ENGINEERING

Less Friction in World

Bearings speed almost all equipment that rolls and floats. Smallest bearings used are part of high-powered microscopes, largest are in giant presses.

See Front Cover

By MARTHA G. MORROW

➤ THERE is much less friction in the world because little and big balls and rollers are bearing some of the burdens in our vast array of machines—from lawn mowers to locomotives.

The smallest ball bearing actually used today is one that is part of high-precision electric gauges and high-powered microscopes. It is small enough to get through the eye of a needle, and not an oversize needle at that.

One of the largest roller bearings is used in giant presses that roll steel into finished sheets. This bearing is five feet in diameter.

Millions upon millions of ball and roller bearings are twirling around, reducing to a minimum useless friction in bicycles, dial telephones, vacuum cleaners and washing machines.

Use in Automobiles

Every automobile incorporates 25 to 30 anti-friction bearings. About 2,500 precision-smooth bearings are used in commercial air lines.

One of the strangest applications is in a building that has roller-bearing foundations. The idea is to allow the building to stand still when an earthquake moves the earth beneath it. The bearings take the force of the tremor from any given direction.

Some scientists want to split hairs. A knife that cuts specimens of human or animal tissue into slices 500 times thinner than a human hair whirls around on ball bearings.

Microscopic balls only 1/64th of an inch in diameter may soon replace jewels in watch bearings. Of a special chrome alloy, they do not crack as easily as the conventional quartz or gem jewels.

Ball and roller bearings reduce friction to a minimum in practically every piece of man-made equipment that rolls, floats or flies. If it contains turning parts, anti-friction bearings are probably used.

But steel balls or rollers alone do not make a bearing. Merely inserting steel balls, for instance, between a wheel and its shaft would not solve the friction problem.

The balls are held in place by two concentric steel rings. They run in grooves or "raceways" cut in the rings. A retainer or separator is usually inserted to keep them from rubbing against each other.

In a roller bearing, essentially the same set of parts is used, except that rollers are employed instead of balls.

In modern mechanical equipment, bearings may have to carry loads of three general types. The load may be at right angles to the shaft, it may be parallel to the shaft, or it may be a combination of both, called an angular load.

The earliest modern ball bearings, used in all bicycles and automobiles, were of the angular type. In these the inner ring was placed on the axle and the outer ring on the wheel hubs. Modern anti-friction bearings are designed to operate under various combinations of these loads. They must meet different space limitations and fulfill literally thousands of variable requirements. That is why so many standard varieties are needed.

Today more than 30,000 different sizes, types and specifications of anti-friction bearings are serving millions of machines. But despite the wide range, all bearings are precisioned to a tolerance of one-thousandth to one-millionth of an inch, depending upon the size.

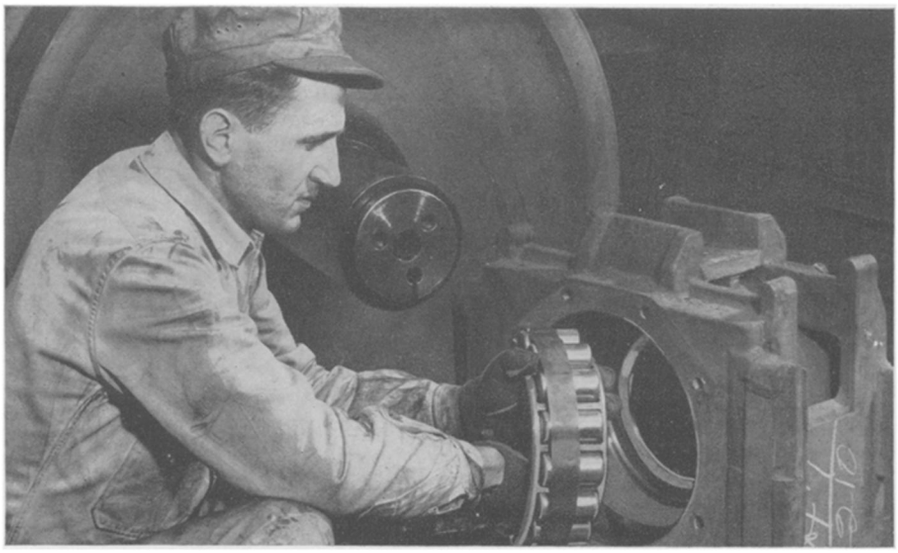
During the last two years of the war, more than 30,000,000 complete ball and roller bearings were made each month for military equipment of the United States alone. Today 72% of the total output of the industry is used to give us smoother rides in trains and trucks, airplanes and buses.

Made From Steel

Balls for bearings are made from high-quality steel wire. For all sizes up to three-quarters of an inch in diameter, slugs of wire are chopped off and placed between the cup-shaped dies. These bang the steel slugs into a rough ball shape.

A ring of extra metal, left where the two dies meet, is removed in oil. The excess metal is not ground off, but is literally rolled off.

If the balls are ⅜ inch in diameter, or larger, they are hardened to relieve strains caused by upsetting the grain structure in heating. After heating in an



LUBRICATION—Eliminating hot-boxes, roller bearings installed on high-speed locomotives and trains are lubricated only when the equipment is brought into the shop for general inspection. Ball and Roller Bearing Information Center photographs.

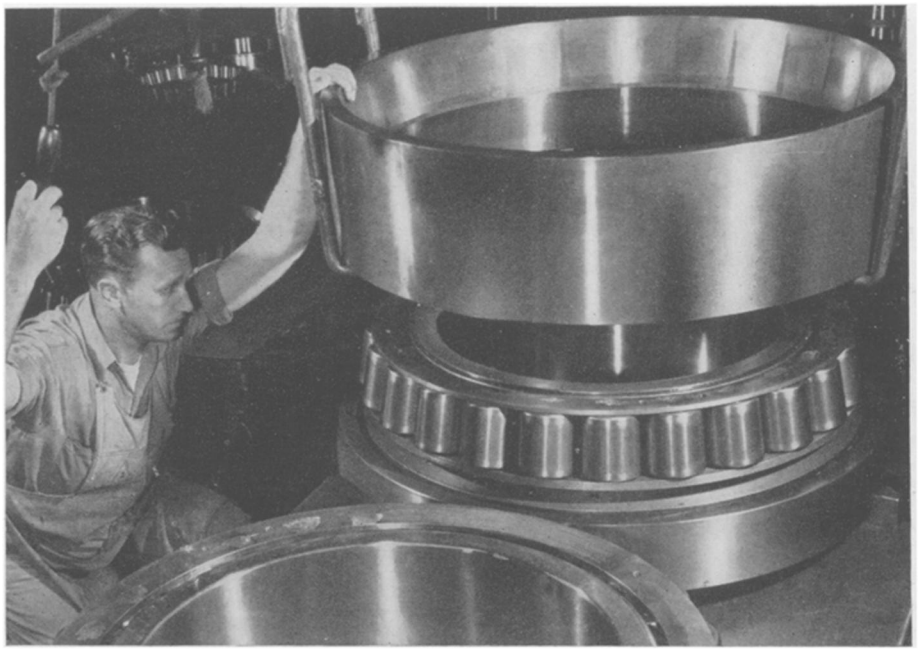
electric furnace, the still-hot balls are dipped in oil or water to cool.

The steel spheres are reground, heat-treated and given a final precision grinding. They then may differ in size by only a small fraction of an inch and are glass-smooth.

To make them perfectly uniform in size, the balls are tumbled in barrels containing lime and water. The lapping action of the balls rubbing against each other actually cuts their diameter down a minute fraction and polishes them until they shine like mirrors. For a super-finish, the balls are tumbled against pieces of kid and chamois leather.

Trained inspectors use high-powered gauges and other special apparatus to detect any imperfections such as cuts, cracks, dents, out-of-rounds and soft spots.

The balls must be graded carefully for size. If they vary more than one ten-thousandth of an inch in precision smoothness, some might have to bear an unequal proportion of the load.



CROWNING IT—Outer ring is being put on enormous tapered bearing.

Perfect Fit

Inner and outer rings and retainers are handled with equal exactness. All parts must fit perfectly with nothing to cause friction as the balls silently and smoothly travel in the greased raceways.

Some bearings have a single row of mirror-like balls. Ball bearings of this type are used in drills, presses, on rotating shafts of automobile engines and lawnmowers.

Sometimes a double row of ball bearings are used. These are particularly useful where greater accuracy of shaft location is required, as on grinder spindles. Special non-metallic retainers reduce friction so the shafts can make 30,000 revolutions a minute.

The movable parts of a bearing are carefully greased so they will run smoother and wear longer. Occasionally the balls are protected on the outside by metal strips to seal in the grease and keep out abrasive dirt and dust.

Many rollers for bearings are uniform in shape. Known as straight roller bearings, these are used where heavy loads are required.

The rollers in other bearings are thicker at one end than the other. A tapered bearing incorporating such rolls is used to carry thrust, radial and combination loads.

Where the shaft of the machine acts as the inner ring, needle bearings are used. Slim rollers, pointed at both ends, are kept in place by a retaining lip on the outer ring or shell.

Bearings are made from several types of steel. A low carbon steel is used for the ordinary bearings, such as those in roller skates, bicycles, casters and pedals. Special chrome steel alloys make the finest super-precisioned ball bearings.

Metal alloys such as stainless steel are used for non-corrosive metal balls when the bearings will be exposed to acid fumes, salt water or food products.

Anti-friction bearings are inspected and tested by devices of incredible precision. One sensitive electric gauge must be shielded from the sun, or its metal parts might expand enough to permit a

slight error. It is this type of gauge that measures balls and rollers to tolerances of millionths of an inch.

In soundproof chambers, trained testers listen to bearings on rapidly moving shafts. The slightest "foreign" noise—sometimes inaudible to the untrained ear—is detected instantly by unique instruments. The offending bearing, which may have a rough spot, a slight speck of rust an under-size ball, is discarded.

The picture on the cover of this SCIENCE NEWS LETTER shows workers giving roller bearings a final going over as they ready them for streamlined passenger equipment.

Gloves, masks and gowns, familiar to operating rooms, are standard equipment in making the extremely small bearings. Hypodermic syringes are used when a single drop of oil must be placed on the miniature ball bearings slightly larger than the head of a pin.

The rooms are air-conditioned to filter the dust from the air and keep the temperature and humidity constant. Air-jets like those in a "fun house" remove dust from workers' clothes before they enter the assembly rooms.

To understand how bearings act as

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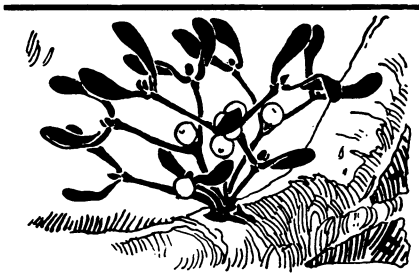
BOTANY

NATURE RAMBLINGS

by Frank Thone



Christmas Conservation

➤ CHRISTMAS wreaths and garlands are on the market again, their glossy green leaves and bright red berries tempting even the thriftiest to open his purse. Yet it is well to eye before you buy, and to refuse certain items entirely because they violate the spirit of the feast by doing real harm to God's gardens, where wild things grow.

No thoughtful Christmas shopper, for example, will ever buy anything made of ground pine, the prickly, fine-leaved plant that is often the only ground cover in great reaches of thin-soiled woods. Gatherers of ground pine rip it up heedless of later consequences, leaving the trees' precarious roothold open to rapid erosion. Ground pine just doesn't mean Christmas to people who know.

Similarly, when buying holly you should insist on English holly. It is grown for the market in this country, and by purchasing it you help the growers to make an honest living. Native American holly, on the other hand, is always obtained by raiding the woods where it grows. Usually the raiders work in haste, for theirs is an illicit trade, and they break and rip the branches disgracefully. You can tell English holly readily by its bigger, redder berries, by its pricklier, darker green leaves—and by its higher price. But it's worth the difference.

It is all right, however, to buy the synthetic Christmas "greens" made by combining the evergreen leaves of mountain laurel with twigs of the red-fruited winterberry, gathered usually in swampy places. This plant is a first cousin to holly, but sheds its leaves in autumn. Both mountain laurel and winterberry are so abundant in the regions where they grow that once-a-year cropping seems unlikely to do any material harm.

Mistletoe, also, is something you can buy freely without any qualms of your conservationist conscience. In fact, the more mistletoe is harvested the better it is for the woods. For mistletoe, despite its romantic connotations, is a harmful parasite that robs trees of their sap, and the more of it is removed the better off the trees will be.

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simple, non-technical terms, covering such subjects as plastics, electronics, television, penicillin, radar and rockets, among others, and giving an insight into the future of new industries and new jobs.

YOUNG PEOPLE'S BOOK OF ATOMIC ENERGY—Robert D. Potter—*Robert M. McBride,* 171 p., illus., $2.50. Written with simplicity and clarity for the young reader from 12 to 16.

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steel cushions for moving parts, place a heavy book on a table and try to push it with a long, thin ruler. Now put two round pencils of about the same size underneath the book and push at right angles to the parallel pencils.

When the book lay directly on the table, there was friction—resistance to motion of two surfaces in contact—at every point of contact. When the pencils were placed beneath the book, a rolling motion was substituted for a sliding motion and the book moved much more easily. Rollers and balls move more freely because only a tiny part of their surface touches the surface on which they move.

The wheel was the first important victory over friction. But wheels were poorly built at first and remained so even to comparatively modern times. The first wheel was probably a cross-section of a tree trunk. A hole in the center, perhaps burned through, held a crude type of axle.

Simple wheels, however, could not turn fast or carry heavy loads, because each rested directly on the axles on which they turned. Sliding friction soon wore away both wheel and shaft. The wheel wobbled, turned loosely, and finally fell off.

Man fought friction in early days by greasing axles and shafts with animal fat. Such lubrication helped somewhat, but heat built up by turning axles soon burned up the grease. The fat, settling toward the bottom of the shafts when at rest, was soon squeezed out. Hubs had to be greased frequently.

Until the beginning of the twentieth century most wheels worked on the sliding principle. Although the wheels turned, the axle and wheel still slid in relation to each other. Power began to be used efficiently only when wheels were rested on an assembly of balls and rollers—when the bearings between the wheel and the axle were themselves free to roll.

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