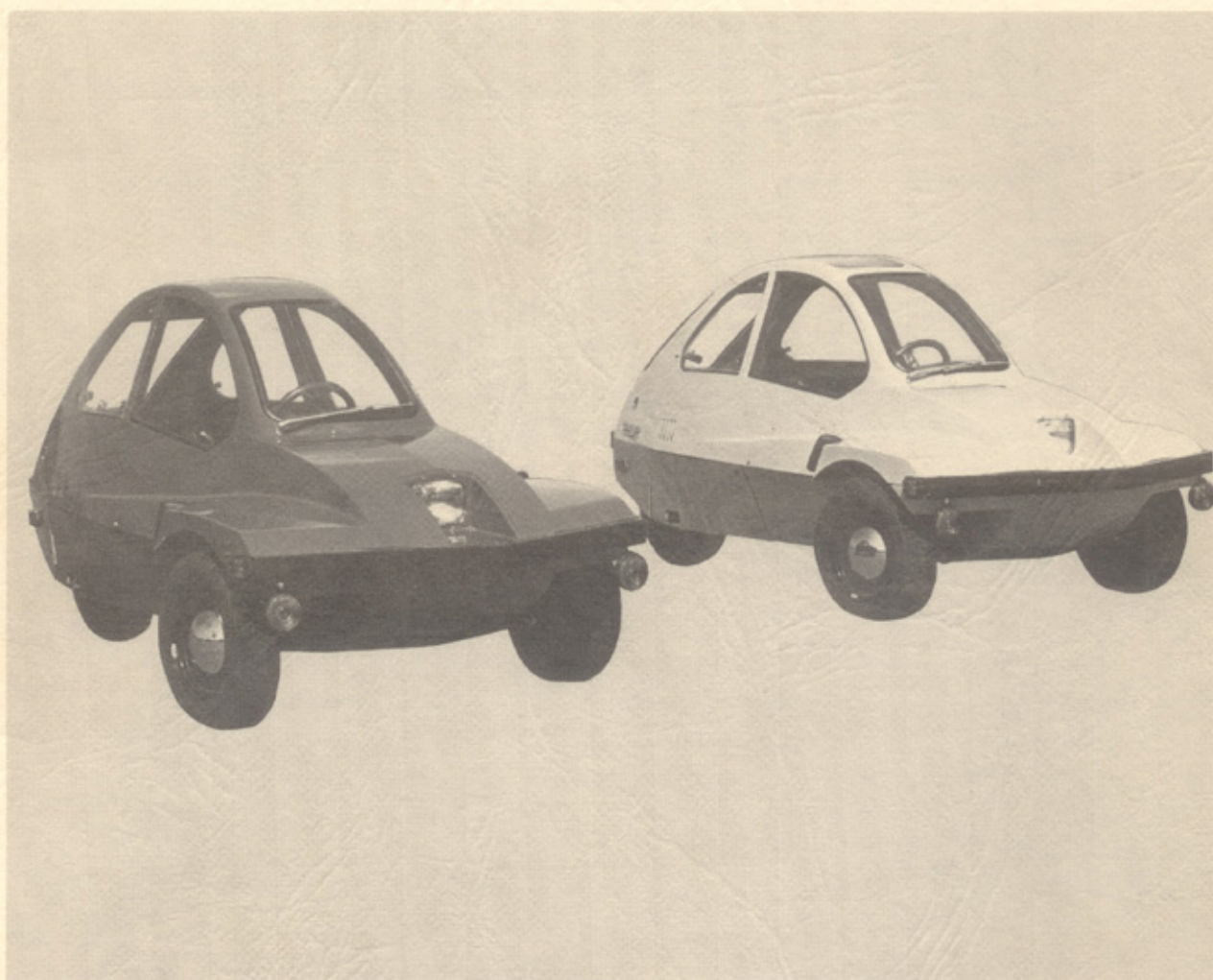


HIGH MILEAGE VEHICLES

A NEW TECHNOLOGY



H-M-VEHICLES, Inc.

1116 EAST HWY. 13
BURNSVILLE, MN 55337
PHONE: 612/890-8680

Dear Motorist;

H-M-Vehicles was incorporated in 1977 and has been located in Burnsville since August of 1979. Our business purpose is to manufacture, sell, and service a unique type of vehicle called the "Free-Way", a product of nearly a decade of thought that has only recently become a reality. We feel the "Free-Way" offers a sensible alternative for people who are concerned about the cost and amount of energy expended for certain types of travel.

The "Free-Way" is unique in the sense that it blends some innovative engineering ideas with some basic, common sense notions about transportation. Since new and innovative ideas don't always get the kind of exposure necessary for their success, this booklet will serve to acquaint you with our ideas and how we implement them into the "Free-Way". Although we have been manufacturing vehicles since January of 1980, we are still in the development stages in many areas and must reserve the right to change price, performance, or specifications. But an honest effort has been made to present accurate information that will provide insight into the technology that makes the "Free-Way" possible.

Currently, our Burnsville plant is the only location building and selling the "Free-Way". But as this edition of "High Mileage Vehicles — A New Technology" goes to press, a plant is being finished in Ft. Walton Beach, Florida to help meet the demand and fill the backlog of orders already placed. As our production increases, the need for dealerships will also increase, and information concerning this will be made available.

We invite you to read through our booklet and to analyze our vehicle and the technology behind it. Your continuing interest in this concept will help us to be responsive to your needs.

Best Regards;

David Edmonson, President

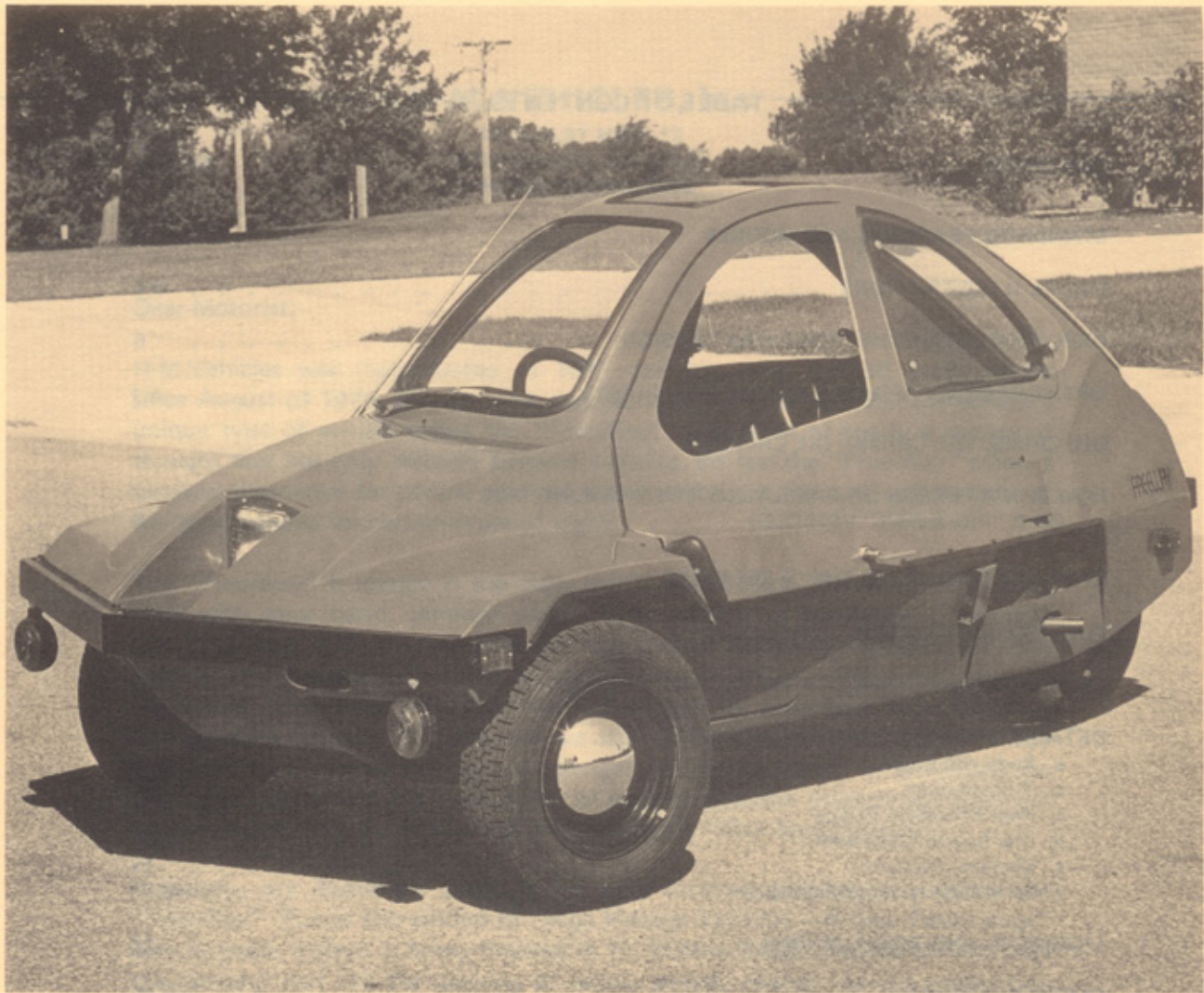
TABLE OF CONTENTS:

CONTENTS:	PAGES:
STANDARD FEATURES AND MODELS	2
MODEL ILLUSTRATIONS	3-5
EXPLANATION OF THE "FREE-WAY" DESIGN	6
OPTIMUM SMALL VEHICLE DESIGN FOR SAFETY	6-7
OIL CRISIS. OIL CRISIS? OIL CRISIS !!	7
HOW CAN A PERSON OR FAMILY JUSTIFY THE PURCHASE OF A "FREE-WAY" VEHICLE?	8
OPERATING COSTS OF THE "FREE-WAY"	8
FUEL ECONOMY OF THE "FREE-WAY"	9
HANDLING AND PERFORMANCE OF THE "FREE-WAY"	9-10
DETAILS OF THE "FREE-WAY" VEHICLE	10-16
a. Body and frame	10
b. Transmission	10-11
c. High Efficiency Engine	11-14
d. The Engine Illustrated	12-13
e. Optional Features	15
f. Serviceability and Maintenance	15-16
LICENSING AND REGULATIONS	16
"FREE-WAY electric"	16-20
a. Electric Vehicles of the Present	17-18
b. High Efficiency Motor	18
c. Performance of the "FREE-WAY electric"	18-19
d. Deep-Cycle Batteries	19-20
e. Charging the Batteries	20
HIGH MILEAGE TECHNOLOGY	21-22
WHY DO PEOPLE DRIVE BY THEMSELVES?	22
3 VIEW ILLUSTRATION	BACK COVER

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"FREE-WAY" Patents: The "FREE-WAY" is covered by Patent #248461 and Other Patents are Pending.



"FREE-WAY II" STANDARD FEATURES:

1. Automotive lighting system
2. "Non-rusting" fiberglass body
3. Standard automotive controls and instruments
4. Large storage area
5. Smooth automatic transmission
6. Mid-engine or mid-motor design, gas, diesel or electric powered
7. Bucket seat — room for temporary tandem seat
8. Large convenient door
9. Front wheel steering system
10. 360 degree protective steel frame at bumper height
11. Hydraulic drum brakes on all wheels
12. "340" engine, electric start
13. Electric windshield wiper

CHOICE OF MODELS:

The "FREE-WAY" is available in 3 basic models. All vehicles are completely assembled and ready to drive as delivered.

THE "ELECTRICS":

"Deluxe FREE-WAY electric" — is an enclosed all-weather electric vehicle. It comes complete with batteries and on-board charger. It is also available with an optional heater and sun roof.

"ENGINE POWERED", GAS, OR DIESEL

"Free-Way II" — is an enclosed all-weather vehicle powered by a "340" engine. It is available with many options.

"Deluxe FREE-WAY II" — offers many of the popular options as standard equipment and is priced less than if the options were added to the basic "FREE-WAY II".

For pricing information and a complete listing of options, exterior and interior colors, and delivery information, consult the current order form.

We are often asked whether this vehicle is available in kit form, and how much could be saved by buying a kit. It is less costly to assemble the product than to package it in kit form. A kit is not offered.



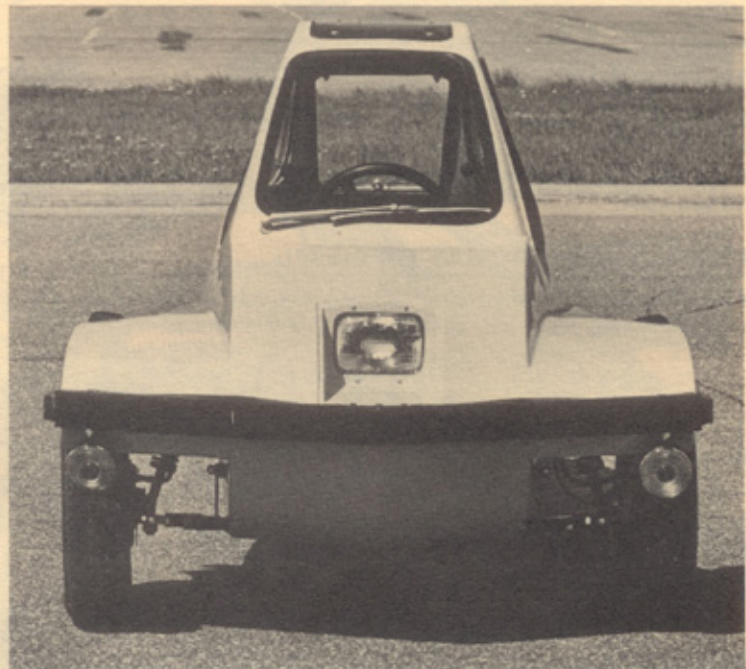
DELUXE FREE-WAY II

STANDARD FEATURES:

high mileage performance
"340" or "450" engine
electric start
automatic transmission

reverse
heater-defroster
deluxe instrumentation
"LDR" fuel system

DELUXE "FREE-WAY" ELECTRIC

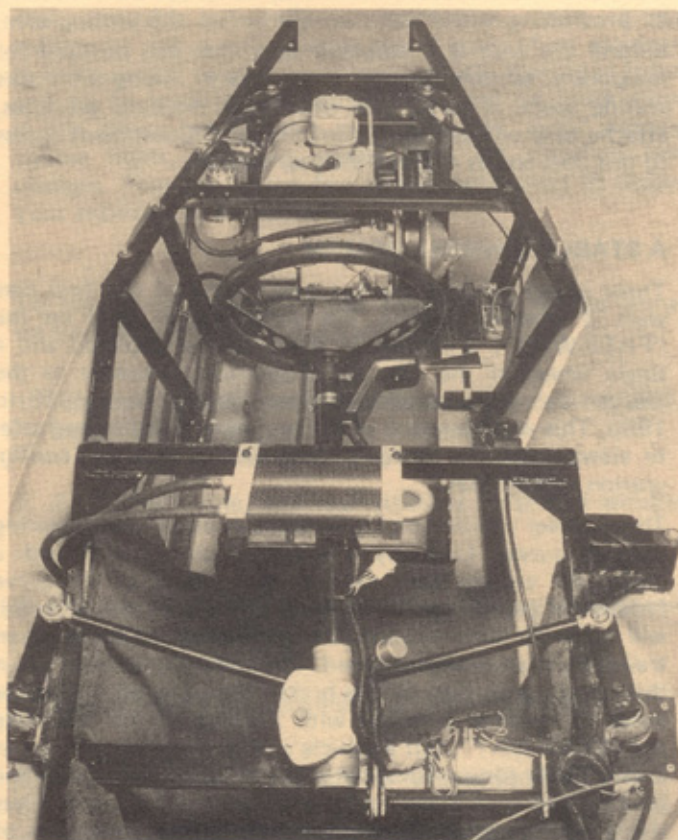


DELUXE "FREE-WAY" ELECTRIC

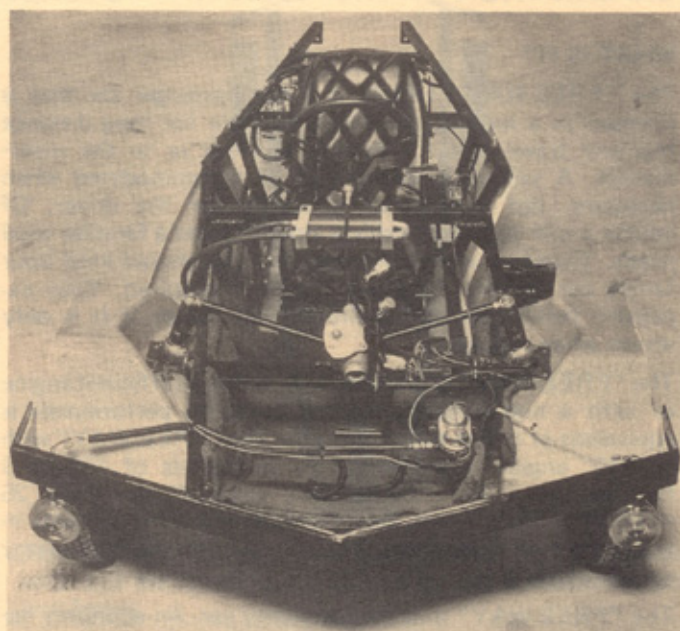
STANDARD FEATURES:

high efficiency performance
batteries
on board charger
automatic transmission

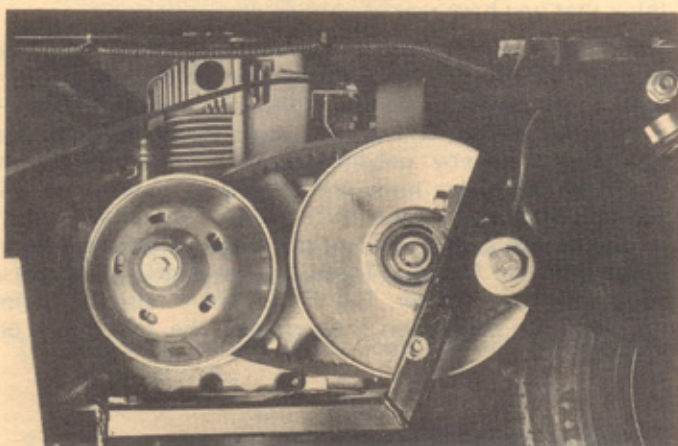
electric reverse
windshield wiper
voltmeter gauge
ammeter gauge



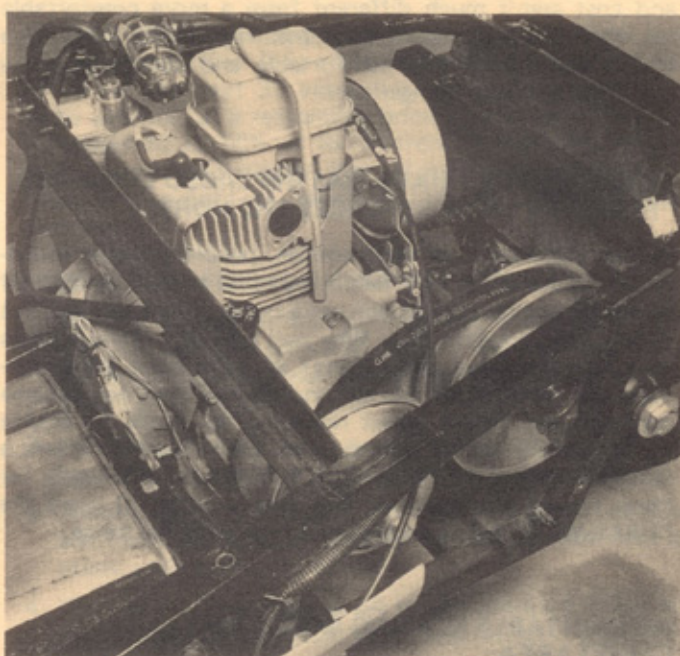
Chassis shown without top and seat.



Protective steel frame.



Automatic variable ratio transmission.



Engine carriage assembly and drive train.

EXPLANATION OF THE "FREE-WAY" DESIGN:

WHAT IS IT?

The "FREE-WAY" vehicle is a one passenger car that is licensed as a motorcycle and is suitable for long distance highway travel and for driving to work or to the supermarket. A second passenger can be accommodated when necessary, but is designed primarily for the driver. Of course a one passenger vehicle doesn't meet a families total needs. Therefore we recommend that you should keep your family car for the occasions that it is required. Your expensive family car will definitely last longer if it is only driven when needed.

The "FREE-WAY" is available with either an efficient engine or with a non-polluting electric drive. Its performance is equivalent or better than most cars. The "FREE-WAY" with a "340" engine is guaranteed to be capable of 100 MPG fuel economy. The "FREE-WAY electric" can travel 40 miles on a 20¢ charge. Both vehicles are advancements in transportation technology. They excel in the field of energy conservation.

The "FREE-WAY" is not an economy car. An economy car has generally been a squashed down full size vehicle capable of carrying 2 to 4 people in discomfort. Of course they are improving economy cars, but as long as their performance and cost aren't much different from a more comfortable car, there is no reason to want one. The "FREE-WAY" is a whole new concept, a comfortable and convenient, low cost, one or two passenger car.

HORSE AND CARRIAGE WAS REPLACED LONG AGO, "FREE-WAY" NOW REPLACES THE HORSE!

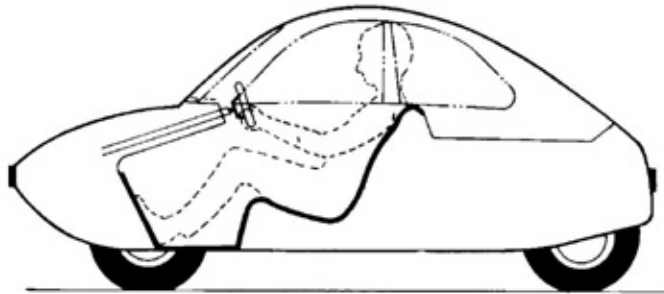
Before the advent of automobiles, people traveled individually by horse, or as a family by horse drawn carriage. Of course one person could also use a horse drawn carriage, but people were smarter then. Why pull around a carriage when all that was needed was a horse? Well the horse drawn carriage was replaced by the automobile and everyone became confused and forgot about replacing the horse. Of course the manufacturers of automobiles didn't want to invent a replacement for the horse when it was more profitable for them to sell automobiles. But finally after 70 years the "FREE-WAY" has been invented to replace the horse.

COMFORTABLE SEATING SPACE, AND LARGE CARGO AREA:

The "FREE-WAY" has seating dimensions for the driver that are the same as a comfortable full size car! Imagine, a small vehicle that isn't plagued by protruding wheel wells and cramped seating. Even many full size cars aren't as comfortable. Often inconvenient bumps are placed in the floor exactly in the locations where one wants to place their feet. The seating arrangement in the "FREE-WAY" has been carefully developed for comfort, because we like to use the products that we design.

If you are familiar with the economy imports, you probably know all about the hole between the two front wheels where one is supposed to insert their legs and feet and be able to manipulate 3 tiny pedals that control accelerator, brakes, and clutch. It's amazing that drivers can learn how to manipulate these vehicles with such an adverse design. The "FREE-WAY" has ample foot space and only 2 large control pedals, an accelerator and brake pedal. All of our vehicles have an advanced design automatic transmission so that antiquated shifting and clutching are eliminated.

Along with good seating space, a large cargo area has been provided. Groceries, luggage, briefcase, or camping gear can be carried. Convenient access has been provided through the rear window.



Cross Sectional View Showing Interior Detail.

A STABLE, 3 WHEEL DESIGN:

Three wheel vehicles are not new. Some of the first cars were 3 wheeled designs. The configuration used on the "FREE-WAY", 2 wheels in front that are steered and a single wheel in the rear for propulsion, is similar to the Morgan car manufactured in Great Britain from 1910 to 1950. **This configuration is the best from stability and safety viewpoints!** The Morgans' long success with this configuration proved that.

Three wheel vehicle tipping tendencies occur when steering through curves. Like any 4 wheel vehicle going through a curve, the vehicle leans towards the outside of the curve because of centrifugal force. Most vehicles, even 3 wheeled, will begin to slide towards the outside of the curve when travelling at an excessive speed. The common reaction when this occurs is to step on the brakes. Stepping on the brakes tends to stabilize a vehicle with 2 wheels in the front like the "FREE-WAY", but a vehicle with a single wheel in front is very likely to tip with application of the brakes because the braking and centrifugal forces are combining towards a less stable configuration. Even neglecting tipping tendencies of a single wheel in front vehicle, that configuration isn't acceptable because it is difficult to relate where the rear wheels are when approaching something. It is very easy to think that you have rear wheel clearance, but don't.

The "FREE-WAY" design is even more stable than the Morgan. The Morgan was a 2 passenger vehicle, side by side, with a high center of gravity. While a 2 passenger Morgan is a balanced design, it was used most of the time by one person and thereby unbalanced. In a small vehicle, the driver is the major mass and should be located on the vehicle center line. In the "FREE-WAY" the driver does sit on the vehicle center line and the center of gravity is much lower than the Morgan. These factors combine to make a good design even better. The "FREE-WAY" also has an improved front suspension that reduces the roll forces on curves.

OPTIMUM SMALL VEHICLE DESIGN FOR SAFETY:

The "FREE-WAY" is classified as a motorcycle, and as such isn't required to meet the same standards as cars. But we have been very concerned about passenger safety in the design of the "FREE-WAY". The initial concept was chosen for development because its physical shape is resistant to damage in the passenger zone. Unlike motorcycles, it is a stable vehicle that isn't dependent on road friction characteristics, and the passenger is protected by the vehicle structure.

Lower speed limits have increased the safety of small vehicles. There is no chance of reverting to pre-55 MPH speed limits because the majority of U.S. drivers prefer driving at safe speeds, and the U.S. Congress has pledged to retain the 55 MPH maximum. With ever increasing numbers of small cars on the road like Honda Civics, Ford Fiestas, and V.W. Rabbits, there will be less size difference between vehicles in the future. Also, small vehicles have less chance of being hit because of their reduced target size, greater maneuverability, and ease of staying in a lane.

The best safety device in a small vehicle is a good driver that practices safe driving techniques. Safe driving techniques can greatly reduce the chances of an accident. It is important to maintain proper vehicle spacing in front, and to be ready to relinquish your lane on quick stops if the driver behind isn't alert. Likewise, avoid running yellow lights, and give ample time for signaling lane changes. These are but a few of the many ways to reduce your exposure to an accident.

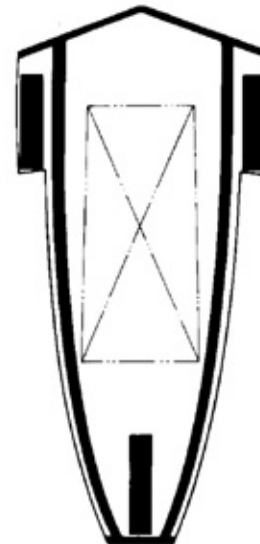
To reduce the chances of an accident by vehicle design we have chosen the following approaches:

1. Appropriate width and height dimensions so the "FREE-WAY" is easily seen.
2. Good front, side, and rear visibility by proper window layout.
3. Chrome isn't used in visual areas. Glaring chrome can obstruct vision.
4. A large rectangular headlight for good night vision.
5. Side marker lamps and reflectors for visibility.
6. High visibility body colors (red, yellow, and orange) that don't blend with the surroundings. Black, white, and earth tones blend with surroundings and make a vehicle difficult to see at times.
7. Good vehicle performance so there isn't a speed mismatch.

To reduce the chance of injury in a collision the following design approaches have been chosen:

1. A centrally located driver zone with impact absorption space on all sides.
2. A protective steel frame around the entire vehicle at normal bumper height.
3. A wedge shaped front-end that tends toward glancing rather than engagement.
4. A 3 point seat belt attached to the steel frame. The latch side is by the door so that a seat belt retractor isn't required and avoids the resultant entanglement during entry.
5. A thick door section with steel reinforcement.
6. The front wheels provide protection in front and side collisions, the rear wheel protects the rear.

Small vehicles are less safe in a collision, it is a simple physical law. Those people that are accident prone or have a phobia concerning accidents should ride a bus.



This top view shows the central location of the passenger zone and the protection provided by the wheels, bumpers, and frame.

OIL CRISIS. OIL CRISIS? OIL CRISIS!!!

Presently there is a controversy about whether there is an energy or oil crisis. It is a known fact that there is plenty of oil for the next 30 years, but whether it will continue to be available at a reasonable price isn't known. The U.S. purchases 40 to 50% of its oil from foreign sources who control price and supply. We are vulnerable to changes in price and supply as witnessed by the 1973-1974 oil embargo.

HOW ATTRACTIVE IS OIL IMPORTATION?

1. We buy foreign oil with U.S. dollars, and they come to the U.S. and buy advanced military weapons, our banks, our businesses, and our technology! Something must be given up for all of that oil!!
2. Will the U.S. start a war to gain control of oil producing countries? It has been discussed. Who is the aggressor?
3. Should military weapons and technology be used for blackmail to coerce the oil producers into low oil prices and continuous supply?
4. Will we continue to use oil at astronomical levels and find suddenly that it's gone and suffer catastrophic depression?
5. Will foreign countries continue to sell oil to us as the value of the U.S. dollar continues to decline and our assets dwindle?
6. Will the U.S. Government have to control its people and take away freedoms by economic or social restrictions?

BUT WHY?

Why must we continue in our greedy practices when advanced technology high mileage vehicles are possible?

Why must we be so ignorant that we accept media brainwashing from the antiquated auto empire?

Is it possible to revive the sleeping U.S. public?

HOW CAN THE "FREE-WAY" HELP?

With the "FREE-WAY", mobility and freedom can be retained while highly reducing our dependence on oil.

An average family should be able to reduce gasoline consumption by 50%. Oil imports could be greatly reduced. Running out of oil would occur sometime far in the future. Our society can be stabilized with no fear of oil crisis, war, economic chaos, or government restriction of freedom.

Air pollution can also be reduced! Although today's engines burn air cleaner, they still burn vast quantities. The amount of air burned is proportional to the amount of gasoline used, 1100 cubic feet of air is consumed for each gallon of gas. And as everyone knows, it doesn't take a gallon of fuel to fill a garage up with noxious fumes.

HOW CAN A PERSON OR FAMILY JUSTIFY THE PURCHASE OF A "FREE-WAY" VEHICLE?

Most people justify the purchase of a new car by need, benefits, or desire. Often the justification is based on fictitious reasoning like: "We must have that neat \$8,000 sports car because it will save so much money on gas". The "FREE-WAY" is an unusual vehicle to justify because it really can save a person money.

This section will discuss the many monetary reasons for owning a high mileage "FREE-WAY" vehicle. We believe that a multiple car family would be better off by selling one of their old gas guzzlers and replace it with a "FREE-WAY". Single car families will find it advantageous to become a 2 car family with a "FREE-WAY" and another car suitable for family driving. A single person will find the "FREE-WAY" satisfactory as the only vehicle or may want to also have a large car. Transportation costs are so high that just about anyone can justify a "FREE-WAY".

BENEFITS OF MAKING THE FAMILY CAR LAST LONGER:

The family car is a costly vehicle that has been completely misused. We have driven these cars day after day almost entirely by ourselves. These valuable cars have been quickly worn out because we need to travel many miles during our day to day activities. Just think how long that your car would last if it was only used for family travel? Cars don't get obsolete with age. Keep them in good condition for your family needs. They are very economical for your family needs, but very expensive for your personal needs.

TOTAL OPERATING COSTS (EXCLUDING INSURANCE) FOR DIFFERENT VEHICLES: A COMPARISON BASED ON 100,000 MILES OF USE:

For the sake of comparison, we will assume the following data:

The vehicles include a subcompact (Rabbit, Civic, etc.), a full sized family car (Pontiac Bonneville, Chevrolet Impala, etc.) and a "FREE-WAY" gas model with a 340 engine. The vehicles will have been kept 8 full years during which they will have accumulated 100,000 miles, and at this time will have a resale value of \$350. The license and sales tax figures are computed according to Minnesota fees.

A new "FREE-WAY": A new cost of \$3,300, will last for 8 years, travel 100,000 miles, go through 1 set of tires, cost \$200 to repair and maintain, cost \$56 for 8 years of licensing, use 1250 gallons of fuel at an average of \$1.75/Gal., cost \$120 for sales tax, and have a resale value of \$350, with 80 MPG fuel use.

TOTAL COST/100,000 miles is \$5,513. 5.5¢/MILE

A new "FULL SIZE CAR": It will typically cost \$7,500 new, last for 8 years, travel 100,000 miles, go through 2 additional sets of tires at the cost of \$700, cost \$500 to repair and maintain, cost \$600 for 8 years of licensing, and use 5,555 gallons of fuel at an average of \$1.75/Gal., cost \$300 for sales tax, and have a resale value of \$350, with 18 MPG fuel use.

TOTAL COST/100,000 miles is \$18,906 or 18.9¢/MILE

A new sub-compact (Rabbit, Civic, Fiesta, etc.): Typical cost of \$5,800 will last for 8 years, travel 100,000 miles, go through 1 set of tires at the cost of \$240, cost \$500 to maintain, cost \$400 for 8 years of licensing, use 3,333 gallons of fuel at an average of \$1.75/Gal., cost \$236 for sales tax, and have a resale value of \$350, with 30 MPG fuel use.

TOTAL COST/100,000 miles is \$12,659 or 12.65¢/MILE

FURTHER COMPARISONS

Another way to look at these vehicles is to consider \$100 worth of gasoline, or about 80 gallons if figured at \$1.25 per gallon.

At 18 mpg, the full sized car will go about 1400 miles.

At 30 mpg, the subcompact will go about 2400 miles.

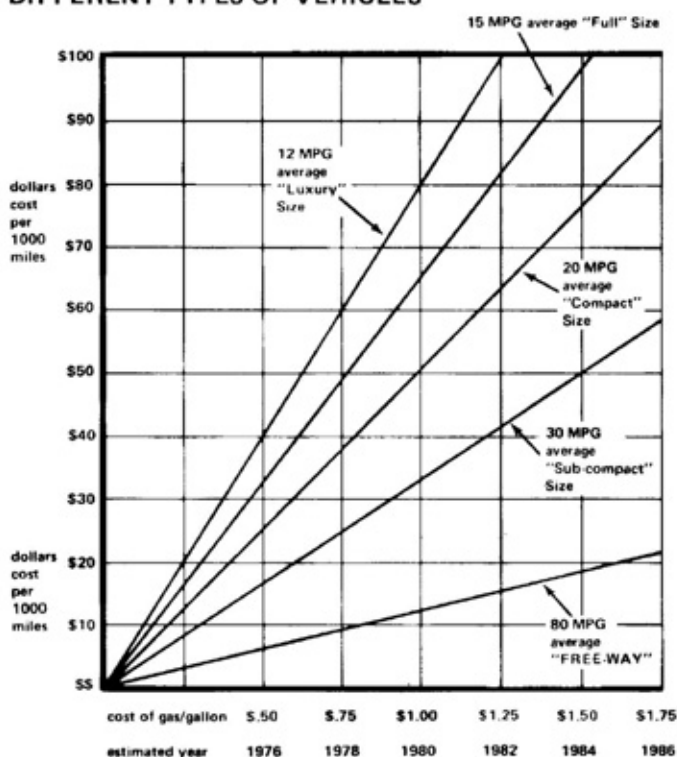
At 80 mpg, the "Free-Way" will go about 6400 miles.

This means that a person could get into a "FREE-WAY" in Miami, Florida, drive to Seattle, Washington, do about 300 miles of sight seeing, drive all the way back to Miami and not have spent more than \$100 for gasoline.

FUTURE PRICE TRENDS OF GASOLINE:

When examining fuel savings one must consider what will be paid over the life of the vehicle, not present cost. A large vehicle when looked at in terms of today's gas prices doesn't seem like a bad deal, but at tomorrow's prices it will be a poor investment. The following chart is a forecast of future gas prices and gas costs for different vehicles:

PROJECTION OF FUEL COSTS FOR DIFFERENT TYPES OF VEHICLES



FUEL ECONOMY OF THE "FREE-WAY":

The exceptionally good fuel economy performance of the "FREE-WAY" design is due to its light weight and minimal air drag coupled with a small efficient engine and transmission. After much research and comparison with other vehicle designs, we have not found any other vehicle that has the high mileage capabilities of the "FREE-WAY". Our "FREE-WAY" vehicle with the "340" engine is guaranteed to be capable of 100 MPG performance in an accurately conducted test. If a customer finds that their vehicle with a "340" engine will not attain 100 MPG with the vehicle adjusted to specification, within the first 90 days after purchase from us, we will take the vehicle back and refund the purchase price. When we at H-M-VEHICLES discuss fuel economy, we mean results that a person can obtain.

Don't believe EPA ratings! We don't, and we will not advertise them. The EPA ratings for small cars don't even pretend to relate to actual performance and actually confuse real data. As a matter of fact, some magazines are not equipped with the proper knowledge or equipment to perform fuel economy measurements. Many so-called tests are conducted by filling the fuel tank to the top, and driving 100 miles and refilling. This will result in mileage readings that are too high. That happens because of inaccurate filling and especially from fuel expansion due to the gas tank being heated by the muffler, engine, or rising ambient temperature. To get good statistics on fuel consumption requires driving far enough to use several tanks of gas and keeping careful records. For vehicle research, we use a removable gas tank that can be weighed before and after a test run which provides very accurate results even after 10 to 20 miles of driving. Other more sophisticated techniques are available, but still many claims are circulated that can't be verified.

STREAMLINED "FREE-WAY" DESIGN:

Since air drag at highway speeds is the major factor affecting fuel economy, there has been considerable discussion concerning drag coefficient. Most of the discussion by Detroit marketing people is just salesmanship. Little has really been done to cut down on drag.

The "Free-Way" vehicle has a full smooth belly pan which reduces drag considerably. Racing car designers have found that open wheels have less drag than wheel wells. The "Free-Way" wheels have a minimal wheel well arrangement. The drag coefficient of the "Free-Way" is estimated at .3 to .35. Normal automobiles are in the .45 to .55 range. Motorcycles are in the .7 to .8 range.

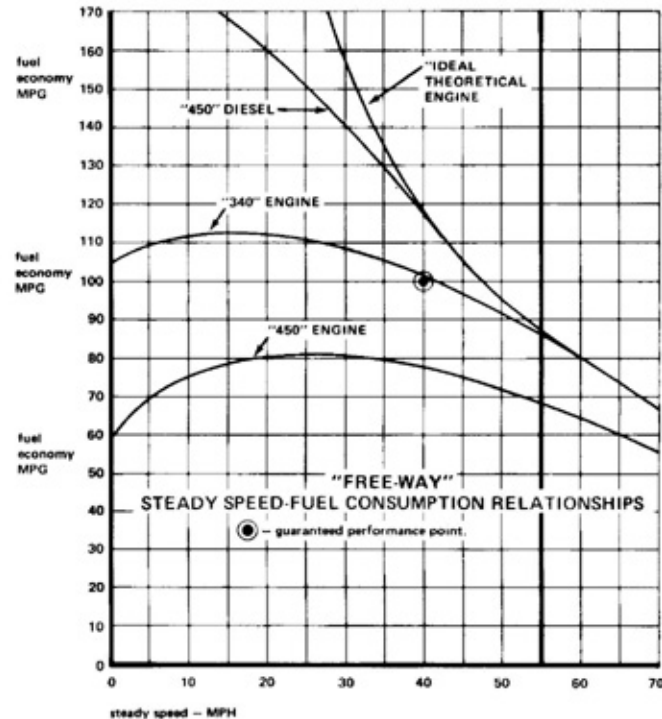
The power to overcome air drag at 50 MPH is 3½ times higher on the typical car than the "Free-Way". A motorcycle takes twice as much. The 3 view drawing on the back cover reveals the primary secret behind the high mileage performance of the "Free-Way", a streamlined functional design.

WHAT IS A GALLON OF GASOLINE?

A gallon of gas can have many identities because of differences in density and the type of oil that it is refined from. This also means that gasoline can vary in energy content per gallon. In general, it varies from region to region and is defined only as a one gallon volume as it is delivered from the gas pump. The fact that it can have different energy content means that vehicles should be compared on the same fuel.

SPEED AND ACCELERATION RATES HAVE A DEFINITE EFFECT ON FUEL CONSUMPTION:

With faster speed, more fuel is used. We have provided the speed and fuel consumption relationships for the "FREE-WAY" in graph form so that you may see the effects and know what to expect from your vehicle. Of course rapid acceleration and repeated stops and starts will detract from this performance. The following data assumes that a constant speed is maintained on a level highway with no wind aid:



HANDLING AND PERFORMANCE OF THE "FREE-WAY":

The "FREE-WAY" vehicle has excellent performance and road handling characteristics. In this section we will discuss the performance with the "340", and "450" engine powered models. The performance of the electric powered models are discussed in the "FREE-WAY electric" section, but general handling of the electric is the same.

ACCELERATION PERFORMANCE:

Because of the special automatic transmission in the "FREE-WAY", even with a low power to weight ratio, good acceleration is possible. Naturally with the larger displacement "450" engine, higher acceleration rates are possible. But even with the "340" engine, performance is good. Let's compare the performance of these 3 engines in acceleration to 50 MPH:

Speed, MPH	10	20	30	40	50	Engine:
Elapsed	1.7	2.8	4.9	8.2	13.2	"340"
time,	1.2	2.1	3.6	6.0	9.4	"450"
seconds	1.7	2.8	4.9	8.2	13.2	"450" Diesel

It should be noted that even with the "340" engine, acceleration is more than ample to stay ahead of normal traffic, and to get faster acceleration than the "450" is quite unnecessary. Less than 4 seconds separates these 3 engine sizes at 50 MPH. 13 seconds was the slowest elapsed time to 50 MPH, while normal driving acceleration to 50 is in the 20 to 30 second range.

TOP SPEED:

Although the "FREE-WAY" has enough power to go over 70 MPH, the gear ratio limits the top speed to 65 MPH. This provides for better acceleration. Engine life will also be prolonged by running at less than full power output at steady speeds.

GOOD BRAKING:

With light weight, high braking torque, and good weight distribution, the "FREE-WAY" can stop quickly. The hydraulic drum brakes and shifting of weight distribution to the front during stops combines to give rapid deceleration.

QUICK, PRECISION STEERING:

A tight, 3 turns lock to lock steering system gives quick, accurate steering at highway speeds and a good feel of the road. The turning circle is approximately 24 feet in diameter which means a U-turn is possible in just about any road. We feel that the slalom course that sports cars are compared on will yield really good speed for the "FREE-WAY" because of its small size, narrow width, tapering to the rear shape, and strong anti-roll front suspension.

PARKING:

Parking problems are over with this car. Those front row parking spots that other vehicles can't use are yours. It also saves space in your garage making the garage more useful.

ATTENTION TO DRIVING, NOT CLUTCHING AND SHIFTING:

Most small cars have antiquated transmissions that require manual shifting and special attention. Four and five gear ranges demand continual operation in normal traffic. Not so with the "FREE-WAY"! An automatic, high efficiency transmission is standard on all models. It does the work so that you can pay attention to driving, step on the accelerator pedal and go, let up or step on the brake and stop. There is nothing tricky about the operation of this vehicle.

HANDLES LIKE A CAR ON THE ROAD:

It's hard to believe that you are driving down the highway in complete comfort, yet getting better fuel economy than a motorcycle. The smooth driving "FREE-WAY" will convince you that a new age of economy and fun has arrived.

DETAILS OF THE "FREE-WAY" VEHICLE:

The "FREE-WAY" is a durable high quality vehicle. It has many unique features that are not found in ordinary passenger cars. The body, frame, suspension, engine, transmission, and fuel system are extraordinary. The following sections highlight the major systems.

STEEL FRAME:

A heavy gage tubular steel frame provides the vehicle structure. The steel frame is located at floor level and also at bumper level and is joined by supports forming a strong steel cage. All components are mounted to the frame and it also provides protection to the passenger compartment. The steel frame is completely enclosed by the fiberglass body so that it is not subject to destruction by rust.

BODY (NON-RUSTING):

The body shell is made from FRP (fiberglass-reinforced-plastic) which is a very durable and attractive material. FRP is a premium quality material that has been proven in many difficult applications. The average thickness of this body shell is 1/8 inch thick compared to the normal 1/32 inch steel sheet shells used on most cars. It has a deep surface finish (gel coat) that is as thick as the sheet metal on most cars. Normal scratches won't penetrate the surface finish. It can be washed, waxed, polished, or repainted just like any paint finish.

FRP will never rust! The automotive companies have been promising a rust resistant steel shell for decades. Every year they once again try to convince their customers that it won't rust now. Don't hold your breath while waiting for that to become reality. It's against the nature of thin steel sheet and corporate profits. Presently FRP is used on truck cabs, luxury sports cars, and on boats (fresh and saltwater). It is truly a durable material for the future.

The FRP body parts are fastened to the frame and are removable. A damaged section can either be repaired or replaced. Repairing is easy with no special tools being required. The complete underside is also enclosed with FRP!

SUSPENSION:

The "FREE-WAY" basically has independent suspension. The rear suspension is of trailing link design. The front suspension is a new design that is advantageous to a 3 wheeled vehicle. It has a strong anti-sway feature built into it to increase stability on curves. Further information isn't available at this time because patent protection has been applied for.

TRANSMISSION (AUTOMATIC):

A smooth, high efficiency, automatic transmission is used in the "FREE-WAY". It is continuously variable through its speed range which provides good fuel economy and acceleration. It shifts automatically without hesitation while allowing the engine to run at almost constant speed. This transmission is better than a manual stick shift or the automotive automatic types both for fuel economy and smoothness.

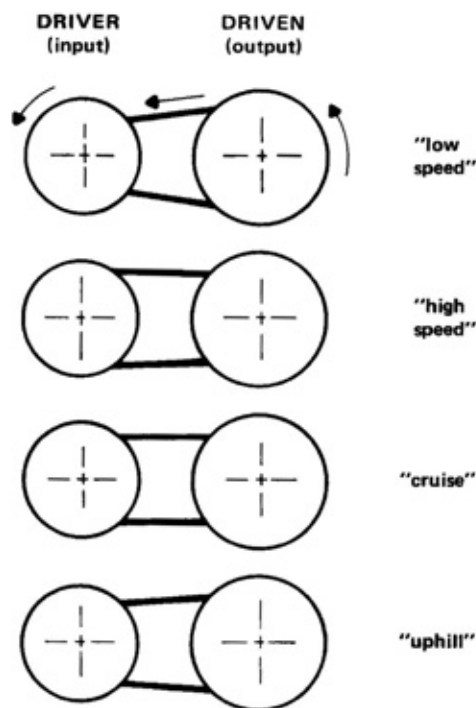
This "VRT" (variable ratio transmission) consists of 2 variable diameter pulleys coupled by a belt. The pulleys are designed to shift appropriately for the vehicle. A driver pulley is mounted to the engine crankshaft and has centrifugal weights that respond to engine RPM. The centrifugal weights force the pulley closed as the RPM increases which increases the effective diameter. The driven pulley is spring loaded with special designed cams that control shifting characteristics. Together these two pulleys determine the "VRT" operating characteristics.

The 3 advantages of the "VRT" are:

1. high efficiency-optimum fuel economy.
2. Fast acceleration with a small engine.
3. Smooth starts and continuous shifting.

The "VRT" technology has existed for a long time, but it is only suited for small vehicles. The "VRT" has made the snowmobile perform well and easy to control. The two-stroke engines used in snowmobiles have a very poor speed torque curve and without the "VRT" would bog down. The "VRT" belt has been improved greatly for snowmobiles, and with the "FREE-WAY" requiring much less power, should seldom require replacement.

The following sketches show some of the operating modes of this drive system:



FINAL DRIVE:

The transmission is coupled to the rear wheels by roller chain and hardened sprockets. A heavy duty chain is used for long life and low maintenance. The chain has a special plating that increases the lubricity and efficiency. The chain and sprocket drive has been very successful in small power applications and is durable and reliable. An occasional lubrication of the chain is all the maintenance that is required. It is quite inexpensive to replace if it ever wears out.

BRAKING SYSTEM:

Drum brakes are located on each wheel. They are hydraulically actuated brakes with the addition of a mechanical parking brake on the rear wheel. The master brake cylinder is a dual system unit with the two front brakes on one line and the rear on the other.

The weight distribution and braking torque are very good which provides for good braking even on slippery surfaces. Our supplier of brake system components is very well known and also supplies the automotive industry.

FUEL SYSTEM AND OPTIONAL "LDR" FUEL SYSTEM:

The "FREE-WAY" comes standard with a 3 gallon fuel

tank. 200 to 300 miles of driving are possible before refilling is necessary.

An optional fuel system, "LDR" (long distance range), is available that greatly extends the range between fills. This optional fuel system is of 9 gallon capacity which means that with a "340" engine a person might travel 900 miles before running out! A fuel gauge is also provided that is mounted in the instrument panel which will hopefully remind you not to run out. At more than 800 miles, just think how seldom gas station stops are required. When the next embargo occurs, it will have little affect on those with the "LDR" system. Long waits at the gas stations will be avoided with the "LDR" system.

DETAILS OF THE "FREE-WAY" VEHICLE: "HIGH EFFICIENCY ENGINE"

The "FREE-WAY" uses a single cylinder, 4 cycle, spark-ignition engine. It is a durable cast-iron engine that will give many years of reliable service before requiring an over-haul. This large bore over-head valve engine has a high compression ratio and many other attractive features that make it ideal for our "HIGH MILEAGE VEHICLES".

A single cylinder engine has been chosen because it is the optimum configuration for low power applications that require exceptional fuel economy. Multiple cylinder engines of the same displacement will generally consume more fuel at the same power levels and the wasted fuel is exhausted as hydrocarbons into the atmosphere. The single cylinder design is also easier to carburetor precisely, allowing for leaner fuel-air mixtures. Further advantages are less maintenance, lower initial cost, less costly to repair, simple enough for the do-it-yourself person to repair, yet rugged enough to ignore between normal maintenance intervals.

Some people have been concerned about vibration with a single cylinder engine. It is true that a single cylinder engine can't be balanced as well as a V-8. But this engine has been balanced and is isolated from the main vehicle frame by 4 large rubber isolation mounts. An additional dynamic balance system is provided that further reduces vibration. The experience of many people has been with light weight engines bolted directly to flimsy structures as in some lawn and garden equipment.

AIR COOLED:

This engine is forced air cooled by a large fan which is part of the flywheel. Air is ducted over the critical engine components keeping them at safe operating temperatures. There is no need for anti-freeze, water pumps, V-belts, thermostats, radiators, or hoses. It is a **completely maintenance free system** that has been proven even in large diesel engine applications.

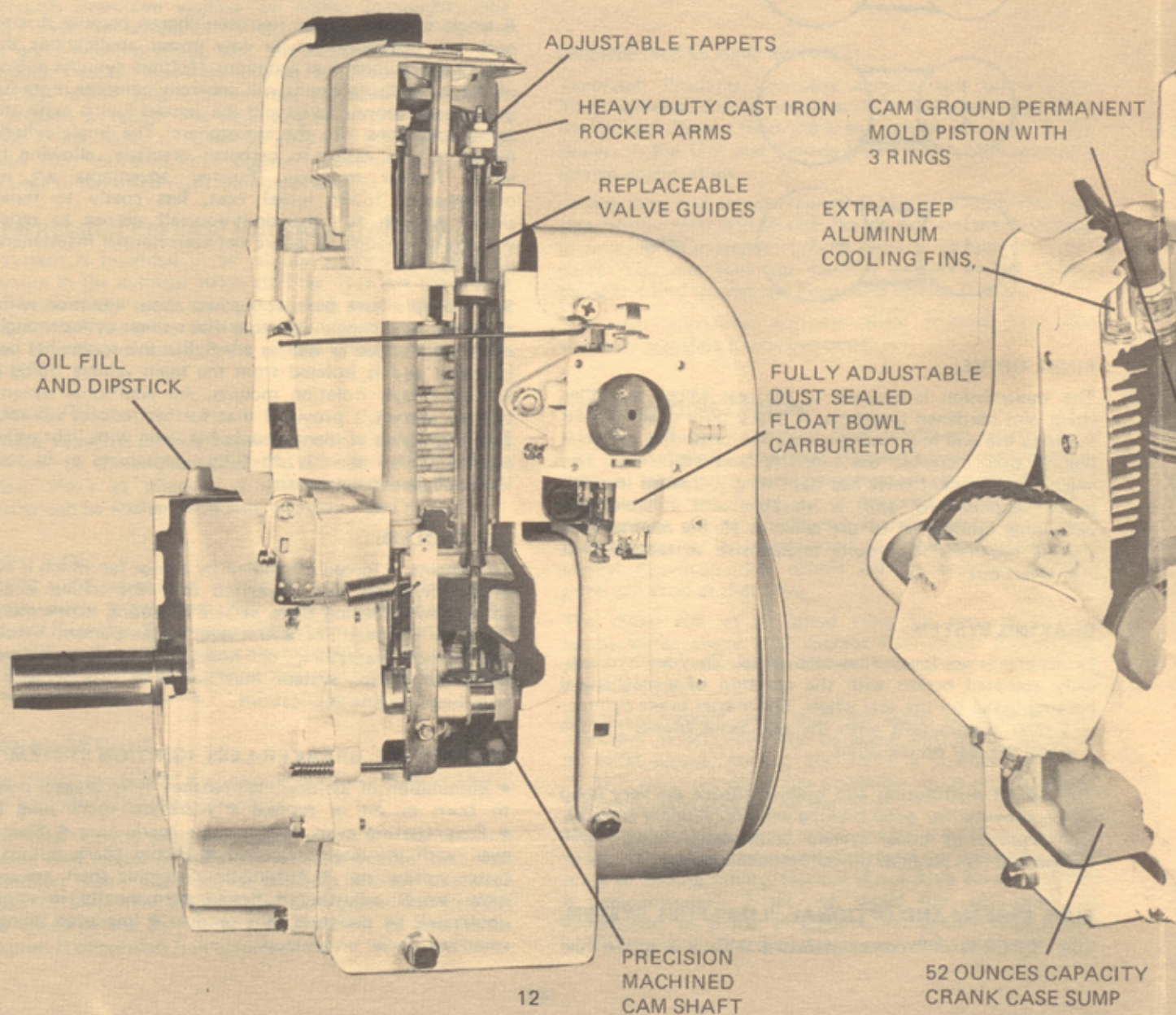
SOLID-STATE, BREAKER-LESS, IGNITION SYSTEM:

- Elimination of ignition maintenance
- No breaker points to burn or pit or replace
- Increased spark plug life
- Easy starting even with a poor spark plug
- Starting even with the engine flooded
- Higher spark output — faster voltage rise
- Automatic electronic spark advance, never needs adjusting
- Sealed permanently in epoxy, unaffected by moisture, dirt or dust
- Improved idling — smoother power under load

340

Bore — 3-1/8" (79.38mm)
Stroke — 2-3/4" (69.85mm)
Displacement — 21.09 cu. in. (345.68cc)
Compression Ratio — 8.65:1
Type — 4 Cycle, Valve-In-Head

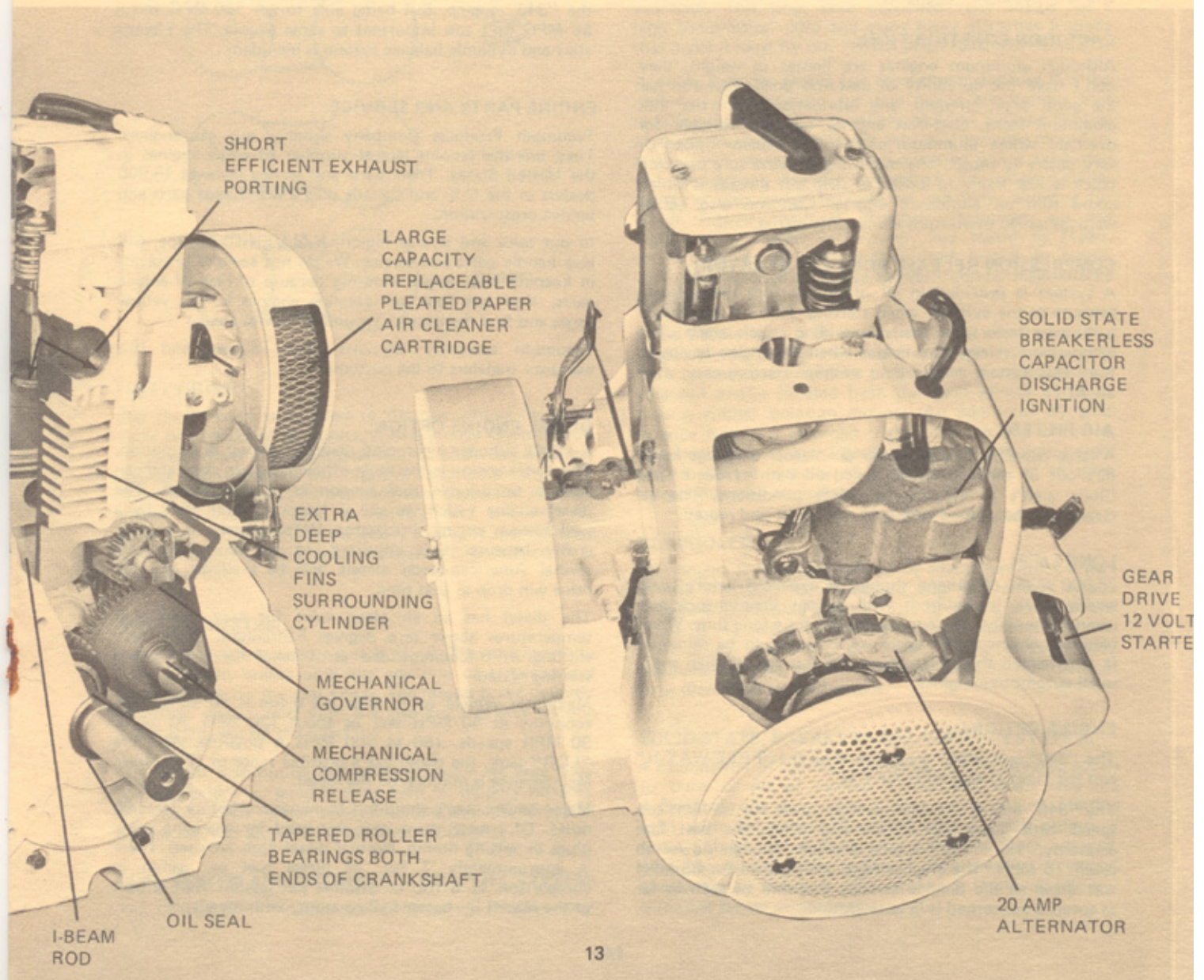
Electric Start



450

Bore — 3-1/2" (88.90mm)
Stroke — 2-7/8" (73.02mm)
Displacement — 27.66 cu. in. (453.25cc)
Compression Ratio — 8.70:1
Type — 4 Cycle, Valve-In-Head

Electric Start



No more ignition tune-ups! A solid-state ignition is standard on all of our engines. It is triggered by a magnetic pick-up and charged by a high voltage magneto. Timing is set and doesn't need adjustment. Fast starts and reliable ignition are assured by this high energy system. An occasional replacement of the **single spark plug** is the only routine maintenance to the ignition system!

20 AMP ALTERNATOR:

How many times have you purchased a rebuilt alternator for your car because of bad bearings or a burnt out diode? This alternator is located at the engine flywheel and has no bearings to wear out. It isn't belt driven either — **no belts to replace**. A rectifier-voltage regulator is external from the alternator and is much less costly and easier to replace if it should malfunction.

TAPERED ROLLER BEARINGS:

Since this is a single cylinder engine, the crankshaft can be supported by two anti-friction tapered roller bearings. Reducing friction at the crankshaft is very important because of the high pressure loads that are placed on it. Less power wasted in the engine means more power at the wheel or better fuel economy.

CAST-IRON CONSTRUCTION:

Although aluminum engines are lighter in weight, they don't have the durability of cast-iron ones. Cast-iron has the good wear, strength, and lubrication properties that aluminum lacks. Cast-iron engines are also suitable for overhaul where aluminum engines are usually ruined or very costly to repair. The mounting of parts to a cast-iron block is less likely to loosen or strip out threads — which could ruin an aluminum engine. Cast-iron also resists warpage which often ruins aluminum engines.

COMPRESSION RELEASE FOR EASY STARTING:

A system is provided in all of our engines that releases pressure in the cylinder when starting. This lets the engine turn over faster and easier providing quick starts. The compression release deactivates when the engine begins to fire. This system makes cold weather starting easy, even at -20° F.

AIR FILTER:

A large capacity pleated paper air cleaner cartridge keeps dirt out of the engine. So called oil bath or oiled foam filters aren't as effective in dusty conditions. The air cleaner can be washed with soap and water and reused.

LONG LIFE:

75,000 miles of driving should be expected before basic engine work is required. With proper maintenance and engine rebuilding, this engine will last for a long time. When required, engine repair costs are expected to be minimal. It is expected that this engine will last longer than most small automotive engines.

ENGINE OPTIONS:

The "340" and "450" are optional on the "FREE-WAY II" and the "DELUXE FREE-WAY II".

The "340" engine provides enough power for 65 MPH top speed with good acceleration and offers the best fuel economy. The "450" engine provides enough power to reach 75 MPH. The engines have been geared for 65 MPH top speed so the only difference that will be seen as far as speed is concerned is in acceleration.

We recommend the "340" with electric start as the engine to choose, and offer it with a 100 MPG guarantee. The larger engines are offered for those people who might want to sacrifice a little of the exceptional fuel economy for faster acceleration.

THE "340":

The "340" is optional on all units and is recommended where peak fuel economy is desired. It has a gear drive electric starter and dynamic balancing for extra smooth running. Although this is the smallest engine size offered, it has plenty of power for rapid acceleration and maintaining freeway speeds. The "340" comes with the 100 MPG guarantee.

THE "450":

The "450" is optional on all units. It offers the best acceleration and should be surprising in performance. This engine in combination with the unique transmission will probably exceed many cars in acceleration. It is recommended where high performance and still exceptional fuel economy are desired. Only a 20% loss in fuel economy is expected over the "340" engine. But being able to get 100 MPG versus 80 MPG isn't too important to some people. The Electric start and dynamic balance system is included.

ENGINE PARTS AND SERVICE:

Tecumseh Products Company supplies our gas engines. They are the second largest supplier of small engines in the United States. Their parts and service involves 15,000 dealers in the U.S. and Canada plus a world-wide parts and service organization.

In our sales and service region, H-M-VEHICLES, Inc. will also handle parts and service. We do not see any problems in keeping your engine running because of lack of engine parts. You can look up gasoline engines in the yellow pages and find the nearest Tecumseh Service Dealer.

Tecumseh currently warrants their engines, and this warranty transfers to the customer.

DIESEL ENGINE OPTION:

A single cylinder air cooled diesel is offered as an option. The diesel engine is the most efficient power plant and can achieve remarkable fuel economies at low speeds. The diesel engine which we use is imported from Italy by a well known engine distributor. Unfortunately, it is quite costly because it is imported. In the next few years several American-made diesels will be available and the price will drop at that time.

The diesel has an air bleed valve for easy starting at temperatures above zero degrees Fahrenheit. Below zero starting isn't recommended as it taxes the battery and starting system.

Maximum vehicle speed with the diesel is 60 MPH. Fuel economy at 40 MPH will be about 120 MPG. At 20 to 30 MPH speeds, 160 to 200 MPG is possible. With the "LDR" tank, the diesel has a possible range of 1200 miles. Maintenance is minimal on the diesel.

Major engine work shouldn't be necessary before 150,000 miles. Of course there isn't any need for changing spark plugs or setting timing. Normal diesel fuels are used. There is approximately 7 lbs. of diesel fuel per gallon in comparison to 6 lbs. of gasoline per gallon. That is part of the reason for better fuel economy with diesels.

REVERSE GEAR:

The "FREE-WAY electrics" and the "deluxe FREE-WAY II" have a reverse drive as a standard feature. On the "FREE-WAY II" a reverse drive is optional.

It might seem peculiar to have a reverse drive offered as optional equipment, but there is a reason for it. The "FREE-WAY" is so light and free rolling that a child could push it if the parking brake was released. It isn't difficult to back it out of the garage or out of a parking space manually. Or it is also easy to avoid parking spots where backing up is necessary. Those that don't mind the slight inconvenience can order a vehicle without reverse. People who are used to the convenience of reversing have the choice to order a reverse drive.

HEATER-DEFROSTER:

An unique heating system is used in the "FREE-WAY". This system is optional except in the "deluxe FREE-WAY II". Heat from the engine crankcase oil is transferred by pumping oil from the crankcase to a radiator. Air is forced through the radiator and part is ducted to the windshield defroster and the rest into the passenger compartment. Since this is a closed system there is never any danger of engine fumes entering the passenger compartment like some of Nader's favorite cars did. The engine is air-cooled so anti-freeze is not used. The hot oil that is pumped through the radiator can't freeze so there is never any worry about freezing the engine.

This heating system not only heats the vehicle in the winter, but it also keeps the engine cool in the summer. Lower engine operating temperatures extend the engine life. The heating system consists of an electric oil pump, a filter, tubing, a radiator, blower fan, ducting, vent control, and on-off switch.

With this system, the larger oil capacity and replaceable filter combines to provide long oil change intervals. With this heater system, a 20,000 mile oil change is possible when using Mobil #1 synthetic oil. Mobil #1 is recommended because it reduces engine friction and is more stable at high temperatures than normal oils.

Without this optional heating system, the engine doesn't have an oil filter and therefore oil changes are recommended every 2,000 miles and normal oil will be more economical.

VENTILATION AND OPTIONAL SUN ROOF:

A front vent is provided that controls the amount of air entering the passenger compartment on warm days. Depending on just how hot the day, the side vents and rear window can also be opened.

For those that really like open driving, an optional sun roof is available. It may either be opened partially or taken off and stored in the storage area. This is an attractive feature for those southern states where temperatures are often warm.

AUTOMOTIVE LIGHTING:

A large rectangular headlight provides plenty of light for night driving. These are the new lights that have just started to appear on the new models and are an updated

version of the old 4 light rectangular system. Side marker lights, turn signals, and tail lights give the "FREE-WAY" good visibility and conventional identification. A "SLI" battery along with a 20 amp alternator provide the power to keep the lights bright. Good lighting is very important for night driving.

OPTIONAL deluxe INSTRUMENTATION:

For those that like to know how well their vehicle is functioning, or how it functions, a complete instrumentation package is offered that consists of an ammeter, oil temperature gauge, and fuel gauge. These are all high quality instruments that are vibration resistant and have long life.

OPTIONAL MICHELIN TIRES:

The "FREE-WAY" is supplied with bias ply 4.8 x 12 tires. These tires are available nationally and there are many replacement brands, i.e. Goodyear.

Michelin steel belted radials are available as optional equipment. They will last longer and have less rolling resistance which gives better fuel economy. They are the 145 SR 12 xxx size and can be purchased through Michelin dealers when replacement is necessary.

SERVICEABILITY:

Special attention to easy access and routine maintenance has been observed. Parts requiring occasional maintenance have been placed in convenient locations. Unlike automobiles where one must crawl underneath or raise it up on a hoist, the "FREE-WAY" is accessible from the sides. The "FREE-WAY" components are easy to understand and no special skills or tools are required for maintenance. An owner's and maintenance manual are provided with each vehicle so that it can be kept in proper order by the owner or hired mechanic.

Major repairs are also easy because of this vehicle's modular construction and light weight. The "FREE-WAY" consists of 5 major modules; upper body assembly, lower body, frame assembly, front suspension assembly, and engine assembly. The upper body assembly consists of windows, upper body, wiring harness, instrument panel, and lighting system. The wiring harness has a connector for ease of removal, and this upper body assembly is bolted to the frame. The lower body is a shell that encloses the underside of the vehicle and is also bolted to the frame. The frame assembly consists of all the parts that remain attached to the frame; brakes, steering system, controls, etc. The front suspension assembly consists of front wheels, suspension and steering links, and shock absorbers. The engine assembly includes the engine mounting frame, engine, transmission, rear wheel and suspension. This engine assembly is attached to the frame assembly by 4 large rubber mounts so that it is very easy to remove when major repairs are required.

In a few hours, the whole vehicle can be disassembled and reassembled with ease. Each component is reliably attached so that repeated removal will not result in damage. Try to take the body off your automobile and see the kind of mess that results.

We have designed this vehicle to be reliable, but we also recognize that occasionally major repairs might be required. That is why so much attention has been paid to serviceability. It is important that the vehicle can be quickly and inexpensively repaired and returned to reliable service.

MAINTENANCE:

The following schedule shows the recommended maintenance intervals:

2,000 MILES:

Check tire pressure . . . Change oil (only if optional heater system isn't used)

10,000 MILES:

Change spark plug . . . Lubricate roller chain . . . Check battery level

20,000 MILES:

Change oil and filter: (with optional heater system) . . . Check brake fluid

40,000 MILES:

Engine inspection . . . Clean air filter

After each refueling:

Check oil level . . . Clean lights and windows

Checking tire pressure is recommended often to keep the high mileage performance. Tires, suspension, and steering linkages should be checked occasionally for abnormal wear. Changing the spark plug every 10,000 miles is necessary only as a precaution. If an engine that uses only one spark plug is allowed to run too long before changing the plug, an operating failure is sure to result.

PARTS AVAILABILITY:

In the Minneapolis-St. Paul area we offer a complete repair service and a parts department. For out state customers, we offer fast shipment of replacement parts. In just about all areas there is a Tecumseh engine service and parts center (this can be located in your yellow pages under engines, gasoline). But most common service items are handled at your local auto parts shop. The following items should be available in most localities: Oil, oil filter, air filter, fuel filter, brake fluid, chain lube, headlights, turn signal and tail light bulbs, tires, batteries, and miscellaneous electrical components.

LICENSING AND REGULATIONS:

An adequate classification for the "FREE-WAY" doesn't exist now. It is neither a motorcycle or a car. But it is classified as a motorcycle by the Federal Code of Regulations:

"Motorcycle" means a motor vehicle with motive power having a seat or saddle for the use of the rider and designed to travel on not more than three wheels in contact with the ground.
CFR 49: 571.3

Due to different licensing requirements in each state, we can't make a definite statement about the regulations in your state. As this type of vehicle becomes popular, we think that some uniformity of regulations will develop. But for now it is advisable that you call your State Motor Vehicle Registrar and ask them about the requirements for licensing a three wheeled motorcycle.

In Minnesota the vehicle is licensed as a motorcycle and a motorcycle drivers license is necessary. The drivers license

requires a short multiple choice exam and a simple road test. Of course the road test is ridiculous since the "FREE-WAY" is no different to drive than a car, but it only needs to be done once. The vehicle license fee is only \$7.50 yearly which is much less than that for an automobile.

PRODUCT NAME-COMPANY NAME ? ?

H-M-VEHICLES, Inc. means "HIGH MILEAGE VEHICLES". It was chosen to emphasize our high mileage vehicle technology, and our dedication to only produce high mileage vehicles.

"FREE-WAY" was chosen to indicate the economics of using this type of vehicle and to also imply freeway or highway application. It also implicates the individual freedom of the driver who doesn't have to depend on buses, car pools, or the schedules of others.

We hope that you like these names and the practical aspects of our advertising. It is quite different from the typical glamorous beauties perched on the hoods of new cars with a wild beast (cougar) at her side whispering to you that you must have their new model.

"FREE-WAY ELECTRIC"

THE QUIET, LOW COST, POLLUTION FREE WAY TO DRIVE!

The "FREE-WAY electric" is probably the only practical type of electric vehicle at this time. The unique low power requirements of the "FREE-WAY" design lends itself to battery-electric motor propulsion. It can be driven on the highway at highway speeds for short trips. Speed and acceleration performance are adequate for mixing with normal traffic. But if automotive performance is expected, then this vehicle isn't for you. This vehicle is for the person who wants practical, everyday transportation at minimum cost.

The "FREE-WAY electric" has been designed to satisfy a person's short trip needs. As you know, a considerable portion of most driving involves short trips to work, to the store, or visiting. In general, any round trip of 30 miles or less is ideal for this vehicle. If it is possible to recharge at your destination, then 60 mile trips become practical.

Our goal has been to develop an economical, high performance electric vehicle. We feel that this is a very practical product and that this "FREE-WAY electric" will be enjoyed by its owner. The light weight, one passenger design is suitable with the current technology now. In the future electric vehicles will gain more public acceptance.

ADVANTAGES OF THE "FREE-WAY electric" OVER ENGINE POWERED CARS:

1. No gasoline needed! Instead of paying 5¢ a mile for gasoline, you can save 4½¢ a mile by using the "FREE-WAY electric". Only ½¢ of clean electric power is required to travel a mile!
2. Pollution free! No exhaust fumes!
3. No waiting at gas stations! Simply plug the power cord into a standard household outlet when you get home.
4. No immediate payment is necessary for fuel. If you drive every day, your electric bill will only go up about \$6 per month.
5. No tune-ups or oil to mess with. No spark plugs, anti-freeze, or engines to fix.

6. Always starts!
7. An economical auxiliary vehicle that will cut down on your transportation costs.
8. Doesn't idle during stops, no energy wasted once your foot leaves the accelerator pedal.
9. Quiet and vibrationless!
10. Long life reliability!

ELECTRIC VEHICLES OF THE PRESENT:

Presently, there are two electric vehicles offered for sale in the U.S.; the Elcar and the Citicar. They are both 2 passenger vehicles with top speeds of 35 MPH. Power is provided by a series wound motor that produces 3½ HP at 3000 RPM. Eight 6 volt batteries are used that weigh approximately 525 lbs. Retail price is about \$5000.

The following chart compares the specifications, characteristics, and performance of the "FREE-WAY electric" to the "Citicar" and "Elcar":

	"FREE-WAY electric"	"Citicar"	"Elcar 2000"
Length, inches	115	95	84
Width, inches	53	55	53
Height, inches	51.5	58	63.5
Wheelbase, inches	80	63	51
Road clearance, inches	7.5	5.5	5
Curb weight, lbs.	700	1250	1091
Operating weight, lbs. (passengers)	850-1000 (1) (2)	1400-1550 (1) (2)	1240-1390 (1) (2)
Frontal area, sq. ft.	9.5	19	19.5
Drag coefficient	.35	.45	.45
Motor performance	6 HP continuous at 3500 RPM, 12 HP intermittent at 3150 RPM.	3.5 HP at 3200 RPM.	3.0 HP at 3000 RPM.
Motor type	"HIGH EFFICIENCY" permanent magnet 48 VDC	Series wound 48 VDC	Series wound 48VDC
Batteries	4, 12V DEEP-CYCLE 2.5-3 KWHRS. at one hour rate	8, 6V Deep-Cycle 5-6 KWHRS. at one hour rate	8, 6V ????
Battery weight, lbs.	210	525	500 ?
Speed control type	Mechanical, variable speed drive	Multi-voltage speed switch	Multi-voltage 6 speeds- hand operated switch
Drive ratio	variable, 9 - 3	7.14 fixed	??? .
Body-frame type	Reinforced fiberglass shell over a steel tube frame.	Cyclolac plastic over an aluminum tube frame.	Reinforced fiber- glass over an alum- inum tube frame.
Brakes	Drum	Front-disc Rear-Drum	Drum
Top speed, MPH	55	35	30
Time, 0 to 30, secs.	10	15	25
Time, 0 to 50, secs.	25	X X X X X	X X X X X
Approximate range at:			
30 MPH	27 miles	30 miles	30 miles
40 MPH	19 miles	X X X X X	X X X X X
50 MPH	12 miles	X X X X X	X X X X X

X X X X X — denotes not capable.

In the last few years, many experimental vehicles have appeared in the news media. Claims of good top speeds and range have been reported. But why aren't they on the market? In the first place, their claims of speed and range haven't been simultaneous. In other words, they didn't tell us that one could travel 100 miles at only 20 MPH, or 5 miles at 65 MPH. But the major reason for not introducing them as a product is cost. Who is going to pay \$6,000 to \$10,000 for a 4 passenger electric car that goes less than 50 miles on a charge and can't be driven on the highway! An electric vehicle will always be more expensive than an equivalent size, engine powered car, and with less performance.

There has been a lot of discussion concerning batteries, control circuits, and motors. Some vehicles have lethal power sources with voltages exceeding 100 and high current capacity. Exotic solid-state control circuitry has been the rule in these designs with the proponents debating the merits of regenerative braking and flywheel hybrids. All types of batteries have been proposed with a so-called break-through always just a few years off. Some of the U.S. auto producers have even demonstrated vehicles with battery packages worth \$15,000 in materials alone. Current thought is that high voltage motors are the answer. Hardly ever does one hear about how the average person would recharge one of these exotic systems safely or what the retail and operating costs would be.

In the near future, we seriously doubt that electric vehicles will be practical in any size larger than a small 2 passenger vehicle. Even if batteries are improved 500%, there are other problems that have been ignored that are even more serious and difficult for large electric vehicles.

But our one or two passenger "FREE-WAY electric" is practical now! For this small size vehicle, battery, motor, speed controller, and charger are presently designed into an efficient package that is economical to own and operate. An examination of your short trip needs compared to the performance of this vehicle should convince you that this vehicle is ideal.

HIGH EFFICIENCY PERMANENT MAGNET MOTOR:

The motor used in the "FREE-WAY electric" is a permanent magnet motor that is rated for 6 HP continuous use. At 6 HP output, a speed of 48 MPH can be sustained. The vehicle is geared to produce a maximum speed on the level of 52 MPH which corresponds to 8 HP output which is acceptable for the time that it can run on the battery source. Peak output of the motor is more than 12 HP but that can only be used for a short duration.

The permanent magnet motor is the best type for a small vehicle. It has better efficiency in an equivalent size range than a series wound motor. It also has a better speed-torque curve (RPM doesn't vary so drastically with load like a series wound motor). Series wound motors have to be controlled to keep from over-speeding at low power levels by either voltage switching or regulation by electronic control. The permanent magnet motor runs efficiently at low power levels where the series wound doesn't do well.

The higher efficiency permanent magnet motor will get more miles on a battery charge. The following chart illustrates the differences in performance between the permanent magnet motor that the "FREE-WAY electric" uses in comparison to the series wound motor in the "Citicar":

"FREE-WAY electric" (6 HP permanent magnet)		
HP	Speed	Efficiency
0	3850	—
2	3750	82 %
4	3650	84 %
6	3600	85 %
8	3500	86 %
10	3390	86 %
12	3280	85 %
14	2700	75

(rated for 6 HP continuous)

"Citicar" (3½ HP series wound)		
HP	Speed	Efficiency
Not capable of running at no load		
1	6000	60 %
2	4500	72 %
3	3500	78 %
4	3000	79 %
5	2600	79 %
6	2350	78 %
10	not capable — — —	

(rated for 3½ HP for 45 minutes)

Other advantages of the permanent magnet motor used in the "FREE-WAY electric" are:

1. Field coils and the consequent possibility of their burn-out is eliminated.
2. A dual-pass convection cooling system cools both magnets and armature for maximum motor efficiency (only a 4% decrease from cold to hot).
3. Industrial-type, long-life brush system with brush guide heat radiators and constant pressure springs.
4. Strontium-ferrite, ceramic, permanent magnets utilized for greater motor efficiency and resistant to demagnetizing.
5. Armature design matched to magnet design to make full use of high energy magnets.

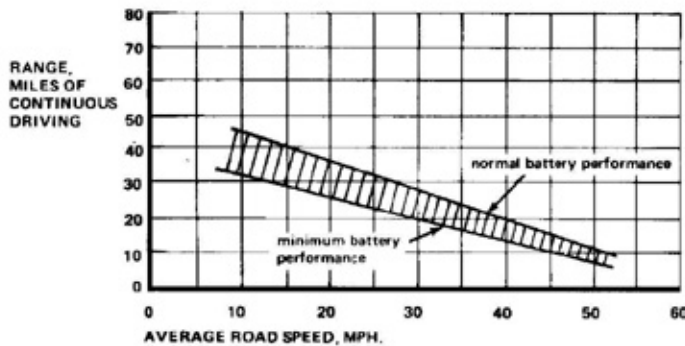
PERFORMANCE OF THE "FREE-WAY electric":

The two primary performance features missing in most electric vehicles are acceleration and highway speed! Of secondary importance is range. It is a known fact that electric vehicles have a limited range and can only be used for short distance trips. But positioned as a special duty, short trip vehicle, they are acceptable for the majority of travel if they have good speed and acceleration.

The "FREE-WAY electric" has been designed for highway speeds and good acceleration. 45 to 50 MPH speeds can be maintained when necessary for short amounts of highway travel. But the driver must be certain of the distance that needs to be traveled at this speed and that it is safely within the operating range of this vehicle. Where alternate slower routes are available, we would recommend that those should be taken since speeds over 50 MPH take excessive power.

As in all electric vehicles, speed and range are directly related. The following graph illustrates this relationship for the "FREE-WAY electric":

RANGE-SPEED RELATIONSHIP



Another factor affecting range is whether the vehicle is driven continuously, or driven ½-way and then parked for more than one hour, before a return trip is made. If the vehicle is driven to work, and then driven home, the rest period allows the battery to recover. An additional 25% range will then be achieved. This is explained in the battery section.

Although acceleration of this vehicle is much less than engine powered cars, it can more than keep up with traffic. Ultimate acceleration is very rarely used and almost never needed. Ultimate acceleration is a competitive figure among car buffs, and future trends toward energy efficiency will automatically tend toward more practical statistics. If you would time your acceleration in normal driving, you would find that quite slow acceleration is the rule. Because of this fact, we feel confident that these statistics for accelerating to a certain speed are satisfactory:

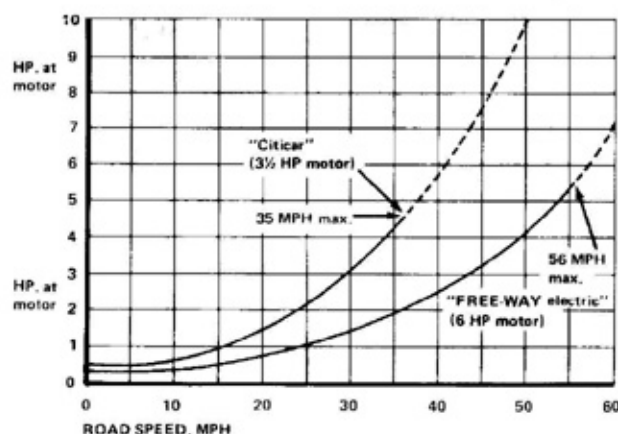
Speed, MPH	10	20	30	40	50
Elapsed time, seconds	1.4	3.3	7.2	13.7	25.3

In comparison, the Citicar took 15 seconds to reach 30 MPH and could not be driven on roads where speeds in excess of 35 MPH were required.

As a further explanation of the good performance of the "FREE-WAY electric", the following graph shows the lower power requirements versus the Citicar:

POWER-SPEED RELATIONSHIP

"Citicar" vs. "FREE-WAY electric"



DEEP-CYCLE BATTERIES:

The "FREE-WAY electric" is powered by four 12 volt batteries. They are deep-cycle, lead-acid batteries that are connected in series providing a 48 volt power source. Lead-acid batteries are the only suitable type at this time. The 48 volt power source provides from 2.5 to 3 KWHRS.

output at a 1 hour discharge rate. The total weight of the 4 batteries is 210 Lbs. These are not common automotive batteries, but are designed for electric vehicle use.

The deep-cycle, lead-acid batteries are capable of being fully charged and fully discharged for hundreds of cycles. Their design has been nearly optimized and further dramatic improvements are not expected. The next real advancement in battery technology is expected to be the nickel-zinc cell. Several companies are now developing this technology for production within the next 2 years. The power capacity is expected to be 2 to 3 times better than lead-acid. But for now, lead-acid is the only type available.

One of the dilemmas with electric vehicles has been the range, and whether to use more batteries for more range. But with more batteries, more power is required to carry the batteries. The net result is that not much is gained. The strategy with the "FREE-WAY electric" was to minimize weight and optimize range. The resulting package also has the advantage of being economical. The object isn't to see how many batteries can be carried!

An interesting phenomena with lead-acid batteries is their rate sensitivity. If these batteries are discharged slowly they will deliver 105 amp hrs. at a 20 hour discharge rate. But if they are discharged rapidly (one hour discharge), they will only deliver 65 amp. hrs. Further, if they are allowed to sit after a partial rapid discharge, they will recover some of the lost capacity. This could allow up to a 25% increase in range. This would be the typical situation where the vehicle was driven to work, allowed to sit, and then return.

The capacity of a deep-cycle battery varies during its life. Initially, it has a lower capacity and as it is cycled it improves to full capacity after about 20 cycles. After a large number of cycles it begins to deteriorate gradually and eventually reaches a point where the range is no longer acceptable. The initial capacity of the power source used in the "FREE-WAY electric" is 2.5 KWHRS. After about 20 cycles it reaches full capacity of 3 KWHRS. and will remain at the high level for several hundred cycles before it begins to deteriorate and lose capacity. The effect of the battery capacity is seen in the range of the vehicle. For example: the initial range will be about 20 miles at 30 MPH, and that will increase to 24 miles at 30 MPH as the battery reaches its peak level.

After several hundred recharge cycles, the batteries will begin to deteriorate and replacement will be necessary. In our service region, old batteries may be returned for credit on the purchase of new batteries. In other regions, batteries are available through a nation wide merchandiser.

Our batteries are manufactured by an experienced company with over 50 years of battery design and research. Their reliable high quality batteries are an important link to our high performance design. At 1980 prices, a total battery pack replacement will cost approximately \$300. The battery cost per mile will be about 1½ to 2¼¢. When future improved batteries become available, they should be interchangeable and will further improve the performance of the "FREE-WAY electric". New types of batteries can be scheduled for installation during normal battery replacement.

Except for checking the battery electrolyte level, the electric vehicle is almost maintenance free. Once each week, a visual inspection of the electrolyte level is necessary. The battery cases are translucent and the level can be seen in relationship to marks on the side of the

case. If the level is down, simply add drinking water until the level mark is reached. Water will not be required very often, but it is a good idea to check the level on a regular basis. If the level is below the tops of the lead grids, the percent of exposed plate will be the percent of lost capacity until the level is again raised.

CHARGING THE BATTERIES:

The batteries in the "FREE-WAY electric" are charged with a 48 volt charger. A three wire extension cord will plug into the vehicle receptacle and 110-120 volts is required (standard household outlet) for the charger. The connections are all insulated and the low voltage reduces chances of electrical hazards. The charger is supplied with the vehicle and is built in.

The charger will charge at a rate of 10 amps initially and will taper down as the battery gets up to charge. The charger compensates for differences in line voltage and will always provide the proper charge rate. A timer automatically turns the charger off after the set amount of time so that you don't have to worry about forgetting it. Depending on driving conditions, distance and speeds, charging should take from 4 to 8 hours. Typically 3 to 4 kilowatt hours are required for a complete charge. At today's price of 4¢ per kilowatt-hour, and 20 miles per charge, per mile cost is less than a penny!

Any standard household circuit is capable of providing power for charging. Current draw is less than 5 amps at 110-120 VAC. A grounded outlet must be provided.

SPEED CONTROL:

The electric motor is turned on when the accelerator pedal is first depressed. As the accelerate pedal is depressed further, the drive ratio decreases allowing the vehicle to go faster. The drive ratio is continuously variable to any speed from 10 to 55 MPH. There is no manual shifting because the drive is automatic. The motor will draw as much power from the batteries as the drive ratio and speed demands. At low vehicle speeds, the motor will run fast, but draw less power. At high vehicle speeds, the motor will run slower and draw more power. When decelerating, the accelerate pedal is released and current to the motor is switched off.

The drive ratio is altered by a three mode accelerator pedal. In the first mode, or off position, the motor is not running. The second mode, as the accelerator is first depressed, actuates power to the motor through a resistor. This cuts down on initial power draw and provides for smooth starting. As the accelerator is depressed further, full power is applied to the motor (the resistor is bypassed) and the vehicle will accelerate to full speed. Any intermittent speed can be selected by releasing the accelerator back to the second position which will hold the selected speed. For traveling down a grade or stopping the accelerator can be released (all power to the motor off) and the vehicle will coast freely. This control system provides very simple operation and people have driven the vehicle even without instruction.

Reverse is achieved by switching the polarity to the motor. The transmission compensates for motor over-loads by downshifting. When hills are encountered, the transmission automatically downshifts. Likewise when the batteries start to run down, lose voltage, the transmission downshifts reducing the power draw and extending range. This also gives you an adequate warning for taking action.

When hill conditions are encountered, it is advisable to travel faster going downhill and to reduce speed going uphill to keep current draw down and to extend range.

A 5 MPH speed reduction can significantly reduce power requirements.

We have tried regenerative braking on the vehicle and have decided that it is better to provide a convenient coasting mode. The regenerative braking mode was very simple and inexpensive to install, but we have found that better range can be obtained without it. Regenerative braking is one of those neat concepts that attracts attention, but in practical terms, is very inefficient when compared to the 100% efficiency of coasting.

HEATING:

Heating an electric vehicle is a problem. There is virtually no waste heat that can be used for heating. Therefore a heater isn't provided except as an option for those who must drive in cold weather. Without the optional heater-defroster, no travel is recommended when defrosting is required.

If the vehicle is to be stored during the cold season, it is only necessary to fully charge the batteries. They don't need to be charged again until the vehicle will again be used. As long as the batteries are charged, they will not freeze. For prolonged storage, charging every 4 months is recommended.

"FREE-WAY" electric" INSTRUMENT PACKAGE:

The "FREE-WAY electric" comes standard with a speedometer, voltmeter and an ammeter. The ammeter will indicate the motor HP output and current draw. The voltmeter will indicate the battery state of charge.

LONG DISTANCE BATTERY PACK:

To increase range by 80%, from 19 miles at 40 MPH to 34 miles at 40 MPH, we are offering an optional long distance package. It consists of six 12 volt batteries instead of four and utilizes a 72 volt motor and charger. The two additional batteries increase the vehicle weight by 105 lbs, but they won't have an effect on performance because the motor has more power. The long distance pack has a power rating of 4.5 to 5.7 KWHRS. versus the standard 2.5 to 3 KWHRS. The per mile cost of charging will remain the same. The long distance battery pack should be seriously considered by those people traveling more than 15 miles one way.

HIGH MILEAGE TECHNOLOGY:

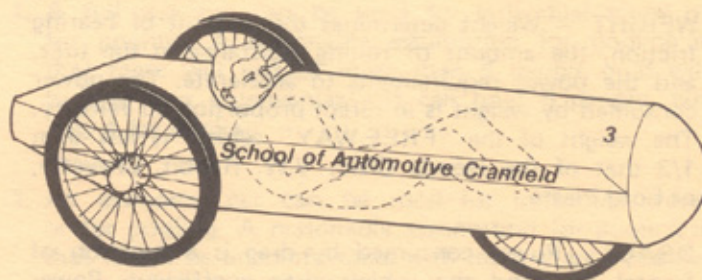
H-M-VEHICLES has developed an expertise in "high mileage technology". We understand the principles behind vehicles achieving 100 to 2,000 MPG. We claim that our "FREE-WAY" vehicle will achieve at least 100 MPG performance at a constant speed of 40 MPH. This vehicle is a practical one that is comfortable, easy to get into, and is large enough so that it mixes with normal traffic.

Recently there have been articles about fuel economy runs where 1,000 and 1,500 MPG were accomplished. This is no surprise to us because we have known that this is possible by using bicycle wheels, moped engines, and light weight structures. These contests have allowed speeds of 10 to 20 MPH with acceleration up to 20 and coasting back down to 10. From the looks of the mechanics of some of these vehicles, it has been interesting to note the large batteries supposedly used for starting the engines and wondering just how much of their short runs were actually battery powered. The duration of these contests was about 10 miles and it is questionable whether anything practical was proven. The course could have been completed by a bicycle or jogger in better time. Under these rules, 2000 MPG should be possible. One of these vehicles would take about 1/4 the power that

the "FREE-WAY" requires at that speed. The "FREE-WAY" with a suitable very small engine would get 350 to 400 MPG at those speeds.

It is interesting to note that the approaches taken in these designs are basically the same as those of the "FREE-WAY"; light weight, small frontal area, low drag, and single passenger profile. These vehicles are interesting, but a more meaningful contest should be developed where the competition is among practical designs traveling at

highway speeds. The following sketch illustrates some of this vehicles features:



HIGH MILEAGE TECHNOLOGY:

FIRST PROTO-TYPE OF THE "FREE-WAY":

The following photo shows the first proto-type of the "FREE-WAY" which was finished in 1976. It has won the SAE "GREAT ECONOMY RACE" in 1977 and 1978. In 1977 it finished first with 80.3 MPG and in 1978 with

88.3 MPG. The course consisted of highway and city driving at normal speeds. The 1978 course was run at an average speed 5 MPH higher than in 1977 and more than 1/3 of the course was into a head wind. Honda motorcycles turned in 45 to 55 MPG in comparison. Better performance in the future is expected from the "FREE-WAY" production units.



Great Economy Race Run

The second annual running of Twin Cities Section's Great Economy Race was held May 21. The route consisted of a challenging 102 miles of heavy urban traffic, suburban expressways, and open freeways. Awards were presented in six weight and engine classes, plus two sweepstakes — Best Overall MPG and Best Ton-MPG.

Best Overall went to Dave Edmonson (see photo), whose 3-

wheeled "personal" car of his own design and construction achieved 80.3 mpg.

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Plans for the third annual running, to be held next May, are well under way with an even longer course in the works.

72

Automotive Engineering, August 1977

WHAT AFFECTS FUEL ECONOMY?

1. **WEIGHT** — Weight determines the amount of bearing friction, the amount of rolling resistance in the tires, and the power requirements to accelerate. The power consumed by weight is in direct proportion to velocity. The weight of the "FREE-WAY" vehicle is less than 1/3 that of the Honda Civic, V.W. Rabbit, Chevette, or Ford Fiesta.
2. **DRAG** — Power consumed by drag is a function of frontal area and the vehicle drag coefficient. Power consumed by drag is proportional to the velocity cubed. Above 40 MPH, drag becomes the major factor in fuel consumption. The frontal area of the "FREE-WAY" is 1/2 that of the above vehicles. The drag coefficient is expected to be considerably lower also because of the streamlined design and the fully enclosed and smooth underside.
3. **ENGINE SIZE** — A minimum engine size is required that will accelerate the vehicle fast enough to mix with other traffic, and also that can maintain speed uphill at the maximum limit. Above this minimum size, a larger engine will increase fuel consumption. Below this size, fuel consumption is decreased but the vehicle is no longer acceptable. The engine used in the "FREE-WAY" meets this optimum requirement.
4. **TRANSMISSION** — The transmission governs the efficiency of the engine operation, and also consumes power in doing this. Therefore, it is best to have a transmission that keeps the engine running at peak efficiency, and that is efficient in transmitting the power. The "VRT" belt drive used in the "FREE-WAY" is considerably more efficient than the standard automotive transmissions (automatic and stick shift). It also provides peak power for acceleration and allows the engine to cruise at the point of minimum fuel consumption for any speed.
5. **SPEED** — Speed has a direct effect on fuel consumption. The lower the speed, the less power is required and fuel used. Every vehicle has minimum fuel consumption at low speeds. But the engine size and weight of the vehicle will determine the speed at which minimum fuel consumption occurs. It is important when comparing fuel economy results, to compare them at equal speeds.
6. **FUEL ECONOMY RATINGS** — The current EPA fuel economy results do not represent attainable ratings. The vehicles that are tested are selectively picked and tuned and driven on a dynamometer. The ratings for small cars are 10 to 20% higher than results from actual use. The public is being misinformed by the EPA and the auto industry loves it.
7. **FUEL ECONOMY MEASUREMENT** — It has been found that there are many variables in fuel economy measurement that make measurement inaccurate. One can't assume to fill the tank to the same level because of fuel expansion with heat and inaccurate filling. Driving on a slight grade or downwind can make a considerable difference even though it isn't noticed by the driver. Also, a person is only too quick to brag about the so-called super results when high mileage seems to have been attained, and all too quiet when it can't be repeated. The fuel economy of the "FREE-WAY" has been accurately tested several times by the weighing of fuel consumed on down and back runs on still days.

THE FUEL ECONOMY OF THE "FREE-WAY" IS UNEXCELLED BY ANY OTHER VEHICLE THAT IS ACCEPTED BY THE PUBLIC

1. It is more efficient than a motorcycle, one that is capable of the same top speed. It has slightly more frontal area, but has a much lower drag coefficient.
2. It can double the fuel economy of the Honda Civic, Chevette, Ford Fiesta, and the gasoline Rabbit. It has 1/3 the weight and 1/2 the drag.
3. A moped and some low powered motorcycles can get better mileage, but then they can't be driven on the highway or in normal situations.

WHY DO PEOPLE DRIVE BY THEMSELVES?

Generally, people drive by themselves when traveling to and from their jobs. Everybody recognizes that most travel is on an individual basis. The Nation-wide average during the work week is 1.3 passengers per vehicle. The U.S. Government considers the automobile to be a very inefficient vehicle because of this, and tries to promote car pooling and bus commuting. Actually an automobile is the most efficient and inexpensive means of travel if it carries its design capacity.

But it is a current reality that the majority of people do drive by themselves, except for family travel. They do this for the following reasons:

1. **PROXIMITY OF HOME AND JOB** — Most people live and work in different localities because of their quest for good jobs and a home in pleasant surroundings. The person finding a satisfactory home and job in close proximity for any length of time is rare.
2. **CUSTOM** — People are accustomed to freedom of travel and enjoy it at almost any price.
3. **FREEDOM** — People enjoy the freedom to come and go at will. Getting to work as early or as late as desired. Being able to make appointments during the work week for professional services. Doing those special errands that happen to be most convenient during lunch hour, or on the way home. The ability to change schedules or destinations is important.
4. **COMFORT** — People like the comforts of their personal vehicle, not having to talk to anyone, or listening to the entertainment of their choice. Just being able to unwind while going home.
5. **CAR POOLS** — Schedules, jobs, and suitable friends to pool rides with is hard to arrange, and usually short lasting. Car pools are time consuming and non-productive. Often they are only tolerated because of lack of an additional vehicle.
6. **VAN POOLS** — Van pools are even worse than car pools. More time is wasted and the passenger miles gained are often lost in extra travel picking up the many riders required. They also demand keeping an exact schedule.

POOLING RIDES IS A GREAT IDEA FOR SOMEONE ELSE!

7. **PUBLIC TRANSPORTATION (BUS, TRAIN, SUBWAY, TROLLEYS, ETC.)** — Public transportation is found to be inefficient, inconvenient, and very expensive for the tax-payers to subsidize. Mass transit is super expensive and the government is saying no to its further development.

IN MANY SITUATIONS, THERE IS NO ALTERNATIVE TO INDIVIDUAL TRAVEL BY CAR ! !

Why should people feel guilty driving by themselves? Why shouldn't they have the best possible means of transportation? Why shouldn't they have all of the advantages of personal transportation?

The problem is that a large family car is wasteful, expensive, and detrimental to the welfare of our country and environment when used for individual transportation. That's where the "FREE-WAY" fits in. It is a convenient means for individual travel that isn't detrimental!

Based on the benefits of individual travel, a "realistic" analysis of vehicle types concerning energy consumption and cost will be determined:

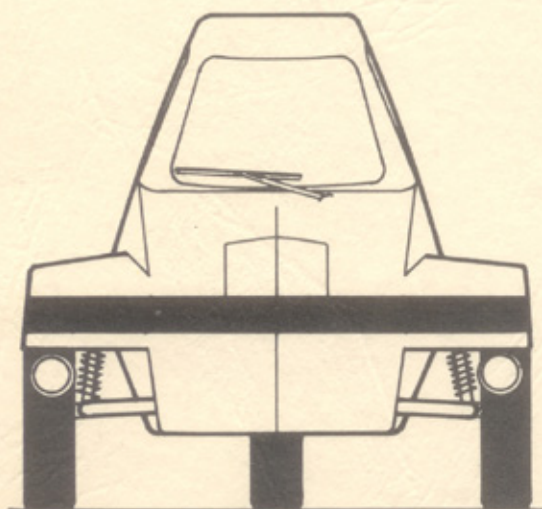
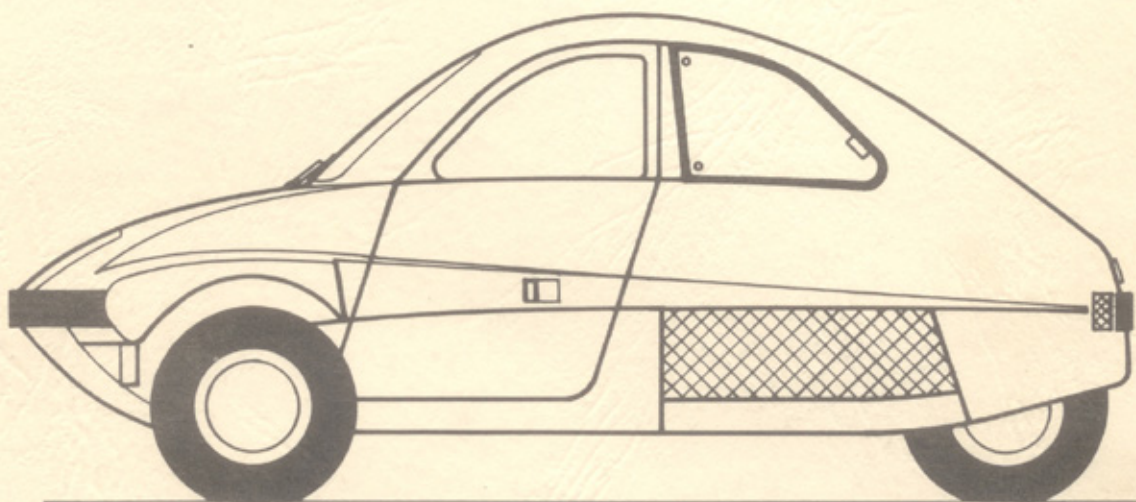
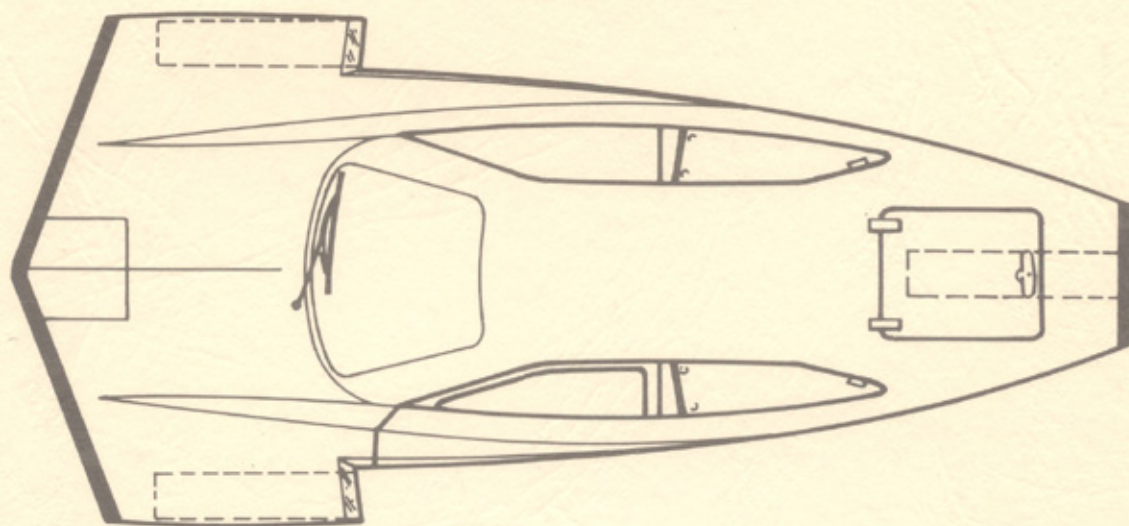
Assumptions:

1. A full size car can be used for individual travel or for pooling. A reasonable assumption for pooling is that there will not be more than 4 people or it will become too inconvenient. It can hold 6 people, but only 4 for pooling.
2. An economy car can be used for individual travel or for pooling. A reasonable assumption for pooling is that it will be uncomfortable with more than 2 people. It can hold 4, but only 2 for pooling.
3. A "FREE-WAY" vehicle can be used for individual travel. It can hold 2 in a pinch, but normally only one.

VEHICLE TYPE	BTU's per passenger mile	Gallons of gas per passenger mile	Cost per passenger mile
1. Full size:			
a. With one	6,323	.0556	18.9¢
b. With four	1,581	.0139	4.7¢
2. Economy size:			
a. With one	3,794	.0333	12.65¢
b. With two	1,897	.0167	3.16¢
3. The "FREE-WAY":			
With one	<u>1,423</u>	<u>.0125</u>	<u>5.5¢</u>
4. Heavy rail**			
a. ? ? ? ? ?	3,080	.027	??? ?
5. Light rail**	2,590	.0228	??? ?
6. Bus**			
a. ? ? ? ? ?	1,420	.01248	??? ?
7. Van pool			
a. With ten	1,264	.0111	??? ?
(at 75% efficiency of route)			

**Taken from government report — includes heating of necessary facilities and construction of special systems.

NOTE: TWO CAN'T RIDE CHEAPER THAN ONE, IF THE ONE IS IN A "FREE-WAY".



"FREE-WAY"

Length:	115 inches
Width:	53 inches
Height:	51.5 inches
Curb weight:	525 Lbs. Gas 650 Electric
Top speed:	65 MPH Gas 55 MPH Electric
Range:	up to 900 Miles
Mileage:	100 MPG at 40 MPH Gas 25 Miles at 30 MPH Electric
Classification:	3 Wheel Motorcycle

THE "HIGH MILEAGE VEHICLE"