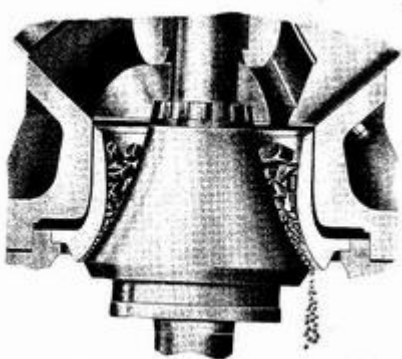
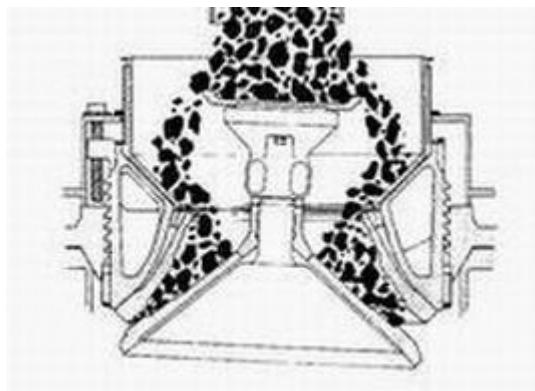


Gyratory and Cone Crushers

Gyratory crushers and cone crushers, while looking the same and performing similar duties, are two different machines. A quick look at a machine will allow you to determine if it is a gyratory or a cone. In simple terms, if you look at the top of the crusher and it has supporting arms (“spider arms”) going out to the centre of the machine (normally 2 or 3) it’s a gyratory. The presence of the spider arms is generally said to indicate that the crusher has a “restricted” feed opening (i.e. the arms may get in the way of the feed), whereas the cone crusher, without the spider arms, has an “unrestricted” feed opening. This is a little misleading, however, as the gyratory crusher nearly always has a larger feed opening than an equivalent-sized cone crusher. This is due to the shape of the crushing head, which in a gyratory, is a very steep cone where the head on a cone crusher is quite flat.



Typical Gyratory Crusher Head

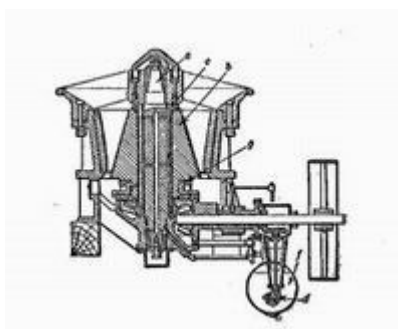


Typical Cone Crusher Head

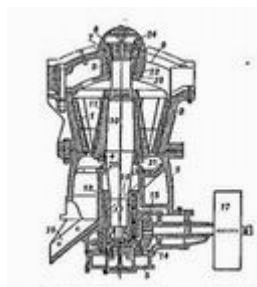
The gyratory crusher is the older design, dating from the late 1870’s. Traditionally there are three main types of gyratory crusher:

- Suspended shaft
- Fixed shaft
- Supported shaft

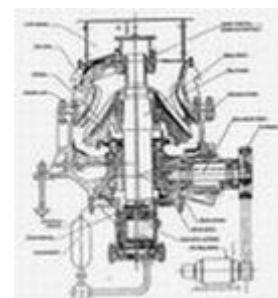
Fixed shaft crushers are a rarity and suspended shaft machines are now less common, although there are still many suspended shaft machines in daily operation, such as the older Jaques Traylor TX, TY and TZ machines. These crushers have limited tramp (uncrushable material) relief, and have now generally superseded by hydraulic Supported Shaft machines.



Fixed Shaft



Suspended Shaft

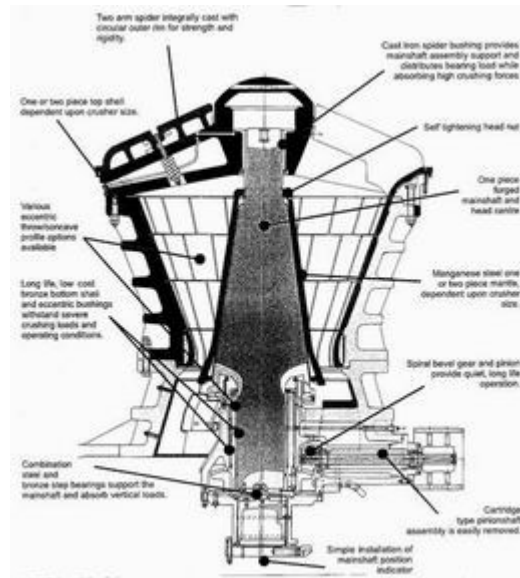


Hydraulically Supported

Gyratory crushers can be used for most crushing operations in quarries and mines, from primary crushing duties to tertiary crushers. Although it is unusual, there are a few Australian quarries operating primary gyratory crushers, although they are more commonly found in high-throughput mining operations. Primary gyratories are mainly specified where capacities in excess of 800 t/h are required, and they can handle up to 8,000 t/h. The major drawbacks as far as quarries are concerned are in their size, mass, power requirements and, last but by no

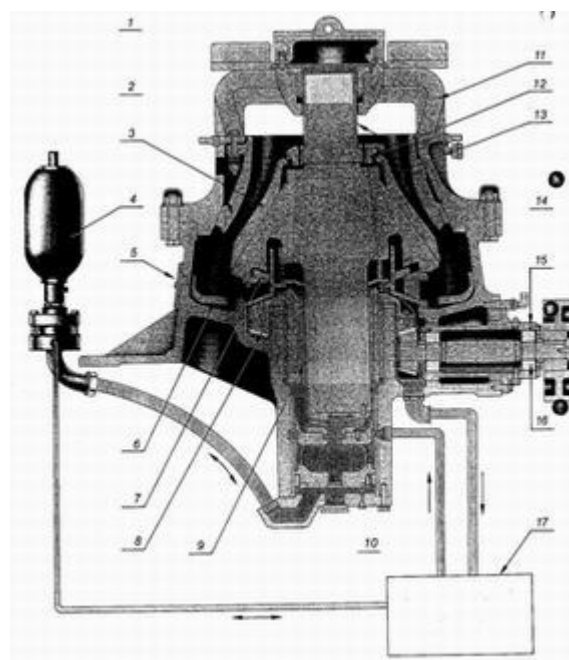
means least, cost. They can be over 10m high, weigh in excess of 600 tonnes and require up to 1,000kW of motor power. When installed in a plant they do not require a feeder, generally being fed directly by dump-truck, and can accept feed lumps of 1500mm x 4000mm. Crusher costs can run in excess of \$4,000,000.00, with installation costs approximately the same. Whereas mining operations can generally justify this expense it is very difficult to do so in the quarrying business!

Primary gyratory crusher sizes are generally nominated in imperial dimensions. The first two numbers designate the feed opening and the other numbers (can be two or three) the diameter across the bottom of the crushing head, i.e a 54-74 has a 54" feed opening and a (nominal) 74" diameter crushing head. There are a few exceptions, for instance one Japanese manufacturer uses metric dimensions, but the imperial designations are generally understood throughout the industry.



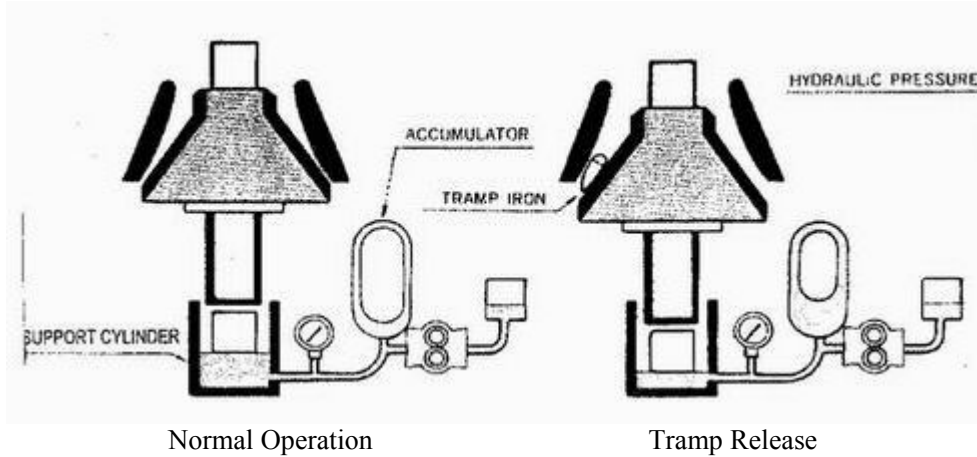
Primary Gyratory Crusher

In today's quarrying operations gyratory crushers are generally used as secondary and tertiary machines. With increasing requirements for plant automation the hydraulically supported design of gyratory crusher, such as the Allis Hydrocone, is becoming very common. The hydraulic shaft support allows the operator to adjust the crusher setting while the machine is operating and also provides excellent protection against tramp. Modern control systems will even automatically maintain the crusher setting during operation without any input from the plant operator.



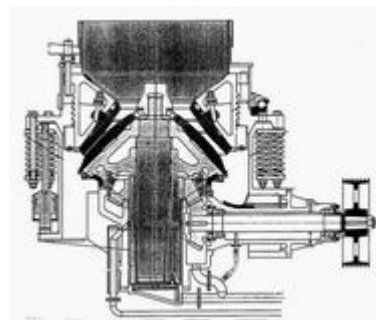
Hydraulically Supported Shaft Gyratory

The main shaft of these machines is supported on a specially manufactured hydraulic cylinder, with a nitrogen-filled accumulator in the line. To adjust the setting the operator generally only has to push a button, which will start the hydraulic pump, pumping oil into or out of the cylinder, thus raising or lowering the shaft. In the event of an uncrushable object entering the crushing chamber the oil is forced through the large-diameter line at the bottom of the machine and into the accumulator, thus dropping the shaft and allowing the tramp material to pass. As soon as the tramp has passed through the cavity the nitrogen forces the oil back into the cylinder, thus returning the crushing head to the previous setting.



Sizes of secondary and tertiary gyratory crushers are generally nominated by the diameter of the crushing head, either in imperial or metric dimensions, although some manufacturers also use the feed opening of the machine in the size designation. As such a machine could be called a 36", a 4-36 (i.e. 4" feed opening, 36" diameter head), a 1000 (mm) or a 1010 (100mm feed opening, 1000mm head diameter). It's somewhat confusing, but most people can relate to the simple head diameter designation.

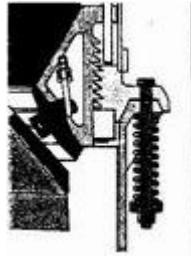
The first cone crusher was designed by the Symons Brothers in the 1920's, and is now well known throughout the world. They were looking for a machine with a larger throw, which would provide a better reduction ratio than the gyratories of the day. Although cone crushers can be used as secondary and tertiary machines, the same as gyratories, they sometimes have a problem in a secondary application because the available feed openings may not suit the plant primary output. Selection of a suitable secondary then becomes a balancing act between size of machine, price and available installation space. A cone crusher of equivalent size to a gyratory will require less head-room to install, however to get an equivalent feed opening you will generally have to go up one size in cone crusher over a suitable gyratory. Conversely a cone crusher will generally have a higher throughput than the equivalent size of gyratory.



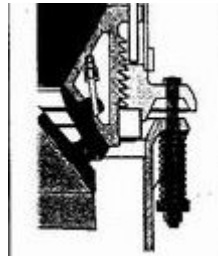
Typical Symons-style Cone Crusher

Cone crusher sizes are mostly nominated by the diameter of the bottom of the head, but the dimensions may be either imperial or metric, depending on the manufacturer. More recently some manufacturers have taken to nominating the machines by the maximum horsepower, such as the Metso HP series (i.e. HP300 will take a maximum of 300 HP- note this is HP, not kW). Cone crushers can be either "standard" machines, generally considered suitable for use as secondary crushers, or "short head" (also called "fine head") units mainly designed to work as tertiary machines. The main differences are in the size of the available feed openings and the closed side settings they can operate at (as a rule coarse feed opening = coarse minimum CSS). In some makes conversion from "standard" to "fine head" can be achieved simply by changing the manganese. In other crushers it may require a change in major components to obtain the same result.

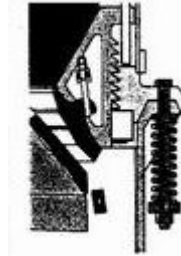
Older style cone crushers, such as the original and possibly most-copied cone, the Symons, use springs to provide tramp material protection. In this situation the “bowl” (the fixed crushing member) is held in position during normal operation by a number of springs around the machine. If an uncrushable object enters the chamber the bowl lifts up against the springs, allowing the uncrushable object to pass in most cases. Clearance in this system is fairly limited, and it is not uncommon for the tramp to be larger than the available clearance, causing the machine to stall and delivering plenty of exercise to the plant operator to clean the crushing chamber and remove the tramp!



Normal Operation
bowl lifts up

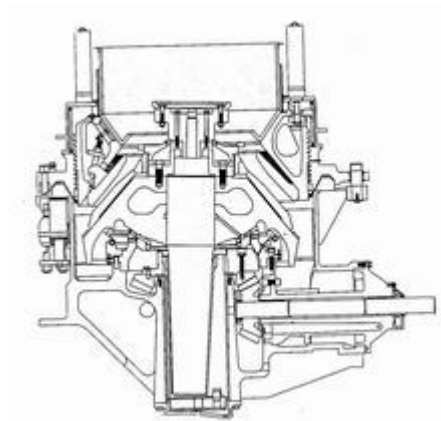


Tramp in Cavity
bowl returns



Tramp Released

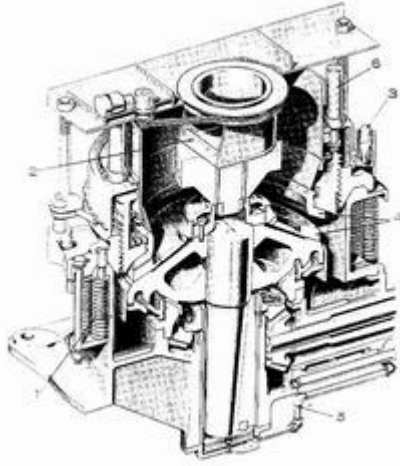
More recent designs (such as the Cedarapids Rollercone and Metso HP) have replaced the springs with a number of hydraulic rams, which are said to react more quickly and provide greater clearance to pass uncrushable materials.



Cone with springs replaced by hydraulics

As with most crushers, the maximum feed size a cone or a gyratory will accept without problem is about 80% of the nominal feed opening. They will accept an occasional lump larger than this, but too many in the feed will cause bridging of the feed opening, leading to blockages and more work for the operator. As a general rule feed into a gyratory should be directed over a spider arm, thus providing even distribution around the crushing chamber. The feed into a cone crusher should be on-centre of the cone (some have a feed plate on the top, others do not), with even distribution around the chamber. Uneven feed will cause uneven loading, leading to uneven wear of major components.

A few manufacturers have developed the cone crusher into a quaternary machine, specifically designed to produce a manufactured sand. These are machines such as the Nordberg Gyradisc, the Cedarapids Sandcone and the Kobe AutoFine. The machines require a closed circuit to operate effectively, and maximum feed size is generally limited to around 50mm. They have special profile manganese and should not be considered for applications other than those they are specifically designed for. It is strongly recommended that the manufacturers be consulted if considering the use of these special cone crushers.



Nordberg Gyradisc

When selecting a gyratory or cone crusher the following points should be considered to guarantee best performance from the unit:

- Maximum feed size should not exceed 80% of the nominal feed opening. This will ensure that the machine will accept the same maximum feed over the life of the manganese.
- Maximum product size can be up to twice the nominal closed side setting of the crusher.
- Generally 60% - 70% of the product will pass through a sieve with an aperture equal to the closed side setting.
- Reduction ratios for cones and gyratories can vary between about 5:1 for short head cones to 8:1 for gyratories.
- Cones and gyratories generally operate best when all material finer than the closed side setting is removed from the feed. Inclusion of fines in the feed can result in packing of material in the crushing chamber.
- Feed to any gyratory or cone crusher should be constant. If necessary include a surge bin or surge pile prior to the machine to ensure even feed.
- For best results gyratory and cone crushers should be choke fed.

In any cone or gyratory crusher installation the lubrication system is of major importance. This not only lubricated the moving parts of the machine but also provides cooling, minimising wear and maximising life of the unit. With regular scheduled maintenance and attention to the operating parameters gyratories and cones should not cause major operational headaches in any operation.

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