Galaxy

SCIENCE FICTION

JUNE 1956

35¢

THE VENUS TRAP
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MUTANT OF THE IRON HORSE
By WILLY LEY

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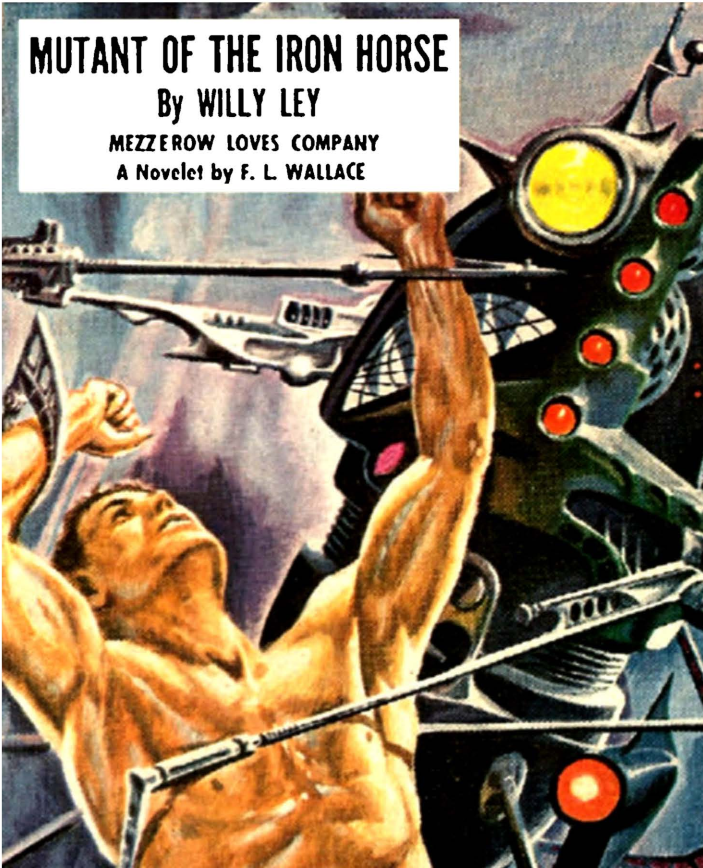

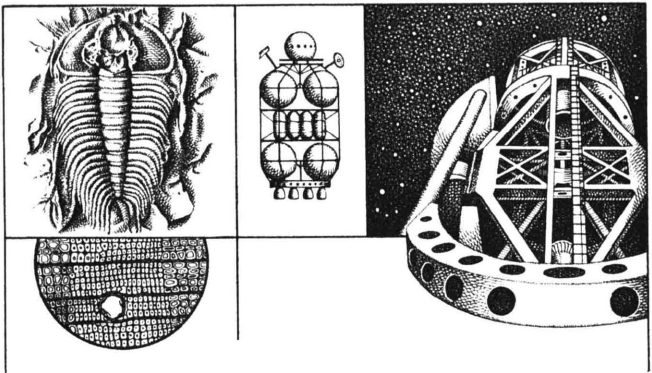

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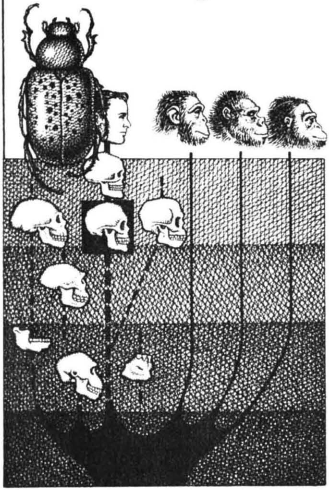
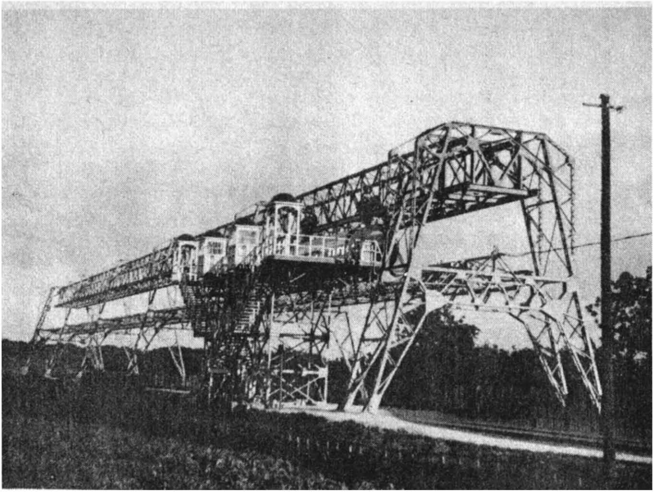
By WILLY LEY



MUTANT OF THE IRON HORSE

IN THE days of the Second World War, when every old ax blade and every rusty girder suddenly acquired importance as scrap steel, the English dismantled an interesting structure located some ten miles from Glasgow. Just a few years later, immediately after the end of the war, British Army engineers



George Bennie's experimental monorail track with station, photographed in 1930

worked hard and with top priority on the repair of a bomb-damaged structure of almost the same kind in a city in West Germany in the British Zone of Occupation.

Both the structure that was dismantled in England and the one that was repaired in Germany were monorail tracks, the only ones in the world. They were not completely alike, but the main difference was not one of construction.

The most important difference was that the one in England was experimental and had been built for purposes of testing and demonstration, while the one in Germany was and is a hard-working part of the city's public transportation system, the city being Elberfeld-Barmen. It has been ever since it was built in 1900 and its history, except for the bomb damage sustained during the Second World War, is happily devoid of any dramatic incident. It simply worked from the first day on and, through all these years, it was a unique offshoot of the iron horse. There was no other like it.

But it is quite probable that

one day in the future, the passenger-carrying monorail of Elberfeld - Barmen will not be unique any more. It will then be the oldest example of a special and very useful means of transportation. And it is also likely that the newer examples will owe their existence and usefulness to a premeditated disregard of the principles that guided the design and construction of the first.

I THINK the story will emerge best when told in proper chronological order. The city of Elberfeld-Barmen was originally two cities, Elberfeld and Barmen, both situated some distance apart on the banks of a fairly small river, the Wupper, which is a tributary of the Rhine River. The valley of the Wupper River was in the center of what was to become one of the most heavily industrialized sections of all Europe.

Even before the turn of the century, the traffic situation of the whole area had become very nearly unmanageable. And the neighboring cities of Elberfeld and Barmen were in an especially difficult spot. As almost always happens—nobody knows why—people living in one city had jobs in the other. Local traffic was heavy and, in addition to the local traffic, there was a good deal of through traffic.

In both cities, the streets were generally old and rather narrow and by no means straight. The Imperial Railroad bought what rights of way it needed and, in time, took care of much of the through traffic. The local traffic problem still remained to be solved.

An engineer from Cologne, by the name of Eugen Langen, pointed out to the harassed city officials of both cities that there was something that might be called open space between the two cities, namely the Wupper River. One might build an elevated railroad running over the river, without hampering the river traffic itself.

Eugen Langen probably was not the first to think of this, but if others had harbored the same idea before him, they had given up, for the river does not happen to be very straight, either. No elevated railroad, if circumstances forced it to stay over the river, could follow all its twists and turns and run at a speed faster than a brisk walk. The answer, presented by Langen, was a type of railroad which could follow the twists and bends and still run at a reasonable speed.

He evolved a structure resembling a steel-girder bridge running the length of the river, with supports looking like inverted "V"s, planted into the banks of the river. This structure supported two single rails and the trains were suspended from these rails. Each car hung from so-called bogies and each bogie had two wheels, one behind the other, which rested on the single rails. In each bogie, the front wheel was the driving wheel with an electric motor, while the second wheel merely trailed. The current for the driving wheels was furnished in the same manner as for any other electric train.

Naturally, a car hanging from bogies could take rather sharp turns fairly fast in perfect safety. The name given to the new device was *Schwebebahn*, which might be translated nearly literally as "levitated railroad," but is usually referred to in English engineering literature as the Wuppertal Monorail.

SOME twenty-five years after its completion, somebody wrote a paper proving conclusively that the structure must be unsafe, since it should collapse under its own weight. At the time this was written, the *Schwebebahn* had a record of having handled 4200 passengers per hour in each direction ever since it was opened to the public. It obviously was far less unsafe than the critic had calculated. Whoever was in charge then modified operations somewhat, however. Instead of three-car trains, which had been customary, the Monorail ran only two-car trains, but more of them.

Since the stations are spaced rather closely together, the speed of this monorail is never very high. Its function, and consequently its speed, might best be compared to a fairly fast streetcar line operating under ideal traffic conditions, with nobody else ever getting in the way.

The Wuppertal Monorail has shown that such a transportation system has definite advantages in crowded areas because it can provide urban mass transportation without taking up any space on the ground worth mentioning. It is with just this thought in mind that there have been sporadic studies of a monorail project for southern California.

This monorail, if built, would be a suburban rapid transit — let's say *fairly* rapid—line running from the center of Los Angeles to Van Nuys in the San Fernando Valley, a distance of 18 miles. Instead of following a river, the San Fernando Valley Monorail would follow a proposed freeway and it would look different for this reason. Instead of being supported by inverted "V"s, the rails would be supported by T-shaped girders which would be imbedded in the center-park strip of the freeway.

As in the example of the Wuppertal Monorail, the San Fernando Valley Monorail is to have electric drive and the cars are to be suspended from two bogies apiece, each bogie with two wheels. But in the new proposal, every bogie wheel is supposed to be a driving wheel, equipped with an electric motor of 55 horsepower, which would result in a maximum speed (this is purely a coincidence of figures) of 55 m.p.h. No higher speeds are possible under the circumstances because of economic spacing of the stations.

For the sake of passengers, especially standees, acceleration and deceleration of the cars must not surpass a maximum of six feet per second squared, and this would imply a spacing of stations a minimum of 5 miles apart if one wanted to reach 100 m.p.h. between stations.

The most important talking point of the advocates of monorail systems is, of course, safety, for which the Wuppertal Monorail has produced a most impressive record.

A suspended monorail cannot be derailed except by difficult and highly ingenious sabotage. The rails cannot possibly be flooded. No snow can accumulate on the rails, although this consideration, of course, does not apply to sunny California. No driver, however reckless or careless, can stall his car on the track.

The second talking point is that, in this particular case, where a rapid transit line has to be built in a heavily populated area, a monorail would be cheaper than a surface railroad.

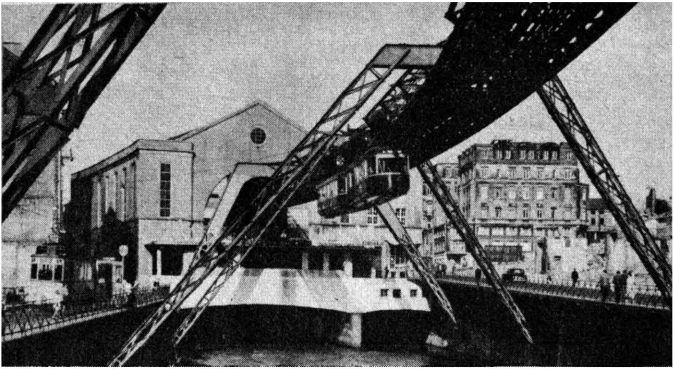
IN AUGUST, 1947, the Metropolitan Traffic and Transit Committee of the Los Angeles Chamber of Commerce completed a study of what it would cost to build a double-track surface railroad in the center of the freeway. This, of course, meant widening the freeway and buying some right-of-way for the purpose. The final figure read that this double track railroad would cost $1,165,000 per mile.

But that was only for the widened freeway and the roadbed. There would be additional expenses for tracks, stations, signal systems and, naturally, the trains themselves.

The monorail along the same route would cost $834,000 per mile, including structures, signal system, car yard, repair shops and eight intermediate stations. This figure of $834,000 per mile included everything but the cost of the terminal station and the price of the rolling stock.

Interesting — but how about that other monorail structure the English used up for scrap during the Second World War?

Well, that one, though also a



The Döppersberg station of the Wuppertal monorail in Elberfeld

monorail, is something from an entirely different chapter of the same book, maybe even a chapter from a different book. To understand it, we have to go back to early entries in the story of the iron horse.

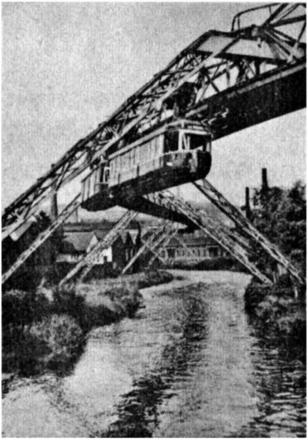
When the first locomotives were in what would now be called the planning stage, a few people who had learned mathematics severely lectured the inventors on their lack of mathematical knowledge.

A rail, they said, is a straight line. A wheel is a circle. A locomotive wheel on a rail is, mathematically speaking, a circle and a tangent. As everybody knows, a circle and a tangent touch in *just one point*. Therefore no car could possibly be moved by applying force to its wheels. Since wheel and track touched in one point only, there could not possibly be enough friction to move the vehicle. The wheel, in all probability, would merely spin.

A few inventors took this information to heart and came up with "designs" in which the wheels were cogwheels fitting a notched rail—or else in which all wheels were all freely spinning and the motion was to be accomplished by pushing rods engaging either the cross ties of the tracks or else the ground directly.

The latter type had imitation horse feet at the end of the push rods! But some people just built locomotives and found out that, tangent to the circle notwithstanding, they got enough traction not only to move the locomotive but to make it pull a train, too.

FROM then on, traction on the rails was taken for granted and the railroads grew rapidly, in numbers, size and in weight. As a matter of fact, they grew too much in weight. Rolling stock was built to last and if it grew heavy in the process, well, that was the way things were. Around 1900, a good solidly built passenger car in which every seat was occupied weighed just three per cent more than the same car without any passengers!

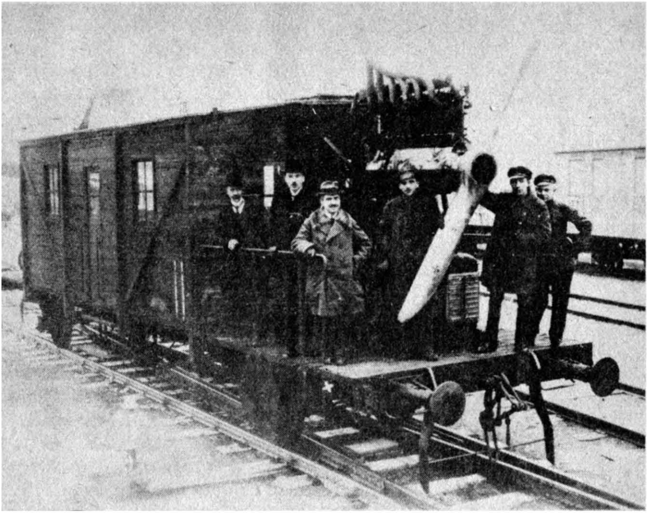


Two-car train of the Wuppertal Monorail traveling over the Wupper River

Every once in a while, somebody noticed this obvious inefficiency and made suggestions for lightweight trains. He was then either told that durability was the most important consideration or was suspected of being a camouflaged salesman for an aluminum company. Only recently have lightweight trains actually appeared on the scene, but they are still rare.

In the meantime, imaginative engineers had gone a step further in their reasoning. Except for heavy freight engines, where their great weight was useful when it came to traction, there was no need or reason for inefficient overweight in rolling stock. One should, therefore, use all the tricks of the trade to lighten the cars. It would then, obviously, take much less power to move a car. And with lessened power requirements, one could think of engines other than the steam engine.

Moreover, why rely on traction of turning wheels? Airplanes moving around on the ground moved on wheels, but no wheel traction was involved. Why not investi-



The first propeller-driven railroad car in history—Berlin, 1919

gate whether an airplane propeller might not furnish the motive power for wheeled vehicles, too?

It turned out after the First World War that several engineers had secretly toyed with this idea for years. But it also turned out that the first propeller-driven railroad car had been built in a most unprofessional manner.

The year was 1917 and the place was Palestine. A contingent of German soldiers stationed there found the climate too warm for their taste, but fortunately the shore of the Mediterranean Sea was only a little more than a mile away. Unfortunately, however, they had to walk that mile, though there was a railroad track. There also was a flatcar but no locomotive.

Then somebody looked speculatively at a wrecked airplane. Its propeller was undamaged, its engine in running condition. No harm in taking the engine out of the wrecked plane and mounting it on the flatcar. Maybe it would work.

It did.

Without knowing about this

example, a German scientist who had been in charge of propeller production and testing (for airships) through the war advocated, in 1918, that available railroad cars and available aircraft engines should be put together as emergency propeller-driven railroads. The scientist was Dr. Otto Steinitz, who had devoted some spare time to the problem of propeller-driven trackbound vehicles for several years.

The reason he publicly advocated his ideas at that particular time was that he believed that such emergency vehicles would help to return German soldiers home after the Armistice had been signed. Theoretically, the months just following a revolution may be the proper psychological time for advocating new ideas in other fields, too. In reality, nothing happens as a rule, if only because of the lack of means.

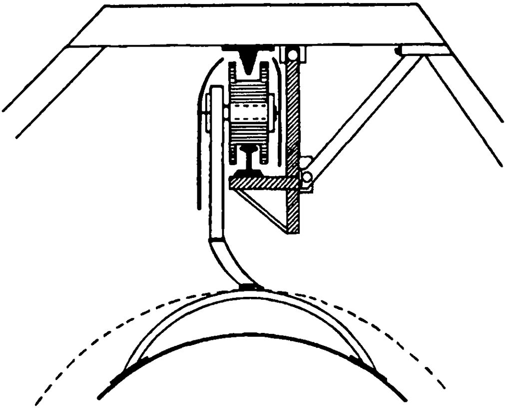
At any event, the Germans finally got their soldiers home without taking advantage of Dr. Steinitz's suggestion.

BUT the proper sub-section in the Office of the Federal Railroads of the Ministry of Transportation was interested and a single car was built. It wasn't built quite the way Dr. Steinitz wanted it. The chief engineer of this particular railroad shop considered it a rather extreme case of lunacy that Dr. Steinitz wanted ball bearings; who had ever heard of a railroad car running on ball bearings? Dr. Steinitz lost this particular battle. The same man also could not see why the front end of the car should not be square.

Dr. Steinitz had stated that he wanted the front end of the car to look "somewhat like the stem of a ship." The man in charge of the actual building decided that one did not build pointed railroad cars; it just wasn't done. After much complaining, a kind of compromise was reached.

It was not very good, but the completed vehicle did work. It passed a test run with flying colors in May, 1919. It made a run with the railroad committee of the National Assembly on board. It pulled a trailer; by chance, only the heaviest type of freight car happened to be available to serve as a trailer on that day. But the propeller car pulled it just the same.

Then, after a number of noncommittal statements had been issued, it ran for a year around freight yards in Berlin, doing odd jobs of moving freight over short distances, even though Dr. Steinitz had stated over and over again that the propeller drive for trackbound vehicles would work most efficiently for long runs at rather high speeds and that the



Principle of bogie-wheel suspension for a propeller-driven monorail. The broken line marks the path of the propeller blade tips

propeller drive was not good for stop-and-go driving.

The German railroads had to replace most of their rolling stock, which had been worn out in four years of war with continuous duty and little maintenance. But they built conventional equipment. No lightweight rolling stock. And certainly no propeller drive.

More than ten years later, another engineer by the name of Krukenberg succeeded in persuading the railroad office to build him a streamlined (and lightweight) test car with a pusher propeller. It made several runs between Berlin and Hamburg at record speeds and became the favorite subject of newspaper and newsreel photographers.

And then there came an official statement that propeller-driven railroad cars were "not yet practical."

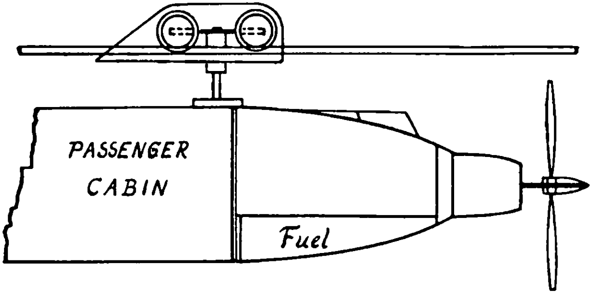
THE next step was taken by the Scotsman George Bennie in putting together the propeller drive and the monorail.

Many of the objections, some silly, some justified, that had been brought forth against propeller drive for surface vehicles became automatically invalid when applied to overhead monorails. And the propeller drive, on the other hand, greatly simplified the construction of the monorail car. The wheels in the bogies no longer had to be powered and the problem of current supply and current pickup along the line could be eliminated by having the propeller driven by an airplane type engine running on aviation gasoline.

George Bennie was in the fortunate position of being able to do more than write articles about his project and publish detailed drawings. In 1929, he built a 750-foot test section of monorail track, complete with a station and a propeller-driven car. And he predicted as a result of both calculations and tests that a propeller-driven monorail ought to be able to reach speeds of 200 m.p.h. This sounded pretty far-fetched at the time, but he may very well have been conservative in his prediction.

Of course the propeller-driven monorail is something entirely different from the bogie-wheel-driven type in action over the Wupper River and under study for the San Fernando Valley. There the goal is reasonably fast transit for many passengers between closely spaced stations.

The propeller-driven monorail is a means of really rapid transit for large passenger loads in any kind of weather over fairly long distances, with stations spaced widely apart. Just what the spacing of the stations will be and to what overall range monorail systems might be expanded will depend entirely on local conditions, on actual transportations needs.



Front end of a propeller-driven monorail train

Ideally, for high speeds and efficient operation, the stops should be at least 15 miles apart, while the total length of a run may be 200 miles. Above distances of 200 miles, especially if they are to be traveled non-stop, the airplane begins to assert its superiority.

But within the 200-mile range in congested areas, the only possible competitor in terms of speed would be the large helicopter—the bus-type helicopter. Not being trackbound, it is more flexible than a monorail, but it is not as independent of local weather conditions. And its fuel consumption per ton/mile of payload flown is much higher, of course, probably about ten times as high because airborne equipment has to lift the physical payload in addition to moving it.

Strange as it may seem at first glance, the traffic density on a rigidly proscribed track can compete with that in the apparently boundless atmosphere. The helicopters could fly at many different levels, but at some time they have to land in a specific place, which is the place where a congestion might occur.

AS LONG as a discussion like this one deals with technological problems like speed versus fuel consumption, passenger-carrying capacity over a given route for a specific time interval, and safety of operations in various kinds of assumed weather, you are on reasonably firm ground. But when it comes to financial aspects, such firm foundation for thinking seems to vanish more often than not. I don't know the reasons; I just remember examples from the past.

At one time, a railroad had to go around mountains. It had to do that—or so it was stated—because drilling a tunnel through a mountain would cost far too much, provided it was possible at all.

At some other time, somebody showed why the automobile would always remain a city vehicle. The reason was so simple that a child could understand it. To travel in an automobile from one city to another would require a road of exceptional quality, a quality comparable to a city street. Naturally such roads could be built, but hundreds of miles of such roads would cost so much that the public simply could not afford them.

To discuss the probable cost of a monorail system is, therefore, a very difficult undertaking and a general comparison of costs between monorail, railroad, superhighway and helibus line would quickly turn into science fiction. A real answer can be given only after a specialized and thorough study of one particular route, as was made in the case of the San Fernando Valley project. There the financial superiority of the monorail was extreme, to put it mildly, because of the rights of way that had to be bought in an area where they are expensive.

DISTANCE alone is certainly no guide: Chicago to Peoria, Illinois; San Antonio to Corpus Christi, Texas; Atlanta, Georgia, to Birmingham, Alabama; Tacoma, Washington, to Portland, Oregon; Burbank, California, to San Diego; and Providence, Rhode Island, to Newark, New Jersey, are all about the same milage as the Piper Cub flies. But even assuming equal transportation demands—which is certainly wrong—the cost of construction of any connecting trackage would vary enormously from place to place, *without* counting the cost of right of way.

Among the places just quoted, the Chicago to Peoria line probably has the flattest country. There a double-track monorail structure might cost more than a double-track railroad. But once you deal with country that is not flat, the surface rail line encounters expensive items such as grading, cutting through hills, crossing rivers and creeks and similar vagaries of nature.

The monorail encounters the same natural features, but in the vast majority of cases, the structure can neutralize them by the simple expedient of lengthening or shortening the supports. It is just the type of structure that can cope with difficult territory.

Moreover, it is just the type of vehicle that would be useful for serving an airport which is a score of miles from the city to which it belongs.

In short, it is the means for really fast ground transportation and it accomplishes this feat by raising the vehicles a little off the ground—truly a mutant of the iron horse.

—WILLY LEY

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