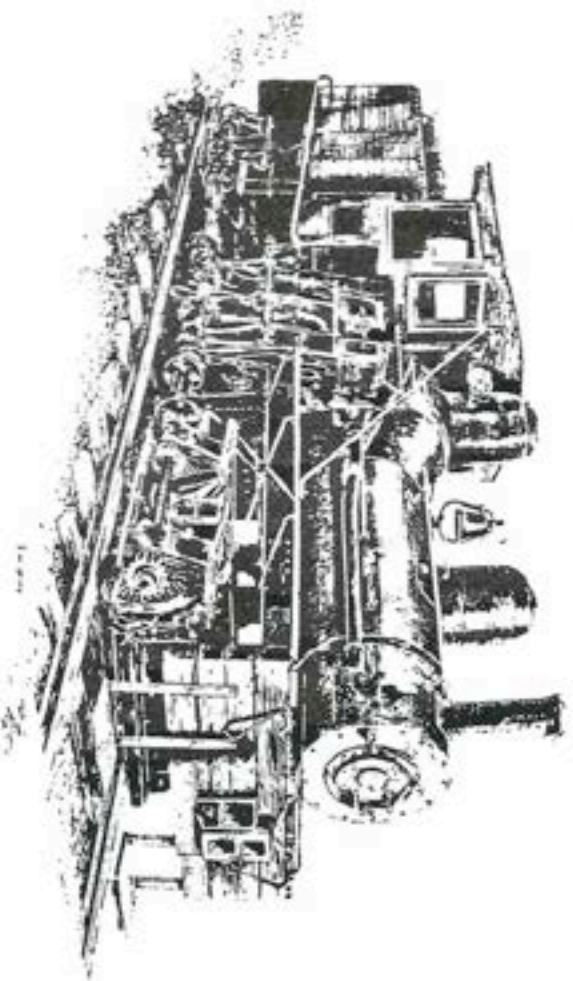


*Cadillac's*

# Shay Locomotive



## TITAN OF THE TIMBER

**HISTORICAL PRESERVATION PROJECT**

**Minimum Donation \$2.00**

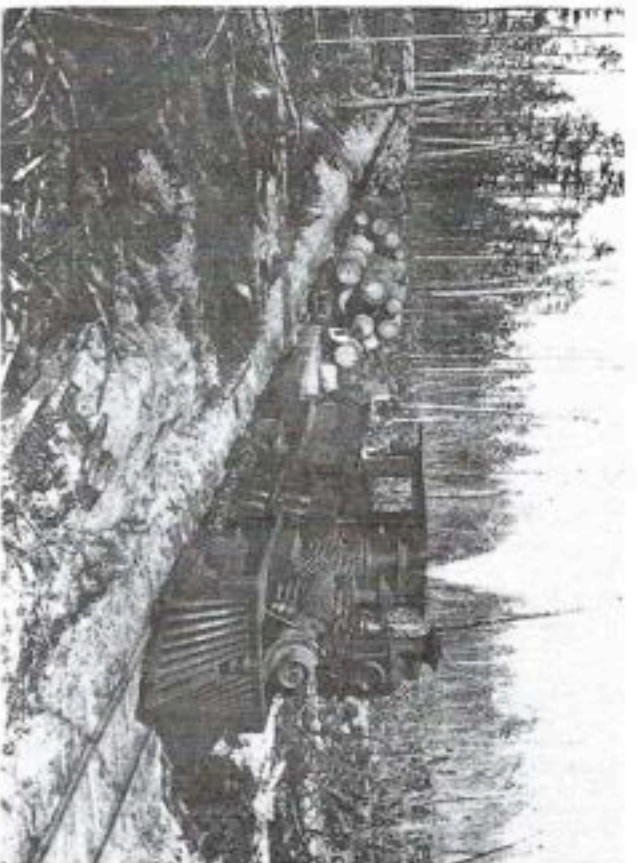
**CP** Cadillac  
rubber & plastics, Inc.

and

**NB**  
**CD** CADILLAC BANK

...are proud to contribute toward the restoration of the Shay Locomotive by sponsoring the printing of this booklet.

All funds derived from the sale of this booklet will go directly to the restoration of the Shay.



Mitchell Bros' 1887 Shay taking timber to the company's extensive facilities at Jennings, northeast of Cadillac.

Cadillac, founded in 1871, has a rich heritage in lumbering and the wood products industry. There is a special sense of accomplishment of having been one of the few early inland, non-river lumbering communities that has grown and prospered since the cutting of the vast forests that greeted settlers when they first arrived.

The Shay locomotive, possibly more than any event, person or thing, made possible the success of Cadillac in the late 1890's and well into the 1900's. The powerful, versatile Shay could bring timber from the hills and valleys of the Cadillac area which could not be reached profitably by other then-existing methods of transportation.

A local man, Mr. Ephraim Shay, invented this unique locomotive, which would later be used world-wide to enhance lumbering and mining. Judge William Peterson of Cadillac in his book "The View From Courthouse Hill" stated as follows: "The efficiency of the logging railroad having been demonstrated, it was the major mill owners who moved to utilize it on a large scale enabling themselves to buy tracts of pine far removed from the mills and justifying a greater investment in larger, more modern mills centrally located. Shay's locomotive guaranteed the continued prosperity of Cadillac's mills which would continue to function long after the pine in the immediate vicinity was exhausted."

The SAVE OUR SHAY Committee would like to invite you to learn more about the Shay and its importance to the history of Cadillac. The committee also hopes you will join them in restoring and preserving this last tangible memento of our lumbering heritage for the generations yet to come. Your total tax deductible donation will go directly to the restoration project.

## SHAY'S INVENTION TIED TO HARVESTING AREA'S TIMBER

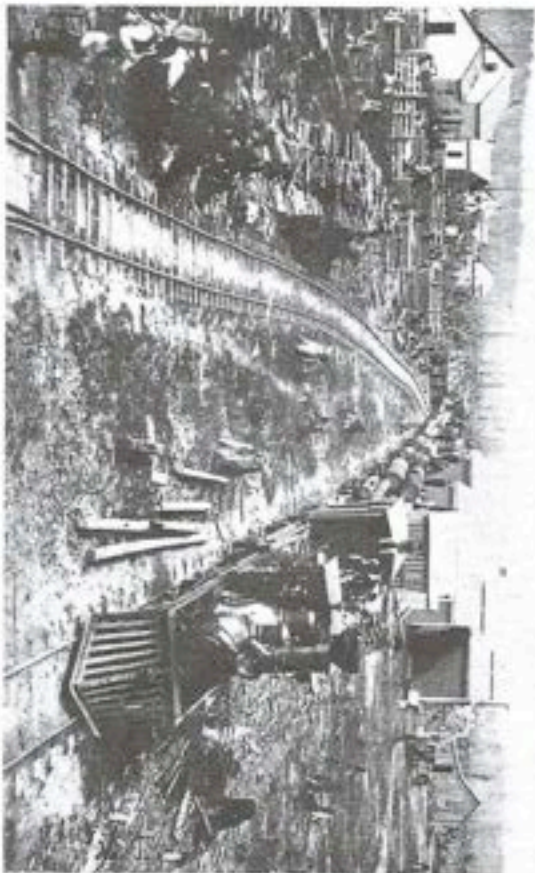
The who, what, why, where, when and how of the invention of the famous Shay locomotive is tied directly to the harvesting of the valuable stands of white pine and Norway pine timber that were to be found in the hilly countryside around Cadillac.

The inventor, Ephraim Shay, was born in Ohio in 1839. He taught school and is reported to have studied medicine. In 1873 he moved to Haring where he established a general store and then constructed a sawmill. Haring was two and a quarter miles north of Cadillac, adjacent to the newly constructed tracks of the Grand Rapids and Indiana Railroad, now known as the Michigan Northern.

In 1967 an author stated that "E. Shay was a rugged man with a strong but kindly look about him. His interests ran from medicine to machinery and he was capable of coping with almost any mechanical or engineering problem."

Shay first constructed a tramway on which he used cars pulled by horses. This was not satisfactory. On downgrades, cars built up such momentum that the horses sometimes were killed when hit by runaway loaded cars.

On May 25, 1877, the Cadillac Weekly News reported, "E. Shay had built nearly two miles of railroad track and William Crippen, the Cadillac machinist, is building a locomotive to run the logging trains. If Shay's plans succeed, it will greatly reduce the expense of getting out logs." His first locomotive proved to be a money-maker as Shay was able to get logs to the mills at considerably less cost than other lumbermen. However, this first locomotive did not contain the features that later made Shay's geared locomotive so famous.



August 12, 1882, this Henderson type Shay, made in Cadillac by the Michigan Iron Works, pulled record train of 45 cars of logs to the Gunmer Lumber Co. mill in Cadillac.

The SAVE OUR SHAY Committee would like to acknowledge and thank those who contributed to this book.

Mr. Fred Lamb for use of his Cadillac Shay drawing.

Mr. Tom Huckie, Cadillac Evening News Publisher, for use of their photos.

Mrs. Leanna Johnson of The Home Office for typing and editing services.

Mr. Ken Cole for use of his Cadillac Shay Photo.

Cadillac Evening News employees for the excellent job of composition and layout of this book. Their efforts, coupled with the sponsors — NBD Cadillac Bank and Cadillac Rubber and Plastics — have made it possible for your entire donation to go directly to the Shay Restoration Project.

The contents of this booklet have almost entirely been taken from the writings of Mr. Earl Huckie, Editor Emeritus of the Cadillac Evening News, which were published and copyrighted by the Cadillac Evening News in 1971. As is evident, Mr. Huckie has done extensive historical research on the Shay locomotive and its history. All credit for the writings belongs to him.

Keith H. Johnson  
July 4, 1984



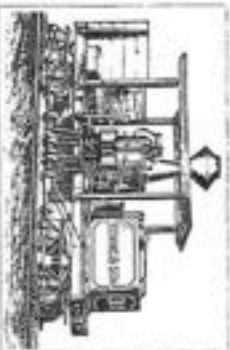
Ephraim Shay — 1880; Bragg photo in the Shay family collection.

The first locomotive severely damaged the wooden tracks then in use where curves were encountered as the rigid trucks tore the trackage from the ties. A practice for building the tramways and a few of the early railroads for spur lines was to string long pine rails on the ties and then cap them with strips of hardwood.

It was the ingenuity of Shay that produced a locomotive that solved the transportation problems encountered in the Haring area, where it was necessary to have a locomotive that could be used on sharp curves, temporary and sometimes undulating trackage and with sufficient power to haul loaded cars over steep grades.

While the exact date of the first use of Shay's new geared locomotive is not known, it was within a year or two of his use of the first rigid rod drive type. The area logged by Shay was east of Haring. His original cost per thousand board feet from stump to mill using horses was \$3.50. His first horse-drawn two-truck car using maple rails reduced the cost to \$1.25 per thousand. Later reduced costs with his famous locomotive made him the envy of other lumbermen who soon took steps to copy Shay's methods of transportation.

Shay's first rigid drive locomotive as well as his first geared locomotive were manufactured in a foundry and machine shop established by William Crippen. They were near the Grand Rapids and Indiana RR right-of-way near the west end of Bremer Street.



RIGHT RIGID DRIVE TYPE (LIMA)



RIGHT RIGID DRIVE TYPE (LIMA)

The Cummer Lumber Co., of Ouzette, Mich., for double trackcars now loaded with pine logs as an ordinary right-hand wheel, and the double-track geared engine, one of our best designs. The rigid engine has no rollers and also has double wheels on the truck. The Shay engine has no rollers and also has double wheels on the truck. The Shay engine has no rollers and also has double wheels on the truck. The Shay engine has no rollers and also has double wheels on the truck.

1882 advertising card put out by E. Shay. Pictured at the left is Lima's No. 31 built in April 1882 for Dewing & Son of Tustin, Michigan. Right is one made by Michigan Iron Works of Cadillac for Cummer Lumber Co. of Cadillac, with drive shaft inside the right wheels but using Shay's basic patents.

From 1877 to 1879, Shay spent considerable time experimenting with various propulsion ideas and finally came up with the four unique features that made Shay and his locomotive so famous.

After Shay had developed his geared locomotive, he not only had solved his own transportation problems in getting logs to his mill, but he also found a great deal of interest by other lumbermen in securing similar transportation for their logs. Cadillac's Michigan Iron Works manufactured locomotives using the Shay features in modified form and Crippen also made similar locomotives.

Twenty-six Shays were used by Cadillac lumbering companies from the first by E. Shay in the late 1870's, then Milton Bond in 1890. Cobbs and Mitchell, one of Cadillac's three largest lumbering concerns, bought their first Shay from Lima in 1890 and later bought four more. The Cummer lumber companies used four Shays from 1881 to 1934. Mitchell Bros., the third largest firm, had six Shays. Five other local concerns used the remainder.

In March 1881, Shay secured patents covering the features of his locomotive. He had already provided manufacturing rights to the Lima Machine Works of Lima, Ohio, which was later to become the country's major locomotive manufacturer due primarily to its early production of the Shay.

Shay completed his lumbering activities in the Cadillac area in 1888 and moved to Harbor Springs, further north in Michigan. There he went into the lumbering business and also built a logging railroad known locally as the Hemlock Central. Shay was also the founder of a water company for Harbor Springs, which he donated to the city. During his lifetime he had a number of other inventions, many related to the lumbering industry. He also experimented with steam boats and built one of steel, 40 feet long.

Shay died at 77 on April 19, 1916, and was buried at Harbor Springs.

SHAY ADDED GENIUS TO FAMILIAR DEVICES

The individual units that comprised the Shay locomotives' functions were not unknown to mechanical engineers before Shay used them. However, it was Shay's unique combination of these units or features that made the Shay locomotive so practical for its many uses. As Koch said in his book, "What Shay did was to take a number of familiar devices and pieces of machinery and put them together in a highly unusual fashion to meet a particular need — the need for a locomotive by the logger or miner to be used over temporary trackage (even tracks of wooden rails or poles) and with curves and grades and undulations in the extreme. To point out that there was nothing really new in Shay's invention is not to disparage the ingenuity he displayed, however, but rather to call attention to it. Shay took what had been available to all and put it to a new and ingenious use."



Power Features — Famous power features on the locomotive invented by E. Shay in the late 1870s are shown on Cass Railroad's engine No. 5 used on the scenic railroad in Cass, West Virginia.

"A" shows the universal joints connecting sections of the drive shaft that permit bends among the different sections. This permits the pairs of wheels or "trucks" to go around sharp turns and vertical imperfections in the rails. "B" and "C" show unique slip-joint sections of the drive shaft. "B" is larger and has a hollow square opening into which the smaller square shaft, "C," can extend inward and outward as the entire shaft shortens or lengthens as the trucks go around turns.

"D-1" and "D-2" show the gears on the drive shaft and on the side of one of the six drive wheels alongside the locomotive. They transmit power to the wheels. All six have similar gears.

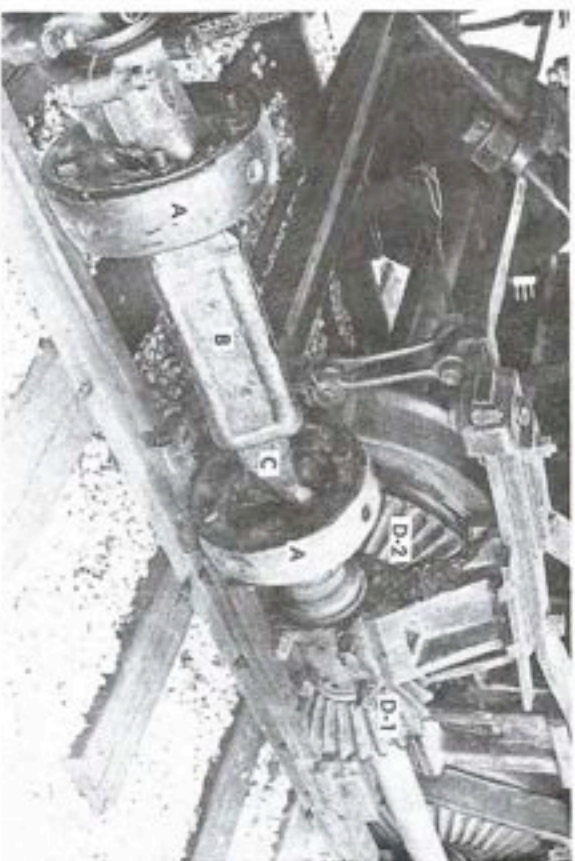
"E" shows the three steam cylinders above the connecting rods that provide smooth, continuous power to the drive shaft. These features in turn combine to power all 12 wheels, six on each side, including those under the tender of the locomotive, to provide maximum power and traction on any kind of track.

The four main outstanding features of the Shay locomotive included (1) two or three vertical steam cylinders, powered from either a vertical or horizontal boiler, driving a crankshaft. This crankshaft, or pinion shaft, of cast steel had sections joined by (2) sleeve couplings. Also joining sections of the shaft were (3) universal joints similar to those used in modern day automobiles. Fastened to the shafts, as each locomotive wheel on the right-hand side of the locomotive, were (4) bevel gears that meshed into additional gears on the side of the wheels to transmit the power to all wheels.

The steam cylinders provided considerably more even, constant torque than the usual rod type of locomotive. Using three steam cylinders, 15 exhausts per revolution of the driving wheels was secured on the Shay. The smooth, even flow of power thus produced enabled the Shays to negotiate

steep mountain grades effortlessly. As can be seen in one of the accompanying pictures, these cylinders, with their connection rods to the drive shaft, look somewhat similar to the cylinders and connecting rods and shaft in automotive engines.

The sleeve couplings in the drive shaft made it possible to have power on all the wheels of the locomotive even when the sets of wheels or "trucks" were being turned on sharp curves. With a large sleeve into which a smaller square-ended portion of the shaft was inserted, the small sections would pull outward in the sleeve as the locomotive made a left turn and slide further into the sleeve as the locomotive would be turned to the right, while it was continually transmitting power.



Flexible Drive Shaft — This close-up of a Shay locomotive drive shaft, or drive train, shows three of the main features of the flexible power transmission. "A" shows two universal joints, somewhat similar to those used later on automobiles to permit moving to the sides and up and down from connecting drive shafts.

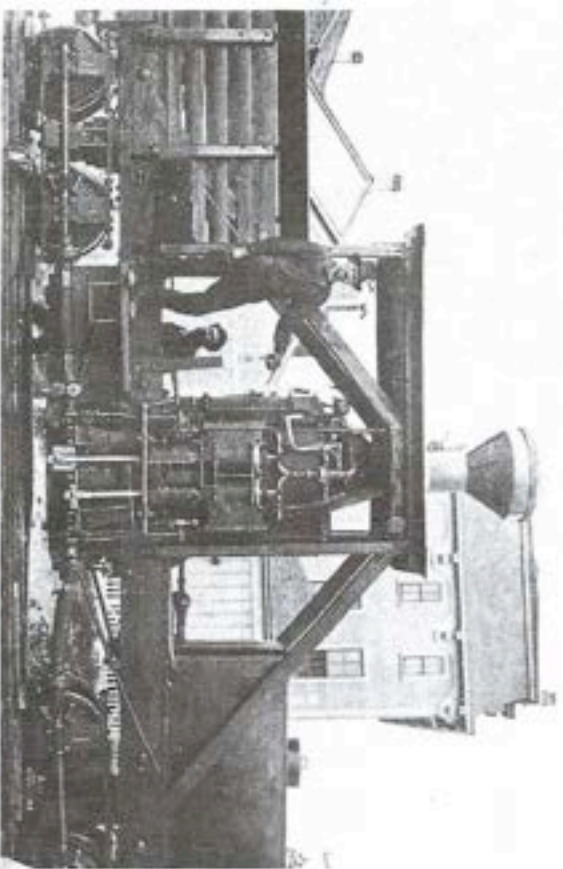
"B" shows the larger portion of a hollow drive shaft into which a smaller square-sided portion of the drive shaft "C" slides in and out as the various groupings of wheels or "trucks" are turned. "D-1" shows a gear on the drive shaft that transmits the power to the locomotive wheels, shown as "D-2." Power in turn is transferred to wheels on the opposite side of the locomotive connected with a rigid fixed axle. Each group of four wheels is designed in connection with the locomotive itself so they may easily turn around sharp curves.

Because a rigid shaft would have been twisted out of shape as the trucks were turned, it was necessary to have some flexible mechanism in the shaft itself. This Shay was produced by using universal joints. This permitted a shifting up and down between the various sets of wheels on uneven or undulating track. Thus, both horizontal and vertical flexibility was possible.

Unlike a standard steam locomotive, the Shay had direct gearing to each and every wheel of the locomotive and tender. The wheels on the right of the locomotives, to which the power was transferred by the shaft, were connected with rigid axles to the wheels on the other side.

Shay's first locomotives had the boiler cylinders and fuel on one frame with a four-wheel truck forward and a four-wheel truck aft. This resulted in power being given to eight wheels. Later Shays with separate tenders had three four-wheel trucks, thus providing traction on 12 wheels at all times.

There were other characteristics of the Shay that were unique in their time. For instance, the boiler was offset on the left side of the locomotive, giving it a lop-sided appearance. However, there was a good balance because the heavy cylinders and drive mechanism gave weight to the right side.



Lima Locomotive Co.'s tenth Shay shown on the GR&I RR tracks in Cadillac with the George Mitchell Building in the background (now the site of N. W. Savings & Loan Co.).

One advantage of the Shay was the ease of maintenance. There were only two major mechanical failures that could cause a Shay to fail: A broken crankshaft or a broken tire. A broken cylinder head, a broken piston head or a broken connecting rod still left two cylinders on which the Shay could limp in.

The early single frame Shays were used until 1890. Then the more familiar design, which mounted the fuel bunker on the rear of the locomotive frame and used a tender, or more correctly the tank, supported solely by the third truck for water only became popular. By 1885, the third cylinder was added to most of the Shays. This provided a smoother power pulse than was obtainable with the older two-throw crankshafts. It was also about this time that another feature, that of counter-balances on the crankshaft, were added to reduce vibration.

While the Shays, as popularly known, all had the drive shaft outside of the wheels along the right side of the locomotive, several early Shays carried a drive shaft in the center of the locomotive. These were ones made under Shay patents in Cadillac by the Michigan Iron Works under the direction of James Henderson. These were known as "Henderson Shays." In the Henderson Shay, the cylinders and crankshaft were underneath the wagon-top boiler forward from the firebox.

The multiple vertical cylinders and crankshaft, the sleeve couplings, universal joints and offset boiler and bevel gears, giving power to all of the wheels, may be seen on the Shay locomotive on display in Cadillac's City Park.

It is surprising that over the long period of years from 1879 until 1945 that the four basic features combined in Shay's locomotive remained virtually unchanged.

#### NATIONAL RECOGNITION GIVEN SHAY INVENTION

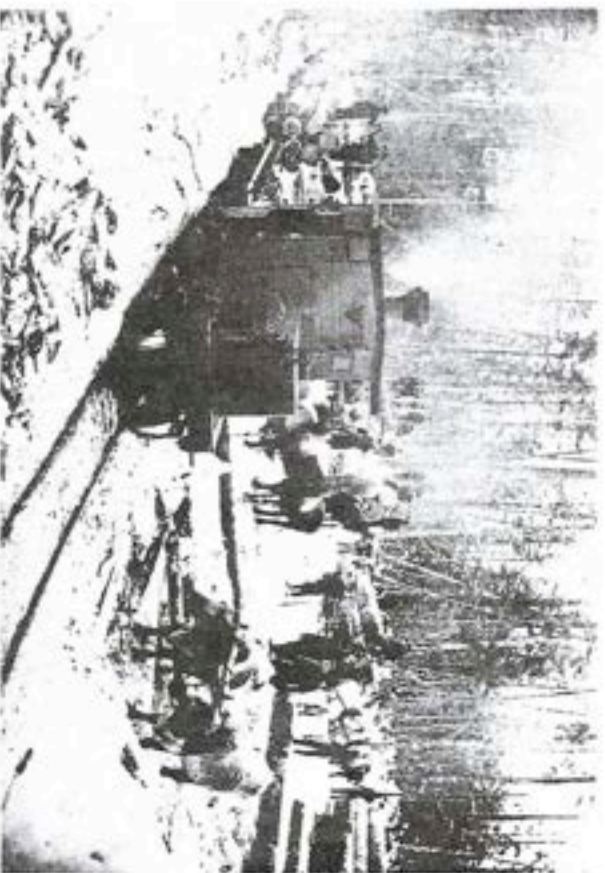
National recognition of the Shay locomotive was received in 1976 in the Historic American Engineering Record. This publication, by the U. S. Department of the Interior's Office of Archeology and Historic Preservation, carried both a picture of the Shay in Cadillac's city park and a brief Shay history. It is the only locomotive included in the inventory of historic engineering and industrial sites in Michigan.

The Shay locomotive presently in Cadillac's City Park was secured for the city as a gift from the Cadillac Soo Lumber Co. of Soo Ste. Marie, Michigan, through efforts of T. Walter Kelly, a former Cadillac mayor. This Shay locomotive was constructed in April of 1898. After several owners, it was used by the Cadillac Soo Lumber Co. until it was given to the city of Cadillac in 1956.

An excellent example of recognition for the Shay locomotive is in Chattanooga, Tennessee. There, a reconditioned Shay locomotive has been given a prominent place of honor in the city's outdoor Tennessee Railroad Museum.

The oldest known Shay locomotive to be on display is one built in September, 1884, and is in the museum at Camino, California, where it was placed in 1968. This Shay was built for the Rumsey Lumber Co. of Big Rapids, Michigan, and is just about big enough to fit into your garage.

The oldest three-truck Shay known to be in existence is also in California where it has been recently acquired by the Pacific Locomotive Association for restoration and eventual operation. It was constructed in 1903.



The fifth Shay built by Lima (1882) was purchased by the Cummer Lumber Co. of Cadillac. It drew a train of 34 cars of logs, averaging better than 1,300 feet to the car, for a distance of six miles to the mill on the north shore of Lake Cadillac. It made four round trips daily. At the time, this train was the largest train of logs ever drawn on a narrow gauge railroad.

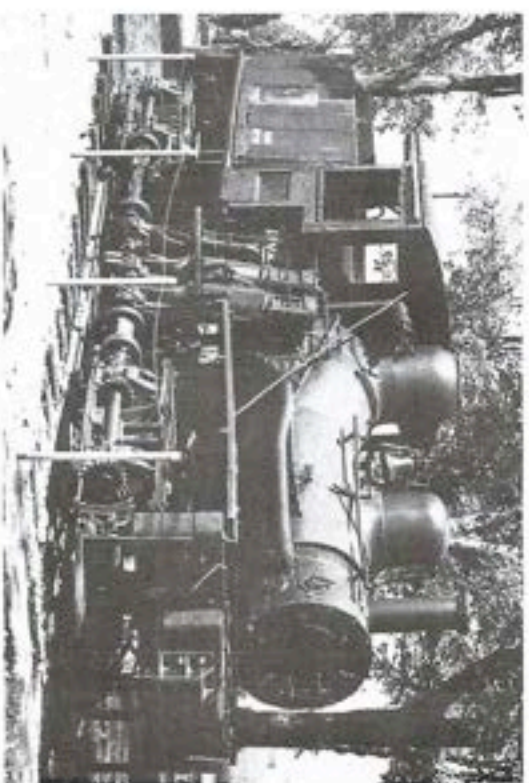
The last Shay locomotive to be built by the Lima Locomotive Company in 1945 has been given an honored spot in the Baltimore and Ohio Railroad Museum in the Mt. Clare roundhouse in Baltimore, Maryland.

This 1945 Shay incorporates the same four basic principles as used by Shay nearly 70 years earlier. John T. Hankey, in charge of archives at the Baltimore Museum, stated that from 80,000 to 100,000 persons visit the museum annually and that the Shay is one of the most interesting items in the extensive display.

Numerous other organizations and individuals familiar with the important part that the Shay locomotives played have also spoken out in recent years commending Shay for his invention and the continued manufacture by Lima Locomotive. Historical articles on lumbering and transportation have stressed the unique contribution that the Shays made in their over three-fourths of a century of use.

Aside from the Shays in museums or being used in several scenic passenger railroad operations, most of the 2,770 Shays have been relegated to history. The Shays were not suitable for general transportation as they were slow but possessed tremendous power and versatility.

An 1882 Shay is but one of five locomotives honored with photographs in a Michigan Historical Fund publication, "When the Railroad Was King" relates the history of locomotives and railroads in the state and was printed by the Michigan Historical Commission in 1966.



Current photo of Shay locomotive built in 1898. Presently on display in Cadillac's City Park.

## OUTLINE OF RESTORATION PROCESS

The goals of this project are two-fold. First is to restore the Cadillac Shay locomotive to an as-manufactured condition, although non-operational. The other goal is to preserve this memento of our heritage for the generations yet to be born.

### Disassembly and Cleaning

#### Disassembly

1. Remove tender tank and cab
3. Remove boiler jacket and insulation
4. Remove smokebox front
5. Remove piping, etc., as needed.

#### Cleaning

1. Blow off loose rust and dirt — including interior of firebox and tubes
2. Wash with high pressure water
3. Mechanically chip heavily rusted areas
4. Sandblast exterior
5. Treat metal with rust retardant and prime paint exterior

### Locomotive Repairs

1. Straighten locomotive frame
  - Bow beneath boiler
  - Twist behind tender
  - Install support beneath firebox adjacent to engine unit
2. Repair smokebox, frame, cab floor and pipes.

### Reconstruction of Missing Components

1. Construct tender and boiler to original specifications.
2. Construct ash pan
3. Construct front and door for boiler
4. Construct new pipes and wooden parts with treated lumber.

### Reassembly of Locomotive

1. Install tender onto frame
2. Install new boiler jacket
3. Install new cab
4. Install rest of reproduction parts, i.e., piping, running boards, end beams, couplers, etc.

### Refinishing of Locomotive

1. Clean entire unit
2. Mask off bright work, windows, etc.
3. Apply one coat primer paint and two coats finish paint
4. Unmask and touch up paint
5. Re-letter as per city of Cadillac specifications