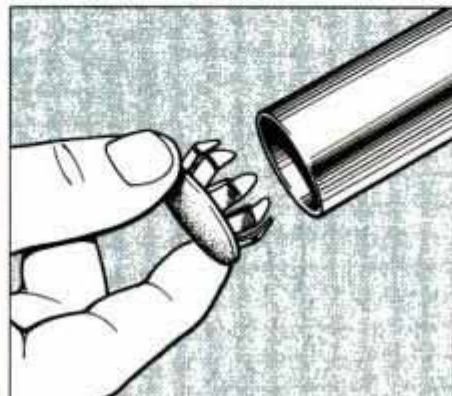
3 Slide the tubing end with the plug button into the tube support housing on top of the door opener power unit.



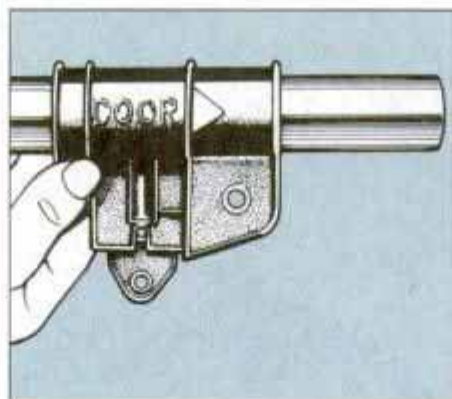
6 Place traveler 44 in. from front edge of tube support on power unit. Mark 44-in. dimension on tubing for later reference.

serts (Fig. 1). Press the inserts into the tubing ends as far as possible. Next, press the plug button into one end of the tubing (Fig. 2). Then, insert the tubing end with the plug button into the tube support on top of the power unit (Fig. 3). Slide the traveler onto the tube assembly so the arrow on the traveler points toward the door (Fig. 4). Push the idler assembly onto the end of the tubing (Fig. 5).

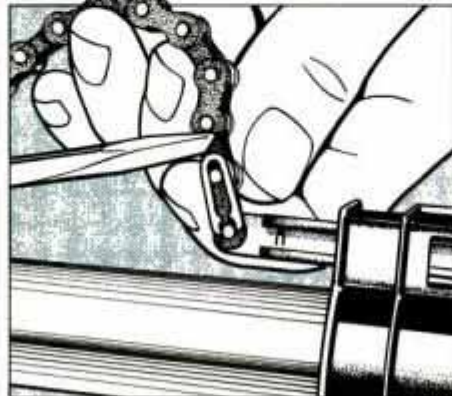
Next, position the traveler 44 in. from the front edge of the tube sup-



2 At one end of the assembled length of tubing (it doesn't matter which end), push in plug button until it's fully seated.



4 Slide the traveler onto the tubing so the arrow on the traveler points toward the door and away from the power unit.



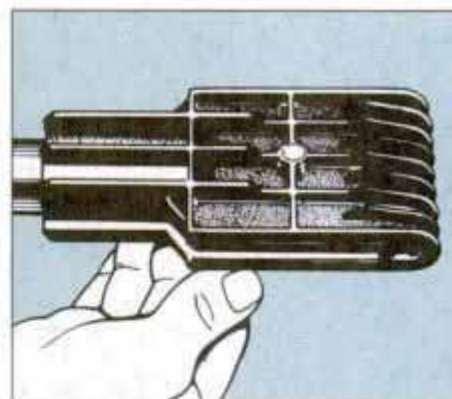
7 Attach chain to traveler using a master chain link. Use a screwdriver to push on retaining clip that secures the link.

port. Accurately mark the tubing for future reference (Fig. 6). Then, attach the loose end of the chain to the traveler using a screwdriver to push the master chain link's retaining clip into position (Fig. 7). Carefully unroll the chain and wrap it around the drive sprocket on top of the power unit (Fig. 8). Thread the cable at the end of the chain through the idler assembly (Fig. 9). Check that the traveler hasn't moved from the 44-in. mark. Now, attach the loose end of the cable to the traveler with a master chain link (Fig. 10).

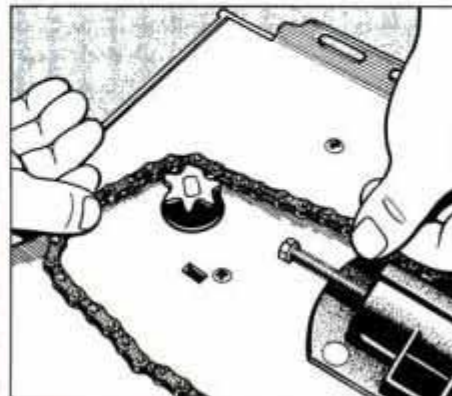
Next, adjust the chain by tightening the adjustment bolt on top of the power unit (Fig. 11). Turn the bolt until the chain sags about 1/2 in. below the midpoint of the tubing assembly. Finally, tie the manual disconnect cord to the latch on the traveler (Fig. 12). This safety feature allows you to disconnect the traveler and raise the door by hand.

Installation

First, mark the centerline of the garage door at its top. Use a level to transfer this line to the header joist above the door (Fig. 13). Have a help-



5 Place idler assembly on the end of the tubing. The idler assembly houses a free-spinning pulley that guides the cable.



8 Run the chain from the traveler back to the power unit. Then, loop the chain around power unit's drive sprocket.

er raise the door to its highest point. Measure the distance from the floor to the door's top edge (Fig. 14).

Next, add 2 in. to this high-rise dimension, and mark this new dimension on the header. Align the bottom edge of the header bracket with this mark, and fasten it with two lagscrews (Fig. 15). Now, with the power unit on the floor, lift the end of the tubing and secure the idler assembly to the header bracket with a clevis pin. Pass the pin through the bracket and idler and secure it with a lock clip (Fig. 16).

With the tubing end secured to the header bracket, carefully lift the power unit and set it on top of a ladder. Now, prepare to hang the unit so the tube assembly slopes up gently toward the header bracket. However, it's more important that the door open freely than to maintain this slope. Hold the unit in place and have a helper raise the door slowly to check the clearance.

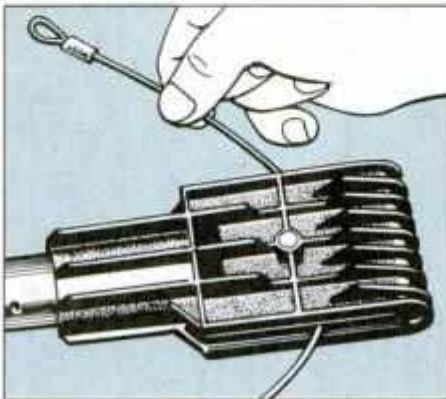
For an open-frame ceiling, simply secure the mounting straps to an exposed joist with lagscrews (Fig. 17). If the garage has a finished ceiling,

screw a 1x6 through the drywall into the ceiling joists. Then, screw an angle iron to the 1x6, and bolt the mounting straps to the angle iron.

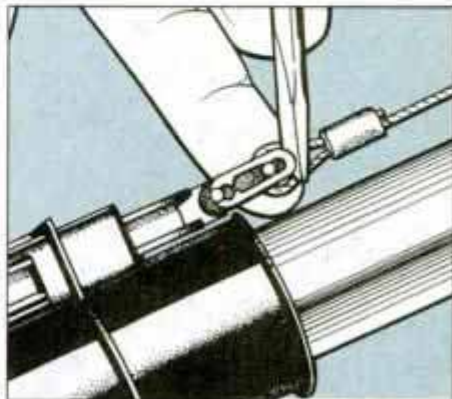
Next, attach the straight steel bar link to the traveler with a clevis pin and lock clip. Then, bolt the L-shaped steel arm to the bar link (Fig. 18). Bolt the door bracket to the end of the L-shaped arm (Fig. 19). Now, tug on the disconnect cord, and slide the traveler up to the closed door. Hold the bracket against the door so that the center

of the bracket is between 3 in. and 6 in. from the door's top edge. The exact position is not critical as long as it's within this area. Mount the bracket to the door with two carriage bolts (Fig. 20) that are installed through the door with their heads on the outside.

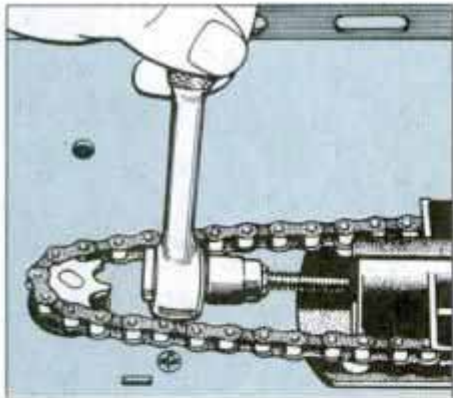
The last step of the installation is to wire the pushbutton wall switch to the power unit. Attach the wire leads to the switch and mount the switch to the garage wall (Fig. 21). The switch should be at a convenient height, and



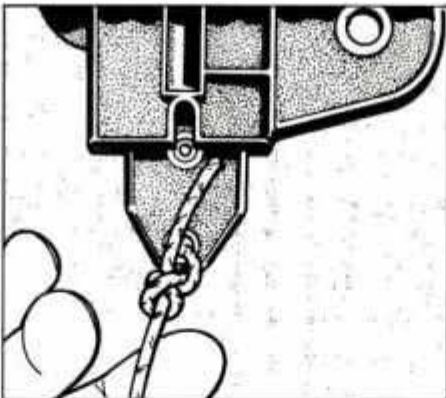
9 Feed the steel cable, connected at the end of the drive chain, around the pulley housed in the idler assembly.



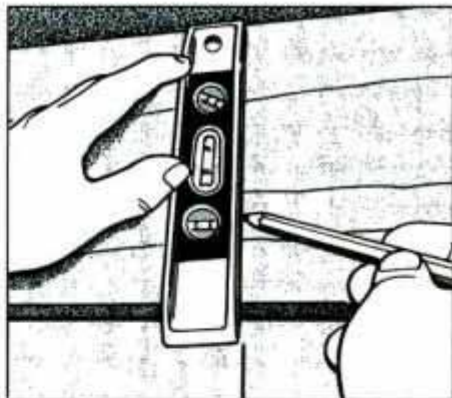
10 Attach the cable end to the traveler with a master chain link. As before, secure the cable with a retaining clip.



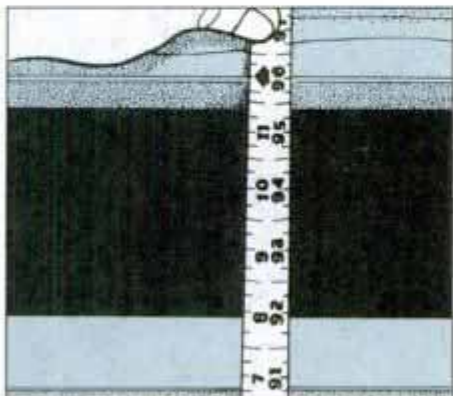
11 To adjust chain tension, tighten the adjustment screw on top of the power unit. Chain should sag about 1/2 in.



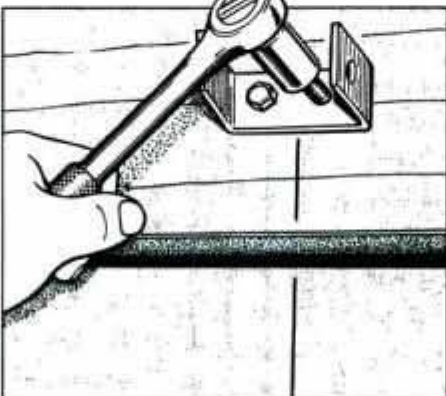
12 Tie the disconnect cord to the latch on traveler. Pull cord to disengage traveler so garage door can be lifted manually.



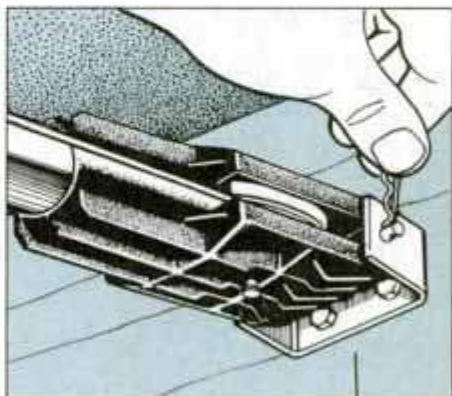
13 Mark the centerline of the garage door. Then, transfer this line to the header just above the door with a level.



14 Find the highest point the door reaches by measuring from the floor as a helper lifts door. A typical height is 92 in.



15 Fasten header bracket above door with two lagscrews. Place bottom edge 2 in. above door's high-rise dimension.



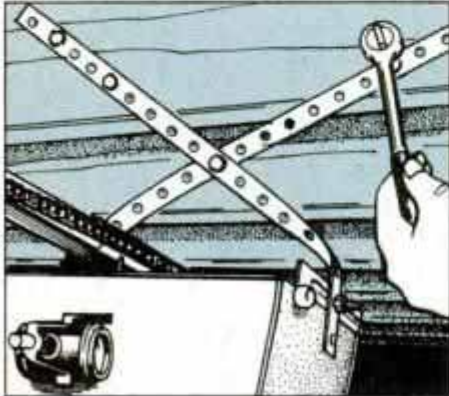
16 Slide clevis pin through header bracket to fasten idler pulley in place. Secure assembly with pin passed through lock clip.

a person standing by it should have an unobstructed view of the door. Run the switch wire to the power unit and connect it to the terminals on its back (Fig. 22).

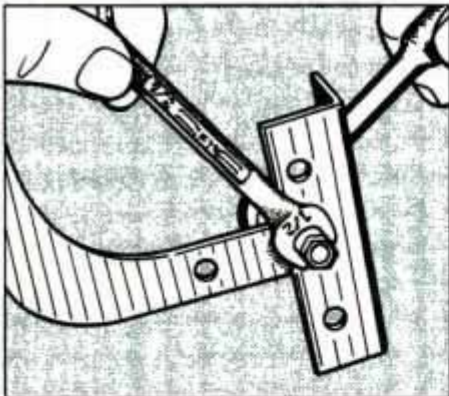
Adjustments

The final adjustments to an automatic garage door opener are important steps toward permitting smooth and safe operation.

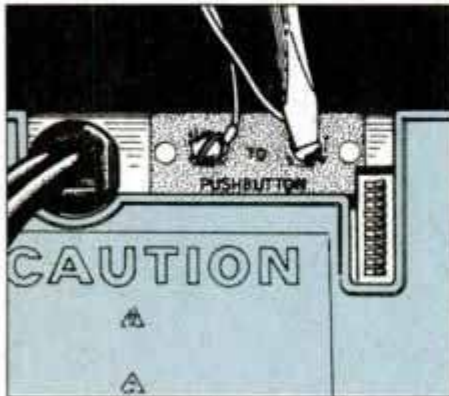
Begin by setting the same frequency code on the transmitter and the



17 Hang power unit from ceiling joists with metal mounting straps. Bolt straps to unit and secure to joists with lagscrews.



19 Bolt right-angle door bracket to the L-shaped arm. A special shoulder bolt permits the bracket to pivot freely.

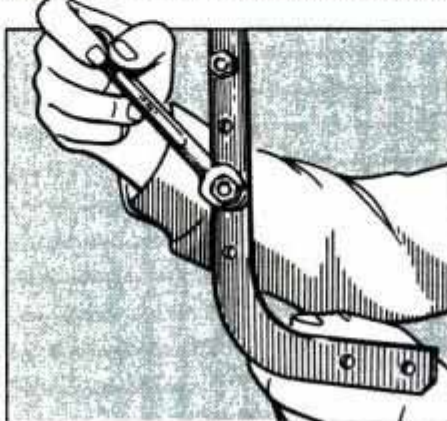


22 Run wire from pushbutton switch to terminals on power unit. Strip insulation and secure wires under the terminals.

power unit. This is done by pushing the tiny rocker switches located inside the transmitter and on the back of the power unit (Figs. 23 and 24). Use a sharpened pencil to randomly set the switches.

Next, plug the unit's power cord into an electrical outlet. If an outlet isn't within reach, have a licensed electrician install one near the unit.

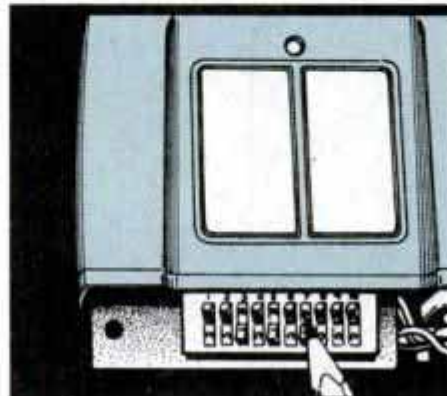
Now, test the reverse force adjustment. Press the transmitter button to close the door. While it's closing, use



18 After attaching straight steel bar to traveler, bolt on L-shaped arm. The mounting holes in the bar permit adjustments.



20 Fasten bracket with carriage bolts. Bore bolt-shank clearance holes through door and insert two bolts from outside.



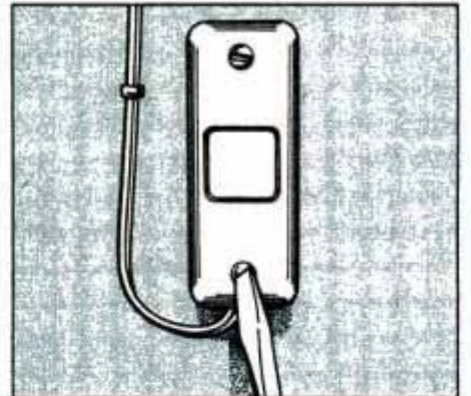
23 Remove cover on transmitter to reveal 10 tiny rocker switches. Use a sharpened pencil to set the frequency code.

both hands to hold the door until it reverses automatically. If the door reverses when barely touched (or before you touch it), then twist the large knob on the underside of the power unit clockwise a quarter-turn to decrease its sensitivity (Fig. 26). If the door is difficult to stop by hand, turn the knob counterclockwise to increase sensitivity.

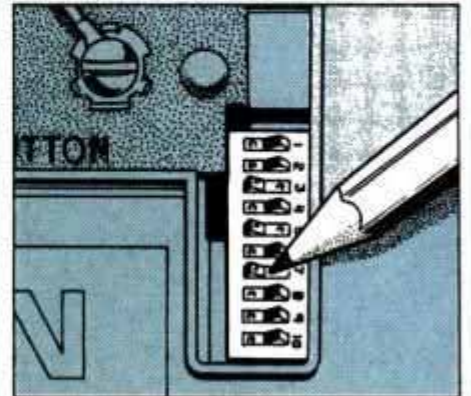
Next, adjust the fully opened and closed positions of the door. Adjust the closed limit first. Push the transmitter button to close the door. It will stop a foot or two above the floor. Then, slowly rotate the small black knob on the underside of the power unit until the door is closed.

Now, press the transmitter button to open the door. This time rotate the small white button on the underside of the power unit to adjust the door to the fully opened position.

Next, try the safety reverse adjustment. Place a 1-in.-thick board on the floor across the threshold. Then, push the transmitter button to close the door. The door should reverse after coming in contact with the block. If it doesn't, adjust the close-limit knob. **PM**



21 Install pushbutton switch inside garage. Place switch above reach of children and within sight of garage door.



24 Repeat procedure on rocker switches at rear of power unit. Frequency code should be identical to that on transmitter.

Homeowners' Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Bulge In Plaster Ceiling

I live in an old house with plaster ceilings. When I moved in, I noticed that the ceiling in one room had a bulging section. Is this something I should be concerned about?

SARA MAGEE
WALDEN, NY

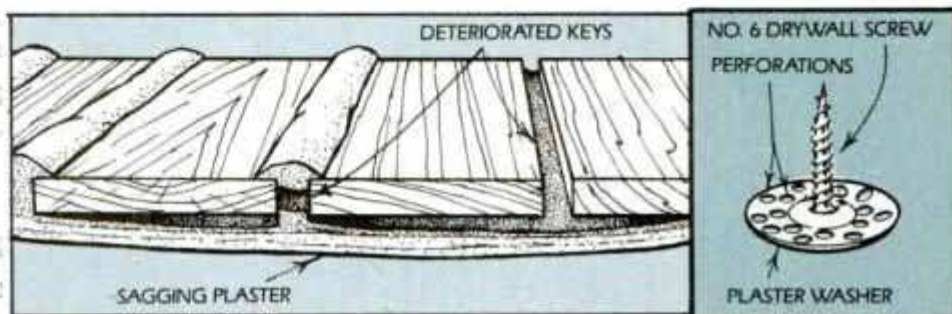
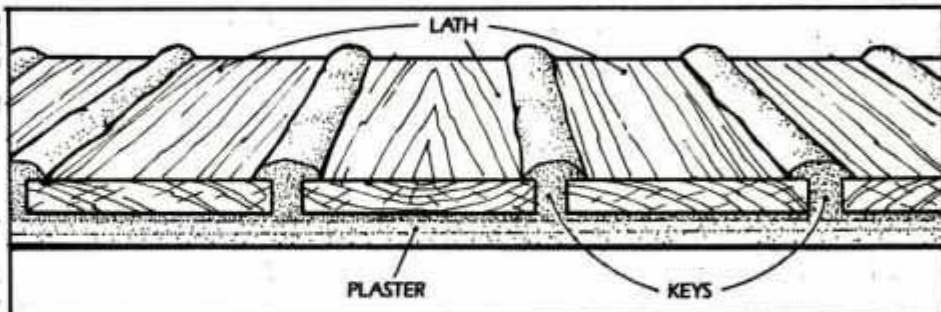
The sag may well be something to be concerned about. Older homes often have plastered ceilings and walls. The plaster is applied over wood, metal or gypsum lath. The first plaster coat is applied with just enough force so it squeezes between the spaces in the lath and into the wall cavity behind it. The plaster slumps over the lath as it squeezes past it and hardens into keys, locking on the first coat.

The first layer is scratched with a trowel so the next coat can adhere to it. The next coat is called the brown coat and the final one, the finish coat.

Over time, vibrations and wetting from roof and plumbing leaks may weaken the keys, cracking them. The combined weight of the three coats causes the plaster to break away from the keys, forming the sag you mentioned. In cases where the house has been unheated for prolonged periods, the finish coat alone may separate and sag, though the keys are intact.

You can call in a plaster contractor (not the same as a drywall contractor) and have the sag removed and replastered or you can try to repair the area with plaster washers.

Drive a 1/4- or 1/2-in. No. 6 drywall screw through the washer's hole and into the ceiling framing above the plaster. The washer supports the plaster around the screw as the screw pulls the plaster against the framing. Driving the screw into the framing is more secure than driving it into the lath, in which the screw may or may not grip. Encircle the sag, driving the screwed-in washers 6 to 10 in. apart. Once the outside perimeter is secured, move inside the perimeter and repeat the process in concentric circles, until the sag is fully secured. The washers are perforated to hold the Spackle that covers them. For plaster washers, contact Charles St. Supply Company, 54 Charles St., Boston, MA 02114.



Ceiling plaster can sag down from lath when keys securing base coat give way. Remove sag and replaster or screw in plaster washers to pull plaster back into place.

Roof Shingle Coating

In the November '88 "Homeowner's Clinic" (page 141), you mention coating asphalt shingles to extend their life. Coat them with what?

WILLIAM ROUW
LAS VEGAS, NV

There are a number of asphalt shingle coatings sold through roofing suppliers. One is Roof Guardian, manufactured by Oregon Research & Development Corp., Salem, Oregon. The product is a granulated elastomeric plastic coating (a plastic coating with elastic, rubber-like properties). The manufacturer claims its product was specially formulated for shingle roofs.

Apply two coats to roofs in fair condition but with a slight curl. The coating comes in six colors: white, gray, tan, brown, red and blue. It comes in one and five-gallon cans. One gallon covers 75 to 100 sq. ft, depending on the shingles' surface condition. For information, call the manufacturer at (800) 345-0809.

Noisy Water Pipes

The pipes leading to the exterior faucets on my house rattle loudly sometimes when I water the lawn. The

pipes rattle loudest when I partially open the faucet for lower water pressure through the garden hose. I replaced the exterior faucet but this didn't help. Now I think the rattling is because I have copper pipes.

RYAN SPETS
SPOKANE, WA

The problem is not because you have copper pipes but because there is a loose washer somewhere in the water line to the hose bib (the exterior faucet). Water under moderate pressure flowing across a loose washer will cause it to rattle, but under high pressure the washer is pinned down so it doesn't rattle.

I suspect that the loose washer is in the shutoff valve on the pipe leading to the hose bib. It's not necessary to replace the valve, just remove the valve stem and tighten the screw holding the washer in place. **PM**

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, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH, P.E., Contributing Editor

Leaking Dishwasher

I have a 7-year-old Whirlpool Supreme dishwasher model SDU5001, serial No. F81650618. Water appears to leak from the bottom of the door. I replaced the door gasket, and the sealing edge indentation on the gasket looked fine. Removal of the front panel did not reveal the problem. At the start of a wash or rinse cycle, water seems to splash up under the door edge. I have been unsuccessful in getting a repair and maintenance manual from my local parts distributor.

BRAD SHEPLEY
GRIDLEY, IL

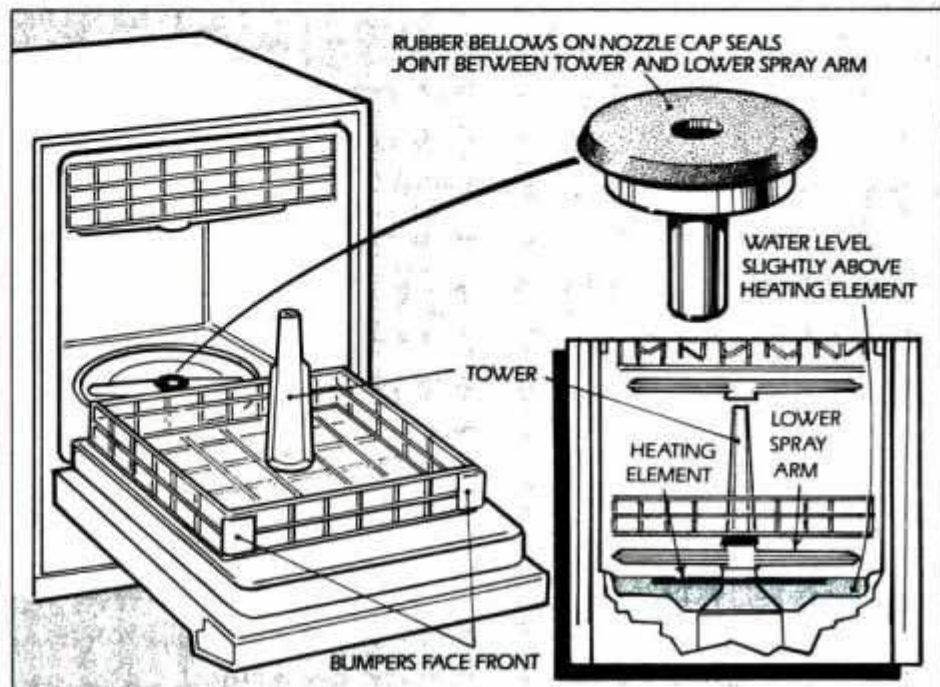
First, check the height of the water in the tank during the wash cycle. Set the machine to normal wash, and let it run through the first two water changes. When the machine has filled for the third time, check the water level. If the water level is more than 1/4 in. over the heater element, the washer is either overfilling or not pumping out properly. Check that the drain hose is not kinked or blocked.

If the water level is okay, check the rubber bellows on top of the nozzle cap. The bellows expands under water pressure and seals the joint between the lower spray arm and the tower. Slide out the lower rack. Unscrew the nozzle cap and stretch the bellows to inspect for cracks. Water could stream out through a crack, hit the door and leak out. The bellows, part No. 3367910, costs \$6.

Also, make sure the lower dish rack is not in backward. Its bumpers should face the door. If the bumpers face the back, the rack moves during the wash cycle. This results in the tower moving out of alignment with the pressurized water stream entering from below. Excessive water will splash around inside the washer and leak out under the door.

Next, check the spray arm. Lift it off the pump and look for splits and faulty crimping between the top and bottom face. Check that the arm is not bent or warped. A new spray arm is part No. 302767, and costs \$17.

An unlikely source of trouble is an eroded flow washer on the intake side of the water inlet valve. This would let too much water into the machine.



A tear in nozzle cap bellows, plugged drain hoses and cracked spray arms can cause water to leak from dishwasher. Also, check that dish rack is not reversed.

The description of that repair is included in the repair manual available from your Whirlpool service center for about \$7.50.

Freeze Up

In November 1984, I bought a Frigidaire Elite, frost-proof refrigerator, model No. FPE-24-VWAL-0, serial No. 4 OAD3855. The ice dispenser screw that passes ice from the tray through the door freezes up. The icemaker, however, works fine. Repair personnel have repaired or replaced nearly everything connected with the ice system to no avail. Any hints would be greatly appreciated as my 5-year service contract runs out this year.

HAYWOOD W. LUSK
RICHARDSON, TX

You should contact Frigidaire. Send them a letter stating your problem and include the following: a copy of the refrigerator's sales receipt, a copy of the service contract, copies of service work orders relating to the problem, the refrigerator's model number and serial number, and the name and phone number of the company that performed the repairs.

Send the letter to White Consoli-

dated Industries, Inc., Consumer Relations Center, P.O. Box 7181, Dublin, OH 43017. To check on the progress of your complaint, call (800) 327-2440.

Needs Vintage Cord

The thermostat electric cord on my Hoover stainless-steel frying pan is broken. Its model number is JPR-1104-1057606. Where can I buy a new cord?

HELENA M. BENGTSON
HOLDEN, MA

A new cord and thermostat is no longer made for your vintage frying pan. The Hoover Co. tells me there is a company that may be able to repair your existing control with cord.

Send your old cord with a check or money order for \$20, to Noffsinger and Bashor Appliances, 728 E. Main St., Trotwood, OH 45426. They will disassemble your control and repair it, if possible, and mail it back to you as soon as possible.

PM

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.



WHAT'S NEW AND EXCITING IN RECREATIONAL SHOOTING?

It's no longer just paper targets, plinking and clay pigeons.

BY BOB MacCLOY

Target shooting has been traditionally a sport that changes slowly—but not any more! Sure, there are still lots of devotees of Trap and Skeet shooting and plenty of others who enjoy punching holes in paper targets or just plain plinking at tin cans. But in just the last few years, many exciting new games have developed, attracting shooters of all skill levels (and many formerly non-shooters) seeking new challenges.

Some of these new competitions combine shooting with other popular sports, such as running and bicycling. Others simulate conditions encountered in the field. Many use reactive targets that fall down, break apart or otherwise "react" when a hit is scored. Still others demand mastery of several different types of firearms within the context of one tournament. But the common denominators for all of the new shooting games is that they are exciting and action oriented and a lot of fun for both participants and spectators.

Shooting and Running

Summer Biathlon is one of the new events that combines shooting with another sport. Two years ago about the only people who had ever heard of

Summer Biathlon were a small group of athletes who used this version of the Olympic sport to train for the Biathlon, which combines cross country skiing and rifle shooting. Today, several thousand road runners—many of them men and women who have never participated in shooting—are now hooked on this sport, intrigued by the physical and mental challenge it involves.

The running portion of a Summer Biathlon approximately duplicates a 5K race. Participants run about a mile to a rifle range, fire five shots from the standing position; run another mile and fire five shots from the prone position; and finally, run slightly more than a mile to the finish. The rifles used are either .22 caliber or airguns. Unlike the Winter Biathlon, the summer version does not require participants to carry their rifles during the race. The metal targets are about the size of a saucer and are usually positioned 25 meters from the firing line. Scores are based on race times combined with shooting scores. Thirty seconds is added to a runner's time for each missed target. The racer with the lowest net time within each of seven men's and seven women's categories is the winner.

Part of the appeal of Summer Biathlon is that it gives the middle-of-the-pack runner who is a good marksman a chance to move up to the front. The best competitors learn to slow down as they approach the firing range in order to gain respiration control that will improve accuracy on the

firing line. Winners usually get off their five shots in about 30 seconds at each station.

Summer Biathlon is administered by the United States Biathlon Association which in 1989 is conducting a ten city national series that culminates on October 14 with the National Championship in St. Louis. First timers are encouraged to enter. Rifles are provided for participants who do not have their own equipment and for all who are new to the sport. Age categories range from 15 to over 60. A free Biathlon clinic on procedures, shooting fundamentals and safety is mandatory.



Summer Biathlon is a challenging new sport combining running and rifle shooting.





Bikathlon tests skills in air gun marksmanship and off-road bicycle racing.



Shooting and Bicycling

Bikathlon is an event that combines shooting with another popular sport—off-road bicycling. Competitors in this game are primarily ten to fifteen

year-old youngsters who compete in three age categories.

Bikathletes race their mountain bicycles over a rugged one-third mile course which usually includes steep hills, water traps and other obstacles. At a shooting station along the course, the riders dismount, pick up airguns and shoot until they knock down four reactive targets placed 15-20 feet down range. Then, it's back on their bikes and a dash to the finish line.

Bikathlon is fast paced and exciting. Because the course is reasonably short, it can be watched from one spot and it attracts many spectators. All competitors must attend an instructional clinic on safe gun handling and mountain bike riding prior to the race. For the past three years the national championships have been held simultaneously with the Masters International Shooting Championships in Barry, Illinois in August. The principal sponsor of Bikathlon is Crosman Airguns.

Sporting Clays

Unlike the structured, repetitive format of Trap and Skeet and some other shooting games, Sporting Clays is typical of the new wave—lots of ac-

tion and variety and endless challenge.

A popular game in England for years, but only recently in the United States, Sporting Clays simulates various actual conditions and a variety of game found in the field. It is fast becoming *the* "in" sport for many shooters—and almost an obsession for its many devotees.

Like a golf course, each layout for Sporting Clays is different. Typically, there are ten shooting stations, each one applicable to a different type of game—duck, pheasant, quail, grouse, teal, rabbits, etc. The clay targets launched from each station duplicate these different types of game and their pattern of flight and movement. Ten shots are fired from each station, usually from a 12 gauge shotgun. A perfect score is 100 which happens about as often as a perfect game is pitched in baseball.

Metallic Silhouettes

For the rifle and handgun shooters, the equivalent of Sporting Clays is a game that originated in Mexico and has gradually filtered across the border. Silhouette shooting involves firing at metal animal targets—turkey, chicken, boar and ram, for example—from various distances ranging from 200 to 500 meters. The targets are "reactive" and topple over with a satisfying "ping" when a hit is scored.

Probably for the same reason that the shooting gallery is usually the most popular stand at a carnival, Metallic Silhouette shooting now has a huge following, not only with high power and small bore rifle shooters, but also with handgun, airgun and black powder marksmen. The National Rifle Association and the International Handgun Metallic Silhouette Association conduct and sanction many local, regional and national tournaments.



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Metallic Silhouettes appeal to shooters looking for more action-oriented events.



The Sportsman's Team Challenge measures overall shooting ability in rifle, handgun and shotgun events.

Sportsman's Team Challenge

It used to be that there was little crossover from one type of target shooting to another. The shotgunners and the riflemen and the handgunners were all specialists in their own particular discipline. Sometimes they would nod to each other on the way into the range. But rarely did they try each other's sport.

Now all this is beginning to change due in part to a new concept called The Sportsman's Team Challenge. Sponsored by the National Shooting Sports Foundation, this is a series of local and regional tournaments culminating in an annual National Cham-

pionship in which teams are required to compete in shotgun, rifle and handgun events. There are three members on each team and every team must compete in all three categories. The ultimate goal of the Sportsman's Team Challenge is to determine the overall shooting championship team in the United States—a first in the history of recreational shooting.

Every event in Sportsman's Team Challenge competitions is designed for maximum action, excitement and spectator interest. Rifle events usually incorporate knock-down metal plate targets and strict time limits; handgun events may involve a team relay in which each member must hit a prescribed number of targets before



"passing the baton" to the next shooter on the team; shotgun events might include a "team flurry" where all members shoot together from individual shooting boxes at 60 targets thrown in rapid succession.

Partly because of this interest in "overall" shooting, many sportsmen's clubs and public ranges now offer facilities for rifle, shotgun and handgun practice and competition. A directory of these clubs and others in the United States is published by the National Shooting Sports Foundation. The next Sportsman's Team Challenge Championship Tournament will be held in Fort Lauderdale in April, 1990.

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Firearms Safety

Thanks to the many educational programs sponsored by the National Shooting Sports Foundation, the National Rifle Association and other organizations and the high safety standards at shooting ranges and clubs throughout the country, recreational target shooting is among the safest of sports. Listed below are the cardinal rules:

1. Always point the muzzle in a safe direction.
2. Keep your finger off the trigger until you are ready to shoot.
3. Keep the action open and gun unloaded until ready to use.
4. Know how the gun operates.
5. Be sure your gun and ammunition are compatible.
6. Carry only one gauge/caliber of ammunition when shooting.
7. Be sure of your target—and what's beyond.
8. Wear eye and ear protection as appropriate.
9. Don't mix alcohol or drugs with shooting.
10. Be aware that circumstances may require additional rules unique to a particular situation.

For More Information . . .

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(208) 524-0880

National Rifle Association
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Washington, DC 20036
(202) 828-6000

National Shooting Sports
Foundation
555 Danbury Road
Wilton, CT 06897
(203) 762-1320

United States Biathlon Association
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Circle #7 on Reader Service Card



CITGO INTRODUCES NEW GENERATION OF MOTOR OILS

SUPERGARD® is the name for CITGO's new line of motor oil for passenger cars and light trucks. The complete line exceeds API's requirements for the latest "SG" service category, as well as the requirements of all major car manufacturers. SUPERGARD is engineered to provide maximum performance and state-of-the-art engine protection for longer, carefree engine life. SUPERGARD is the motor oil for people who won't settle for anything less than the absolute best. Available in SAE grades 5W-30, 10W-30, 10W-40, 20W-50 and SAE 30.

Circle #8 on Reader Service Card



SEE FARTHER, DRIVE SAFER WITH GE HALOGEN HEADLAMPS.

You can actually see up to 25% farther* down the road with GE Halogen Headlamps. The crisp, white light is twice as bright as ordinary headlamps*, so you can see more clearly and drive safer. Our new packages show the headlamp as well as provide important product information. So put GE Halogen Headlamps in your car for a safer, surer view of the road.

**All comparisons on high beam.*

Circle #9 on Reader Service Card



CARE FOR YOUR CAR FROM ROOFTOP TO ROCKER PANEL.

Mar-Hyde® offers a line of quality paints, specialty chemicals and cleaners—perfect for automotive, household and marine applications. We produce the highest quality product with attractive packaging and final results which are pleasing to the consumer. This is what has kept customers coming back to MAR-HYDE® brand products for over 30 years.

Use MAR-HYDE® brand products to paint, protect and revitalize. Recolor and preserve vinyl with Mar-Hyde® VINYL COLOR SPRAY; bring back color to faded carpet and upholstery with FABRIC COLOR; remove paint safely and effectively with TAL-STRIP® Paint Removers; coat aluminum, stainless steel, steel and automotive plastics with BLACK SATIN; renew the color of your bumper with BUMPER BLACK; convert rust to black primer with ONE-STEP® Rust Converter; prime and paint wood, fiberglass and metal with SANDABLE PRIMER and ACRYLIC ENAMEL—there is virtually no end to the applications of MAR-HYDE® products!

So when your application calls for a "face-lift", reach for MAR-HYDE® brand products to get the job done. TALSOL CORPORATION, 4677 Devitt Drive, Cincinnati, OH 45246. Circle #10 on Reader Service Card



FRAM, BENDIX, AUTOLITE—THREE GREAT NAMES TO GO WITH!



A leading consumer magazine gave Fram Wearguard® oil filters their highest rating.* Utilizing MR 10-20, a thicker, advanced filter media, Wearguard® allows up to three times fewer engine-harming particles through the filter on the first pass, for better engine protection and longer life. In today's harder-working engines, efficient oil filtration is crucial. Fram Wearguard® filters trap particles in the critical 10 to 20 micron range, safeguarding engines against the most damaging contaminants.

**This does not imply an endorsement of the product.*

Circle #15 on Reader Service Card

A brake system is only as safe as its weakest component which is why a brake job is more than just replacing shoes and pads. Bendix brake hardware completes the job and helps eliminate noise. Worn or missing hardware—springs, clips, rubber bushings, shims—is a leading cause of noise, premature wear and brake system performance problems. Brake hardware is designed to reduce vibration and noise, promote even lining wear and to ensure safe braking. According to Bendix engineers, every brake job should include new hardware to prevent trouble down the road.

Circle #16 on Reader Service Card



Engineered to meet the increased demands of today's precision engines, Autolite Platinum spark plugs outperform standard plugs in performance, durability and longevity. The platinum tip on the center electrode provides critical heat resistance, with virtually no gap erosion for up to 50,000 miles. In demanding turbo and high performance cars, platinum works best to withstand high temperatures to fire precisely for smooth acceleration and better fuel economy. And only Autolite Platinum plugs are backed with a three-year unlimited mileage guarantee. Circle #17 on Reader Service Card





WHEN THE GOING GETS TOUGH, A CAR THIEF WILL GO ELSEWHERE FOR EASIER PICKINGS.

It's terrible when a car is stolen. Even if a thief doesn't succeed in stealing your car, he is likely to damage the doors, windows, dash or steering column. Let's face it, the best automotive security device is one that discourages a thief from even touching your car. That device, the highly visible, bright red CarGuard, uses a Medeco® lock cylinder. It's a totally engineered portable locking device that protects your vulnerable ignition lock and steering column. Call or write ARAD, Inc., 8813 Knight Rd., Houston, TX 77054, (713) 796-8373.

Circle #12 on Reader Service Card

GO-JO HAND CLEANER

GO-JO (#1224) hand cleaner and dispenser value pack is the convenient, no mess, no waste system which mounts easily anywhere. GO-JO hand cleaner cleans grease, stains and other dirt that ordinary soaps can't touch. GO-JO is easy on hands, safe, non-toxic, biodegradable and the No. 1 choice of do-it-yourselfers. GO-JO Industries, Inc., P.O. Box 991, Akron, OH 44309-0991.

Circle #13 on Reader Service Card



A BRIGHT IDEA FOR ANY VEHICLESM

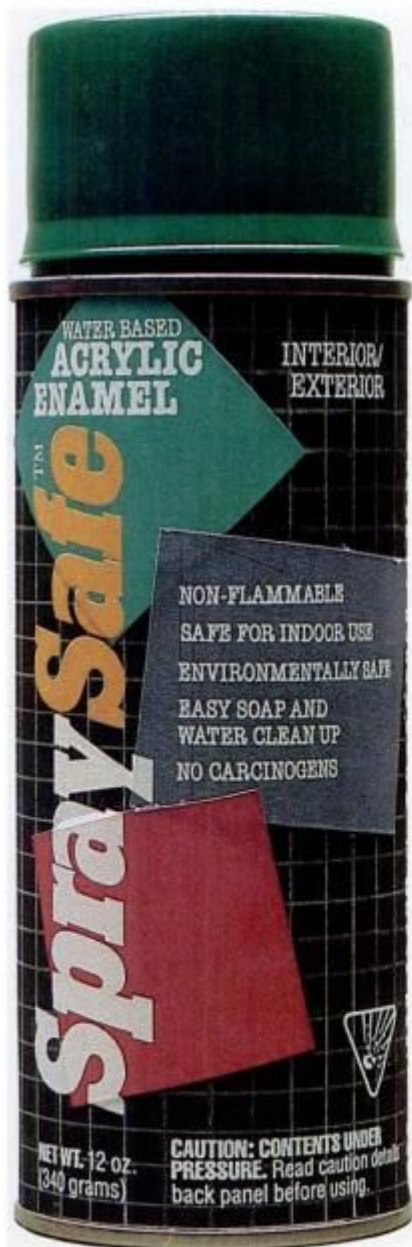


NITE-EYES™ can provide you with a complete line of professional quality lights design-coordinated to provide the "matched-set" custom look for the perfect finishing touch to any personalized vehicle. Large or small, chrome or black-out trim, rectangular or round lights...NITE-EYES™ are available to complement your vehicle's looks and provide the lighting you need at the same time. Please contact UNITY MFG. COMPANY, 1260 N. Clybourn, Chicago, IL 60610.

Circle #14 on Reader Service Card

TWO MORE REASONS TO DISCOVER PETROFAM PRODUCTS.

Introducing the SPRAYS SAFE™ line of safe spray paints which are non-flammable, non-carcinogenic, ozone friendly and environmentally safe. These are the only spray paints safe for indoor use. Formulated to deliver a tough, long-lasting acrylic enamel finish on all interior/exterior surfaces. SPRAYS SAFE™ is also available in special Decorator's Choice line of colors developed specifically for the home decorator. Available soon at most leading retailers, in 40 colors—including clear coats and polyurethane clears for wood surfaces. Look for special introductory prices and money saving rebates on these and other Petrofam products for your car and home. For additional information, write to Petrofam International, Inc., 1800 West Loop South-Suite 1250, Houston, Texas 77027. Circle #11 on Reader Service Card



ROBERK DESIGNER SERIES WIPER BLADES, BOOTS AND ANTENNAS



It's time to show your colors! Available in red, white, and black, these accessories make it easy to customize your car, truck or sport vehicle. Designer Series wiper blades perform as well as they look year-round. Colorful boots hide scratched and faded wiper arms. Universal AM/FM antenna works with any radio and looks like a mobile phone antenna. Circle #18 on Reader Service Card

ROBERK LINEAR TEMPERATURE SENSOR

Utilizes the latest in liquid crystal technology for convenient, go-anywhere temperature measurement. Scale lights up in 5° intervals. Specially designed for car's side mirror to alert driver of freezing road conditions. Also mounts on dashboard for interior climate control. Handy for boats, campers, around the house. Made of Mylar, can be trimmed for custom fit.

Circle #19 on Reader Service Card



PLEWS BREAK-OUT BOX TESTS ON-BOARD COMPUTERS



Versatile tool analyzes computer wire harnesses, engine sensors and engine control solenoids on the most popular domestic models. Helps mechanic analyze voltage readings quickly, accurately and safely without hand probing or crawling under car, even while engine is running. Simply connect the proper adapter (Ford/Chrysler/GM) to the computer and dial up the wire to be analyzed. Circle #20 on Reader Service Card

IDEAL LOUD TURN SIGNAL FLASHER

The result of popular demand and scientific research. Specifically engineered to give a 90-decibel pulsating sound (more than twice as loud as regular flashers) to warn the driver that his turn signal is flashing. Advantageous to all drivers, but especially useful to the hearing-impaired. Replaces existing 12-volt, 2-terminal flashers.

Circle #21 on Reader Service Card



WARN MULTI-PURPOSE WINCH SYSTEM— A POWERFUL PULLING TOOL

**PRODUCT
PREVIEWS**
PUBLISHED BY **Automotive Marketing**

Warn's new Multi-Purpose 4000 Winch System will do more than pull you—or someone else—out of trouble. It delivers 4,000 lbs. of pulling power to pull stumps, stretch fences, haul firewood or to rescue stuck vehicles. It's lightweight, portable and attaches easily to the front or rear of your vehicle, or any stable winch anchor. The Multi-Purpose Winch System comes with both receiver hitch and chain attachment mounting options, a 12' remote control plus quick-connect power leads. It's available in stores carrying specialty auto parts and truck accessories.

Circle #50 on Reader Service Card



AEROCOVER™ TRUCKBED COVER LOCKS THIEVES OUT OF YOUR LIFE.

With Warn's Aerocover™ secured to your truckbed, you can literally put a lid on theft. You get three hinged panels that fold down and lock together with a single key. Best of all, the panels automatically lock the tailgate, so your valuables are hidden *and* protected. Each panel is made of a durable, molded polymer that keeps rain and snow off your cargo. And the finish won't fade, crack or peel. Aerocover can be removed in just seconds and it gives you easy access to all parts of your truck bed. You'll also have clear visibility through the rear window.

Aerocover is available where quality truck accessories are sold. For more information on Warn products, call (800) 522-WARN (in Canada: (800) 225-5965) for a dealer near you. Circle #51 on Reader Service Card



SUPER-SLIPPERY LUBRICANT PROTECTS ENGINES WHEN THE BEST MOTOR OILS ARE USELESS.

Slick 50 Engine Treatment proves it can cut wear by 50%. Even the best motor oils and additives can't provide engine protection during start-ups. At these critical moments, 70 to 80 percent of engine wear occurs because oil is down in the pan and engine parts grind against themselves. But this serious engine wear is history when you substitute a quart of Slick 50 with your next oil/filter change. Slick 50 bonds super-slippery PTFE resins (polytetrafluoroethylene) to mechanical engine parts. Documented tests by an EPA-approved independent laboratory using ASTM procedures proved Slick 50 reduced engine wear by 50 percent. More than 15 million car owners worldwide have logged more than a billion Slick 50 miles. Users include the U.S. Government, truck fleets, race car drivers and police departments. Slick 50 is the way professionals protect the investment in their vehicles. And one treatment protects engines for more than 50,000 miles. Ask for Slick 50, The Engine Wear Protector, at your nearby auto parts store. Or call toll-free for the name of your nearest source: (800) 231-1733.

Circle #23 on Reader Service Card



**PERMATEX® GLASS GLAZE™
 AND FAST ORANGE™ HAND CLEANER**



PERMATEX® GLASS GLAZE™, cleaner and protectant, repels rain, frost, bugs and road film. Rain drops bead up and are blown away by aerodynamic windflow. Exclusive POLYDI II™ additives provide durable, long lasting protection that resists repeated washings up to eight weeks. Once you've used PERMATEX® GLASS GLAZE™, you won't drive without it. Experience the cleaning power of natural citrus. FAST ORANGE™ Hand Cleaner harnesses citrus extracts to remove the toughest soils: paint, adhesives, grease and oil. Solvent-free FAST ORANGE™ has lanolin, aloe and jojoba oils to smooth and soothe even the hardest working hands. Both pumice and smooth formulations are available. Circle #24 on Reader Service Card

AUTO VENTSHADE RAIN DEFLECTORS

Ventvisor® Rain Deflectors are made from impact-resistant, high-density, smoke-colored acrylic. Ventvisors® allow windows to remain partially open in all weather while venting stale air out and letting fresh air in. Other styles are the acrylic EZ Shade™, the original stainless steel Ventshade®, and the Rear Window Deflector. For further information, call (800) 241-7219. Circle #25 on Reader Service Card



**MAREMONT INTRODUCES THE NEW
 SOUND OF PERFORMANCE.**

The Cherry Bomb Turbo muffler, designed for today's new breed of performance enthusiast, reduces back pressure and improves acceleration. It has a deep, mellow sound that's sporty, but not loud like a glasspack. Plus, it's 100% aluminized and comes with a lifetime limited warranty. Circle #26 on Reader Service Card

CONVENIENCE AND SAFETY WITH THE NEW POWERSLIDER™ ELECTRIC REAR SLIDING WINDOW FOR PICKUPS

The luxury of power is inviting, and available for new trucks including; Chevy, Dodge, Ford, GMC, Isuzu, Jeep, Mazda, Mitsubishi, Nissan and Toyota. Owners of extended cabs and pickups with campers will genuinely appreciate the ease of slider adjustment at the touch of a button—just touch the switch and PowerSlider™ opens or closes automatically. You'll never have to take your eyes off the road. Its single vent panel slides in a deep security channel, making operation smooth. Plus, because it has no latches, you never have to remember to lock it. For security, simply push the switch and close it. With features like tinted glass, safety and convenience designed in, PowerSlider™ is hard to resist. To get one installed in your truck, look in the yellow pages under Glass, Auto Glass, Truck Dealers, Truck Accessory Shops or call toll free for a distributor near you: 1-800-262-5151
 Circle #27 on Reader Service Card



THE CONVENIENCE OF POWER

ANES PRESENTS THUNDERBOLT PORTABLE STROBE ALARM

A visible deterrent to any potential vandal. Unlike installed alarms hidden from view, the THUNDERBOLT alarm is highly visible on the dash and the flashing LEDs alert any would-be intruder that the vehicle is being protected. The THUNDERBOLT alarm incorporates sound and light activation, as both are effective in deterring potential vandals. The alarm has an ear-piercing 120db siren and a Xenon strobe that can be seen miles away. (Xenon strobes are used on aircraft wing tips to make them more visible.) The sensor technology, which activates the alarm, will detect high frequency sounds such as breaking glass, and motion vibration. The current (voltage) sensor detects the opening of any doors, hood or trunk that activate a courtesy light. The THUNDERBOLT alarm has its own back-up battery, which takes over in the event the unit is unplugged or tampered with, and the built-in panic button allows you to activate the alarm in a personal emergency. The alarm is portable and needs no costly installation! All these features make the THUNDERBOLT alarm the smart choice in vehicle security protection!

Circle #28 on Reader Service Card



PROTECT YOUR VALUABLE TIRES AND WHEELS FROM THEFT



Simply replace one lug nut per wheel with a McGard wheel lock and you will have the best protection available for your tires and wheels. McGard locks are fully machined from special alloy bar stock, through hardened, and triple-nickel chrome plated. Their hard, smooth, round surface protects against unauthorized removal. Each set contains four locks, one key and a registration/I.D. card. McGard, Inc.

Circle #29 on Reader Service Card

UNDER HUBCAP WHEEL LOCKS

The same high quality protection that McGard wheel locks have offered for 25 years is available now to fit under hub caps. This new style wheel lock is very low in profile and fits regular steel wheels plus most new aerodynamic alloy wheels that have covers over the lug nuts. Protect your valuable tires and wheels with McGard's easy to use, under the hub cap locks. McGard, Inc.

Circle #30 on Reader Service Card



RUST PROOF LUG NUTS



McGard's "Tough-Nuts" are the answer to rusty lug nuts. They are guaranteed not to rust, chip or peel for as long as you own your car. While staying beautiful, "Tough-Nuts" also exceed OEM safety specifications for critical fasteners. Applications are available for most popular wheel styles on import and domestic cars and trucks. McGard, Inc.

Circle #31 on Reader Service Card

**WINTER START™ MULTI-VISCOSITY
OIL CONDITIONER IS SPECIFICALLY
FORMULATED TO HELP ENGINES TURN
OVER EASIER AND LUBRICATE FASTER
IN COLD WEATHER.**

In tests performed by two independent laboratories, Winter Start is proven to help engines turn over 27% easier than regular motor oils in cold weather. And Winter Start, with its special blend of regular and synthetic petroleum additives, actually lubricates engines 36% faster than regular oil, while maintaining the oil's normal viscosity at engine operating temperatures. The result is reduced friction and wear while the car warms up. Compatible with all petroleum-based and synthetic motor oils, Winter Start is simply added with each oil change and is good for the life of that change. Winter Start is recommended for use with any gasoline or diesel engine, including cars, trucks, and even snowblowers. It is available in both 15 ounce and one gallon sizes from most automotive and discount department stores, as well as factory direct. For more information on this exciting new product, Shaler offers a free booklet, *The Cold Facts About Winter Start*. The Shaler Co., 21 E. Jefferson St., Waupun, WI 53963, (414) 324-2211.
Circle #32 on Reader Service Card



EAGLE ONE "WRITES THE BOOK" ON AUTO DETAILING



Today's vehicles are more expensive than ever, and people want to keep them looking their best, both from pride of ownership and to protect their investment. Eagle One, the leader in car care products, has published a comprehensive, 50-page, full-color booklet called "Guide To Auto Detailing." This glove box-sized booklet is a complete guide to auto detailing, from tops to tires. Included are photos, charts and illustrations, along with a selection guide on which Eagle One product to use for professional results. Available where Eagle One products are sold, or by sending \$2.00 to Eagle One, Dept. P.M., 15 Chrysler, Irvine, California 92718. Circle #33 on Reader Service Card

MFE ENGINE TREATMENT

EMERALD CHEMICAL CO. has developed an engine treatment for gasoline and diesel engines containing TEFLON (P.T.F.E.) resin to reduce internal friction/wear and temperature thus increasing horsepower and fuel mileage. MFE will also save on costly repairs caused by friction/wear in the engine and save on annual fuel costs. MFE can also be added to standard transmissions. MFE is available direct for \$9.99/bottle, or call (800) 876-9404 for the nearest retailer. Emerald Chemical, Austin, TX 78720-2077. Complete satisfaction guaranteed or your money back!!

Circle #34 on Reader Service Card



SNOW SHIELD INTRODUCED WITH NFL/NHL IMPRINTED LOGOS



Eliminate ice, frost, and snow accumulation on your car windshield with an official NFL or NHL Snow Shield. No brushing, no scraping! Heavy duty reusable vinyl with security flaps to lock onto car windshield. All teams' logos. Available wherever auto parts are sold, or by mail for \$19.95 plus \$3.00 postage and handling from State Products Corp., 535 W. Germantown Pike, Norristown, PA 19403. Circle #35 on Reader Service Card



IMPROVE YOUR FUEL ECONOMY WITH A RUSSELL ULTRATECH TAILGATE NET.

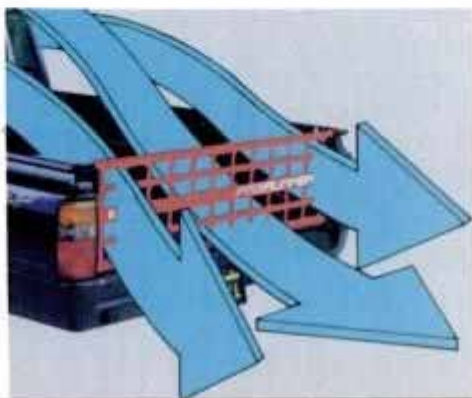
Now you can choose a truck tailgate net that fits your personality by selecting a Russell UltraTech Net in one of our hot, new designs. Not only do these nets improve a truck's aerodynamics (and that means better gas mileage), but their contemporary designs make any truck an eye-catcher.

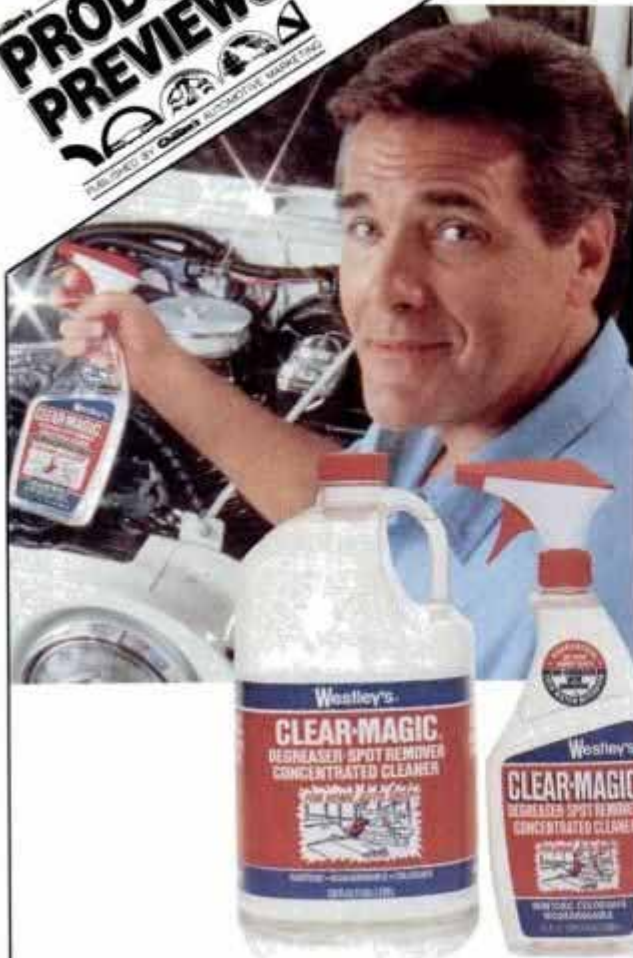
Russell UltraTech Tailgate Nets are manufactured from a single 22 oz. panel of PVC coated, vinyl-laminated polyester that meets ULC S-109 and NFPA 701 flame retardant requirements. Resistant to mildew, rot and UV rays, they test out at 500x475 tensile grab lbs. and 100x100 tear strength lbs. Our nets are professionally screened to resist cracking and fading, and the colors are guaranteed to be long lasting! Finally, their easy on/easy off six point mounting system keeps the net tight, eliminating troublesome flutter.

So go ahead. Choose from our solids (black, red or blue) or from our hot, contemporary designs. Russell UltraTech Tailgate Nets: for that quality, finishing touch!

For more information on Russell Products and to receive both the Russell Power Plumbing and the UltraTech Accessories Catalogs, send \$3.00 to Department PM: Russell Performance Products, 6301 E. Alondra Blvd., Paramount, CA 90723. Tech Line: (800) 334-8231 (outside CA), (213) 602-1202 (inside CA).

Circle #36 on Reader Service Card





**WESTLEY'S
CLEAR MAGIC.
DEGREASER,
SPOT REMOVER, AND
CONCENTRATED CLEANER.
NON-TOXIC, BIODEGRADABLE**

If you love your car, home, shop—but hate grease, CLEAR MAGIC is for you. CLEAR MAGIC plus cold water equals the strongest and safest cleaner ever. The secret? A catalytic chain reaction that "melts away" grease, oil, ink, grime and most other stains. An all-around degreaser/concentrated cleaner, CLEAR MAGIC takes the place of all those single-use products that clutter your home, shop and garage. Powerful enough to tackle greasy engines, yet gentle enough for removing stains from delicate fabrics. There are thousands of uses for CLEAR MAGIC. CLEAR MAGIC cleans everything—or your money back. Safe, non-toxic, non-flammable, totally biodegradable. From the makers of Blue Coral—your Guarantee of Quality.
Circle #37 on Reader Service Card

**MECHANICS BRAND.
CHEMICAL TOOLS FOR
PREVENTIVE MAINTENANCE**

MECHANICS BRAND—the Pro's Choice for the Do-It-Yourself! A full line of under-the-hood chemicals, three of which are featured here.

Simply add to your gas tank. Easy to use—keeps engines running smoothly, effectively, economically. FUEL INJECTOR CLEANER cleans and conditions fuel injector nozzle, screens, filters, fuel lines and metering valves. Restores optimum performance. Guaranteed to clean in one application. OCTANE BOOSTER increases octane, stops knock and ping. Removes deposits around valve seats and faces. Assures faster acceleration. Restores lost horsepower. GAS TREATMENT cleans dirty carburetors and exhaust emission control systems. Fights gas line freeze up. Blasts carbon deposits. Helps stop stalling. MECHANICS BRAND Products. They work while you drive. From the makers of world famous Blue Coral.
Circle #38 on Reader Service Card





CHILTON'S AUTO REPAIR MANUAL 1983-90

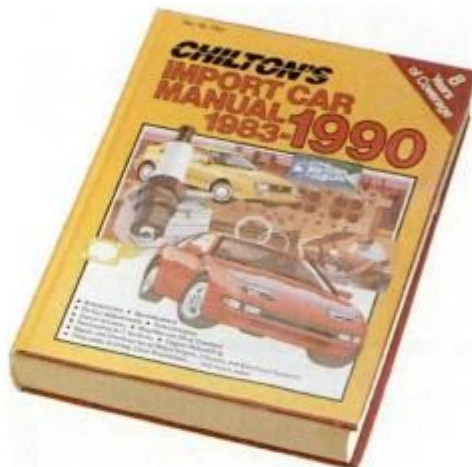
The manual that do-it-yourselfers have relied on to save money now covers 1983-90 domestic cars. This updated edition covers Detroit's newest models including the Eagle Summit, Dodge Spirit, Plymouth Acclaim and Ford Taurus SHO. Car sections cover specific makes and models grouped according to manufacturer and body style with specifications, removal and installation and service procedures unique to each car. Unit Repair Sections cover component repair and overhaul. Includes nearly 3,000 drawings and photographs plus thousands of tables and specifications.

Circle #40 on Reader Service Card

CHILTON'S IMPORT AUTO REPAIR MANUAL 1983-90

CHILTON'S IMPORT CAR REPAIR MANUAL is the most complete, up-to-date service manual made for the import owner. This new edition covers virtually every car imported into the U.S. and Canada in significant numbers. New manufacturers covered include Geo and Suzuki. New models include BMW 525i, 535i and 735iL; Chrysler Colt; Nissan 240SX and Maxima; Toyota Cressida. Unit Repair Sections tackle maintenance, repair and operation of automotive systems and components from Air Conditioning to Turbocharging. Includes thousands of detailed illustrations, charts and line drawings.

Circle #41 on Reader Service Card





THREE WAYS TO BEAT THE SUN

The Sunup division of IMI, Inc., the sun control people, offers a complete line of automotive roll-up sun shades for windshields, sunroofs, side, and rear windows; the amazing reusable Glare-Master UV-X Instant Window Film, and easy do-it-yourself installation requiring no glue or adhesives; trim-to-size rear window louvers; front sun screens; and colorful rear window screens.

Circle #42 on Reader Service Card

GOLD EAGLE STA-BIL

Do not store your lawn mower, boat, RV or anything that uses fuel, without treating it with Gold Eagle STA-BIL. By protecting the fuel system, STA-BIL will ensure that next season, the engine will start the first time and every time. STA-BIL prevents gummy deposits and protects the fuel system.

Circle #43 on Reader Service Card



THE LAST HEADLIGHT YOU WILL EVER BUY

Big A Halogen Headlights are light years ahead. They're 40% brighter and shine 200 feet further down the road than regular headlights. Big A Halogen Headlights are also backed with a Lifetime Warranty. If they should ever fail, Big A will replace them, free, as long as you own your car. * Contact your nearest Big A Auto Parts Store for details.

*A limited warranty. Certain limitations and validation requirements apply—see warranty certificate for details.

Circle #44 on Reader Service Card

GROUND EFFECTS KIT

A new masterpiece of aerodynamic angles and curves for the 1989 Thunderbird has been created for Bill Elliott, superstar of racing, by Design Effects, Inc. Now, the company's own version of this ground effects kit is available with the Design Effects logo embossed on the front. The kit may be purchased at your local Ford dealer or specialty trim shop. For further information and brochure on all Design Effects products, call or write Design Effects, Inc., 4563 South Berkeley Lake Road, Norcross, Georgia 30071, (404) 662-3001 or (800) 443-8691.

Circle #45 on Reader Service Card



RETAIL SHOPPER

The retail chains listed below specialize in selling automotive parts, chemicals, and accessories. With some product ads, there is an 800-number toll-free customer service line to help locate the nearest store which carries this merchandise. **AUTOMOTIVE MARKETING** has made every effort to make this list of auto parts retailers as comprehensive as possible for the convenience of automotive do-it-yourselfers.

ALABAMA

AutoZone
Carport Discount Auto Parts
Chief Auto Parts
Harco Drug
National Automotive
Superstores
Super Shops, Inc.
Taylor Parts Inc.

ALASKA

(See list of national chains.)

ARIZONA

AutoZone
Checker Autoworks
Chief Auto Parts
Fletcher Enterprises
Pep Boys
Super Shops, Inc.

ARKANSAS

AutoZone
Chief Auto Parts
O'Reilly Automotive
Stinger Sam Auto Parts
Super Shops, Inc.

CALIFORNIA

Chief Auto Parts
Fast Company
Grand Auto
Kragen Autoworks
Pep Boys
PPG, Western Division
Scherbas Auto Stores, Inc.
Super Shops, Inc.
Trak Auto
Von Housen Auto Parts Stores
10,000 Auto Parts of CA

COLORADO

Champion Auto Stores
Checker Autoworks
Super Shops, Inc.

CONNECTICUT

ACME Auto Supply Inc.
ADAP
Benny's
Fisher Big Wheel
Motomart

DELAWARE

Pep Boys
R&S/Strauss

DISTRICT OF COLUMBIA

Hi-Gear Tire & Auto Supply
Pep Boys
Trak Auto

FLORIDA

Ace Auto Parts Co. Inc.
AutoZone
Apollo Auto Parts
Dennys Auto Parts
Discount Auto Parts Inc.
Harco Drug
National Automotive
Superstores
Nationwide Auto Parts
One Stop Auto Parts
Parts City
Rose Auto Stores
Steego Auto Parts
Super Shops, Inc.
Taylor Parts Inc.
Trout Auto Parts
U Do It Auto Inc.
Walt's Auto Parts
Wingate Automotive Inc.

GEORGIA

AutoZone
Butler Auto Supply
Nationwide Auto Parts
Parts City
Pep Boys
Super Shops, Inc.
Taylor Parts Inc.

HAWAII

Ron's Auto Parts and
Performance

IDAHO

KAPS Auto Stores
Schucks Autoworks

ILLINOIS

Autoworks
AutoZone
Blue Star Auto Stores
Forest City Auto Parts
Giant Auto
Linkon's Auto Supply
Robertson's/Big Bear
Strum Auto
Super Shops, Inc.
Trak Auto
Whitlock Auto

INDIANA

Autoworks
AutoZone
Blue Star Auto Stores
Fisher Big Wheel
County Post
Hires Auto Parts
Nationwide Auto Parts
Quality Farm & Fleet
Ridge Auto Parts
Super Shops, Inc.

IOWA

American Auto Parts
Arts Auto Parts
Autoworks
Big Bear
Bomgaars
Champion Auto
Strum Auto
Super Shops, Inc.
Whitlock Auto

RETAIL SHOPPER

KANSAS

Autoworks
O'Reilly Automotive
Super Shops, Inc.
Whitlock Auto

KENTUCKY

Autoworks
AutoZone
Chief Auto Parts
Cobre Tire
Nationwide Auto Parts
Super Shops, Inc.
Toohey's Auto Supply Co.

LOUISIANA

AutoZone
Fisher's Auto Parts
Hi-LO Auto Supply
National Automotive Superstores
Super Shops, Inc.

MAINE

Motomart
Steego Auto Parts
VIP Discount Auto Center

MARYLAND

Gatlings Auto Stores Inc.
Hi-Gear Tire & Auto Supply
Pep Boys
Trak Auto

MASSACHUSETTS

ADAP
Auto Palace
Steego Auto Parts
Lappen's Discount Auto Parts

MICHIGAN

Action Auto
Auto Parts World
Autoworks
County Post
Fisher Big Wheel
Murray's Discount Auto Stores
Nationwide Auto Parts
Quality Farm & Fleet
Ridge Auto Parts
Short's Auto Parts

MINNESOTA

Big Bear
Big Wheel/Rossi Auto
Champion Auto Stores
Crown Autoworks
Propper Oil & Auto Supply

MISSISSIPPI

AutoZone
Carport Discount Autoparts
Harco Drug
Super Shops, Inc.

MISSOURI

Autoworks
AutoZone
Big Bear
Eastside Auto Parts
O'Reilly Automotive
Stinger Sam Auto Parts
Super Shops, Inc.

MONTANA

Champion Auto Stores
Checker Autoworks

NEBRASKA

Arts Auto Parts
Autoworks
Bomgaars
Champion Auto Stores
Cowdon Auto Elec.
Super Shops, Inc.

NEVADA

Checker Autoworks
Chief Auto Parts
Kragen Autoworks
Pep Boys
Super Shops, Inc.

NEW HAMPSHIRE

ADAP
VIP Discount Auto Center

NEW JERSEY

AID Auto Stores Inc.
Pep Boys

R&S/Strauss
Royal Auto Supply

NEW MEXICO

AutoZone
Checker Autoworks
Cobre Tire
Pep Boys
Super Shops, Inc.

NEW YORK

AID Auto Stores Inc.
Fisher Big Wheel
Forest City Auto Parts
ITTCO Sales
National Auto
R&S/Strauss
US 1 Auto Parts

NORTH CAROLINA

Advance Stores
AutoZone
Crazy Joe's
Nationwide Auto Parts
Super Shops, Inc.

NORTH DAKOTA

Champion Auto Stores
Crown Autoworks

OHIO

All Parts Automotive
Autoworks
County Post
Fisher Big Wheel
Forest City Auto Parts
Guarantee Auto
Nationwide Auto Parts
Quality Farm & Fleet
Short's Auto
Steego Auto Parts
Super Shops Inc.
Whitlock Auto
World Wide Auto Parts

OKLAHOMA

AutoZone
Brad's Auto Parts Centers
Chief Auto Parts
Endurance Auto Parts
O'Reilly Automotive
Super Shops, Inc.

RETAIL SHOPPER

OREGON

Schucks Autoworks
Super Shops, Inc.

PENNSYLVANIA

Beacon Auto Parts
Fisher Big Wheel
Forest City Auto Parts
Gatlings Auto Stores Inc.
National Auto Stores
Pep Boys
R&S/Strauss
Royal Auto Supply
Whitlock Auto
World Wide Auto Parts

RHODE ISLAND

ADAP
Auto Palace
Benny's
Fisher Big Wheel
Steege Auto Parts

SOUTH CAROLINA

Advance Stores
AutoZone
Crazy Joe's
Nationwide Auto Parts
Parts City
Super Shops, Inc.

SOUTH DAKOTA

Bomgaars
Champion Auto Stores
Crown Autoworks

TENNESSEE

Advance Stores
AutoZone
Chief Auto Parts
Nationwide Auto Parts
Super Shops, Inc.

TEXAS

ACI/Binswanger
AutoZone
Checker Autoworks
Chief Auto Parts
Fischer's Auto Parts
Hi-LO Auto Supply
Pep Boys
Pettigrew-Smith
Super Shops, Inc.

UTAH

Checker Autoworks
Cobre Tire
Super Shops, Inc.

VERMONT

(See list of national chains).

VIRGINIA

Advance Stores
Hi-Gear Tire & Auto Supply
Nationwide Auto Parts
Pep Boys
Trak Auto
Twin "B" Auto Parts

WASHINGTON

Al's Auto Supply
Schucks Autoworks
Super Shops, Inc.

WEST VIRGINIA

Autoworks
Fisher Big Wheel
Gatlings Auto Stores
Nationwide Auto Parts

WISCONSIN

Autoworks
Auto Glass Specialists
Big Bear

Champion Auto Stores
Crown Autoworks
Super Shops, Inc.
Whitlock Auto

WYOMING

Champion Auto Stores
Checker Autoworks
Cobre Tire

NATIONAL AUTO PARTS RETAIL CHAINS

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(Montgomery Ward)
All Pro
Auto Value
Big A
Bumper to Bumper
Carquest
NAPA
Parts Plus
Pronto
Western Auto

DISCOUNT AND DEPARTMENT STORES

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Bradlees
Coast To Coast Stores
K mart
Pace Membership Warehouse
Roses Stores
Sears
Target
True Value Hardware
Wal-Mart
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PRO-CARE AutoLube Dry

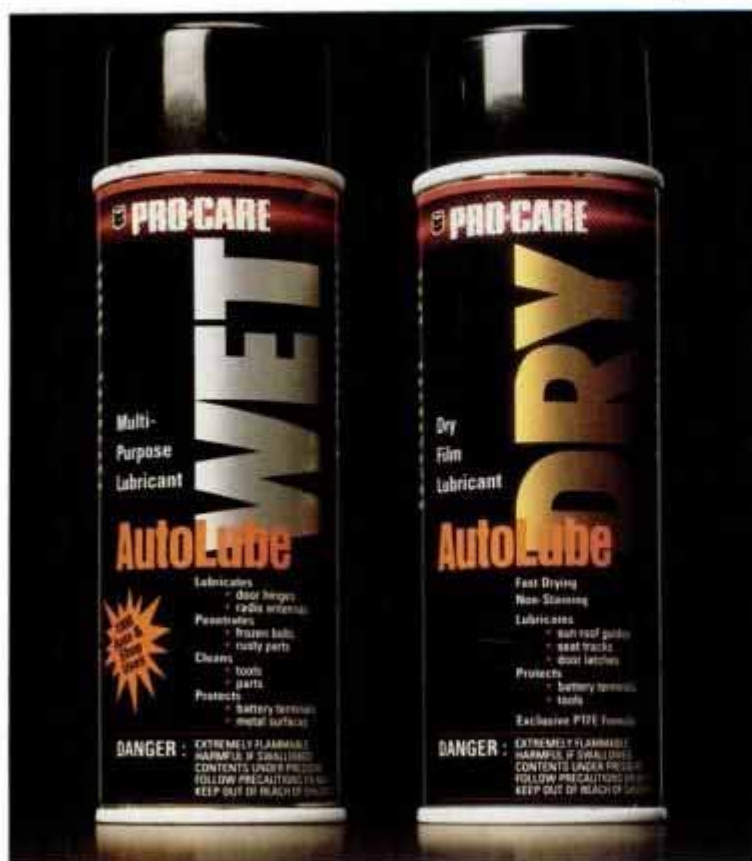
Ideal for lubricating areas where a messy or staining liquid spray cannot be used, AutoLube Dry is a long-lasting, non-staining lubricant that provides an invisible film which dries the instant it touches a surface. A unique PTFE formula, it has a variety of uses from lubricating sun roof guides to convertible top mechanisms and upholstery zippers.

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PRO-CARE AutoLube Wet

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Circle #48 on Reader Service Card



SPECIAL SECTION

Best New Products
**CONSUMER
ELECTRONICS
1989**



VIDEOGAMES: Awesome new ways to play
HOME VIDEO: Sight and sound by laser disc
EDUCATION: Facts by phone and compact disc
HI-FI: Surround sound for home theater
MUSIC: New instruments for a new age
COMPUTERS: Turbocharging accessories for PCs



CAMERICA

FREEDOM STICK

Breakaway
Vocalizer 1000

Breakaway
Vocalizer 1000



NEW DIMENSIONS IN HOME ELECTRONICS

Here's our choice of innovative products and accessories that add exciting new capabilities to your home electronics components.

BY STEPHEN A. BOOTH, *Electronics/Photography Editor*

WHAT CONSTITUTES a good product? This question follows us like a shadow as we walk the aisles of the major exhibitions where new consumer electronics items make their debut.

Among other things, a good product should be innovative. That is, it should do something that couldn't be done before—or accomplish the task in some clever new way that makes the technology accessible to more people than ever before.

Certainly, the product should perform well. For evaluating whether a product lives up to its billing, there's nothing quite like a hands-on approach. This explains the spectacle witnessed at a recent trade show where Editor-In-Chief Joe Oldham, an accomplished drummer and keyboard instrumentalist, played his way through aisle after aisle of electronic music synthesizers. If nobody tossed money, nobody threw bricks either. And we learned a heckuva lot about how the electronic instruments compare to their acoustical cousins, and how easy they would be for our readers to use and enjoy.

This is how we work when we attend the big electronics fairs in Las Vegas and Osaka, Tokyo and Chicago. The latter is the granddaddy of them all, and it was there, in June, where our staff conceived yet another definition of what a "good" product should be.

Upon surveying the five football fields of new electronic gadgets, we couldn't help but notice how many of them were designed to enhance or upgrade the basic electronics products that you might already own. Once we hit upon this distinction, we decided to seek out more of these products, and evaluate them from this new criteria for our Editors Choice of the best in new consumer electronics.

Accordingly, this month's special section is somewhat different from others we've published in the past. Those have concentrated on the latest VCRs, sharpest camcorders, swiftest computers or hottest CD players. Instead, we're taking a home-improvement approach to electronics this time. Our report concentrates on new products and services designed to increase your enjoy-

ment of the electronics marvels you already own—by upgrading them to enhance their performance or improve their usefulness.

The usual focus of POPULAR MECHANICS is on the technologically new, but this home-improvement approach slyly lets us have our cake and eat it, too. That's because these very products and services that upgrade the ones you own are, in themselves, quite technologically innovative.

Unfortunately, because the flashiest new commodities hog up so much of the hype and hoopla in the mass media, these worthy ancillary and accessory products often get crowded out of the trough and their fair share of coverage.

To cite one example of this oversight, let's take the laser video disc. It's been around for a decade, and still is, thanks to the almost singlehanded efforts of Pioneer Electronics. But VCRs get more attention, and unless you study the video enthusiast publications, you won't learn much about the laser disc alternative to home-video entertainment. Computer upgrading is another neglected child when it comes to publicity. While there's always lots of ink on the newest, fastest, most powerful computer on the block, there's scant coverage of the accessory products that will let you bring an older computer up to speed, or extend its powers to exciting new applications. One of those applications is music. There is software that produces sheet music from tunes you compose on an electronic instrument. Another is education. You can visit vast libraries of information from a computer keyboard.

Our Editors Choice selections set the record right, and give these upgrade products the recognition that is their due. So belly-up to the banquet table, and enjoy this electronics enthusiast's feast. We've found better ways of playing videogames. We've got cinema surround sound and laser shows for your living room. Learn how to turbocharge your home computer, and how to use it to explore vast stores of knowledge. If you can carry a tune, we'll show you how to play a musical instrument—and write your own sheet music. **PM**



TRICKED-OUT VIDEOGAMES

Wireless controllers and juiced-up joysticks extend your hands-on excitement.

BY FRANK VIZARD, Contributing Editor



Accessories like Broderbund's U-Force and Mattel's Power Glove enhance videogame play.

VIDEOGAME competition is becoming more intense thanks to a new crop of accessories that let you interact with games like never before.

Perhaps the most remarkable new device to enhance videogame play is the U-Force controller (\$70) from Broderbund Software, designed for the Nintendo game system. It's the first hands-free controller developed for videogame play—essentially a screen packed with motion sensors that is placed upright or flat between the player and the television screen,

depending upon the game in use. Like any standard controller, U-Force plugs into the joystick port of the Nintendo control console. No batteries or other power source is required.

Once U-Force is plugged into the console, you never touch a controller again. Players manipulate on-screen action by placing their hands and bodies within the 3-dimensional range of U-Force. Through a series of sensors and proprietary circuitry, U-Force detects a player's exact motion, velocity and relative position. This information translates instantly into the

on-screen action. For example, to throw a left jab in *Mike Tyson's Punch-Out* you simply punch the air in front of your on-screen opponent. You move and U-Force reacts.

U-Force improves the play of about 40 percent of the existing Nintendo games and new games are being developed to take advantage of U-Force's unique capabilities. By removing the contact barrier between player and machine, games become more realistic.

Hands-on

Another new controller is Mattel's Power Glove (\$75), a cyborg-like device derived from the NASA data glove designed to control robots in outer space.

Power Glove features a built-in numerical keyboard, firing buttons and a sensor bar. By entering special codes into the keyboard, a player can program a built-in computer so that his own hand and finger motions control the videogame. The sensors built into the Power Glove detect the player's hand and finger movements, translating the physical motion into on-screen action.

Power Glove comes in two sizes, and is targeted at players between the ages of 8 and 14. It plugs into the joystick port of the game console, so no additional power source is required. A special Glove Gaming Series of Nintendo videogames is being developed, the first of which is *Bad Street Brawler*. With these special games, more of the video screen can be controlled than with traditional joysticks. The Power Glove gives players the ability to "reach into" the game rather than just move vertically and horizontally across the screen.

Invisible forces

Among the new breed of wireless controllers is the Freedom Stick (\$70) by Camerica, compatible with Nintendo, Sega, Atari and Commodore videogame systems.

Freedom Stick sends commands via a wide-angle infrared light beam to a receiver connected to the console's joystick port. Range is 20 ft., a distance that increases perspective, induces faster eye-hand coordination and reduces eye strain. Features include an arcade-style joystick and switches for rapid fire or manual action. Four AA batteries supply power to the remote joystick.

Camerica also offers wireless remotes specifically designed for Nintendo games. The Supersonic (\$60) is a triangular pad with a centrally located arcade-style joystick. Camerica's Freedom Pad (\$40) looks like a stand-



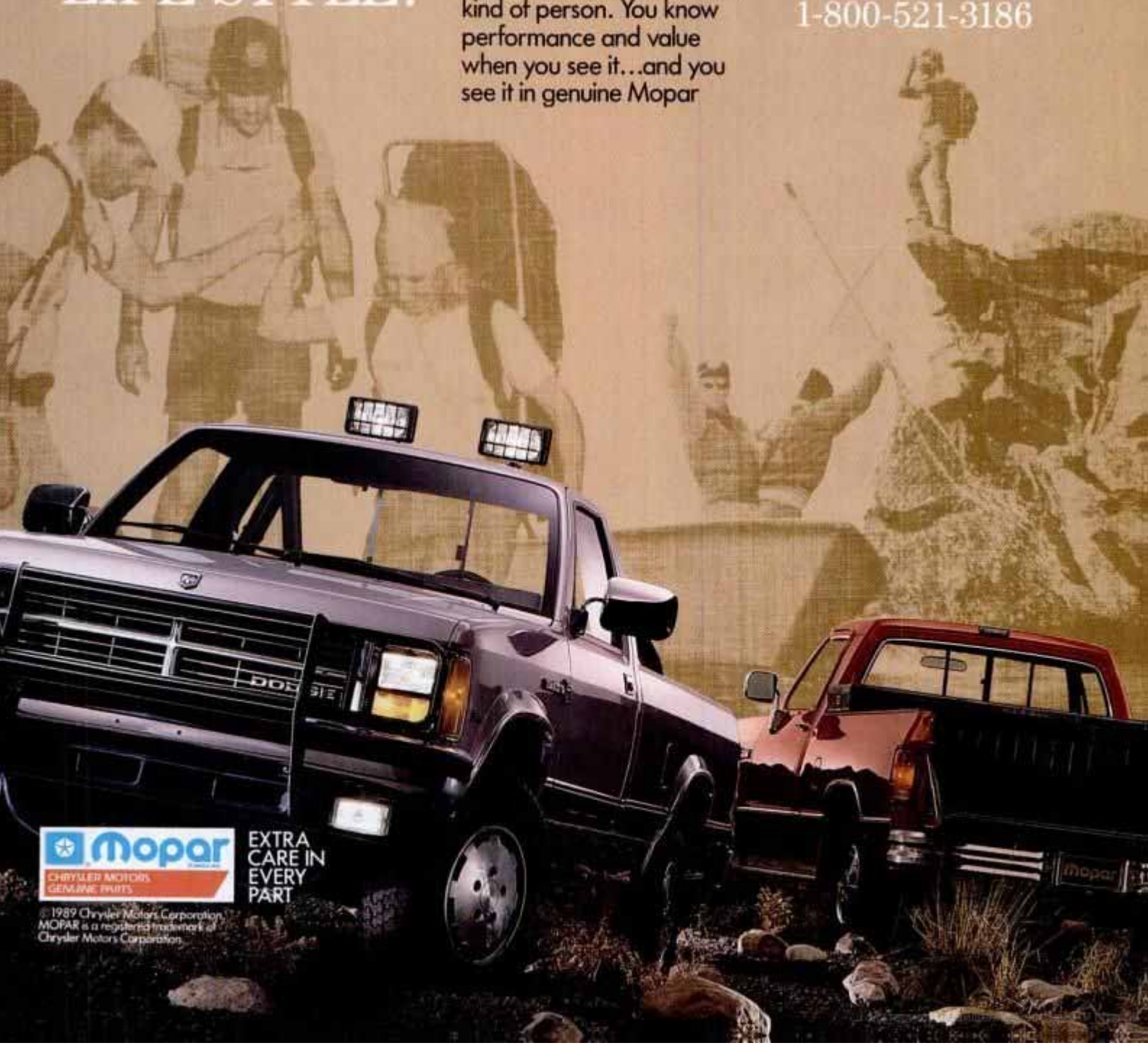
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TRICKED-OUT VIDEOGAMES

ard Nintendo control pad—without the wires. Also duplicating the size and weight of a standard Nintendo control pad is the Acclaim Remote (\$40), a wireless controller with a rapid-fire option. A slightly different design is available from Bondwell. Dubbed Quickshot (\$15), this wireless remote is compatible with most videogame systems. High-speed autofire and a choice of two joystick sizes are featured.

Most videogame manufacturers offer advanced, wired remotes that are more feature-laden than their wireless counterparts. Nintendo's Advantage controller (\$40) includes a slow-motion feature, allowing game players to surmount obstacles that otherwise would be very difficult.

Another type of controller offered as an optional accessory is the pistol, for use in target-oriented videogames. One of the newest is the Video Blaster (\$30) from Camerica. The video Blaster resembles the classic six-shooter of the Old West. The lightweight revolver features tripphammer action, a gunsight and a 10-ft. cord for hookup to the game.

New dimensions

Besides hands-free and wireless remote controllers, manufacturers are experimenting with other technologies that impart a true-to-life feel to their games.

Sega offers a package of hardware and software built around special 3-D wraparound glasses. The glasses employ liquid-crystal shutters that are synchronized with the image generated by the 3-D game cartridges to create a sensation of depth. The Sega 3-D system costs \$149, while additional 3-D cartridges cost about \$45 each.

Accessories can also add more of a physical challenge to videogames. Nintendo's Power Pad (\$70) is an interactive electronic mat that uses a player's body movements to control the action on screen. When used with the *World Class Track Meet* cartridge, for example, the Power Pad simulates the feel of a real track and field competition—and is more healthful than passive play! A variation on the rectangular Power Pad is the oval-shaped Roll N' Rocker (\$36) developed by L.J.N. Toys for use in surfing and skateboard simulations.

Both the Power Pad and Roll N' Rocker introduce a physical element to videogame play. But even if you don't want to work up a sweat playing videogames, any of the new accessories offers you a freedom of movement previously unattainable.

FM



LASER SHARP

Tape is the workhorse of video, and laser disc is the thoroughbred. See how they run.

BY FRANK VIZARD, Contributing Editor



Video discs, like digital audio compact discs, are played by a beam of laser light. Pioneer's CLD-91 plays 3-, 5-, 8- and 12-in. platters.

THE ARGUMENT for video discs is simple: Both the picture and the sound quality are superior to videotape.

The argument against video discs is equally simple: You can't record. The winning argument is not so obvious. Both video discs and video cassette recorders have been on the scene for about the same length of time. The lack of recording capability put video discs on the back burner and VCRs into everyone's living room. VCRs have become so popular that many people are now adding a second model to the household, or upgrading to a fancier model.

Before you opt for a second VCR, you might want to consider the video disc alternative. While 12-in. video discs have been around for a decade, the high-quality video of the format is now married to high-quality digital audio in a variety of disc sizes.

In addition to audio-only 3- and 5-in. compact discs, there are now 5-, 8- and 12-in. discs that might be collectively termed CD-Video (the 5-in.

CD-Videos contain a 5-minute video clip and 20 minutes of music). All of these laser-read discs can be played on newly developed multidisc players. The result is a unified approach to high-quality audio/video entertainment housed in a single machine.

While Philips may be credited with bringing the first multidisc players to market, the price-busting lead has been taken by Pioneer, the company that has almost single-handedly kept the video disc alive during the past decade. Pioneer's new CLD 1070 costs \$600—a new low for a machine of this type. Pioneer also is offering its laser disc player for 12-in. video discs only, at a list price of \$500. Sony, meanwhile, offers a multidisc player, model LV-210, for \$700. Besides Pioneer, Sony and Philips, multidisc players are available from Sharp, Yamaha and Magnavox.

Multidisc players accommodate any size of disc, but allow you to play only one disc at a time. The current exception is Sharp's MV-D100 machine (\$1500). Sharp takes a carousel

approach to 3- and 5-in. discs. Three wells allow you to load any combination of audio-only 3- and 5-in. CDs or 5-in. CD-Videos. The MV-D100 can be programmed to playback from all three wells on a cut-by-cut basis. The larger 8- and 12-in. video discs are loaded singly.

While the lack of recording ability is a minus to time-shifters, the video disc offers a lot of pluses. Most releases now have digital audio soundtracks, but even older discs with analog soundtracks have superb FM stereo quality. Horizontal resolution, the accepted indicator of picture quality, exceeds 400 lines. This resolution is approached only by the Super VHS, Hi8 and ED-Beta tape formats—none of which has the extensive library of prerecorded titles available on video disc. Laser disc titles are generally less expensive than prerecorded videotapes, as discs are cheaper to duplicate than tapes.

Multidisc players generally offer the same type of video playback features as VCRs. They also add special effects of their own. You can, for example, leave a still image on the screen while the audio playback continues.

Video disc sizes generally reflect their content. The 5-in. size contains up to 5 minutes of video and 20 minutes of audio. The 8-in. disc usually offers an extended music video. The 12-in. size is generally reserved for lengthier material, such as movies, musicals and documentaries.

Most of the educational material and many older movie releases use a recording technique called Constant Angular Velocity (CAV). CAV limits the amount of recording time on a 12-in. disc to 30 minutes per side. CAV discs, however, can be accessed on a frame-by-frame basis. An individual still photo of a lunar landscape from among the hundreds in "Apollo 17: Mission To Taurus Littrow" can be found easily by selecting a chapter number from the menu. Pressing the SEARCH and PLAY buttons sends the laser playback mechanism zooming to that point on the disc. Since each chapter represents a relatively small collection of photos, finding the desired still takes only a few seconds. CAV movie titles often include supplemental material of interest to collectors, such as scripts and star interviews.

CAV discs are often referred to as standard-play video discs. Extended-play video discs operate by using Constant Linear Velocity (CLV), a technology that allows 1 hour of video material to be recorded on each side of a video disc. A CLV video disc rotates

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LASER SHARP

at a varying number of revolutions per second while a CAV video disc rotates at a constant speed. The development of CLV video discs means that most movies can be placed on a single disc. And since many new players are now capable of reading both sides of a video disc, it's no longer necessary to flip a video disc over or insert a new one at half-hour increments. The trade-off is that CLV discs are not as accessible as CAV discs in terms of retrieving data. CLV material like Arnold Schwarzenegger's "Predator," for example, doesn't include a menu. Many players, though, can access a specific point in the film by entering the desired minute and second.

Another variation within video discs is the multi-audio disc. Multi-audio discs allow you to mute portions of the soundtrack. This is a plus for language learners, who can eliminate the English dialogue dubbed onto foreign films, and for nature lovers wishing to dispense with the narration.

Many multidisc players themselves also offer features not commonly found on VCRs. A still picture, for example, can be left on screen while the audio continues. Jog/shuttle dials let you vary forward and reverse motion from 2- to 40-times normal speed in the DIAL mode. A thumbwheel inside the dial lets you jog the disc for still-frames or slow scan at 1/2-, 1- or 2-times normal speed. Programmers may enjoy the Picture Window option on Pioneer's CLD-3070 (\$1000). The Picture Window stores preprogrammed sequences for up to 60 discs.

Video disc players also enjoy many of the digital audio features of compact disc players, such as 4- and 8-times oversampling and separate digital-to-analog converters that appear in audio-only CD players.

The quick release of hit movies such as "Predator," "The Untouchables" and others is a positive sign for the disc medium, which was once plagued by a shortage of titles. Pioneer, perhaps the largest U.S. producer of video discs, has increased production to 600,000 discs per month, and Sony begins pressing video discs in Terre Haute, Indiana, next year. At this juncture, however, the number of video disc titles is still only about one-tenth the number of videotape titles. Nevertheless, the roughly 5000 video disc titles available is more than double the number available a few years ago. Video discs are starting to soar on CD's coattails, a fact that's sparking the interest of additional suppliers and making player prices drop. **PM**

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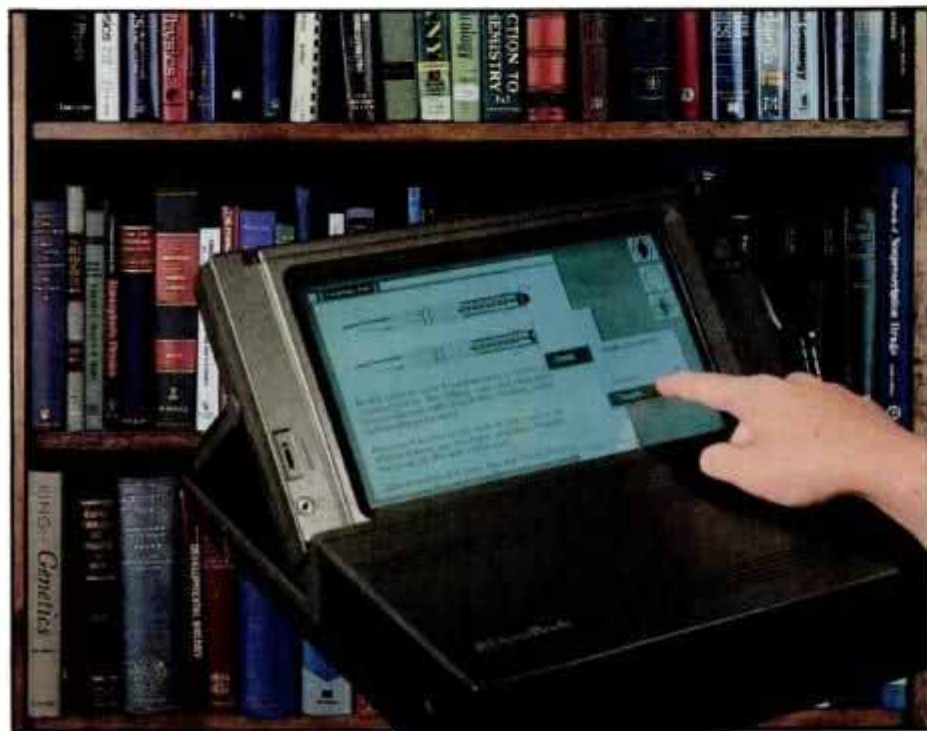
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ELECTRONIC BOOKSHELF

Bookworms beware! Your dictionaries have moved from the library to the TV screen.

BY RON SCIBILIA



Scenario's DynaBook, a CD-ROM player, displays an encyclopedia entry.

WILL COMPUTERS accelerate America's slide into illiteracy, turning potential book readers into image-addicted vegetables? Don't bet on it. The personal computer promises to create a new breed of cyber-savants for whom the video display is a window into a universe of information accessible through the touch of a computer keyboard.

Wordly Wise

PCs already are proving themselves as valuable tools for writing, helping would-be scribes improve their spelling, vocabulary and grammar. A wide range of programs can now serve as on-call writing coaches that work in conjunction with word-processing software. Franklin Computer's *Choice Words* (\$90), based on Merriam-Webster's lexicon, couples an 80,000-word dictionary and a thesaurus with 470,000 synonyms. Simon &

Schuster draws on Webster's *New World Dictionary And Thesaurus* for its *New World Combo*, which includes a 114,000-word speller and 330,000-synonym thesaurus. Microlytics' popular *Word Finder* (\$60) endorsed by no less a word-slinger than William F. Buckley Jr., gives users the option of using the program's full 220,000-synonym thesaurus or, for those with limited computer disk space, a smaller version with "only" 120,000 words.

A fully reliable grammar and style program has yet to arrive, but PC users at least can move in the direction of better prose with smart programs such as RightSoft's *Rightwriter* (\$86) and Reference Software's *Grammatik III* (\$90). Each of these programs takes up residence in your computer, and analyzes any text you write. The programs highlight problems in usage, style and punctuation—even questioning long-winded writing.

Phonetics

Tired of dialing long-distance information when you need to reach out and touch someone? General Information's latest version of *Hot Line* (\$99) is an on-line phone directory that offers 10,000 phone listings, culled from the National Directory, complete with addresses and zip codes. The program will also dial for you, through your modem, and can log your calls, tracking the called number and how long you talk.

If 10,000 directory entries aren't enough, you can add your own, using dBASE III files as add-on phone books, or purchase General Information's specialized directories called InfoPacks, each of which contain upward of 5000 more listings. These supplementary modules cost \$50 each and include computer and high-tech sources, a travel InfoPack focusing on the needs of the business traveler and an Advertising/Media set.

Wisdom-By-Wire

The on-line information seeker has almost an embarrassment of riches to choose from these days, with an arm's-length list of electronic information services offering everything from weather reports and electronic shopping to extremely specialized scientific abstracts.

Among the major for-pay services is CompuServe Information Services out of Columbus, Ohio, an information network with about half a million subscribers. The Source, based in McLean, Virginia, is another popular all-purpose service. Bryn Mawr, Pennsylvania-based NewsNet carries over 300 newsletters on-line. Dayton, Ohio-headquartered Mead Data Central's Lexis and Nexis offer full-text legal and business information, respectively. Princeton, New Jersey's Dow Jones News/Retrieval focuses on business and financial information.

For information junkies, Knight-Ridder's Dialog, based in Palo Alto, California, claims well over 100 million items in its 300-plus databases, ranging from the Electronic Yellow Pages and King James Bible to extremely esoteric technical and scientific repositories. The average cost to search this trove is about \$60 per hour. A less expensive service (\$24 per hour), Knight-Ridder's Knowledge Index, carries about 75 databases.

The latest entrant in the on-line sweepstakes is Prodigy, the Sears-IBM joint venture. While falling far short of some of the major services in breadth of offerings, Prodigy hopes to generate mass appeal by its cost



ELECTRONIC BOOKSHELF

structure: A flat fee of \$9.95 per month, after a \$49.95 start-up cost, entitles the user to unlimited access. By comparison, CompuServe—a far more versatile service with over 100 databases—costs \$40 to join, with a \$12 per hour connect charge (at 1200-baud) and surcharges for certain specialized services.

Discovery

CD-ROM disks, the computer data version of audio compact discs, may prove to be the ultimate information source. The magic of the CD-ROM disk is its astounding capacity: the equivalent of 275,000 typed pages of text on one 4.7-in. platter. CD-ROM players now cost about \$1000, but they're usually discounted. For ambulatory archivists, Boston-based Scenario offers DynaBook (\$5000), a 17-pound portable CD-ROM player with touch-screen display that also can serve as a fully functional AT-compatible PC.

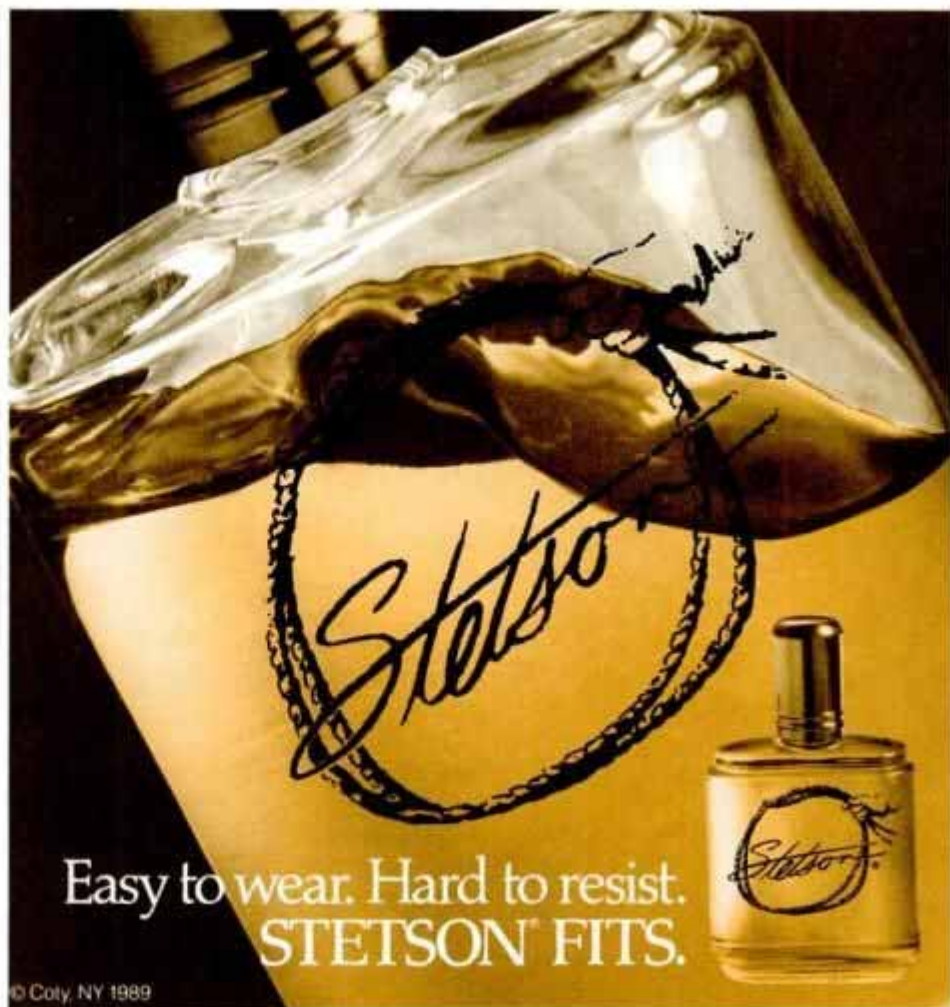
There's already a growing library of general interest reference works on CD-ROM, along with a considerable amount of privately published disks for use by corporations and educational institutions.

Facts On Disk

Already on the market is Microsoft's *Microsoft Bookshelf* (\$295), a 10-book reference set for authors that includes a dictionary, thesaurus, almanac, zip code directory, *Bartlett's Familiar Quotations*, a style manual and a compendium of business forms and letters.

Some other reference disks include Grolier's electronic version of the *Academic American Encyclopedia*, called *The New Electronic Encyclopedia* (\$395), H. W. Wilson's *Reader's Guide To Periodical Literature* (\$1095 per year), and a CD-ROM rendition of *The Original Oxford English Dictionary* (\$950), from Tri Star Publishing and Oxford University Press. Microsoft's *Small Business Consultant* (\$149) contains 200 U.S. government publications about starting and operating a small business, and *StatPack* (\$125) has 10,000 tables of U.S. government facts and figures.

Although CD-ROM players and reference works are expensive today, the potential for lower cost is evident. Hardware prices already are falling. And once the subject matter is prepared in digital form, pressing disks is faster and cheaper than printing—and less costly to ship and warehouse. What a break for people and trees! **PM**



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ALL-POINTS AUDIO

You don't have to go to the movies to hear surround sound. A wide array of electronics brings it home.

BY FRANK VIZARD, Contributing Editor



Catch surround-sound telecasts with Dolby decoders like the AudioSource SS-II.

FOOTBALL RECEIVERS often drop the pass because they hear footsteps behind them. Starting this fall, you're likely to hear those footsteps and much more as television stations begin broadcasting in surround sound. From the standpoint of the home audio/video enthusiast, surround sound is about to become as desirable as stereo.

CBS, NBC and PBS are taking the lead in surround-sound broadcasts of football, basketball and baseball games, in addition to movies and selected episodic productions. Broadcasters, in fact, have been experimenting with surround sound for some time. The past two Super Bowls, for example, have been aired with surround sound, and "Late Night With David Letterman" carries surround sound throughout the year. With a batch of successful experiments behind them, broadcasters are set to expand their surround-sound programming.

Surround sound is appealing because of its ability to put you in the center of the action. As the name suggests, you'll require a minimum of two front-channel and two back-channel speakers to produce the surround-sound effect. More elaborate setups can include the addition of two side speakers and a center speaker up front for dialogue.

These secondary speakers don't have to pack the punch of your primary speakers either. While the audible bandwidth of the primary stereo channels ranges as high as 20 KHz, the bandwidth of the surround-sound channels is generally restricted to about 7 KHz. This restricted bandwidth helps ensure that the very directional, higher-frequency information doesn't leak into the surround speakers. Most of the reverberant information that helps create a realistic aural environment is located below the 7 KHz level.

The brain routing the audio signals

to the appropriate speaker is the surround-sound processor, which is built into a wide variety of new components on the market. Audio receivers such as Technics' SA-R477 (\$530) and televisions like Panasonic's CTL-2791S (\$1099) incorporate surround-sound processors, as well as a second, rear-channel amplifier needed to power the back speakers.

Separate add-on components, such as the remote-controlled AudioSource SS-II (\$250), package surround-sound circuitry with a modestly powered, 30-watts-per-channel amplifier for the rear channels. The rear-channel amplification should never be so powerful as to overwhelm the front primary speakers.

Cinema sound

While surround-sound circuitry can enhance your enjoyment of any audio source, surround sound is often at its most spectacular when used with video. Dolby Surround is the de facto standard used by broadcasters and moviemakers alike. The Dolby Surround circuitry extracts the surround-sound information encoded onto the video's audio tracks. In addition to limiting the audio signal bandwidth, the Dolby circuitry adds a tiny bit of time delay and noise reduction during processing.

Dolby Surround was conceived as a simple, passive circuit that could be inexpensively added to audio/video components. More than 30 manufacturers now include Dolby Surround in one or more products that are becoming less expensive all the time. Yet while Dolby Surround did enhance the soundtrack of films on home video, it didn't quite match the spectacular performance level that frequent theater-goers had come to expect.

Demanding movie buffs now can opt for components incorporating a new circuitry called Dolby Pro Logic Surround. This system eliminates the hole-in-the-middle perception that was sometimes produced by widely placed speakers.

No phantoms

Pro Logic circuitry is active in the sense that it enhances directionality while decreasing the amount of undesirable leakage. Pro Logic circuitry is most noticeable with dialogue. Rather than relying upon a phantom center channel comprised of left- and right-channel stereo information, a steered center channel is used to anchor the dialogue to its on-screen location. This means that you can sit off-center from the primary speakers without



ALL-POINTS AUDIO

the dialogue seeming to drift away from the mouths of on-screen characters. Pro Logic components generally provide for the addition of a small center-channel speaker to the system. The availability of Dolby Pro Logic means that a surround-sound system similar to those in the best movie theaters can be created at home. For example, Denon's new AVC-2000 audio/video amplifier (\$1000) can power five channels: front left and right, front center, and rear left and right. The AVC-2000 also has a 3-position time-delay switch so that the surround effect can be adjusted to suit the size of the room.

The Dolby Pro Logic surround effect in the AVC-2000 can be adjusted in other ways as well. A wide mode increases the apparent separation between the left and right speakers. There's also a phantom mode that helps localize the dialogue when a center speaker is not in use.

The AVC-2000 also has stadium and hall modes that can be used with nonDolby-encoded material. Many components, in fact, include some general type of surround-sound circuit for use with nonDolby-encoded material.

Other modes

Yamaha's line of digital sound processors offers Dolby Surround as well as a variety of preprogrammed settings that replicate various acoustic interiors. Yamaha's DSP-100U (\$699), for instance, offers a Dolby Surround mode as well as two movie theater modes with variable options.



Versatile performers: Carver's CT-17 preamp/tuner (above) and Pioneer's VSX-9500S audio/video receiver have Pro Logic built in.



One option is an acoustic simulation of an old movie house of the type where classics like "The Maltese Falcon" were first previewed. The acoustics of more modern theaters can be simulated as well, for Indiana Jones fans. The DSP-100U can also re-create the acoustic interiors of various concert halls, jazz clubs and discos.

Dolby Surround is also sometimes combined with proprietary circuitry that can yield interesting sonic effects. Carver, for example, uses Dolby Pro Logic circuitry to complement its own Sonic Holography circuit in the CT-17 preamplifier/tuner. The Sonic Holography circuit is designed to make the audio wider, higher and deeper.

Whether used alone or in tandem with other circuitry, the goal of surround sound is to retrieve and restore the spatial information present in all acoustic situations. Manufacturers continually approach that goal in different ways. Sony, for example, employs a 2-speaker approach in its new line of televisions. For the moment, however, audio and video components featuring Dolby Surround best put you in the center of the action. **PM**



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MUSICAL TALENT

Ever wish you could play an instrument or write music?
With the latest electronic tutors, you can.

BY FRANK VIZARD, Contributing Editor



The vocalizer 1000 and Sony Drumpad (top): music for novices.

IT'S A SHORT leap from listening to music to making your own. You might not solo at Carnegie Hall right away, but you'll quickly jump to happy amateur with the aid of various devices designed to make your involvement with music easier and more enjoyable.

Musical aids vary from the simple to the complex. Most of us, for instance, have tapped a drum beat on a table in time to music. Advanced finger tapping now can be added directly to the music with the help of Sony's DRP-1 digital drum pad (\$50).

The DRP-1 is a 4 x 6-in. device that plugs into the microphone input of a home stereo system or portable boombox. The drum pad electronically reproduces bass, snare or synthesized drum sounds at the touch of a button. Additional buttons reproduce

cow bell, hand clap, high-hat and other percussive effects.

The DRP-1 is a useful rhythm-teaching device. The tempo can be adjusted from slow to fast, enabling the would-be drummer to create a rhythmic combination of sounds. Eight rhythm patterns can be stored in the DRP-1's memory. Drummers can either play along with the music or mix a solo riff of their own onto a tape.

Ministudios

You can move from drumming to singing with the band, thanks to a line of products available from Songtech. The Singing Systems developed by Songtech are based on the *karaoke* concept popular in Japan. Each of the three systems allows you to sing, mix and record your own lead vocals against a backup track of contemporary music.

Each Songtech system features a microphone, echo controls and other easy-to-use features. The machine plays a variety of Songtrax audio cassettes made for karaoke use. Side A of each cassette contains only the musical arrangement to the song. Side B includes a vocal guide to the song, to help you rehearse. Four-song cassettes cost \$8; 6-song tapes cost \$10. More than 300 different songs are available, ranging in appeal from Frank Sinatra to Prince.

Two of the Songtech systems differ primarily in their ability to record your vocal efforts. The Junior Studio system (\$60) comes with cables for connection to any portable tape player. The Junior Studio II (\$100) includes a built-in stereo cassette player/recorder.

Songtech's Studio B (\$300) is more appropriate for the professional or serious amateur who needs an inexpensive way to practice vocal stylings. The Studio B system includes an 8-in. speaker, 2 microphone inputs, a dual-well cassette recorder, adjustable pitch control, a microphone mixing control, an output for connection to a separate monitor or PA system, and auxiliary inputs and outputs. The auxiliary inputs can be used to connect an electronic keyboard or guitar if desired. All of these features are shoehorned into a very portable package weighing 16½ pounds and measuring less than 13 x 18 x 10 in.

Maestro!

The term one-man band takes on new meaning in the hands of Breakaway Music Systems. The company's Vocalizer 1000 (\$300) is a music synthesizer triggered by the human voice. Simply humming into the microphone transforms a *dum-de-dum-dum* into one of 28 different musical instrument sounds. Most of the sounds duplicate standard instruments such as guitar, trumpet or violin. The Vocalizer 1000 also includes some unique "instrumental" sounds, the oddest perhaps being "Sara," the name of a baby born to a company employee. Playback can be done using the machine's built-in speaker, through headphones or through a home hi-fi system.

The 3-pound Vocalizer 1000 comes with a dozen built-in background arrangements, generically labeled according to genres ranging from rock to reggae. Supplemental musical arrangements are available from plug-in SmartSong cartridges (\$20 each). The Vocalizer 1000 also is able to compensate for bad humming by combining pitch tracking with what the company calls Voice Guide technology. Pitch tracking allows the



MUSICAL TALENT

machine to digitally separate the desired notes from unwanted overtones. The Voice Guide corrects for off-key humming by substituting the nearest harmonious note culled from a built-in index of pleasant sounds. What comes out sounds good even if what you put in doesn't. While the Vocalizer 1000 may be perceived as a fancy electronic kazoo, it can be a sophisticated aid to music composition. The Vocalizer 1000 includes a multitrack digital recorder with a memory capacity of more than 1000 notes. This allows you to lay down an electric guitar track—complete with slide effects—over a previously recorded saxophone track. The results can be stored on blank SmartSong cartridges.

The MIDI link

The fact that the Vocalizer 1000 is MIDI compatible makes the machine's composing capabilities truly usable. MIDI stands for Musical Instrument Digital Interface, a technology that allows a product like the Vocalizer 1000 to interact with a similarly equipped electronic keyboard, for example. A basic musical idea recorded on the Vocalizer 1000 could be transferred to an electronic keyboard for further development.

An aspiring composer, in fact, might want to use the MIDI connection to interface with a personal computer running a new music transcription program called Finale, developed by Coda Music Software.

Finale is expensive (\$1000) and complicated. But once mastered, it's an enormous timesaver. In a nutshell, Finale instantly transforms a played note into musical notation that appears on the computer screen. Rather than having to re-create an improvisation with pencil and paper, it's preserved on-screen in the form of electronic sheet music—G clefs, half-notes and all—as the music is being composed. The Finale program is also versatile in that it can be used with Apple or IBM-compatible computers with one megabyte capability, so musicians with different computers can communicate with each other.

While the Finale program might not be accessible to everyone, its practicality is the result of advances in digital technology such as MIDI, that allow musical instruments to communicate with each other and computers electronically. This technology puts the joys of music-making into more hands. Music critics might debate the results, but in the meantime, a lot of people are going to be having a lot of fun. **PM**



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BY RON SCIBILIA



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THE IBM PERSONAL Computer might not be the perfect machine, but you certainly can't accuse it of not growing. Thanks to an open architecture that lets owners expand and modify the basic system, the IBM PC and its clan of clones have learned how to age gracefully—and usefully. With a careful selection of both transplants and add-ons you can transform your machine's personality and multiply its utility.

Want to raise your PC's IQ? Replacing your computer's motherboard, its "neural network," with a new and more advanced model is the

most thorough—and expensive—route to boosting your machine's basic brain power.

For prices starting at around \$1600, companies like Hauppauge, AMI and Mylex will supply you with a new motherboard based on Intel's powerful 32-bit 80386 microprocessor. Other companies offer lower priced boards based on Intel's less-powerful 16-bit 80286 processor.

A somewhat less effective but simpler way to get some additional smarts for your machine is to install

an accelerator card. This expansion board contains a faster microprocessor and high-speed, on-board RAM. Intel and Quadram, with their In-Board 386PC and QuadXT386 boards (both \$995), are two manufacturers supplying '386-based accelerators. Among '286-based accelerators, two of the best come from Microsoft and SOTA Technologies.

Add-on boards snap into so-called expansion slots under the hood of your computer, and the number of free slots varies among brands and models. For the slot-poor PC owner, Microsoft's Mach 20 system puts onto a single multimodule board an 8MHz (megahertz) '286 processor, 16KB (kilobytes) of high-speed RAM (random access memory), a mouse port and, optionally, up to 3.5MB (megabytes) of expanded memory RAM and a floppy disk controller able to handle any type of 5.25- or 3.5-in. disk drives. Prices are \$495 for the basic board, \$395 for the memory module (with 512KB RAM), \$99 for the disk controller.

Compared to Mach 20, SOTA's 286i system (\$495) runs faster, at 12.5MHz, and collaborates with a wider range of computers, including both dual-speed turbo 8088s and 8086-based PCs like IBM's own Model 30. It lacks a mouse port and needs a second expansion slot for its extracost floppy controller "daughtercard" (\$149). You can add up to 8MB of RAM, via a modular memory board (\$295 without RAM chips).

Despite the allure of faster processing speed, upping your machine's permanent memory capacity by adding a hard disk drive is probably the first add-on you should consider. You can install an internal hard disk drive—Seagate, Miniscribe and Priam are among the leading brands. Or, if you have the slot space, you can opt for an even easier though slightly more costly solution—a hard disk with an integrated controller on a single expansion board. The clear standouts in this field are the two Hardcard units, available in either 20MB (\$795) or 40MB (\$995) capacities from Plus Development.

Improving your unit's video output should be another high-priority upgrade. Today the name of the game is VGA, the high-resolution standard that IBM introduced in '87.

Many suppliers offer high-quality VGA-compatible boards (priced at \$495 and up). Bronx, New York-based Willow Peripherals offers two multipurpose VGA boards. The Publishers' VGA board (\$699) lets you

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CUSTOMIZING YOUR COMPUTER

import images from any NTSC-compatible video source—a camcorder, for example. Willow's VGA-TV board goes the other way, sending VGA output to NTSC video receivers—VCRs, for example. Digital Vision, of Dedham, Massachusetts, makes ComputerEyes, a full-color (\$400) or black-and-white (\$250) digitizer system that grabs signals from any standard video source and stores them in your computer.

Another way to give your computer eyes is with image scanners, which read photos and artwork into a computer-usable form. Among the best of the desktop units, which link to a PC's serial port is Hewlett-Packard's ScanJet Plus (\$2190), a 256 gray-level machine, DEST's PC Scan 2020 (\$3035), which reproduces a full 256 gray levels, and Canon's simulated 32-gray-level IX-12 (\$1190). For more casual users, hand scanners may suffice, especially if you're scanning only small areas, like logos or signatures. Units are available from The Complete PC (\$249), Logitech (\$299), Packard Bell (\$349) and others.

Electronic communication with the outside world is a major reason to own a PC today, and modems are becoming a must-have accessory for many users. A 2400-bps modem, which can transmit text at approximately 2400 words per minute, is probably the soundest investment for frequent telecommunicators.

Most 2400-bps units sell for under \$200, and serviceable 1200-bps units are now available for less than \$100. Key modem suppliers include market leader Hayes Microcomputing, Ven-Tel, Oki, U.S. Robotics, Zoom Telephonics, Megahertz and Practical Peripherals.

Portable modems are great for on-the-road computing. Northport, New York-based Touchbase Systems' palm-sized WorldPort 1200 and 2400 models (\$199 and \$359) run on either a 9-volt battery or AC.

Fax boards enable PCs to send or receive telephone facsimile transmissions. They're primarily useful for computer owners who need to send messages to a variety of fax addresses and want to automate the process. Quadram and Intel offer fax boards, the JT FAX 9600 (\$795 including a 1200-bps data modem) and the Connection CoProcessor (\$995), respectively. These units use a separate on-board microprocessor for so-called "background operation," an important feature that lets your computer keep computing as you send or receive a fax. Quadram also markets the most cost-effective units for the occasional faxer, the JT Fax, a 4800-bps unit available in either internal or external configurations (\$295 or \$495, respectively).

Several manufacturers feature add-on voice messaging boards that will have your computer business sounding like a Fortune 500 company's switchboard. These add-ons offer features such as separate mail boxes for each person called, passwords, message forwarding and call transfer. Price tags start as low as \$199 for basic systems like Natural Microsystems' Watson. Another voice-message system vendor, The Complete PC, offers a \$349 VM system called The Complete Answering Machine. It also has a combo board, The Complete Communicator (\$899), that packages a Group III-compatible fax modem, a regular 2400-bps Hayes-compatible data modem, and a voice messaging system all in one slot.

If you need to stay in touch with your investments, there are several companies that can put you in constant touch with the stock market. Lotus Signal (\$599) uses an on-board FM receiver and software to pull in financial data. CableSoft's LiveWire system (\$995), meanwhile, uses an expansion board, software and a cable TV line to tap you into the Financial News Network's stock data. With turbocharging products such as these, you ought to splurge on a pinstripping kit to detail your muscle PC.

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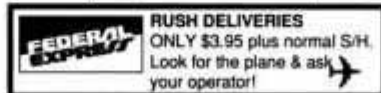
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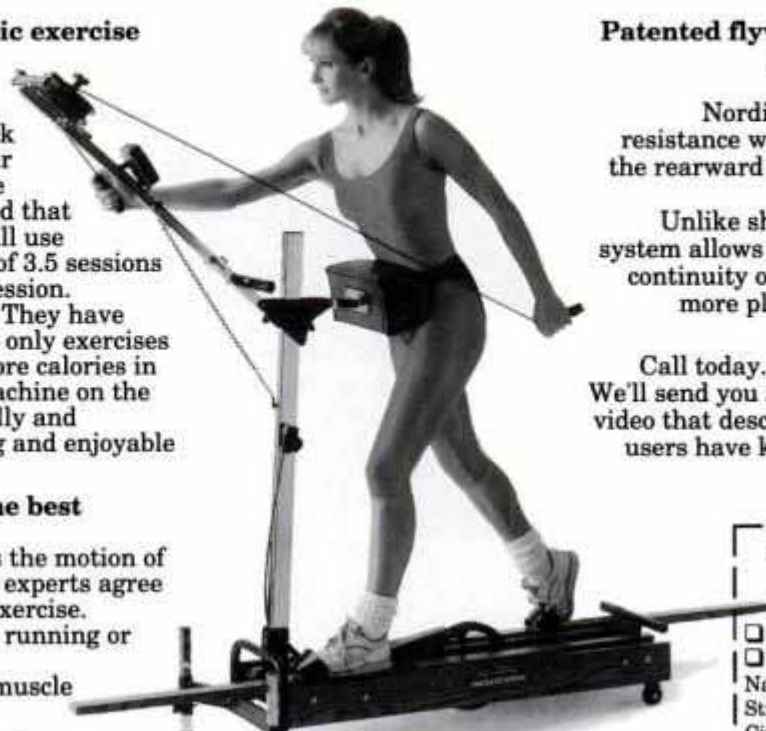
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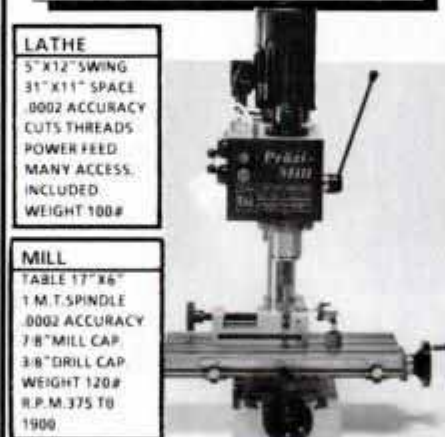
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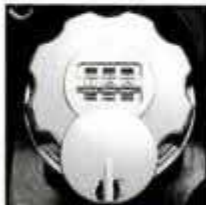
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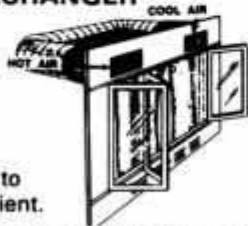
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YOU CAN MAKE UP TO One Million Dollars in 9 Months

Dear Friend,

I made one million dollars in 9 months. You may do better!

My name is John Wright. Not too long ago I was flat broke. I was \$31,000 in debt. The bank repossessed my car because I couldn't keep up with the payments. And one day the landlord gave me an eviction notice because I hadn't paid the rent for three months. So we had to move out. My family and I stayed at my cousin's place for the rest of that month before I could manage to get another apartment. That was very embarrassing.

Things have changed now. I own four homes in Southern California. The one I'm living in now in Beverly Hills is worth more than one million dollars. I own several cars, among them a brand new Mercedes and a brand new Cadillac. Right now, I have a million dollar line of credit with the banks and have certificates of deposit at \$100,000 each in my bank in Beverly Hills.

Best of all, I have time to have fun. To be me. To do what I want. I work about 4 hours a day, the rest of the day, I do things that please me. Some days I go swimming and sailing — shopping. Other days, I play racquetball or tennis. Sometimes, frankly, I just lie out under the sun with a good book. I love to take long vacations. I just got back from a two week vacation from — Maui, Hawaii.

I'm not really trying to impress you with my wealth. All I'm trying to do here is to prove to you that if it wasn't because of that money secret I was lucky enough to find that day, I still would have been poor or may be even bankrupt. It was only through this amazing money secret that I could pull myself out of debt and become wealthy. Who knows what would have happened to my family and me.

Knowing about this secret changed my life completely. It brought me wealth, happiness, and most important of all — peace of mind. This secret will change your life, too! It will give you everything you need and will solve all your money problems. Of course you don't have to take my word for it. You can try it for yourself. To see that you try this secret, I'm willing to give you \$20.00 in cash. (I'm giving my address at the bottom of this page.) I figure, if I spend \$20.00, I get your attention. And you will prove it to yourself this amazing money secret will work for you, too!

Why, you may ask, am I willing to share this secret with you? To make money? Hardly. First, I already have all the money and possessions I'll ever need. Second, my secret does not involve any sort of competition whatsoever. Third, nothing is more satisfying to me than sharing my secret only with those who realize a golden opportunity and get on it quickly.

This secret is incredibly simple. Anyone can use it. You can get started with practically no money at all and the risk is almost zero. You don't need special training or even a high school education. It doesn't matter how young or old you are and it will work for you at home or even while you are on vacation.

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some cases you may be able to cash in literally overnight. If you can follow simple instructions you can get started in a single afternoon and it is possible to have spendable money in your hands the very next morning. In fact, this just might be the fastest legal way to make money that has ever been invented!

This is a very safe way to get extra cash. It is practically risk free. It is not a dangerous gamble. Everything you do has already been tested and you can get started for less money than most people spend for a night on the town.

One of the nicest things about this whole idea is that you can do it at home in your spare time. You don't need equipment or an office. It doesn't matter where you live either. You can use this secret to make money if you live in a big city or on a farm or anywhere in between. A husband and wife team from New York used my secret, worked at home in their spare time, and made \$45,000 in one year.

This secret is simple. It would be hard to make a mistake if you tried. You don't need a college degree or even a high school education. All you need is a little common sense and the ability to follow simple, easy, step-by-step instructions. I personally know a man from New England who used this secret and made \$2 million in just 3 years.

You can use this secret to make money no matter how old or how young you may be. There is no physical labor involved and everything is so easy it can be done

Here's what newspapers and magazines are saying about this incredible secret:

The Washington Times:

The Royal Road to Riches is paved with golden tips.

National Examiner:

John Wright has an excellent guide for achieving wealth in your spare time.

Income Opportunities:

The Royal Road to Riches is an invaluable guide for finding success in your own back yard.

News Tribune:

Wright's material is a MUST for anyone who contemplates making it as an independent entrepreneur.

Success!

John Wright believes in success, pure and simple.

Money Making Opportunities:

John Wright has a rare gift for helping people with no experience make lots of money. He's made many people wealthy.

California Political Week:

...The politics of high finance made easy.

The Tolucan:

You'll love... *The Royal Road to Riches*. It's filled with valuable information... only wish I'd known about it years ago!

Hollywood Citizen News:

He does more than give general ideas. He gives people a detailed A to Z plan to make big money.

The Desert Sun:

Wright's *Royal Road to Riches* lives up to its title in offering an uncomplicated path to financial success.

whether you're a teenager or 90 years old. I know one woman who is over 65 and is making all the money she needs with this secret.

When you use this secret to make money you never have to try to convince anybody of anything. This has nothing to do with door-to-door selling, telephone solicitation, real estate or anything else that involves personal contact.

Everything about this idea is perfectly legal and honest. You will be proud of what you are doing and you will be providing a very valuable service.

It will only take you two hours to learn how to use this secret. After that everything is almost automatic. After you get started you can probably do everything that is necessary in three hours per week.

PROOF

I know you are skeptical. That simply shows your good business sense. Well, here is proof from people who have put this amazing secret into use and have gotten all the money they ever desired. Their initials have been used in order to protect their privacy, but I have full information and the actual proof of their success in my files.

'More Money Than I Ever Dreamed'

"All I can say — your plan is great! In just 8 weeks, I took in over \$100,000. More money than I ever dreamed of making. At this rate, I honestly believe, I can make over a million dollars per year." A. F., Providence, R.I.

'\$9,800 In 24 Hours!'

"I didn't believe it when you said the secret could produce money the next morning. Boy, was I wrong, and you were right! I purchased your *Royal Road to Riches*. On the basis of your advice, \$9,800 poured in, in less than 24 hours! John, your secret is incredible!" J. K., Laguna Hills, CA

'Made \$15,000 In 2 Months At 22'

"I was able to earn over \$15,000 with your plan — in just the past two months. As a 22 year old girl, I never thought that I'd ever be able to make as much money, as fast as I've been able to do. I really do wish to thank you, with all of my heart." Ms. E. L., Los Angeles, CA

'Made \$126,000 In 3 Months'

"For years, I passed up all the plans that promised to make me rich. Probably I am lucky I did — but I am even more lucky that I took the time to send for your

material. It changed my whole life. Thanks to you, I made \$126,000 in 3 months."

S. W., Plainfield, IN

'Made \$203,000 In 8 Months'

"I never believed those success stories... never believed I would be one of them... using your techniques, in just 8 months, I made over \$203,000... made over \$20,000 more in the last 22 days! Not just well prepared, but simple, easy, fast... John, thank you for your *Royal Road to Riches!*"

C. M., Los Angeles, CA

'\$500,000 In Six Months'

"I'm amazed at my success! By using your secret I made \$500,000 in six months. That's more than twenty times what I've made in any single year before! I've never made so much money in such short time with minimum effort. My whole life I was waiting for this amazing miracle! Thank you, John Wright."

R. S., Mclean, VA

As you can tell by now I have come across something pretty good. I believe I have discovered the sweetest little money-making secret you could ever imagine. Remember — I guarantee it.

Most of the time, it takes big money to make money. This is an exception. With this secret you can start in your spare time with almost nothing. But of course, you don't have to start small or stay small. You can go as fast and as far as you wish. The size of your profits is totally up to you. I can't guarantee how much you will make with this secret but I can tell you this — so far this amazing money producing secret makes the profits from most other ideas look like peanuts!

Now at last, I've completely explained this remarkable secret in a special money making plan. I call it "The Royal Road to Riches". Some call it a miracle. You'll probably call it "The Secret of Riches". You will learn everything you need to know step-by-step. So you too can put this amazing money making secret to work for you and make all the money you need.

To prove this secret will solve all your money problems, don't send me any money, *instead postdate* your check for a month and a half from today. I guarantee not to deposit it for 45 days. I won't cash your check for 45 days before I know for sure that you are completely satisfied with my material.

\$20.00 FREE!

There is no way you can lose. You either solve all your money problems with this secret (in just 30 days) or you get your money back *plus \$20.00 in cash FREE!*

Do you realize what this means? You can put my simple secret into use. Be able to solve all your money problems. And if for any reason whatsoever you are not 100% satisfied after using the secret for 30 days, you may return my material. And then I will not only return your original UNCASHED CHECK, but I will also send you an *extra \$20.00 cashiers check* just for giving the secret an honest try according to the simple instructions.

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"As Mr. John Wright's accountant, I certify that his assets exceed one million dollars."

Mark Davis

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8626 Solar Necklace \$19.95

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FLUORESCENT EFFECTS. Black Light (invisible ultra violet ray bulb) makes objects, posters, paints, make-up, minerals, etc. fluoresce in dark. In brilliant, fire-like colors. Create "turned on" and supernatural effects. Many practical and scientific uses. 75 watt, 110 volt.

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5839 Verminox \$39.95

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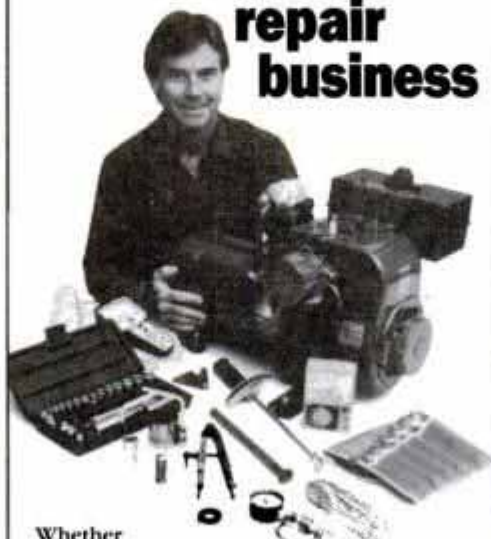


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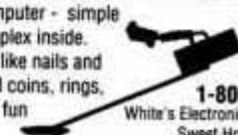
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