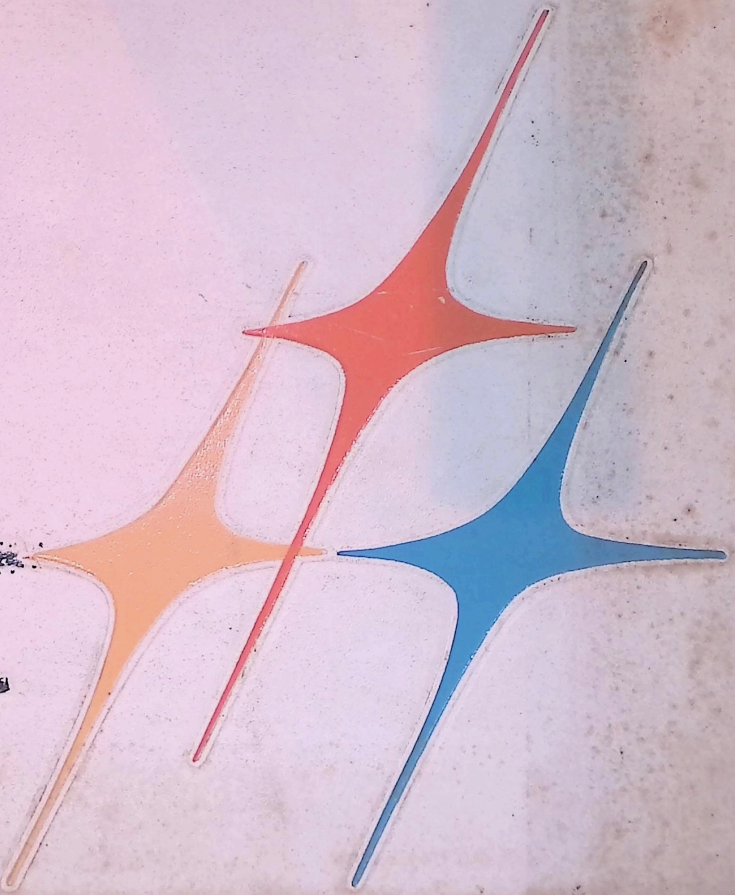
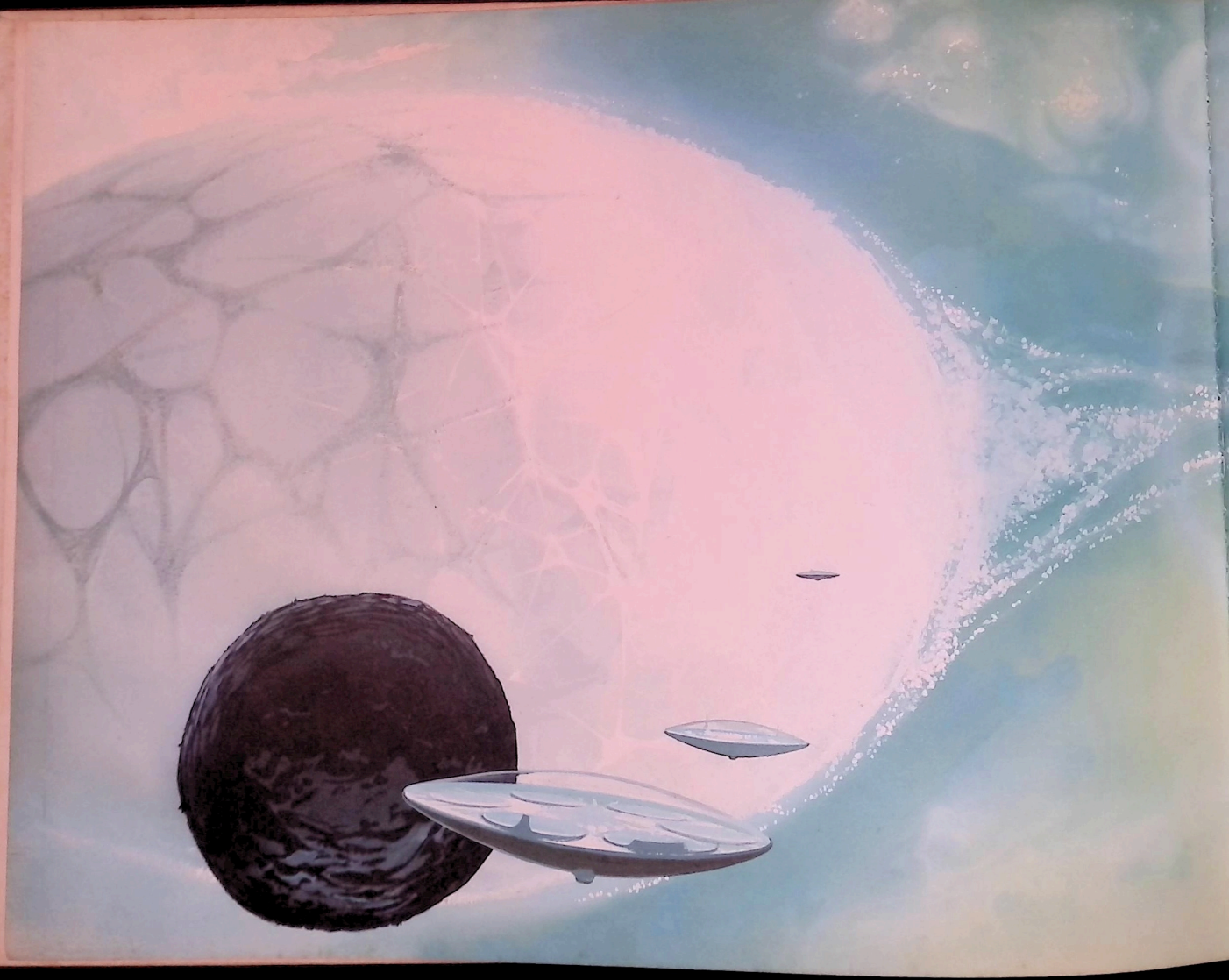
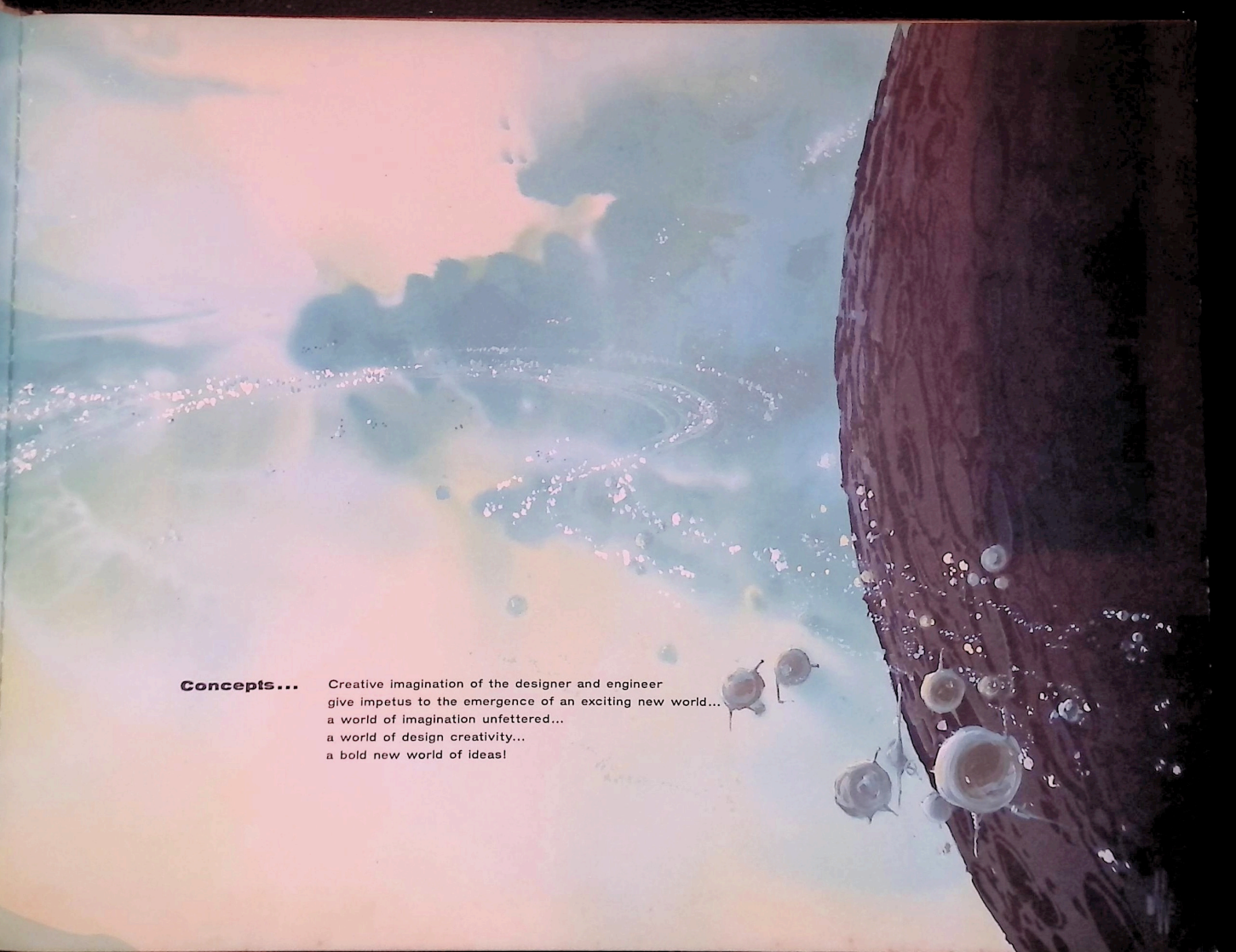
Concepts

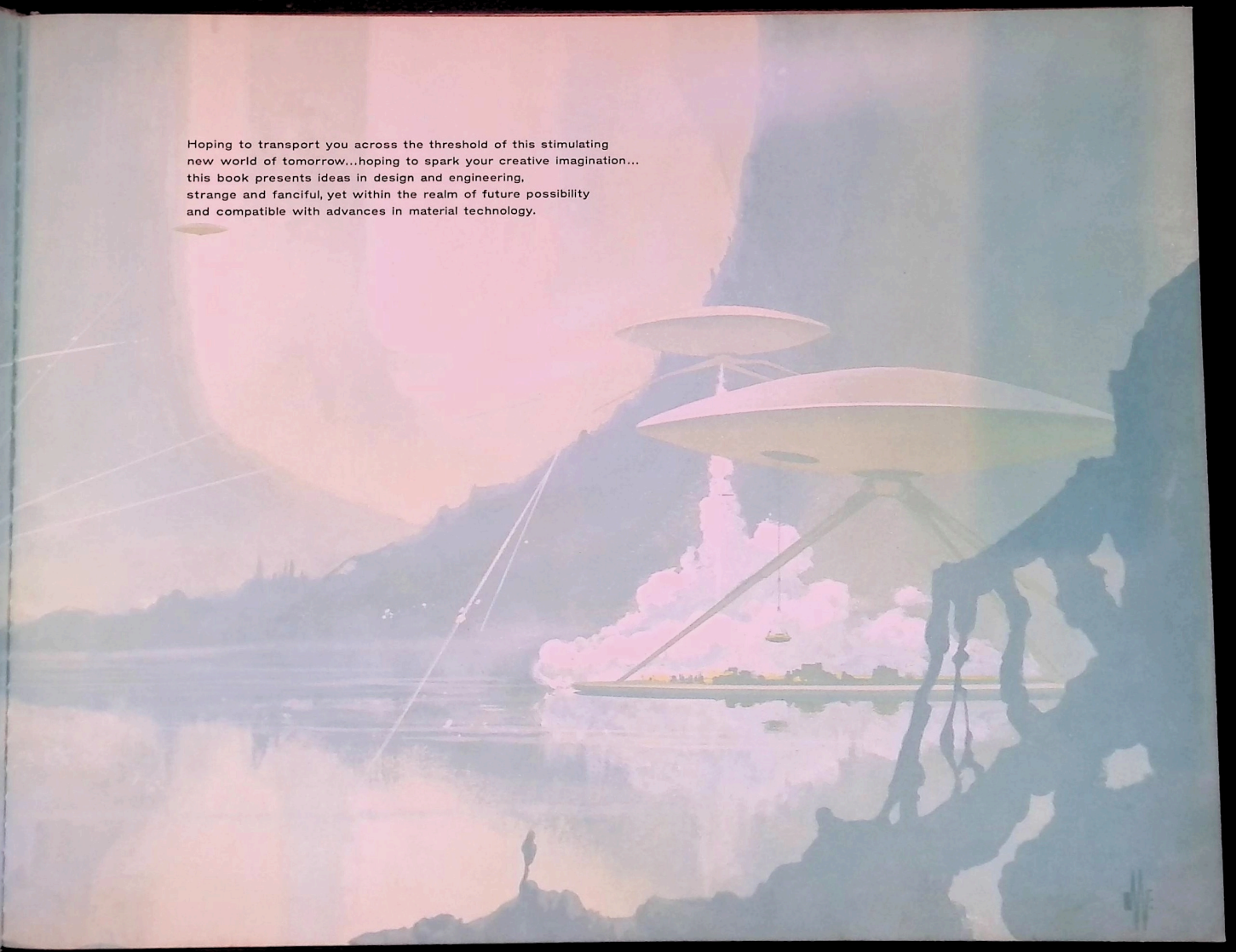






Concepts...

Creative imagination of the designer and engineer
give impetus to the emergence of an exciting new world...
a world of imagination unfettered...
a world of design creativity...
a bold new world of ideas!



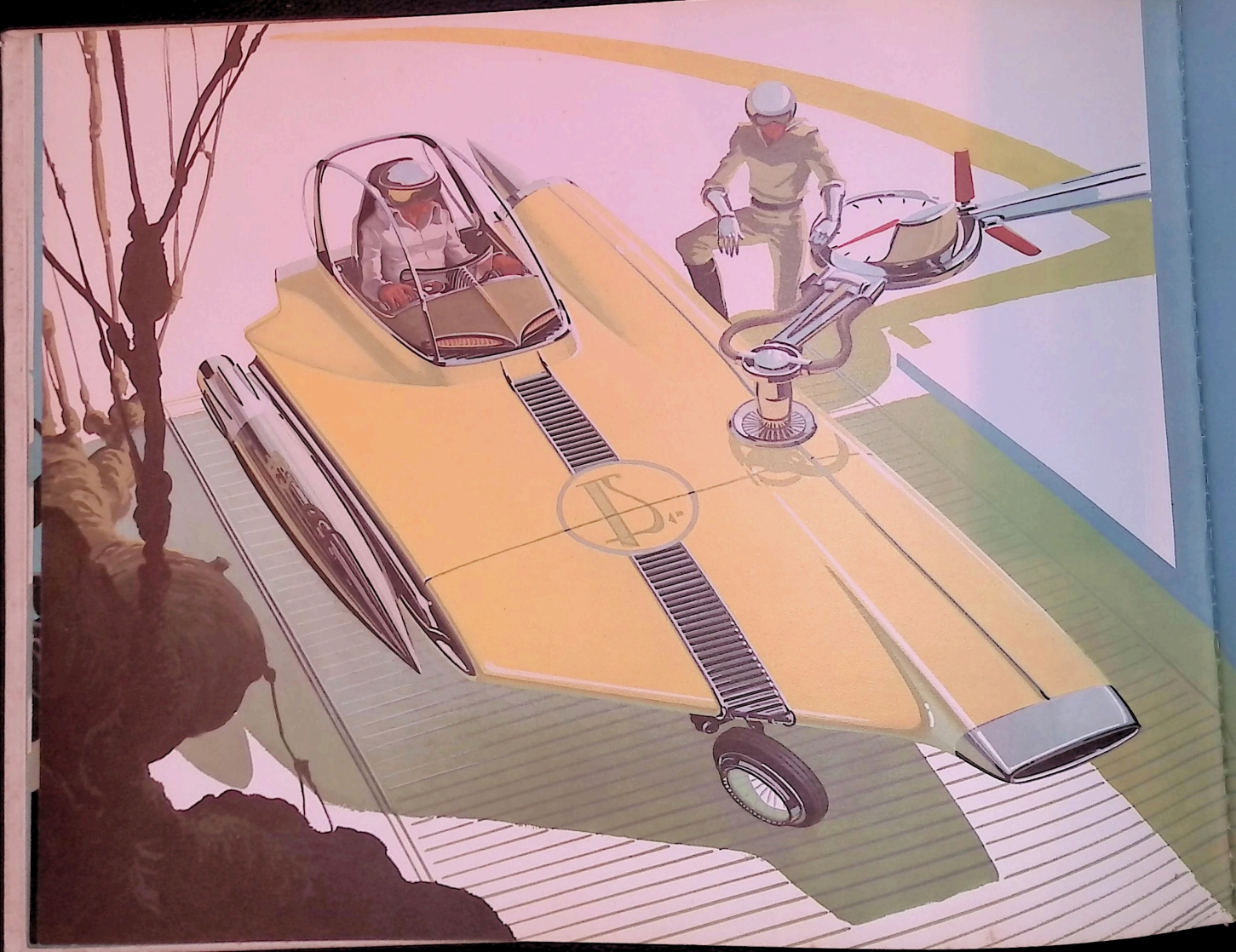
Hoping to transport you across the threshold of this stimulating
new world of tomorrow...hoping to spark your creative imagination...
this book presents ideas in design and engineering,
strange and fanciful, yet within the realm of future possibility
and compatible with advances in material technology.

Today's Dream—Tomorrow's Reality

In the strange world of tomorrow—a
world sometimes difficult to imagine—changes will be dynamic.

Tendril-like highways will bridge primordial bogs,
tap resources in the savage heat of the desert,
or supply a city beneath the biting cold of a polar cap.

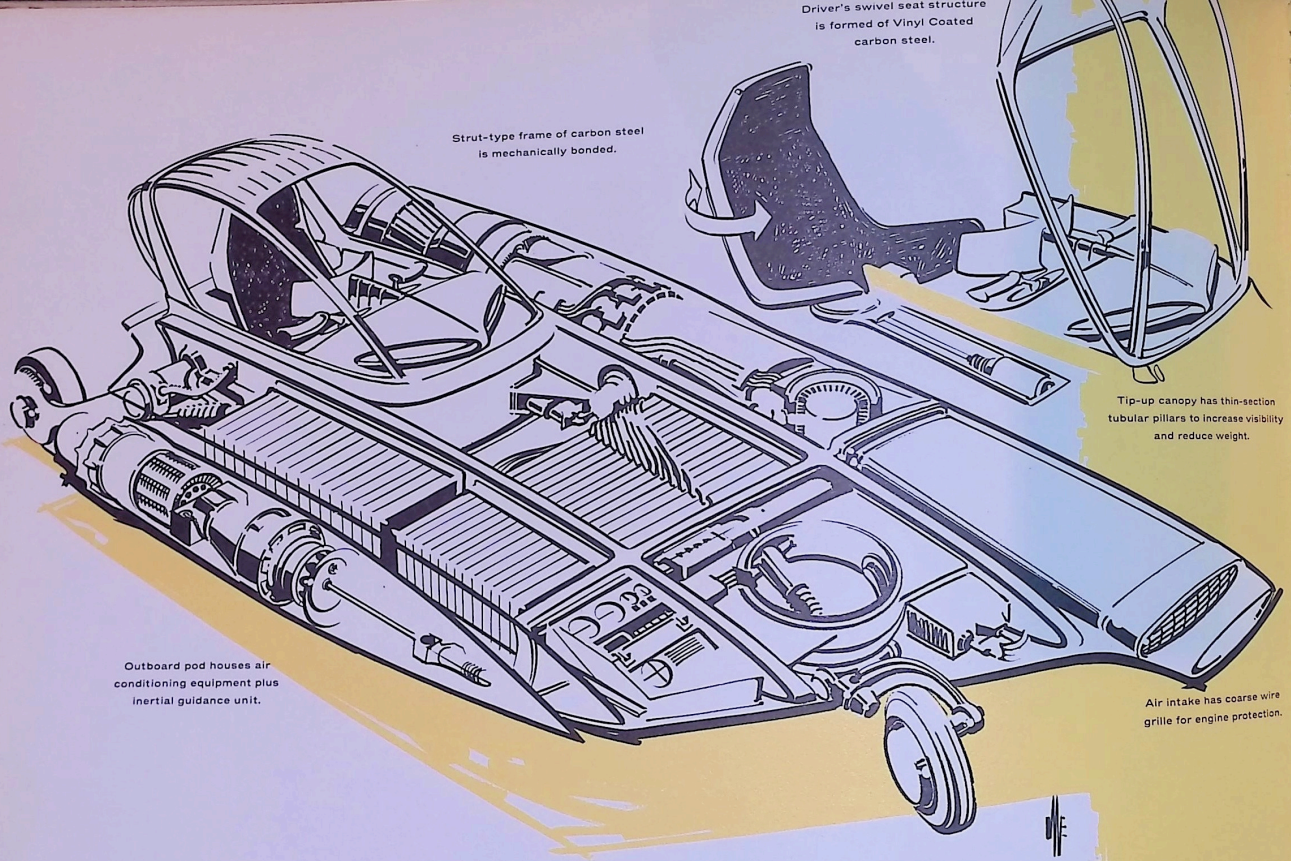
In this new world, new shapes, new forms will
evolve. And steel, with its incomparable application and
design flexibility, will continue to pace progress into tomorrow.

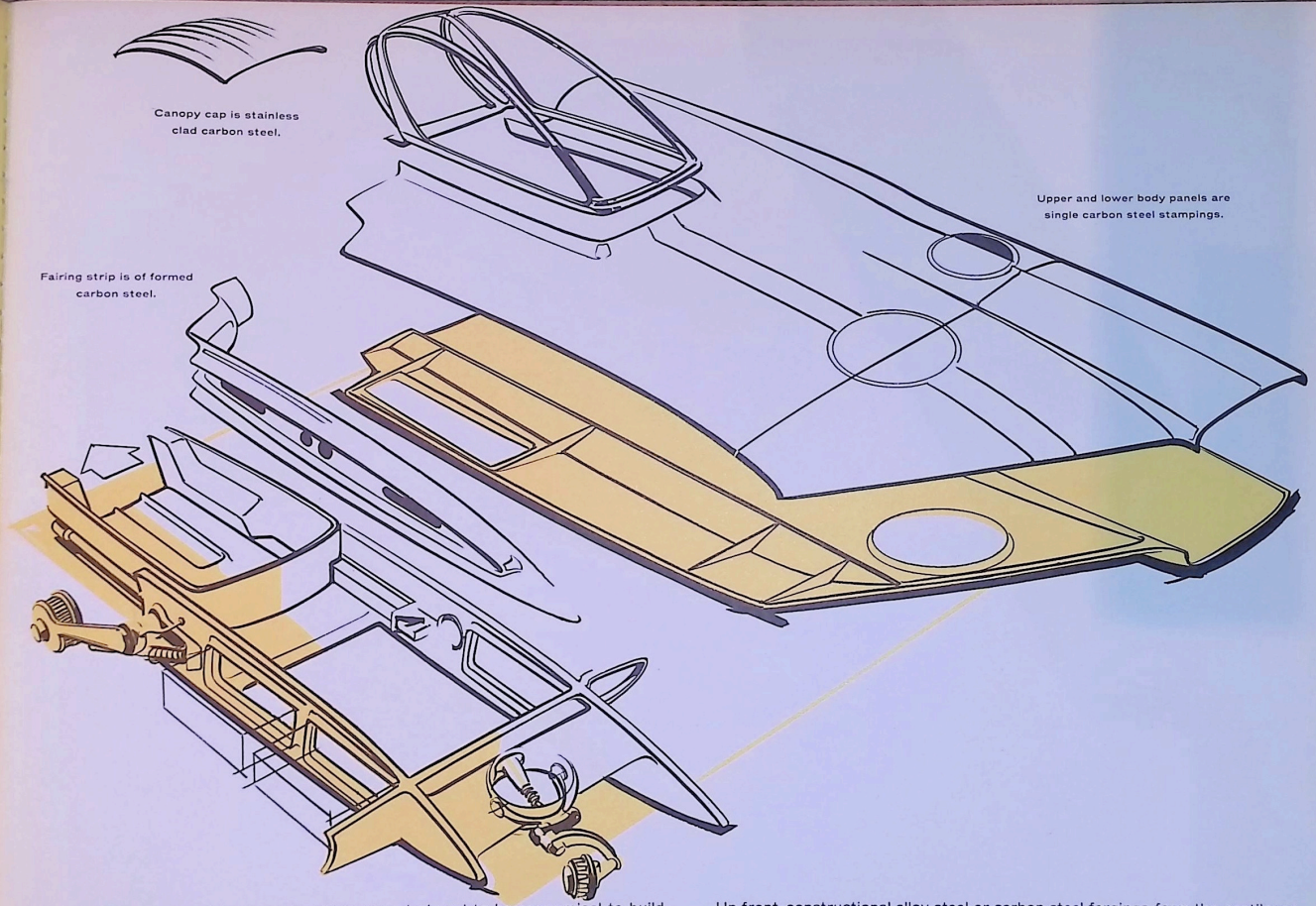


A Quickened Pace with Advanced Technology

Transportation in tomorrow's business world will be measured not in miles but in thousands of miles and executives will be carried across these miles at high speeds in compact vehicles. It is for such fast, one-man travel that this car is designed.

The stressed skin utilizes well known economies possible with carbon steel sheet. Accents in Vinyl Coated steel and brushed stainless steel give luster and durability to the control center.


Driver's swivel seat structure is formed of Vinyl Coated carbon steel.
Strut-type frame of carbon steel is mechanically bonded.
Tip-up canopy has thin-section tubular pillars to increase visibility and reduce weight.
Outboard pod houses air conditioning equipment plus inertial guidance unit.
Air intake has coarse wire grille for engine protection.
Fuel tanks are fabricated of seamless USS EX-TEN steel tubing.



This low-profile, jet-powered vehicle was designed to be economical to build and operate.

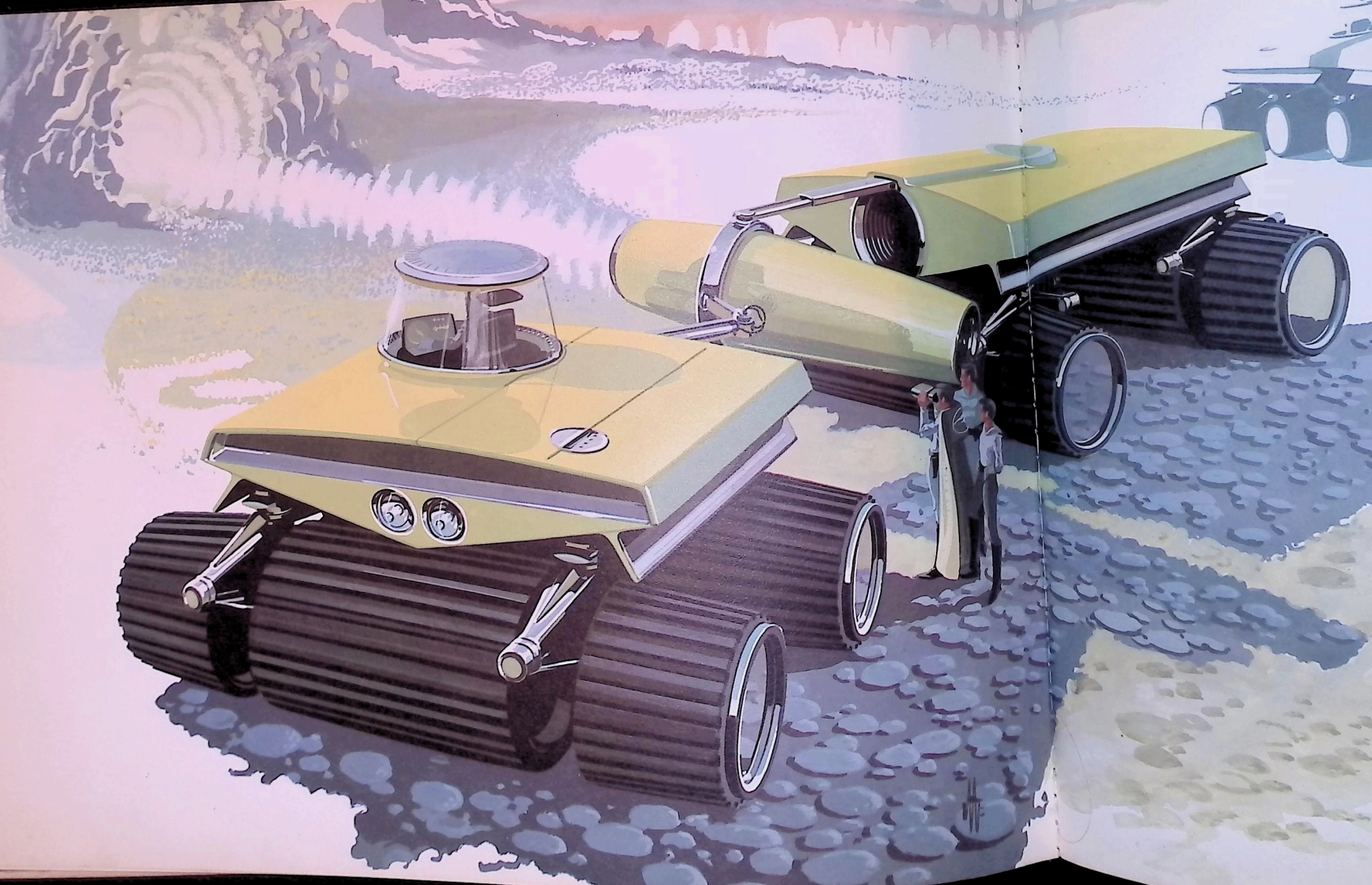
Carbon steel is specified for body panels on this vehicle. Panels may be either galvanized or aluminum coated on the inside to resist corrosion.

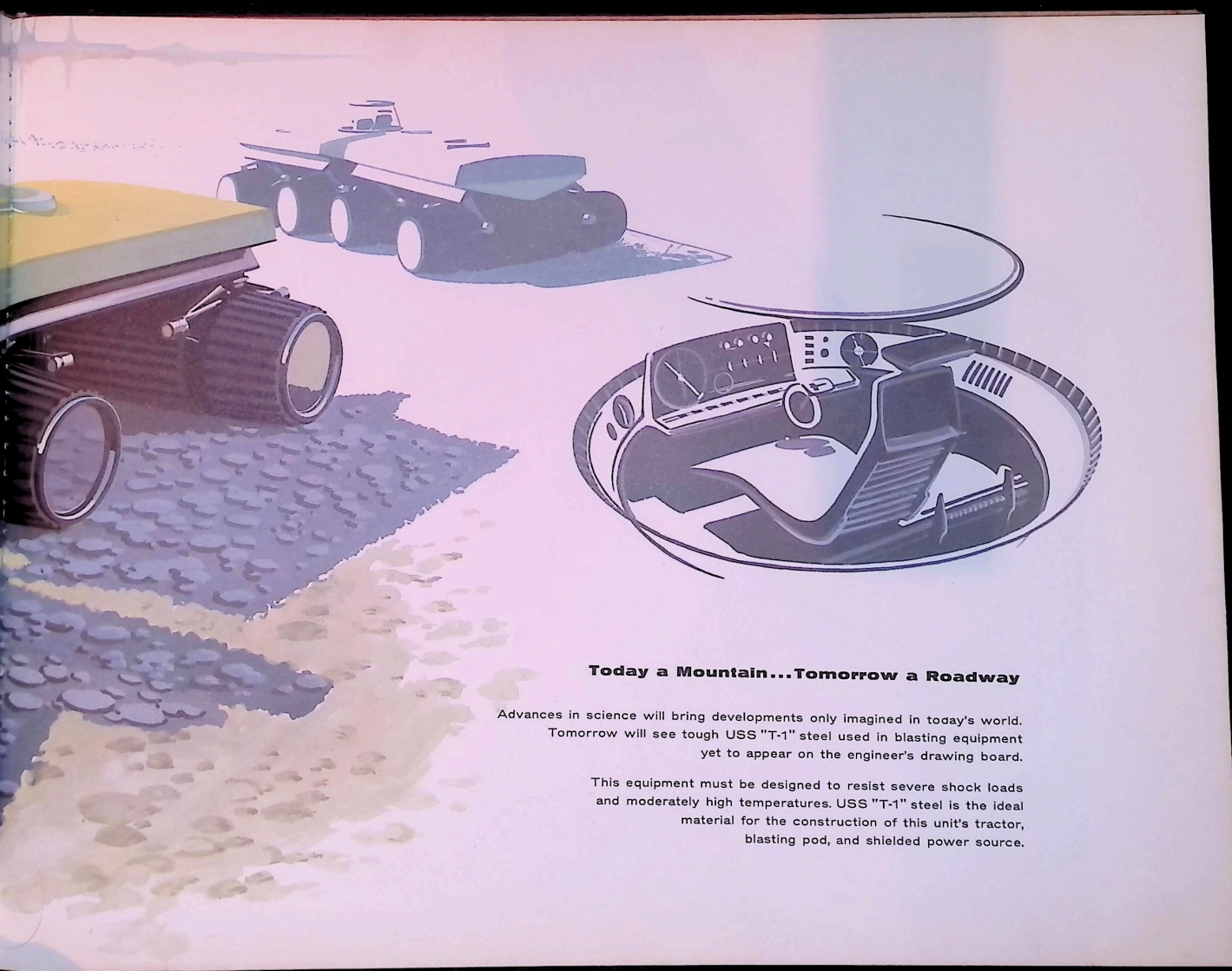
Husky frame members are stamped of carbon steel. The high pressure fuel tanks of USS EX-TEN steel are nested inside the frame members.

Up front, constructional alloy steel or carbon steel forgings form the cantilever half-fork axle.

Seamless tubing and free-machining steels are combined in the front and rear suspension to provide light, yet extremely strong, assemblies.

Only carbon steel offers the designer so many advantages: strength, weldability, formability, drawability, ease of fabrication, surface finish and low cost.

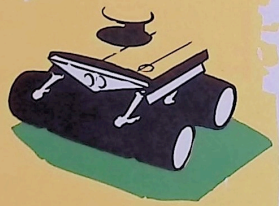




Today a Mountain...Tomorrow a Roadway

Advances in science will bring developments only imagined in today's world. Tomorrow will see tough USS "T-1" steel used in blasting equipment yet to appear on the engineer's drawing board.

This equipment must be designed to resist severe shock loads and moderately high temperatures. USS "T-1" steel is the ideal material for the construction of this unit's tractor, blasting pod, and shielded power source.

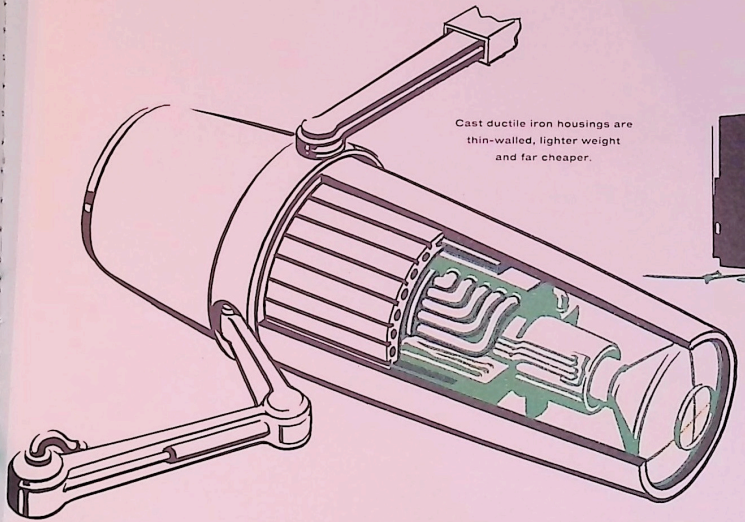


Control arms for blasting pod are fabricated USS "T-1" steel.

Small computer bearings and races are made of seamless alloy steel tube.

Sturdy rims are special contour sections rolled from carbon steel.

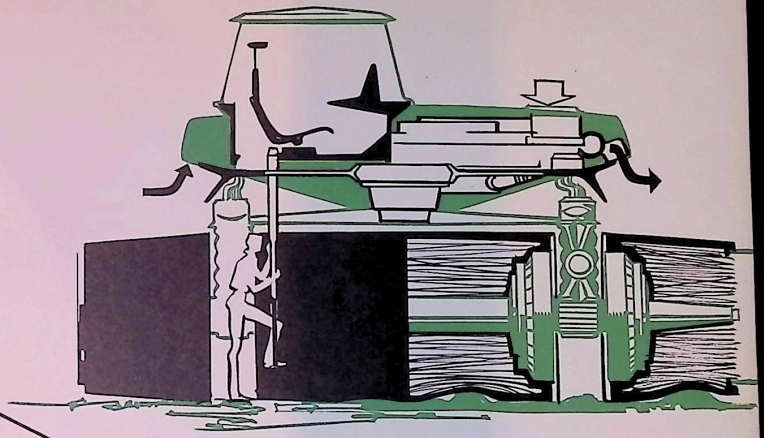
Heavy duty thrust bearing races are machined from tough alloy steel tubing.



Cast ductile iron housings are thin-walled, lighter weight and far cheaper.

Control arm actuating rams are flame hardened, centerless ground and chrome plated seamless steel tubing.

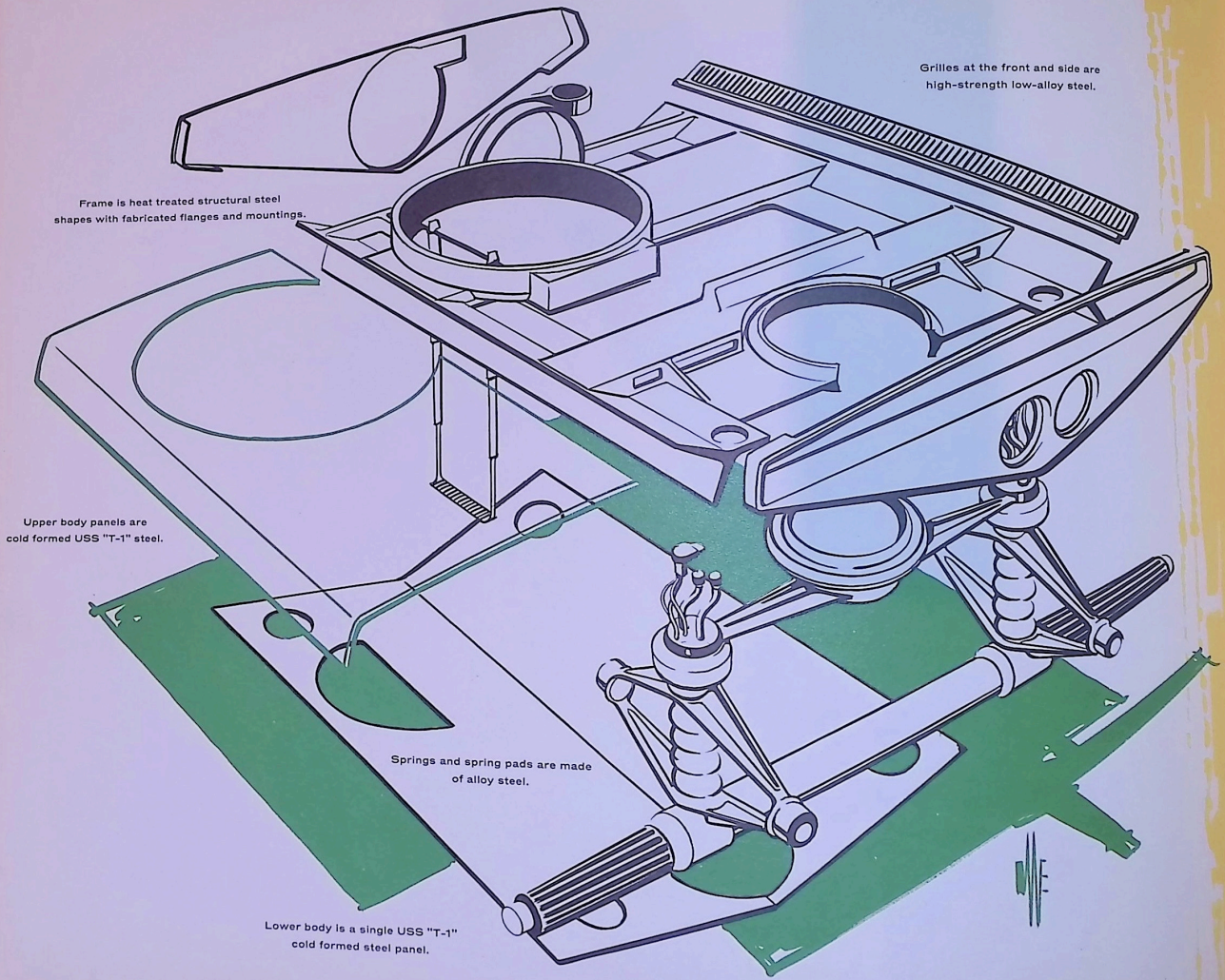
Telescoping energizer adjusts to proper focal range.

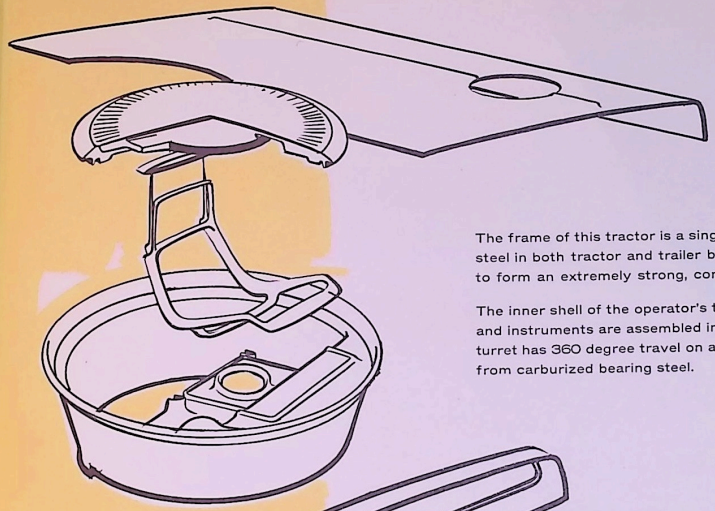


Access to operator's turret is through manway between front wheels. Bar and tube ladder is retractable.

A big machine for a big job. The engineers specify USS "T-1" steel to fabricate frame and body members because USS "T-1" steel is the tough steel. It has high yield strength, is weldable, and offers four times the resistance to atmospheric corrosion and three times the creep rupture strength of carbon steel.

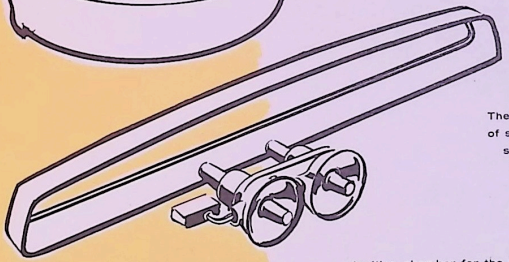
The blasting pod is a USS "T-1" steel casing with ceramic liner. Steel wire coring in "air-bag" tires adds strength and durability to withstand enormous weight and shock loads. Stainless steel caps the operator's turret.


Grilles at the front and side are high-strength low-alloy steel.
Frame is heat treated structural steel shapes with fabricated flanges and mountings.
Upper body panels are cold formed USS "T-1" steel.
Springs and spring pads are made of alloy steel.
Lower body is a single USS "T-1" cold formed steel panel.



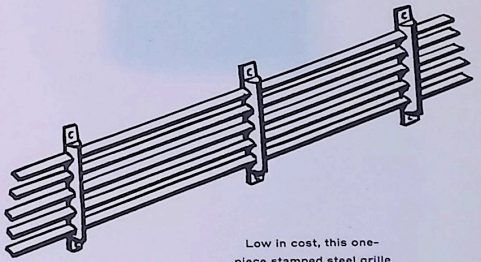
The frame of this tractor is a single USS "T-1" steel member. The use of this tough steel in both tractor and trailer body plates permits the designer to reduce the skin gage to form an extremely strong, corrosion resistant hide without sacrificing strength.

The inner shell of the operator's turret is a single carbon steel stamping. Controls and instruments are assembled in modular units and plugged into the circuitry. The turret has 360 degree travel on a ring gear and bearing assembly machined from carburized bearing steel.

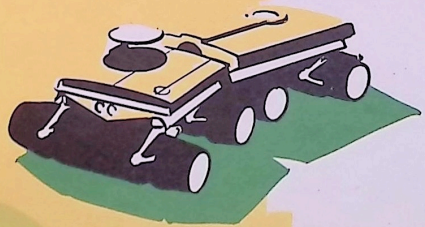


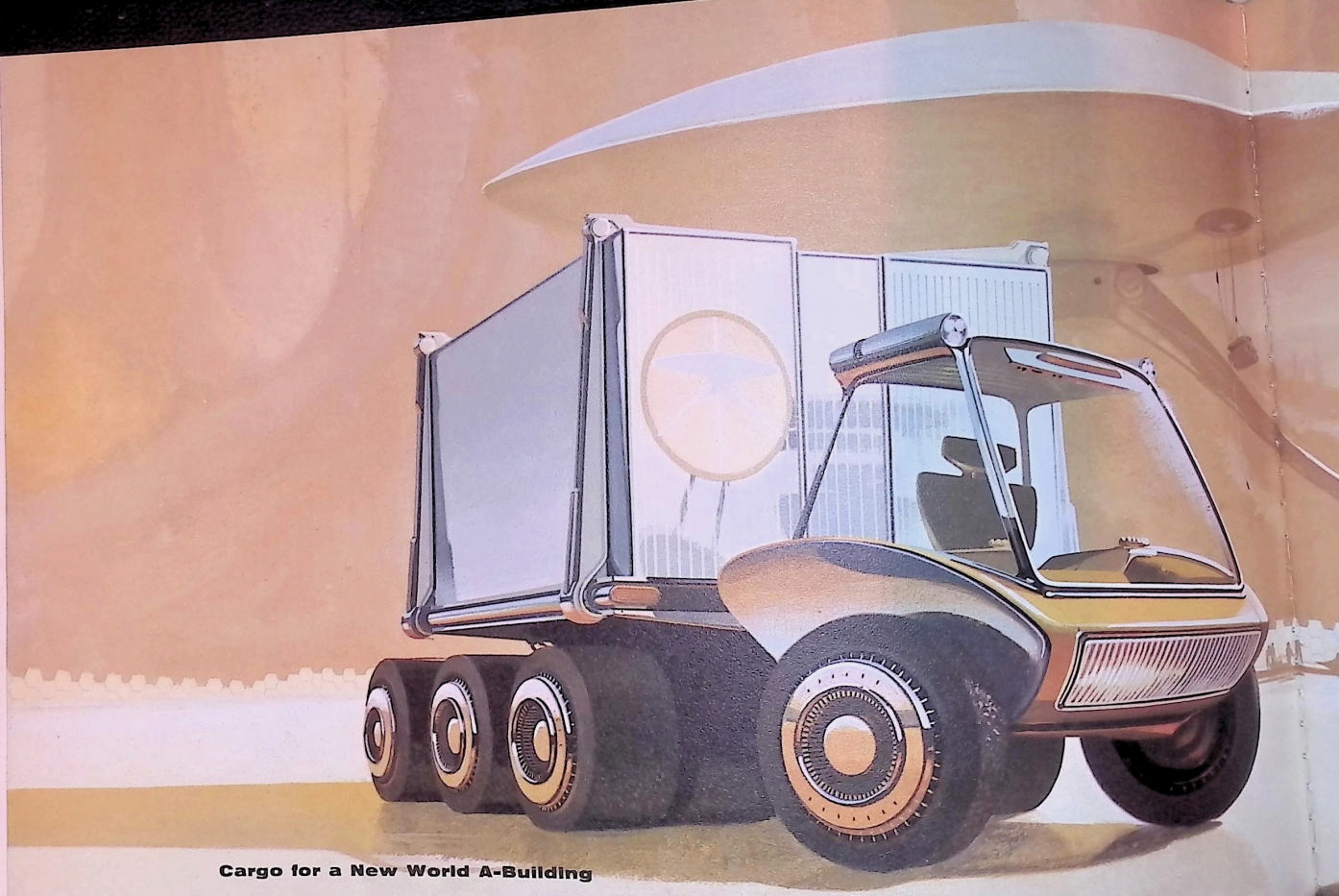
The air intake trim cover, made of special section rolled carbon steel, conceals the ends of structural members and the assembly fixtures.

Ignition chamber for the high intensity arc lamps capitalizes on the heat resistant qualities of stainless steel.



Low in cost, this one-piece stamped steel grille incorporates its own tabs and supports. It is made from high-strength, low-alloy steel.





Cargo for a New World A-Building

The evolution in our social and mechanized living is advancing at such a rapid pace that it will be only a short time before areas now believed beyond our reach will be colonized.

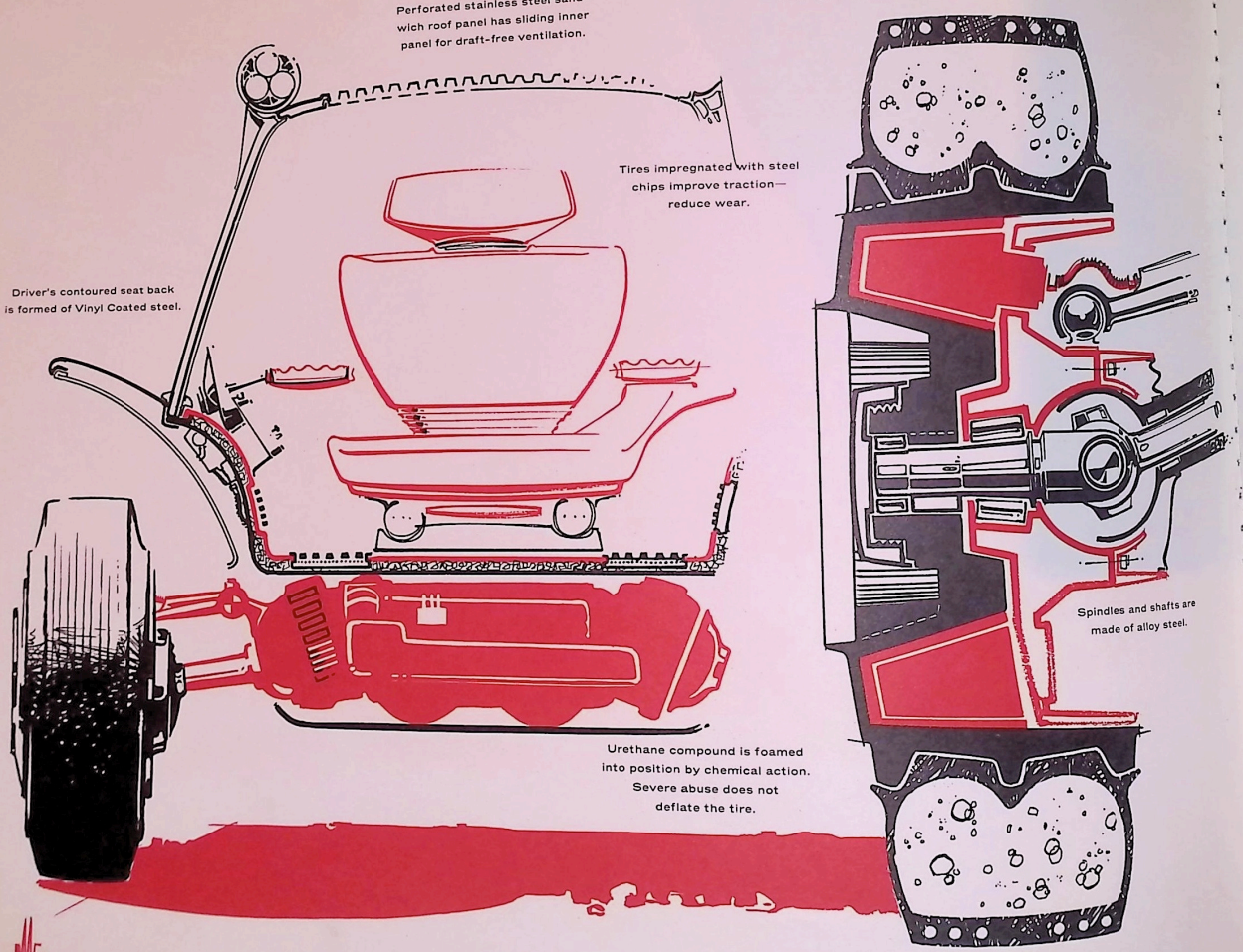
In such an area, industrial acids, in capsule tanks of stainless steel, are being delivered by this husky, self-loading flat-bed carrier, built of strong, corrosion resistant USS COR-TEN steel.

Stainless steel wire cord
in the tire improves stability,
cooling and wear.

Perforated stainless steel sand-
wich roof panel has sliding inner
panel for draft-free ventilation.

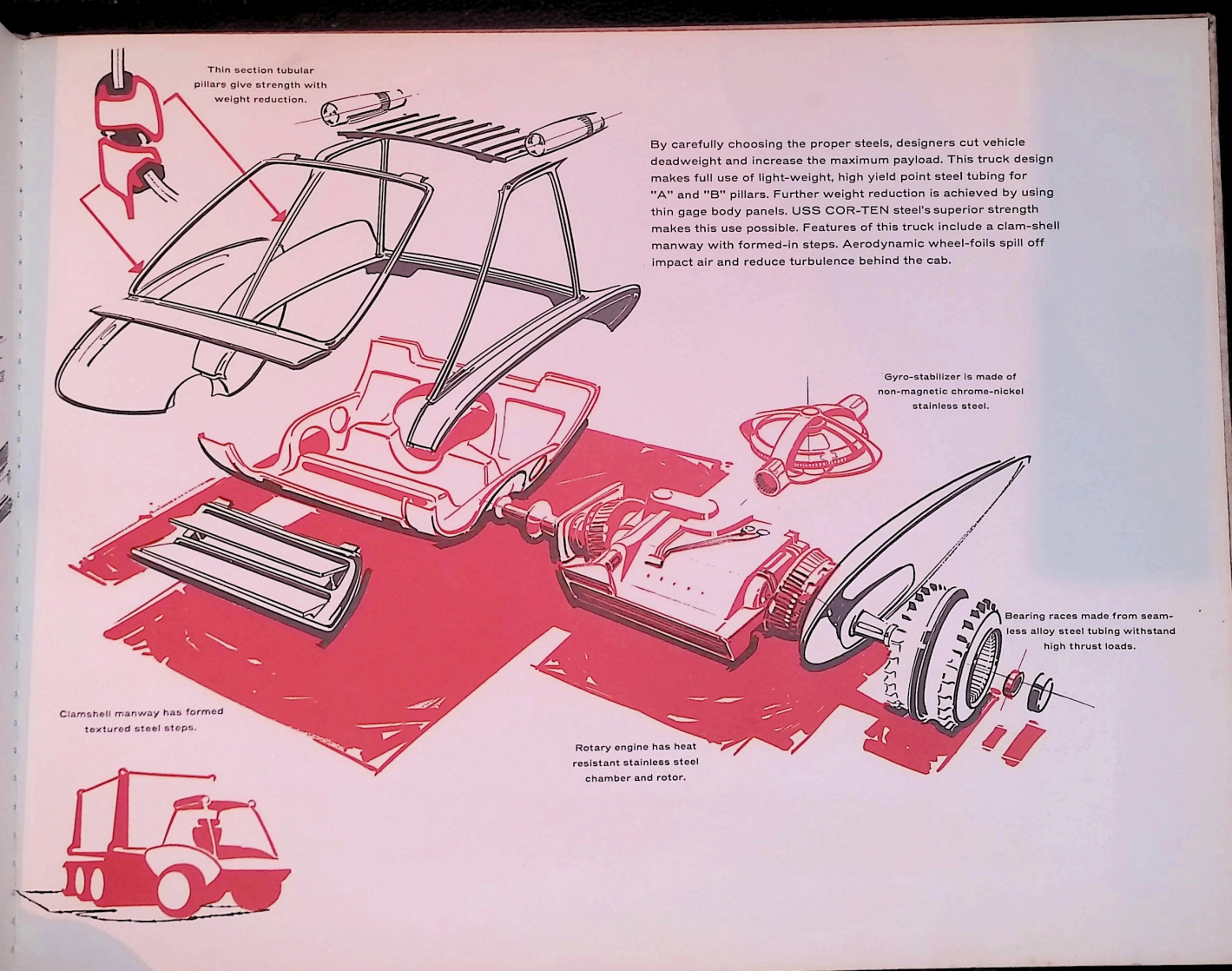
Tires impregnated with steel
chips improve traction—
reduce wear.

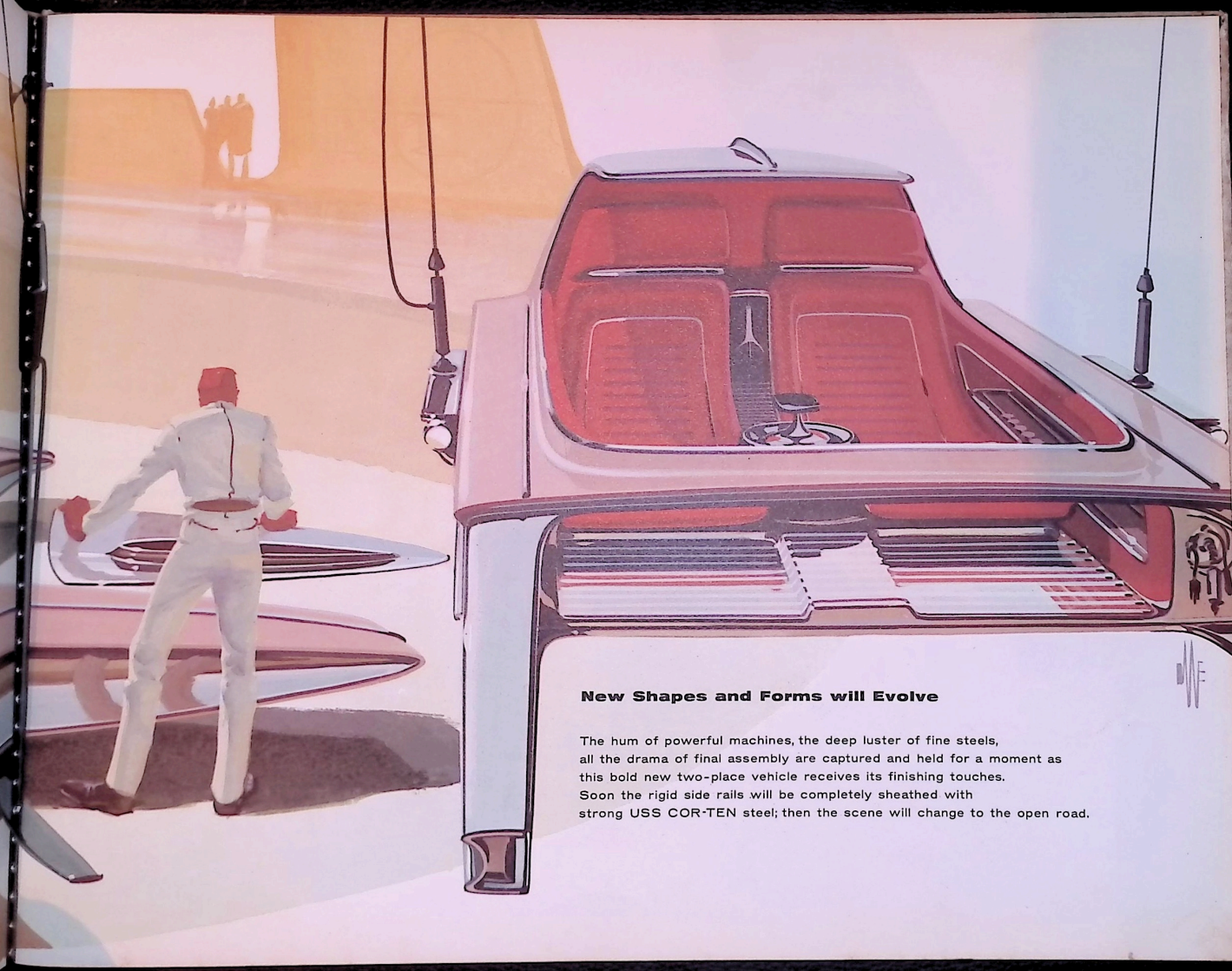
Driver's contoured seat back
is formed of Vinyl Coated steel.



Spindles and shafts are
made of alloy steel.

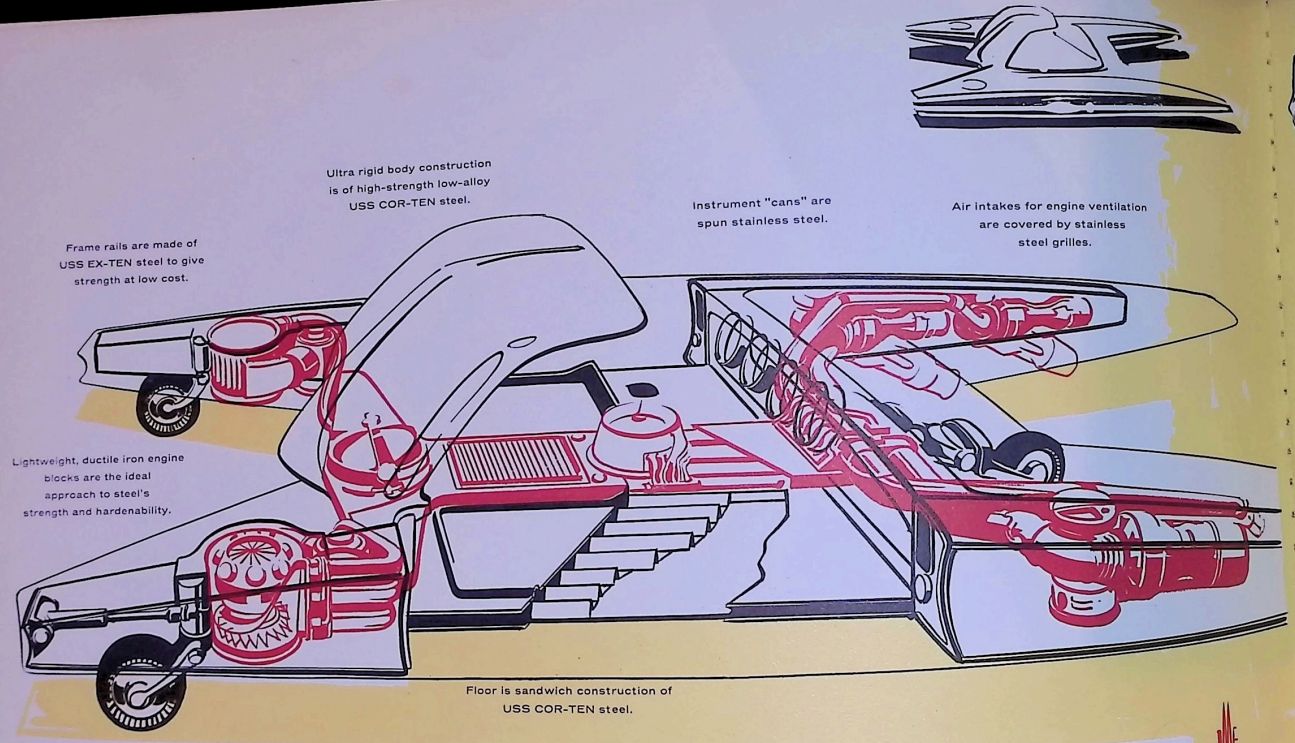
Urethane compound is foamed
into position by chemical action.
Severe abuse does not
deflate the tire.


Thin section tubular pillars give strength with weight reduction.
By carefully choosing the proper steels, designers cut vehicle deadweight and increase the maximum payload. This truck design makes full use of light-weight, high yield point steel tubing for "A" and "B" pillars. Further weight reduction is achieved by using thin gage body panels. USS COR-TEN steel's superior strength makes this use possible. Features of this truck include a clam-shell manway with formed-in steps. Aerodynamic wheel-foils spill off impact air and reduce turbulence behind the cab.
Gyro-stabilizer is made of non-magnetic chrome-nickel stainless steel.
Bearing races made from seamless alloy steel tubing withstand high thrust loads.
Clamshell manway has formed textured steel steps.
Rotary engine has heat resistant stainless steel chamber and rotor.



New Shapes and Forms will Evolve

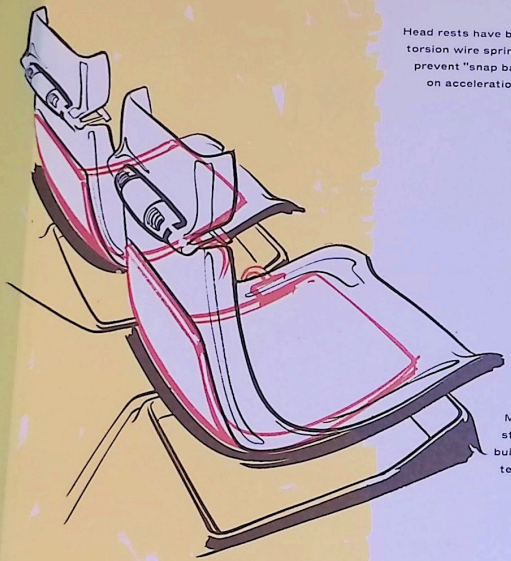
The hum of powerful machines, the deep luster of fine steels,
all the drama of final assembly are captured and held for a moment as
this bold new two-place vehicle receives its finishing touches.
Soon the rigid side rails will be completely sheathed with
strong USS COR-TEN steel; then the scene will change to the open road.



This concept dictates extremely rigid body construction. Only USS COR-TEN steel, with its high yield point and resistance to atmospheric corrosion, measures up to the designer's need for lightweight, rugged construction.

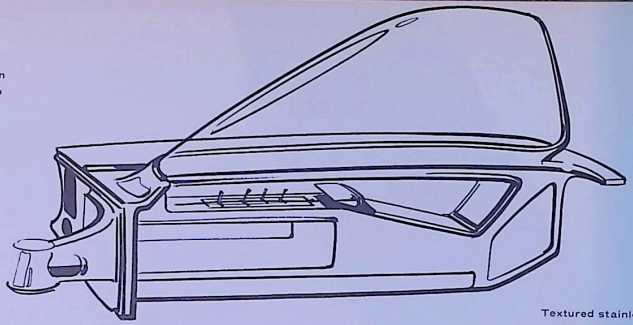
Stainless steel, too, plays a major role in this interesting vehicle. Stainless steel is used in forward grilles where impact air pressure demands a material capable of resisting severe pressure deformation. The canopy is also stainless steel, reinforced with a combination antenna-fin of formed USS COR-TEN steel.

USS EX-TEN steel answers the need for economy and strength in the frame rails.



Head rests have built-in torsion wire springs to prevent "snap back" on acceleration.

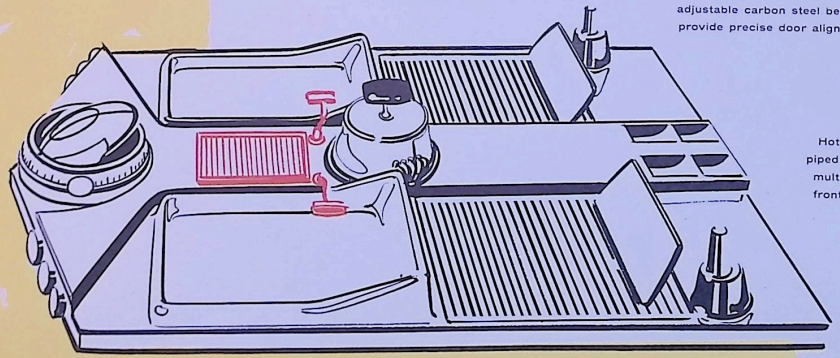
Molded Vinyl Coated steel seat backs have built-in heater pads and temperature controls.



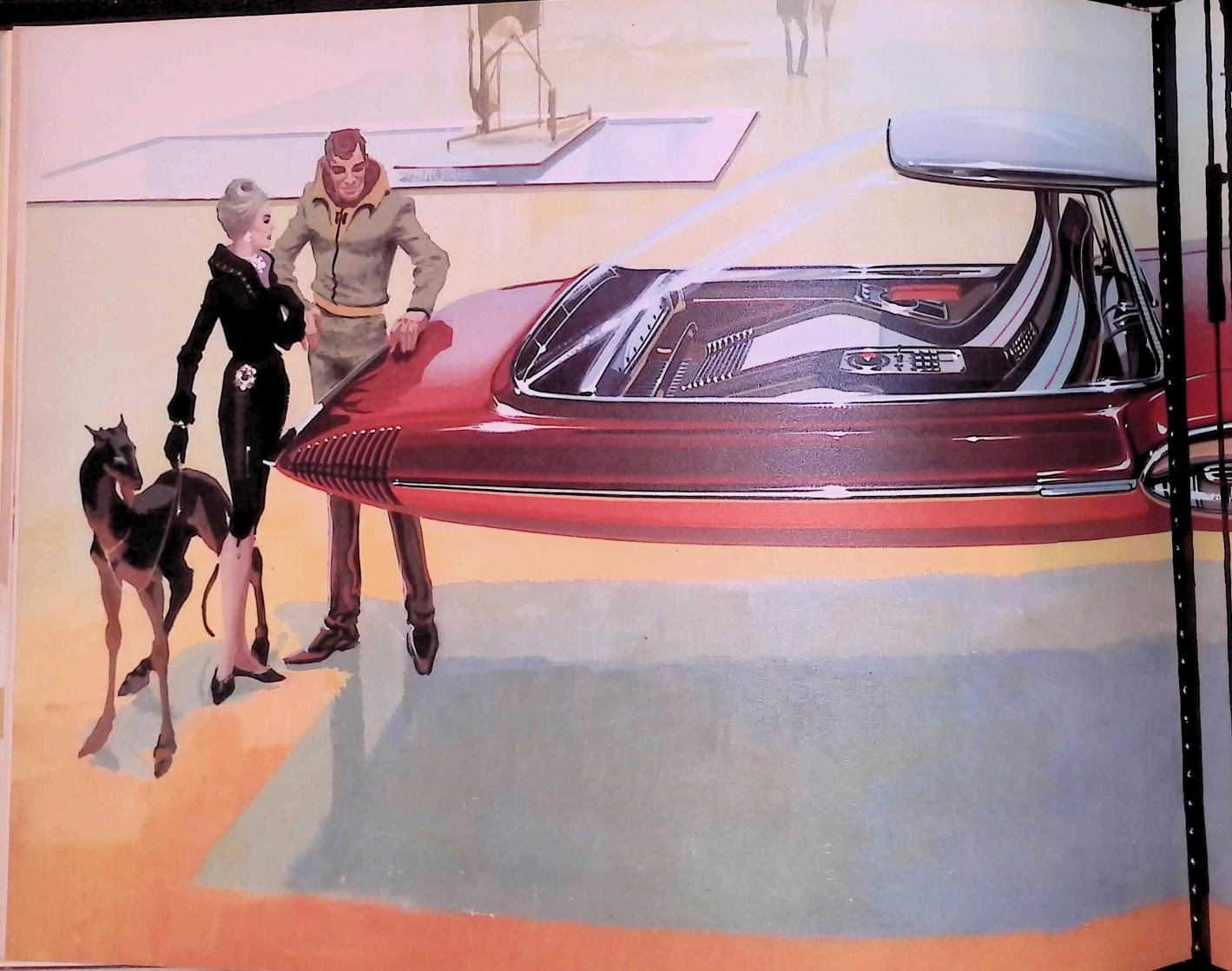
Wide doors swing easily on special contour section steel hinges.

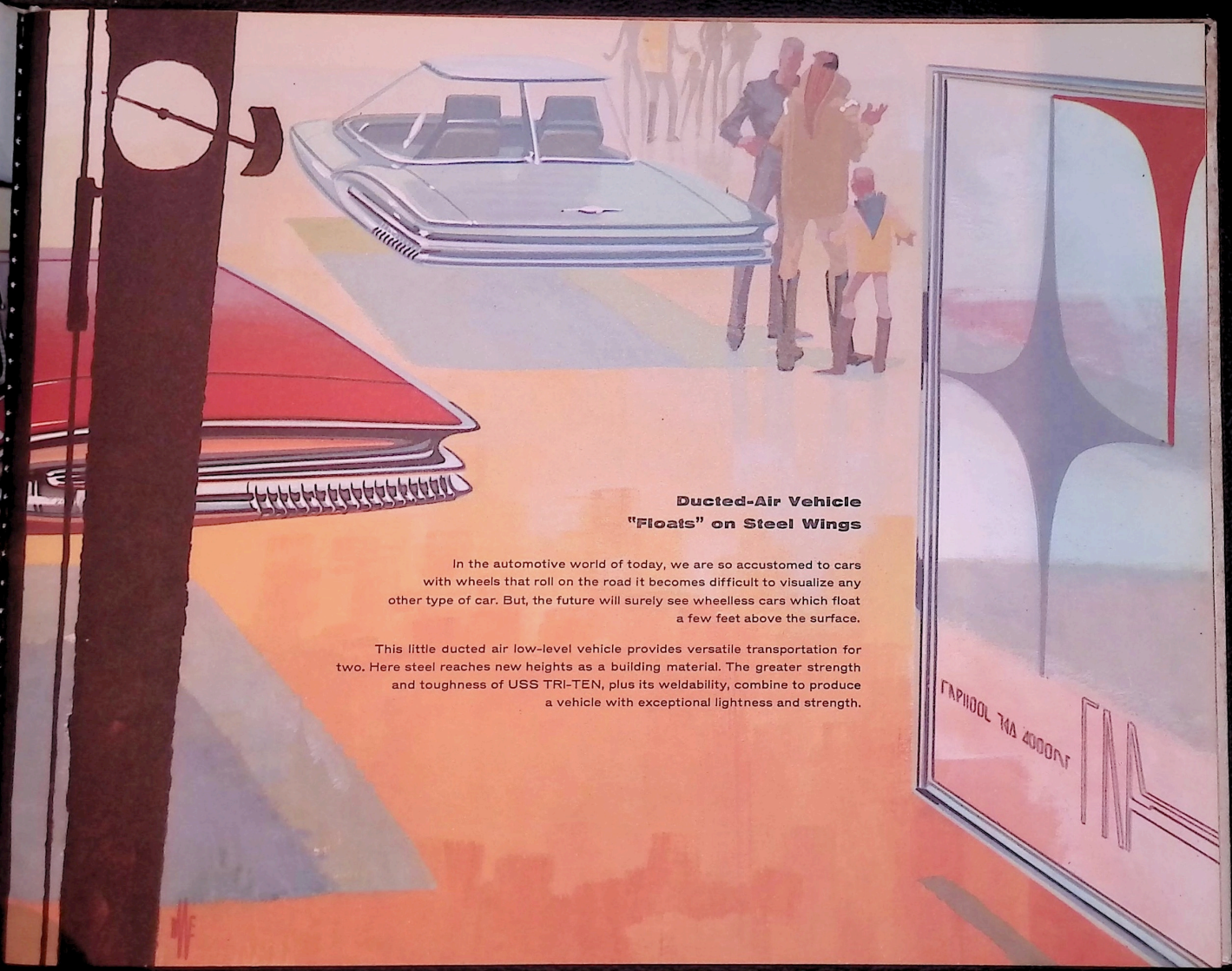
Textured stainless steel passenger control panel and arm rest highlight the Vinyl Coated steel inner door panel.

Large area door hinge pins of hardened carbon steel plus adjustable carbon steel bearings provide precise door alignment.



Hot, corrosive gases are piped through stainless steel multi-channel ducts to the front acceleration engines.

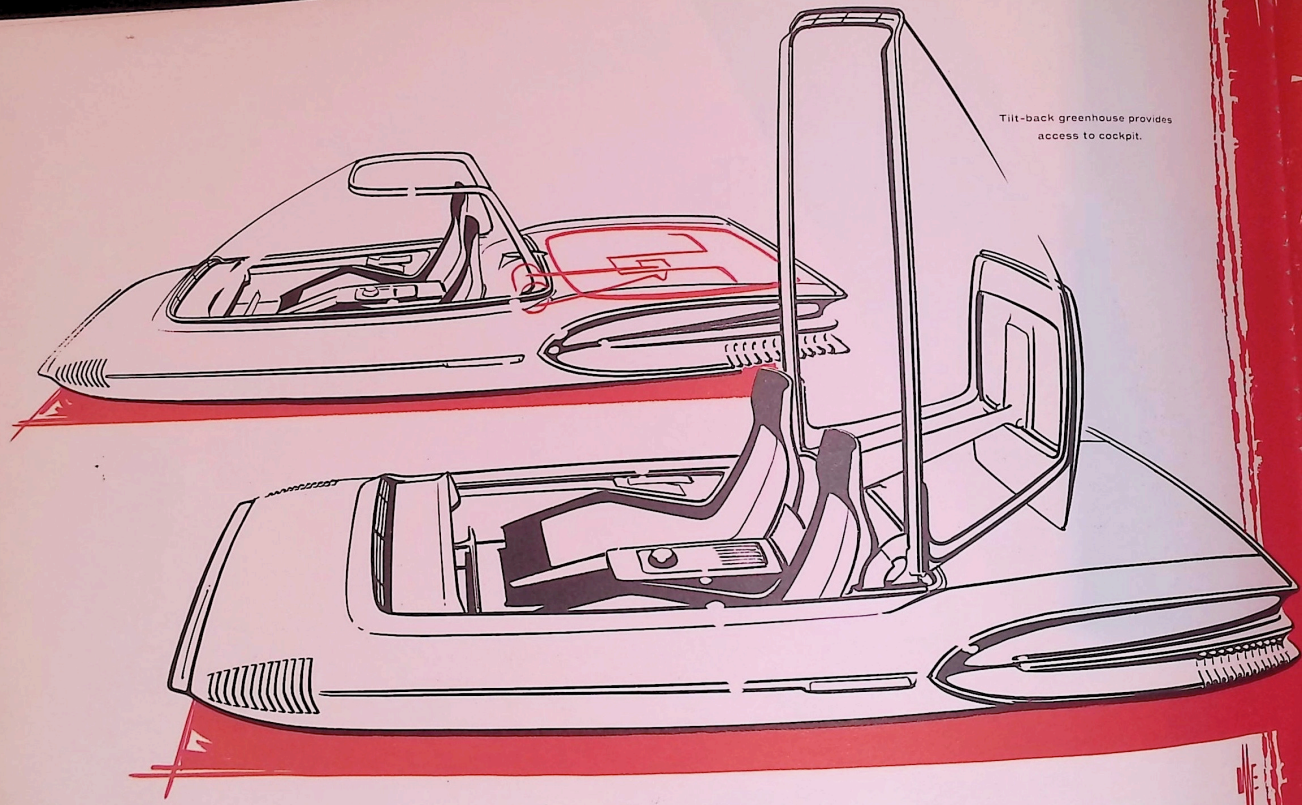




Ducted-Air Vehicle "Floats" on Steel Wings

In the automotive world of today, we are so accustomed to cars with wheels that roll on the road it becomes difficult to visualize any other type of car. But, the future will surely see wheelless cars which float a few feet above the surface.

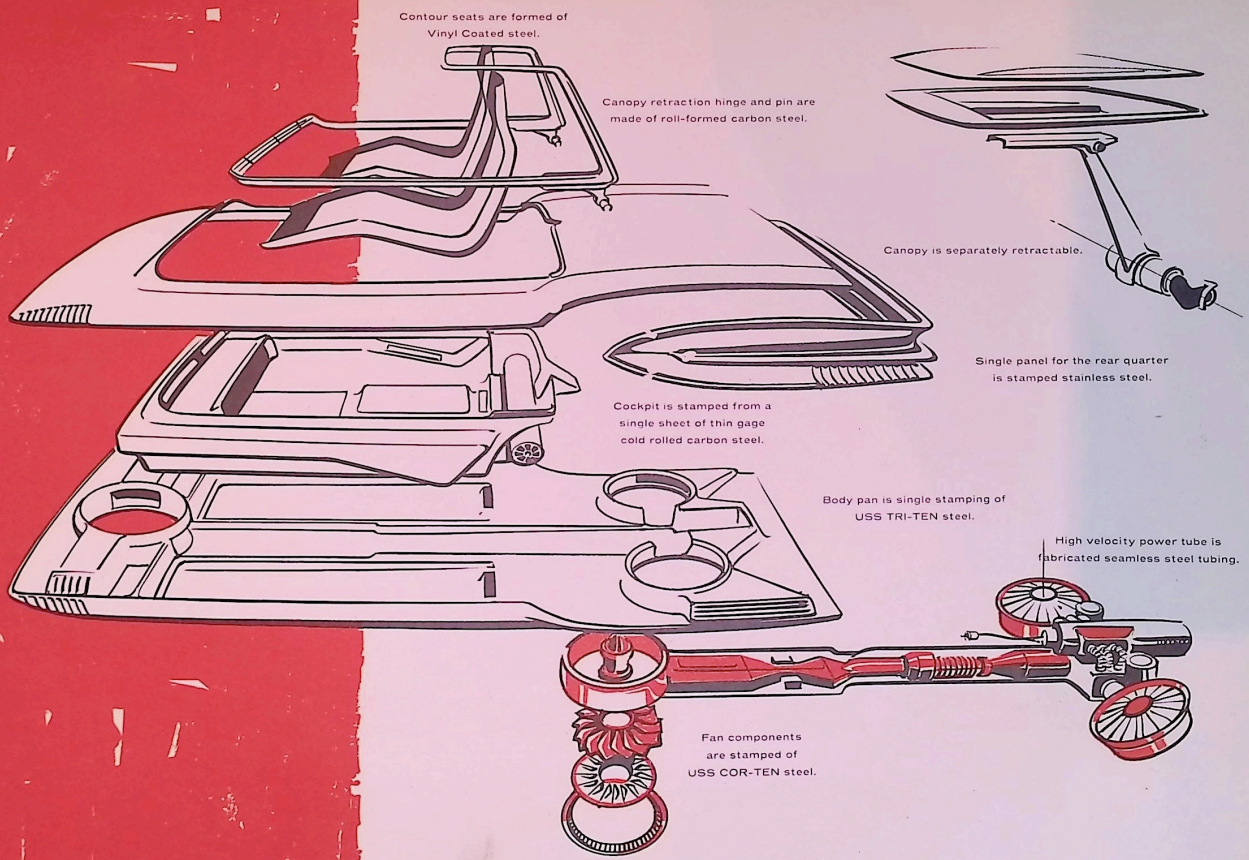
This little ducted air low-level vehicle provides versatile transportation for two. Here steel reaches new heights as a building material. The greater strength and toughness of USS TRI-TEN, plus its weldability, combine to produce a vehicle with exceptional lightness and strength.



Tilt-back greenhouse provides access to cockpit.

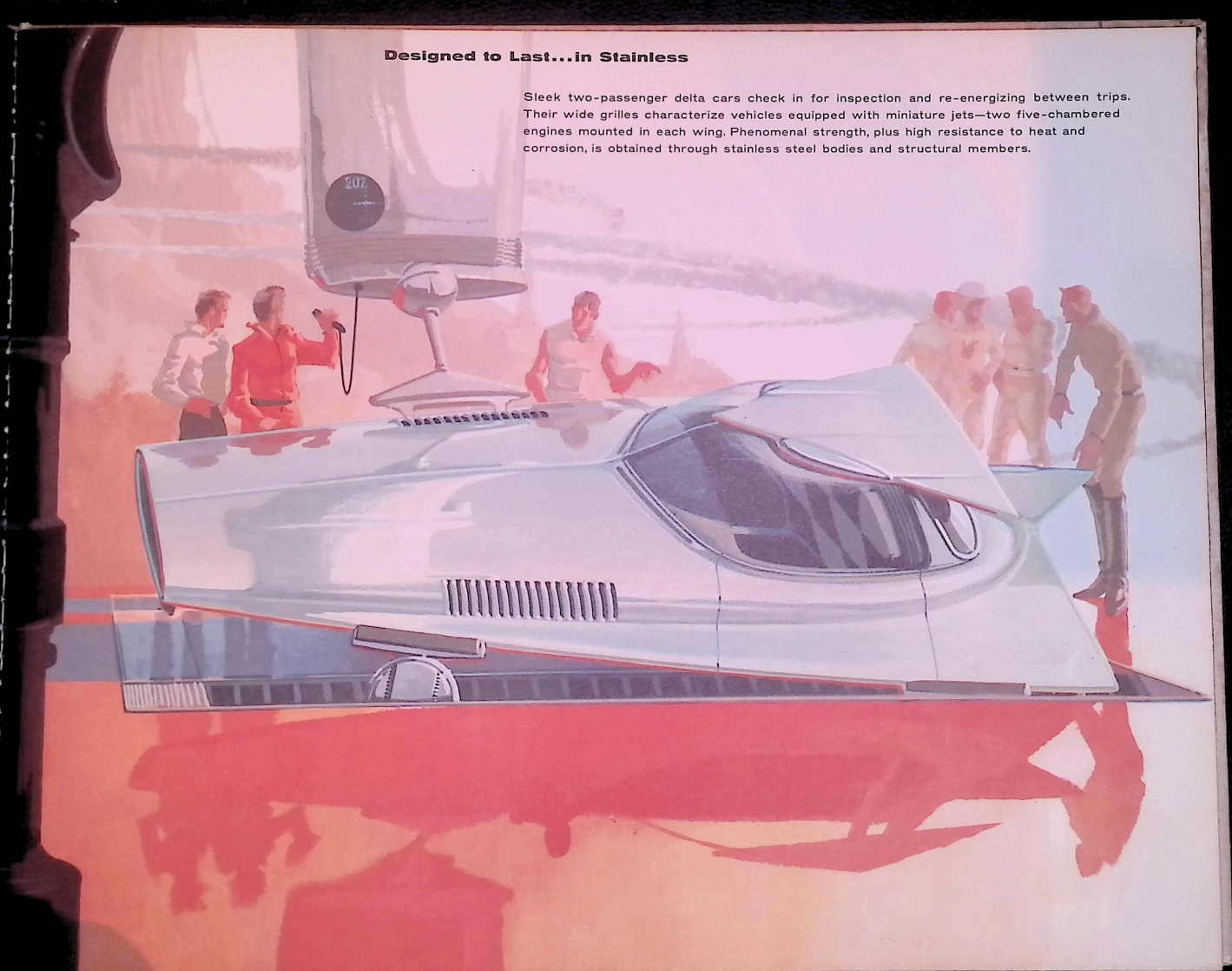
The image of steel as a strong, versatile building material reaches its ultimate in this design for a ducted air car. Featuring a tilt-back greenhouse, plus a retractable canopy, this vehicle offers maximum passenger convenience. Its engine powers three fans which control elevation, propulsion and direction.

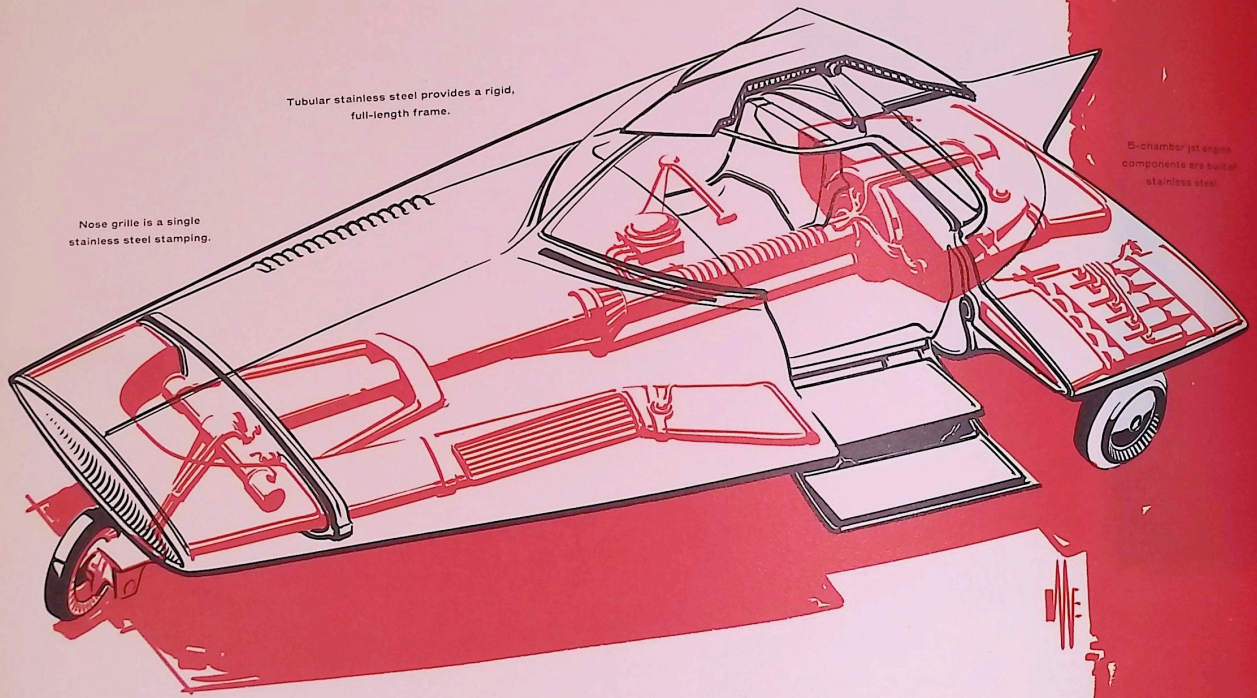
This design takes advantage of the natural toughness, strength, resistance to impact and weldability of USS TRI-TEN steel to create a sturdy, durable body of exceptional compactness. USS TRI-TEN steel's combination of ductility and high yield point make it ideal for this design.


Contour seats are formed of
Vinyl Coated steel.
Canopy retraction hinge and pin are
made of roll-formed carbon steel.
Canopy is separately retractable.
Single panel for the rear quarter
is stamped stainless steel.
Cockpit is stamped from a
single sheet of thin gage
cold rolled carbon steel.
Body pan is single stamping of
USS TRI-TEN steel.
High velocity power tube is
fabricated seamless steel tubing.
Fan components
are stamped of
USS COR-TEN steel.

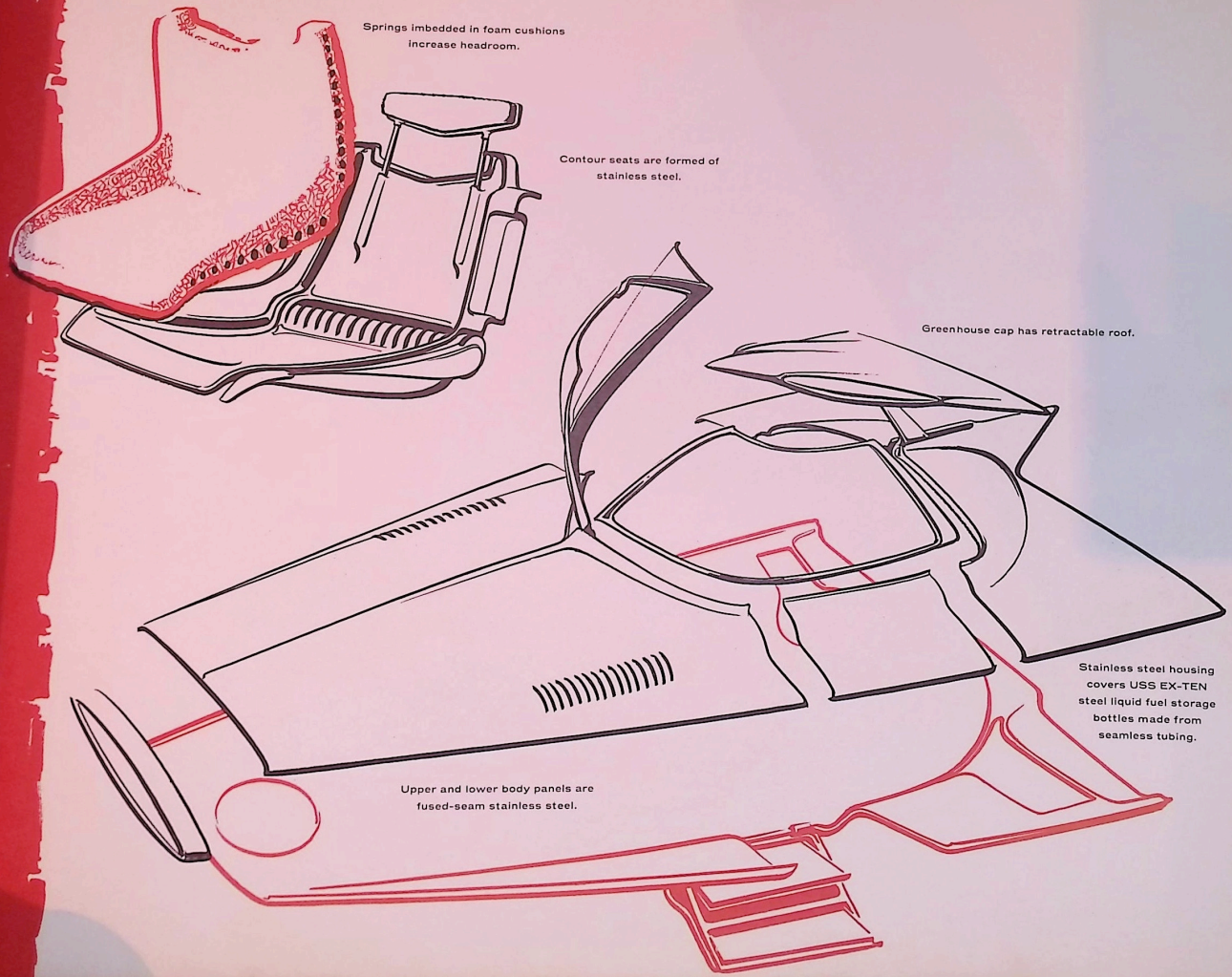
Designed to Last...in Stainless

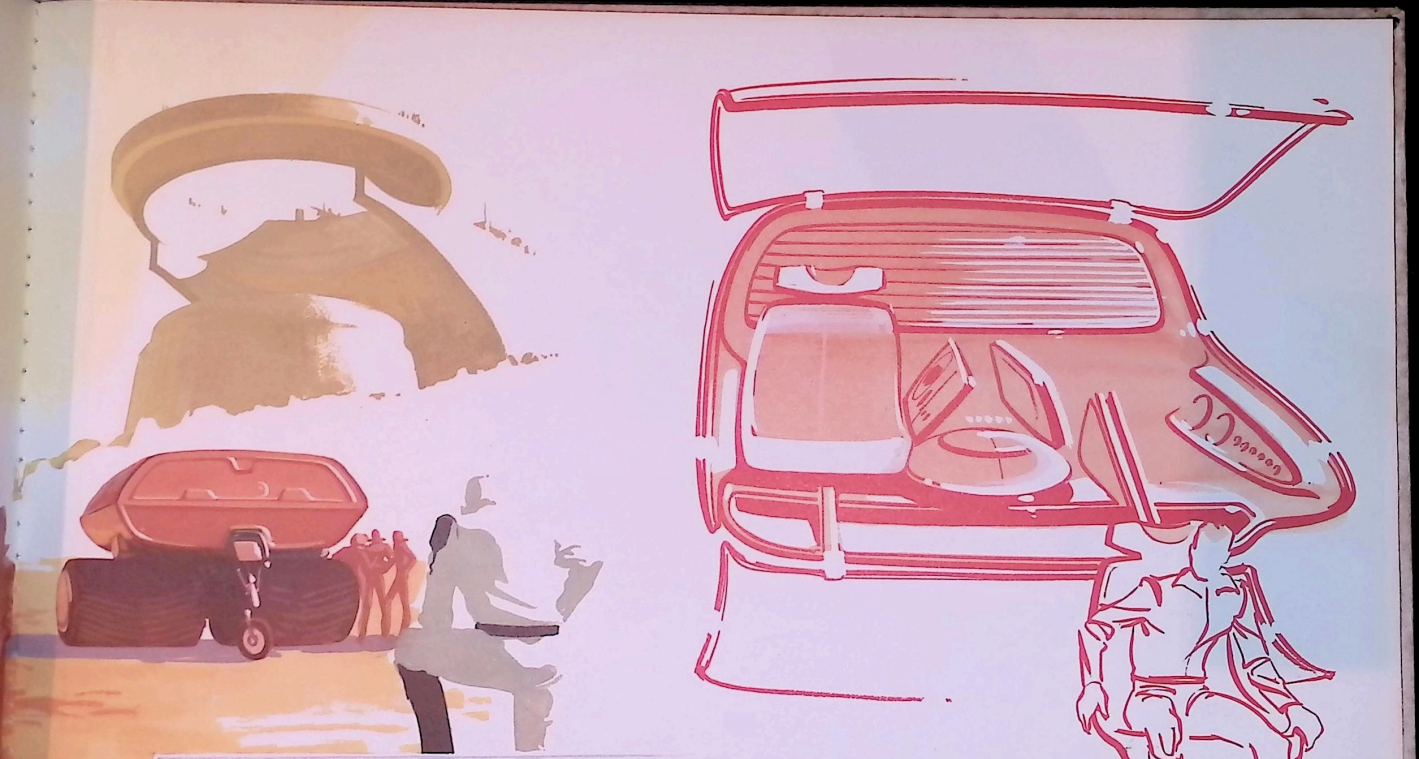
Sleek two-passenger delta cars check in for inspection and re-energizing between trips. Their wide grilles characterize vehicles equipped with miniature jets—two five-chambered engines mounted in each wing. Phenomenal strength, plus high resistance to heat and corrosion, is obtained through stainless steel bodies and structural members.





Function and fashion are combined in this sports car through the application of stainless steel. A high-strength stainless steel tube main spar supports the stainless steel bulkheads and doubles as a housing for the drive shaft and steering mechanism. The forward and side grilles are stainless steel stampings, virtually impervious to corrosion. Body panels are corrosion resistant stainless steel with fused seams to provide an outer skin of exceptional rigidity. The aerodynamic design of the greenhouse cap makes retraction practical at cruising speeds. Seat frames are formed of stainless steel seamless tubing and fitted with wire coil springs imbedded in foam cushions.


Springs imbedded in foam cushions increase headroom.
Contour seats are formed of stainless steel.
Greenhouse cap has retractable roof.
Stainless steel housing covers USS EX-TEN steel liquid fuel storage bottles made from seamless tubing.
Upper and lower body panels are fused-seam stainless steel.

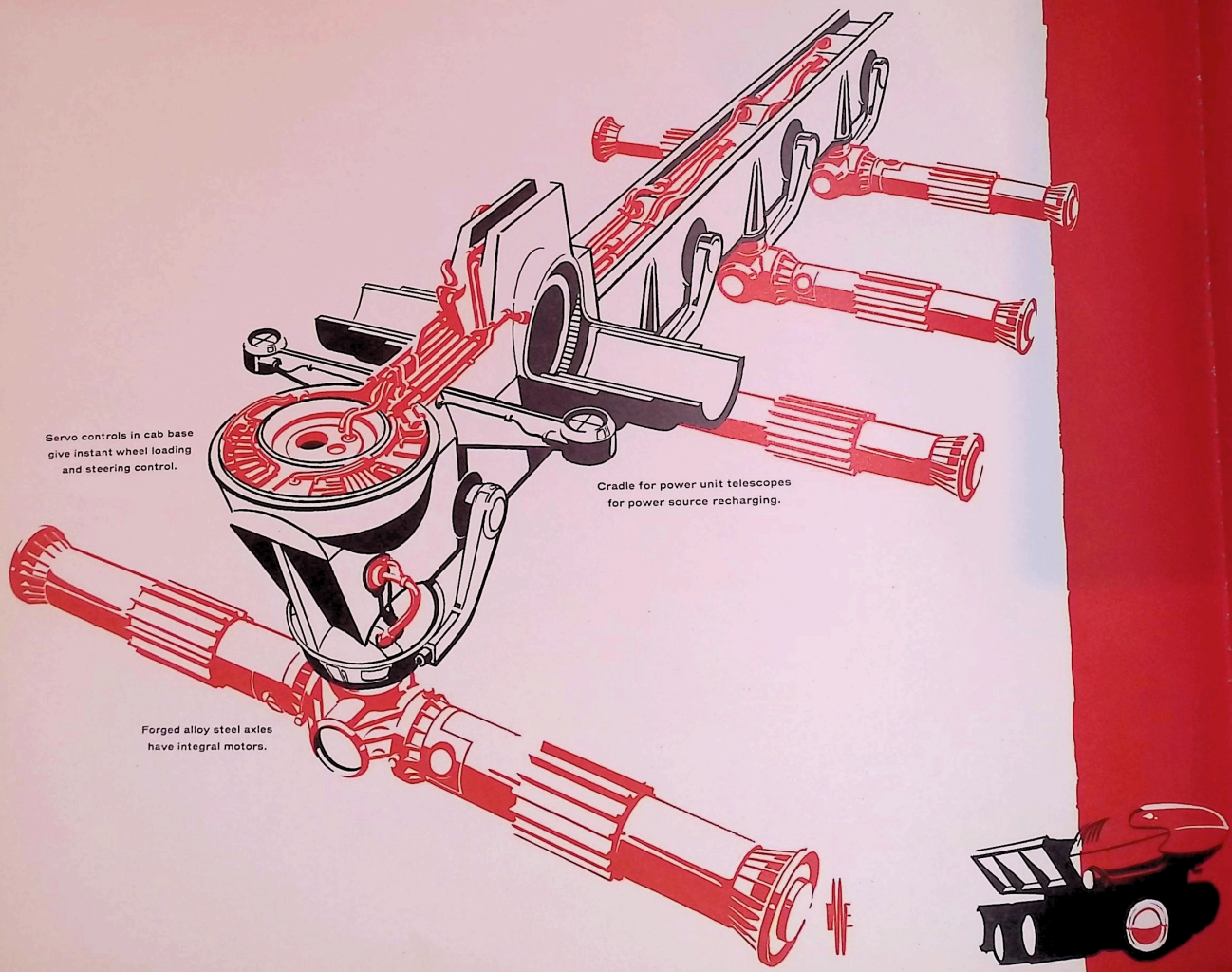


A Mammoth Ore Carrier for a Jules Verne World

Men are impatient in their drive to open new frontiers...to change, improve and broaden their environments...to progress in their social and their material worlds. It is this drive that makes civilization advance.

So, the Jules Verne of today is the prophet of tomorrow. More and more we realize that the imaginative drawings of designers and engineers are not simple flights of fancy; they are often times accurate predictions of things to be.

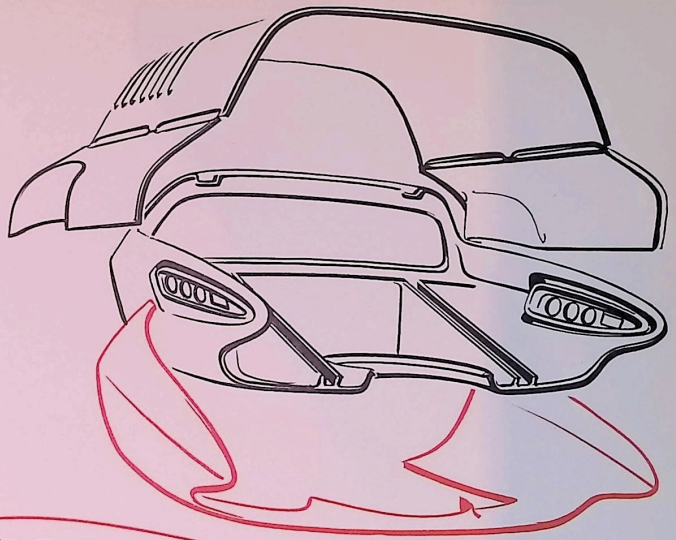
This ore carrier, imaginative in its concept, may never be built. However, the future will surely see similar design ideas developed for actual manufacture. Power and ruggedness keynote the design of this carrier. Its power reactor is housed at the rear of the cab. Strength, formability and weldability are design benefits gained through the use of USS TRI-TEN steel for major body and chassis components.

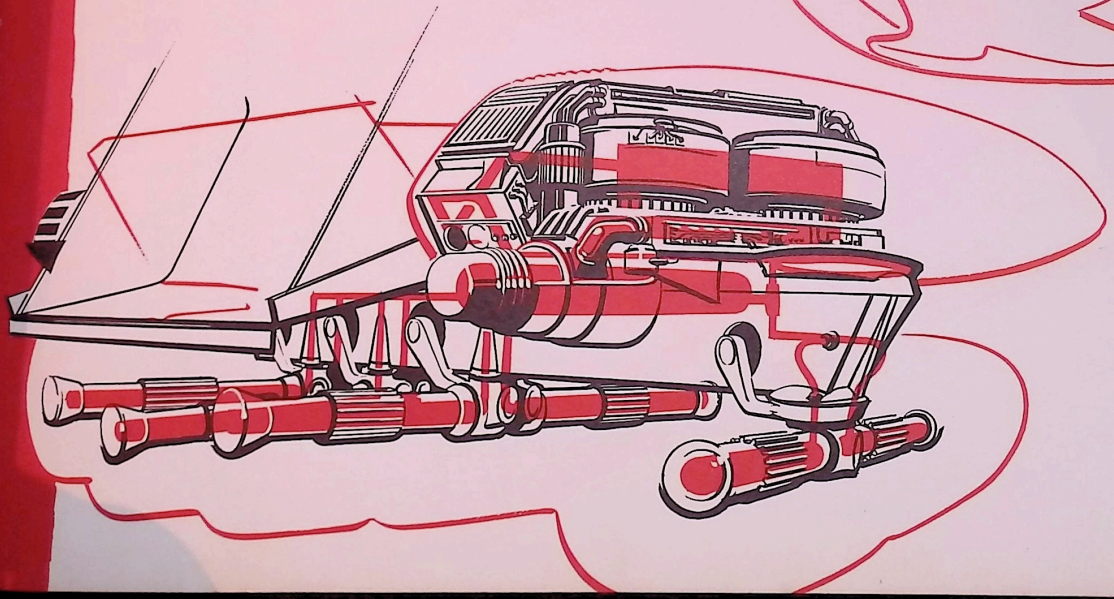

Single beam frame is fabricated from USS "T-1" steel.
Servo controls in cab base give instant wheel loading and steering control.
Cradle for power unit telescopes for power source recharging.
Forged alloy steel axles have integral motors.

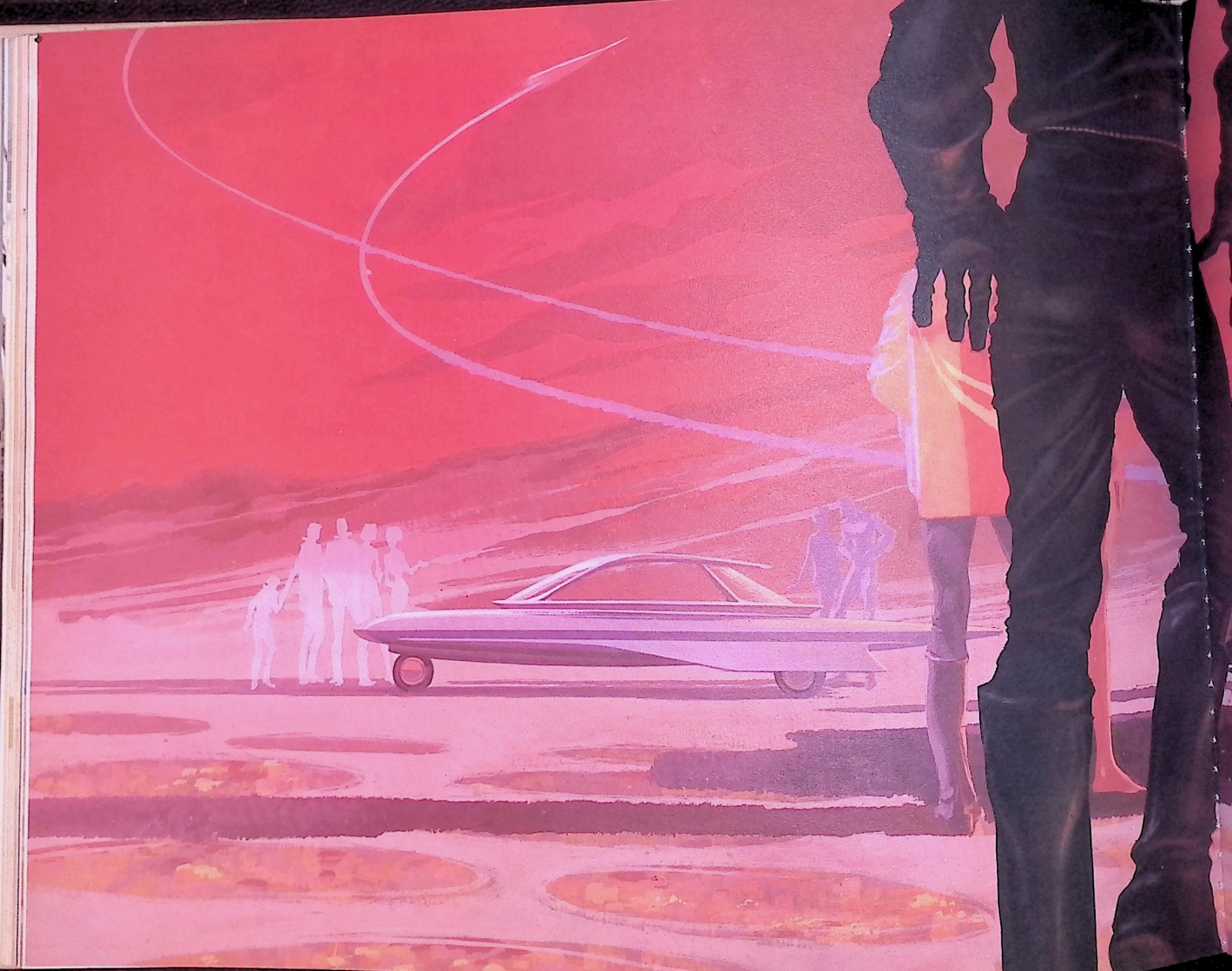
The spine of this ore carrier is fabricated from USS "T-1" steel. The power unit cradle is designed to be an integral part of the single beam frame. Individual motors power each wheel, giving tremendous traction and permitting a high degree of maneuverability. Forged and splined alloy steel axles shoulder the mighty loads with fatigue-free ease.

The electronic brain for this behemoth is forward mounted under the cab.

Economical USS EX-TEN steel forms the cab's tough skin, while the strength and toughness of USS "T-1" steel give the side-dump body the stamina to take it, again and again.



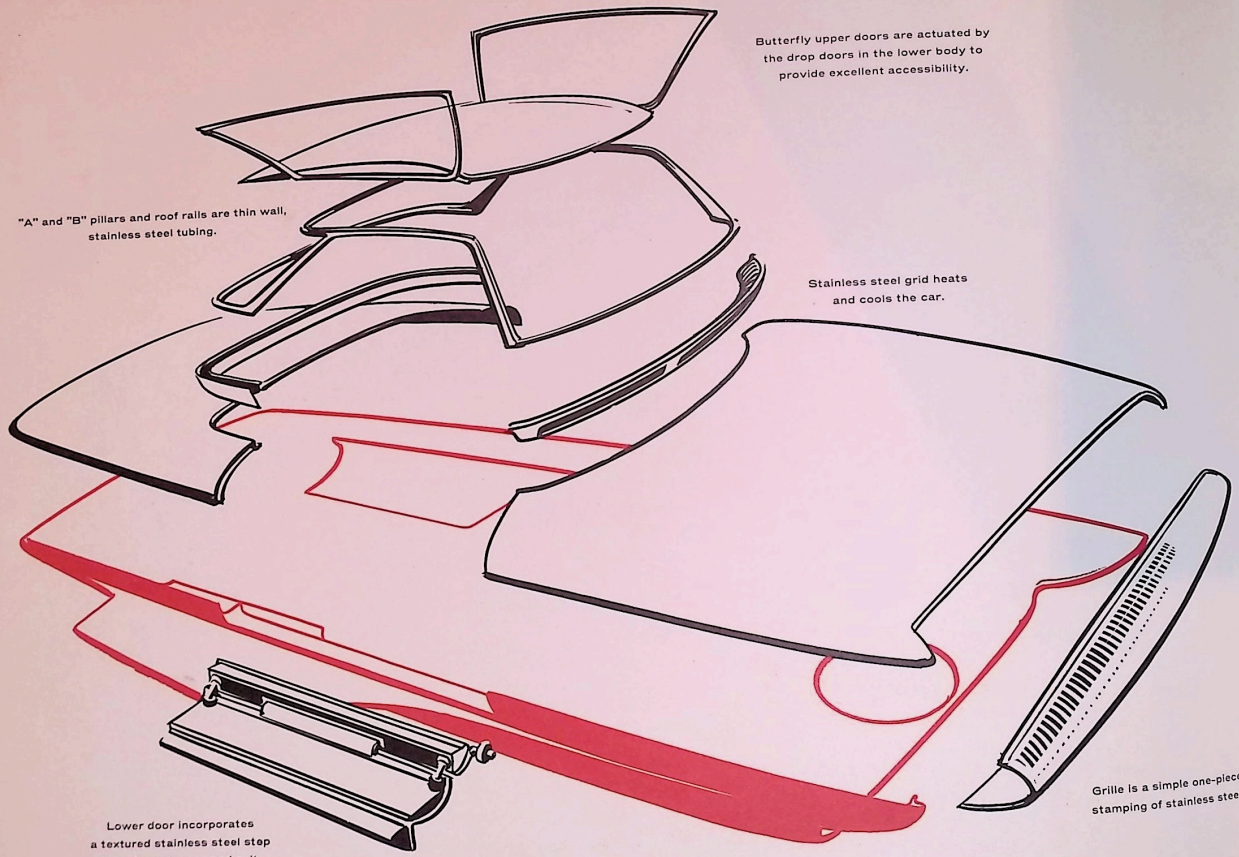




Opening Wide New Horizons

As the challenges of the future are met, brighter and vaster horizons will be opened in all fields of learning. As each day passes, new ideas will be put into effect and old ideas will as rapidly become obsolete.

This intriguing sedan, an idea for tomorrow, is designed for extremely fast, comfortable and safe travel in the highly mechanized world of the future. It takes advantage of steel's ability to create vehicles of great strength and lightness. Thin section alloy steel for frame members, light, strong, seamless steel tubing for framing, plus aluminum-coated carbon steel for body shells, assure stress-resistant durability, lightness and corrosion resistance.

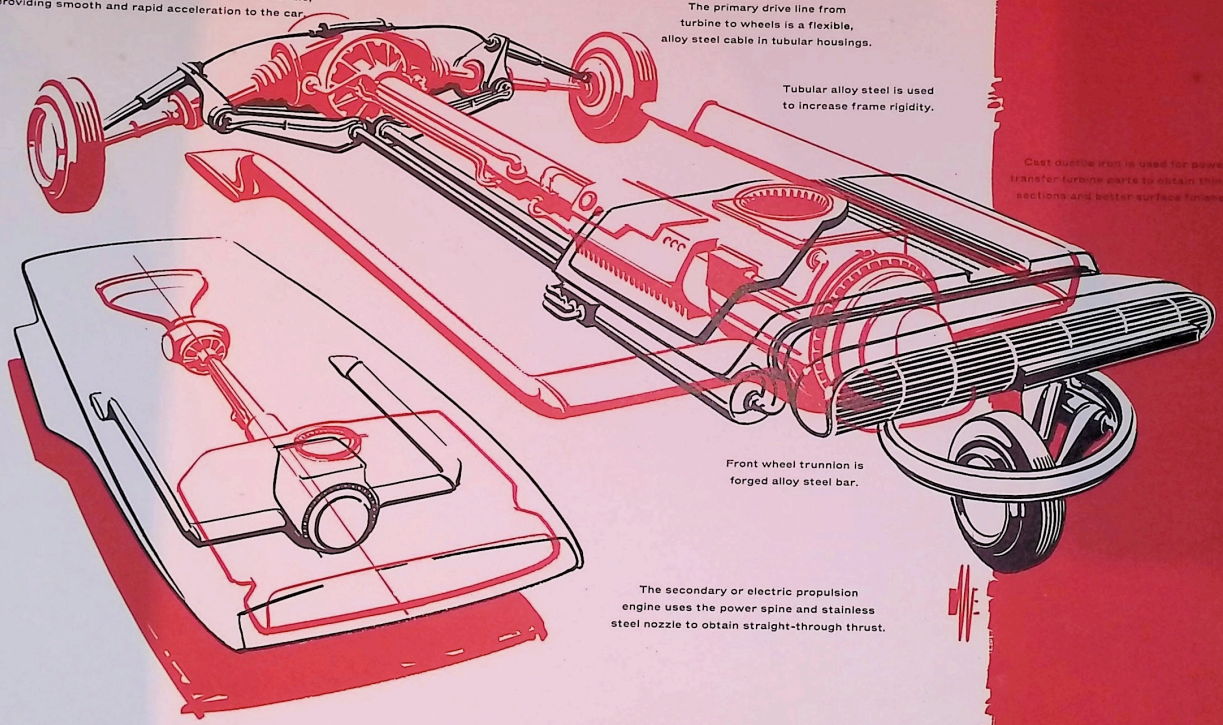

Butterfly upper doors are actuated by the drop doors in the lower body to provide excellent accessibility.
"A" and "B" pillars and roof rails are thin wall, stainless steel tubing.
Stainless steel grid heats and cools the car.
Grille is a simple one-piece stamping of stainless steel.
Lower door incorporates a textured stainless steel step for safer entrance and exit.
All body metal is aluminum coated thin gage steel.

A positive charge of electricity repels positively charged ions so violently that they hurtle from the nozzle, thus providing smooth and rapid acceleration to the car.

The primary drive line from turbine to wheels is a flexible, alloy steel cable in tubular housings.

Tubular alloy steel is used to increase frame rigidity.

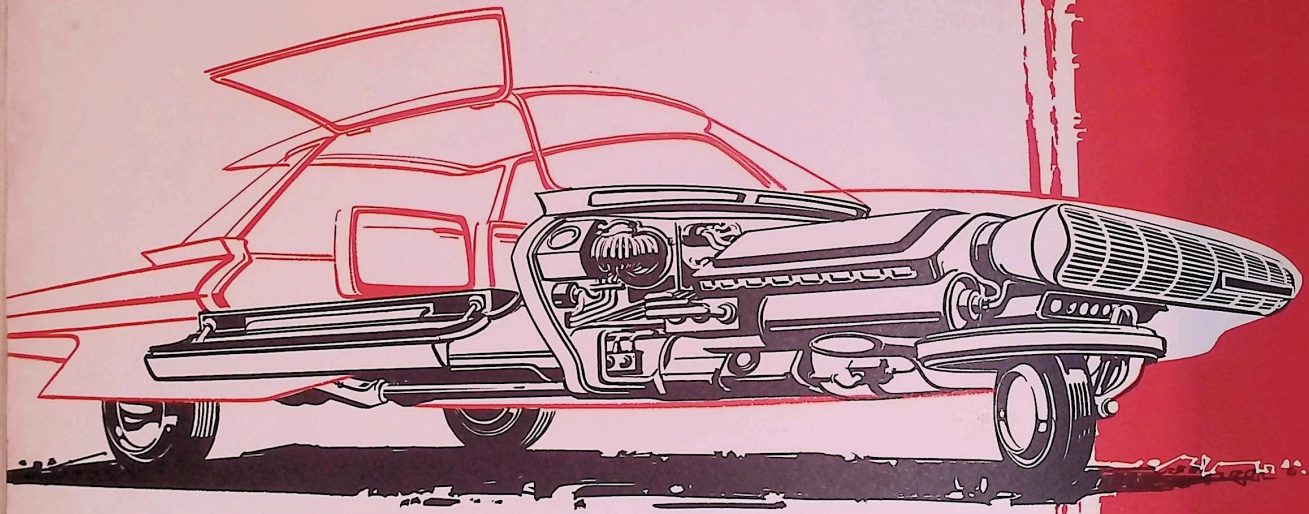
Cast ductile iron is used for power transfer turbine parts to obtain thinner sections and better surface finishes.



Front wheel trunnion is forged alloy steel bar.

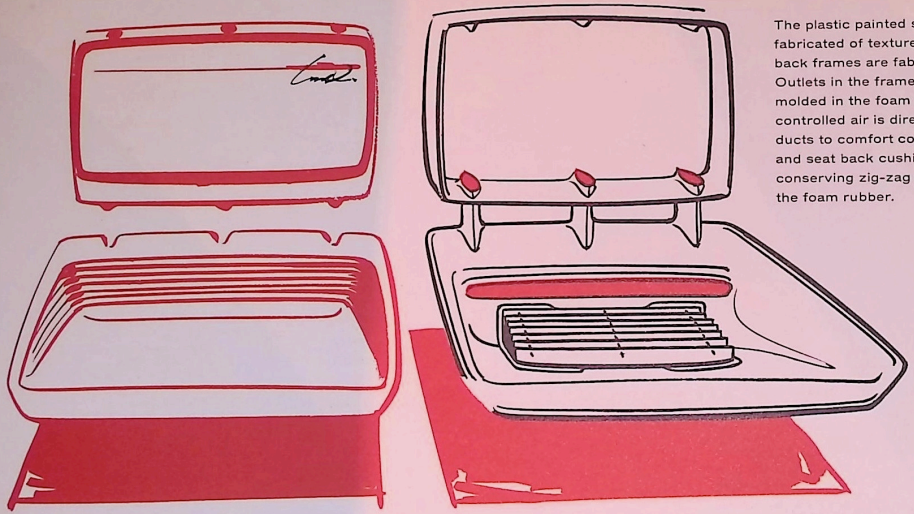
The secondary or electric propulsion engine uses the power spine and stainless steel nozzle to obtain straight-through thrust.

Here the power spine shows the use of heavy wall stainless steel tubing for supporting and driving the car. The primary engine automatically indexes solid fuel propellants according to thrust requirements. Engine blades and rotors are made of heat resisting stainless steel. Tricycle running gear is made lighter by using tubular alloy steel assemblies. The generator, power source for computer and operating equipment, is powered by air bled off behind the front mounted engine.



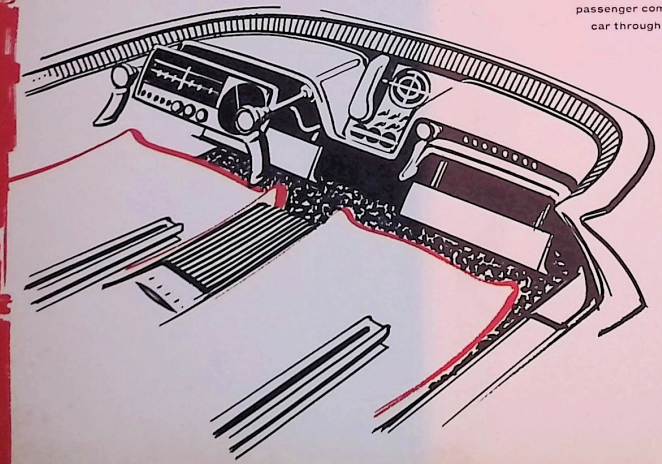
Because this sedan is designed for comfortable and safe driving at fast speeds, it poses problems for the designer and the engineer. Its framing has to be strong, yet light; its sheet metal should be tough, yet thin; even the passenger compartment must possess properties of durability while reflecting high aesthetic appeal. Solutions for these design problems are possible because of steel's application flexibility.

In this imaginary car, ductile iron is used for cams and crankshafts, housings and engine blocks. The toughness, strength and impact resistance of ductile iron permits a great weight and cost savings in these parts. It has the wear and corrosion resistance of cast iron. The interior is paneled with Vinyl Coated steel, which is colorful and durable and adds to the interior design appeal.



The plastic painted seat shells are fabricated of textured carbon steel. The seat back frames are fabricated of steel tubing. Outlets in the frame tubing mate with ducts molded in the foam padding. Temperature controlled air is directed through these ducts to comfort condition the seats. Seat and seat back cushions have space conserving zig-zag springs imbedded in the foam rubber.

A stainless steel grid around the inside of the passenger compartment heats and cools the car through electrical energy exchange.



Suspended treadle-type pedals rock forward to control acceleration and backwards to apply braking.

Imaginative designing permits additional seats to be clipped onto a roll formed traveler bar whenever extra passengers are to be accommodated.

A textured stainless steel panel between the seats adds a decorative accent.

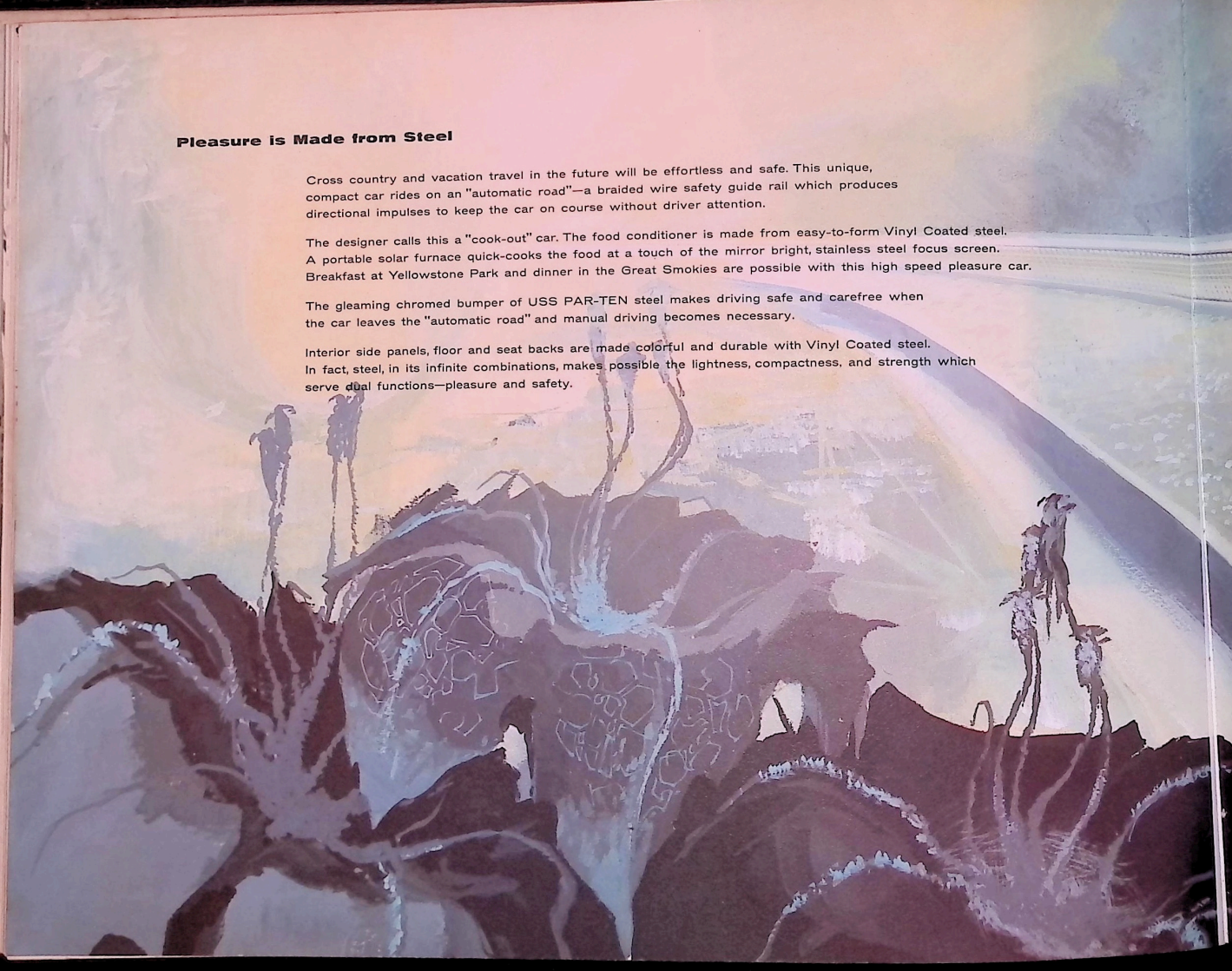
Pleasure is Made from Steel

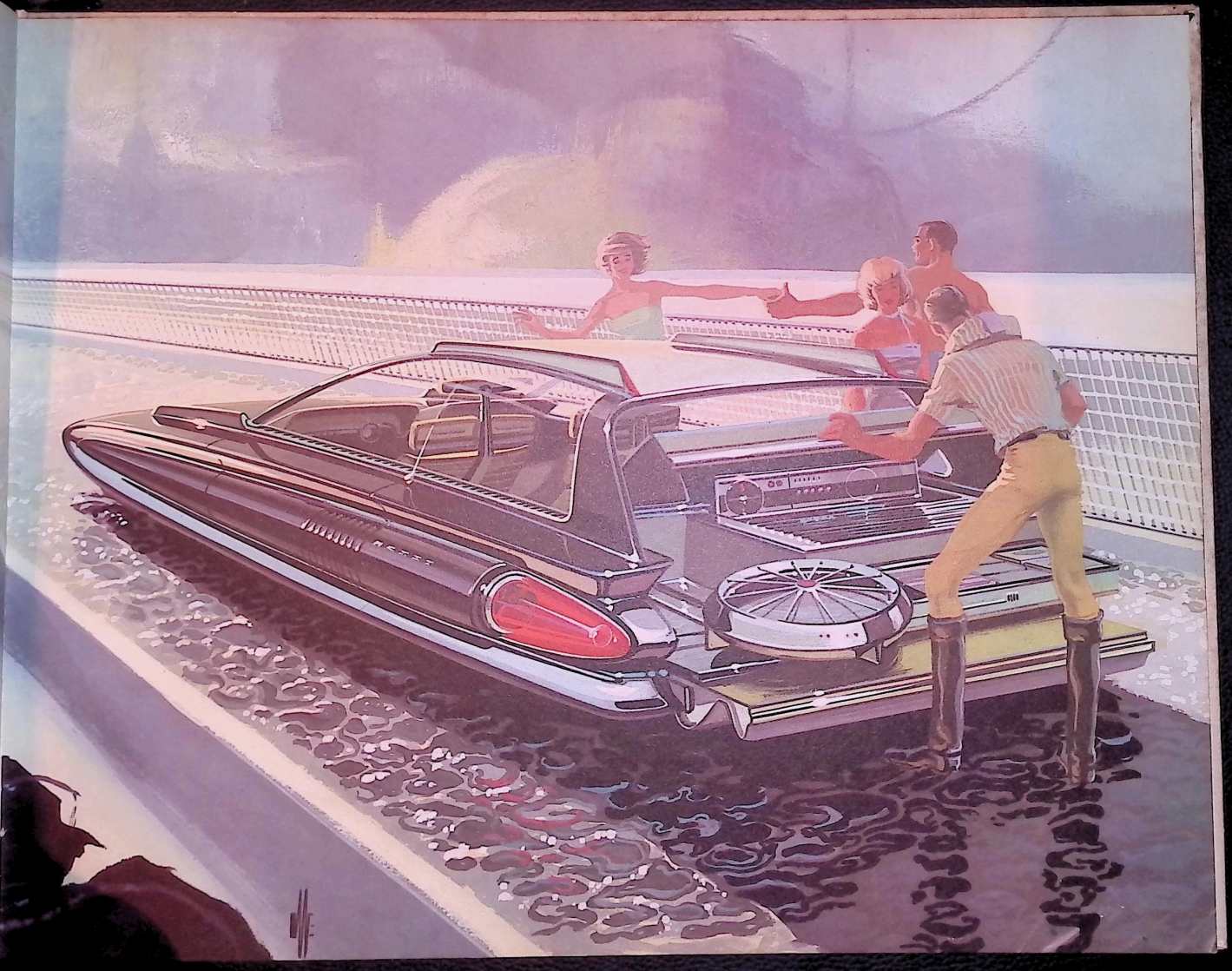
Cross country and vacation travel in the future will be effortless and safe. This unique, compact car rides on an "automatic road"—a braided wire safety guide rail which produces directional impulses to keep the car on course without driver attention.

The designer calls this a "cook-out" car. The food conditioner is made from easy-to-form Vinyl Coated steel. A portable solar furnace quick-cooks the food at a touch of the mirror bright, stainless steel focus screen. Breakfast at Yellowstone Park and dinner in the Great Smokies are possible with this high speed pleasure car.

The gleaming chromed bumper of USS PAR-TEN steel makes driving safe and carefree when the car leaves the "automatic road" and manual driving becomes necessary.

Interior side panels, floor and seat backs are made colorful and durable with Vinyl Coated steel. In fact, steel, in its infinite combinations, makes possible the lightness, compactness, and strength which serve dual functions—pleasure and safety.



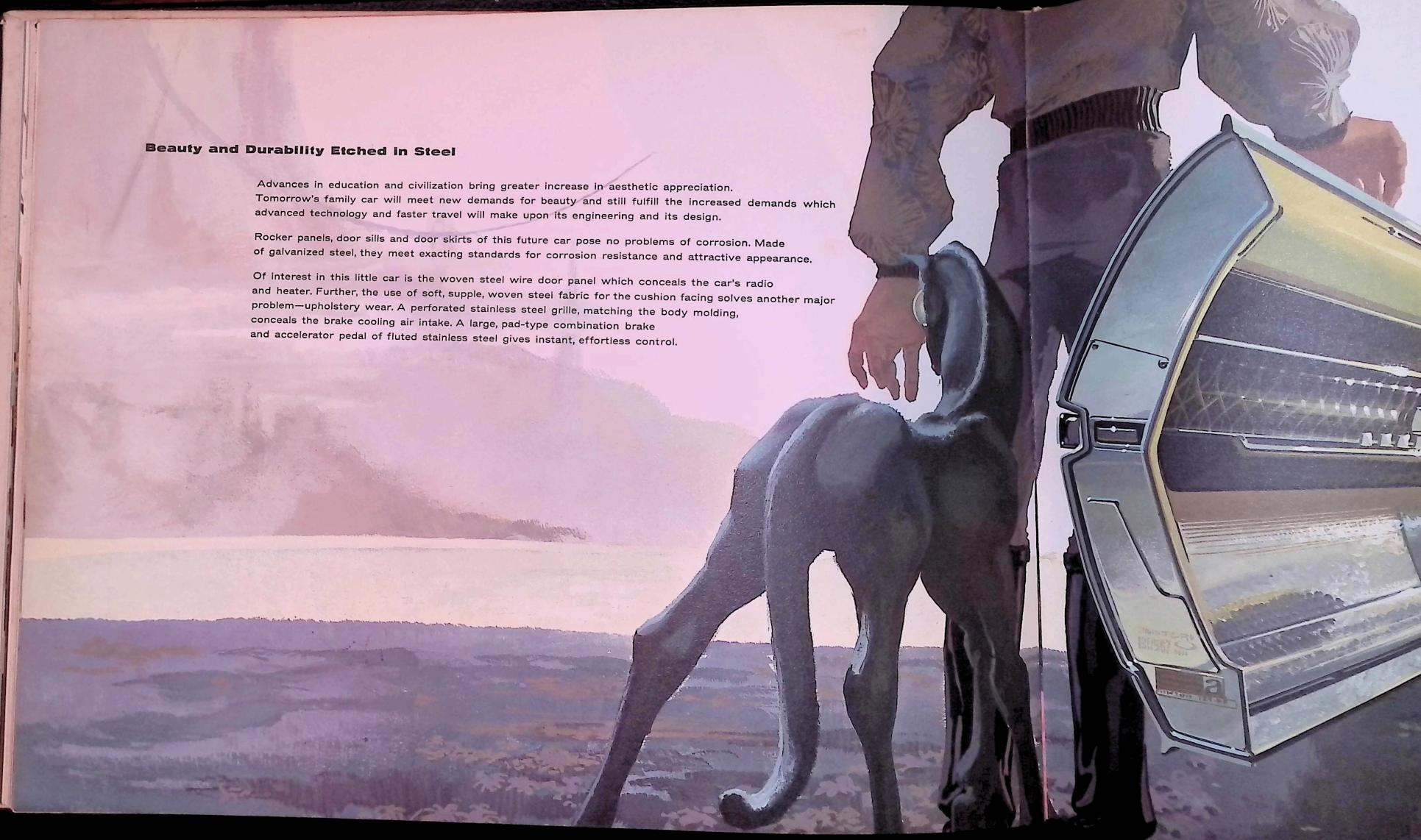


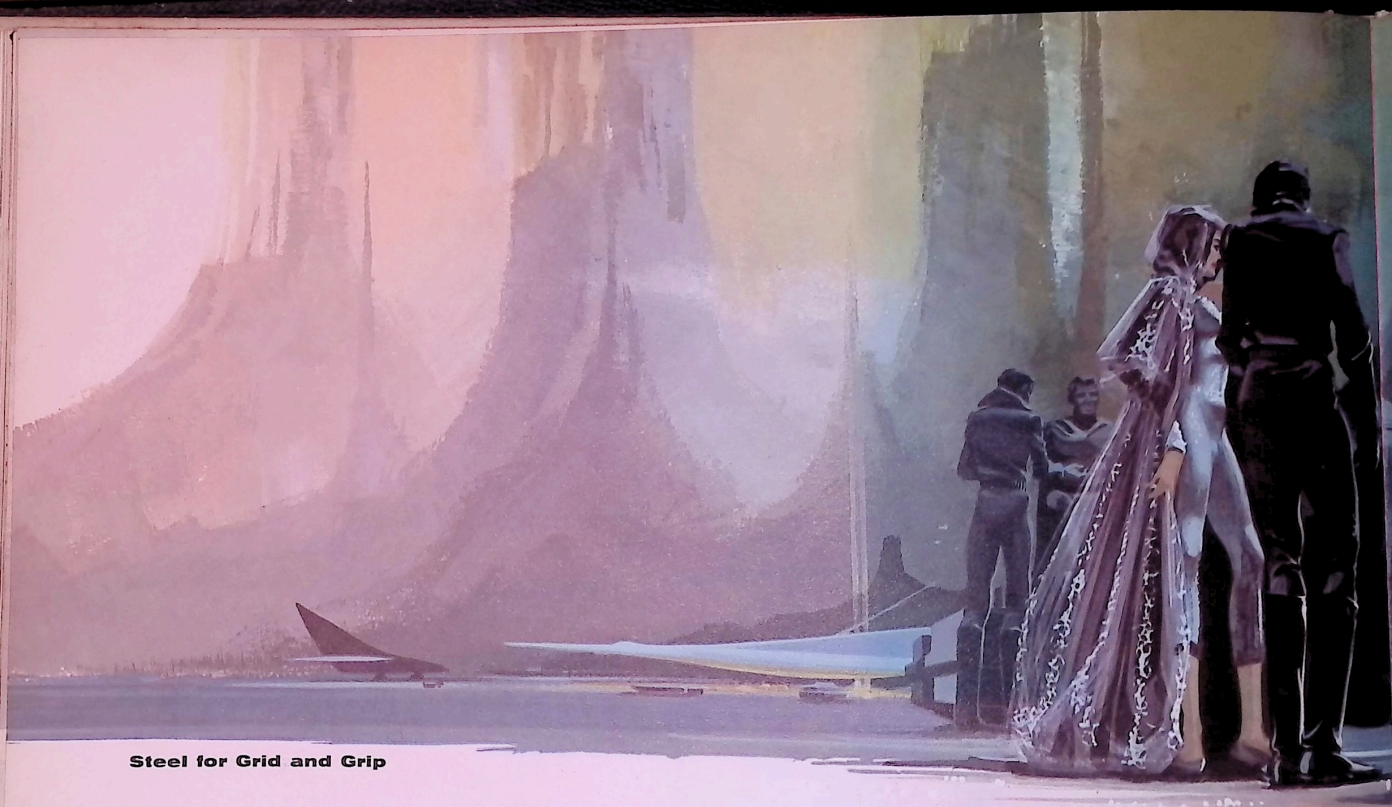
Beauty and Durability Etched in Steel

Advances in education and civilization bring greater increase in aesthetic appreciation. Tomorrow's family car will meet new demands for beauty and still fulfill the increased demands which advanced technology and faster travel will make upon its engineering and its design.

Rocker panels, door sills and door skirts of this future car pose no problems of corrosion. Made of galvanized steel, they meet exacting standards for corrosion resistance and attractive appearance.

Of interest in this little car is the woven steel wire door panel which conceals the car's radio and heater. Further, the use of soft, supple, woven steel fabric for the cushion facing solves another major problem—upholstery wear. A perforated stainless steel grille, matching the body molding, conceals the brake cooling air intake. A large, pad-type combination brake and accelerator pedal of fluted stainless steel gives instant, effortless control.





Steel for Grid and Grip

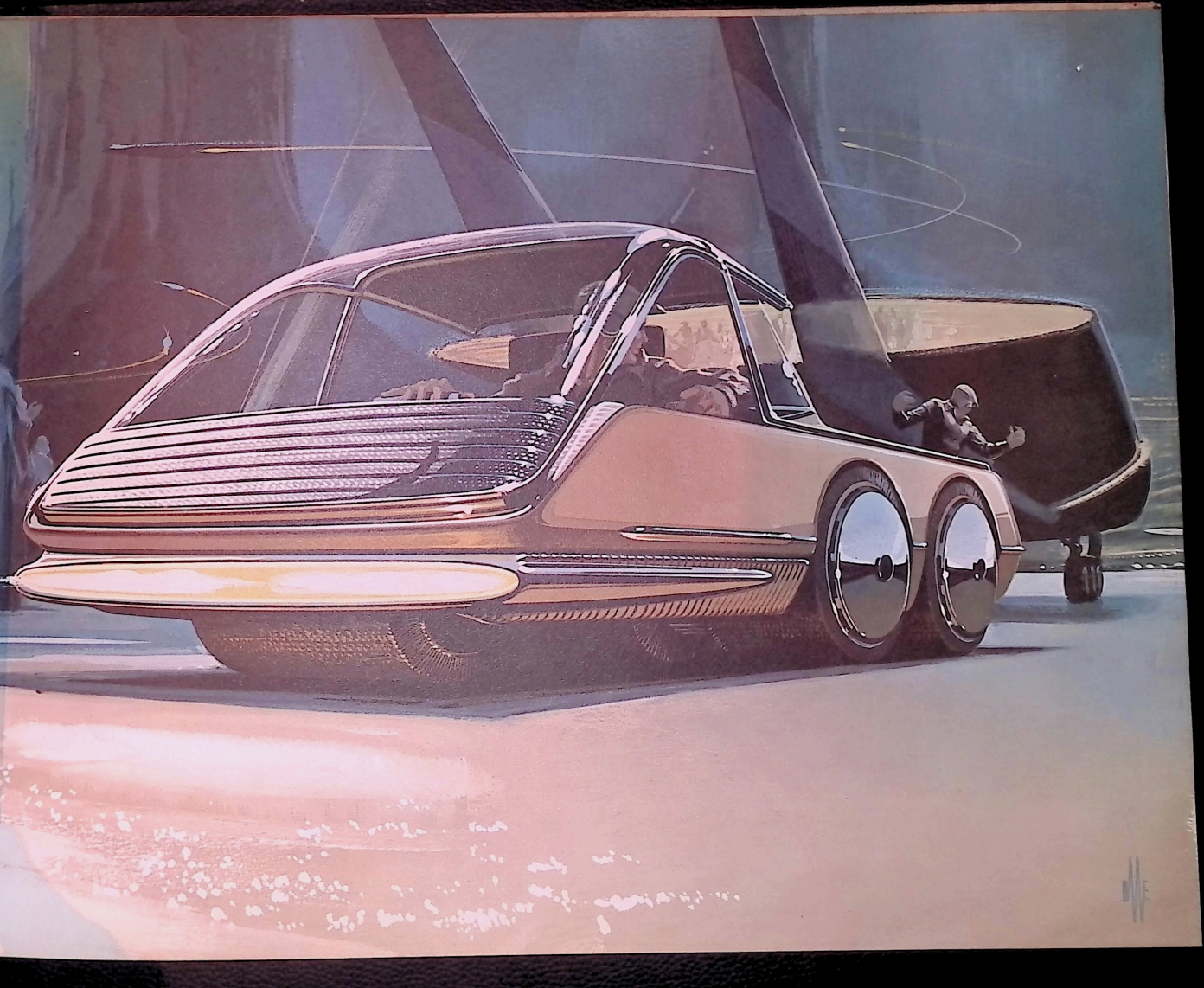
In the years to come, ground will be broken, highways leveled and runways smoothed in remote and untamed areas to make way for the rapid progress of civilization. Strange adventures—some now known only in science-fiction—will become realities, as man strives to conquer his environment and improve his welfare.

Progress comes, however, not from dreams but through serious, realistic approaches to problems and by difficult technological study and research.

This husky tug, conceived as a workhorse for heavy airport duty, is designed to double for highway express duty. Constant traction is delivered by steel wire wheels that have load deflection characteristics much like those of pneumatic tires. The drive application calls for high-tensile steel wire because it has excellent resistance to wear and will withstand high-operating temperatures.

Another feature of this vehicle is the grille-like front end, built of high-strength low-alloy steel tubing. Spanning full width for outstanding driver protection, these grille "bars" are fused at both ends to body "A" pillars. Louvers in the underbody provide fresh air for engine cooling.

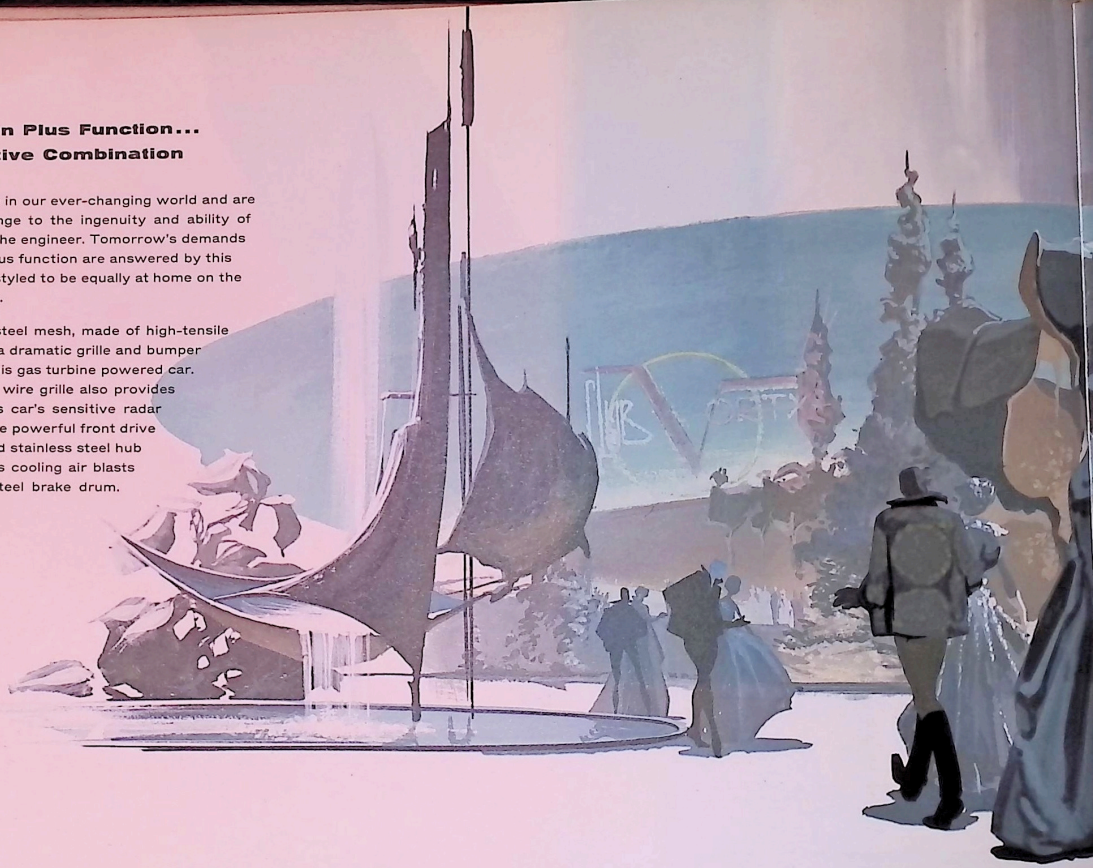
A high intensity lightband is recessed in the plated, USS PAR-TEN steel impact bar. Stainless steel gives moldings and wheel discs a sparkle that is handsome and durable.



High Fashion Plus Function... an Imaginative Combination

Fashions fluctuate in our ever-changing world and are a constant challenge to the ingenuity and ability of the designer and the engineer. Tomorrow's demands for high fashion plus function are answered by this luxury car that is styled to be equally at home on the road or at the club.

The bold look of steel mesh, made of high-tensile steel wire, makes a dramatic grille and bumper combination for this gas turbine powered car. The husky woven wire grille also provides protection for this car's sensitive radar braking device. The powerful front drive wheel has a vented stainless steel hub shell which directs cooling air blasts onto the finned steel brake drum.

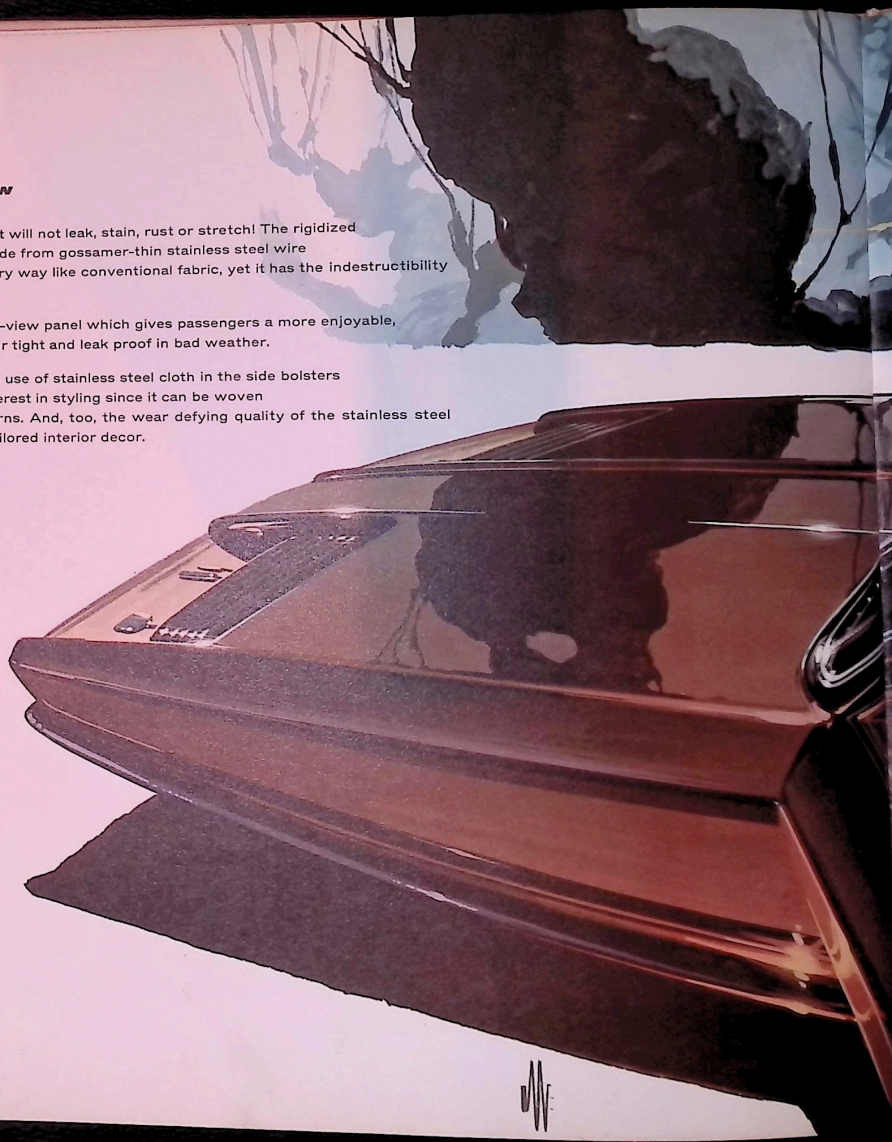


Fabrics of Steel for Tomorrow

A cloth top of steel? Yes—and what is more, it will not leak, stain, rust or stretch! The rigidized fabric used for the top of this sportscar is made from gossamer-thin stainless steel wire woven into cloth. Steel cloth functions in every way like conventional fabric, yet it has the indestructibility of steel, plus exciting new brightness.

This steel fabric roof boasts a retractable sky-view panel which gives passengers a more enjoyable, open-air ride in good weather, and which is air tight and leak proof in bad weather.

Another feature of this smart sportscar is the use of stainless steel cloth in the side bolsters of the seat cushions. This steel cloth adds interest in styling since it can be woven into a variety of different textures and patterns. And, too, the wear defying quality of the stainless steel fabric adds permanence to this sportscar's tailored interior decor.



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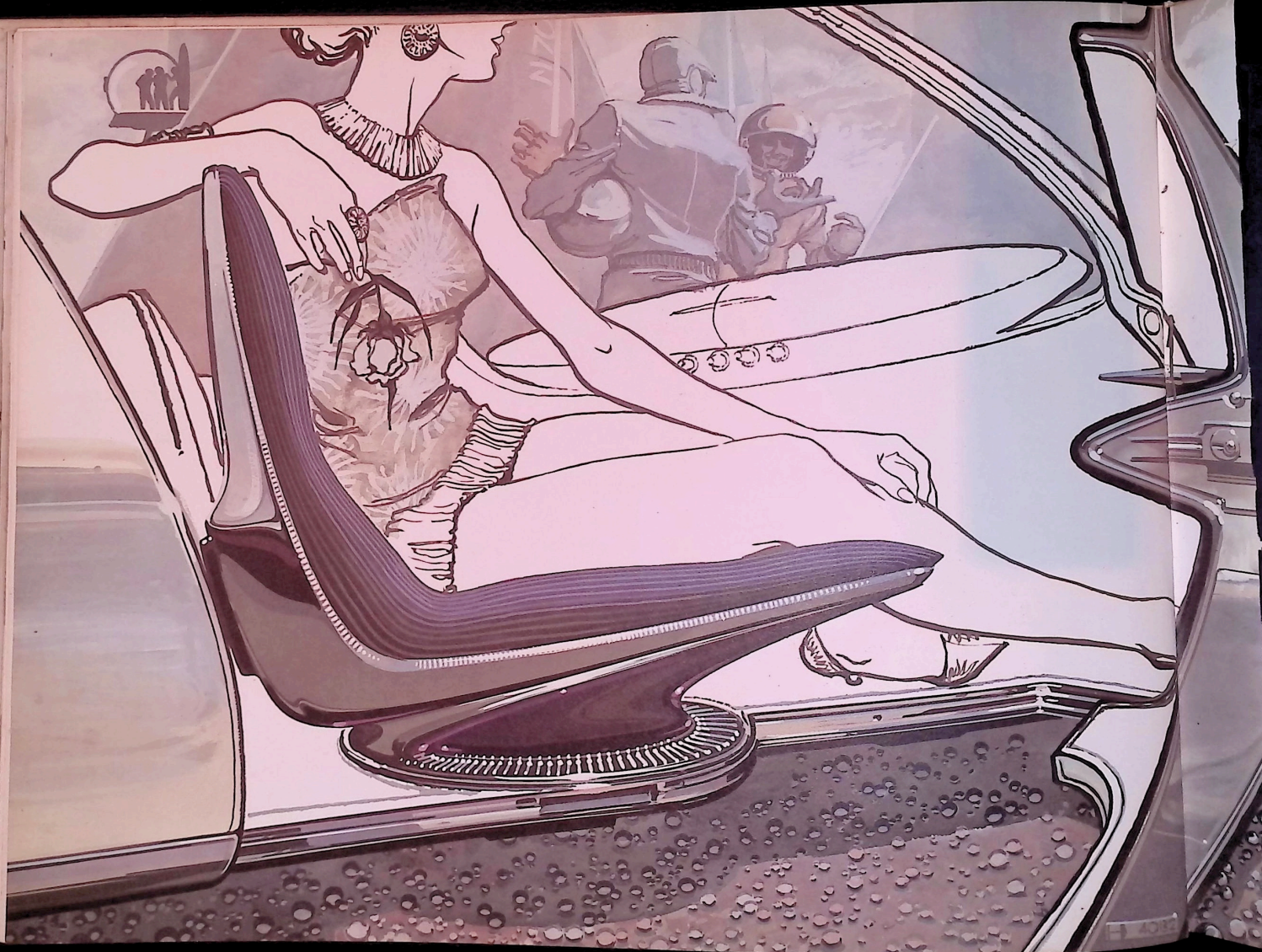
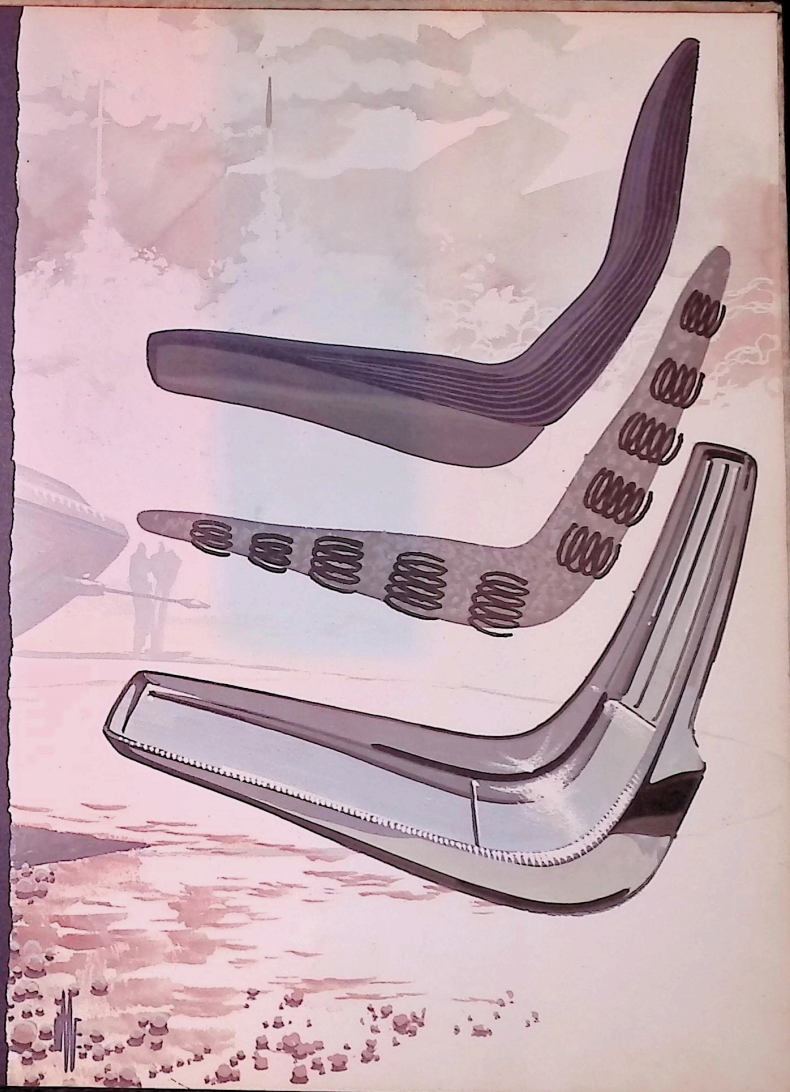


Imagination Plus Materials... the Tools of Progress

No other aspect of interior design exercises greater influence on over-all concept than the automobile seat. Seat design determines, to a marked degree, the vehicle's roominess, comfort, safety, accessibility and visibility.

A number of factors recommend the seat design illustrated. The shell is formed of polished stainless steel, the metal with permanent high luster. Cushioning is molded foam, with imbedded steel wire coil springs. This new concept in comfort reduces over-all cushion thickness and adds inches to headroom. The door opening cuts into the floor pan around the pivoting base of the seat, offering the ultimate in accessibility.

One popular material for seat construction, as well as interior paneling, is Vinyl Coated steel. This steel offers advantages in fabrication which have earned the consideration of both designer and manufacturer. Vinyl Coated steel may be rolled, stamped or sheared to any desired shape—always maintaining the color harmonized surface, so durable, economical and attractive.

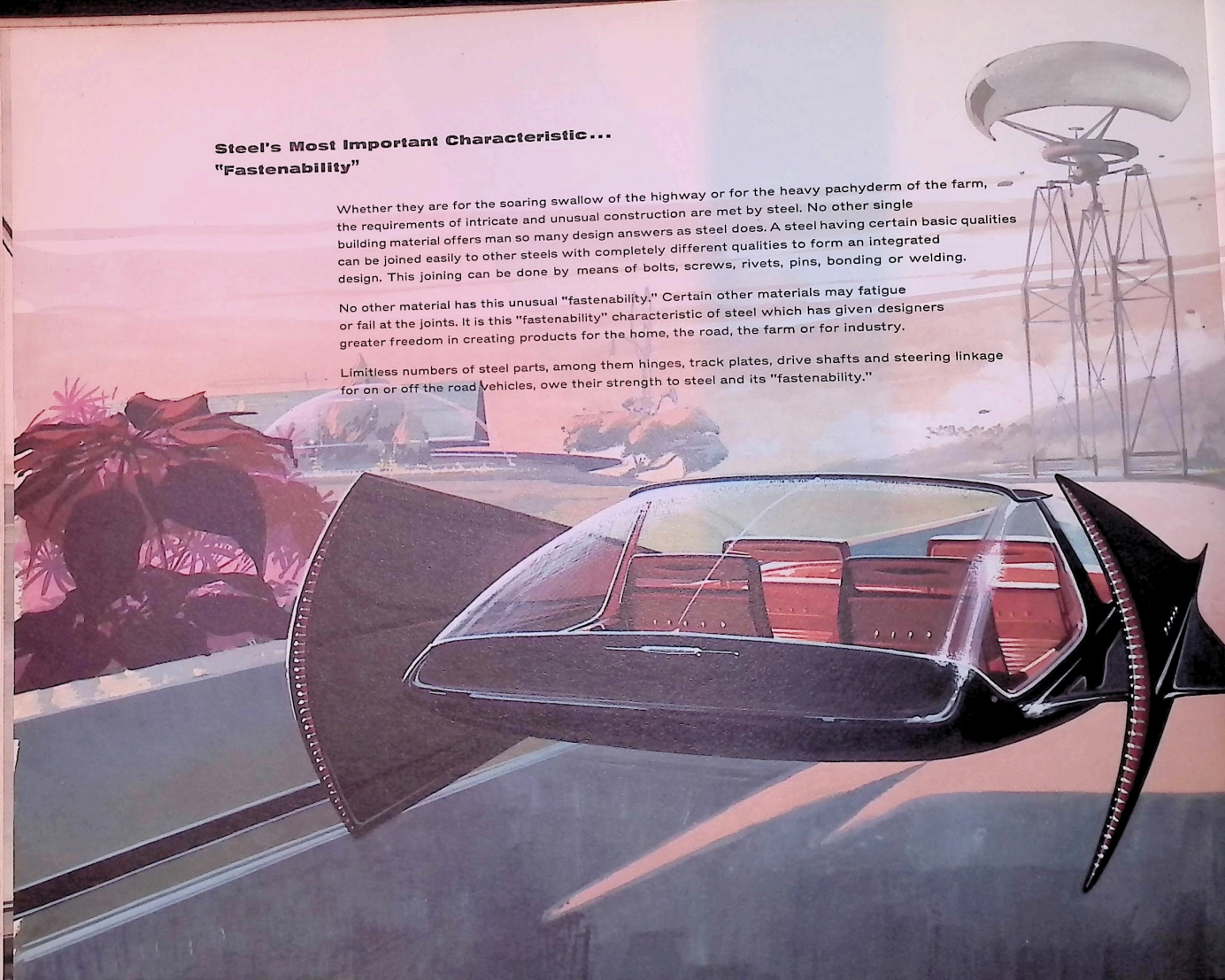


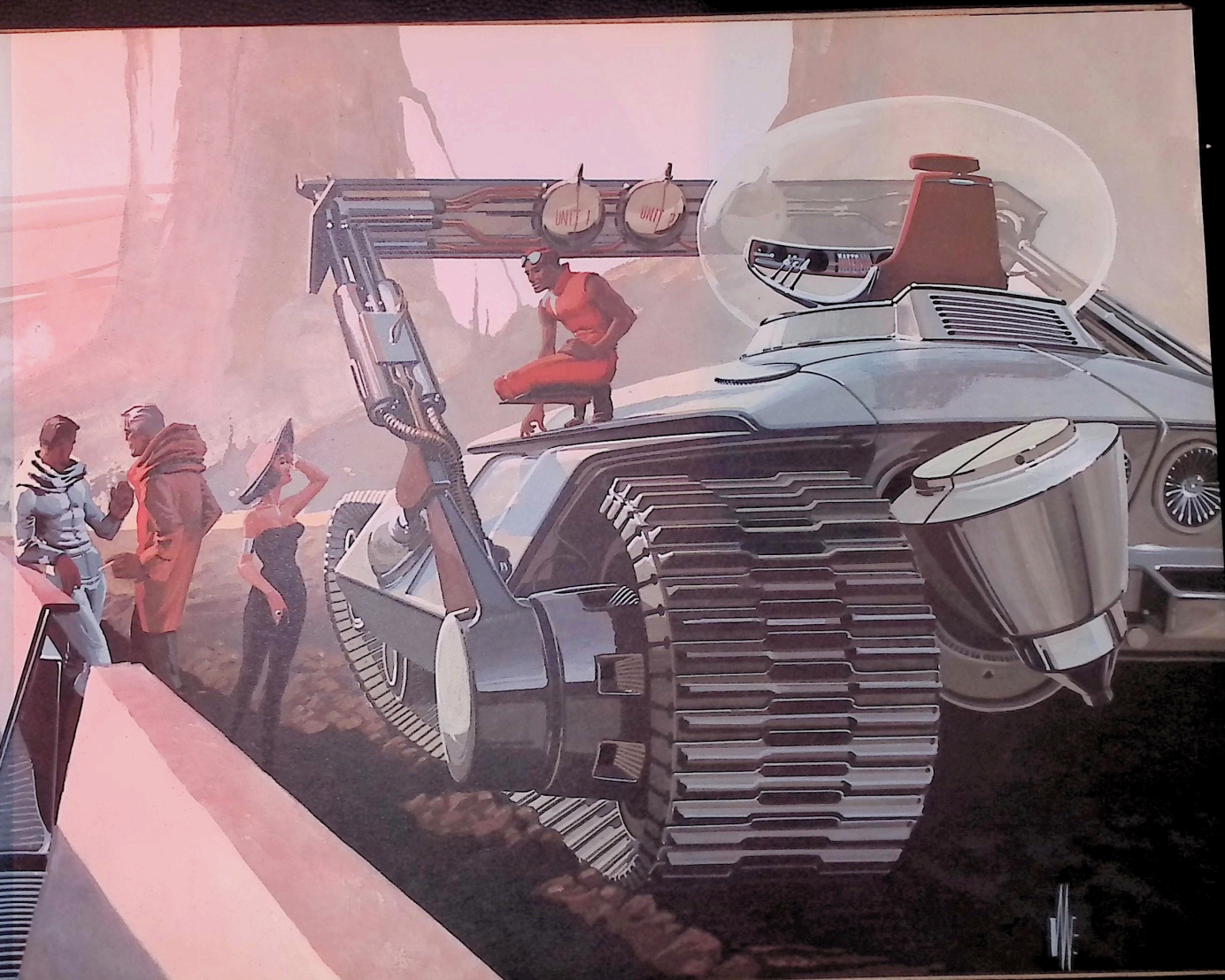
Steel's Most Important Characteristic...
"Fastenability"

Whether they are for the soaring swallow of the highway or for the heavy pachyderm of the farm, the requirements of intricate and unusual construction are met by steel. No other single building material offers man so many design answers as steel does. A steel having certain basic qualities can be joined easily to other steels with completely different qualities to form an integrated design. This joining can be done by means of bolts, screws, rivets, pins, bonding or welding.

No other material has this unusual "fastenability." Certain other materials may fatigue or fail at the joints. It is this "fastenability" characteristic of steel which has given designers greater freedom in creating products for the home, the road, the farm or for industry.

Limitless numbers of steel parts, among them hinges, track plates, drive shafts and steering linkage for on or off the road vehicles, owe their strength to steel and its "fastenability."




UNIT 1
UNIT 2

Tomorrow...Leisure Rules the Home

Although the future will bring little change in people, tomorrow's home will be a home of engineered beauty and leisure.

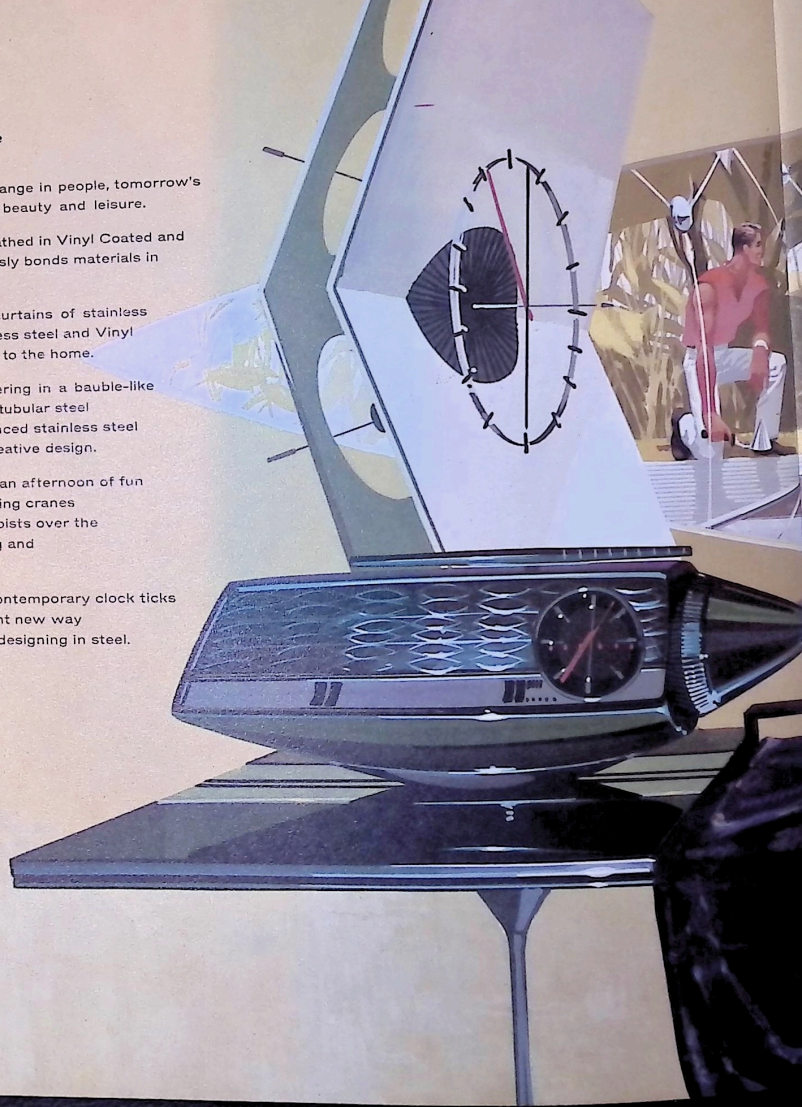
The electronic bonder, gracefully sheathed in Vinyl Coated and textured steel, magically and effortlessly bonds materials in varieties of intricate fashions.

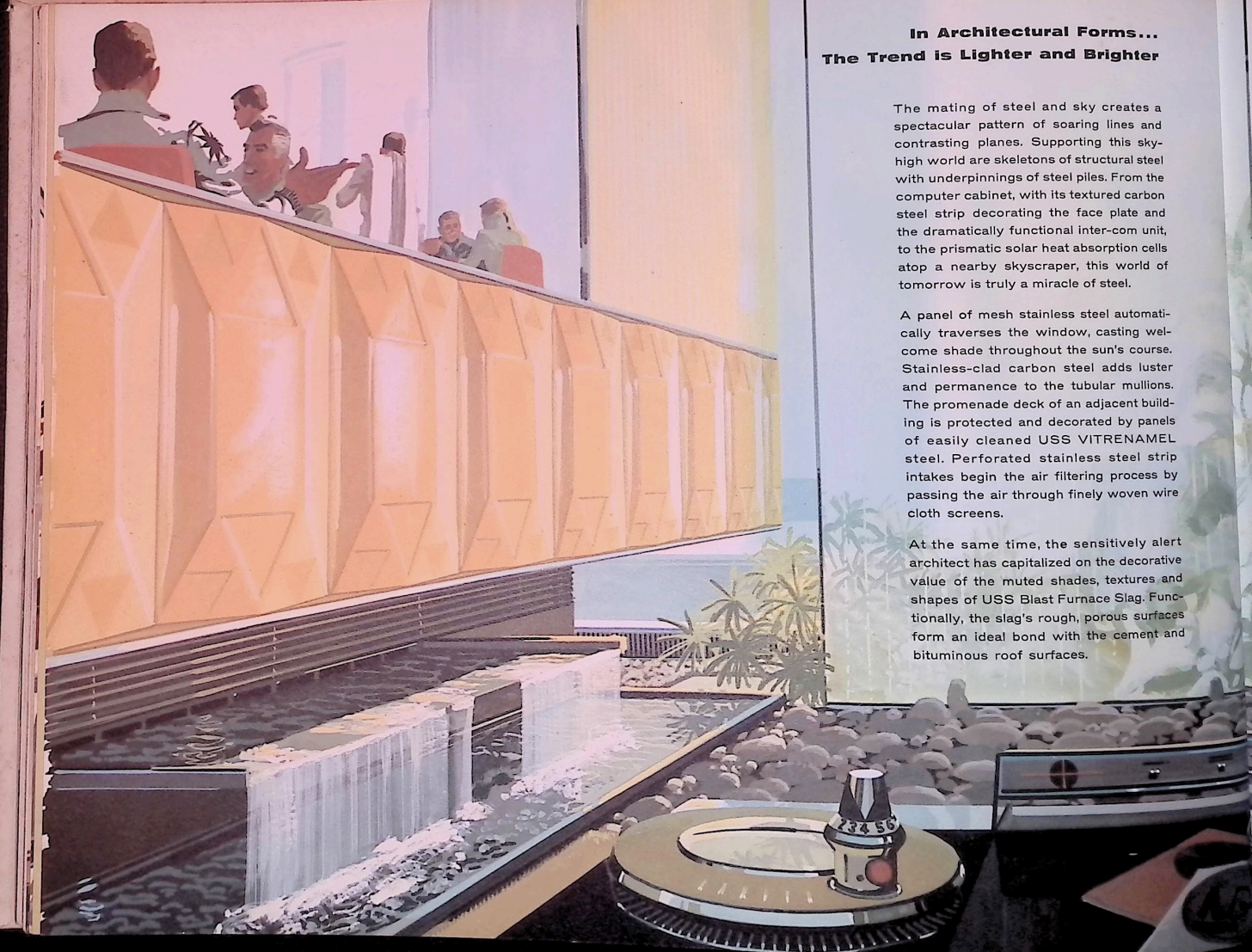
Drapes are transparent or opaque curtains of stainless steel woven cloth. Furniture of stainless steel and Vinyl Coated steel add beauty and comfort to the home.

Imagine the man of the house puttering in a bauble-like solarium hung from a lacy, geodesic, tubular steel frame-work. Even the precisely balanced stainless steel lawn pram reduces effort through creative design.

And, picture the entire family having an afternoon of fun in the all-steel aqua-jet. Self-positioning cranes automatically center the wire rope hoists over the quick-disconnect hooks, so launching and haulout are fingertip easy.

Over it all—the Vinyl Coated steel contemporary clock ticks away the pleasant hours of this bright new way of life made possible by imaginative designing in steel.



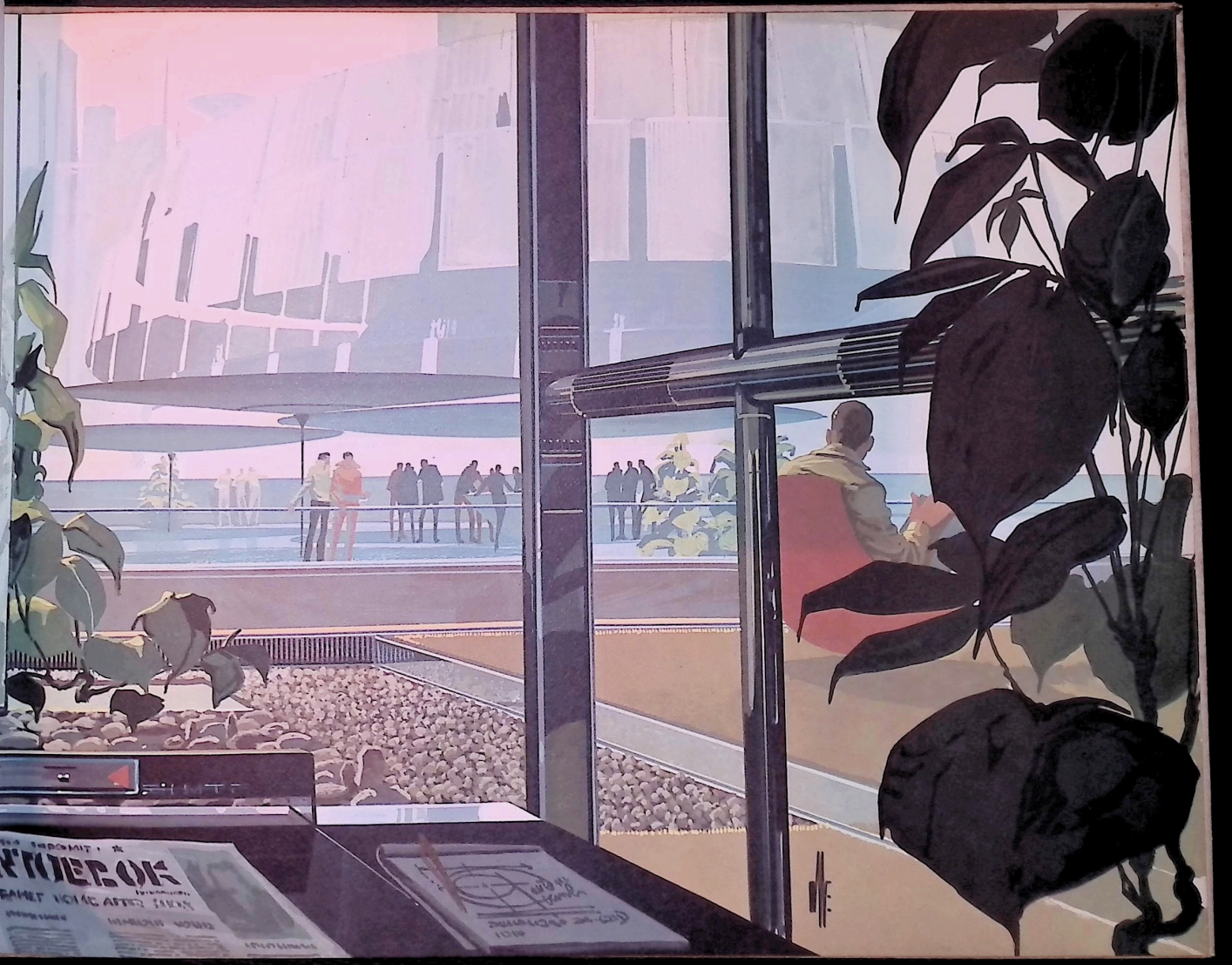


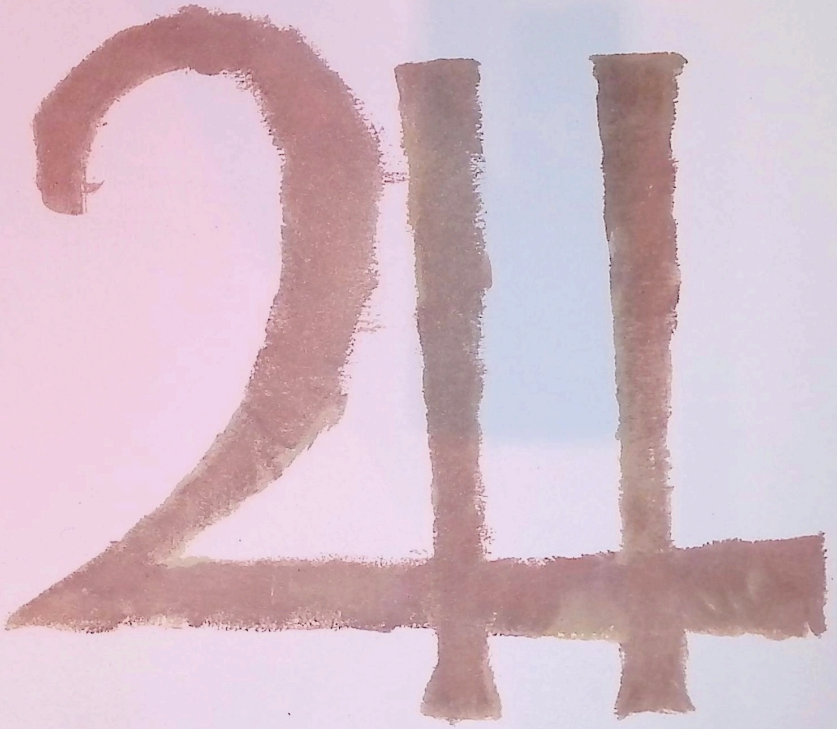
In Architectural Forms... The Trend is Lighter and Brighter

The mating of steel and sky creates a spectacular pattern of soaring lines and contrasting planes. Supporting this sky-high world are skeletons of structural steel with underpinnings of steel piles. From the computer cabinet, with its textured carbon steel strip decorating the face plate and the dramatically functional inter-com unit, to the prismatic solar heat absorption cells atop a nearby skyscraper, this world of tomorrow is truly a miracle of steel.

A panel of mesh stainless steel automatically traverses the window, casting welcome shade throughout the sun's course. Stainless-clad carbon steel adds luster and permanence to the tubular mullions. The promenade deck of an adjacent building is protected and decorated by panels of easily cleaned USS VITRENAMEL steel. Perforated stainless steel strip intakes begin the air filtering process by passing the air through finely woven wire cloth screens.

At the same time, the sensitively alert architect has capitalized on the decorative value of the muted shades, textures and shapes of USS Blast Furnace Slag. Functionally, the slag's rough, porous surfaces form an ideal bond with the cement and bituminous roof surfaces.





Created and produced under the direction of the Advertising and Market Development Divisions of United States Steel by the Hansen Company, 307 N. Michigan Avenue, Chicago 1, Illinois

In the Tapestry of Time—
Steel Binds Dreams to Reality

Early in recorded history, the Alchemist had this symbol for iron. This mark reminds us that centuries ago iron was recognized and identified as one of the vital elements of life.

At the turn of the last century the probing mind of man, looking to frontiers with a beginning but without end, developed the steel making process. Since then thousands of steels have been created for special needs, a few of which have been discussed in this book.

For the most part, stylists and designers work with brush and sculptured clay. However, the engineers and the metallurgists need additional tools, tools for exact measurements, for theirs is a science rather than an art. It is for these scientifically trained people that the following pages of this book are presented, to serve for quick reference or comparative study.

As new forms and shapes in steel change the "look" of tomorrow's world, even newer steels will be created in answer to design challenges yet unforseen. As your own design, engineering and manufacturing challenges arise, our people, products and creative services are available to help you solve them. Address all inquiries to our nearest district sales office listed under United States Steel in your directory, or to:

Automotive Industries, Market Development Division,
525 William Penn Place, Pittsburgh 30, Pennsylvania

United States Steel Corporation
American Steel & Wire
National Tube
United States Steel

Typical Properties of Martensitic-Ferritic USS Stainless Steels

USS GRADES:	USS 12A1	USS 12Tur, 12, 12FM	USS 17	USS 27	USS 5	USS 5S
A. I. S. I. TYPE NUMBERS:	TYPE 405	TYPES 403, 410, 416	TYPE 430	TYPE 446	TYPE 501	TYPE 502
PHYSICAL PROPERTIES						
Density	0.28	0.28	0.28	0.27	0.28	
Lb./Cu. In.	0.97	0.97	0.97	0.95	1.0	
Low Carbon Steel (SAE 1020)=1.00						
Specific Electrical Resistance at 68°F						
Microhms/Cm.[3]	60	57	60	67	40	
Microhms/In.[3]	23.6	22.4	23.6	26.4	15.7	
Low Carbon Steel=1.00	5.5	5.2	5.5	6.1	3.6	
Melting Range, °F	2700-2790	2700-2790	2600-2750	2600-2750	2700-2800	
Structure	Ferritic	Martensitic	Ferritic	Ferritic	Martensitic	
Magnetic Permeability as Annealed	Ferro-mag.	Ferro-mag.	Ferro-mag.	Ferro-mag.	Ferro-mag.	
Specific Heat						
Cal./°C/Gm. (0 to 100°C) OR	0.11	0.11	0.11	0.12	0.11	
Btu/°F/Lb. (32 to 212°F)	1.0	1.0	1.0	1.0	1.0	
Low Carbon Steel=1.00 (0 to 100°C)						
Thermal Conductivity						
Cal./Cm.²/Sec./°C/Cm., at 100°C	—	0.0595	0.0625	0.0500	0.0875	
Btu/Sq. Ft./Hr./°F/In. at 212°F	—	173	181	145	254	
Low Carbon Steel=1.00 at 100°C	—	0.52	0.54	0.43	0.76	
Cal./Cm.²/Sec./°C/Cm., at 500°C	—	0.0686	0.0627	0.0583	0.0807	
Btu/Sq.Ft./Hr./°F/In., at 932°F	—	199	182	169	234	
Coefficient of Thermal Expansion						
Per °F x 10^{-6} (32 to 212°F)	6.0	5.5	5.8	5.8	6.2	
Low Carbon Steel=1.00 (32 to 212°F)	0.91	0.83	0.88	0.88	0.94	
Per °F x 10^{-6} (32 to 932°F)	6.7	6.4	6.3	6.3	7.2	
MECHANICAL PROPERTIES AT ROOM TEMPERATURES	AN-NEALED	AN-NEALED	QUENCHED & DRAWN	AN-NEALED	COLD WORKED	AN-NEALED	COLD WORKED	AN-NEALED	QUENCHED & DRAWN**
Endurance (Fatigue) Limit (1,000 Lbs./Sq.In.)	—	30-50	40-100	35-50	—	30-55	—	—	—
Modulus of Elasticity (1,000 Lbs./Sq.In.)	29	29	29	29	29	29	29	29	29
Tensile Strength (1,000 Lbs./Sq.In.)	60-85	65-85	90-200	70-90	90-110	75-95	85-135	65-85	115-175
Yield Strength (1,000 Lbs./Sq.In.)	35-45	35-45	60-145	35-55	80-105	45-60	55-115	25-45	90-135
Elongation in 2 In., (%)	35-20	35-20	28-15	35-20	25-8	30-20	25-2	35-25	20-15
Reduction of Area (%)	75-55	75-60	75-60	60-40	—	50-40	—	75-60	60-50
Rockwell Hardness	B70-85	B74-85	C10-41	B75-90	B90-C23	B80-90	—	B70-85	—
Brinell Hardness	130-165	131-163	180-375	145-185	—	140-185	—	130-165	240-370
Keyhole Charpy Impact (Ft.Lbs.)	—	25-35*	—	20-40	—	1-10	—	—	—
Stress for a Creep Rate of 1% in 10,000 Hrs.									
At 1000°F, Lb./Sq.In.	—	9,200*		8,600		6,100		9,500	
At 1200°F, Lb./Sq.In.	—	2,000*		2,200		1,400		2,500	
At 1300°F, Lb./Sq.In.	—	1,000*		1,400		700		1,700	
At 1500°F, Lb./Sq.In.	—	—		—		—		—	
Scaling Temperature, °F (approx.)	1500	1300		1500		2000		1150	
Forging Preheat Temperature, °F	1400-1500	1400-1500		1400-1500		1400-1500		1400-1500	
Initial Forging Temperature, °F	1950-2050	2000-2200		1900-2050		1950-2050		2100-2200	
Finishing Temperature, °F	—	1500 Max.		1500 Max.		1450 Max.		1600 Max.	
Annealing Treatment, °F	Air cool from 1350-1450	Cool 50° per hr. max. to 1100° from 1550-1600 or air cool from 1350-1450***		Air cool from 1400-1500		Rapid cool from 1550-1650		Furnace cool from 1525-1600 or air cool from 1325-1375	
ABRASION RESISTANCE	Fair	Fair		Fair		Fair		Fair	
COLD FORMING—Drawing—Stamping	Fair	Fair		Fair		Fair		Fair	
MACHINABILITY	Fair	Fair		Fair		Fair		Fair	
WELDING	Good Does not harden to any appreciable extent.	Fair Welding hardens. Anneal to restore ductility.		Fair Welds are brittle when cold. Slight response to anneal.		Fair Welds are brittle when cold. Slight response to anneal.		Fair Welding hardens. Anneal to restore ductility.	
PRECAUTIONS (See Note)		(A)		(B)		(B)			

*Applies only to Types 403 and 410.
**Applies only to Type 501.
***Hardening treatment: Cool rapidly from 1700°-1850°F.
Tempering treatment: After hardening reheat to a selected temperature within the range 400°-1400°F, depending upon the properties desired.

(A) Preheat slowly to 1450°F, then heat rapidly to initial temperature for forging. Full corrosion resistance is developed only in the heat treated condition.
(B) In forging, preheat slowly to 1450°F. Excessive grain growth takes place above 2000°F. Expert welding is required to avoid excessive grain growth. Prolonged exposure at 850° to 950°F produces cold brittleness. Re-anneal to restore ductility.

Typical Properties of Austenitic USS Stainless Steels

USS GRADES:	USS 17-4-6	USS 17-7	USS 18-5-8	USS 18-8, 18-8FM, 18-8S	USS 18-8L	USS 18-8Mo	USS 18-8MoL	USS 18-8Ti	USS 18-8Cb	USS 25-12	USS 25-20
A. I. S. I. TYPE NUMBERS:	**Type 201**	**Type 301**	**Type 202**	**Types 302, 303 and 304**	**Type 304L**	**Type 316**	**Type 316L**	**Type 321**	**Type 347 and 348**	**Type 309**	**Type 310**
PHYSICAL PROPERTIES											
Density											
Lb./Cu.In.	0.29	0.29	0.29	0.29		0.29		0.29		0.29	0.29
Low Carbon Steel (SAE 1020)=1.00	1.02	1.02	1.02	1.02		1.02		1.02		1.02	1.02
Specific Electrical Resistance at 68°F											
Microhms/Cm.³	70.5	72	71.1	72(c.w.†=72-82)		74		72		78	80
Microhms/In.³	—	27.6	—	28.4(c.w.†=27.6-32.3)		29.2		28.5		30.7	31.5
Low Carbon Steel=1.00	—	—	—	6.6		6.8		6.5		7.1	7.1
Melting Range °F	2550-2650	2550-2650	2550-2650	2550-2650		2500-2550		2550-2600		2550-2650	2550-2650
Structure	Austenitic	Austenitic	Austenitic	Austenitic		Austenitic		Austenitic		Austenitic	Austenitic
Magnetic Permeability as Annealed	1.004*	1.003*	1.005*	1.003*		1.003*		1.003*		1.003*	1.003*
Specific Heat											
Cal./°C/Gm. (0 to 100°C) OR											
Btu/°F/Lb. (32 to 212°F)	0.12	0.12	0.12	0.12		0.12		0.12		0.12	0.12
Low Carbon Steel=1.00 (0 to 100°C)	—	—	—	1.1		1.1		1.1		1.1	1.1
Thermal Conductivity											
Cal./Cm.²/Sec./°C/Cm., at 100°C	—	—	—	0.0390		0.0373		0.0385		0.033	0.033
Btu/Sq.Ft./Hr./°F/In. at 212°F	9.4	9.4	9.4	113		113		112		96	96
Low Carbon Steel=1.00, at 100°C	—	—	—	0.34		0.34		0.33		0.29	0.29
Cal./Cm.²/Sec./°C/Cm., at 500°C	—	—	—	0.0512		0.0512		0.0532		0.045	0.045
Btu/Sq.Ft./Hr./°F/In. at 932°F	—	12.4	—	149		154		154		130	130
Coefficient of Thermal Expansion											
Per °F x 10^{-6} (32 to 212°F)	8.7	9.4	—	9.6		8.9		9.3		8.3	8.0
Low Carbon Steel=1.00 (32 to 212°F)	1.32	—	—	1.45		1.35		1.41		1.26	1.21
Per °F x 10^{-6} (32 to 932°F)	10.1	10.1	10.6	10.2		9.7		10.3		9.6	9.4

Physical Properties are similar to Type 304.

Physical Properties are similar to Type 316.

MECHANICAL PROPERTIES AT ROOM TEMPERATURES	¼-Hard	½-Hard	¾-Hard	Full Hard	An-nealed	An-nealed	Cold Worked	An-nealed	An-nealed	Cold Worked	An-nealed	321 Annealed	347 & 348 Annealed	An-nealed	Cold Worked	An-nealed
Endurance (Fatigue) Limit (1,000 Lbs./Sq.In.)	—	—	—	80,000	—	30-55	40-120	35-45	30-55	40-120	37-47	30-55	35-60	35-60	—	—
Modulus of Elasticity (1,000 Lbs./Sq.In.)	Type 201=28.6		Type 301=28.0		28	28	28-26	28	28	28-26	28	28	28	29	29-26	29
Tensile Strength (1,000 Lbs./Sq.In.)	125,000‡	150,000‡	175,000‡	185,000‡	100-110	75-95	105-300	70-90	80-95	105-300	75-95	75-95	80-100	80-100	110-270	90-105
Yield Strength (1,000 Lbs./Sq.In.)	75,000‡	110,000‡	135,000‡	140,000‡	50-60	30-45	60-250	25-40	30-45	60-250	30-45	30-45	35-50	35-50	65-230	40-60
Elongation in 2 in. (%)	25‡	18‡	12‡	9‡	60-50	60-50	50-2	50-60	60-40	50-2	45-55	55-45	50-40	50-40	25-2	45-30
Reduction of Area (%)	—	—	—	—	—	75-60	65-30	75-60	70-55	65-30	70-55	75-55	70-50	65-50	55-20	65-45
Rockwell Hardness	C25‡	C32‡	C37‡	C41‡	B85-100	B75-90	C5-58	B70-80	B75-90	C5-40	B75-85	B75-90	B75-90	B80-90	C5-40	B80-90
Brinell Hardness	—	—	—	—	163-241	135-185	—	—	135-185	—	—	135-185	135-185	150-185	—	150-185
Keyhole Charpy Impact (Ft.Lbs.)	—	—	—	—	—	70-90	—	70-90	60-80	—	60-80	70-90	50-70	65-80	—	65-80
Stress (1,000 psi) for a Creep Rate of 1% in 10,000 Hrs.																
At 1000°F, Lb./Sq.In.	—	—	—	—	—	17,600**	—	—	24,200	—	—	25,500	32,000	15,900		18,000
At 1200°F, Lb./Sq.In.	—	—	—	—		6,900**		6,800	12,700		8,200	9,700	16,500	8,000		8,600
At 1300°F, Lb./Sq.In.	—	—	—	8,200		3,900**		3,500	7,900		4,800	5,100	9,800	4,800		5,000
At 1500°F, Lb./Sq.In.	—	—	—	—		1,400**		1,500	2,800		1,500	2,000	2,000	1,000		1,000
Scaling Temperature, °F (approx.)	1500		1500	1550	1650	1650		1650	1650		1650	1650	1650	2000		2000
Forging Preheat Temperature, °F	1500-1600		1500-1600	1500-1600	1500-1600	1500-1600		1500-1600	1500-1600		1500-1600	1500-1600	1500-1600	1500-1600		1500-1600
Initial Forging Temperature, °F	2100-2300		2100-2300	2100-2300	2100-2300	2100-2300		2100-2300	2100-2300		2100-2300	2100-2300	2100-2300	2000-2250		2000-2250
Finishing Temperature, °F	1600-1700		1600-1700	1600-1700	1600-1700	1600-1700		1600-1700	1600-1700		1600-1700	1600-1700	1600-1700	1700-1800		1700-1800
Annealing Treatment, °F	1850-1950 and Quench		1900-2000 and Quench	1850-1950 and Quench	1900-2000 and Quench	1950-2050 and Quench		1900-2025 and Quench						2000-2100		2000-2100
ABRASION RESISTANCE	Good		Good	Good	Good	Good		Good	Good		Good	Good		Good		Good
COLD FORMING—Drawing—Stamping				Excellent as Annealed. Decreases with increasing cold work.	Excellent as Annealed. Decreases with increasing cold work.	Excellent as Annealed. Decreases with increasing cold work.		Good as Annealed. Decreases with increasing cold work.	Same as Type 302.	Good						
MACHINABILITY	Fair		Fair	Fair	Fair; Type 303 Superior	Fair		Fair	Fair		Fair	Fair		Fair		Fair
WELDING	Satisfactory			Satis-factory	Types 302 and 304 very good; Type 304 superior in corrosion resistance "as welded."	Very good not necessary to anneal.		Very good	Very good		Very good not necessary to anneal.			Very good		Very good
PRECAUTIONS (See Note)	(B)	(A)	(A)	(B)	(A) (B)	(A)	(B)	(A)	(A)	(B)	(A)	(A)		(A)	(B)	(A) (B)

†Cold worked.
*This value is a function of chemical composition and section size and increases with cold work.
**Undetermined for Type 303.
‡Minimum values.

(A) Preheat heavy sections slowly to 1600°F, then heat rapidly to the forging or annealing temperature.
(B) Cooling rate should be rapid enough to prevent harmful carbide precipitation which impairs corrosion resistance. Retarded cooling through, or heating in, the temperature range of 900° to 1500°F should be avoided if optimum corrosion resistance is desired.

Standard Types Stainless and Heat Resisting Steels

Chemical Ranges and Limits

Subject to Tolerances for Check Analyses

Chemical Composition, per cent

TYPE No.	C	Mn	P	S	Si	Cr	Ni	Mo	Zr	Se	Ti	Cb-Ta	Ta	Al	N
201	0.15 Max.	5.50/ 7.50	0.060	0.030	1.00	16.00/ 18.00	3.50/ 5.50	—	—	—	—	—	—	—	0.25 Max.
202	0.15 Max.	7.50/ 10.00	—	—	—	17.00/ 19.00	4.00/ 6.00	—	—	—	—	—	—	—	0.25 Max.
			0.060	0.030	1.00										
301	0.15 Max.	2.00	0.045	0.030	1.00	16.00/ 18.00	6.00/ 8.00	—	—	—	—	—	—	—	—
302	0.15 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	8.00/ 10.00	—	—	—	—	—	—	—	—
302B	0.15 Max.	2.00	0.045	0.030	2.00/ 3.00	17.00/ 19.00	8.00/ 10.00	—	—	—	—	—	—	—	—
303	0.15 Max.	2.00	0.20	0.15 Min.	1.00	17.00/ 19.00	8.00/ 10.00	0.60* Max.	0.60* Max.	—	—	—	—	—	—
303/ Se	0.15 Max.	2.00	0.20	0.06	1.00	17.00/ 19.00	8.00/ 10.00	—	—	0.15 Min.	—	—	—	—	—
304	0.08 Max.	2.00	0.045	0.030	1.00	18.00/ 20.00	8.00/ 12.00	—	—	—	—	—	—	—	—
304L	0.03 Max.	2.00	0.045	0.030	1.00	18.00/ 20.00	8.00/ 12.00	—	—	—	—	—	—	—	—
305	0.12 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	10.00/ 13.00	—	—	—	—	—	—	—	—
308	0.08 Max.	2.00	0.045	0.030	1.00	19.00/ 21.00	10.00/ 12.00	—	—	—	—	—	—	—	—
309	0.20 Max.	2.00	0.045	0.030	1.00	22.00/ 24.00	12.00/ 15.00	—	—	—	—	—	—	—	—
309S	0.08 Max.	2.00	0.045	0.030	1.00	22.00/ 24.00	12.00/ 15.00	—	—	—	—	—	—	—	—
310	0.25 Max.	2.00	0.045	0.030	1.50	24.00/ 26.00	19.00/ 22.00	—	—	—	—	—	—	—	—
310S	0.08 Max.	2.00	0.045	0.030	1.50	24.00/ 26.00	19.00/ 22.00	—	—	—	—	—	—	—	—
314	0.25 Max.	2.00	0.045	0.030	1.50/ 3.00	23.00/ 26.00	19.00/ 22.00	—	—	—	—	—	—	—	—
316	0.08 Max.	2.00	0.045	0.030	1.00	16.00/ 18.00	10.00/ 14.00	2.00/ 3.00	—	—	—	—	—	—	—
316L	0.03 Max.	2.00	0.045	0.030	1.00	16.00/ 18.00	10.00/ 14.00	2.00/ 3.00	—	—	—	—	—	—	—
317	0.08 Max.	2.00	0.045	0.030	1.00	18.00/ 20.00	11.00/ 15.00	3.00/ 4.00	—	—	—	—	—	—	—
321	0.08 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	9.00/ 12.00	—	—	—	5xC Min.	—	—	—	—

Chemical Composition, per cent

TYPE No.	C	Mn	P	S	Si	Cr	Ni	Mo	Zr	Se	Ti	Cb-Ta	Ta	Al	N
347	0.08 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	9.00/ 13.00	—	—	—	—	10xC Min.	—	—	—
348	0.08 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	9.00/ 13.00	—	—	—	—	10xC Min.	0.10 Max.	—	—
403	0.15 Max.	1.00	0.040	0.030	0.50	11.50/ 13.00	—	—	—	—	—	—	—	—	—
405	0.08 Max.	1.00	0.040	0.030	1.00	11.50/ 14.50	—	—	—	—	—	—	—	0.10/ 0.30	—
410	0.15 Max.	1.00	0.040	0.030	1.00	11.50/ 13.50	—	—	—	—	—	—	—	—	—
414	0.15 Max.	1.00	0.040	0.030	1.00	11.50/ 13.50	1.25/ 2.50	—	—	—	—	—	—	—	—
416	0.15 Max.	1.25	0.06	0.15 Min.	1.00	12.00/ 14.00	—	0.60* Max.	0.60* Max.	—	—	—	—	—	—
416/ Se	0.15 Max.	1.25	0.06	0.06	1.00	12.00/ 14.00	—	—	—	0.15 Min.	—	—	—	—	—
420	Over 0.15	1.00	0.040	0.030	1.00	12.00/ 14.00	—	—	—	—	—	—	—	—	—
430	0.12 Max.	1.00	0.040	0.030	1.00	14.00/ 18.00	—	—	—	—	—	—	—	—	—
430F	0.12 Max.	1.25	0.06	0.15 Min.	1.00	14.00/ 18.00	—	0.60* Max.	0.60* Max.	—	—	—	—	—	—
430F/ Se	0.12 Max.	1.25	0.06	0.06	1.00	14.00/ 18.00	—	—	—	0.15 Min.	—	—	—	—	—
431	0.20 Max.	1.00	0.040	0.030	1.00	15.00/ 17.00	1.25/ 2.50	—	—	—	—	—	—	—	—
440A	0.60/ 0.75	1.00	0.040	0.030	1.00	16.00/ 18.00	—	0.75 Max.	—	—	—	—	—	—	—
440B	0.75/ 0.95	1.00	0.040	0.030	1.00	16.00/ 18.00	—	0.75 Max.	—	—	—	—	—	—	—
440C	0.95/ 1.20	1.00	0.040	0.030	1.00	16.00/ 18.00	—	0.75 Max.	—	—	—	—	—	—	—
446	0.20 Max.	1.50	0.040	0.030	1.00	23.00/ 27.00	—	—	—	—	—	—	—	—	0.25 Max.
501	Over 0.10	1.00	0.040	0.030	1.00	4.00/ 6.00	—	0.40/ 0.65	—	—	—	—	—	—	—
502	0.10 Max.	1.00	0.040	0.030	1.00	4.00/ 6.00	—	0.40/ 0.65	—	—	—	—	—	—	—

*At producer's option; reported only when intentionally added.

PAR-TEN Steel

Strength With Surface And Ductility

USS PAR-TEN steel is a high-strength low-alloy steel intended primarily for use in highly finished end uses, such as automotive bumpers, bumper guards and similar applications after removal of a substantial amount of the surface by grinding.

Summary of Engineering Data

TYPICAL MECHANICAL PROPERTIES	.229" and under in thickness
Yield Point, psi	45,000
Tensile Strength, psi	62,000
Elongation in 2", per cent	29
Cold Bend—180°	Flat

ASTM Standard specimens, minimum number of tests and ductility modifications apply.

Chemical Composition Range,

Per Cent (shown for information purposes only)

C	Mn	P	S	Si	V
.12 max.	.75 max.	.030 max.	.040 max.	.10 max.	.01/.07

Typical Composition, Per Cent

C	Mn	P	S	Si	V
.08	.54	.02	.024	—	.02

COR-TEN Steel

High Strength With Corrosion Resistance

USS COR-TEN High-Strength Low-Alloy Steel is recommended for all applications in which relatively high resistance to atmospheric corrosion is considered necessary to permit either the use of thinner sections to take advantage of the increased strength of the material, or the use of equal or heavier thickness for extended life with or without protective coating.

Summary of Engineering Data

THICKNESS	½ in. and under in thickness	Over ½ to 1½ in. Incl.	Over 1½ to 3 in. Incl.
Yield Point, Min., psi	50,000	47,000	43,000
Tensile Strength, Min., psi	70,000	67,000	63,000
Elong. in 8 in., Min., per cent .180 in. and heavier	18	19	19
Elong. in 2 in., Min., per cent	22	—	24
Cold Bend—180°	D = 1T	D = 2T	D = 3T

When sheet or strip products are specified as galvanized, cold rolled or in coils, or when annealing or normalizing is specified for any product, the minimum yield point and tensile strength requirement will be reduced by 5,000 psi. The furnishing of cold rolled sheets and strip to strength levels other than the above is subject to negotiation.

ASTM standard specimens, minimum number of tests and ductility modifications apply.

Composition Range, Per Cent

C	Mn	P	S	Si	Cu	Cr	Ni
.12 Max.	.20—.50	.07—.15	.05 Max.	.25—.75	.25—.55	.30—1.25	.65 Max.

Typical Composition, Per Cent

C	Mn	P	S	Si	Cu	Cr	Ni
.09	.38	.09	.033	.48	.41	.84	.28

Chemical Composition shown for information purposes only.

Fabricating Practice For Cold Forming

THICKNESS OF MATERIAL	Suggested Minimum Inside Radius
up to 1/16" incl.	1T
over 1/16" to ¼" incl.	2T
over ¼" to ½" incl.	3T

Hot forming is recommended for angle bending thicknesses over ½".

Additional Information for Engineering Guidance:

Atmospheric Corrosion Resistance	4 to 6 times carbon steel
Modulus of Elasticity	28,000,000 to 30,000,000
Abrasion Resistance	Good
Endurance Limit	42,000
Charpy Impact, Keyhole (as rolled, room temp. average) ft.-lb.	40
Shearing Strength, psi	¾ T.S.
Coefficient of Expansion, per degree F, 70°	.0000063
Brinnell Hardness, typical	140
Rockwell "B", typical	70

USS COR-TEN Steel is intended primarily for weight reduction or longer life, by means of greater strength and enhanced atmospheric corrosion resistance in applications involving cold forming and metal arc or spot welding.

USS COR-TEN Steel meets SAE 950 specification in hot rolled products from .071" to ½" thick. For thinner or thicker gages slight modifications apply.

The Greater Strength of USS COR-TEN Steel

USS COR-TEN Steel is a high strength material. Because of its high strength, particularly its yield point, which is one and one-half times that of structural carbon steel, engineers are able to design with higher working unit stresses and still maintain at least the same factors of safety. This property of COR-TEN Steel permits the design of products that may be lighter or that may be stronger and more durable.

High Modulus of Elasticity

The modulus of elasticity is a measure of stiffness or the extent to which a member will deflect without permanent deformation under a given load. USS COR-TEN steel, in common with all carbon and low alloy steels, has a high modulus of elasticity—29 million pounds per square inch—nearly three times that of structural light metal alloys. This characteristic of steel is not affected by heat treatment.

Because of its elastic stiffness, designers prefer steel to other metals and materials where deflection is an important consideration. By employing properly designed, thin USS COR-TEN steel sections, dead weight is reduced without encountering excessive sagging under load.

High Endurance Limit

The endurance limit or fatigue limit of any material is the measure of the resistance of that material to cyclic stresses resulting from repeated loading or vibration. Strictly speaking, it is the greatest stress that a material will withstand indefinitely under cyclic loading. USS COR-TEN steel has a high endurance limit.

Good Shock Resistance

The notch toughness, or the ability of USS COR-TEN steel to withstand sudden blows, as indicated by tests and service performance, is greater than that of structural carbon steel. This greater resistance to shock is important and should be taken into consideration whenever and wherever the service life of mobile equipment is likely to be affected by impact-type loading.

High Abrasion Resistance

USS COR-TEN steel has greater resistance to abrasion than structural carbon steel. It is recommended for equipment where both corrosion and abrasion are important factors in service.

Good Workability

USS COR-TEN steel has exceptional workability and ductility, surprisingly so for a steel with such a high yield point. Successful fabrication depends, to a large degree, on these properties.

TRI-TEN Steel

High Strength With Toughness

USS TRI-TEN High-Strength Low-Alloy Steel is recommended for applications requiring toughness, excellent welding characteristics and improved resistance to impact, particularly at low temperatures.

Summary of Engineering Data

	Sheets and Strip	Plates, Structurals, CB'S and Bars Thickness Ranges		
		¾" and under	Over ¾" to 1½" incl.	Over 1½" to 4" incl.
Yield Point, min, psi	45,000	50,000	46,000	42,000
Tensile strength, min, psi	60,000	70,000	67,000	63,000
Elong. in 8 in., min, %	—	18	19	19
Elong. in 2 in., min, %	25	22	—	24
180° Cold Bend (Specimen Bend) In the case of plates, both the minimum yield point and tensile strength requirements will be reduced 5,000 psi when annealing or normalizing is specified, or when severe forming is involved.	Flat	D = 1 T to ¾" incl. D = 1½ T over ¾" to 1" incl. D = 2 T over 1" to 1½" incl. D = 2½ T over 1½" to 2" incl. D = 3 T over 2" to 4" incl.		

ASTM Standard specimens; minimum number of tests and ductility modifications apply.

Chemical Composition Percent

(For information only)

	C	Mn	P	S	Si	Cu	V
Composition Limits	0.22 max.	1.25 max.	0.04 max.	0.05 max.	0.30 max.	0.20 min.	0.02 min.
Typical Composition Heavy Products	0.18	1.14	0.023	0.034	—	0.28	0.045
Typical Composition Sheet and Strip	0.10	0.72	0.021	0.031	—	0.26	0.042

Fabricating Practice for Cold Forming

Thickness of Material	Suggested Minimum Inside Radius For 45,000 Min. Y.P.	50,000 Min. Y.P.
up to .180" incl.	1T	1½T
up to ¼" incl.	1½T	2T
over ¼" to ½" incl.	2½T	3T

Hot forming is recommended for angle bending thicknesses over ½".

Additional Information for Engineering Guidance:

Atmospheric Corrosion Resistance	2 times carbon steel
Modulus of Elasticity	28,000,000 to 30,000,000
Abrasion Resistance	Fair
Endurance Limit	42,000
Charpy Impact, Keyhole (R.T.)	42
Shearing Strength, psi	¾ T.S.
Coefficient of Expansion, per degree F, 70°	.0000063
Brinnell Hardness	—
Rockwell "B" typical	70

USS TRI-TEN steel is intended primarily for weight reduction by means of greater strength and toughness, in applications involving severe cold forming, metal-arc welding and moderately severe impacts in low temperature service. Its atmospheric corrosion resistance is twice that of plain carbon steel.

USS TRI-TEN steel meets ASTM A242 and A441 specifications.

High Strength

USS TRI-TEN steel is a high-strength steel. Because of its high strength, particularly its high yield point which is one and one-half that of structural carbon steel, engineers are able to design with higher unit working stresses while maintaining at least the same factors of safety. This property of USS TRI-TEN steel permits the design of structures and products which by choice can be made lighter, tougher, stronger and more durable.

Superior Toughness

USS TRI-TEN steel has excellent notch toughness properties as measured by resistance to impact or shock loading at normal and sub-zero temperatures, being superior to structural carbon steel in this respect. Consequently this steel is preferred for mobile equipment and other structures subject to severe shock loading in service at normal and even at sub-zero temperatures. Service results have demonstrated the exceptional toughness of USS TRI-TEN steel.

High Modulus of Elasticity

The modulus of elasticity is a measure of stiffness or the extent to which a member will deflect without permanent deformation under a given load. USS TRI-TEN steel, in common with all carbon and low-alloy steels, has a modulus of elasticity of 29 million pounds per square inch—nearly three times that of structural light metal alloys. This property of steel is not affected by heat treatment.

Because of its elastic stiffness, designers prefer steel to other metals and materials where deflection is an important consideration. By employing properly designed, thin USS TRI-TEN steel sections, dead weight is reduced without encountering excessive sagging under load.

High Endurance Limit

The endurance limit is a measure of the resistance of any material to cyclic stresses resulting from repeated loading or vibration. Specifically, it is the greatest stress that the material will withstand indefinitely under cyclic loading. USS TRI-TEN steel has a high endurance limit.

High Abrasion Resistance

USS TRI-TEN steel has greater resistance to abrasion than structural carbon steel. It is used for equipment where both toughness and abrasion are important factors in service.

Good Weldability

USS TRI-TEN steel plates, structural and bar shapes are readily weldable by the shielded metal-arc, submerged-arc and gas welding process. Hot rolled sheets are considered readily weldable by arc and the usual resistance processes of spot, seam, projection, flash, upset, and percussion welding.

Good Workability

Considering its high strength level, USS TRI-TEN steel has exceptional formability and workability in sheet and strip products. In these forms, the steel is designed particularly to withstand difficult cold forming operations. USS TRI-TEN steel in heavy products has excellent workability for a steel with such a high yield point and it is well suited for regular fabricating operations such as bending, shearing, punching and machining.

EX-TEN Steel

Strength With The Greatest Economy

USS EX-TEN High-Strength Low Alloy-Steel is a Columbium-bearing steel intended for applications where economy and strength are the main considerations. It is produced, at present in hot rolled sheets and strip only. It is a semi-killed steel made by open top practice. Atmospheric corrosion resistance is equal to carbon steel.

Summary of Engineering Data

TYPICAL MECHANICAL PROPERTIES	Hot Rolled Sheets and Strip Only
Yield Point, min., psi	50,000

ASTM Standard specimens and minimum number of tests apply.

Chemical Composition Range,

Per Cent (shown for information purposes only)

C	Mn	P	S	Cb
.20 max.	1.00 max.	.040 max.	.050 max.	.01/.04

Carbon Steel Sheet and Strip

The Most Important Group of Engineering Materials Known

Carbon steel sheet and strip have the widest range of application, at the lowest cost, of any engineering material. They have greater ductility and strength, at the lowest cost, than any alternate, formable material. Ductility, combined with resistance to denting, are proved qualities of carbon steel sheet and strip. These steels possess the uniformity and the deep drawing qualities necessary for today's high speed, mass production of cold formed parts. Design freedom is possible with these steels for they may be spot welded easily and quickly. They meet exacting requirements for thickness, width, ductility and finish. And, they are easily and economically finished with a wide variety of attractive coatings.

Summary of Engineering Data

Hot Rolled Carbon Steel Sheets and Strip—Typical Mechanical Properties

	CQ	DQ	DQ—SK
Yield Point, psi	28-39,000	28-34,000	—
Tensile Strength, psi	43-55,000	43-50,000	—
Elongation, % in 2"	24-28	35-42	—
Rockwell "B"	45-60	45-60	—

Cold Rolled Carbon Steel Sheet and Strip

Yield Point, psi	25-35,000	23-29,000	20-27,000
Tensile Strength, psi	38-46,000	40-44,000	41-45,000
Elongation, % in 2"	35-42	38-43	40-45
Rockwell "B"	40-60	38-50	38-45

Regular and Differential Coated Galvanized Carbon Steel Sheet and Strip

Yield Point, psi	30-40,000	28-38,000	25-35,000
Tensile Strength, psi	45-55,000	43-53,000	40-50,000
Elongation, % in 2"	23-33	28-38	30-40
Rockwell "B"	50-65	42-57	40-55

Aluminum Coated Carbon Steel Sheet and Strip

Yield Point, psi	35-45,000	—	35-45,000
Tensile Strength, psi	45-55,000	—	45-55,000
Elongation, % in 2"	25-35	—	28-38
Rockwell "B"	55-70	—	50-65

"T-1" Steel

. . . Improves Your Product—Cuts Your Costs

USS "T-1" steel is a low carbon, quenched and tempered constructional alloy steel combining weldability, exceptional toughness and strength. It is a unique combination of elements which have been chosen to impart one or more desirable properties. This all-purpose steel permits bigger tools stronger equipment and larger yet less massive structures.

Summary of Engineering Data

USS "T-1" steel can be furnished to the following heat treated mechanical properties:

THICKNESS	¾" to 2½" incl.	Over 2½" to 4" incl.	Over 4" to 6" incl.
Yield Strength, Ext. under load (min.)	100,000 psi	90,000 psi	90,000 psi
Tensile Strength	115,000/135,000 psi	105,000/135,000 psi	105,000/135,000 psi
Elongation in 2", % (min.)	18	17	16
Reduction of Area, % (min.)	50*	50	45
Longitudinal or Transverse Charpy Keyhole Impact Values (ASTM Procedure)	15 ft. lbs. at −50°F	—	—
Charpy V-Notch Impact Values			
Longitudinal (ASTM Procedure)	30 ft. lbs. at +10°F	—	—
Transverse (ASTM Procedure)	20 ft. lbs. at +10°F	—	—

Chemical Composition*

(shown for information purposes only)

C	Mn	P** Max.	S** Max.	Si	Ni	Cr	Mo	V	Cu	B
.10/.20	.60/1.00	.040	.050	.15/.35	.70/1.00	.40/.80	.40/.60	.03/.10	.15/.50	.002/.006

Cold Bend Properties

COLD BEND	.1875" to .249", incl.	¼" to 1", incl.	Over 1" to 2", incl.	Over 2" to 4", incl.
Transverse Test	90°D = 4T	180°D = 2T	180°D = 3T	180°D = 4T
Longitudinal Test	180°D = 2T	180°D = 2T	180°D = 3T	180°D = 4T

Longitudinal bend tests are made except when Flange or Firebox Quality is specified in which case transverse bend tests are made.

Cold Forming Data for Plates

THICKNESS	Suggested Minimum Inside Radius
Up to 1", incl.	2T
Over 1" to 2", incl.	3T

Bending with the axis of bend parallel to the final rolling direction of the plate should be avoided.

Additional Information for Engineering Guidance:

Heat Treatment

USS "T-1" steel is water quenched from 1650/1750°F and tempered at 1100/1275°F.

Modulus of Elasticity

In tension.....approx. 30,000,000 psi
In compression.....approx. 30,000,000 psi

Coefficient of Expansion

7.74 x 10^{-6} inches per inch per °F in the range of 70° to 1300°F.

Weldability

Joint efficiency—with AWS 11015, 12015 or equivalent electrodes.....100%
Joint efficiency—automatic welding.....100%
Kinzel transition temperature—welded ½ and 1" plate specimens.....minus 40/90°F
Maximum hardness—heat affected zone.....410 DPH
Minimum hardness—heat affected zone.....260 DPH

Shear Strength

Yield.....approx. 58% of tensile yield
Ultimate.....approx. 75% of tensile ultimate

Fatigue Strength

Rotating beam endurance limit—polished specimen.....67,000 psi
Pulsating fatigue endurance limit—unwelded (surface as rolled).....50,000 psi

Atmospheric Corrosion Resistance

Four times that of structural carbon steel.

High Temperature Strength

Creep rupture strength at 900°F—three times that of carbon steel and equal to conventional 1/20/0 Cr-1/20/0 Mo steel.

*A standard .505" tensile specimen is used if thickness exceeds ¾". For sizes ¾" and under, an ASTM plate tensile specimen is used which necessitates lowering of the Reduction of Area specification to 40% minimum.

Plates over 6" thick may be obtained on special application.

Impact tests apply only to Firebox and higher qualities. Test results can be reported upon negotiation.

Minimum impact values shown above apply only to plates ½" to 2½" incl. thick. Modified values may be negotiated for lighter plates.

Impact test results on Firebox Quality plates over 2½" to 4" incl. thick can be reported for information only if required.

Transverse mechanical properties may be specified in thicknesses up to 4" incl.

Mechanical properties to closer limits than those shown may also be negotiated.

USS "T-1" Constructional Alloy Steel

Since its introduction in 1953, USS "T-1" steel has been a remarkable bargain. A bargain in the sense that time after time its higher initial cost has been more than offset by drastic weight reduction in equipment of all kinds. Its extraordinary toughness has enabled equipment to last far longer without breakage even in the coldest weather. Its resistance to impact abrasion has increased service life of equipment up to ten times. Its weldability has opened new avenues of design at high working stress levels. No other steel has USS "T-1" steel's record of success for the simple reason that no other steel offers the "T-1" steel combination: strength, toughness and weldability.

Stronger Than Ever

In the past, USS "T-1" steel plates were treated to 90,000 psi minimum yield strength. Today, "T-1" steel plates from 3/16" to 2½" thick inclusive come with 100,000 psi minimum yield strength, and minimum tensile strength has been boosted from 105,000 to 115,000 psi.

For maximum resistance to impact abrasion, USS "T-1" steel may be ordered to a minimum hardness of 321 BHN, in which case all other specification properties are waived.

Availability

USS "T-1" steel is primarily a plate steel furnished in the quenched and tempered condition. It is also available as bars, semi-finished products, forgings, tubing, and a limited range of structural shapes.

Size Ranges

USS "T-1" steel plates are normally furnished in thicknesses from 3/16" to 6", and in standard widths up to and including 136". Maximum length is 450". Under certain conditions, longer and wider plates can be produced and are handled on a special inquiry basis, as are plates over 6" thick.

*U.S. Patent No. 2,586,042.
**For qualities higher than Regular quality the phosphorus and sulphur limits are lowered to conform to ASTM standards.

Vinyl Coated Steel Sheet

A Custom Material at a "Mill" Price

Vinyl Coated steel is a decorative and durable new design material that offers in a single product the color, warmth, and texture of vinyl and the strength and inherent fabrication characteristics of steel.

Color

Vinyl Coated steel is available in a wide range of colors. All the brilliant primary, pastel, "high fashion" and some metallic colors are available on production orders.

In addition to the almost unlimited range of solid colors, Vinyl Coated steel is also available in a variety of flecked or speckled effects.

Texture

Vinyl Coated steel is presently available in ten distinctive textures. These include four vinyl coatings with the appearance and feel of leather, one of cloth and five other designs. Custom textures to your own design can be supplied on an exclusive basis.

Production Data

Vinyl Coated steel can be supplied in cold rolled, galvanized or black plate steel, in cut-lengths or coils. Gauges range from 16 through 32; widths from 24 to 52 inches and lengths from 24 to 144 inches. Coils can be supplied in weights of up to 10,000 pounds.

Liquid vinyl is applied in coatings ranging from .008 to .020 inch thick. The coating thickness may be specified in increments of .001 inch within this range.

Hardness of the coating ranges from approximately 70 to 90 Shore A Durometer.

Properties—Heat Resistance

USS vinyl plastisol and adhesive have been specially formulated to withstand temperatures of 160°F continuously, to 180°F intermittently and up to 200°F for seven days without damage to the coating or adhesive.

Stain Resistance

Resistance to stain is of particular importance in considering a material for interior applications in homes, offices and vehicles. In general stain resistance is very good. Numerous tests have been conducted using a variety of staining agents. It is of course virtually impossible to consider all possible stain producing agents, but where data is required for specific materials not covered, such tests can easily be run.

Abrasion and Scuff Resistance

Another significant property of Vinyl Coated steel is its resistance to wear and abrasion, particularly in relation to competitive materials. Thickness, texture and resilience of Vinyl Coated steel give it the ability to conceal scratches and abrasions. Scratches a few thousandths of an inch deep, or very narrow ones which would mar the appearance of wood or painted surfaces are virtually invisible in vinyl.

Moisture Resistance

Vinyl Coated steel demonstrates excellent moisture resistance. Tests have been conducted in which specimens have been elongated by 30 per cent and immersed in 70°F tap water for 240 hours. Other elongated specimens have been subjected to 100 per cent relative humidity at 100°F for 200 hours. After such exposures the vinyl-to-metal bond has been found satisfactory.

Chemical Resistance

Vinyl Coated steel has been exposed to a great many chemicals, ranging from household detergents to concentrated acids. Their resistance is generally very good. Samples have withstood exposure of 2 hours in 10 per cent solutions of sulfuric, nitric and hydrochloric acids at temperatures up to 160°F, as well as solutions of caustic potash.

Color Stability

Color stability of vinyl coating is equal to the best paints. Vinyl coatings show no appreciable change in color or finish after 300 hours exposure in an Atlas Fadeometer or 200 hours in a Weatherometer.

Vinyl Coated steel has an outdoor life expectancy of five to seven years, with fading in that period comparable to the best paints.

Dielectric Strength

Vinyl coating has a dielectric strength of 750 volts per mil of coating thickness.

Low Temperature

Low Temperature tests have been conducted by exposing Vinyl Coated steel samples to minus 20°F for 30 minutes. After the exposure period and also at minus 20°F, the samples were wrapped on a 1½ inch diameter mandrel. When subjected to this test condition the vinyl coated material showed no evidence of cracking, crazing or delamination.

Adhesion

The production of Vinyl Coated steel by roller coating process results in excellent adhesion. Specifically, the bond between the vinyl coating and the steel has been found to be satisfactory after any one of the following tests.

1. Elongation of 30 per cent.
2. Immersion in boiling water for 5 minutes.
3. Immersion in tap water of 70°F for 240 hours.
4. Exposure to 100 per cent relative humidity at 100°F for 200 hours.
5. Exposure in a dry oven at 200°F for 7 days.
6. On a coated, extended sample with the vinyl cut through in the elongated area, vinyl shrinkage will not exceed 1/16" after exposure to 200°F for 4 hours.

Noise Reduction

Vinyl Coated steel exhibits a noise reduction quality that can be used to advantage in such applications as business machines, equipment cabinets, appliances, trucks and automobiles.

Fabrication

Vinyl Coated steel can be formed and fabricated in generally the same manner as cold-rolled sheet—no costly retooling or special techniques are necessary.

It can be sheared, slit, punched, lock seamed, stamped, drawn or roll formed without damage to the coating or change in color. Drawing quality, special-killed Vinyl Coated steel readily withstands elongation of 30 per cent.

Joining Techniques

Except for welding limitations, joining techniques are generally the same for Vinyl Coated steel as for unfinished steel sheets. No costly retooling or complicated, special techniques are required.

Mechanical Fastenings

Some of the many fastening methods possible with Vinyl Coated steel are: nut and bolt, sheet metal screw, rivet, lock seam, entrapment, spring clip, steel-to-steel adhesive, vinyl extrusion, vinyl-to-vinyl adhesive, staple, tab and crimp. Mechanical fasteners, interlocking by bending, crimping or any standard lock seam are practical and require no additional set-up time for tooling changes.

Welding

Several types of indirect welding are possible on this product. These types are generally classed as "capacitor discharge" for stud welding and "fractional cycle" for projection welds. Both types use indirect welding equipment and apply high welding currents of short duration, so that heat build-up at the welds is minimized and damage to the vinyl coating is avoided.

Adhesives

Vinyl Coated steel may be readily joined to other materials with presently available adhesives.

Underwriters' Rating—Fire Hazard Classification

The following Fire Hazard Classification is established for this material in comparison with untreated red oak as 100:

Flame spread—55
Fuel contributed—5
Smoke developed—101-200

As indicated by the Underwriters' classification of Vinyl Coated steel, the flame spread and fuel contribution characteristics are substantially lower than red oak. The smoke developed on Vinyl Coated steel, however, is higher than for red oak but it compares favorably with most other types of plastic coated building materials.

American Steel & Wire Division

Steel and Wire Products that Serve the Nation

American Cold Rolled Steel Strip

AS&W produces a full variety of flat and special shape cold rolled strip steel for every manufacturing purpose. Whether it is flat cold rolled strip for trim or for window channels or high carbon or alloy cold rolled strip for special parts, AS&W supplies grades of proper quality steels, true to physical specifications, tolerance and finish to allow you maximum economy in your fabricating operations.

American Stainless Steel Strip and Wire

The advantages of stainless steel in consumer or industrial products include: higher tensile and yield strength; resistance to corrosion, rust and wear; ease of cleaning; lasting beauty; and enhanced product appearance.

Functionally, the lighter weight of stainless steel has enabled engineers to cut deadweight and increase payload of mobile equipment, such as trucks, trains or cars, so they are more economical and profitable to operate.

Amercut Steel Bars

These cold finish steel bars are supplied in a variety of sizes, shapes, tempers and finishes to meet your requirements. You get the savings and advantages that come from producing machined parts with minimized machining operations. The superior finish of these bars eliminates the need for turning down bars prior to machining operations.

American Pig Iron

AS&W central furnaces manufacture merchant pig iron exclusively. The following grades of pig iron are available at all times: Bessemer, Low Phosphorus, Basic, Malleable, Foundry and Low Manganese for Nodular Castings. The nodular iron made from pig iron is also known as ductile iron. It is stronger than gray iron, 10% to 20% lighter and about 5% cheaper. Ductile iron offers the reliable, all-around satisfactory performance of gray iron and permits weight saving and production economies. Ductile iron has specifications one might expect from steel:

Tensile Strength	60,000 psi
Yield Strength	45,000 psi
Elongation	15 percent

This material can be processed like gray iron because of its low melting point, good fluidity and easy machinability. Ductile iron approaches the strength, toughness and hardenability of steel. In addition, it has the wear and corrosion resistance of cast iron.

Premier Spring Wire

For the best choice of wire for operation in automatic spring coiling machinery you can rely on AS&W's 125 years of wire making experience. AS&W wire assures maximum production from your high speed automatic machinery, with maximum freedom from down time.

Cold Drawn Carbon and Alloy Wire for Manufacturing

Special purpose wire for industry has been and continues to be a major part of AS&W production effort. This wire is supplied to your exacting engineering specifications to help you maintain your high quality products. Included in the list of manufacturer's wire products are the following:
Round, Flat, Square, Oval, Octagonal or other shapes
Premier Spring Wire (Upholstery)
Pin Wire
Bolt, Rivet and Screw Wire
Tempered Wire
Music Spring Wire
Valve Spring Wire
Mechanical Spring Wire
Flat Nut Stock
Carbon and Alloy Wire for Cold Formed Parts such as Fasteners.
Bright, Annealed, Coppered, Liquor-Finish, Tinned, Galvanized and Aluminum Coated Wire for various manufacturing purposes.

American Springs

Fine and heavy springs and wire forms of all sizes, shapes and descriptions are available to your specifications. These springs are manufactured to the highest quality standards with stringent controls and inspection during every stage of manufacture. AS&W research, design and test engineers are always ready to assist you in designing and testing springs that will perform exactly as you wish them to, yet, these specially designed springs can be produced at minimum cost. Re-design in our engineering department has saved many manufacturers considerable expense in the production of springs.

Tiger Brand Electrical Wire and Cable

From the smallest instrument wire to the largest submarine cable, AS&W makes a complete line of wire and cable. A wide variety of conductor materials, constructions and insulations are available to meet or surpass established specifications. Though the conductors can be varied to meet specific requirements, it is equally important that the proper insulating materials be selected. No one or two insulations will meet all the conditions encountered in electrical wire and cable operation. Realizing this, AS&W engineers and chemists have developed a variety of cable constructions designed to meet your specific installation requirements, such as:

Amerclad . . . Portable Cord and Cable
Amersheath . . . All Rubber Cable
Amerbestos . . . Asbestos Wire and Cable
Plastic Insulated Cable
Paper Insulated Cable
Varnish Cambric Cable
Armorlokt—Interlocked Armor Cable
These and other Tiger Brand products are designed to save you time and money, and to assure you better service at lower cost.

American Welded Wire Fabric

For homes, buildings, concrete pipe and highways, Welded Wire Fabric provides excellent reinforcement for concrete at minimum cost. This outstanding product is made from high yield strength steel wire, and is welded at each joint for positive mechanical anchorage in the concrete. Large areas can be covered by one roll or sheet thereby providing minimum placement costs.

American Multi-Safety Highway Cable Guard

Designed to provide maximum safety for modern highways, this Cable Guard is available in a variety of designs to meet every need. These high-strength steel cables on spring-type bumpers provide maximum protection on today's high speed highways. They are relatively low in cost for the protection they afford, and extremely low in maintenance costs. Many sizes are available for use on primary and secondary roads.

American Super-Tens Wire & Strand

Prestressed concrete has created widespread interest in the engineering and architectural fields because this material offers untold opportunities for structural designs of the future. AS&W developed the high tensile wire needed for prestressed concrete pipe about 20 years ago. When linear prestressing started in this country AS&W again was the first to develop the labor-saving 7-wire strand that has become the industry standard. AS&W's 125 years of experience in the manufacture of top quality wire and wire products are assurance of the consistent quality required for fabricating structural products.

Whether your construction problem involves pipe, bridges or some other application, whether it be pre-tensioned or post-tensioned, there is a type of AS&W wire and strand to meet your requirements.

Tiger Brand Wire Rope

Wire rope is made to various strict specifications and for widely diversified uses ranging from brake or winch cable to crane slings.

National Tube Pipe & Tubing

The Ideal Material for Modern "Parts" Making

No other form of steel offers more intriguing possibilities for the designer, nor more direct and simple application in those structures or assemblies requiring the optimum combination of light weight and high strength. Tubing is available both seamless and welded in such a variety of grades of steels, anneals, and surface finishes that almost any requirement involved in fabricating parts—such as machinability, formability, weldability, strength or ductility—has been anticipated. The practically limitless number of sizes and wall thicknesses, O.D.—I.D. contour combinations, and strength variations available make it possible to select just the right tube for a particular purpose.

Boring or extensive machining for shape and size are typical operations which often may be minimized or avoided by using tubing—and with a net saving in time, labor, material, and wear and tear on tools. Further, tubing provides greater uniformity in the finished part because the necessary work in forming and shaping the part has largely been done in making the tubing itself.

Special Shapes

A large percentage of tubing is in the round form. This is especially true where the tube is used as an integral part of a mechanism. However, there are many applications where only special-shaped tubes will fill the need. This is particularly true where the tube is used as a structural part and its attachment is a matter of importance. Such shapes as square and rectangular facilitate making strong, but simple joints—as well as saving weight because of their hollow form. They may afford additional advantages in the case of directional service stresses because of their shape alone. Other shapes can be furnished where the nature of service and economics of the case justify their application. Hexagonal or octagonal O.D. tubes used in the manufacture of nuts is a simple example.

Formed Tubes

The use of formed tubular specialties, both seamless and welded, has proved an economic means of providing parts and articles combining all the requirements of strength, light weight, and wear-resisting properties. Tubes are regularly furnished with ends formed by upsetting (inside and outside), swaging, expanding, and flanging. Such forming operations at the mill are usually performed in accordance with the customer's drawings.

Tubing For Hydraulic Cylinders

Recently there has been a tremendous increase in the use of hydraulic cylinders as actuating mechanisms on auxiliaries and attachments for mobile equipment employed on farms, in construction, in road building as well as in dump-truck bodies.

Tubing for hydraulic cylinders generally ranges in size from 1¼" O.D. x ⅛" wall to 10¾" O.D. x 1" wall.

Plain carbon steels, with carbon content ranging from .15 per cent to .35 per cent, are most commonly used for cylinders, but heat-treatable medium carbon alloy steel and 12 per cent chromium stainless steel are occasionally used for special applications requiring very high strength and/or corrosion resistance.

Alloy Tubes

Due to the increasing demand for lightweight construction the alloy tubular section, which has the greatest strength-weight factor under multidirectional stresses, and which permits effective heat treatment and cold working, is finding wider applications every day. Alloy tubes are available in a variety of analyses of steel and a wide range of diameters and wall thicknesses.

Stainless Tubing

For ornamental, architectural, and structural applications, stainless tubing offers several most attractive features not usually combined in one metal. For decorative purposes, atmospheric corrosion-resistant surfaces vary from a soft, silvery luster to a brilliant polish. For merchandising purposes, handles and tools of stainless tubing offer definite consumer appeal. Corrosion resistance leads to applications in the instrument, chemical and food processing fields. High temperature strength and oxidation resistance lead to uses at elevated temperatures such as exhaust manifolds. Of interest to the fabricator they can be machined, threaded, drilled, welded, soldered, or formed by observing a few simple rules. Stainless tubing is available in sizes, weights, and wall thicknesses in the range ¼" to 10¾" outside diameter, from 22 gauge to ¼" wall thickness, and in corresponding standard and extra-strong pipe sizes ⅛" to 10".

Uses of Tubing

In addition to the basic and generally known uses, tubing has been adopted for thousands of other important purposes. These applications involve use in both the raw state and after being worked or machined. For example, it is used with practically no alterations as hollow shafting, a pillar, or a balcony railing. It is specially formed into simple or complex shapes for uses as fountain pen barrels, hypodermic needles, motor parts, as ankle joints in artificial legs or surgical instruments. Such uses illustrate the diversity of tubing applications.

A review of the following partial list of tube applications in the automotive field may suggest other places where the designer and engineer, regardless of their fields, can replace rolled or forged stock with tubing. They will find that greater over-all economy and accuracy of finished parts are advantages that are inherent in the steel tube.

Automotive Parts

Axle Housings
Axles (front and rear)
Bearings
Body Frames
Brake Cross Shafts
Drag Links
Engine Cylinders
Exhaust Lines
Frame Spacers
Grease Guns
Hydraulic Brake Lines
Hydraulic Bumpers
Hydraulic Hoist Cylinders
Ignition Wire Tubes
Jacks
Piston Pins
Propeller Shafts
Push Rods
Seat Frames
Shock-Absorber Casings
Spring Bushings
Spring Housings
Steering Posts
Tie Rods
Torque Tubes
Trailer Axles
Transmission Parts
Truck Axles

Hot Rolled Carbon Steel Special Sections

—Profiles of The Finished Parts

USS Special Sections offer widespread benefits in practically every industry for they can be produced in an almost unlimited variety of shapes and sizes. To the designer and engineer they permit flexibility of design that allows them to include many cost reducing features in their products. These USS Special Sections may be considered for any part that has a uniform cross-section throughout its length. A greater section modulus for a specific weight per foot of steel may be obtained by utilizing the greater freedom of section design.

Being an authentic profile of the finished part, USS Special Sections offer considerable savings in raw material tonnage, freight costs, production costs, scrap loss and scrap handling costs. Besides, the designer-engineer can minimize labor, overhead costs, assembly and welding. He may reduce or eliminate machining and forging operations, particularly in bars. In many cases he can replace expensive castings and forgings with Special Sections. USS Special Sections also offer possible advantages in the manufacture of certain forgings, for raw stock can be furnished with the material already gathered in place where it will be ultimately needed in the finished part. In this way preliminary blocking operations may become unnecessary.

Check these advantages of using USS Special Sections

Savings

1. The Special Sections can be purchased closer to size, weight and contour of the finished part. Appreciable savings in material costs can be effected.
2. Reduction in material tonnages reduce handling and freight costs.
3. Forging, machining, finishing and assembly costs are greatly reduced.
4. Reduction of scrap and scrap handling provide additional savings.

Time Savings

1. Special Section rolls may be produced in a relatively short time.

Quality

1. Special Sections can be rolled to close tolerances, depending on the requirements.
2. If extra strength is needed at points of stress, the finished section can be designed and rolled to have additional steel at these points.
3. Special Sections perform as stronger, tougher and longer-lasting parts because hot-rolled carbon steel, as it is rolled, acquires inherent qualities of greater strength.
4. A lighter and less bulky product is often possible because of the strength and durability of Special Sections.

Availability

1. Special Sections are readily rolled.
2. Special Sections are available in Alloy, Carbon, Stainless and High Strength Steels.
3. Bar shapes can be rolled into light, intricate designs, or into heavier, less complicated sections.