

# [An inverted tooth chain engineering essay](https://assignbuster.com/an-inverted-tooth-chain-engineering-essay/)

An inverted-tooth chain operates quietly and smoothly and is also known as a silent chain. Silent chain consists of a series of toothed link plates assembled on joint components in a way that allows free flexing between each pitch. The teeth on the link plates mesh with a sprocket, similar to the way a rack meshes with a gear. The great majority of silent chain is used in drives. Silent chains are made up of stacked rows of load carrying link plates. Increasing the number of rows of links increases the chain width, tensile strength, and load carrying capacity. Using this feature, manufacturers make silent chains ranging from less than a 1 in. wide to more than 20 in. wide, with power capacities ranging from a fraction of a horsepower to more than 2000 hp.

A chain is a reliable machine component, which transmits power by means of tensile forces, and is used primarily for power transmission and conveyance systems. The function and uses of chain are similar to a belt. There are many kinds of chain. It is convenient to sort types of chain by either material of composition or method of construction.

There are five types of chains:

Cast iron chain

Cast steel chain

Forged chain

Steel chain

Plastic chain

Demand for the first three chain types is now decreasing; they are only used in some special situations. For example, cast iron chain is part of water-treatment equipment; forged chain is used in overhead conveyors for automobile factories.

## History:

Chains have been used for centuries to drive machines and move materials on conveyors and elevators. In 225 B C, Philo described a chain- driven water lift. Leonard da Vinci sketched the chain designs in the 1500s. Some are similar to modern bar link, leaf, and silent chains.

Cog chain was developed in the early 1800s to transmit power or motion between the shafts of treadmills to water elevators, weaving looms and harvesting machinery. This chain was used to mechanize farm implements, but it broke easily and was difficult to repair in the field.

Cast detachable chain was introduced in 1873 and overcome many of the problems of cog chain. This chain was made of simple identical cast links that were easily coupled and uncoupled by hand. This basic detachable chain design is one of the early chain concepts that have been unchanged nowadays also.

After few years cast detachable chain was introduced, a chain made of all steel parts was introduced for driving bicycles. A patent for roller chain was issued in 1880. By early 1900s, roller chains drove the wheels of safety bicycles, as well as automobiles, trucks, and the propellers of the Wright Brothers airplane that flew at Kitty Hawk.

Two major factors combined to make the roller chain industry were automation and standardization. Automation helped manufacturers meet the demand for the large amounts of high quality that were used on machines made by other industries. Standard dimensions and capacities ensured that roller chains would fit and operate as the designer planned. The result was that the industry soon became as the precision roller chain industry.

Engineering steel chains were first developed in the 1880s. They were developed for greater strength, speed and shock resistance and for better dimensional control than could be obtained from cast chains. Pitch, strength, wear life, and carrying capacity were increased to meet the heavy duty needs of industry. There are many types of engineering steel chains. Those with steel rollers are the most widely used on both drives and conveyors. The bushed, roller less style are the needs of many conveyor and bucket elevator applications.

Sir Isambard Kingdom Brunel supervised the building of the Great Britain, and it was a revolutionary ship design. It was the first sea going iron steamship, the first propeller driven steamship to cross the Atlantic, and the first vessel driven by inverted tooth, or silent chain. The silent chain drive delivered power from the engines to the propeller shaft by way of large wooden- tooth sprockets.

From 1895 to 1925, the chain industry improved the design of silent chains. From 1930 onwards, silent chain was used in a variety of industrial applications such as drives in paper and textile mills, flour and feed mills, printing presses, pumps and machine tools. Throughout the 20th century, the industry improved material quality, processing technology, and chain designs to increase the load and speed capacity of silent chain. Silent chain is also used in the drive train of snowmobiles and four wheel drive recreational vehicles. Outside the power transmission market, silent chain can be used as a conveying surface in a variety of material transport applications.

Major improvements were made in the production of food and beverage products. The introduction of high speed processing, filling, and packaging equipment drove the need for a chain with a flat carrying surface for material handling. The first flat-top chains were produced by welding steel plates to roller chain, producing a flat surface where products or packages could be carried. These first flat-top chains were made of carbon and corrosion resistant steel and were widely used in the brewing industry to convey glass bottles.

## Construction and Features:

Silent Chains have a very simple construction: only plates and pins. Silent Chains are actually an update of a 19th-century design. ANSI B29. 2M-1982 regulates the standard pitch, width, and kilowatt ratings of the chains and sprockets.

There are eight different pitches from 9. 52 mm to 50. 8 mm.

The link plate receives tension and has a notch for engaging the sprockets. There is no notch on the guide plate. These plates act as guides for the sprockets.

Pins may be round or have other shapes, such as D-shape.

All the chain components share the tension. Silent Chains have higher capacity than roller chains of the same width.

Since the link plates of Silent Chain strike the sprocket at an angle, the impact and the noise are reduced. This is why these chains are called silent. The higher the chain speed, the greater the difference from roller chains.

Driving Links: Driving links, also known as plain links, engage with sprocket teeth to drive the chain. They are typically the most common component in the chain.

Guide Links: Guide links maintain proper tracking of the chain on sprockets. They are positioned on the outer edges of the chain in side guide and multi guide chain or in the centre, with the centre guide chain.

Pins: Pins allow the chain joint to flex and hold the assembled chain together. Chains may have a single pin in each joint or two pins, depending on the chain type.

## Design considerations:

## Tensile loads and strength:

Silent chain with single pin assembly may be subjected to all of the tensile loads, but silent chain with two pin assembly eliminates chordal action. It is not affectd much by tensile loads from chordal action.

Fatigue limit: It is a most important consideration in designing silent chains. The lower speed part of the power ratings for silent chain is based on a minimum fatigue limit.

Fatigue strength: Loads exceed the fatigue limit in very high performance drives. The chain must have adequate fatigue strength to endure these loads only if the chain is to be used in high performance drives. Fatigue strength in the finite life range is an important consideration in designing silent chains.

## Wear:

Wear is an important consideration in designing silent chain. The two major types of wears are joint wear and link plate and sprocket wear.

Joint wear: As the chain runs over the sprockets, the joints flex. Material is worn off the joint components and chain gets longer. Then chain then rides out farther on the sprocket teeth. This increase noise and reduce efficiency.

Link plate and sprocket wear: These wears are also caused by friction on the chains which reduces the efficiency of the silent chains.

## Advantages of silent chain drives:

Silent chain drives require nearly as precise alignment as gear drives to obtain peak performance and service life.

• Silent chains are less affected by chordal action and joint friction than other chains; silent chains engage sprockets with reduced vibration, noise, and frictional losses.

• Silent chain can operate at loads and speeds that often exceed the capability of belts and other types of chain.

• Silent chain drives are quieter and smoother than roller chain drives, and in some cases are quieter than gear drives.

• Silent chain drives are more compact than gear drives when the shafts must turn in the same direction.

## Manufacturers of inverted tooth chain are:

## Bosch Rexroth AG, Germany:-

Bosch Rexroth is an engineering company based in Germany. It is the result of merging between Mannesmann Rexroth AG and the Automation Technology Business Unit of Robert Bosch. It employs over 35, 000 people worldwide. The industries Bosch Rexroth serves are Agricultural machinery, automotive manufacturing, Machine tools, Civil engineering and many more.

Rexroth’s inverted tooth chains: The largest delivery program in the world for inverted tooth chains used for driving and transporting are from Rexroth. Rexroth’s new inverted tooth conveyor chains come with the axle pivots welded to the outer plate by laser. This new technology prevents lateral movement of the joint pivots. These innovative inverted tooth conveyor chains are fully interchangeable with previous design and the sprockets do not require any machining.

## . Advantages of Bosch Rexroth inverted tooth chain drives over:

## Gears / Transmissions

## Belts

## Roller Chains

Reduced bearing loads

Non-slip

Rolling pivot joint

Insensitive to temperature fluctuations

Higher Speeds

High maximum velocity

No need for intermediate sprocket

Silent – no whistling

Low-noise

Zero tooth flank backlash

Space-saving

Smooth running due to involute toothing running

Larger permissible tolerances for shaft installation

Small sprocket diameters

99% efficiency

Vibration damping

Insensitive to extreme temperatures or humidity levels

Wear-resistant sprockets

Low-cost sprockets

Reduced bearing loads

Vibration damping

The advantages over other conveyor systems are:

Due to high power density, the space used is optimum

Extremely long service life and availability

Very low lubrication requirements

High temperature tolerance

Highly robust and resistant

## Comparison with different types:

## Characteristics

## Tooth chains

## Roller chains

## Toothed belts

## Toothed wheels

## Noise behaviour

Very good

Average

Bad

Good

## Temperature sensitivity

Good

Good

Bad

Good

## Space required

Good

Average

Bad

Very good

## Wear

Good

Bad

Average

Very good

## Maintenance

Partly necessary

Necessary

Not necessary

Not necessary

Ramsey Products in USA is another major company. Ramsey manufactures an extensive range of silent chain and sprockets for use in industrial power transmission and conveying applications. For the companies that work with glass, silent conveying chains offer many benefits in applications like handling to precision inspection and measurement from hot-end and cold-end. These chains are made through hardened steel link plates and case hardened steel pins.

Characteristics of Ramsey chain:

Flatness and uniformity: The flat, uniform surface of the chain provides transport of smaller bottles without any trouble.

Surface velocity: The chain wears, the pitch increases uniformly throughout the chain, and velocity remains constant. Uniform velocity reduces breakage.

Heat resistance: The temperatures are high with hot-end handling, to withstand these temperatures chains are made from hardened steel. Heat transfer from transported glassware and heating torches does not effect the uniformity of the conveyor surface.

Economy: Improved product handling, and requires very less maintenance, chain provides a cost effective means for conveying glassware in high speed production lines.

Types of chain:

Ramsey manufactures four basic types of conveyor chain.

Ultralife

Standard

Lo-profile

Extended pitch

Ultralife are best quality conveyor chain. They consists single pin and two pin assembly.

The straight edge of the aperture maximizes the link area contacting the pins and reduces joint bearing stresses and wear. Single pin joints provide a durable, smooth acting joint, satisfactory life, and easy to install than two pin joints. These are developed specifically for the glass industry. Two pin joints are originally developed for use in power transmission and have been adapted for use in conveying chains. They have the advantages such as long life, low friction and high efficiency.

## Advantages of Ramsey silent chain over :

## Gears / Transmissions

## Belts

## Roller Chains

Greater elasticity and shock absorption capability

No slippage

Longer sprocket life

Less critical shaft location and alignment

Higher Speed and power capacity

High speed and power capacity

No end thrust

Greater efficiency

99% efficiency

Detachable and easily replaced

Easily installed

More uniform wear characteristics

Lower bearing loads

Lower bearing loads

Less velocity variation

More economical with large centre distances

Larger drive ratios

Reduced noise and vibration

Reduced noise and vibration

Less affected by temperature

Less affected by chordal action

R. Prinz KG Maschinenfabrik, Austria

Wippermann jr. GmbH, Germany

ZITEC Industrietechnik GmbH, Germany

These are major companies in manufacture of inverted chain and exporting them. There are many small industries in China, India which manufacture these chains.

## Applications of Inverted tooth chains:

Roller table drive applications

Cost-efficient group drive

Uniform synchronous running

No backlash when reversing

Quiet even at high speeds

Good meshing conditions minimize wear

Outer tooth ring applications

More cost-efficient than a milled tooth ring

Suitable for large transmission ratios

Full circle rotary motion or swivel motion along an angle segment possible in reverse or continuously

Gripper and robot drive applications

Precise synchronized motion

High load capacity even at narrow widths

Optimum meshing depth on the toothing provides a high a degree of security against skipping

Flexible shaft coupling applications

High elasticity

Uncouples quickly by opening the lock or by radial offset when closed

Angles can be shifted to 1° and shafts can be shifted radially to 2% of the pitch