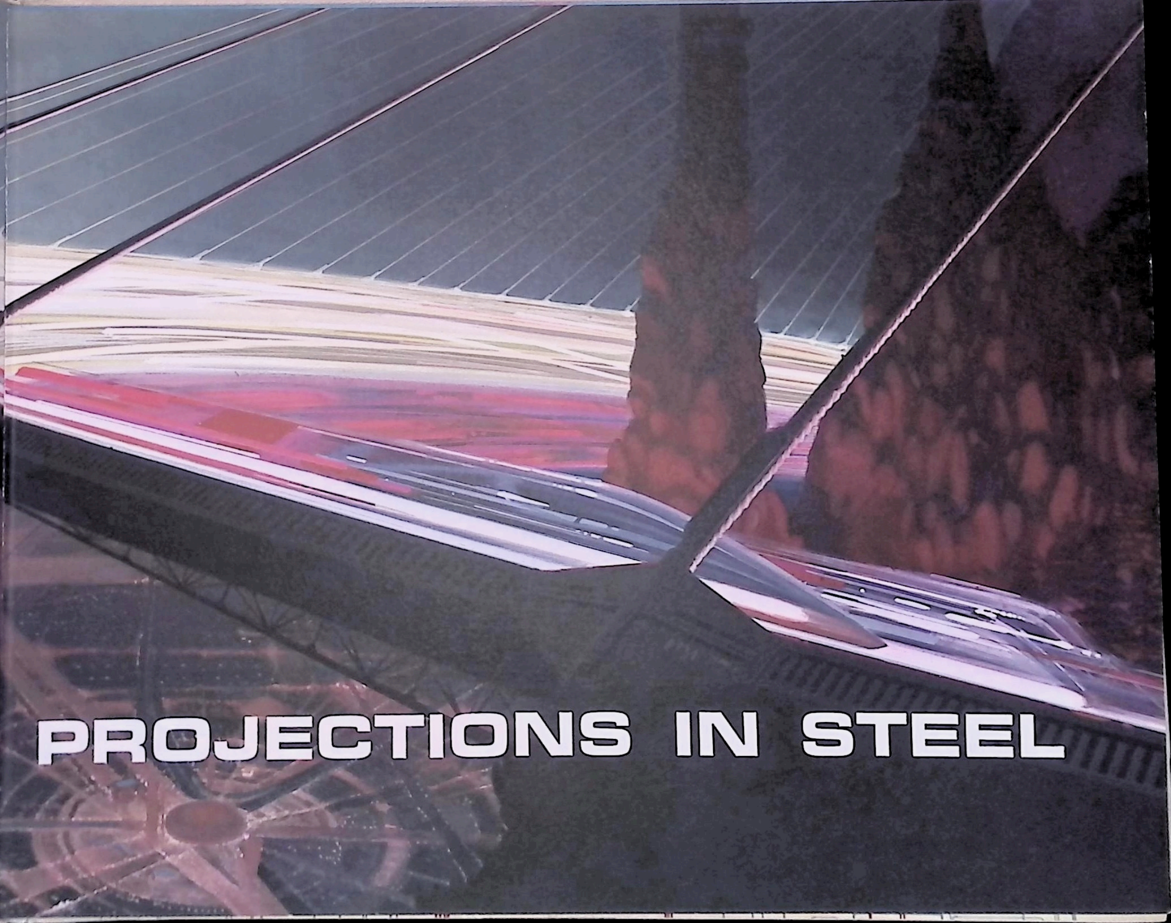
PROJECTIONS

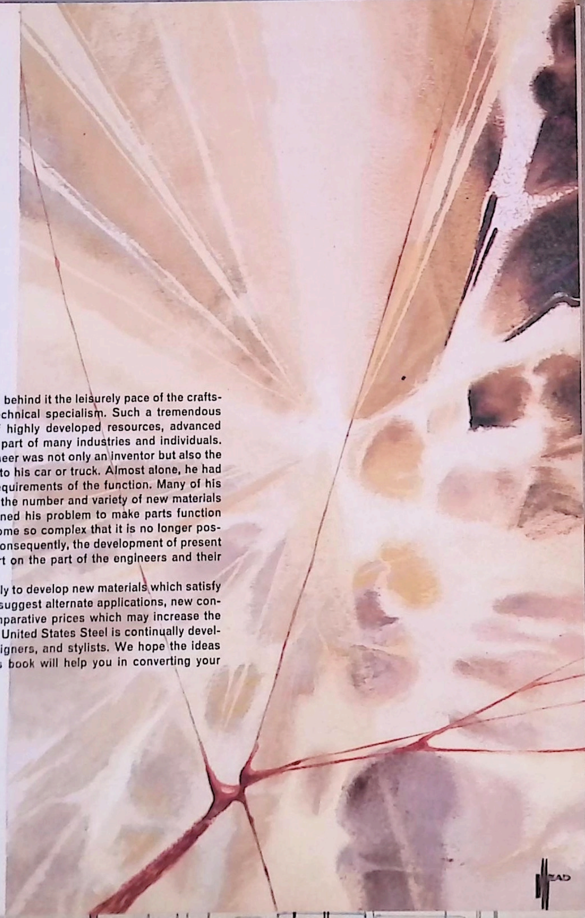
02/23/95



PROJECTIONS IN STEEL

This is a book of engineering and styling ideas obtained from various sources—some already in use, some imaginary. It is intended as a tribute to the industry and its men. • The renderings and drawings are simply artists' concepts and United States Steel can assume no responsibility for any use you may make of this book. Should you be interested in any of these concepts or steel applications we shall be pleased to assist you in any way we can.

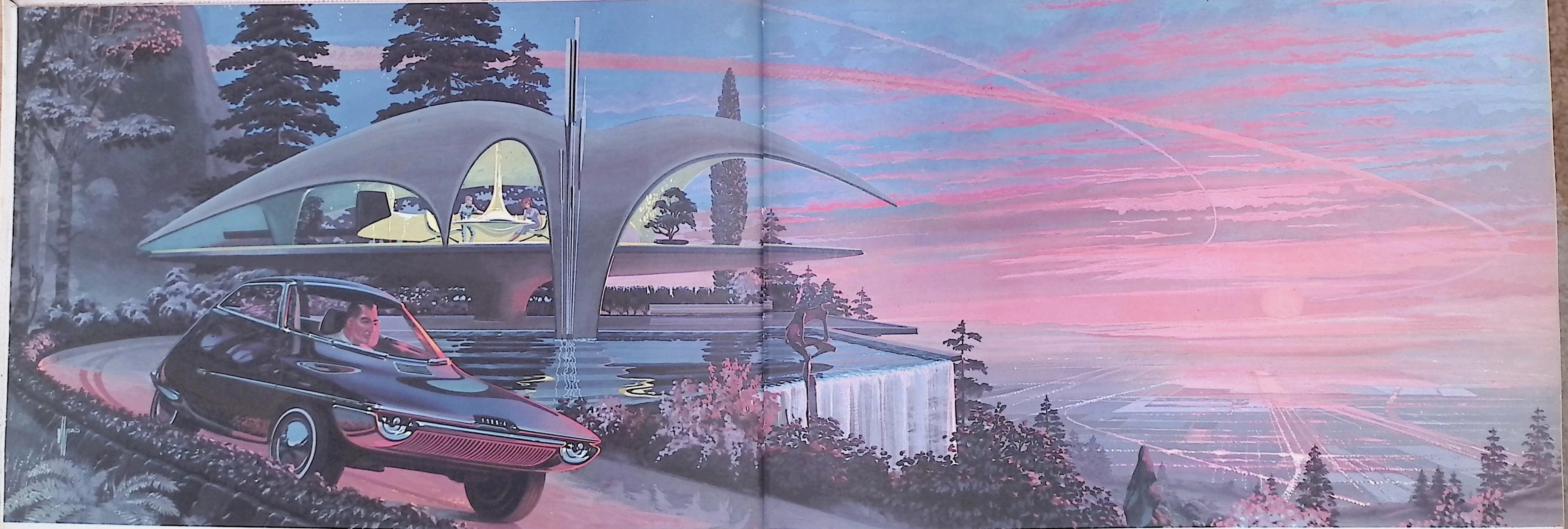
FOREWORD



Our age of space exploration is rapidly leaving behind it the leisurely pace of the craftsman and is creating in its place a kind of technical specialism. Such a tremendous change could take place only in a period of highly developed resources, advanced technical skills and creative ingenuity on the part of many industries and individuals.

There was a time when the automotive engineer was not only an inventor but also the final authority on all the materials that went into his car or truck. Almost alone, he had to determine whether the materials met the requirements of the function. Many of his ideas could not be brought to reality because the number and variety of new materials available to him were so limited. Yet, it remained his problem to make parts function better at a lower cost. Now vehicles have become so complex that it is no longer possible for him to be an expert on all materials. Consequently, the development of present day products is the result of cooperative effort on the part of the engineers and their supplying industries.

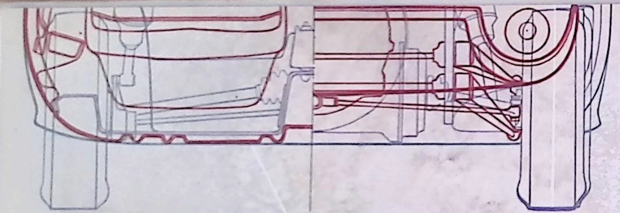
It is the job of the materials producers not only to develop new materials which satisfy design and engineering problems, but also to suggest alternate applications, new concepts, material properties, availability and comparative prices which may increase the effective and economic use of these materials. United States Steel is continually developing new steels of interest to engineers, designers, and stylists. We hope the ideas on the current uses of steel presented in this book will help you in converting your ideas to practical reality.

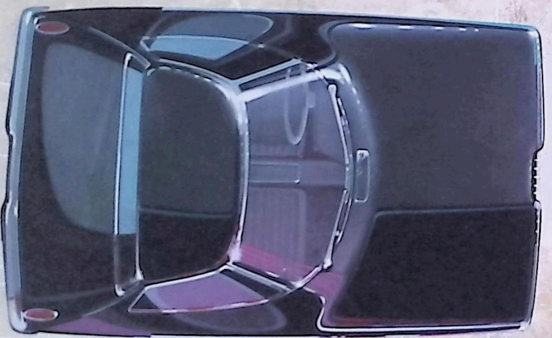


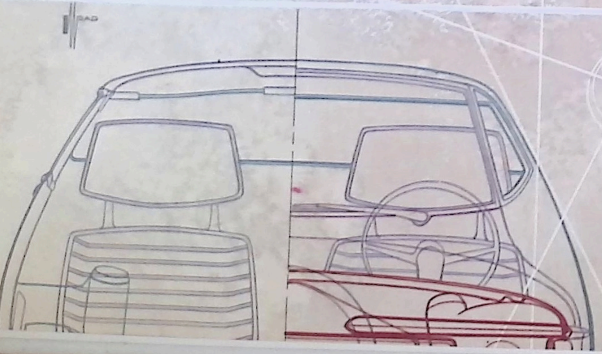
THE DESIGN OF CARS TO COME

This is lightness in design made possible through the ability of steel to perform dual functions of skin and structure. In this way the cowl, floor and quarter panels carry loads formerly carried by structural underbody parts. Inexpensive, versatile and extra light, this two-passenger car is designed for short-haul commuter-type transportation. It can be driven in all climates and under all road conditions with an absolute minimum of maintenance. Although small it is neither cramped nor uncomfortable since its minimum outside dimensions have been functionally (coordinated-designed) around the standard seating package. Light enough to give excellent performance and operating economy, it is remarkably stable in crosswinds because of its aerodynamic design. Adverse effects of lift on traction are also offset by this design.

From the engineer's and stylists' viewpoint, it is a concept in convolutions and shapes which can be readily designed and fabricated into present car bodies. Manufacturing teams are now realizing the greater advantages of large, lightweight, steel body panels since they reduce the necessity for the excessive number of braces and joints which are common today and which are difficult and expensive to cover. This design concept diminishes the fabricated look and presents a new, smoother exterior styling. Its promises are great for the near future realization of fully automated manufacturing.







EVOLUTION TO LIGHTNESS

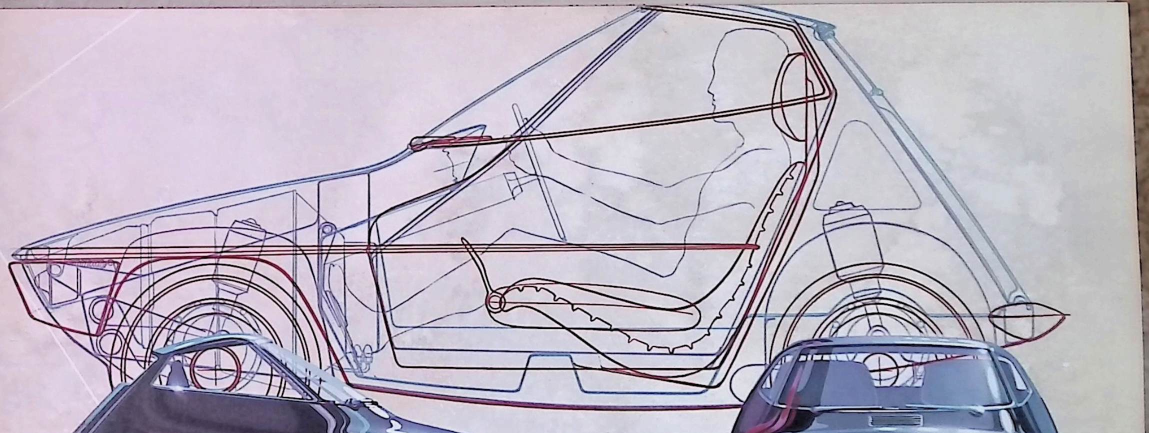
A moving vehicle is subjected to three kinds of resistance: 1. mechanical friction, 2. rolling friction, 3. air drag. At low speeds, friction provides the greatest drain on a vehicle's power plant. At higher speeds, aerodynamic design can materially reduce power requirements, for the greatest part of the engine power is spent moving the air aside and then overcoming the partial vacuum or drag created by the vehicle's passage. This commuter car has a design objective which is to minimize high-speed resistances with a small frontal area and with positive air pressure on the car all the way to the "B" pillar. In this way a path is opened through the almost solid air medium ahead of the vehicle. Rear end design which is also important for favorable forward suction effect can be negated by the drag in the wake of the vehicle. This car's rear end is designed to lower the coefficient of drag by conforming to the space created by the inherent lag in the air medium's rate of closure.

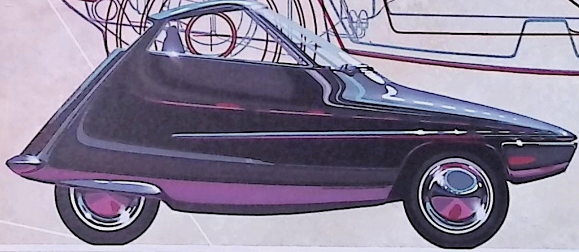
The total package dimensions of this car give the customer more of what is desired: economical, fast and comfortable short-haul transportation with a minimum weight. Headroom in this car is an important measure of comfort. Door cut, entrance space, seat height, legroom, hiproom, steering wheel position and visibility over the hood are more examples of dimensions which contribute to comfort and safety. Design which provides better dimensions results in improved comfort and performance.

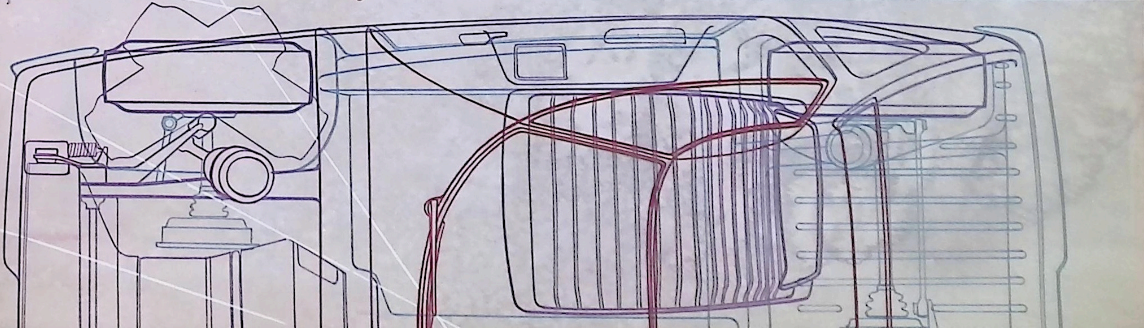
It goes without saying that the functions of propulsion, suspension and braking should be performed by the lightest possible component weights. This is doubly true in such a vehicle as this small, lightweight commuter car. A successful solution here greatly simplifies the packaging problem of the propulsion components and also improves the ride and handling characteristics.

The propulsion package is a constant speed gas turbine engine teamed with a hydrostatic transmission to provide an all-wheel drive. This engine delivers horsepower roughly equal to its weight. It uses neither anti-freeze nor cooling water and it has no transmission gears. Oil consumption is almost zero and it will run on practically any kind of liquid fuel. It starts quickly at very low temperatures and is virtually free of vibration. The advanced type transmission provides infinitely variable forward and reverse speeds. Gear shift lever, clutch, throttle, and brake pedal are eliminated; the transmission is simply a variable displacement hydraulic pump which delivers high pressure oil to radial hydraulic motors on each wheel.

Forward and reverse drive, acceleration and speed are all controlled with one lever which governs the amount and direction of the hydraulic oil flow.







DESIGN SIMPLIFICATION LEADS TO AUTOMATION

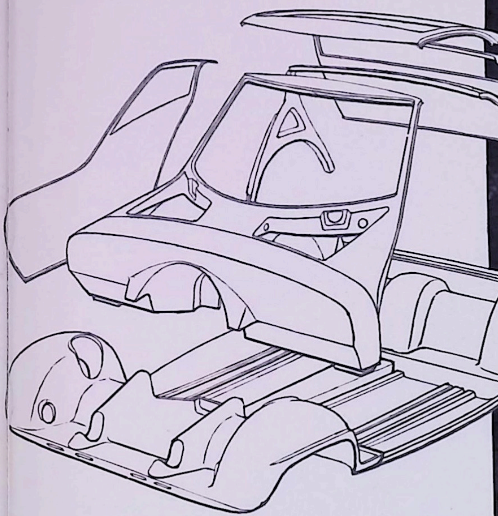
Automotive engineers and stylists know that the full promise of automation lies in their ability to design cars and their components so they can be made without direct human contact in all phases of their manufacture. They analyze their product and the manufacturing process in terms of function rather than in terms of present manufacturing methods or practices. They are quite aware that however strong, light or simplified their cars have become there is still much that they can and must change in their products and processes before fully automated production is possible.

As functional integration is attained, monocoque or integral frame construction with the required stiffness can be achieved with little or no framing. Strength and rigidity can be stamped in, and not added as extra strainers, framing, doublers or gussets.

When the functional, box-like cars of 30 years ago or so gave way to styling designs with soft contours, rakish lines and long, low silhouettes, the better surface finishes, drawing qualities and strength of carbon steel permitted the roof rails to be thinned down, the pillars slimmed, the glass area increased and the front and rear overhang to become greater. On some cars even the structural function of the center pillar was eliminated. Such developments gradually cut down the superstructure effectiveness until today, with the elimination of the separate frame, much of the loads and stresses of integral frame cars is carried by the understructure. In such designs the emphasis is put on the use of galvanized steel to protect the load-bearing members against corrosion.

In unit construction, body sheet metal is usually designed to distribute loads into pillars, roof rails and headers. Consequently such integral frame cars require heavier metal in these sections. However, as car size is reduced, section thickness can dimensionally decrease until a point is reached where the thin gage steel is sufficiently efficient. Weights of such thin gage body sheet metal stampings are largely affected by their designed contours. Large, low crowned panels are subject to deflection or flutter. To correct this condition the gage of the metal has to be increased or stiffeners added to the interior of the panels, with the result that weight and costs are increased. For this reason debossing, rounding, deep configurations and shaping, which double for reinforcements, are used to make these thin gage panels more rigid. Such practices give the desired high initial stiffness to the integral frame and relieve the burden of heavier sections and greater weight.

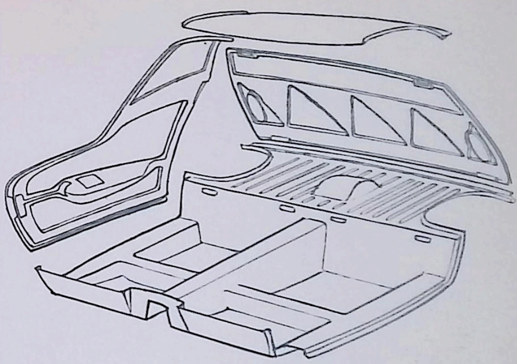
The roof and Vinyl Coated steel headliner are one and the same part. Also the galvanized steel floor pan has been combined with the vinyl covering material. The top of the gas tank is the floor of the trunk compartment. The instrument panel is welded-in so it becomes a strong cross body structural member. Where acoustical and thermal insulation is needed, urethane foam is sprayed or foamed-in-place on the steel stampings and so becomes an integral part. Doors are sandwich construction with steel honeycomb structures in between the panels to give the necessary support commonly obtained from heavier gages, braces and many joints. In addition to the factors of greater impact strength and durability, such sandwich exterior panels provide extensive safety functions and shock absorption. Windows are stationary.



Considering overall body and frame design, integral frame construction for the small cars offers weight saving features over the conventional separate frame construction. The most important weight saving feature is the elimination of duplicate body and frame functions. The frame front and rear X-members and side members have body counterparts in the integral frame designs, with corresponding frame members eliminated. In the immediate future weight and cost saving rewards are offered by further combinations of structural members and body panels.

The large panel construction makes frequent styling changes readily feasible.

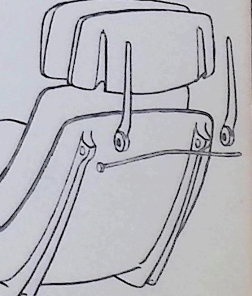
The cold drawn or heat treated alloy steel tubing roll-over structure provides roof rigidity and extra protection in case of crash impact.

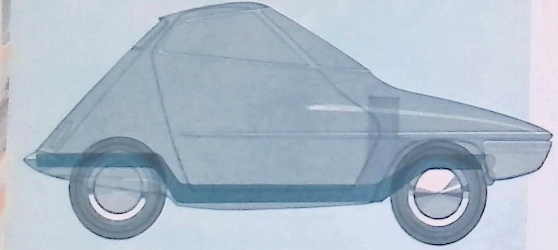


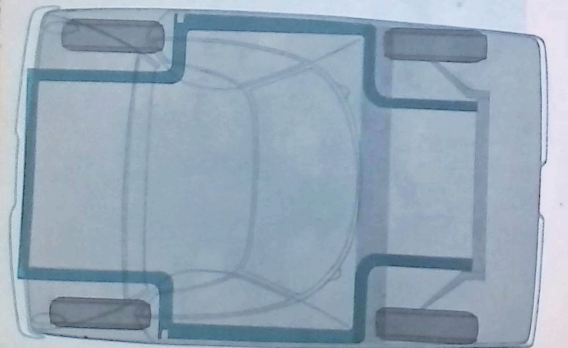
Some of the advantages of integral frame design are:

1. The required stiffness is gained with less weight by reducing the number of frame sections.
2. Body panels perform dual functions of skin and structure.
3. Reduces weight and costs.
4. The weight reduction contributes to fuel economy and performance.
5. Lighter bodies permit weight reduction in mechanical components also.

Steel's ability to perform both ornamental and structural functions is coupled with design simplicity to demonstrate one way to improve automotive seating. At the same time manufacturing complexity is simplified. End product cost is reduced while appreciable weight savings are effected.







DESIGN IMPROVEMENTS ON OLD SYSTEMS

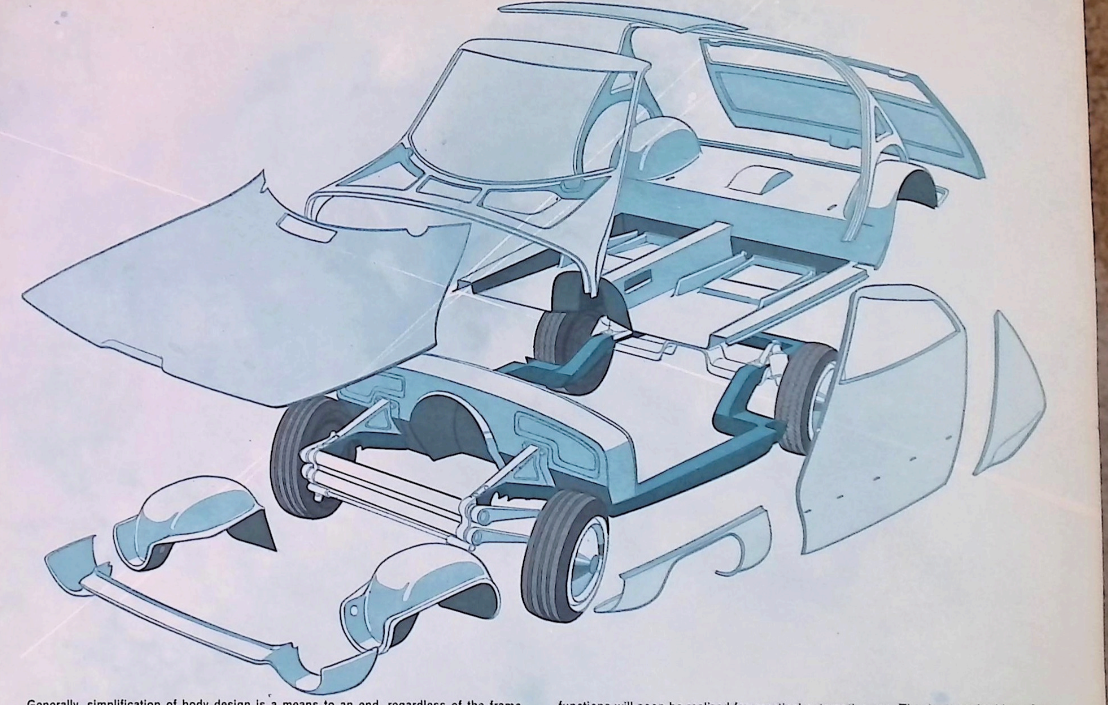
The choice between separate frame and integral frame depends upon such factors as car height, seating dimensions and car type. Comparative structural experience is inconclusive in determining which is superior; each conception has its merits. The relative rate of progress of these two designs within the next few years in the areas of performance, strength, weight, cost and safety will determine the ultimate trend.

Separate frame design is far from obsolescent, especially in wheelbase lengths over 100". As the wheelbase increases, the greater structural requirements either eliminate or considerably diminish the advantages of structure gain or weight reduction which are obtainable with integral frame construction.

Some of the advantages of separate frame design over integral frame design are:

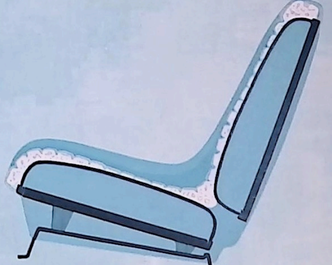
1. **Design flexibility over a wide range of models and styling variations.**
2. **Advanced frame designs which meet the requirements of mechanical improvements and ride advances.**
3. **Reduction of threshhold step-over areas.**
4. **Satisfactory exhaust system space requirements.**
5. **Beam and torsional stiffness which complement the body with high values.**
6. **Compensation for the loss of effective roof structures.**
7. **Shortening of body lead time by three to six months.**
8. **Considerably more margin of error allowable.**

A typical frame design advancement is this "wide-hip" frame. It eliminates the X-member and cross-members in the body center section. The function of such members is moved outboard to the rocker panels through the use of efficient structural "torque-boxes." These are located at the four corners where inner and outer frame side rails join. They transfer the body and suspension loads from the narrow front and rear frame sections to the wide, box-section center side rails of the frame. High-Strength, low-alloy steel provides additional strength to these side rails, which are located immediately inboard of the body rocker panel. This allows direct attachment of the body to the side rails through rubber mounts. The cost and weight of body out-rigger brackets are eliminated in this way.

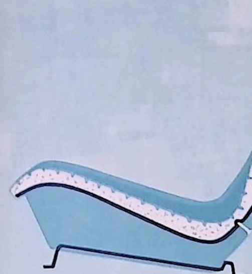


Generally, simplification of body design is a means to an end, regardless of the frame concept used. Here weight savings are achieved by thinner door sections. Garnish moldings are designed as a part of the inner door panels. The fuel tank top and floor pan are part of the same stamping. The reinforced carbon steel, combination instrument panel and cowl crossbody structure carries printed circuits that reduce the amount of wiring connections. With the rapidly advancing trend toward miniaturization bringing full facilities for comfort-conditioning within the car and satisfactory means for traffic signaling outside, it is no longer necessary for windows to open or close. Cellular carbon steel structures in the body panels allow air transfer into or out of the car as desired. More graceful car design lines are now possible since the gas turbine eliminates the chronically troublesome radiator. The engineer's dream of a single fluid for steering, braking and other power functions will soon be realized for practical automotive use. The ducts and tubing of preformed painted carbon steel sheets become a part of the body structure and serve a dual purpose. They conduct the hydraulic fluid and provide greater rigidity to the body shell. In future body designs it will be possible to combine and reduce even more the number of body parts. The art of integrating skin, structural and functional parts will be improved, enabling the engineer to add more functional components to the body. Integration of the entire exhaust system into the body shell is a possibility for the near future. Or, muffler systems may be eliminated entirely when more advanced types of powerplants become available. For the present, the corrosion resisting characteristics of Stainless, galvanized and aluminum coated steels make them especially well suited for muffler and exhaust systems.

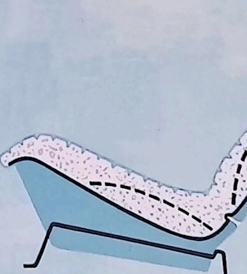
IMPROVED SEATS BY DESIGN



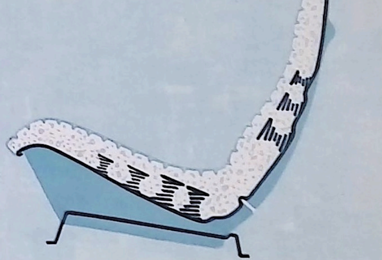
This low cost American Steel and Wire carbon steel woven-wire mesh spring base, which is imbedded integrally with the foam, provides desirable supplementary springing. This springing helps offset the return rate limitations of foam. The seat can be easily adapted for a heated or air conditioned seat by the addition of perforations to the upholstery surface.



These seats not only meet the design objectives; they also provide for quality and further comfort step-ups. The large area of weight distribution of this basic-design contour seat gives a hard but comfortable feel to the driver who is suspended in and supported by resilient, body-conforming foam.



American Steel and Wire conventional carbon steel zig-zag springs, integral with the foam, provide lateral stability, more comfortable driver support and implement foam's slow return rate.



American Steel and Wire PREMIER carbon steel Spring Wire hour-glass springs, with their variable pitch and density rates, supplemented by the use of varied thicknesses of foam, provide distribution and concentration of different density spring support in exact accordance with design weight/load requirements.

Today, appearance design in automotive seats is highly important from a stylist's viewpoint. But these new designs are useless if they are not combined with practical mechanical know-how and understanding of materials and techniques so the seats can be developed and refined according to their basic utilitarian function. Studies have shown that seats must have a pleasing appearance and they must provide real comfort and security as well. Spring design and material developments now make it possible to build seat forms that were never practical before. So, design objectives can be set:

1. Improve seating comfort through design. 2. Reduce the size and seat complexity to increase effective interior space. 3. Increase seat construction simplicity. 4. Reduce manufacturing costs.

For the driver to operate his vehicle efficiently he must feel comfortable and secure. The driver's principal weight is generally on the two bony points of his pelvis. Since the rear half of the seat cushion supports most of the driver weight the designed spring support must be greater. A lesser part of the driver's weight is taken by his thighs. A support at this seat area which is too firm results in excessive pressure on the large blood vessels under the thighs. A minimum spring support alleviates this pressure over the front half of the seat cushion. The flexible spring support takes the driver's leg weight. Adjustable seat back design follows this same weight/support relationship.

In addition to varying the weight/support as needed the seats are contour-shaped both laterally and longitudinally. Deep lateral contours provide greater driver stability and security than conventional seat designs. The longitudinal contour-shaping gives support to the driver's complete body. Adjustable, comfortable head and knee rests provide compensation for individual driver differences and are easy to install. Each complete seat is thus divided into four sections for fabrication and assembly ease. This construction permits offering the head and knee rests as options.

The upholstery skin is formed over a heated male mold to obtain the designed seat shape. This temperature-forming of the skin helps prevent thermal distortion later under operating conditions. The under and rear limits of the seat and seat-back cushion shapes are determined by the seat shell, which is formed of either carbon, Vinyl coated or Stainless Steel. Polyurethane is foamed-in-place between the upholstery skin and the seat shell. This foam adheres to every surface it touches so the seats become in effect a single unit. By contouring the steel seat shell, desired variations in foam thicknesses can be controlled. In this way foam thickness variations meet the driver's weight/support distribution requirements.

Deep forming in the upholstery skin provides two other advantages:

One, it prevents stretching of the upholstery skin as the foam deflects on compression. Two, it improves seat ventilation, since the formed folds become air circulation passages from an underseat blower fan.

All of these seats offer:

Maximum comfort, convenience and security.

Contemporary appearance which is a direct result of the functional design philosophy.

More compact construction, reducing interior space requirements.

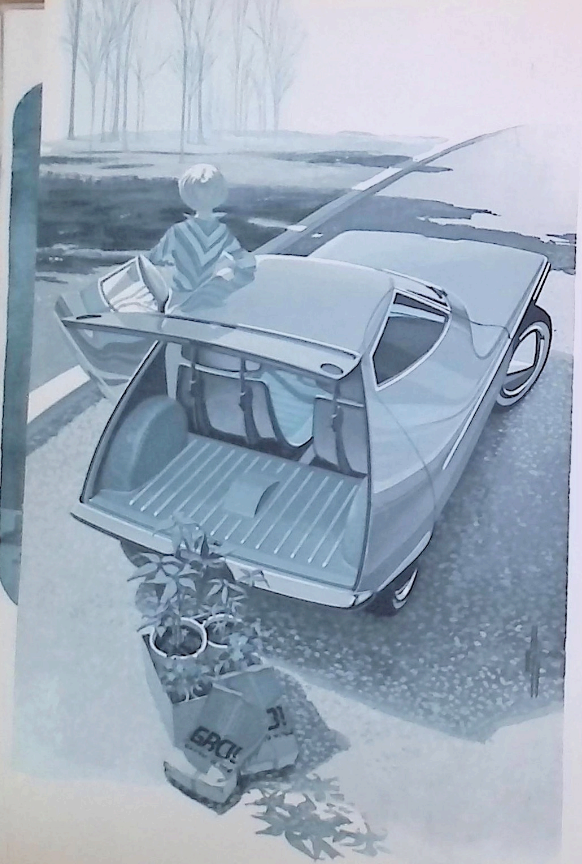
All of these seats are good examples of designing to substantially reduce weight and to eliminate costly, time-consuming assembly of many structural and decorative seat parts.

In conventional seating design there usually are these components:

1. Seat frame. 2. Upholstery trim. 3. Cotton pad. 4. Foam rubber cored pad. 5. Cotton pad. 6. Wire insulator. 7. Coil or zig-zag springs. 8. Jute spring silencer. 9. Trim tape. 10. Hog rings.

Advanced design eliminates six of these components, requiring only the following four:

1. Seat shell. 2. Upholstery trim. 3. Coil, wire-mesh or zig-zag springs integral with the foam. 4. Resilient polyurethane foam molded to the trim.



TYPICAL MECHANICAL PROPERTIES

USS 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"	23-33	35-42	—
Rockwell "B"	45-70	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"	25-35	30-40	34-44
Rockwell "B"	50-65	42-57	40-55

Aluminum Coated Carbon Steel Sheet and Strip

			SK
Yield Point, psi	35-45,000	—	35-45,000
Tensile Strength, psi	45-55,000	—	45-55,000
Elongation, % in 2"	23-33	—	28-38
Rockwell "B"	55-70	—	50-65

USS 17 TYPE 430

MECHANICAL PROPERTIES AT ROOM TEMPERATURES	ANNEALED	COLD WORKED
Endurance (Fatigue) Limit (1,000 Lbs./Sq. In.)	35-50	—
Modulus of Elasticity (1,000 Lbs./Sq. In.)	29	29
Tensile Strength (1,000 Lbs./Sq. In.)	70-90	90-110
Yield Strength (1,000 Lbs./Sq. In.)	35-55	80-105
Elongation in 2 in., (%)	35-20	25-8
Reduction of Area (%)	60-40	—
Rockwell Hardness	B75-90	B90-C23
Brinell Hardness	145-185	—
Keyhole Charpy Impact (Ft. Lbs.)	20-40	—

Stress for a Creep Rate of 1% in 10,000 Hrs.	
At 1000°F, Lb./Sq. In.	8,600
At 1200°F, Lb./Sq. In.	2,200
At 1300°F, Lb./Sq. In.	1,400
At 1500°F, Lb./Sq. In.	—
Scaling Temperature, °F (approx.)	1500
Forging Preheat Temperature, °F	1400-1500
Initial Forging Temperature, °F	1900-2050
Finishing Temperature, °F	1500 Max.
Annealing Treatment, °F	Air cool from 1400-1500
ABRASION RESISTANCE	Fair
COLD FORMING—Drawing—Stamping	Fair
MACHINABILITY	Fair
WELDING	Fair Welds are brittle when cold. Slight response to anneal.

USS 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.

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.

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 1¼ 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.

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 percent 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.

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.

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

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.

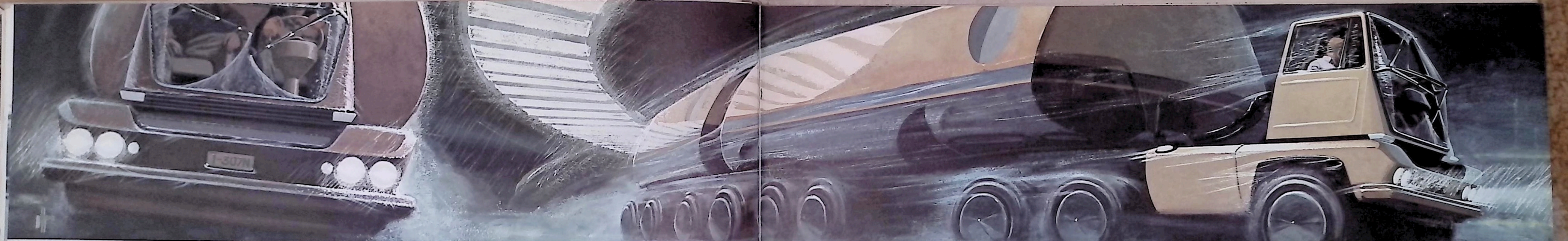
Vinyl Coated steel has an outdoor life expectancy of five to seven years, with fading in that period comparable to the best paints.

UNDERWRITERS' RATING

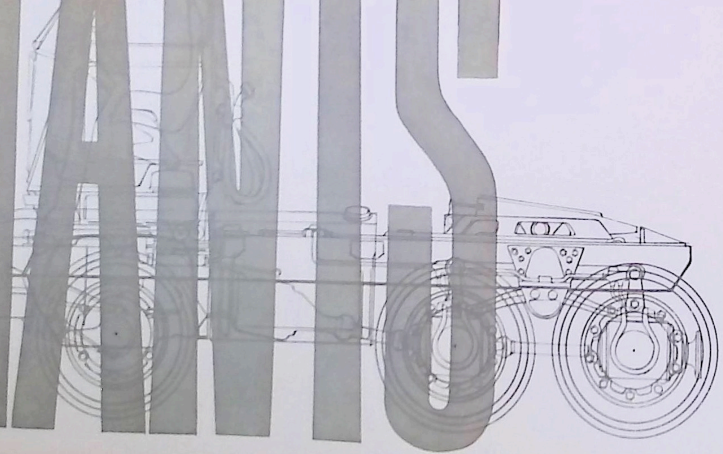
FIRE HAZARD CLASSIFICATION—The following Fire Hazard Classification is established for this material in comparison with untreated red oak as 100:

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.



GIANTS

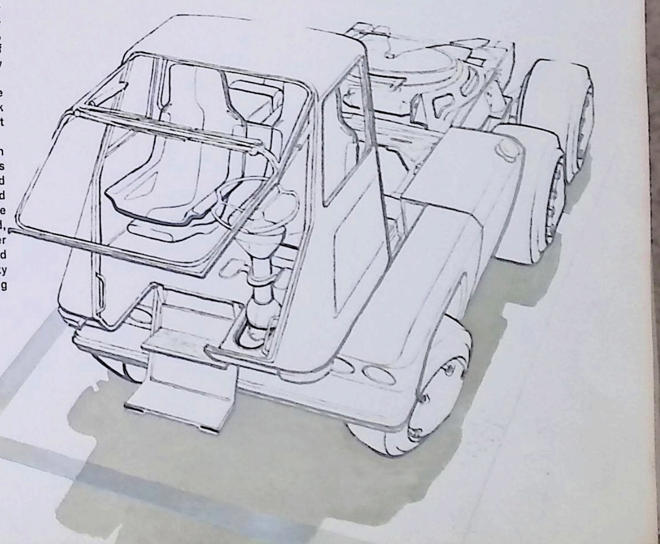


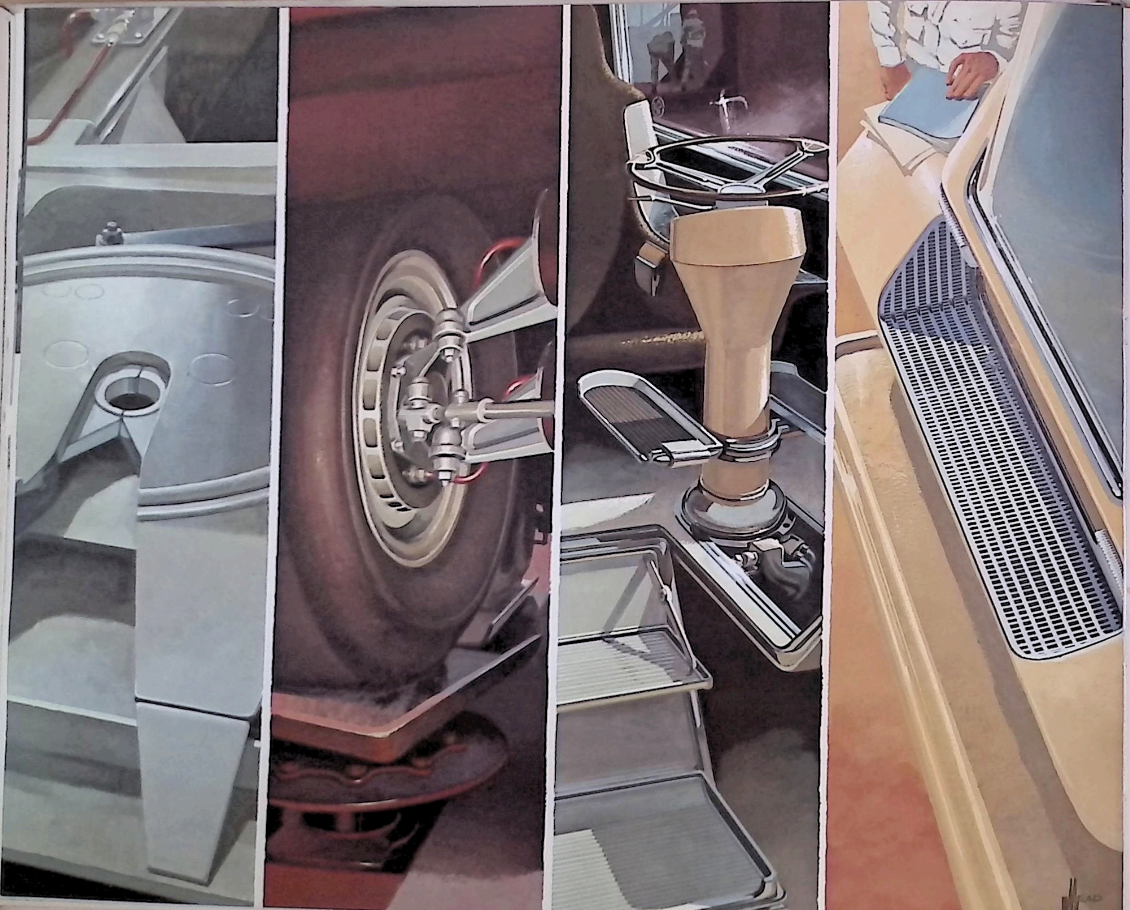
ON THE MOVE...

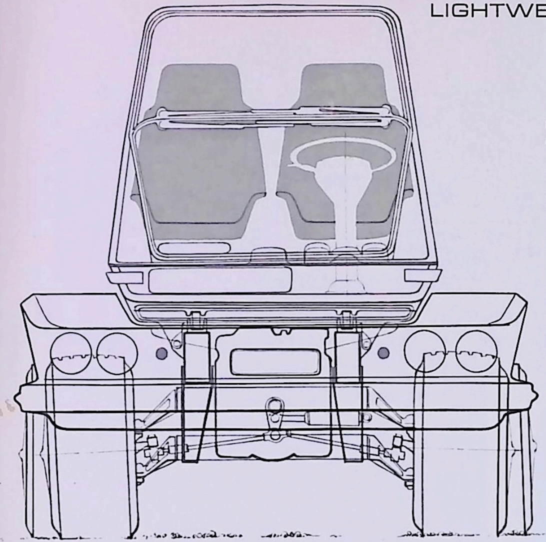
Unlike the first trucks of more than a half century ago, the powerful and sturdy trucks of today are precision tools of transportation. Every conceivable type of hauling job is met by a specialized type of vehicle made possible because of advances in engineering, superior manufacturing methods and new and better steels. Continuing progress of the transportation industry is based on such pioneering and development of new designs, parts, processes and new steels.

This short-depth cab design permits bigger and heavier payloads in tight squeeze situations. The compact, sliding cab is built of carbon steel. The tractor has set-back front suspension designed to provide tight-turning steerability and improved weight distribution.

Engineering and styling design fits this carbon steel cab to low volume production needs, for it may be built with "one-direction" bends on a press brake. This simplifies tooling and greatly reduces costs. The giant, duplicate-piece, full-wrap windshield provides a safe view of all the road and traffic ahead. The combination windshield and entrance door lifts easily on a steel torsion-spring hinge assembly which combines the functions of a hinge pin and counterbalance. The torsion bar passes through rugged, forged carbon steel bearing and anchor brackets securely attached to the cab. Under constant spring load, even in the down position, the mechanism stays tight, quiet and shakefree. In the driving position the door and cab are secured by a manual safety latch lever. The full height doorway and the slim line roof provide maximum opening height and make entrance or exit easy.







LIGHTWEIGHT DESIGN FOR A HUSKY TRACTOR

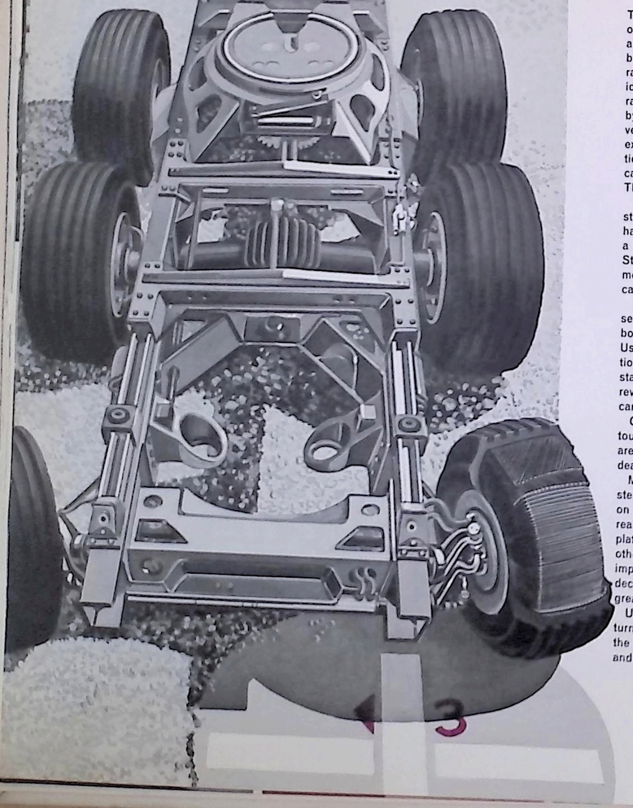
For the driver—handling ease, safety and riding comfort. For the mechanic—complete engine and suspension accessibility. For the owner—minimum first cost plus substantially reduced maintenance cost and downtime. This maximum room, short depth cab rolls forward to expose the complete engine and suspension components for service. Flexible cab mountings on USS EX-TEN or USS MAN-TEN steel frame footrails reduce transmission of chassis vibration to the cab. The simple one-piece, cab shell with its double-wall construction and foam insulation takes full advantage of the strength of carbon steel. This construction provides proof against rattles and body wracking and it requires a minimum number of body parts. Embossed thin-skinned body panels, Vinyl Coated steel interior panels, double-walled construction and foamed-in-place insulation in the floor, sides, back and roof provide maximum weight reduction, simplify manufacturing and give a ride which is sound-free, rattle-free and weather tight. Decorative, durable Vinyl Coated steel combines a choice of color, warmth and texture with the strength and inherent fabrication characteristics of steel. In this way interior multi-color styling and inner body shell structure may be obtained with one manufacturing operation.

Galvanized steel headlight cans resist corrosion so bulb changing is still easy after years of truck service.

The independent front wheel suspension is a parallel arm type using heat treated steel torsion bar springs. The front suspension assembly is bolted to the front end of the frame and includes two rigidly joined tubes which carry the torsion bar springs and the upper and lower forged carbon steel parallel arms. Virtually frictionless, the torsion springs flex freely on the smallest bumps and yet have the capacity to absorb the jolts. In severe torture tests and in over-the-road applications steel torsion springs have consistently demonstrated their ability.

1/The use of USS "T-1" type A constructional alloy steel to fabricate this heavy duty fifth wheel gives the wheel the strength of an exceptionally thick conventional casting, yet it eliminates a major part of the weight. The use of USS "T-1" type A steel and fabricated reinforcing ribs also stops throat bending or spreading. Double-acting cam locks of forged, chrome molybdenum steel encircle the king pin. Pressed, High-Strength, low-alloy steel such as USS EX-TEN or USS TRI-TEN steel pick-up aprons have a wide entrance angle to facilitate trailer pick-up and protect trailer front panels during coupling. 2/Steel for such uses as steering linkage and parallel arm type suspensions is improved by forging, since the grain structure of steel is refined and oriented for greater strength in the process. Heat treatment of the forged parts refines the grain structure still further and produces the required mechanical properties. In heat treatment, annealing, normalizing, quenching and tempering all serve the purpose of improving the quality of the steel. Annealing develops the maximum ductility of the steel. Normalizing the as-forged part refines the grain and establishes a more uniform grain size to increase both the toughness and the ductility of the steel. Quenching and tempering refines the grain of steel and also improves its mechanical properties. These processes are all methods of increasing the desirable characteristics of steel in order to combine strength with torsional and shock-resisting properties, a combination important in heavy-duty truck suspension and steering. 3/The use of expanded USS Stainless Steel for the entrance/exit steps makes them light in weight and slip proof. Vinyl Coated steel, with its resistance to scuff, wear, abrasion and moisture is especially practical for the interior floor. This durable floor finish eliminates the need for the usual jute pad and rubber mat. Rigidized USS Stainless Steel floor inserts take the beating in the heaviest wear areas. The master control column uses Vinyl Coated steel for its strength and color coordinated styling. The column-contained operating instrument panels are Vinyl Coated steel, used for its antiglare properties. Aircraft type brake and clutch treadles are mounted on the control column to eliminate the usual toe board holes. Roll-forming the carbon steel treadles and accelerator pedal makes them slip-proof. 4/The ability to absorb impact is a first requisite of heavy duty truck bumpers. Since plating quality finish is uncalled for in such truck applications, the advantages of USS EX-TEN steel's strength can be utilized to reduce section thickness and so gain the benefit of weight reduction. Heavy ribbing and U-channel design add strength to this bumper. Rigidly bolted to the frame rail ends, the bumper also serves as an extra stiffening frame cross member. A stamped USS Stainless Steel grille provides ready access to the air intake filter. This self-cleaning, baffle filter, made of carbon steel wire mesh, screens incoming fresh air for the regenerative gas turbine engine.

LIGHTENING THE DEADLOAD — INCREASING THE PAYLOAD



The frame is the backbone of a truck and the durability of the entire rig depends on how well the frame is designed, the materials used and how sturdily it is assembled. Different steels are specified for different frame construction combinations. These range from a single channel steel side rail up to triple channel rails. The use of USS "T-1" type A steel for "C" channel side rails result in an ideal frame for heavy-duty truck operation. For heavier duty, composite side rails which give maximum relief from full load concentrations may be obtained by using a steel inner liner. This gives greater strength to the side rails. Inverted "L" reinforcing members may be mounted on top of the side rails and extended well beyond the front and rear suspension mounting points. Conventional "L" reinforcements can be welded to the "C" web while hybrid side rails can be fabricated of USS "T-1" type A steel flanges and carbon steel webs. This gives the desirable flange strength and vertical rigidity.

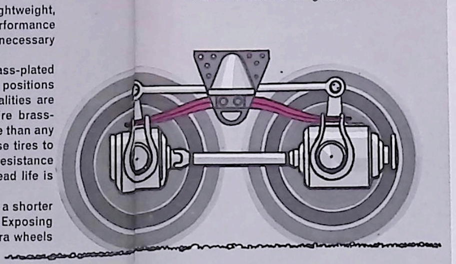
The High-Strength, low-alloy, steel such as USS COR-TEN or USS TRI-TEN steel, box-section front crossmember of this tractor is a fully enclosed deep hat-section. This construction provides exceptional front frame strength and a solid foundation for the forged carbon steel independent suspension. High-Strength, low-alloy steel "K", "Z", inverted "L", i-beam or alligator jaw cross-members and gussets provide outstanding torsional rigidity plus high load-carrying strength.

Forged USS "T-1" type A steel rear spring and multi-purpose brackets are securely bolted to the frame side rails with high strength, heat-treated steel bolts and self-locking nuts made of American Steel & Wire AMERLOY steel. Use of this bolted construction permits changes in frame length or bogie position if desired later. When these bolts are tightened to their working load, they stay tight despite vibration and they are resistant to fatigue from constant load reversals. They cut costs and speed up final assembly, for their size or number can be reduced while still obtaining greater joint strength.

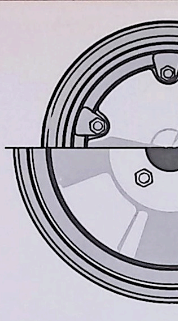
Careful steel selection and imaginative frame design can provide lightweight, tough frames that are stronger and more resilient. Payload and performance are greatly increased since they have all of this strength without unnecessary deadweight.

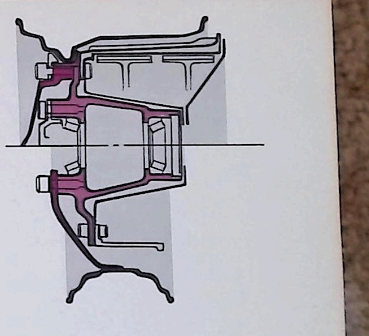
More universal in its applications than the textile tire, the belted, brass-plated steel cord tire can be used equally well on fronts, drives or on trailer positions on over-the-highway rigs. Great improvements in tread wearing qualities are realized from belted, steel cord tires. The American Steel and Wire brass-plated steel tire cord reinforced carcass gives better rubber adherence than any other product. Added advantages are found in the resistance of these tires to impact, puncturing, bruising and penetration. Reduction of rolling resistance decreases fuel costs and since non-slip traction is improved, the tread life is greater than that of ordinary tires.

Use of the new low, wide tires provides greater vehicle stability and a shorter turning radius since it permits a wider spring base and wheel treads. Exposing the brakes to the airstream reduces brake fade. Elimination of the extra wheels and tires give an obvious weight and cost savings.



NEW WHEELS FROM THE WHEEL AND TIRE INDUSTRY





Steel plates and hot rolled special rim sections are used to make tapered disc steel wheels that are round and true. These wheels give truer running performance, virtually eliminating lateral and radial runout. These smoother running qualities increase tire and vehicle life, cut down driver fatigue and protect the cargo.

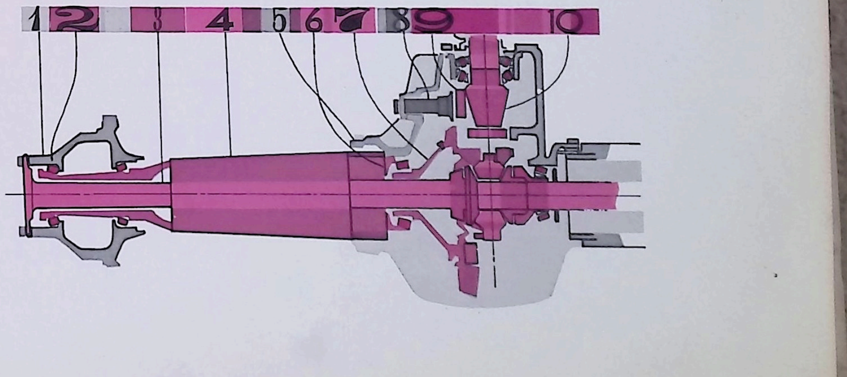
Wheel strength and running qualities begin with the extremely uniform section thickness of the plate delivered from the mill. In cold working the disc to its design shape and taper, the steel's mechanical properties are improved. Tapering the disc reduces its finished weight and allows a desirable resiliency in the disc and increases its resistance to fatigue. The raised center of the disc helps reduce stress concentrations at the wheel center.

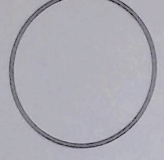
Concentrating rim section thickness where it is needed to withstand inflation and load pressures permits an overall rim weight reduction. Cold working gives a true running wheel rim that will take constant abuse.

Appreciable deadweight reduction per suspension can be achieved with tapered, shot-peened steel, leaf spring design. Only two long, tapered, resilient leaves are used in each spring. This designing saves much of the weight of multi-leaf spring suspensions and yet provides the same strength and load carrying capacity. This Duo-flex spring design provides a buoyant ride with less vehicle pitching and swaying. It also reduces interleaf friction so even slight road imperfections are absorbed. The shock absorbing action of these new springs keeps vehicles tight, minimizes maintenance, reduces cargo damage and makes vehicle handling easier.

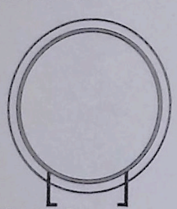
A variety of steels provides a unique combination of mechanical properties for gear and drive line use. Quick shifts and power surges put terrific strains on truck drive line gears, shafts and counter shafts. Steel's inherent advantages of high-strength with a low coefficient of friction, excellent noise damping capacity, free-machining characteristics, resistance to surface fatigue failure, a hardenability that assures maximum core hardness and the ductility needed to absorb shock and impact loads all contribute greatly to gear accuracy and reliability in service.

1. Wheel Hub
2. Outboard Bearings
3. Axle
4. Axle Housing
5. Differential Housing
6. Inboard Bearing
7. Differential Cage
8. Ring Gear Back-up Thrust Pad
9. Ring Gear
10. Pinion

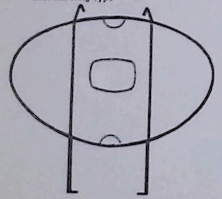




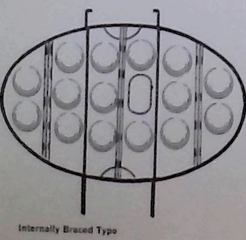
Blimp or Neckdown Type



External Ring Type



Modified Oval Type



Internally Braced Type

MODERN TRAILERS FOR GREATER PAY LOADS

Imaginative design, sound principles and the weight-saving advantage of thinner, but stronger steels are combined to:
Eliminate excessive deadweight without loss of structural strength.
Achieve lower overall height and a lower center of gravity.
Perform both tank and structural functions.
Reduce manufacturing complexities and costs.

Blimp or Neckdown Type. This design simplicity is made possible through the use of USS "T-1" type A constructional alloy steel's great strength. Such fully proved tank-trailers for pressurized liquid cargos comply with highway and Code regulations. External Ring Type. This construction reduces weight by providing the strongest possible shell without the need for internal reinforcing members. This construction also serves to reduce overall height. The absence of weak, flat surfaces in the round, exterior ring shell provides sufficient strength for higher operating pressures and permits a wider range of cargos.

Modified Oval Type. The modified oval design reduces the overall height greatly compared to a round type tank of the same capacity. The center of gravity is lowered too and this greatly increases the road stability of the complete trailer. Finally, this modified oval design provides progressively greater strength toward the tank bottom where the loads are heaviest. This progressive increase in strength toward the tank bottom is partly due to the short radius, round shape of the lower half of the tank. A combination of lighter gages of steels with different strength levels also provides greater strength where it is needed most—at the tank bottom. Baffles and bulkheads are dish-shaped and flanged to add strength to the shell and reduce surging forces on the bulkheads. Openings in the baffles provide complete drainage and a convenient access to each compartment.

Internally Braced Type. Placing special members and reinforcements at high stress areas distribute the stresses evenly, rather than concentrating them. This permits the use of the complete USS Family of Steels: USS "T-1" type A for highly stressed areas; USS COR-TEN for medium stressed areas and USS carbon steels for relatively low stressed areas. Formed, vertical head stiffeners and rugged reinforcing girders over the upper coupler section, transition section and axle assembly distribute concentrated stresses over a wide shell area to assure liquid-tight operation. Dimpled, flanged baffles are reinforced with large wedge-shaped stiffeners to add strength to the shell and to reduce surging forces on the bulkheads. Dimpled, flanged and reinforced bulkheads add strength to the load carrying tank shell and distribute localized stresses over a large shell area. Reinforcing ribs are welded to the longer radius sheets in the bottom shell of the necked-down sections. These reinforcing ribs eliminate buckling due to surging of the liquid and localized kingpin loads.

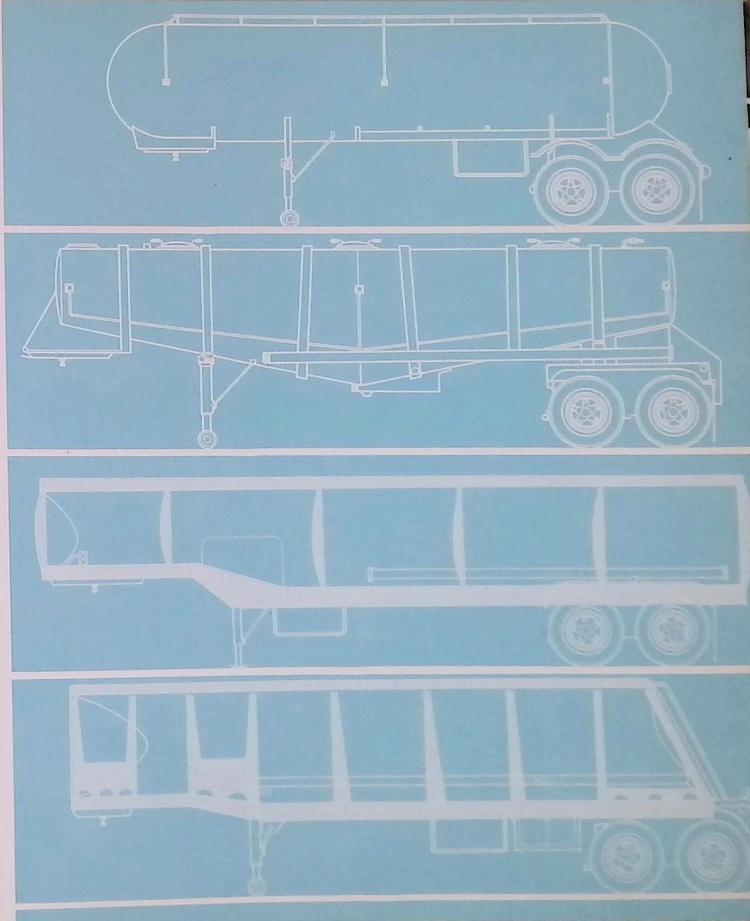
TANK TRAILERS

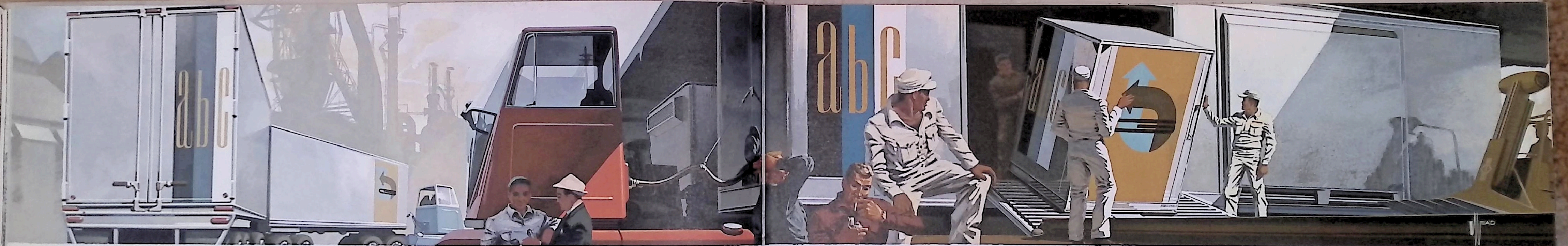
Blimp or Neckdown Type. Even the carbon steel toe rail-conduit performs multiple functions on the top deck of this clean-lined tank trailer. They carry the electrical lines for protection against weather and damage. Extra packaged goods can be carried on top of the tank for the toe-rail also acts as a package rail. A full length, non-skid abrasive safety tread lends sure footing to the catwalk without adding weight. Wide flanged, USS EX-TEN steel hat-sections reinforce the tank at the upper coupler, landing gear and tandem positions.

External Ring Type. This double conical, external ring reinforced bulk tank trailer can be easily converted to a non-coded liquid pressure tank trailer. The shell is two cones joined at the center and provides a continuous round cross-section for greater containing strength. Elimination of the usual heavy slope sheets increases cargo capacity while reducing deadweight. The USS COR-TEN or USS EX-TEN steel external ring reinforcing construction also reduces weight by providing the strongest possible shell construction without internal reinforcing members. Trailers of this and similar types are available in High Strength, low-alloy steel such as USS COR-TEN and USS EX-TEN steel or USS Stainless Steels with a variety of coatings and linings to handle all types of corrosive and non-corrosive fluids and bulk cargos.

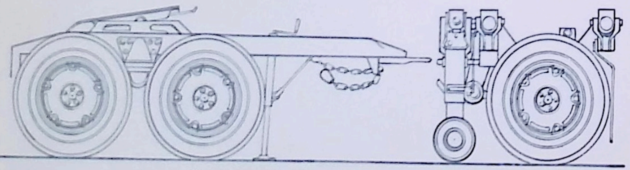
Modified Oval Type. Carbon steel for the upper tank and USS COR-TEN steel for the bottom sheets are combined in this "hybrid steel" tank design. In this way, the tank is made progressively stronger toward the bottom where the loads are the greatest. Two, full length USS "T-1" type A steel tension members support the bottom sheets. Two, full length USS "T-1" type A steel catwalk members brace the tank top against longitudinal compression forces and resist any tank buckling tendency. These compression and tension members are tied together by an integrated structure that relieves both the tank shell and the heads of concentrated forces of load and road shock.

Internally Braced Type. Two continuous-welded, full length tension members add depth to the load-carrying shell and absorb tension stresses under load. They also reduce the size of unsupported sections of the bottom shell sheets and thereby minimize vibration of the sheets. Vertical stiffeners welded to the nose sheets distribute kingpin load stresses over a large area thereby relieving the bottom section of the head and shell from the highly concentrated stresses caused by these loads. The upper coupler or fifth wheel is bolted on to permit adjusting the kingpin location for proper weight distribution when required by tractor changes. The high mechanical properties of heat treated alloy steel, such as chrome molybdenum or nickel chrome molybdenum steel for the king-pin is further assurance it will withstand the severe loads of "piggy backing" or "panic" stops.





A SEMI OR TANDEM TRAILER THROUGH DESIGN FLEXIBILITY



TRAILER DESIGN KEEPS PACE WITH PROGRESS

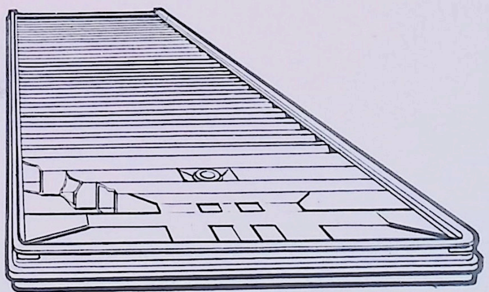
This tandem axle dolly provides a maximum safe payload distribution. An "A" type combination frame and drawbar is hybrid designed of tough, USS "T-1" type A steel for the flanges and carbon steel for the webs. Weight-saving tapered leaf springs reduce deadweight. The lightweight but heavy duty fifth wheel is USS "T-1" type A steel. The forged USS "T-1" steel pintle hook is rubber mounted and air cushioned so it absorbs pulling and braking shocks.

This complete bogie—axle, springs, brakes and landing gear—is shiftable on and removable from the trailer bottom rails. It can be used as a single axle, equalized tandem or triple axle suspension. Correctly positioning the bogie and landing gear on the bottom rails is a one man operation, after which the bogie is pinned and positively clamped.

Dry freight and food hauling problems call for especially designed trailers that meet as many of the operators' varying needs as possible. Advanced engineering and manufacturing know-how, plus versatile new steels, provide practical solutions to these van and reefer type trailer problems. Today, the engineers' efforts show continual advancements in the use of lighter gage steel, elimination of excess weight without altering structural strength, and achievement of a lower center of gravity and lower overall height. He looks to lighter, more versatile suspensions that will permit easy conversion from semi- to tandem trailer for "double bottom" operation. Or, he may seek removable and shiftable bogies that permit better weight distribution to meet highway restrictions. He advocates new constructions that provide strength, greater payload capacity and allow a big cut in trailer weight. As the engineer achieves these ends, he adds revenue producing payload.

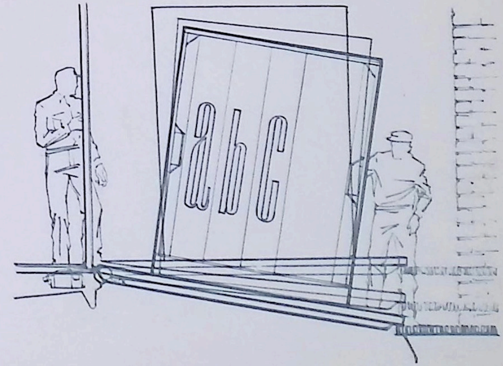
Multi-stops and short haul deliveries often sap trailer operation profits. So, the engineer designs to allow the driver to load or unload at final or intermediate destinations as he chooses, regardless of the cargo loading. And, to protect the cargo in transit, the engineer designs strength and ruggedness into the trailer body, thus enabling it to withstand highly concentrated load stresses, impact forces and torsional wracking. To meet the increasingly severe demands on trailer design, the engineer turns to the new carbon, High-Strength, low-alloy steels or High-Strength heat treated constructional alloy steels or Stainless Steels.

REDUCED WEIGHT AND REDUCED COSTS WITH HIGHER STRENGTH STEELS



USS "T-1" type A steel's high mechanical properties allow trailer designers to further reduce the weight of trailer understructures. The USS "T-1" type A steel suspension members are main load bearing members. USS COR-TEN or USS TRI-TEN steel outriggers and cross members are placed on 12" centers between the two main outer rails. Cross member ends are welded to the USS TRI-TEN steel outer rails which also act as sturdy rub rails and longitudinal load bearing members. USS TRI-TEN steel has good shock resistance even at low temperatures, and a high endurance limit. The rugged upper coupler is a sandwich grid structure of rectangular tubing made of USS "T-1" type A steel. A full-width USS MAN-TEN or USS TRI-TEN steel pick-up plate on the underside of the coupler structure prevents trailer damage during coupling.

ONLY STEEL SERVES SO LONG —SO WELL



If the driver is to be able to load or unload at intermediate or final destinations as he chooses, regardless of the cargo loading, every inch of cube must be readily accessible. Rear, curb or roadside doors divide the van into easy-to-reach areas that permit fast loading and unloading. Deep USS TRI-TEN steel outer rails eliminate side door trusses and give door location flexibility. The High-Strength, low-alloy steel top rails permit big side openings that are free of gussets which might restrict loading.

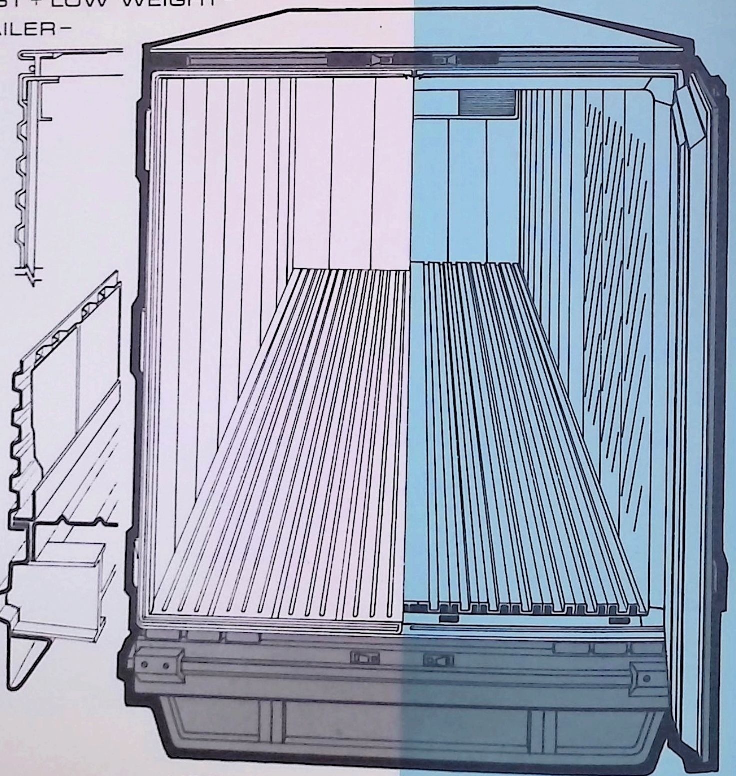
STRENGTH + LOW COST + LOW WEIGHT– FOR EVERY TYPE TRAILER–

Bigger payloads can be carried and they can be loaded and unloaded more easily because engineering design, combined with unique applications of the right steels, provides more useful van width, length and height plus higher and wider door openings. The unique construction of nose, sidewalls, doors and roofs allows them to be thin, yet gives exceptional ruggedness, rigidity and strength. The use of USS High-Strength, low-alloy steel results in long life, shock resistance and a high strength to-weight ratio. These steels have up to 4 to 6 times the atmospheric corrosion resistance of carbon steel. The strongest possible construction for the weight is obtained by designing every part of the van's structure to add strength, to improve rigidity and to increase payload capacity.

Integral corrugations on 2-inch centers in the roof, nose and side panels provide longitudinal rigidity. Low depth, hat-shaped roof bows provide cross-body strength and extra inside height. Exceptionally strong and durable hat-shaped side posts insure vertical stability. Welding every corrugation to every side post makes a virtual box-section of every corrugation. Constructed in this manner, these box sections can withstand wracking loads and stresses from any direction. Permanently fastening these parts by welding gives a tremendous torsional strength without increase in weight. A modified I-beam, USS COR-TEN or USS EX-TEN steel rolled section quarter panel welded to a deep USS TRI-TEN or USS EX-TEN steel top rail running the full length of the trailer provides the body strength that permits big side openings.

The wide roof bows are welded to the substantial inner flanges of the quarter panel I-beam. The roof bows and side posts give solid roof and side support for the full length of the trailer. Welding and rolling the roof panel over and under the top outer flange of the quarter panel ties the roof and side panels into one strong, leak-proof structure.

Each side post is welded to the USS TRI-TEN steel outer rail while the lower edge of the corrugated panel is rolled around, under and welded to the upper flange of the outer rail. This heavy section USS TRI-TEN steel outer rail gives rigidity to the trailer sides. The USS "T-1" type A steel rear frame cross member supports the ICC bumper. The roll-formed steel dry freight floors are welded to the wide-flange cross members for still greater trailer strength and torsional rigidity.

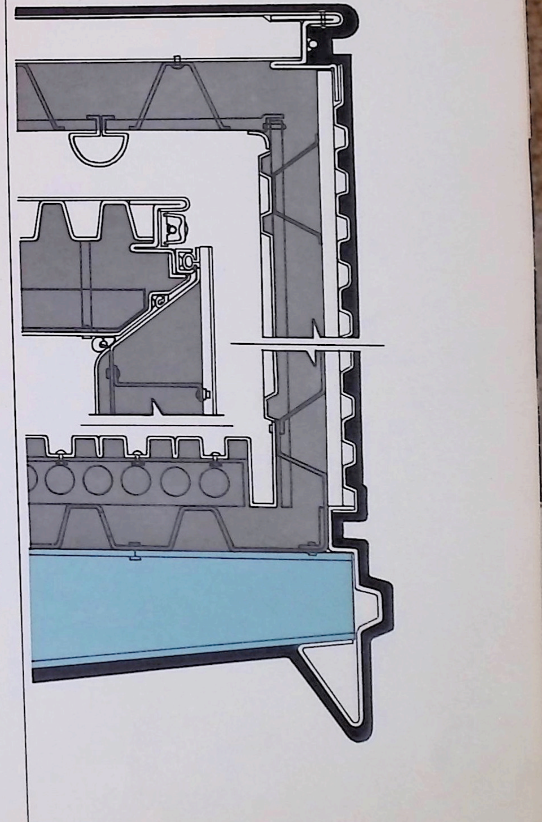


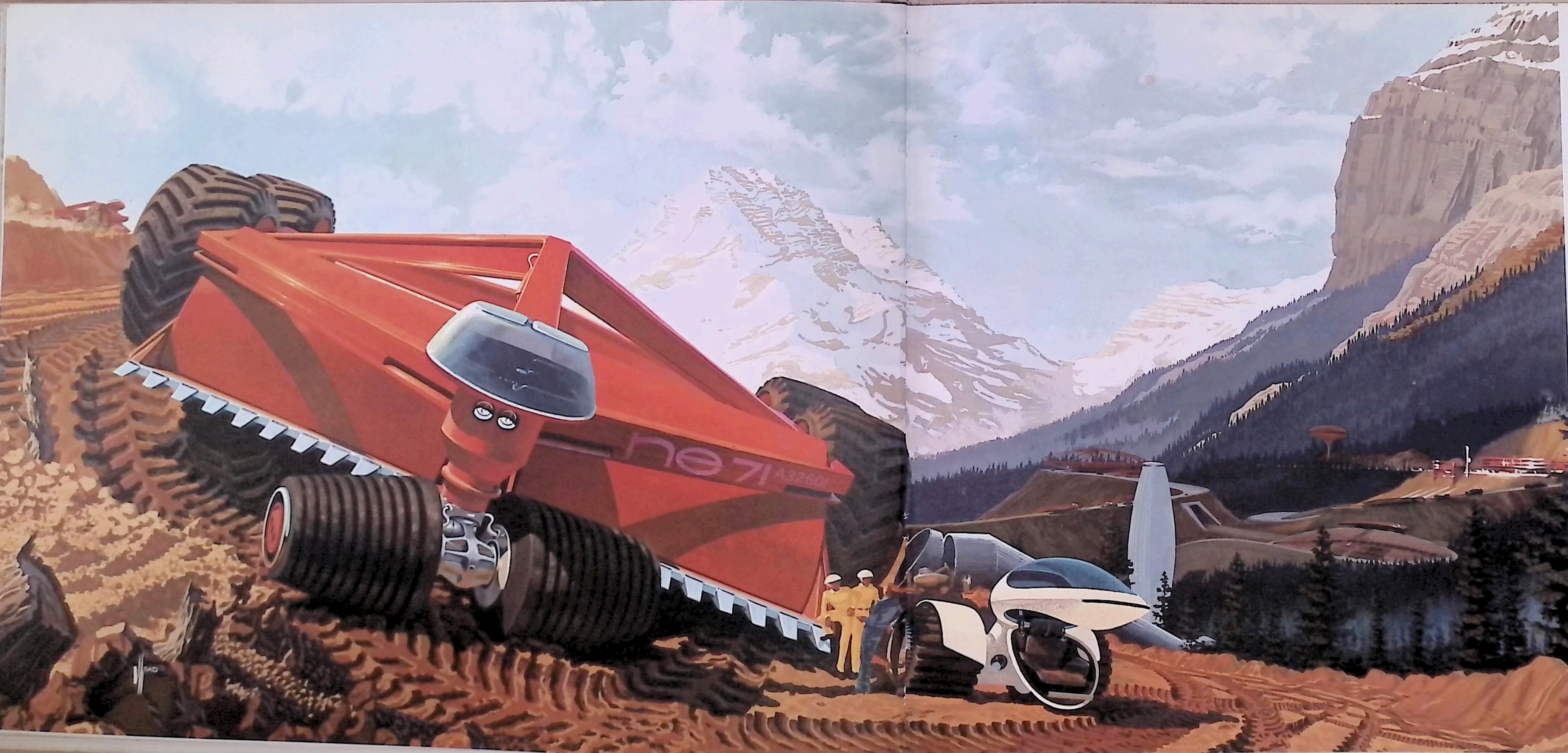
USS COR-TEN STEEL VAN TRAILER

STAINLESS STEEL REFRIGERATOR TRAILER

- Rolling, caulking and welding the corrugated USS Stainless Steel roof panel over and under the quarter panel flange seals out air and moisture. Such construction minimizes rammed air filtering through tiny crevices in the outer shell.
- Extra wide, double hat-section Stainless Steel roof bows are securely welded to the quarter panel flanges and to each roof corrugation. This provides cross-body and torsional strength.
- Heavy gage, roll-formed Stainless Steel quarter panels provide structural strength for the side and end walls. The lower quarter panel flange laps and air-weather seals the corrugated Stainless Steel outer panel.
- Corrugations in the inner liner permit cold air movement around closely packed cargo.
- The Stainless Steel strip outer shell has ¼" corrugations on 2" centers which are welded to Stainless Steel sidewall posts at every corrugation. This construction gives exceptional strength in every direction to the outer shell. Only Stainless Steel has the strength to permit such thin-walled construction which will give trouble-free service for the life of the trailer.
- "V"-strut spacers separate the outer shell from the inner sidewall posts and cargo liner. A low K factor, foamed-in-place insulation forces its way into every cavity and crevice of the complete trailer body structure—sides, floor, roof and doors. The trailer is thus completely sealed against air, moisture and heat penetration.
- Corrugated, glass-reinforced plastic sub-floor spacers are screw fastened to the floor pan and frame cross members. Different screws fasten the cargo floor to this plastic sub-floor. In this way there is no through metal fastening and consequent cooling loss.
- The USS Stainless Steel sanitary gutter facilitates cleaning and also serves as a base scuff plate.
- The deep, Stainless Steel cargo floor provides fore and aft air circulation. Welding it into one piece eliminates joint leaks and waterproofs the floor for the trailer's life.
- Stainless Steel inner floor "Z"-beam cross members are placed on 12" centers and screw fastened to plastic sub-floor spacers.
- 180° marker lights are protected from impact by the deep quarter panel flanges.
- Double hat-section roof bows provide great cross-body roof strength without penalizing inside height.
- Triple seal, compression gasketed doors have full contact all around. This gives full insulation that is effective at high or low temperatures.
- The foam filled door provides thermal insulation.
- Corrugated door inner liner provides the structural strength to keep the door aligned and sealed tightly. Foamed-in-place insulation bonds the door into an integral one-piece construction.
- Inner door spacer provides structural alignment without permitting metal-to-metal transfer of heat to the cargo liner.
- Stainless Steel floor pan is screw-fastened to the trailer frame and cross members.
- USS "T-1" type A steel serves as a base for weld attaching the frame cross members.

Reefer trailers, subjected to refrigeration's continuous drying and wetting sequence, are increasingly expected to meet rigorous requirements of maintaining low temperatures in transit. Stainless steel's qualities of corrosion resistance, strength and fabricability enable designers to meet these requirements with satisfactory, airtight, lifetime trailers. Because of these qualities the thinnest shelled, greatest cube and strongest reefer trailers are built with stainless steel.



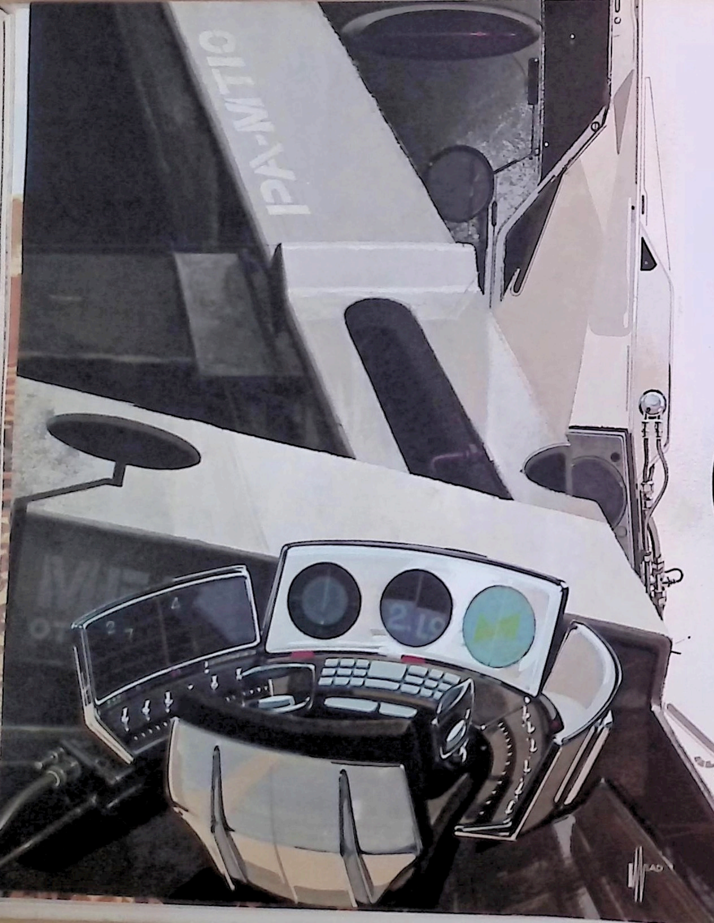


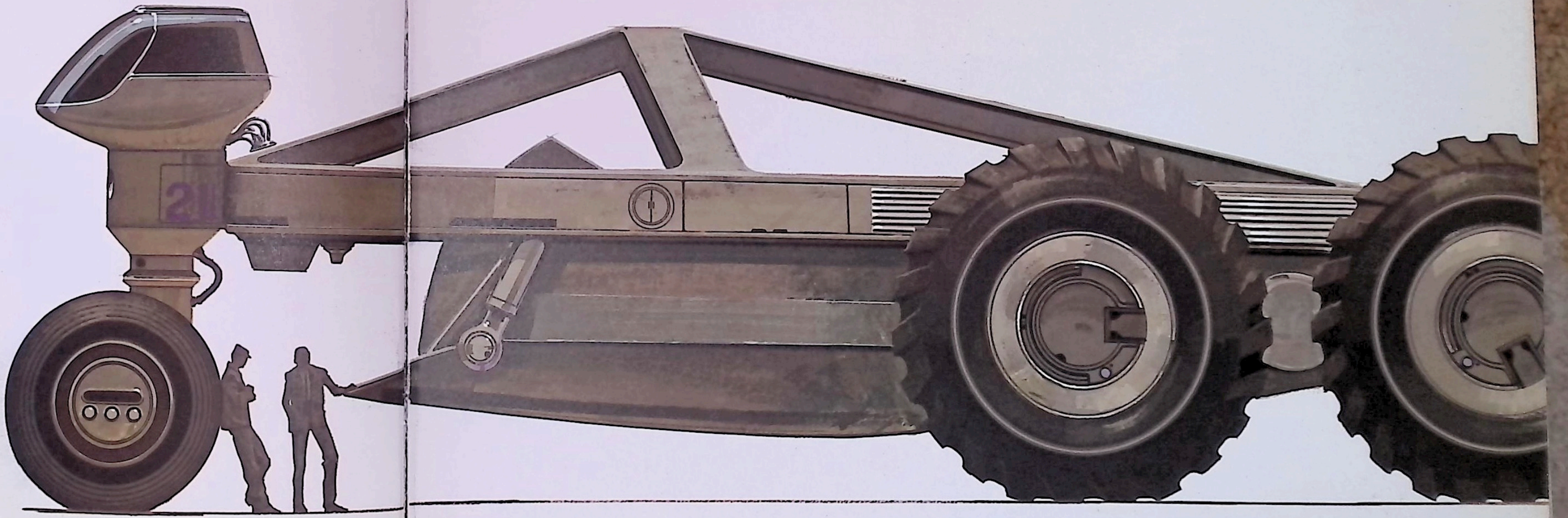
DESIGNED AND BUILT TO TAKE SHOCK, IMPACT AND ABRASIVE FORCES

Fast handling of production dirtmoving is necessary on big yardage, time-measured jobs today. Earth-moving with self-propelled scrapers takes raw power: power to pack in heaped capacity payloads rapidly regardless of how tough and sticky the material; power to high-ball up and out of steep cuts; power to accelerate quickly with a full load, cycle fast and return at top speed. But, important as power alone is, it is only one factor in determining what the scraper will do. The power-to-weight factor is a most important factor to consider. As the percentage of dead-weight drops the higher the percentage of payweight rises. Efficiency can be greatly improved by decreasing the scraper deadweight and thereby improving the power-to-weight ratio so that more dirt and less scraper weight is being moved. Decreasing scraper weight can be accomplished in two ways: by improving the design, and thereby the efficiency, of the scraper, and by using selected steels to meet the rigid demands of earthmoving jobs.

The whole family of USS steels is available to meet the demanding requirements of improved scraper designs. These steels range from 30,000 psi to 100,000 psi yield strength. Each fills a particular need, such as improved strength, elevated temperature properties, toughness, corrosion and abrasion resistance, fabricability or other specific requirements.

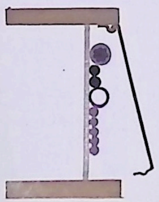
Of these steels, ASTM A 36 fills the need for a higher yield point carbon steel in plates and shapes at a minimum cost. The High-Strength, low-alloy steels, such as USS COR-TEN and USS TRI-TEN steels, have yield points at the 50,000 psi level and offer better atmospheric corrosion resistance. USS "T-1" and "T-1" type A constructional alloy steels have 100,000 psi minimum yield strength and far greater atmospheric corrosion resistance than carbon steel. Compared to carbon steel, USS "T-1" steel has four to six times greater atmospheric corrosion resistance than structural carbon steel and "T-1" type A steel has twice the atmospheric corrosion resistance. And despite their high strength, they can be formed and welded. All of these new steels are now being applied in the design of stronger yet lighter vehicles and off-the-road equipment. For example, careful application of combinations of such steels for frame members results in weight savings over previous designs. Truck, trailer and off-the-road equipment designs use this concept of materials combinations.





SELECTED STEELS MEET THE RIGID DEMANDS

The driver's full view cockpit is the highest part of the earthmover. This design, plus the fact that there are no conventional exhaust stacks, gives him unobstructed vision in all directions. He can see the haul road ahead and he can just as easily watch his ground plate, while finishing a grade or building up his load.

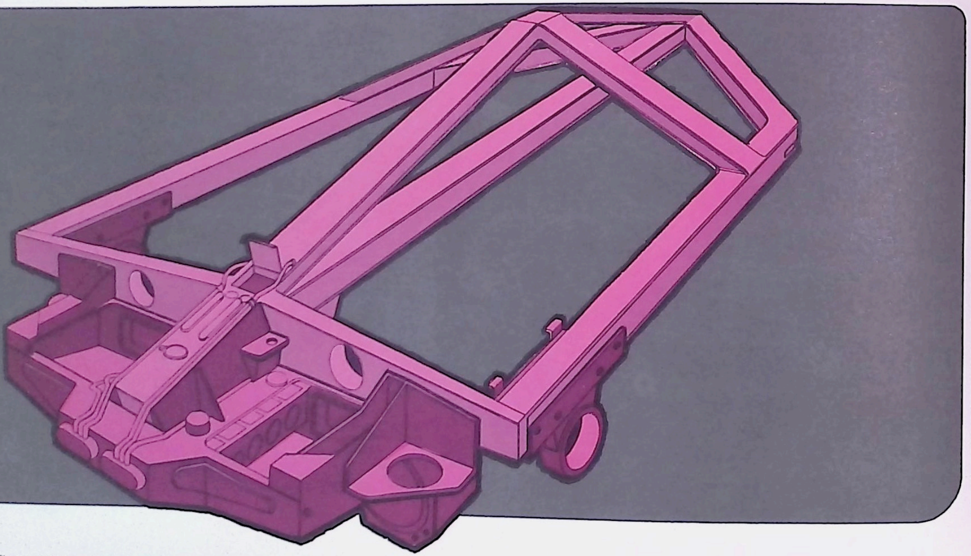


The driver's 4-way adjustable seat is located slightly to left of center. The right-hand tubular carbon steel lever controls all braking, accelerating and steering functions. Rearward movement applies braking; forward controls acceleration; left or right controls steering. The left-hand tubular carbon steel lever controls the bowl position, apron and tailgate jacks. Both levers are spring loaded and damped so they return automatically to neutral positions. The switches and instruments for the twin engines, generators, and hydraulic pumps are cluster mounted on the non-glare Vinyl Coated steel instrument panels.

Twin engines drive the electrical generators and hydraulic pumps and provide mechanical power through a short-coupled drive-train to the four rear wheels. Front wheel drive is direct, with electric motors in each wheel. This eliminates the long shafts, gearing and complex linkages which would otherwise be required. Flexible American Steel and Wire ARMORLOKT electrical cables carry the current through the box-section, octet truss frame members to motors mounted on the front axle. These same box-section frame members also provide protective channels for air and hydraulic lines. All line connections—air, electrical and hydraulic—are made with quick-disconnect jacks that are readily accessible through service doors in the frame.

The slightly curved, double-sheeted bowl bottom lessens loading resistance and aids the rolling dirt action that gives heaped capacity loads. In the haul position the lowest point of the bowl leaves plenty of ground clearance for soft going. The clean, smooth underside of the bowl prevents wasted power in pulling through sticky muck. Controlled hydraulic down pressure on the cutting edges of the USS "T-1" steel ground plate assures quick penetration of tough materials.

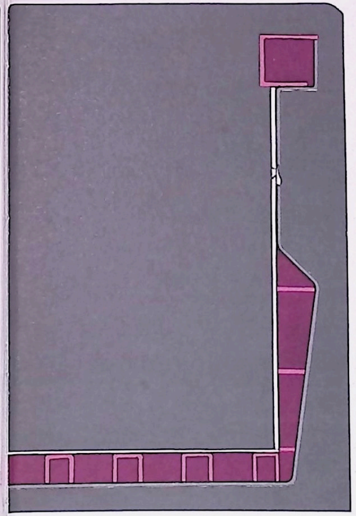
The double-acting hydraulic jack cylinders for bowl control and dirt ejection are made of USS NATIONAL cold drawn carbon steel mechanical tubing, precision controlled for wall thickness. The exacting O.D. and I.D. tolerances, plus the uniform concentricity of this tubing, provide finished jack cylinder parts without material wasting or costly machining. The hardened, centerless ground, chrome plated piston shafts prevent rusting, peeling and denting. These shafts are made from carbon steel, cold finished bars which are straight, hard, free of nicks and scratches. This assures a leak-free hydraulic cylinder packing.

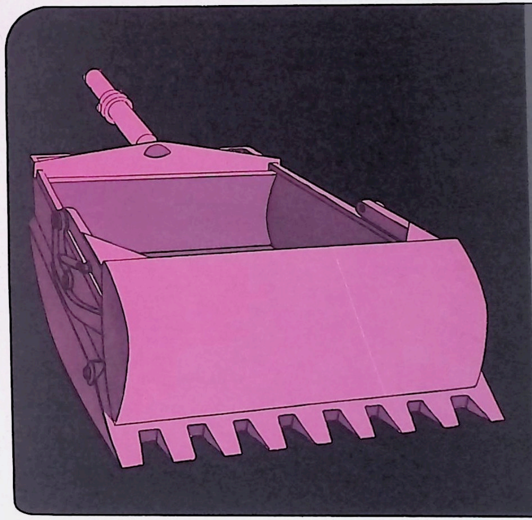


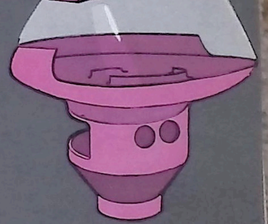
The rugged, one-piece main case supports the twin engines, clutches, transmissions, drive lines, generators and hydraulic pumps. Each of these units can be removed for servicing without removing adjacent assemblies. The underside of the main case is a box-beam USS TRI-TEN steel belly pan and guard. This sturdy and compact main case is made of reinforced and welded USS "T-1" type A steel plates. Where heavier thicknesses are needed USS "T-1" steel is used for the members. Both of these steels are readily cut, welded and fabricated. After fabrication the case is then line-bored to provide perfect and lasting alignment and rigidity of all bearings, shafts and gears.

The octet truss frame design concentrates and proportions the load on the drive wheels to increase traction so that steeper grades and rougher terrain can be negotiated. To give great strength and lightness USS "T-1" steel is used for the flanges of the I-beams and carbon steel for the beam webs. The I-beams are boxed-in with carbon steel sheet to form a protective raceway for electrical, air and hydraulic lines.

The low bowl design provides a wide dirt entry for easy and fast loading. The bowl entrance angle is low to minimize the lifting of the dirt into the bowl. Engine power is not wasted lifting the dirt but is used for cutting and loading. Momentum carries the dirt rearward against the curved tailgate which directs the dirt back to the correspondingly curved surfaces of the apron. This circular motion of the dirt continues until all voids and corners of the bowl are packed solidly. Engineering design provides a smooth, clean interior with no dirt traps or projecting structural members which would interrupt the dirt-flow during loading or unloading.







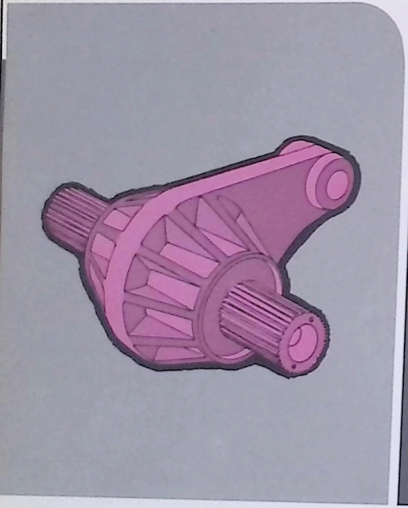
The superior toughness of USS TRI-TEN, MAN-TEN, or "T-1" type A steel bowl side sheets helps to maintain the inside smoothness of the bowl structure, which takes repeated shock loading and stress reversal. The deep curve of the apron allows more of the dirt to be carried forward. This gives better weight distribution and a lower center of gravity, both features contributing to stability on the haul. During unloading, the hydraulic jacks move the tailgate toward the cutting edge in order to bulldoze the dirt from the bowl.

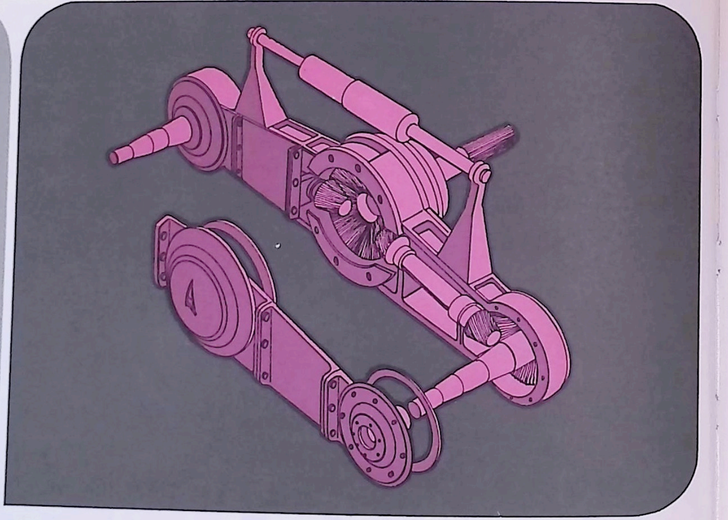
USS TRI-TEN or USS MAN-TEN steel debossed linkage arms between the tailgate and apron automatically lift the apron to permit unloading of chunky material and rocks and also to provide smooth, positive high speed spreading. USS TRI-TEN or USS MAN-TEN steel box-section reinforcements provide rigid support to the bowl side sheets. The inside and outside plates of the bowl floor are made of USS MAN-TEN or USS TRI-TEN steel to take the constant abrasive action of the loads and to resist denting or distortion. This prevents partial loads and "carry-backs." USS TRI-TEN steel U-channels in the sandwich bowl floor provide further strength and bowl rigidity.

Engine exhaust heats the bowl to keep cold, wet dirt from sticking. This gives faster, easier winter dumping. To do this the exhaust is circulated through the hollow box-section reinforcements of the bowl side sheets and bottom. The exhaust outlet is at the rear, away from the driver.

Bowl points or teeth are forged USS "T-1" steel to permit dirtmoving later in the fall and starting earlier in the spring. USS "T-1" steel, 3-piece ground plates are optional equipment. Being reversible and interchangeable, they double their life expectancy.

The cellular USS Stainless Steel roof panel contains both cab heating and cooling equipment. The 360° tinted Lucite windshield gives the driver the kind of fullsweep visibility he needs. The lower body of deep-dished design is made of carbon steel.





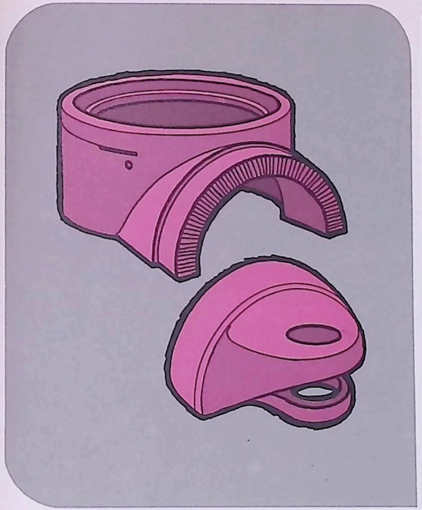
THE BEST STEELS ARE IMPROVED BY THE FORGING PROCESS

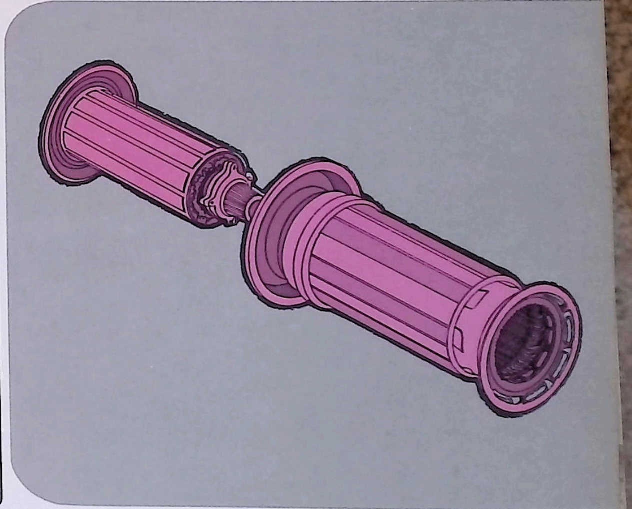
New metal working machines, new forging techniques and metallurgical break-throughs extend forging applications in every design dimension. Today, top quality forged parts can be produced at prices that are hard to beat. The dense, fibrous structure and controlled, superior grain flow of this front wheel trunnion alloy steel forging concentrates extra strength and impact resistance at points of greatest shock and stress. Forging makes possible thinner sections and close tolerances with smooth, flaw-free surfaces that eliminate extra finishing operations. The absence of shrink cracks and voids in forged parts reduces the scrap loss common with cast parts, often after much high-cost machining has been done. Dependability is improved by designing the part to be forged so as to avoid costly field-breakdowns of equipment. The safety factors are increased while manufacturing costs and weight are reduced.

FORGED STEELS PREVENT FIELD FAILURES

All gears and other stressed drive line parts in the mechanical drive system are forged and precision machined for greatest strength, durability and maximum load-carrying capacity. Forging gives these vital parts maximum resistance to gear clashing shifts and power surges. Forging provides the highest strength to weight ratio. In severe service conditions it provides the highest resistance to impact, shock, vibration and torsion. Orientation of the grain flow lines concentrates the strength where it is needed most.

The use of USS alloy gear steels for the stressed drive line parts prevents failure in actual service. These premium steels forge and machine with minimum distortion. They are dimensionally stable and they are available in the widest range of mechanical properties: carburizing for shock and wear resistance; through-hardening for heavy loads at slow to medium speeds; cyaniding and nitriding for wear. All of these drive line parts are rigidly supported and held in accurate alignment by heavy duty roller bearings. The induction-hardened shafts, pinions and bearings ride in heavy malleable iron carrier cases to maintain their true alignment. This also simplifies servicing of all the assemblies.





VERSATILE USS "T-1" STEEL

The steering motor transmits its torque to a heavy duty, ring gear in this USS "T-1" steel universal, swing-hitch mount to turn the earthmover speedily and smoothly. This hitch is big, simple and rugged with its wide bearing surfaces designed to provide years of hauling gross capacity and unevenly distributed payloads with no trouble. USS "T-1" steel's 105,000 to 135,000 psi tensile strength and through-hardening give this hitch the strength, toughness and uniform hardness to stand up to hundreds of swing-pivot-stop-start cycles during every working shift.

PERMEABLE STEELS FOR QUIET POWER

The front drive train consists of a variable speed, reversible electric motor in each front wheel. These motors are independently push-button controlled from the driver's cab. They reach full rpm in a fraction of a second and reverse to full power in the opposite direction just as quickly. Their instant response permits faster cycles with low maintenance costs. They operate at full efficiency even under the most adverse conditions of heat, cold or humidity. Motor construction is simple. It consists merely of a stator which is splined to its trunnion shaft and an accompanying rotor.

The permeable, magnetic flux-carrying, punched lamination parts of the stator and rotor cores are made from USS Motor, M-27 Silicon steel. Current to the motors from the main generators is carried by American Steel and Wire ARMORLOKT flexible power cables.

MECHANICAL PROPERTIES

USS COR-TEN STEEL

	Thickness Ranges	
	1½ in. and under	Over 1½ in.
Yield Point, min, psi	50,000	46,000
Tensile Strength, min, psi	70,000	67,000
Elong. in 2 in., min, per cent	22	24
Elong. in 8 in., min, per cent (0.180 in. and heavier)	19	19
Cold Bend (180° specimen bend)	¾" & under D=1t Over ¾" to 1" D=1½t Over 1" to 1½" D=2t	Over 1½" to 2" D=2½t Over 2" 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 to strength levels other than the above is subject to negotiation.

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

USS "T-1" TYPE A STEEL

	Thickness Ranges	
	3/16" to ¾", Incl.	Over ¾" to 1", Incl.
Yield Strength, Ext. under load (min)	100,000 psi	100,000 psi
Tensile Strength	115,000/135,000 psi	115,000/135,000 psi
Elongation in 2", % (min)	18	16
Reduction of Area, % (min)	40	50
Longitudinal and Transverse Charpy Keyhole Impact Values (ASTM Procedure) (min)	15 ft. lbs. at —50°F	15 ft. lbs. at —50°F

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

USS MAN-TEN STEEL

	Thickness Ranges		
	14 Ga. to ½" Incl.	Over ½" to 1½" Incl.	Over 1½" to 3" Incl.
Yield Point, Min., Psi	50,000	45,000	40,000
Tensile Strength, Min., Psi	75,000	70,000	65,000
Elong. in 8", Min., Per Cent*	18	19	19
Elong. in 2", Min., Per Cent	20		22
Cold Bend—180°	D=1T	D=2T	D=3T

The minimum yield point and tensile strength requirements will be reduced by 5,000 psi when annealing or normalizing is specified, or when furnished in coils.
*For all products except sheet and strip.

USS EX-TEN STEEL

	EX-TEN 45 Plates, Bars, Structurals, Bar Shapes to ⅜" Incl., HR Sheets, HR Strip, CR Sheets	EX-TEN 50 Plates, Bars, Structurals, Bar Shapes to ⅜" Incl., HR Sheets, HR Strip, CR Sheets	EX-TEN 55 Plates to ⅜" Incl., HR Sheets, HR Strip	EX-TEN 60 Plates to ⅜" Incl., HR Sheets, HR Strip
Yield Point, psi Min.	45,000	50,000	55,000	60,000
Tensile Strength, psi Min.	60,000	65,000	70,000	75,000
Elongation, Min. Sheets & Strip % in 2" Other Products % in 8"	 25 19	 22 18	 20 17	 18 16
Cold Bend (Specimen Bend) Sheets & Strip Other Products	 Flat D=1T	 D=1T D=1T	 D=1½T D=1½T	 D=2T D=2T

When hot rolled products are ordered annealed or normalized, the mechanical property requirements do not apply.
ASTM Standard Specimens; minimum number of tests and ductility modifications apply.

USS TRI-TEN STEEL

	Thickness Ranges			
	*Sheets, Strip and Light Plate	Plates, Structurals, CB's and Bars**		
		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, %	19	18	19	19
Elong. in 2 in., min, %	25	—	—	24
180° Cold Bend (Specimen Bend)	(See below)	D=1t	Over ¾ to 1" D=1½t Over 1 to 1½" D=2t	Over 1½ to 2" D=2½t Over 2 to 4" D=3t
Sheets and Strip	Flat			
Light Plate	D=1t			

*When as rolled plates ⅜" and under are required for severe cold forming or when produced on sheet or strip mills, the mechanical properties of the sheet and strip grade will apply.

**When plates or bars are ordered normalized or annealed or when severe cold forming is involved, both the minimum yield point and tensile strength requirement will be reduced 5,000 psi.

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

USS "T-1" STEEL

THICKNESS	Thickness Ranges 3/16" 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) Transverse (ASTM Procedure)	 30 ft. lbs. at +10°F 20 ft. lbs. at +10°F	 — —	 — —

For maximum resistance to impact abrasion, USS "T-1" Steel may be ordered to minimum hardness of 321 BHN, (4" max. Thickness) or 360 BHN (1½" max. Thickness) in which case all other specification properties are waived.

THE GAS TURBINE

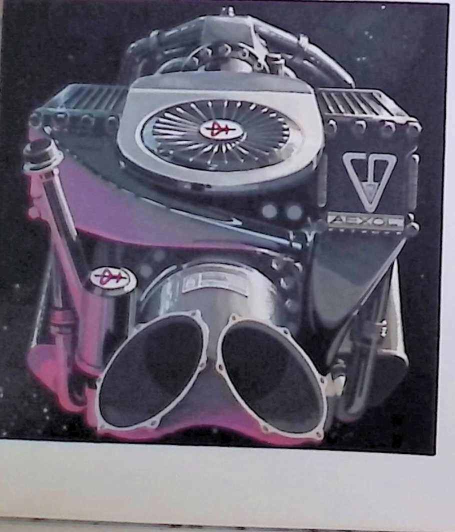
Whether a high performance vehicle is designed for highway use, test track work or competitive racing, the automotive engineers, designers and stylists profit by the valuable experience which is gained through racing such vehicles. Test results of racing competition augment the test data obtained during private track testing. The racing objectives are to achieve the lowest fuel consumption and best control, at the highest average speed on any kind of road or track. Competitive racing calls for the lowest weight, the utmost safety through stability and braking ability, the minimum fatigue through the optimum springing and steering control, and the maximum reliability of high performance engines.

Think of a 400 horsepower engine in a dry weight car of 1650 pounds. Such a car equipped with a gas turbine engine could attain 225 mph on a straightaway and accelerate like a rocket. The gas turbine engine's mechanical simplicity, small size in relation to power produced, power-to-weight ratio and stall torque characteristics are intriguing and its latent potentialities are great. The dynamic impact of the surprisingly simple gas turbine engine on the automotive industry continues to be felt. However, packaging for the envelope dimension limitations of race, truck, or passenger cars challenges the designer's ability to arrange turbine components to the utmost compactness if they are to be incorporated into present, confined engine compartments.

EXPERIMENTAL TODAY– PRACTICAL TOMORROW

The progress made by the automotive engineers with the gas turbine engine in its relatively short development life, plus experience in other fields with these engines, indicates that the gas turbine engine is inherently durable, feasible and reliable, with excellent prospects for eventual use in trucks, buses and passenger cars. Some of the highly desirable characteristics of this engine for such uses are: ability to operate on a wide variety of low-cost fuels; ability to start quickly after extended cold soaking; savings on size and weight; operation for prolonged periods without service; and smooth operation which gives a steady, vibration-free ride.

The engineers to date have achieved remarkable turbine design simplicity, since the gas turbine engine has relatively few parts. The gas turbine engine has about one fifth the parts of a reciprocating engine. It is small and light for the horsepower it develops. Its horsepower delivered at the output shaft about equals that of a reciprocating piston engine. Also, weight savings by design is clearly demonstrated with the gas turbine engine. Not only is the engine lighter, it saves both the space and the weight required by a radiator and liquid cooling system. And, because of the gas turbine torque characteristics, the gearbox can be made smaller and lighter.



Some of the troublesome operating drawbacks of the gas turbine for automotive use which have received the engineers' closest attention in order to make the gas turbine a competitive power source are: high fuel consumption; slow throttle response and acceleration delay; high exhaust gas temperatures; and excessive power roar. Also there are factors affecting engine durability and manufacturing costs. These engines require steels having high strength at red heat and depend for their safe and efficient operation on the ability of these steels to maintain their dimensions and adequate strength at these elevated temperatures over long periods of time. So, raising the temperature limits of steels used for gas turbine engines becomes increasingly important if gas turbine power is to be generated more efficiently and economically.

The high temperatures of the gases pose difficult problems in insuring durability of the turbine blades, since the physical properties of steel are affected by very high temperatures. However, the development of heat-resistant steels and the development of entirely new engine designs permit the engineers to accept such temperatures.

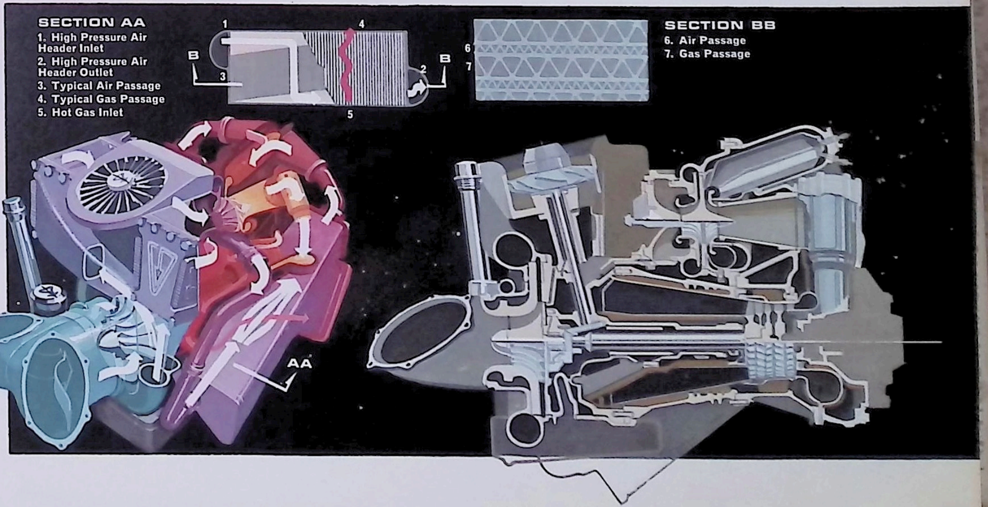
The problems resulting from the mechanical effects of centrifugal force are added to the problems of the high temperatures. Due to the centrifugal forces resulting from extremely high rotational speed, the blades are subjected to a tensile stress greater than the bending load produced by gas pressure on the blades' working faces. The tendency for blades to lengthen under the effects of centrifugal forces at high temperatures is called growth or creep. Special steels are needed to withstand these temperatures and the speeds of the turbine blade-tips, since the blade itself weighs only a matter of ounces, of which about 1/5th represents the actual anchorage. Resolution of these problems has been rapid.

Baffle filters that perform a double function as absorption silencers have reduced the noise, one of the major turbine engine problems, so successfully that it is little more than a whirr and approaches the piston engine in quietness. Also, stationary or drum-type regenerators transfer heat from the exhaust gases to the compressed air and recapture most of the exhaust heat formerly wasted. Consequently, fuel economy approaches that of the piston engine. At the same time, the excessively high and objectionable exhaust temperatures are reduced. A gas turbine's rate of acceleration is still sharply limited by the temperatures its parts can stand. If fuel is added too fast, those safe temperatures may be exceeded. While the gas turbine engine still won't reach its full speed range as quickly as a piston engine, it will accelerate from idle to full speed with open throttle in about three seconds.

The overall efficiency of the gas turbine engine continues to be improved as the maximum allowable temperatures are raised through the use of various alloy steels. For fifteen years United States Steel Research Laboratories have actively engaged in developing and testing such elevated temperature steels. In that time, they have developed special steels to meet difficult high temperature problems, alloy and USS Stainless Steels with improved high strength and resistance to extreme heat and high rotational speed.

TWO-STAGE CENTRIFUGAL COMPRESSOR GAS TURBINE ENGINE CYCLE

In operating principle this turbocharged gas turbine is simple. It receives its incoming air through carbon steel ducts located on either side of the car behind the passenger compartment. This air is then compressed in a first stage, centrifugal compressor. Pressure ratios of 4:1 at this point require compressor speeds of 40,000 to 50,000 rpm. The air is then fed through ducting to the two cross-flow type intercoolers. Here the intercooler fan, turning at 18,200 rpm and discharging into the plenum chamber, cools the air. This reduces the work, size and blade-tip speed otherwise required of the second stage or high-pressure compressor. From the intercoolers the compressed air flows through the high temperature alloy high-pressure compressor which runs at 91,500 rpm and where the air is compressed to an overall pressure ratio of 16:1. The relatively cool air then passes through the compressor scroll to the cool air side of the regenerator. Distribution channeling of this air within the Stainless Steel foil regenerator matrix air cells prevents thermal buckling. And, regenerator channeling of this compressor discharge air provides optimum heat absorption by maximum exposure of the air to the hot turbine exhaust cellular flow passages. As a result, less fuel is burned in bringing the air to its operating temperature. From the regenerator the highly compressed air enters the high temperature alloy can-type primary combustor. Low grade kerosene is sprayed into the combustor where combustion is continuous after a spark from the igniter plug ignites the mixture for starting. The high flow rate of the fuel injection nozzles provides a good spray pattern and efficient combustion. The resulting hot, expanded gases entering the high temperature alloy nozzle are accelerated and directed against the curved blades of the high temperature alloy radial inflow high-pressure turbine. This use of the gases to drive the turbine and high-pressure compressor reduces both temperature and pressure of the gases. So, these gases then pass to the reheat combustor. From there the hot, high pressure gases enter the power turbine nozzles which are fabricated from forged Stainless Steel. These nozzles are actually blades, generally similar in contour to the high temperature alloy steel turbine blades, against which they direct the gases. At the power turbine some of the heat and pressure is converted through an output shaft and planetary reduction gear into torque or rotary motion. More of the heat and pressure is used to drive the low-pressure turbine, which in turn drives the low-pressure compressor through an alloy steel shaft which is welded to the turbine wheel and splined to the compressor wheel. The remaining gases are further cooled by passing through the hot gas cells of the regenerator. In doing so they preheat the incoming relatively cool, high pressure air. Finally, the spent gases are exhausted through twin ports to the atmosphere.



THE PRINCIPLES BEHIND SPACE-FRAME DESIGN

Space-frame design is 3-dimensional structural application of the true truss principles in order to obtain a very lightweight, exceptionally strong and efficient frame structure.

The simple, basic principles are:

a. The correctly designed truss has only compression or tension forces acting on its members.

b. Such members are tremendously strong when subjected to compression forces but may be weak if subjected to bending forces.

c. Members in compression must be kept to the correct length. They may become flexible if too long and may tend to buckle under compression. In working practice usually it is better to keep compression members as short as possible.

d. A member in tension is exceptionally strong and this strength is not affected by its length.

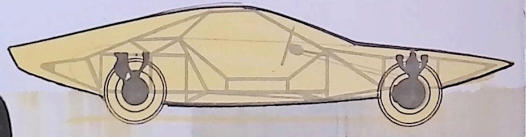
e. Eliminate any forces exerting a bending effect.

Although space-frames may seem to be complex structures, they all conform to these principles.

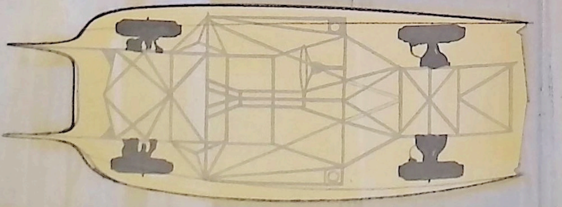
SAFE, LIGHT, RIGID AND STRONG

The scientific construction of light chassis and body work also owes much of its development to the demands of racing. There is no surplus sheet metal. The rigid space-frame body of this sports car has a multi-tube construction that provides maximum strength to the load-carrying members. Truss-like, such advanced type frames are made up of USS NATIONAL chrome molybdenum steel seamless tubing. This tubing, with a high inherent strength factor, is welded into a highly stressed frame. Since the individual members are stressed only in compression or tension and not subjected to bending stresses, the frame of this racing car has excellent torsional rigidity. Road strain, shock and deflections cannot distort or fracture it. Compared with other types of frames, it has the additional advantage of being very lightweight. This lightness makes itself impressively felt in the car's lightning acceleration and almost breath-taking high speed.

The very compact aerodynamic body, relieved of any structural functions, is also of very lightweight construction. Because of such body construction, simplicity and removal of structural strength requirements, body panels can be changed almost at will so that either major styling or running changes can be made easily. The body is securely fastened to frame outriggers and brackets so the body and frame form one rigid integral unit. This construction permits greatly reduced outside dimensions, a radical weight reduction and such total torsional stiffness and strength that this sports car can take relentless abuse and still be light enough to give top performance.



The rear mounted turbocharged gas turbine engine eliminates the usual radiator, liquid cooling system and the long drive line. This permits a slender nose, minimum frontal area design and good weight distribution. Streamlined styling minimizes turbulence and reduces the resistance of drag. The form evolved from a coordinated effort between styling and engineering wind tunnel tests offers minimum turbulence and maximum beauty.



AN IDEA STARTS A DESIGN— RACING PROVES IT

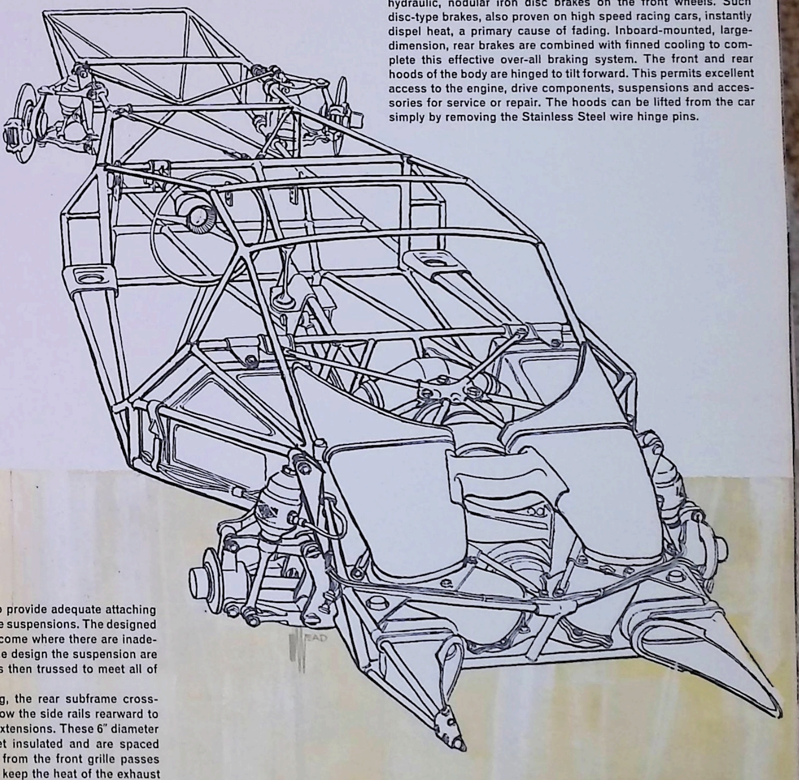
In order to permit the stylist and body designer as much freedom as possible the space frame is designed to handle all of the structural loads. Although supporting all these structural loads is the designer's first consideration, his choice of space frame design, plus the use of light gage chrome molybdenum steel tubing, results in an exceptionally low total structural weight. USS NATIONAL chrome molybdenum steel tubing has such high inherent strength that it is a logical choice as an ideal load-carrying member for space frame design. It resists stresses equally in all directions and gives a superior cross section. It absorbs and localizes shock. In torsion and compression it provides a better material distribution. And for a given weight, USS NATIONAL chrome molybdenum steel tubing withstands more load than any other comparable section. In this space frame design the main chords and lacings or web members are seamless tubing welded at common points to the chord. This creates a banding effect and the result is a lighter, stronger, more rigid and torsion resistant frame. The triangulated forward structure provides the necessary support bases for the front suspension, accessories, steering gear and linkage.

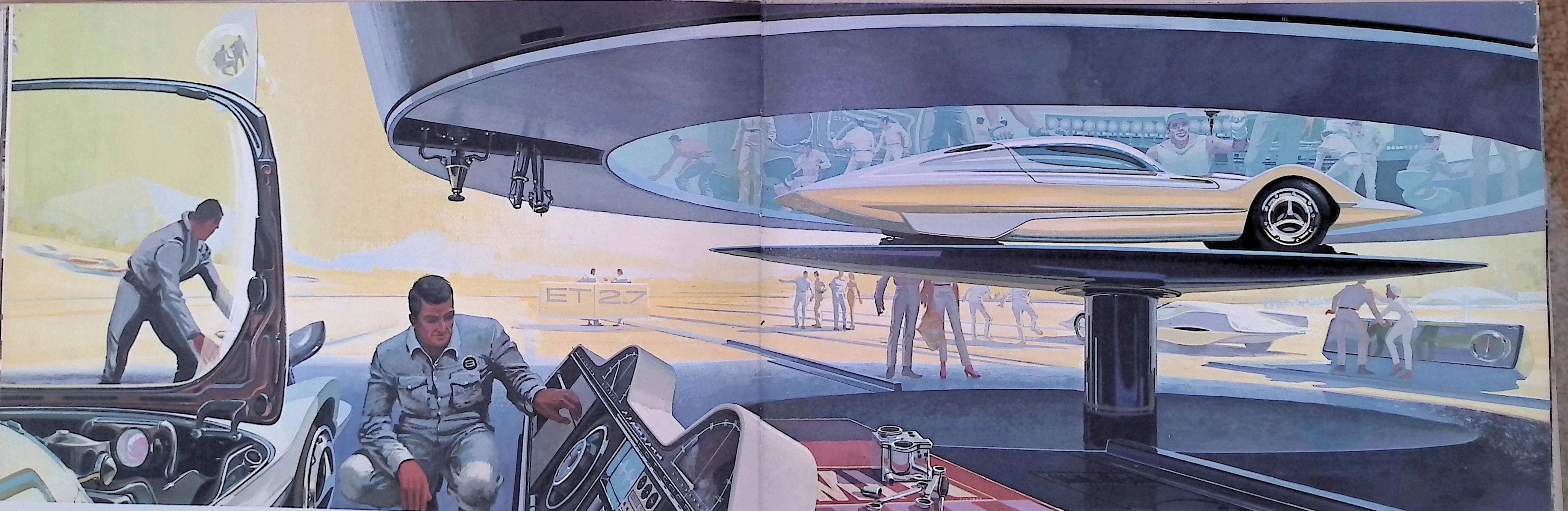
The large greenhouse requires a frame structure capable of providing the necessary rigidity to prevent deflection of the roof. Tubing, which forms the windshield and rear light pillars and headers, provides part of this necessary structure. It also doubles as roll bars with the capacity to take abuse—even the full impact of the car. Large body side sills prevent bending and add to the torsional stiffness throughout the passenger space section of the car. This body side sill design, the low door cut and the elevated roof provide optimum entrance and exit conditions. The feet can be swung easily to the ground and the head and shoulders are allowed to follow their natural path without stooping when the driver or passenger is sitting down or getting out. So, in spite of the car's low silhouette it is possible to enter or leave easily.

On any frameless type of body it is usually a problem to provide adequate attaching points which are correctly located and strong enough for the suspensions. The designed suspension points either come in awkward areas or they come where there are inadequate body structural members for this use. In space frame design the suspension are located in their optimum design-position and the frame is then trussed to meet all of the force angles.

For simpler manufacturing and easier engine servicing, the rear subframe cross-bracing is bolted together. The turbine exhaust tubes follow the side rails rearward to meet the twin exhaust ports at the ends of the rear frame extensions. These 6" diameter USS Stainless Steel exhaust tubes are asbestos-blanket insulated and are spaced away from the body panels by brackets. Finally, ram air from the front grille passes through the clearance space around the exhaust tubes to keep the heat of the exhaust gases from being transmitted to the passenger compartment.

Safety under all driving conditions is provided in this car by the hydraulic, nodular iron disc brakes on the front wheels. Such disc-type brakes, also proven on high speed racing cars, instantly dispel heat, a primary cause of fading. Inboard-mounted, large-dimension, rear brakes are combined with finned cooling to complete this effective over-all braking system. The front and rear hoods of the body are hinged to tilt forward. This permits excellent access to the engine, drive components, suspensions and accessories for service or repair. The hoods can be lifted from the car simply by removing the Stainless Steel wire hinge pins.





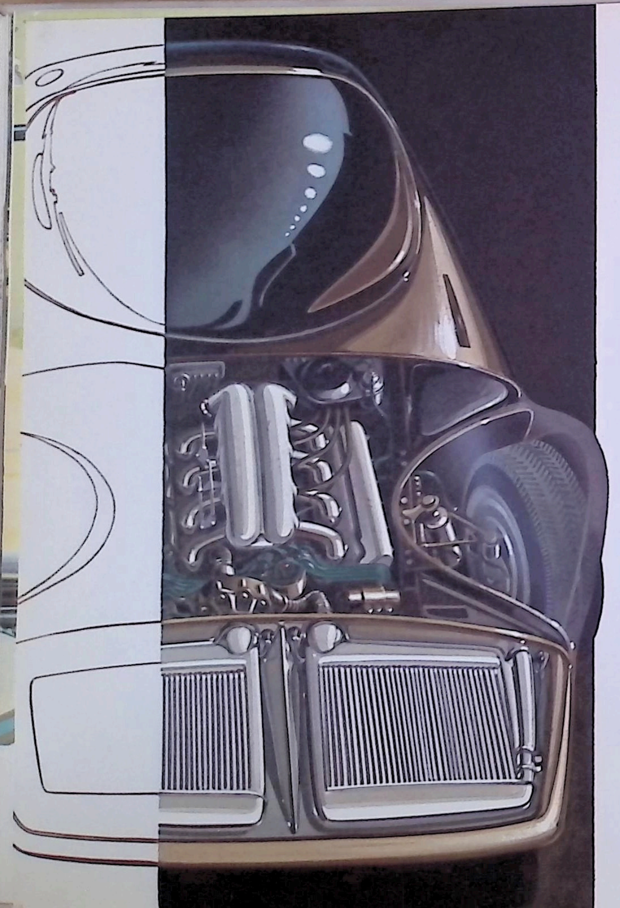
STAMPING—AN ANSWER TO LOW VOLUME ENGINES

The development and adoption for vehicular use of the sophisticated future engines will still leave a place for the piston engine. For years the piston engine has demonstrated its constantly improving staying powers and impressive qualities of reliability, speed and acceleration. Improved manufacturing techniques, combined with imaginative engineering, often lead to practical design innovations such as this combination stamped Stainless Steel and precision cast, opposed 8-cylinder engine.

MAJOR SPECIFICATIONS:

Type	8-cylinder opposed
Bore	3.00 inches
Stroke	Various, to meet cubic inch displacement desired
Camshafts	Dual, forged alloy steel
Crankshaft	Forged steel, one-piece, circular cheeked
Connecting Rods	Stamped carbon steel
Crankcase	Precision cast, thin-walled nodular or gray iron
Compression Ratio	Up to 14:1
Maximum Power	Develop at 6500 rpm. Red-line at 8000 rpm. Test to 10,000 rpm.

This practical, high-performance engine combines lightness with brute power and is designed to develop a minimum of one horsepower per pound. Its design greatly reduces tooling requirements and simplifies manufacturing techniques to allow efficient, limited production. Displacement is optional with a common bore size through a choice of crankshafts and camshafts.



HIGH HORSEPOWER ON A LOW BUDGET

Until the production quantity in a given engine size is significant the capital expenditure to tool up is not economically feasible. In limited production of varied horsepower engines the complete group of engines produced should maintain a close design relationship. Controlling engine designs in this manner provides maximum interchangeability of identical parts as well as lowest cost parts. This limited production, stamped Stainless Steel and nodular or gray iron engine is one which would fit into such a controlled design plan. The engine calls for a minimum variety of patterns, equipment and tooling. Its simplicity offers a definite advantage in foundry and machining procedures. The unique construction features of this engine offset the cost of Stainless Steel from which it is fabricated compared to the low cost of cast iron used in conventional engines. It requires about one-third the machining needed on a comparable cast engine. The use of 0.055 inch Stainless Steel compared to a ¾ inch casting explains the remarkable weight savings. In addition to low weight, Stainless Steel provides superior strength and high corrosion resistance. The use of thin Stainless Steel sections gives a rapid, uniform heat dissipation. The uniformity of its wall thickness minimizes troublesome "hot spots," a common cause of cooling problems.

The prime feature of this lightweight engine is its use of formed Stainless Steel cylinder blocks. These blocks are formed from copper plated Stainless Steel, which is also used for the combustion chambers, cylinders, water jackets, intake and exhaust ports, upper housings and spark plug tubes. Fabrication of this engine begins with flat sheets of Stainless Steel trimmed to size. Intake and exhaust ports are punched and the sheets are then formed into the sides and bottom of the engine blocks. Stamped water galleries are tack-welded to both sides of the blocks. Copper paste, brazing wire and foil are applied to all joints as the components are added.

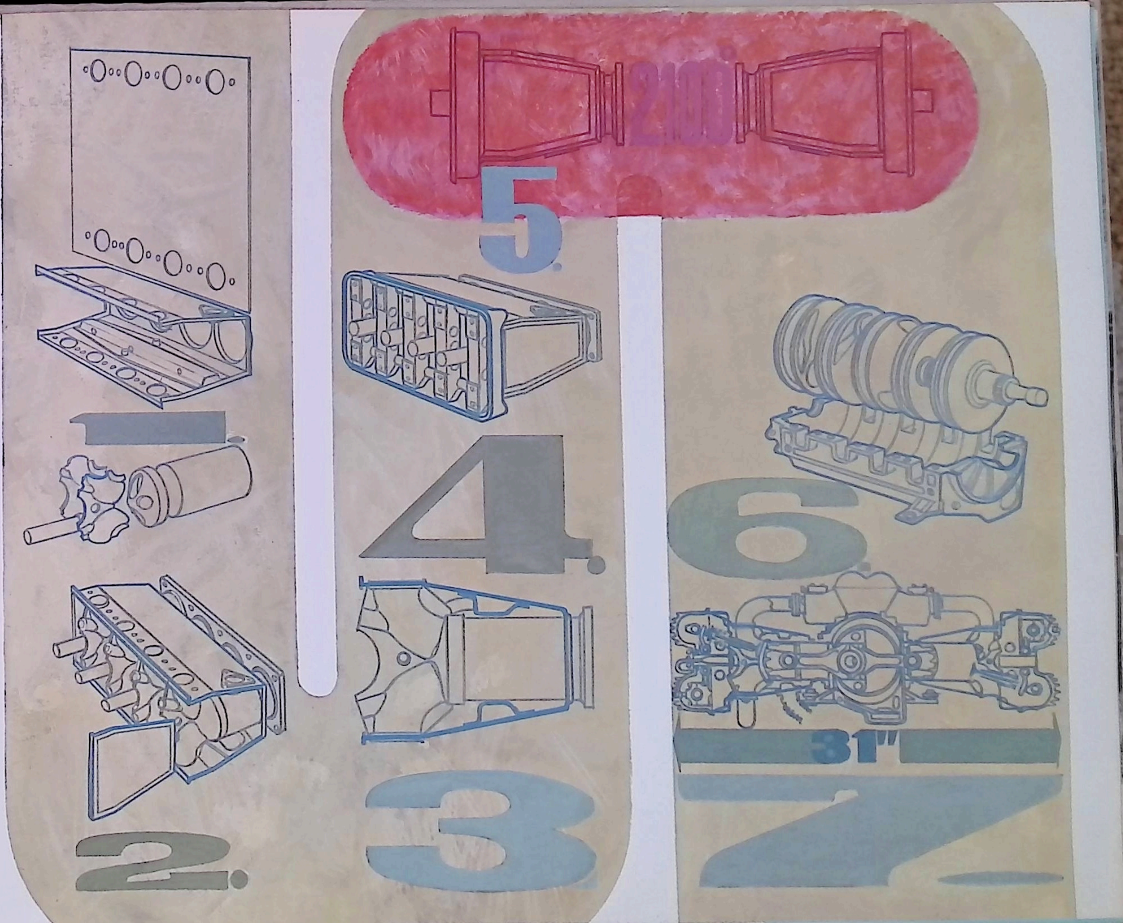
Individual Stainless Steel tubes, with high wear-resistant chrome molybdenum steel liners, form the cylinders. Combustion chambers and ports are formed of Stainless Steel. These and the spark plug tubes are inserted in the blocks.

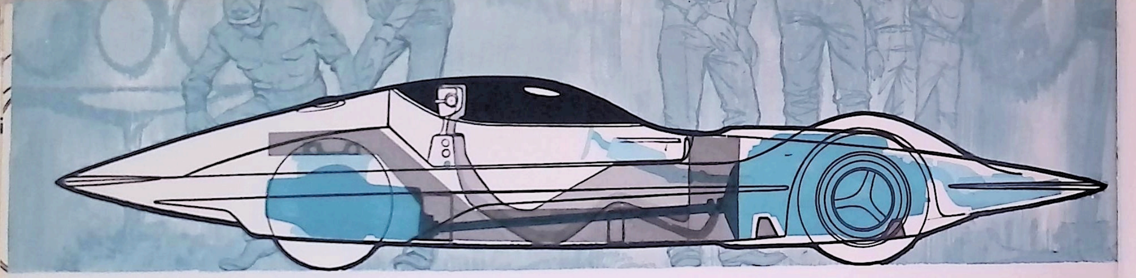
End sections of the blocks are placed in position and the tops of the blocks are fitted. When all components are in position they are tack-welded at several points to maintain accurate alignment. Then all parts of the entire blocks are joined by brazing in a hydrogen-filled oven at 2100°F. At such temperatures the copper flows into every crevice so a metallurgical and mechanical bond is obtained. These brazed engine assemblies are then fully annealed. Distortion in this engine is held within 0.002-inch. No cleanup and little finish machining is required. This unitized block design, plus Stainless Steel's high strength, permits exceptionally high compression ratios.

Variable displacement is readily possible by changing the crankshaft to change the stroke. Timing is modified by changing the forged alloy steel cams which ride in five plain bearings. The cams are driven by a combination alloy steel gears and carbon steel roller chains. The cam drive cover cases which are made of nodular or thin-walled gray iron provide extra stiffness to the assembled engine. All of the different displacement engines weigh approximately the same.

The forged steel, circular-cheek-design crankshaft with its rugged construction and shorter length has greater stiffness than a conventional crankshaft. In this design the cheeks form the main journals and are encircled by main roller bearings. Such a design permits an extremely short engine length and a minimum distance between the cylinders. The use of forged steel, the short crankshaft length and the exceptional bearing support area all reduce deformation, vibration and torsional stresses of the crankshaft.

New production techniques now permit precision casting and weight reduction of such gray iron or nodular iron parts as the crankcase and cam drive cover. The secret is the thinner walls of these new castings. They have a wall thickness of approximately 0.10 inch compared to 0.14 to 0.15 inch in ordinary cast iron castings. Such thinner castings weigh less for a given size.

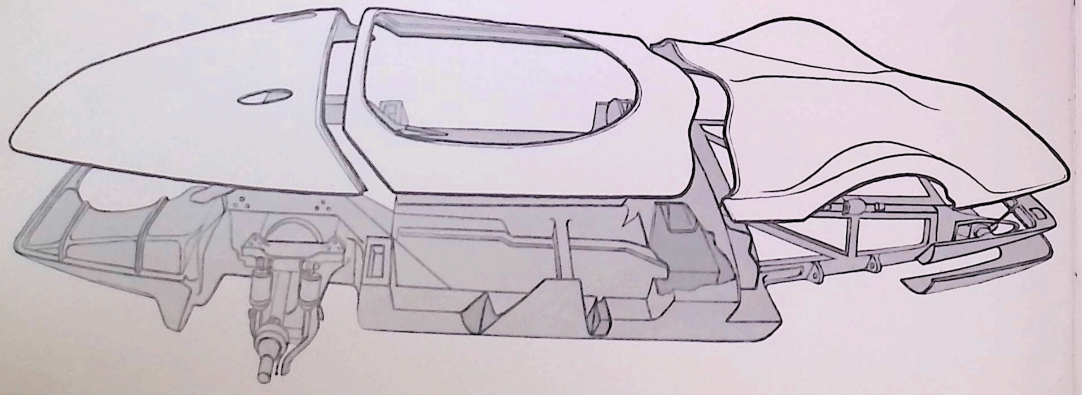




THE PLAN — TO PROVE AND IMPROVE

This integral, carbon steel, stressed-skin body design has been proven in searching tests under the severe conditions of the race course. Based on a combination of deep configuration, monocoque principles and carbon steel tube front and rear stub-frames, it is a remarkably rigid structure with a worthwhile savings in weight. The flat-mounted, thin radiators, with their integral Stainless Steel expansion tanks and the 180° engine, permit a low frontal area design. Bulkheading between the engine and radiator compartments provides unrestricted ram air flow through the thinner, twin radiators.

For easy and economical servicing, the forward and rear stub-frame assemblies permit quick removal of the complete front or rear end mechanical components which include the engine, transaxle, suspensions and wheels. Rubber insulating the stub-frames at their mounting points on the main frames isolates road noise and harshness from the passenger compartment.



Stressed steel skin, or monocoque construction, contributes to a high exploitation of available body space. Location of the essential units, such as fuel tank or batteries, can be planned with regard to space needed, weight distribution and functional requirements. Wheel housings, engine and trunk compartments can be designed as integral parts of the load-carrying structure.

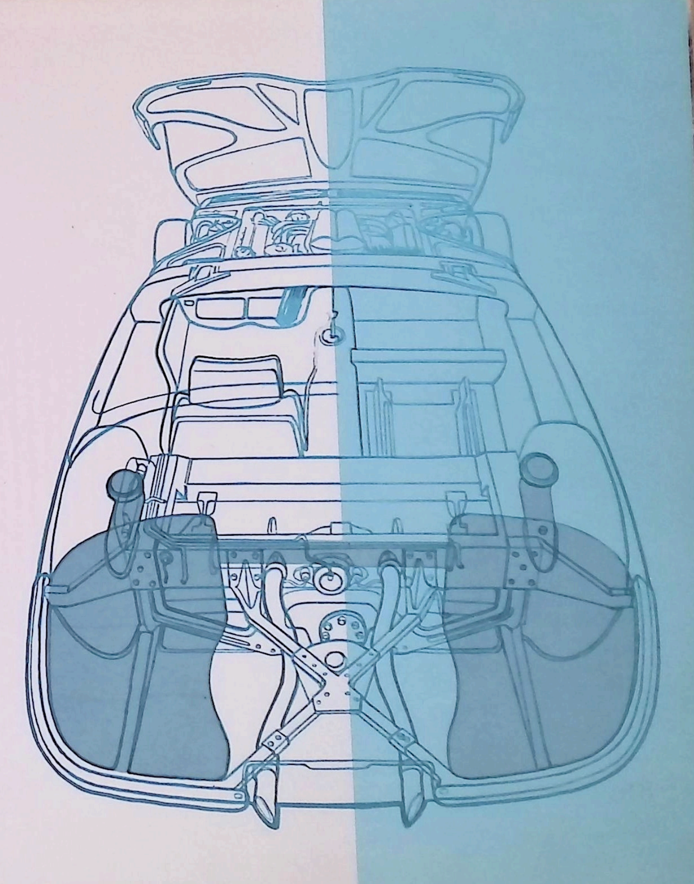
The stiff central body assembly is fabricated from galvanized carbon steel. The deep configuration used in the body shapes provides a significant contribution to structural stiffness. The basic structure consists of two large, box-section longitudinal members, one on each side of the body shell. These are built-up from the outer skin panel and inner body sill. They are maximum size for rigidity but do not obstruct the passenger entry or exit. Two large vertical box-sections form the front door hinge pillars and are welded to a very deep box-section structural crossmember, which forms a combination cowl and instrument panel.

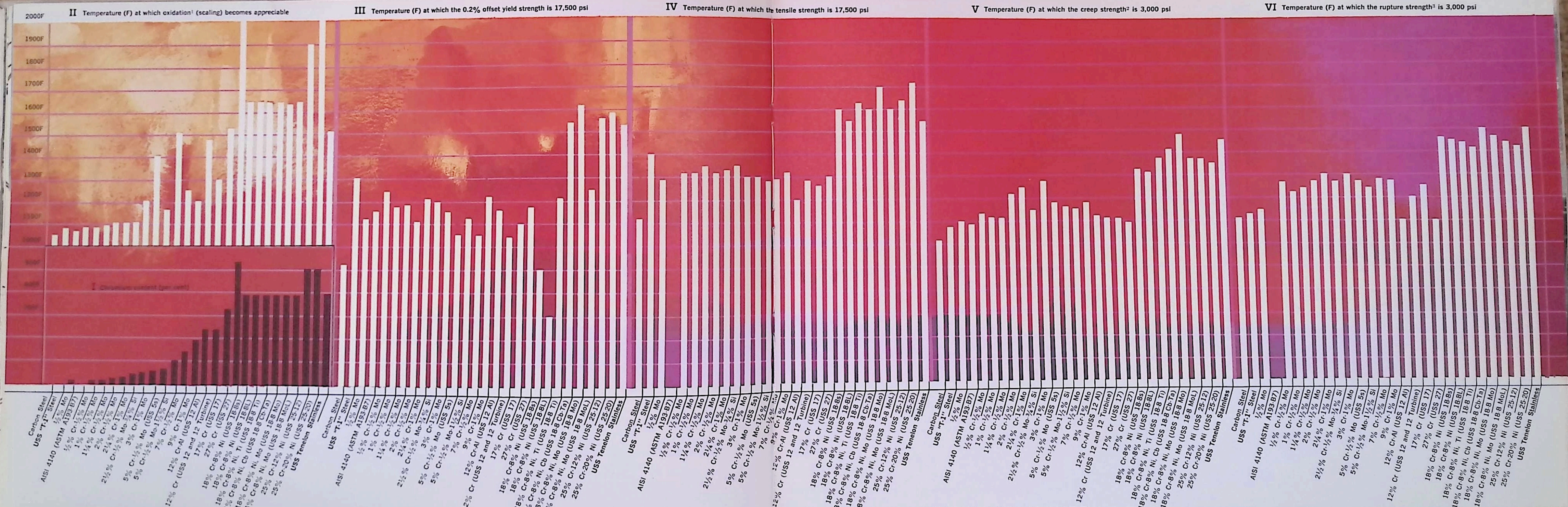
At the rear, the deep, stamped steel, box-section longitudinal members extend through the "frame kick-up." A rear, box-section crossmember ties the ends of these longitudinal members together. In front of the transaxle assembly another box-section member forms an additional cross-body structure between the rear wheel housings. Finally, a panel across the top of the rear wheel housings is also boxed for still further stiffness. These heavy gage members provide the necessary pivot points for the suspension arms and a base for mounting the transaxle and springs.

The forward stub-frame is a unique assembly of square-section, USS NATIONAL steel tubing onto which the engine, front suspension, steering gear, and linkage are mounted. For manufacturing and replacement simplicity this stub-frame is made up of two triangulated side members and a deep front crossmember, all bolted together. This bolted-together construction, even though it may impose a slight weight penalty, facilitates servicing and repair.

Since this stub-frame carries the entire load forward of the dash panel, the carbon steel front hood and fender panels are unstressed. This bolted-together, 3-panel construction reduces repair costs of minor accidents. Excellent access to the engine and suspension is obtained by hinging this hood section to swing forward.

The resultant monocoque structure has a high degree of rigidity and it is also light. Use of large panels makes it an easy structure to assemble, and fabrication is not difficult on a large volume.



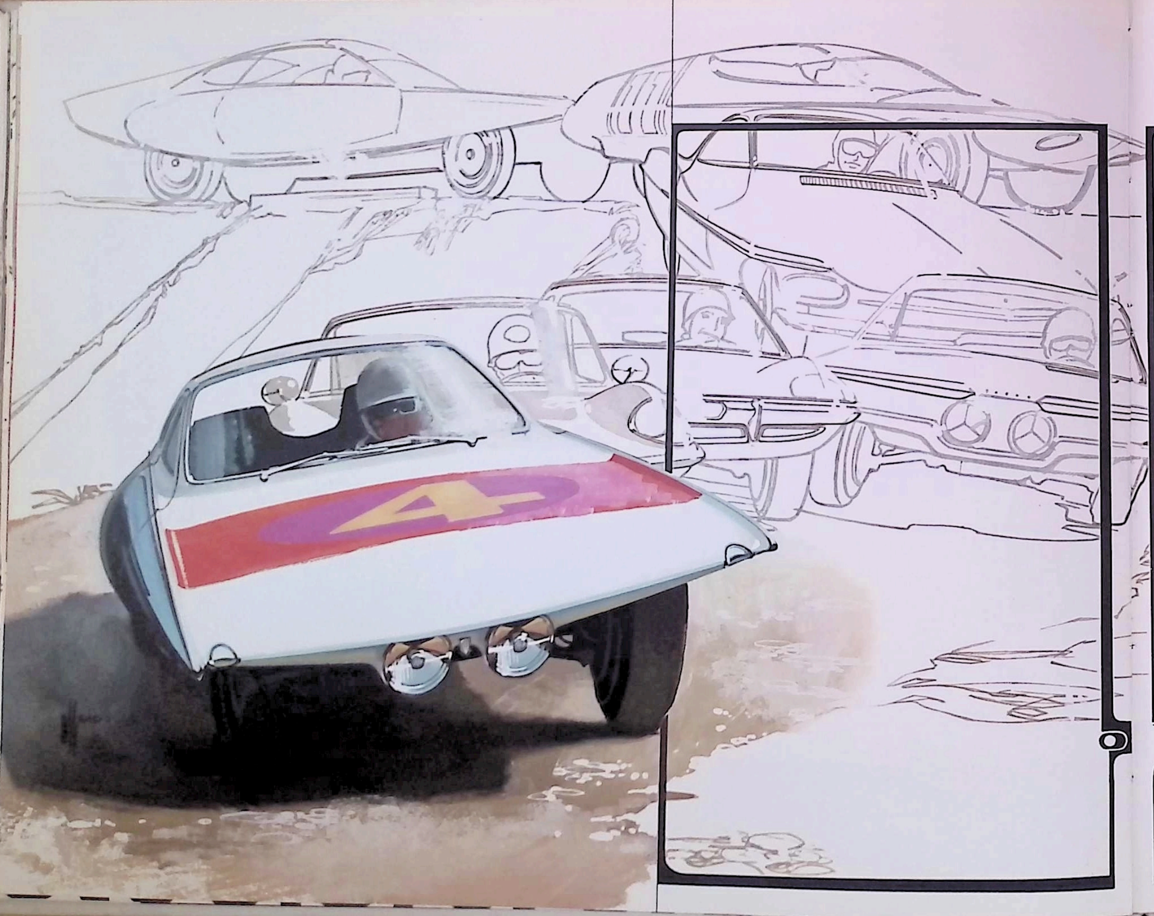


(1) Weight gain of 10 mg per sq. cm in 1,000 hours

(2) Stress for a creep rate of .0001% per hour (1% in 10,000 hours)

(3) Rupture time of 10,000 hours

steels for elevated temperatures



TYPICAL MECHANICAL PROPERTIES

STAINLESS STEELS

	Type 301		Types 302, 303 and 304	
	¾-Hard	Full Hard	An-nealed	Cold Worked
Endurance (Fatigue) Limit (1,000 Lbs./Sq. In.)	—	80,000	30-55	40-120
Modulus of Elasticity (1,000 Lbs./Sq. In.)	Type 301 = 28.0		28	28-26
Tensile Strength (1,000 Lbs./Sq. In.)	175,000‡	185,000‡	75-95	105-300
Yield Strength (1,000 Lbs./Sq. In.)	135,000‡	140,000‡	30-45	60-250
Elongation in 2 in. (%)	12‡	9‡	60-50	50-2
Reduction of Area (%)	—	—	75-60	65-30
Rockwell Hardness	C37‡	C41‡	B75-90	C5-58
Brinell Hardness	—	—	135-185	—
Keyhole Charpy Impact (Ft. Lbs.)	—	—	70-90	—
Stress (1,000 psi) for a Creep Rate of 1% in 10,000 Hrs.				
At 1000°F, Lb./Sq. In.	—		17,600**	
At 1200°F, Lb./Sq. In.	—		6,900**	
At 1300°F, Lb./Sq. In.	—		3,900**	
At 1500°F, Lb./Sq. In.	—		1,400**	
Scaling Temperature, °F (approx.)	1500		1650	
Forging Preheat Temperature, °F	1500-1600		1500-1600	
Initial Forging Temperature, °F	2100-2300		2100-2300	
Finishing Temperature, °F	1600-1700		1600-1700	
Annealing Treatment, °F	1900-2000 and Quench		1900-2000 and Quench	

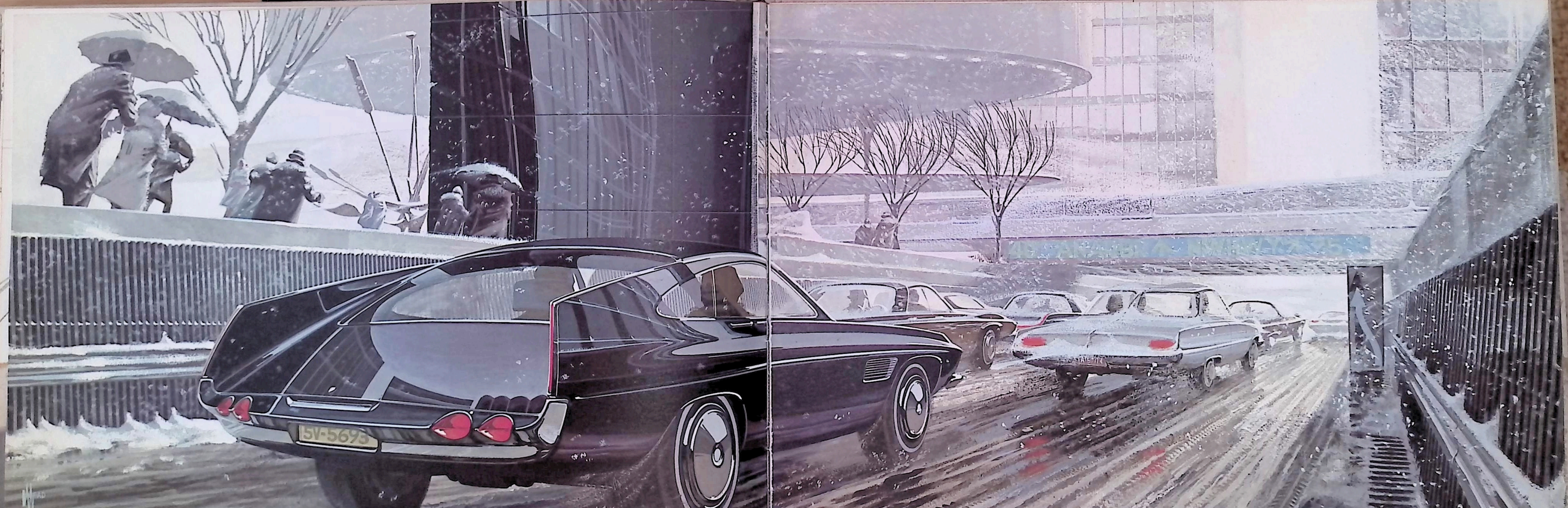
**Undetermined for Type 303.
‡Minimum values.

AMERICAN PIG IRON

American Steel and Wire 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 can be made stronger than gray iron. Ductile iron offers the reliable, all-around satisfactory performance of gray iron and permits weight saving and other economies. When required ductile iron may be produced which has specifications one might expect from steel:

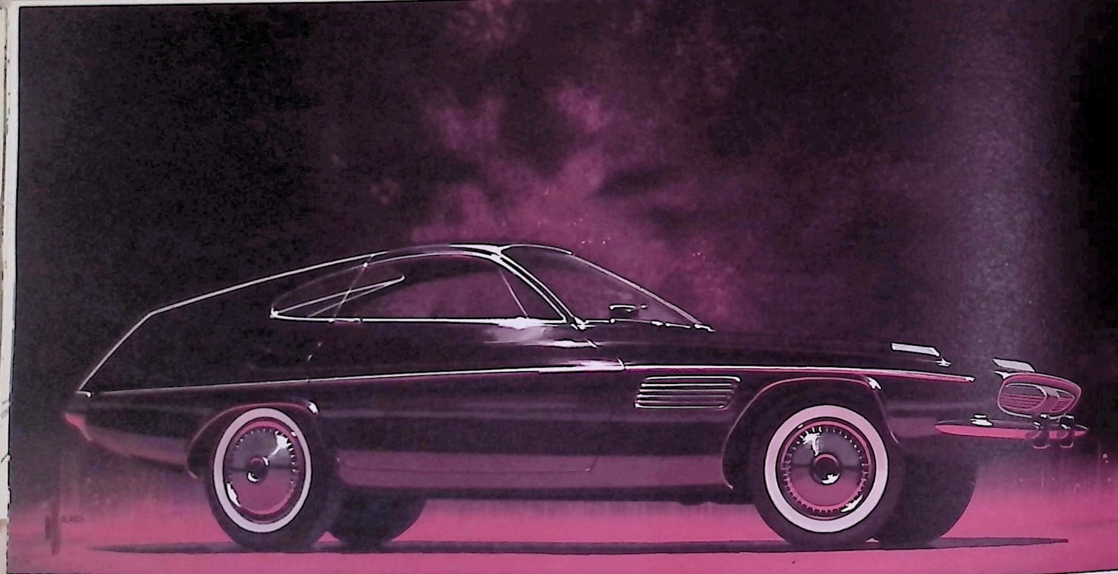
Tensile Strength	**60,000 psi min**
Yield Strength	**45,000 psi min**
Elongation	**15 percent min**

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.



INCREASING STEEL'S LIFE SPAN

Weather will always be with us, and too often it is "dirty weather." Dirty weather to a motorist quite often means worry over corrosion from sodium and calcium chloride salts and cinders used on northern roads and thoroughfares for deicing. These corrosive conditions, plus corrosion problems resulting from the box-type construction of unitized bodies, have resulted in an increased emphasis on precoated metals. Such metals as aluminum-coated steel, galvanized steel, chrome plated USS PAR-TEN steel and USS Stainless Steels have become the work-horses for effective corrosion resistance and control. There are many advantages in using these steels. They provide uniformity of appearance; they have a low product cost, especially for mass produced parts; they furnish a good paint base when the surface is given proper preparatory treatment; they improve the product durability through their good corrosion resistance; and they withstand severe forming.



Bumpers
Impact
Abrasion
Stone Pecking
Pitting

Exhaust Systems
Heat Differentials
Acids
Peeling
Road Salts
Moisture
Impact

Step Plates and Gravel Shields
Abrasion
Moisture
Erosion

Door Sills and Rocker Panels
Internal Moisture
Stone Pecking
Abrasion
Street Chemicals

Underbody
Wheel Splash
Road Salts
Road Dirt
Crevice Corrosion
Stone Pecking

Wheel Covers
White Sidewall
Detergents
Road Salts
Scratching
Pitting
Stone Pecking

Exterior Trim
Denting
Moisture
Street Chemicals
Scratching
Pitting

CORROSION RESISTANT STEELS PROTECT VITAL BODY PARTS

The areas of automotive vehicles that are subjected to abrasion, denting, pitting, moisture entrapment and crevice or joint corrosion are of major concern in corrosion protection. Protection to these areas is particularly important in unitized body construction since structural framing member strength may be jeopardized by premature corrosion. The precoated metals, especially galvanized steels, are successfully controlling corrosion. Parts now made of precoated steel, but formerly made of low carbon steel, give much longer life under normal use.

Galvanized steel is especially prepared to take an ultra-smooth, lasting paint finish. The hot-dip zinc coating prevents rusting when the paint is damaged and gives protection from corrosion where there is no paint at all. It is compatible with phosphate protective systems in common automotive use. Body assemblies, whether cold rolled carbon or galvanized steel, can be treated for painting at the same time. Separate, special painting preparations are not required. Galvanized steel withstands severe deformation without losing its corrosion resistance, for the Zinc coating flows with the base metal without chipping, peeling, flaking or powdering.

Although precoated steels are corrosion resistant as long as their coatings are unbroken, there is a tendency for sheared edges, punched holes, score marks and sometimes severely stretched areas to constitute potential corrosion areas. This tendency is offset in galvanized steels by the "self-healing" galvanic action of the coating.

BETTER CORROSION RESISTANCE AND A BRIGHTER FINISH

Exterior bright trim parts require superior dent and corrosion resistance, good strength characteristics and good ductility. USS Bright Annealed Stainless Steel strip has these characteristics, plus a mirror-like finish that holds through forming operations with only normal precautions. Since the bright finish minimizes the need for costly buffing and pickling operations finishing costs are greatly reduced. This USS Bright Annealed Stainless Steel strip passes the CASS and other corrosion tests and provides the greatest corrosion resistance of any of the straight chrome Stainless Steels.

Only Stainless Steels come close to meeting the many requirements of wheel covers and caps, many of which are almost mutually incompatible: springiness, formability, dent resistance, dimensional stability, corrosion resistance, scratch resistance and brightness. Wheel covers and caps made of USS Stainless Steel shrug off the effects of road chemicals, moisture, detergents and white sidewall cleaners. Moreover, they stay strong, rigid and retain their rich luster.

USS Stainless Steel contributes its crisp styling, prestige and beauty to front and rear end designs. Engineers are becoming increasingly aware of its prestige-building appeal for grilles, head and tail light bezels.

It is a difficult design problem to integrate the need for structural durability in bumpers with the over-all body concept. From both the structural and aesthetic standpoint USS PAR-TEN steel plays a part here. Fabricated USS PAR-TEN steel bumpers offer an unmatched combination of strength and beauty. They are easily formed and may be worked into a variety of front and rear designs. These bumpers are repairable by straightening, welding and buffing—all relatively simple operations. For protection and impact strength with light cross-sections, USS PAR-TEN steel offers excellent design possibilities for bumpers and bumper guards.

BETTER RUST PROTECTION BY BETTER PLATING

Better performance and appearance can be realized from nickel-chromium plating over USS cold rolled carbon steel or USS PAR-TEN steel using semi-bright plus bright nickel in multi-layer coatings, rather than by increasing the thickness of a single nickel layer. The thickness ratio of the two layers of nickel is an important factor. Successful results have indicated that the ratio of semi-bright to bright should be approximately four to one. Two important advantages of the multi-layer coatings are greater resistance to corrosion and impact.

TYPICAL FORMING PROPERTIES OF CARBON STEEL COMPARED TO MORE CORROSION RESISTANT STEELS

Mechanical Properties	C 1010 Carbon Steel as a Standard	Pre-Coated Steels		Stainless Steels		
		Galvanized	Aluminum Coated	Series 200	Series 300	Series 400
Yield Strength X1000, psi	25—30	30—40	35—45	55	40	40
Ultimate Strength X 1000, psi	40—45	45—55	45—55	105	90	70
Modulus of Elasticity X_{10}, ⁶ psi	29	29	29	28	28	29
Elongation, % in 2 inches	35—45	25—35	23—33	55	60	25—30
Yield/Tensile Ratio	0.67	0.73	0.82	0.52	0.44	0.55

Since C 1010 carbon steel is widely used in automotive body designs and its forming characteristics are well known to engineers it is used as a comparison standard in the above chart. Steels with properties less favorable than the properties of C 1010 carbon steel will naturally put great limitations on design creativity while steels with superior properties will allow much greater design and manufacturing freedom.

It will be noted that galvanized steel does not have as favorable mechanical properties as plain, uncoated carbon steel. However, drawing performance on a wide variety of stampings have proved successful.

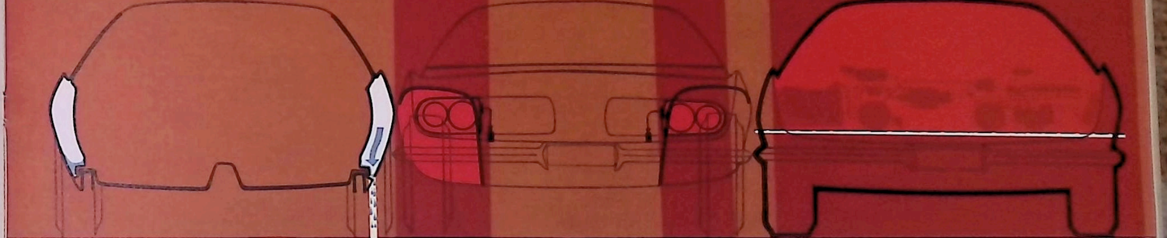
The 200 and 300 series Stainless Steels are considered the best drawing steels. Their very large elongation and favorable yield/tensile ratio combine to permit extreme stretch without local failure. In the 200 series, and to a lesser degree in the 300 and 400 series, the higher ultimate strength and yield strength requires higher blankholder pressure and greater punch loads.

The 400 series steels are somewhat less formable because the elongation is less for steels in this series than for C 1010 carbon steel. The 400 series Stainless Steels are limited to the less severe draws—the draws where multiple operations are permitted.

It is true that plastic coated steels will stretch the same as the uncoated steels. However, they do not flow well through the blankholders and consequently present serious problems. Therefore, forming is limited to bending, rolling or stretch forming.

$3Fe+2CO=Fe_3CO$

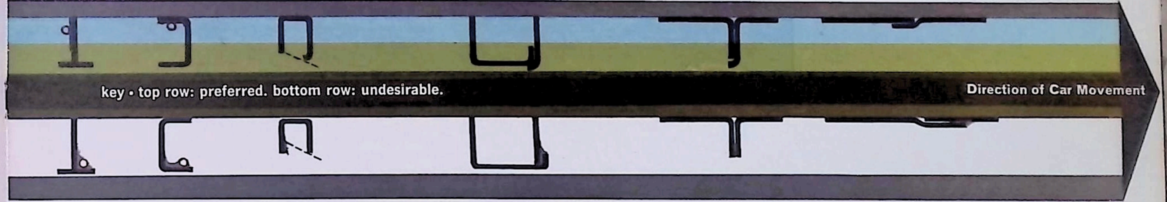
CONTROLLING CORROSION BY DESIGN



Wherever possible avoid box section design and enclosed channels below the floor pan.
Design door sills and rocker panels to avoid entrance of wheel splash.
Slant drain channels to the rear and keep openings large so as to avoid plugging.
Design drain openings on the inside of the outer door panels.
Allow for priming of internal surfaces of cavities, panels, sills and doors with protective coatings.

Avoid horizontal flanges and ledges below floor pan to keep road dirt and deicing salt from accumulating.
Design fender side shield contours so splash is directed away from engine compartment.
Design underfloor flanges as narrow as possible. Turn them away from the nearest wheel.

Mount electrical components as high as possible on engine, fender side shields or dash panel for protection from splash.
Protect tail, direction signals and parking lights from wheel splash.
Provide tight seals around starter mounting flange and all openings into bell housing.



Clip wires along the side of the frame rail or the bottom side of the rail top flange. Place connectors so as to minimize splash.

Design all channels so as to keep road dirt and deicing salts from accumulating. Lengthen or roll flange away from the direction of the splash.

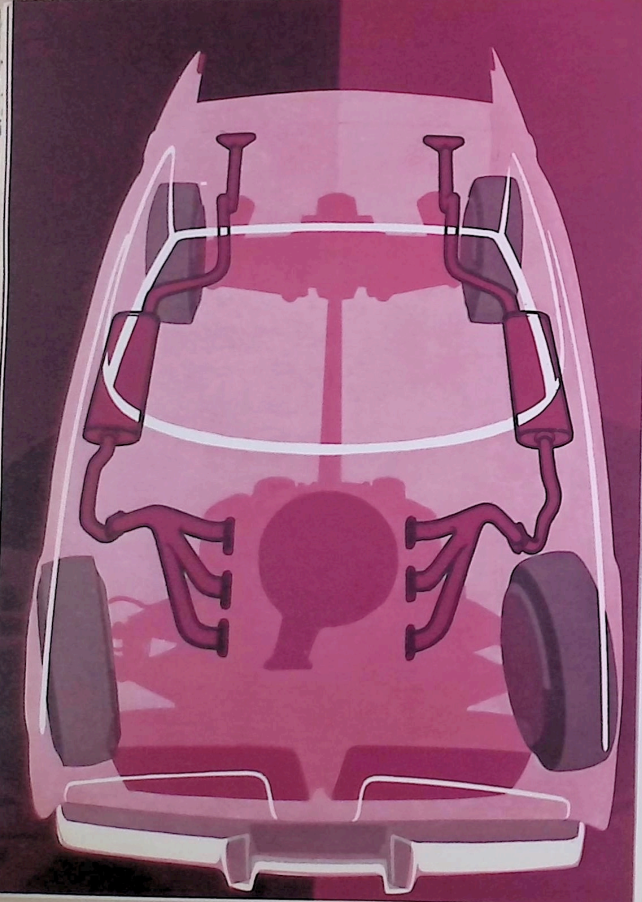
Flange the joints in the path of wheel splash so water, deicing salts and road dirt cannot be driven between the jointed surfaces.

Always keep flanges as narrow as possible and seal off the flange edge by rolling it away from the direction of wheel splash.

If more than one panel is used for the floor pan, make sure the front panel laps **over** the rear panel. This will minimize the entrance of water and road splash.

EXTRA CORROSION PREVENTION MEASURES

There will be fewer rust damaged cars because of the increasing use of corrosion resistant steels. Further protection measures that can be taken against corrosion are assurance that the steel bodies now will outlast all other parts. This added protection is provided largely by special processes before, during and after body assembly. Joints, seams, edges and surfaces subject to corrosion are sealed with caulking compound, asphalt felt or other sealers. After assembly, cavities and pockets may be protected with various primers, zinc-rich bituminous coatings, rust inhibitors or gunk. These are applied by flow coating, immersion dipping or spraying with long-nose pressure guns as an undercoat and in a thinner consistency as an interior coating. These coatings avoid unprimed pockets, protect unreachable crannies and nooks that can rust and dangerously weaken important load-bearing framing members. If a spot is missed by the spray or if some of the undercoat is scraped from the understructure, "creeping" or capillary travel by these rust inhibitors will cover the voids. Primer paint coats followed by sprayed synthetic paint or enamel complete the corrosion protective measures.



IMPROVING EXHAUST SYSTEM LIFE

In addition to silencing the engine and conducting obnoxious gases to the rear of the vehicle, the muffler and exhaust system assures a free-breathing engine and preserves its full power. The merits of an exhaust system can be determined by how well it quiets both high and low frequencies with the least power loss, by the least amount of space it requires and by how well it lasts.

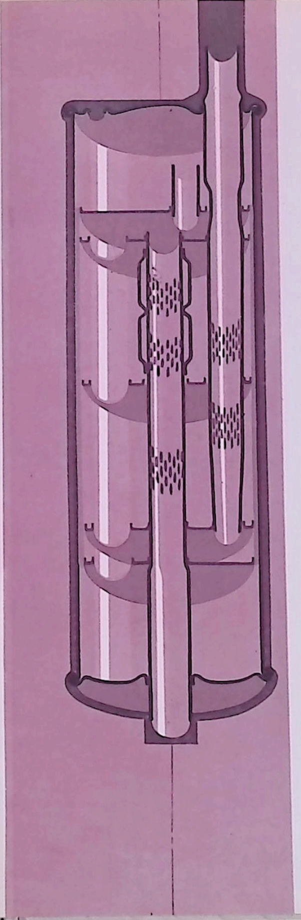
Popularity in recent years of V-8 engines has led to the use of dual exhaust systems which, in their complexity, have doubled the maze common to the earlier, more conventional systems. These high performance engines also necessitated higher octane gasolines with more and more lead compound added. While lead in itself is not a corrosive element, certain properties of the fuel and the additives to the fuel change during combustion to highly corrosive acids, such as sulfurous, sulphuric, hydrochloric and hydrobromic acids. Tests have indicated, for instance, that increased quantities of ethylene di-bromide, which produces hydrobromic acid in the exhaust, play a heavy role in increasing muffler corrosion rates. Another part of the problem is increased engine displacement and compression ratios which increase fuel consumption, especially in start-and-stop driving. As more fuel is burned more exhaust gases are produced and the quantities of corrosive by-products are increased. Warm-up of the dual exhaust system is slower than in single exhaust systems. This delay causes a greater deposition of corrosive condensate to collect in the muffler.

Driving habit patterns are a prime factor in muffler corrosion, especially start-and-stop, short distance driving. In addition to these highly corrosive chemicals the internal combustion engine also produces about one gallon of water for every gallon of fuel consumed. These chemicals and the water must pass through the exhaust system to the atmosphere. In passing through the cool exhaust system this solution of chemicals and water coats the internal muffler surfaces and collects at the bottom of the mufflers. Under the worst start-and-stop driving conditions this condensate remains in the mufflers and tailpipes longer, vaporizes slowly and therefore exerts a great corrosive effect on the steel.

Many ideas have been tried to rid mufflers quickly of this collected acid condensate, among which are: ventilation to accelerate gas passage; drainholes in the muffler bottom; and aspirators to suck the condensate from the bottom of the muffler and expel it. However, these do not wholly solve the problem because checks of failed mufflers indicate they also fail at the top where condensate does not collect in a puddle.

Research has also shown that maximum exhaust system corrosion takes place within the temperature range of 170°F to 190°F, with a peak of about 185°F. In start-and-stop, short distance driving the exhaust system seldom gets beyond this temperature range of greatest corrosion.

At present a practical solution to the problem of increasing exhaust system life is to use steels that are resistant to corrosion from combustion by-products. The ability of USS Stainless Steel to withstand elevated temperature differentials for long periods of time and its ability to resist highly corrosive environments under such conditions makes it economically the best steel for service on mufflers and tailpipes. Service temperatures run as high as 1300°F with the presence of accompanying corrosive acids formed from present day fuels such a factor that only



Stainless Steel should be actively considered for premium exhaust systems. It is formable and weldable; and, commensurate with the service life afforded and the high degree of protection given, it is not prohibitively priced. But, where cost is the determining factor and a high degree of protection is still required, a combination of steels is the answer. In such cases, the corrosion susceptible package consisting of heads, inner shell and inner parts can be made of Stainless Steel and the outer wrap and other internal parts can be made of aluminum coated steel or galvanized steel.

A good overall choice for increasing muffler life in most high production cars built today would be aluminum coated steel mufflers or combinations of aluminum coated and galvanized steel mufflers. Corrosive condensates and their effect on mufflers can now be controlled to an acceptable limit on most car applications by the use of these precoated steels along with improved muffler design. Such durable quality corrosion-resistant mufflers and tailpipes can be manufactured at a practical cost. Use of these corrosion-resistant, precoated steels inside the muffler as well as in the outer package stops corrosion where most of it usually starts—inside. Aluminum coated steels are used for high temperature as well as low temperature corrosion conditions. Hot dipped galvanized steels are used for most cold temperature corrosion conditions. The use of precoated steels for the shell wraps protects the muffler against impact, abrasion, road salts, heat, cold and moisture. A laminated, asbestos-insulated, wrapped shell construction assures better acoustical deadening. This construction consists of a layer of asbestos covered by an external layer of steel. It is one of the reasons why the higher cost muffler systems are velvety quiet. The asbestos wrapping also insulates the muffler so it heats up faster and maintains a more uniform muffler temperature which vaporizes the condensate more effectively. This wrapping prolongs muffler life as much as 5% to 10%.

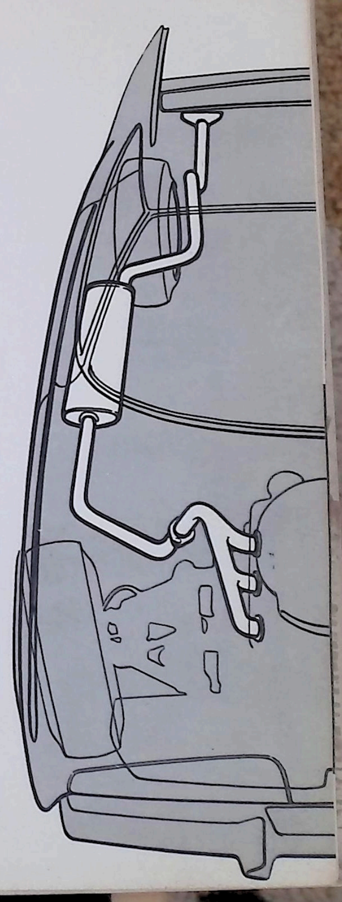
Carbon steel muffler parts can be treated to make them highly resistant to the corrosive acids present in exhaust systems. To do this, the muffler's internal shell assembly and other internal parts and tailpipes are dipped in a ceramic refractory coating so that all of the inner and outer surfaces, baffles and tubes are completely coated to an approximate thickness of 0.003 to 0.004-inch.

The problem which exists in the manufacture of ceramic mufflers is to get the internal parts of the muffler completely coated with the ceramic material. To insure proper flow of the ceramic coating on the inner parts, special mufflers should be designed. Such ceramic coated mufflers permit the use of less expensive carbon steels.

Much work is being done to improve ceramic coated carbon steel mufflers and some cars are now equipped with them. Although there are many unresolved problems in ceramic coating, time may prove this a most satisfactory method of providing corrosion resistance in exhaust systems.

Most passenger car muffler corrosion takes place in a narrow range of temperatures close to 185°F. Therefore, it would be ideal if all muffler parts and other exhaust system parts could be maintained above these temperatures at all times in order to drive the condensate from the exhaust system. This, of course, is impossible. However, muffler design can be such that temperatures are maintained at the highest degree possible for the particular type of operation involved. Asbestos outer wraps are used to help even-out temperature in the muffler, as well as for acoustical deadeners. Some methods of design whereby most of the internal parts are heated up as rapidly as possible have been devised. Wherever possible these designs are utilized in order to prevent corrosion. It is not always possible to attain the acoustical silencing necessary in a muffler and at the same time design for the best heat distribution.

Improved internal designs, stronger steel structures and the use of precoated carbon steels help mufflers to absorb internal temperature differentials, to withstand road shock and vibration, to absorb thrust and withstand full charge engine backpressure. By using precoated carbon steels in mufflers, corrosion is greatly retarded.



TYPICAL MECHANICAL PROPERTIES

USS 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

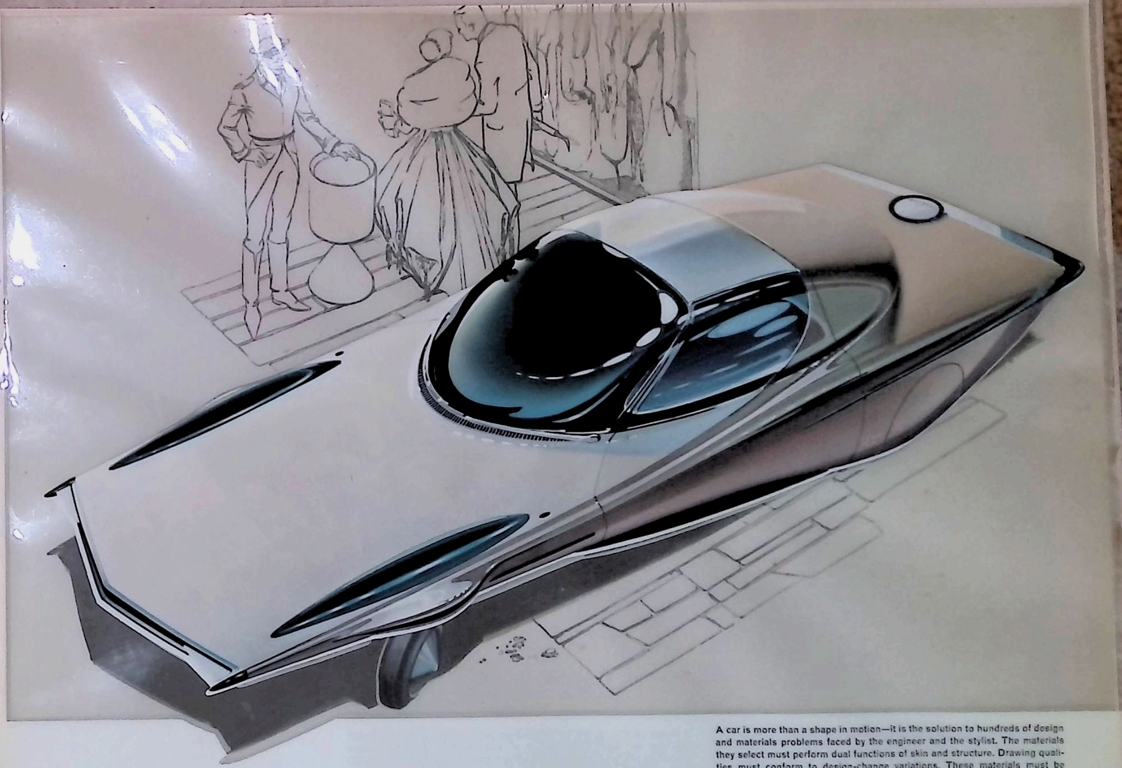
ASTM Standard specimens, minimum number of tests and ductility modifications apply.

PRE-COATED CARBON STEEL

Regular and Differential Coated Galvanized Carbon Steel Sheet and Strip

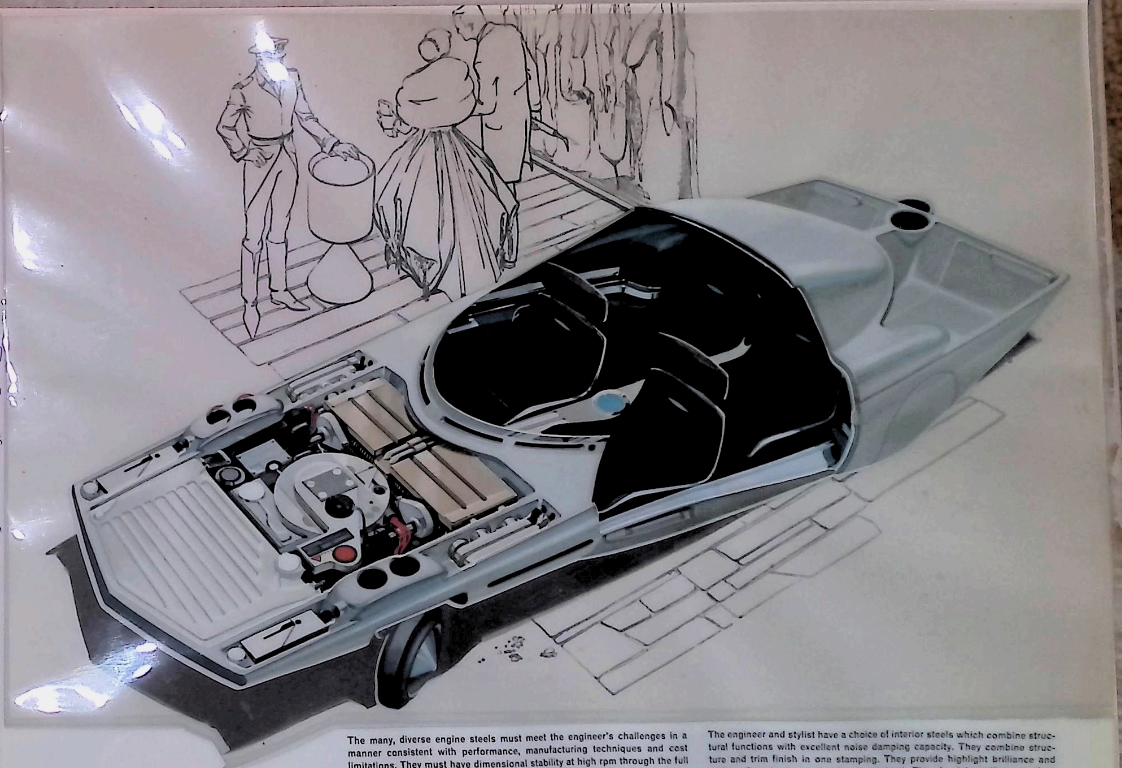
	CQ	DQ	DQ—SK
Yield Point, psi	30-40,000	28-38,000	25-35,000
Tensile Strength, psi	45-55,000	43-53,000	40-50,000
Elongation, % in 2"	25-35	30-40	34-44
Rockwell "B"	50-65	42-57	40-55

Aluminum Coated Carbon Steel Sheet and Strip			SK
Yield Point, psi	35-45,000	—	35-45,000
Tensile Strength, psi	45-55,000	—	45-55,000
Elongation, % in 2"	23-33	—	28-38
Rockwell "B"	55-70	—	50-65



A car is more than a shape in motion—it is the solution to hundreds of design and materials problems faced by the engineer and the stylist. The materials they select must perform dual functions of skin and structure. Drawing qualities must conform to design-change variations. These materials must be inexpensive commensurate with their performance requirements. Fastenability and ease of fabrication are essential. High impact properties are important. Paintability with minimum preparation is a requisite. Corrosion and abrasion resistance is vital.

There are USS steels to answer the most difficult exterior design problems.

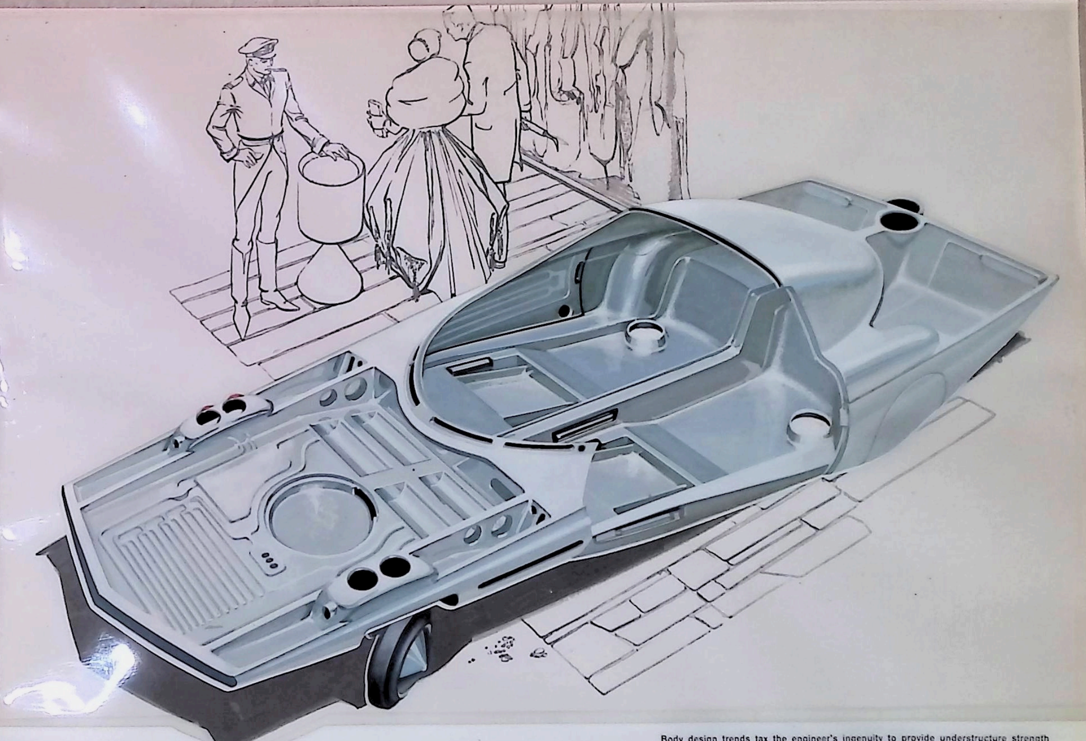


The many, diverse engine steels must meet the engineer's challenges in a manner consistent with performance, manufacturing techniques and cost limitations. They must have dimensional stability at high rpm through the full temperature range. They should permit a high horsepower to weight ratio, withstand endless torsional, compressive and bending stresses and be resistant to fatigue from constant load reversals. They should be able to accept high shaft loadings and high rpm under red heat conditions. They should lend themselves to cold or hot forging to close tolerances and thin dimensions.

There are USS steels to meet the demanding requirements of efficient engine design.

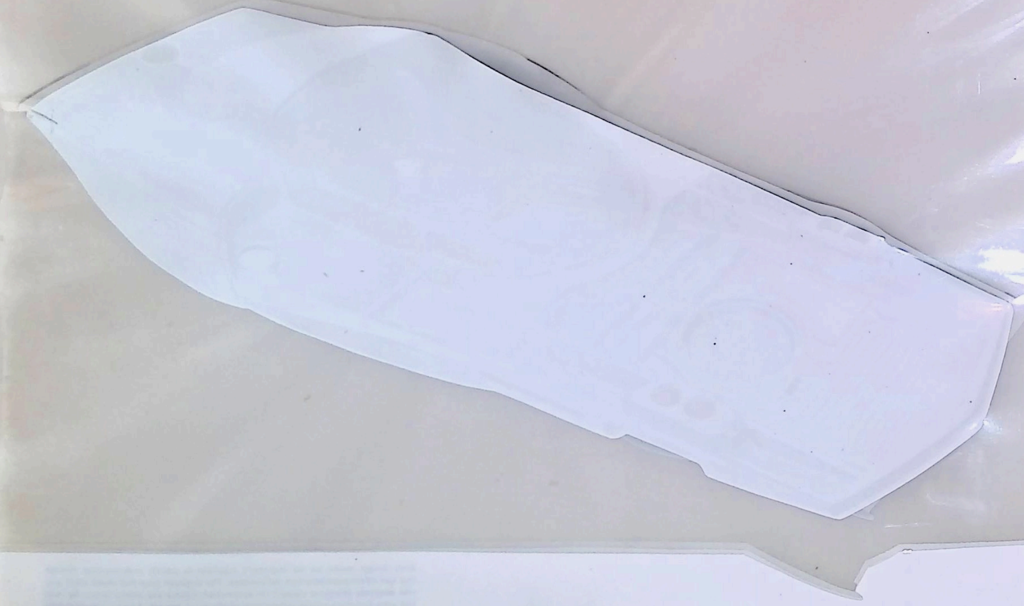
The engineer and stylist have a choice of interior steels which combine structural functions with excellent noise damping capacity. They combine structure and trim finish in one stamping. They provide highlight brilliance and points of contrast so attention is retained. They furnish resilient comfort. These steels also have aesthetic qualities in their patterns and give a feeling of dignity, stability and security. They require only a minimum of maintenance. They can be thin skinned and yet be rugged, rigid and strong.

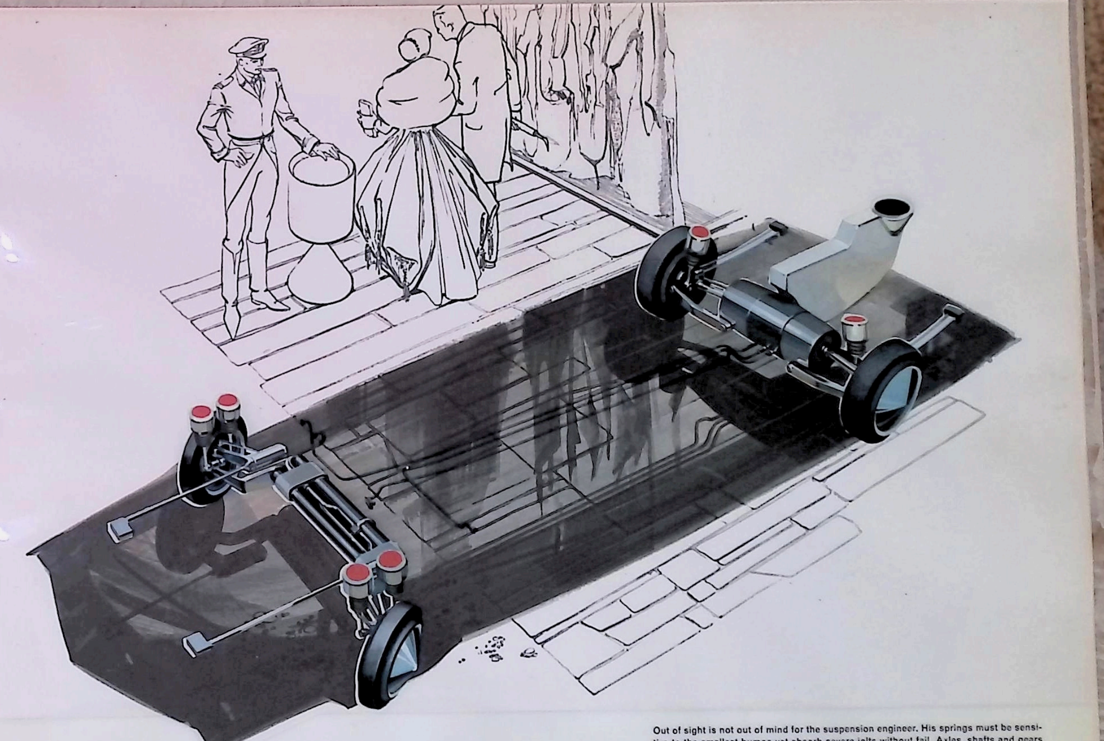
There are USS steels to fulfill the most rigid interior design requirements.



Body design trends tax the engineer's ingenuity to provide understructure strength that can offset superstructure deficiencies. The engineer must find steels which provide adequate structural support for suspension mounts and driving forces. He must find ways to reduce weight without loss of structural strength. Framing members must give high strength and reduced weight. He must design for built-in safety for crash conditions and he must consider functional components as integral parts of the load-carrying structure. His choice of precoated steels must be compatible with current corrosion proofing practices and his designs should improve performance by providing a lower weight to power ratio.

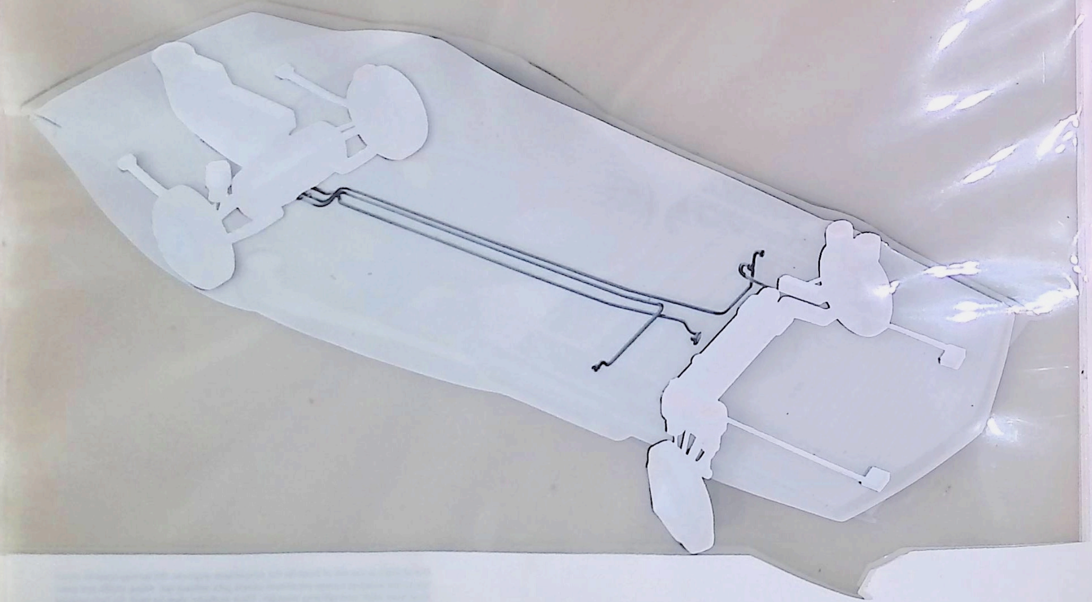
Most body design and materials problems facing the engineer can be answered by USS steels.

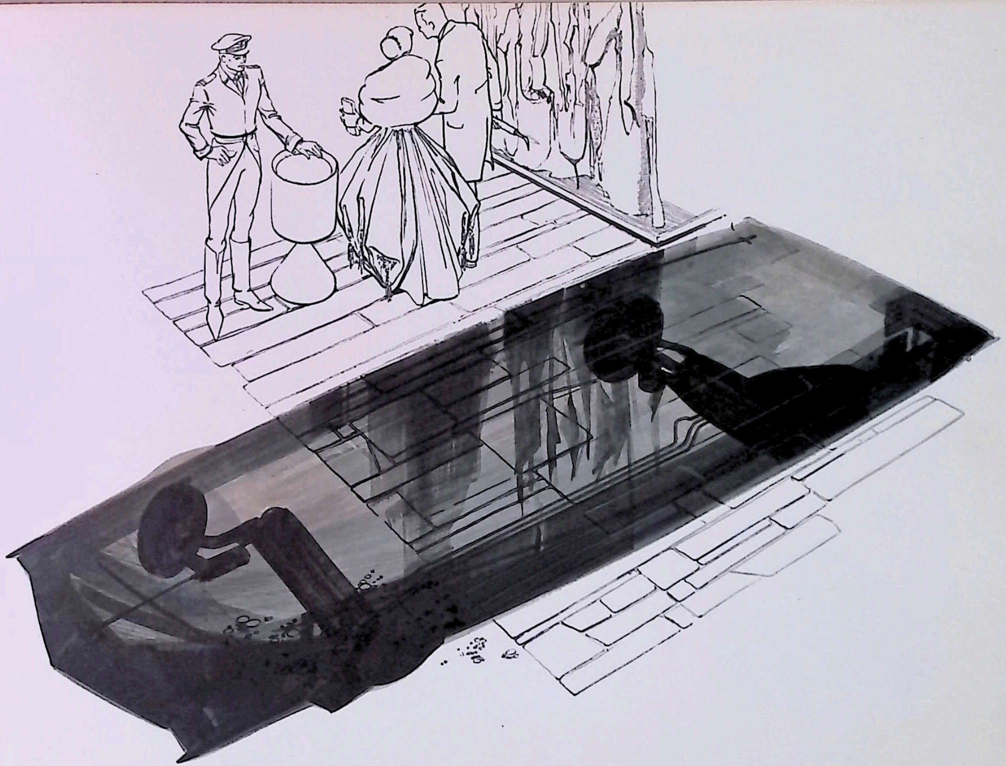




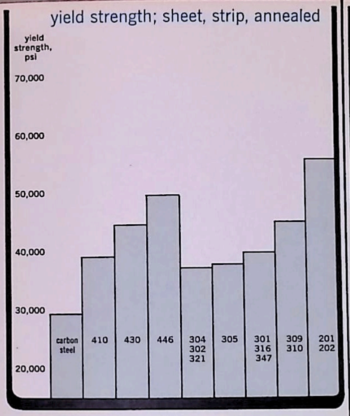
Out of sight is not out of mind for the suspension engineer. His springs must be sensitive to the smallest bumps yet absorb severe jolts without fail. Axles, shafts and gears must have high load-carrying strength. Their surfaces must be hard, for long wearing life, yet their cores must be ductile so as to withstand tooth-clashing, impact, quick shifts and sudden power surges. Suspension arms must be rigid to prevent deflection and misalignment. Power steering components must withstand flying rocks without denting. Wheels must run true without hop or run-out, and wheel covers must remain sparkling bright even under the worst corrosive and abrasive conditions.

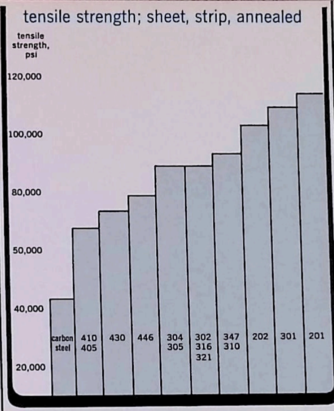
There are USS steels to help the engineer solve the most difficult chassis problems.

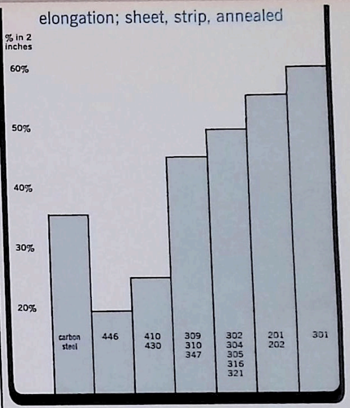


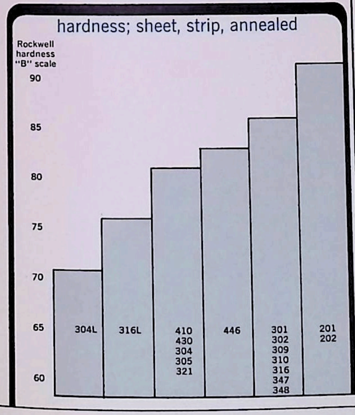


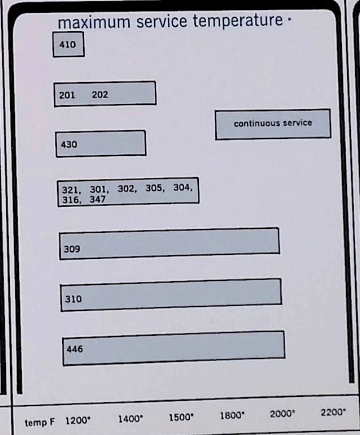
MECHANICAL PROPERTIES COMPARISON

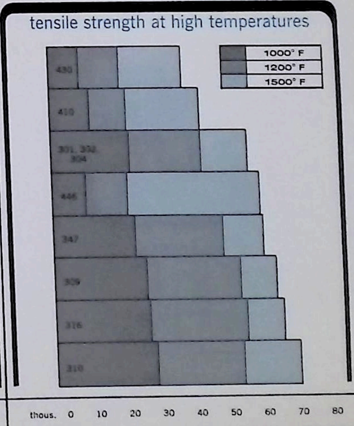












Values listed above are typical of sheet and strip. They may vary within chemistry range and product form.

*These vary with service conditions.

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									
Lb./Cu. In.	0.28	0.28		0.28		0.27		0.28	
Low Carbon Steel (SAE 1020)=1.00	0.97	0.97		0.97		0.95		1.0	
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 Btu/°F/Lb. (32 to 212°F)	0.11	0.11		0.11		0.12		0.11	
Low Carbon Steel=1.00 (0 to 100°C)	1.0	1.0		1.0		1.0		1.0	
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								Physical Properties are similar to Type 304.			Physical Properties are similar to Type 316.					
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			149			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
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	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
Initial Forging Temperature, °F	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	1700-1800		1700-1800
Annealing Treatment, °F	1850-1950 and Quench		1900-2000 and Quench		1850-1950 and Quench	1900-2000 and Quench		1850-2050 and Quench	1950-2050 and Quench		1900-2025 and Quench	1750-1950	1850-2050	2000-2100		2000-2100
ABRASION RESISTANCE	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.		Good as Annealed. Decreases with increasing cold work.	Same as Type 302.	Good	Good		Good
MACHINABILITY	Fair		Fair		Fair	Fair; Type 303 Superior		Fair	Fair		Fair	Fair		Fair		Fair
WELDING	Satisfactory				Satis-factory	Types 302 and 304 very good; Type 304 superior in corrosion re-sistance "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

TYPE No.	C	Mn Max.	P Max.	S Max.	Si Max.	Cr	Ni	Mo	Zr	Se	Ti	Cb-Ta	Ta	Al	N
	Chemical Composition, per cent														
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	— 0.060	— 0.030	— 1.00	17.00/ 19.00	4.00/ 6.00	—	—	—	—	—	—	—	0.25 Max.
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.		—	—	—

TYPE No.	C	Mn Max.	P Max.	S Max.	Si Max.	Cr	Ni	Mo	Zr	Se	Ti	Cb-Ta	Ta	Al	N
	Chemical Composition, per cent														
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

BRAND

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

BRAND

This premier high-strength low-alloy steel, with its combination of greater strength and outstanding resistance to atmospheric corrosion, is ideally applicable wherever weight reduction or longer life, or both, are prime considerations.

USS COR-TEN steel is available in all rolled steel products—plates, structurals (including wide flange), bars, sheet and strip.

USS COR-TEN steel has been improved and now provides:

- A minimum yield point of 50,000 psi for thicknesses up to 1½" inclusive (previously only to ½" inclusive).
- Atmospheric corrosion resistance 4 to 6 times that of carbon steel (same as previously).
- A grade weldable in all thicknesses by the usual methods.

For the shielded-metal-arc welding process, the following practices are suggested:

Electrode	Thickness, Inches	Minimum Preheat or Interpass Temperature, °F.
Low-hydrogen type mild steel (E60 or E70 group)	2 and under	Not required
	Over 2 to 4	200
Ordinary covered mild steel (E60 or E70 group)	½ and under	Not required
	Over ½ to 2 incl.	200
	Over 2 to 4 incl.	300

The above welding practices for 2" to 4" also pertain to thicknesses over 4" except for designs involving severe restraint. Our Metallurgical Engineers are available to advise in these instances.

Mechanical Property Requirements

	THICKNESS RANGES	
	1½" and Under	Over 1½"
Yield Point, min, psi	50,000	46,000
Tensile Strength, min, psi	70,000	67,000
Elong. in 2 in., min, per cent	22	24
Elong. in 8 in., min, per cent (0.180 in. and heavier)	19	19
Cold Bend (180° specimen bend)	¾ & under D=1t Over ¾" to 1" D=1½t Over 1" to 1½" D=2t	Over 1½" to 2" D=2½t Over 2" 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 to strength levels other than the above is subject to negotiation.

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

Chemical Composition

Thicknesses ½" and under	C	Mn	P	S	Si	Cu	Cr	Ni	V
Composition Ranges, per cent	.12 max	.20/.50	.07/.15	.05 max	.25/.75	.25/.55	.30/1.25	.65 max	—
Typical Composition, per cent	.09	.38	.09	.033	.48	.41	.84	.28	—
Thicknesses over ½"									
Composition Ranges, per cent*	.10/.19	.90/1.25	.04 max	.05 max	.15/.30	.25/.40	.40/.65	—	.02/.10
Typical Composition	.16	1.15	.02	.03	.20	.32	.50	—	.05

*U.S. Patent No. 2,845,345

Acid Soluble Al .01/.06 (Fine Grain Practice)

Additional Typical Properties For Engineering Guidance

Resistance to atmospheric corrosion.......4 to 6 times carbon steel
Compressive Yield Point, psi.......Equal to Tensile Yield Point
Shearing Strength, psi.......Equal to 60% Tensile Strength
Modulus of Elasticity, psi.......28,0000,000 to 30,000,000
Endurance Limit, (Rotating beam—polished specimen) psi.......35,000
Charpy Impact, keyhole notch, (as rolled, room temp. avg) ft-lb......40
Coefficient of Expansion per degree F, 70° to 200° F.......0000063

Fabricating Practice For Cold Forming

Thickness of Material	Suggested Minimum Inside Radius
Up to ⅙ in. incl.	1t
Over ⅙ to ¼ in. incl.	2t
Over ¼ to ½ in. incl.	3t

Hot forming is recommended for angle bending material over ½ inch in thickness.

USS COR-TEN steels meet the requirements of the following specifications:

ASTM **A242** for plates, structurals and bars
ASTM **A375** for hot rolled sheets and strip
ASTM **A374** for cold rolled sheets and strip
SAE **950** for plates, structurals, bars, hot rolled sheets and strip

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

Mechanical Property Requirements

	*Sheets and Strip Light Plate	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, %	19	18	19	19
Elong. in 2 in., min, %	25	—	—	24
180° Cold Bend (Specimen Bend) (See below)	D = 1t		Over ¾ to 1" D = 1½t Over 1 to 1½" D = 2t	Over 1½ to 2" D = 2½t Over 2 to 4" D = 3t
Sheets and Strip Light Plate: Flat D = 1t				

*When as rolled plates ⅜" and under are required for severe cold forming or when produced on sheet or strip mills, the mechanical properties of the sheet and strip grade will apply.

**When plates or bars are ordered normalized or annealed or when severe cold forming is involved, both the minimum yield point and tensile strength requirement will be reduced 5,000 psi. ASTM Standard Specimens; minimum number of tests and ductility modifications apply.

Chemical Composition Percent

	C	Mn	P	S	Si	Cu	V
Normal 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, Strip and Light Plates	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	—
up to ¼" incl.	1½T	2T
over ¼" to ½" incl.	2½T	3T

Hot forming is recommended for angle bending material over ½ inch in thickness.

Additional Typical Properties for Engineering Guidance:

Resistance to Atmospheric Corrosion	2 times carbon steel
Compressive Yield Point, psi	Equal to Tensile Yield Point
Shearing Strength, psi	Equal to ¾ Tensile Strength
Modulus of Elasticity, psi	28,000,000 to 30,000,000
Endurance Limit, (as rolled, avg.) psi	42,000
Charpy Impact, keyhole notch, (as rolled, room temp. avg.) ft-lb	42
Coefficient of Expansion per degree F., 70° to 200° F	0000063

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.

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.

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 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.

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

USS EX-TEN Steel is the newest member of the USS High Strength Steel Family. It is a thrifty value—offering one of the highest strength-to-cost ratios of all steels.

The numerical designation following USS EX-TEN indicates the minimum yield point. The remainder of the mechanical properties for each grade and product involved are shown.

USS EX-TEN Steel is intended to fill the need for an economical grade for applications in which greater strength, to gain weight reduction, is the primary requirement. USS EX-TEN Steel has good ductility and weldability. Its resistance to atmospheric corrosion is the same as that of carbon steel.

USS EX-TEN Steel is available in hot and cold rolled sheets and hot rolled strip, and in plates, bars, structurals and bar shapes to a maximum thickness of ⅜-inch.

It is suggested for such applications as automotive and truck parts, cargo containers, tote boxes, formed building members, and many others.

USS EX-TEN 45 and 50 Steels can be furnished to meet the requirements of Mil-S-13281 Class B, Grade 2. USS EX-TEN 45 Steel also meets the mechanical property requirements of ICC spec. MC-303 for tank trailers hauling inflammable liquids.

USS EX-TEN Steels are sold to minimum mechanical properties shown in this table. Chemical compositions are shown for information only.

Mechanical Properties

	EX-TEN 45 Plates, Bars, Structurals, Bar Shapes to ⅜" Incl., HR Sheets, HR Strip, CR Sheets	EX-TEN 50 Plates, Bars, Structurals, Bar Shapes to ⅜" Incl., HR Sheets, HR Strip, CR Sheets	EX-TEN 55 Plates to ⅜" Incl., HR Sheets, HR Strip	EX-TEN 60 Plates to ⅜" Incl., HR Sheets, HR Strip
Yield Point, psi Min.	45,000	50,000	55,000	60,000
Tensile Strength, psi Min.	60,000	65,000	70,000	75,000
Elongation, Min.				
Sheets and Strip % in 2"	25	22	20	18
Other Products % in 8"	19	18	17	16
Cold Bend (Specimen Bend)				
Sheets and Strip	Flat	D=1T	D=1½T	D=2T
Other Products	D=1T	D=1T	D=1½T	D=2T

When hot rolled products are ordered annealed or normalized, the mechanical property requirements do not apply.
ASTM Standard Specimens: minimum number of tests and ductility modifications apply.

Chemical Composition, Per Cent

(for information only)

	C	Mn	P	S	Si	Cb
LIMITS:	.26 max.	1.50 max.	.04 max.	.05 max.	.10 max.	.01 min.
Typical EX-TEN 50 Sheets	.16	.75	.02	.03	.05	.02
Typical EX-TEN 50 Plates	.16	1.00	.02	.03	.05	.02

Carbon and manganese are adjusted to meet the mechanical property requirements for the grade and product.

Additional Typical Properties for Engineering Guidance

Resistance to Atmospheric Corrosion	Same as Carbon Steel
Compressive Yield Point, psi	Equal to Tensile Yield Point
Shearing Strength, psi	60% Tensile Strength
Modulus of Elasticity, psi	28,000,000 to 30,000,000
Coefficient of Expansion per Degree F (70° to 200°)	.0000063

Fabricating Practice for Cold Forming

Thickness of Material	Suggested Minimum Inside Radius for Angle Bends			
	EX-TEN 45	EX-TEN 50	EX-TEN 55	EX-TEN 60
Up to 0.180" Incl.	1T	1½T	2T	2½T
Over 0.180 to .2299 (Sheets only)	1½T	2T	2½T	3T
Plates (⅜" Max.)	2T	2½T	3T	3½T

Man-Ten Steel

One of the least expensive yet most versatile steels.

One of the least expensive yet most versatile steels. It features 50% higher yield point than ASTM A-7 structural carbon steel at a moderate price (only about 20% more than A-7). When MAN-TEN Steel's greater strength is fully utilized in design, it is one of the most economical constructional materials. MAN-TEN Steel has found wide use where either weight reduction or increased service life is desirable.

USS MAN-TEN Steel is furnished in two variations to meet different requirements. The properties for each of these are shown herewith.

General

Atmospheric corrosion resistance twice that of carbon steel.

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

Mechanical Properties	Thickness Ranges: 14 Ga. to ½" Incl.	Over ½" to 1½" Incl.	Over 1½" to 3" Incl.
Yield Point, Min., Psi	50,000	45,000	40,000
Tensile Strength, Min., Psi	75,000	70,000	65,000
Elong. in 8", Min., Per Cent*	18	19	19
Elong. in 2", Min., Per Cent	20		22
Cold Bend—180°	D=1T	D=2T	D=3T

The minimum yield point and tensile strength requirements will be reduced by 5,000 psi when annealing or normalizing is specified, or when furnished in coils.
*For all products except sheet and strip.

USS MAN-TEN Steel is intended primarily for weight reduction by means of greater strength in applications involving moderate forming. It is considered weldable under carefully controlled conditions. Suggested for earthmoving machinery, construction equipment, specialized containers and other material handling applications.

Availability

Plates, structural shapes including wide flange beams, bars, bar shapes, hot rolled sheets and strip .071 inches and thicker.

Fabricating Practice for Cold Forming

Thickness of Material	Suggested Minimum Inside Radius
Up to ⅛ in. incl.	2t
Over ⅛ to ¼ in. incl.	2½t
Over ¼ to ½ in. incl.	3½t

Hot forming is recommended for angle bending material over ½ inch in thicknesses.

Composition Range

	C	Mn	P	S	Si	Cu
Ladle	.25 max.	1.10-1.60	.045 max.	.050 max.	.30 max.	.20 min.
Typical	.22	1.40	.020	.036	.07	.27

"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	3/16" 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	—	—

*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.

Chemical Composition

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/.65	.40/.60	.03/.08	.15/.50	.002/.006

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

Cold Bend Properties (ASTM Bend Test)

COLD BEND	Up to 1", Incl.	Over 1" to 2", incl.	Over 2" to 4", Inc.
Longitudinal Test	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

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. 6.2 x 10^{-6} inches per inch per °F in the range of —75° to +200°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 to six 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 ½% Cr-½% Mo steel.

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

For maximum resistance to impact abrasion, USS "T-1" steel may be ordered to a minimum hardness of 321 BHN up to 4" thick, (or 360 BHN up to 1½" thick), in which case all other mechanical 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 147". Maximum length is 480". Under certain conditions, longer and wider plates can be produced and are handled on a special inquiry basis, as are plates over 6" thick.

T-1 type A Constructional Alloy steel

The steel with extraordinary strength, toughness, and weldability.

Since its introduction in 1953, USS "T-1" Steel has become one of the world's best known steels. Its extraordinary strength, toughness, weldability and resistance to impact abrasion have increased service life of equipment as much as ten times. No other steel has equalled "T-1" Steel's record of success.

Now U. S. Steel Research has developed an outstanding new addition to the "T-1" family of constructional alloy steels—USS "T-1" type A Steel. This quenched and tempered constructional alloy steel possesses the same tremendous strength, weldability and resistance to impact abrasion as "T-1" Steel. There is, however, a change in chemistry that reduces costs and makes "T-1" type A Steel a more economical steel for many applications.

Such applications would include earthmoving and mining equipment, building construction, bridges, truck frames and bodies, missile transporters and launchers, oil field rigs and machinery transporters—wherever great strength, weldability, toughness, and resistance to impact abrasion are needed to build equipment stronger, lighter and more durable.

Availability

USS "T-1" type A Steel is primarily a plate steel furnished in the quenched and tempered condition. It is also available as bars, structurals, semi-finished products, forgings, and tubing.

Size Ranges

"T-1" type A Steel plates are normally furnished in thicknesses from 3/16" to 1" incl., and in standard widths up to and including 147". Maximum length is 480". Under certain conditions, longer and wider plates can be produced and are handled on a special inquiry basis.

Chemical Composition

C	Mn	P†	S†	Si	Cr	Mo	V	B	Ti
.12/.21	.70/1.00	.040 Max.	.040 Max.	.20/.35	.40/.65	.15/.25	.03/.08	.0005/.005	.01/.03

*U. S. Patent No. 2,858,206.

†For qualities higher than Regular Quality the phosphorus and sulphur limits are lowered to conform to ASTM Standards.

Summary of Engineering Data—Plates

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

Thickness	3/16" to 3/4", Incl.	Over 3/4" to 1", Incl.
Yield Strength, Ext. under load (min)	100,000 psi	100,000 psi
Tensile Strength	115,000/135,000 psi	115,000/135,000 psi
Elongation in 2", % (min)	18	16
Reduction of Area, % (min)	40	50
Longitudinal and Transverse Charpy Keyhole Impact Values (ASTM Procedure) (min)	15 ft. lbs. at −50°F	15 ft. lbs. at −50°F

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

A standard .505" tensile specimen is used if thickness exceeds 3/4". For sizes 3/4" and under, an ASTM plate tensile specimen is used.

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 1/2" to 1" thick incl. Modified values may be negotiated for lighter plates.

Transverse mechanical properties may be specified if desired.

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

Cold Bend Properties (ASTM Bend Test) when specified.

To 1", inclusive: 180°D—2T

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

Additional information for engineering guidance

Heat treatment

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

Modulus of elasticity at 70°F

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

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

Coefficient of expansion

7.60×10^{-6} inches per inch per °F in the range of 80 to 1300°F. 5.9×10^{-6} inches per inch per °F in the range of −75 to +200°F.

Weldability

Joint efficiency—with AWS 11015, 12015 or equivalent electrodes.............100%

Joint efficiency—automatic welding...........100%

Kinzel transition temperature—welded 1/2 and 1" plate specimens minus 35/90°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

Totating beam endurance limit—polished specimen..................62,000 psi

Pulsating fatigue endurance limit—unwelded (surface as-rolled) about......50,000 psi

Atmospheric corrosion resistance

Two times that of structural carbon steel

Elevated temperature strength

Short-time strength at 900°F—about three times that of carbon steel and about equal to conventional 1/2% Cr—1/2% Mo steel.

Cold forming data for plates

Thickness	Suggested Minimum Inside Radius
Up to 1", incl.	2T

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"	23-33	35-42	–
Rockwell "B"	45-70	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"	25-35	30-40	34-44
Rockwell "B"	50-65	42-57	40-55

Aluminum Coated Carbon Steel Sheet and Strip

			SK
Yield Point, psi	35-45,000	—	35-45,000
Tensile Strength, psi	45-55,000	—	45-55,000
Elongation, % in 2"	23-33	—	28-38
Rockwell "B"	55-70	—	50-65

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.

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.

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 1¼ inch diameter mandrel. When subjected to this test condition the vinyl coated materials 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.

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.

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.

Dielectric Strength

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

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.

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.

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.

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.

American Steel and Wire Division

Steel and Wire Products that Serve the Nation

American Cold Rolled Steel Strip

American Steel and Wire 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, American Steel and Wire 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: high 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

American Steel and Wire 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 can be made stronger than gray iron. Ductile iron offers the reliable, all-around satisfactory performance of gray iron and permits weight saving and other economies. When required, ductile iron may be produced which has specifications one might expect from steel:

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

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 American Steel and Wire's 125 years of wire making experience. American Steel and Wire 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 American Steel and Wire 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 almost 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. American Steel and Wire 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, American Steel and Wire 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, American Steel and Wire 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.

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. American Steel and Wire developed the high tensile wire needed for prestressed concrete pipe about 20 years ago. When linear prestressing started in this country American Steel and Wire again was the first to develop the labor-saving 7-wire strand that has become the industry standard. American Steel and Wire'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 American Steel and Wire 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.

USS 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, nuclear, missile, steam generating 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 various wall thicknesses in the range ¼" to 10¾" outside diameter, from 20 gauge or .035" wall through 1.100" thickness, depending on the grade (300 or 400 series).

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

Ground Support Equipment

Radioactive Systems—Primary and Secondary Side
High Temperature, High Pressure Power Generating Stations
Missiles—Liquid H_2N Helium lines.

ADUCO-95016, May 1962. USS COR-TEN, TRI-TEN, PAR-TEN, MAN-TEN, EX-TEN, "T-1", "T-1" type A, NATIONAL, PREMIER, TIGER BRAND, AMERLOY, AMORLOKT and TENELON are trademarks of United States Steel. Printed in U.S.A.

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.

As yet it is not within the ability of human beings to measure or predict the future, much less to control it. So, we are not assuming the prophet's role. Ours is but a voice that speaks of the imminent horizons and all the wonderful things to come.

This space age offers the automotive industry its oldest and still most versatile category of engineering materials. Steel is a constantly growing family, each new member of which has its special advantage and attributes within the sphere of man-made materials. These new steels can be custom engineered at the mill to provide unbelievably diverse properties and characteristics to meet the needs and objectives of the engineer, designer and stylist.

The inevitability of this family of steels in your future is an exciting challenge and a unique opportunity for creative designing and engineering. Nothing is static in the automotive industry. Every new milestone in the forward march of progress imposes new problems and opportunities. This has always been true and will continue to be true for the automotive industry.

United States Steel, its divisions, its men, its facilities and its laboratories are available to the automobile industry wherever needed to further this forward march of progress. 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

USS

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

TECHNICAL LITERATURE AVAILABLE FROM U.S. STEEL

United States Steel has booklets on many subjects available to you on request. As suppliers of steel to a variety of industries and for a diversity of products the men at United States Steel have acquired a tremendous interrelated metallurgical knowledge and experience. This literature, written by outstanding authorities in their respective fields, contains valuable technical information important to those who style and design products made of steel and to those who specify and buy steel.

STAINLESS STEEL

- **USS STEEL EXTRUSIONS—Form No. ADUCO-03090-60.** This booklet describes the extrusion process and the advantages of USS Extruded Steel Sections. It is basically a re-do of a previous publication, which was out of print, but has been revised and gives more and better illustrations of the extrusion process. Size: 8½ x 11; 16 pages.
- **FABRICATION OF USS STAINLESS STEEL—Form No. ADUCO-03092.** A completely new and revised third edition of this number. This is a comprehensive treatment of the subject that has had considerable revision over previous edition. Partial topics: Welding, Brazing and Joint Design; Machining, Cutting, Forming, Heat Treatment; Surface Finishes; Weights and Gaged Data. An excellent publication for fabricators. Paper-bound 6 x 9, 133 pages.
- **"USS STAINLESS STEEL SHEETS, STRIP"—(Data Card)—Form No. ADUCO-03110.** This is a handy, plastic-coated data card for the shirt-pocket or pocket secretary. It is printed on one side with the available thicknesses of USS Stainless Steel Sheets, decimal-inch equivalents for each standard gage, ordering ranges, and the theoretical weight in pounds per square foot for each gage in the 400 & 500 series and the 200 & 300 series. The reverse side bears similar information for USS Stainless Steel Cold Rolled Strip. Size: 2⅝ x 4⅝; Plastic-laminated card.
- **DATA ON TYPE 316 L MODIFIED STAINLESS STEEL—ADUCO 03134-61.** This property card contains specific data on Type 316 L modified stainless steel, a new grade developed by United States Steel Research. Type 316 L modified was specifically developed to provide a molybdenum bearing stainless steel which is resistant to intergranular corrosion and meets the requirements of the Huey Test (boiling 65% nitric acid). The folder contains data on physical and mechanical properties, characteristic tensile properties, chemical composition and creep and rupture properties. Type 316 L modified stainless steel is ideally suited for applications in the chemical and petroleum industry and welded applications where corrosion is a major problem. Size: 5½" x 8½"; 4 pages.
- **DATA ON USS 304 LN STAINLESS STEEL—304 L WITH NITROGEN—ADUCO 03135-61.** This folder is a property card with specific data on USS 304 LN stainless steel, a new grade developed by United States Steel Research. Type 304 LN offers the engineer a stainless steel with the resistance to intergranular corrosion inherent to Type 304 L and a yield strength of 30,000 psi. min. the room and elevated-temperature strength characteristics of Type 304. The folder contains data on the chemical composition, room temperature mechanical properties, creep rupture strength and corrosion resistance. This new grade of stainless steel should find its primary applications in designs for the chemical and electrical field. Size: 5½" x 8½"; six pages.
- **STEELS FOR ELEVATED TEMPERATURE SERVICE—ADUCO 09005-61.** This is the fourth printing as well as the first thorough revision of this booklet since 1949. Essentially, it contains the high-temperature tensile, creep and rupture data on 28 grades of steel most commonly recommended for hot service. Gives data on USS "T-1" (Constructional Alloy) and USS Tenelon (nickel-free, austenitic stainless), and on other carbon, alloy and stainless grades. Very valuable parts of the publication are those on the behavior of steels at high temperatures, on testing methods, fabrication procedures, code requirements and the useful bibliography as well. 8½ x 11, 60 pp.
- **"USS TENELON STAINLESS STEEL"—Stainless Steel: Tenelon—ADUCO 03133-61.** This publication is a revision of the previous booklet. It contains now the final data on USS Tenelon Stainless Steel and the sections of the book have been revised and expanded. This book gives specific data on composition, physical and mechanical properties, corrosion resistance, impact properties and a completely revised section on Welding of Tenelon Stainless Steel. Size: 8½ x 11"; 12 pages.

ALLOY AND BAR

- **"CARBON STEEL HOT ROLLED SPECIAL SECTIONS"—Form No. ADUCO-11001.** This 12-page book points out the advantages of special rolled sections, their limitations, and describes the examples portrayed. USS Hot-Rolled Special Sections are irregular steel shapes, designed specifically for one purpose, and rolled to the predominating cross section needed. It is a custom-tailored part, designed and rolled so that there is little or no finishing required to meet final specifications. Size: 8½ x 11. 12 silver cover pages.
- **FREE MACHINING STEEL TOOL LIFE CHARACTERISTICS—Form No. ADUCO 06001-61.** This is an anthology of three papers (reprinted through the courtesy of ASME) on the subject of Tool Life Characteristics as related to the use of Resulphurized Steels and Leaded Steels, along with a discussion of Cutting Forces and their influence on Surface Finish and Chip formation. Prepared under the direction of Mr. M. C. Shaw, Professor of Mechanical Engineering at Massachusetts Institute of Technology, (grant-in-aid by U. S. Steel) these discussions are very technical in scope and should be of interest mainly to engineers and other technicians interested in improving screw-machining practice. Size: 8½ x 11"; 48 pp.

MACHINING STEELS

- **USS CARILLOY FC STEEL—Form No. ADUCO-01041.** This booklet describes USS Carilloy FC Steel, a pre-hardened, free-cutting steel especially developed for the manufacture of heavily stressed machined parts without further heat treating. Gives machinability ratings, sizes available, heat treatments employed, tool life figures and suggested uses. 8 pages, size 8 x 10 inches.
- **"USS FREMAX FREE MACHINING PLATE STEEL"—Form No. ADUCO-16057.** Plates: Booklet describing free-machining plate steel, USS Fremax, developed by United States Steel for applications where ease of machining, longer tool life, and internal soundness of finished parts are of prime importance. Booklet lists composition, mechanical properties, machining characteristics, welding instructions, flame hardening, carburizing, and discussion of end uses. Size: 8½ x 11. 12 pages.
- **"HOW TO SELECT FREE MACHINING STEELS"—Form No. ADUCO-06002.** This is a reprint of a technical article, written by T. M. Garvey, Chief Research Engineer, Carbon Bar and Semifinished Products, U. S. Steel Corp., which appeared in the October, 1961 issue of METALWORKING magazine. It discusses, generally, the wide choice of additives available in carbon and alloy steel bars, and their effect on machineability, chip formation, cutting time and tool life—as well as on the ductility, weldability, toughness, hardenability, etc. of finished parts. Also mentioned are Free-Machining Stainless Steels, and Free-Machining Plate Steels (USS Fremax 15 and 45). Tables are included on five representative groups of free-machining carbon steel bars. Of interest to anyone involved in selecting steels for screw-machining. Size: 8½ x 11".
- **USS FREMAX 45 and 15—Form No. ADUCO 16001-61.** This book describes both Fremax 45, the newer, higher carbon, free-machining plate steel and Fremax 15. Both grades were developed for applications where ease of machining, longer tool life and internal soundness of finished parts are of prime importance. The booklet lists compositions, mechanical properties, machining characteristics, welding instructions, and discussion of flame hardening and end uses of both Fremax grades. 8½" x 11", 16 pages.

SHEET STEEL

- **"SHEET GAGE CARDS"—Form No. ADUCO-32001.** Sheets: Two celluloid, wallet-sized cards fastened at corner with metal grommet. Contains tables of Manufacturer's Standard Gages for Sheet Steels, Galvanized Flat Sheet Gages, Long Terne Sheet Gages, and Decimal Equivalents of Common Fractions (to 64ths). Size: 2¾ x 4¼. 2 cards.
- **"USS VINYL COATED STEEL SHEETS"—Form No. ADUCO-37015-60.** Here is the full color story on Vinyl Coated Steel Sheet listing the advantages and limitations of this new design material. Contains a step by step description of the process, complete information on properties and representative illustrations of actual applications. Size: 8½ x 11, 20 pages.
- **"GALVANIZED SHEETS CONTINUOUSLY HOT DIPPED"—Form No. ADUCO-39001.** A comprehensive piece of literature covering sheet manufacturing, typical applications, fabricating, plus tips on general maintenance. Contains a gage table of weights and sizes and a table of mechanical properties, along with information on Paintbond and Galvannealed sheets. Size: 11 x 8½, 32 pages.
- **"USS ALUMINUM-COATED STEEL SHEETS—TYPE 1"—Form No. ADUCO-37019.** This booklet introduces USS Aluminum-Coated Steel Sheets—Type 1. It is designed to acquaint designers and fabricators with the characteristics of these sheets and the advantages of their use, and to establish U. S. Steel as a reliable source of supply. Included are discussions on fabricating, various methods of welding, brazing, painting, as well as tips on handling and storage. Illustrations include step-by-step production of automotive mufflers, and examples of various other products utilizing Aluminum-Coated Steel Sheets. Size: 8½ x 11", 12 pp.

ALLOY AND HIGH STRENGTH STEEL

- **"MODERN STEELS FOR LIGHTER AUTOMOBILES"—ADUCO 04010-61.** This is a reprint from the November 15, 1960 edition of AUTOMOTIVE INDUSTRIES magazine of a paper by M. W. Lightner, Vice President, Applied Research which was originally presented before the American Society of Body Engineers. The paper makes a strong case for the use of higher strength steels to decrease the weight of automobiles. USS COR-TEN, TRI-TEN, MAN-TEN, PAR-TEN, EX-TEN, and "T-1" steels are compared with carbon steel in tables which list properties and bending data (including relative weights and costs). Cross-section drawings of automobile frame members compare carbon steel with high-strength steel design. Size: 8½ x 11", eight pages.
- **USS EX-TEN HIGH STRENGTH STEEL PROPERTIES CARD—ADUCO No. 02051.** It lists the properties and some suggested applications for USS Ex-Ten Steel. Physical and mechanical properties, recommended cold forming practices, availability and additional engineering data are included. Size: 6" x 9"; four pages, four colors.
- **ADUCO 02049—USS COR-TEN Properties Card.** This is a revised properties card for USS Cor-Ten steel that shows the very important changes made in this grade regarding the guaranteed yield point of 50,000 psi min. for thicknesses to 1½" inclusive, and its weldability in all thicknesses. Size: 6" x 9", 4 pages.
- **USS TRI-TEN STEEL—Form No. ADUCO-02741.** This is the comprehensive opus on Tri-Ten. Gives a complete description of the properties and characteristics of this low-cost, low-alloy high-strength steel with its great toughness, weldability and formability. Many diversified applications, most of which are illustrated, are included. Recommended fabricating practices are emphasized. This, with the books on Cor-Ten, Man-Ten and "T-1" Steels should be a prominent part of the working library of any engineer. Size: 8½ x 11. 24 pages.
- **"SPECIAL STEELS FOR DESIGNERS"—Form No. ADUCO-09016.** This is our annual entry into the Sweet's Product Design File of supplier brochures. But we print an extra quantity of it because it so concisely sums up the advantages of the Design Steels—alloy, Stainless and high-strength. In these three types of steel may be found the right steel for applications involving corrosion, high and low operating temperatures, rapid shock loading, extremely high unit stresses, severe abrasion or other hazards.
- **"USS TRI-TEN STEEL PROPERTIES CARD"—Form No. ADUCO-02048.** This latest revision of the card supercedes all other Tri-Ten property cards. Contains a brief description of the steel, and summarizes, in table form, mechanical properties, other properties for engineering guidance, chemical composition and fabricating practice for cold forming. Includes data on this steel in sheet and strip form. These properties meet all the requirements of ASTM A242 and A441. Size: 5½ x 8½ inches. 4 pages.
- **"USS COR-TEN STEEL PROPERTIES CARD"—Form No. ADUCO-02045.** This handy folded card gives minimum mechanical properties, chemical composition, engineering data and fabricating practice for cold forming. Size: 5½ x 8½, 4 page folder.
- **"DESIGN MANUAL FOR HIGH STRENGTH STEELS"—Form No. ADUCO-02215.** The first complete published manual containing criteria for designing structures in the 50,000 psi yield strength range. A book which comprehensively discusses the selection and economic use of steels of this strength level. Some of topics thoroughly covered: proper unit working stresses; design of members for tension, compression; axially and eccentrically loaded columns; flat plates in compression; beam stresses; and many other basic structural design problems. This book is simply a must for the engineer desirous of working to higher strength levels and the creation of lighter, stronger structures. Now published paper-bound only. Size 6 x 9. 186 pages.
- **"USS MAN-TEN STEEL PROPERTIES CARD"—Form No. ADUCO-02042.** Condensed explanation and intended purpose of USS Man-Ten brand steel, showing physical and mechanical properties, recommended cold forming practices and forms in which this low-alloy high strength steel is produced. Size: 5½ x 8½, 4 page folder.
- **EXTRA DURABILITY OF PAINT ON LOW-ALLOY STEELS USS COR-TEN Steel—Form No. ADUCO-02043.** This is a reprint of an article that appeared in the December, 1959 issue of the ASTM BULLETIN. It is a comprehensive description of comparative paint-life tests on carbon steel, copper steel and high-strength low alloy steel in industrial, marine and semi-rural atmospheres. USS COR-TEN Steel is the "low-alloy" steel in all the experiments described in the text and tables in the article. Size: 8½ x 11, 12 pages.
- **"CORROSION RESISTANCE OF HIGH-STRENGTH LOW-ALLOY STEELS"—Form No. ADUCO-02046-60.** This is another reprint of an article by P. C. Larrabee, which was published in the August, 1953 edition of CORROSION magazine. It is a comprehensive report on the results of comparative corrosion tests on low carbon steel, copper steel, and high-strength, low-alloy steel in industrial, marine, rural and semi-rural atmospheres. Includes discussions on corrosion of steel used in tunnels, for roofing, in fresh water, in sea water, and in soils. Steels tested include USS Cor-Ten, Man-Ten, and Tri-Ten brands. Useful to anyone concerned with maintenance of steels in such applications. For sales distribution. Size: 8½ x 11; 14 pages.
- **"LIGHTWEIGHT, STRONG CARGO CONTAINERS"—Form No. ADUCO-02047.** This small folder introduces the reader to the advantages of USS Cor-Ten Steel in modular cargo containers for train, truck and ship transportation. Size: 5¼ x 8½.
- **"LONGER PAINT LIFE WITH USS COR-TEN STEEL"—Form No. ADUCO-02002.** Comprehensive description of results of paint life tests on COR-TEN, copper steel and mild steel in industrial, marine and semi-rural atmospheres. Tests were initiated in 1948, concluded 8 years later. Graphs and Tables clearly demonstrate superiority of COR-TEN Steel for lengthening paint life. Folder also includes N&W hopper car story which provides actual service performance of COR-TEN . . . confirms empirical data drawn from tests. Attractive, meaty, a valuable publication for anyone concerned with cutting paint maintenance costs. Size: 8½ x 11 6 pages.
- **"PERSONALITY ANALYSIS OF HIGH STRENGTH STEELS"—Form No. ADUCO-02016.** Our High-Strength, low-Alloy Steels have many similarities. But each has unique individual characteristics. This little folder tells the story—helps the reader arrive at the optimum high-strength grade for less needs by explaining the differences. Size: 8½ x 5½.
- **"USS COR-TEN HIGH-STRENGTH, LOW-ALLOY STEEL"—Form No. ADUCO-02018.** Here is the granddaddy of books on special steels. Comprehensive, discusses general properties, mechanical and performance characteristics and economic advantages of this high-strength steel. The booklet is profusely illustrated showing many applications of USS Cor-Ten Steel in a variety of industries. Extensive information on fabrication and welding. Size: 8½ x 11.58 pages.
- **"HOW DO YOU MEASURE A MILE?"—Form No. ADUCO-02026.** This colorful item has its own envelope and contains a novel gas-mileage computor. Also, it tells the advantages of High-Strength steels in trucks. Size: 5½ x 8½ folder.
- **"USS A-R STEEL BOOK"—Form No. ADUCO-02027.** The basic booklet of data on this steel. More than 40 very diverse applications of this abrasion resistant steel are illustrated and described. Also, chemical composition, hardness, corrosion resistance, products furnished and service life expectancies, along with fabricating information. Size: 8½ x 11. 32 pages.
- **"TRUCK DESIGN FOLDERS"—Form Nos. various.** These items describe the use of USS High-strength Low-alloy steels in the design of stronger and lighter trucks. All 10 x 8 in size, various colors. Contain design information and properties data.

Form No.	Subject
ADUCO-02030	Stake truck platform
ADUCO-02037	Bulk material truck bodies
ADUCO-02038	"Lowboy" trailer design
ADUCO-02039	Raw material dump body design
ADUCO-02040	Off-road dump bottom trailer design

- **"USS Quenched and Tempered Structural Shapes" — ADUCO 01121-61.** Briefly describes the quenched and tempered structural shapes now available in such alloy steels as "T-1", "T-1" type A, 9% Nickel and HY 80. A listing of the shapes available (beams, channels, equal angles and unequal angles), together with their sizes and weights per foot, is included. Mechanical properties and chemical composition are listed for each of four different steels. Size: 6" x 9"; six pages (single card).
- **"SUPER-STRONG SHAPES HIT MARKET" — Form No. ADUCO 01127-61.** Reprint of an article which appeared in THE IRON AGE, May 18, 1961. It announces the introduction of quenched and tempered structural shapes of such alloys as "T-1", "T-1" type A, 9% Nickel and HY 80. The article briefly lists product benefits and discusses market prospects, probable uses and how quenching is done. Photos of quenching fixture and heat treating furnace are included. Size: 8½" x 11", four pages.
- **"USS QUENCHED AND TEMPERED ALLOY STEEL STRUCTURAL SHAPES—ADUCO 01101.** The comprehensive book on quenched and tempered structural shapes. Contains information on their advantages, suggested applications and the complete rundown on availability, including tables on properties for designing and dimensions for detailing. Engineering data is given for "T-1", "T-1" type A, 9% Nickel and HY-80 steels. Designers and engineers will find the sections on allowable design stresses and material cost comparisons particularly interesting. Also included is a section on fabrication practices for "T-1" steel. Size: 8½" x 11"; 24 pages and cover.
- **"AVAILABILITY GUIDE—USS "T-1" AND "T-1" type A STEELS—ADUCO 01119.** This booklet is an informative working tool for those who can or do buy, specify, or influence the purchase of USS "T-1" and "T-1" type A steels. It contains properties, chemistry and the range of sizes for each type and quality of plate and also for bars, structural shapes and tubular shapes. Applications for each of the products are also discussed briefly. The "Availability Guide" is not intended to supplant technical booklets or other literature on "T-1" steels which contain more information in specific fields.
- **"'T-1' PROPERTIES CARD"—Form No. ADUCO-01042.** Summary of properties and engineering data in small, handy form. For use where "T-1" Steel Booklet would be inappropriate or where only a convenient summary of properties is needed. Size: 6 x 9. 6 pages.
- **" 'T-1' STEEL FOR LPG LITERATURE KIT"—Form No. ADUCO-01052.** An especially prepared file-and-presentation folder that contains "T-1" Steel literature about Liquified Petroleum Gas Tanks. This bright market has resulted in need to bring certain publications together in a kit for convenience of LPG tank-builder, designer and potential owner. When ordered, kit contains:
  ADUCO-01060—USS T-1 Steel
  ADUCO-01006—How to Weld T-1 Steel
  ADUCO-01544—Quenched & Tempered Steel for Pressure Vessels
  ADUCO-01044—What They are Saying about "T-1"
  ADUCO-01064—Boiler Code Case 1204 Latest
  Size: 11¾ x 9½.
- **"T-1" STEEL FOR PRESSURE VESSELS—Form No. 01053.** An especially prepared file-and-presentation folder that holds "T-1" Steel literature slanted at potential or actual pressure-vessel and tank builders or owners. As ordered, will contain: Same contents as "T-1" LPG kit 01052. Size: 11¾" x 9½".
- **"PROPERTIES AFFECTING SUITABILITY OF 9 PERCENT NICKEL STEEL FOR LOW TEMPERATURE SERVICE"—Form No. ADUCO-01059.** The great cry in cryogenics is for materials to handle the embrittling cold. Here are Messrs Armstrong, Gross and Brien with an article (reprinted from Feb. '59 Welding Journal Research Supplement) that presents data on low-carbon 9% nickel steel for handling gasses at temperatures down to that of liquid N_2. Size: 8½ x 11¼. 16 pages.
- **"T-1" STEEL BOOK"—Form No. ADUCO-01060.** The master, comprehensive booklet on USS "T-1" Constructional Alloy Steel. Contains complete information on Fabrication, Engineering Data and Metallurgical Characteristics. Shows case histories where "T-1" steel has been applied to wide variety of applications. Tells how to use the remarkable steel, how to work and weld it; suggests applications. The complete story in one volume. Size: 8½ x 11. 64 pages.
- **"OPERATION CRYOGENICS"—Form No. ADUCO-01087A.** A book which documents metallurgy, properties, engineering, fabrication and performance of nine rectangular and cylindrical vessels made for pressure and impact tests to destruction in order to prove the suitability of 9% Nickel Steel for cryogenic uses. Book gives complete data showing how even quenched and tempered 9% Nickel Steel matches or does better than double normalized and tempered steel. Included in pocket inside rear cover is Question and Answer booklet which contains experts' replies to questions about the tests asked by many of the hundreds of officials invited to witness. Particularly useful for management, engineers and materials specifiers or purchasers in the low temperature equipment manufacturing field. Size: 8½ x 11, 64 pages.
- **"USS 'T-1' TYPE A ALLOY STEEL"—Properties Card—Form No. ADUCO-01114-60.** This 4-page card folder lists the properties and suggested applications of new "T-1" type A Steel. Included are the physical and mechanical properties, recommended cold-forming practices, availability and additional engineering data. Size: 6 x 9, four pages (card).
- **"USS 9% NICKEL STEEL . . . ECONOMY IN CRYOGENICS—Form No. ADUCO-01123.** This booklet was prepared as a supplement to a slide presentation. It contains characteristics, fabrication data, advantages and comparison of USS 9% Nickel Steel with other materials. Size: 9 x 5¼, 24 pages.
- **"OPERATION T-1"—Form No. ADUCO-01200.** "Operation T-1" is the record, including complete data, of the Chicago Bridge & Iron—U.S. Steel joint demonstration of "T-1" Steel's suitability for pressure vessels. Results of pressure-burst and drop impact tests on both as-welded and stress relieved vessels of USS "T-1" Steel. Shell plates withstood more than 136,000 psi (at minus 45°F) and this steel enabled vessels to withstand 2 million ft.-lbs. of energy in drop tests. Still the most dramatic proof of "T-1" Steel's ability on record. Size: 8½" x 11". 58 pages and cover.
- **"STEELS FOR LOW TEMPERATURE APPLICATIONS"—Form No. ADUCO-09000-60** Contains complete properties and engineering data on carbon, alloy and stainless steels for low temperature and cryogenics equipment. Should be very useful to equipment designers, engineers, purchasers and users in the low-temperature field. Chapters on design considerations, economy and selection of steels according to operating temperature ranges are featured. Steels included are carbon (ASTM A 201 and 212); USS "T-1" Steel; Nickel Alloy Steels (2¼, 3½ and 9%), and Type 304 stainless. Size: 8½ x 11. 42 pages.

PIPE AND TUBING

- **GENERAL CATALOGUE.** Handbook presenting simplified description of processes involved in manufacture of products, including raw materials, Bessemer and open-hearth processes, welded and seamless tube manufacture; pipe threading principles, types of joints, etc. Descriptions of products, weights and dimensions. 192 pages. 4½ x 7.
- **SEAMLESS STEEL MECHANICAL TUBING.** Description of process of manufacture of Shelby cold-drawn and hot-finished seamless tubing. Data and standards on tolerances, etc. Weights and dimensions. Formed tubular specialties, pump and cylinder tubing. Chemical and physical properties of steels. Surface finishes; heat treatment, carburizing and machinability, hardness and tensile strength. 116 pages. 5 x 7½.
- **SEAMLESS STEEL TUBES FOR MECHANICAL AND PRESSURE PURPOSES.** Designers reference handbook in seventeen sections describing every phase of mechanical tubing for aircraft, automotive, machine tool industries and tubes for pressure purpose. 152 pages, loose leaf binding. 8½ x 11.
- **PIPE FOR MECHANICAL AND STRUCTURAL PURPOSES—Bulletin No. 2.** An illustrated and informative bulletin on the use and application of the tubular form for various mechanical and structural uses such as furniture, racks, handles, playground apparatus, machines, implements, scaffolding, columns, trusses, etc., including tables of properties and allowable stresses. 68 pages. 8½ x 11.
- **STAINLESS PIPE AND TUBES—Bulletin No. 3.** Grades of stainless steel and type numbers, recommended procedures in handling, tables of weights and dimensions, chemical and physical properties, corrosion resistance data. 28 pages. 8½ x 11.
- **PROPERTIES OF PIPE AND TUBING.** A handbook giving basic engineering data: external and internal properties, safety factors, allowable working stresses, mechanical properties, torsional strength, standard pipe columns. Tables and engineering drawings. 152 pages. 5" x 7½".

MISCELLANEOUS

- **"CORROSION OF STEELS"—Form-No. ADUCO-99-17716.** General: Contains an up-to-date and general discussion of data that deals with the corrosion differences between carbon, copper, and High Strength Steels (Like USS Cor-Ten Steel). Time-corrosion curves for a number of steels exposed under various atmospheric conditions, and photos of test pieces, are also included. Size: 6 x 9. 16 pages.
- **"STANDARD STEELS"—Form No. ADUCO-99005.** This periodically-issued little pocket booklet contains the analyses of grades of steel designated as standard by the American Iron and Steel Institute. It is not meant to be a listing of steels manufactured or offered for sale by United States Steel. Contains composition ranges of all standard alloy, carbon and stainless steels. As AISI changes accumulate, we publish new editions, usually about twice a year. Size: 3 x 5, 20 pages.

You can obtain this literature by writing:

UNITED STATES STEEL, Advertising Division
Room 2801, 525 William Penn Place
Pittsburgh 30, Pennsylvania

Please ask for literature by number and subject