Regrinding Sendzimir Mill Work Rolls

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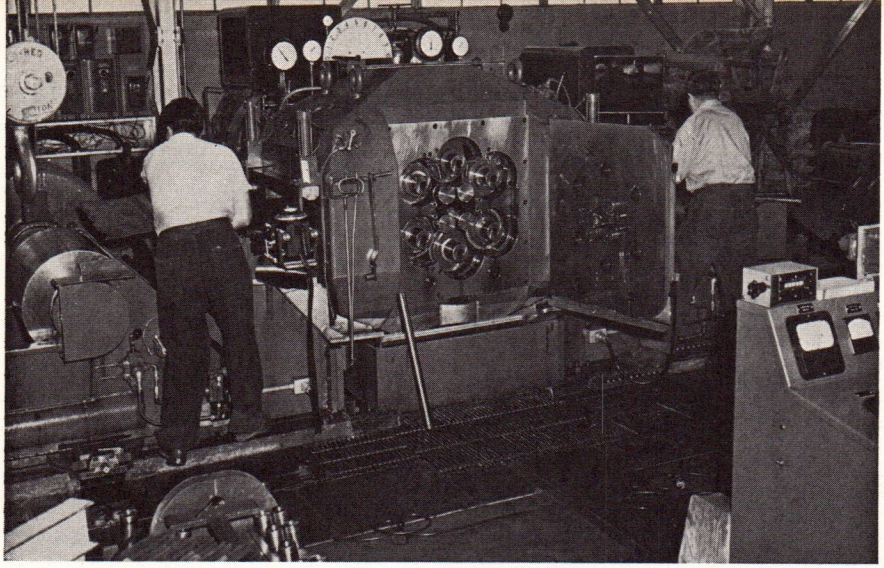

Photo courtesy of Rodney Metals, Inc.

Fig. 1. General view of typical Sendzimir mill with door of mill housing open to show the roll clusters. Note upper work roll leaning against mill

Regrinding Sendzimir Mill Work Rolls

. . . here are the ten basic rules and precautions to observe; also table of wheel recommendations

by Albert I. Palm*

THE Sendzimir mill or "cluster mill" as it is commonly called, is a unique type of cold strip mill in that it incorporates the use of very small work rolls ranging from ¼" to 3" diameter. The arrangement of the various rolls and bearings in the top and bottom roll clusters is clearly indicated in Fig. 2 on the next page.

It will be seen that the small work roll in each cluster is supported by two intermediate rolls and backed up by three second-intermediate rolls which are power driven; these, in turn, by four rows of antifriction bearing casters. As the work rolls are positively supported along their entire length, the rolled strip can be held to extremely close tolerances for gage. Moreover, because the area of contact

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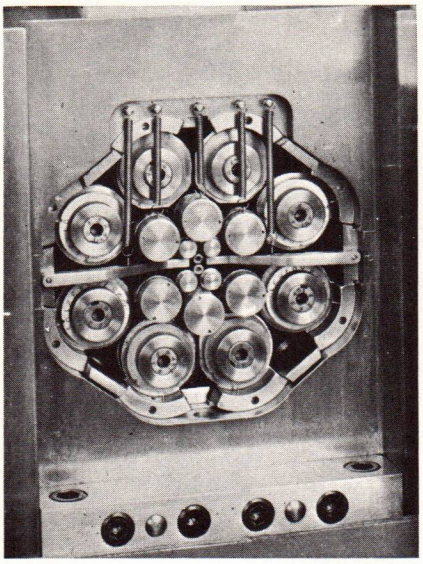

Fig. 2. Close-up of interior of small mill for rolling ultra-thin strip to .0005". Note pair of work rolls at very center

between the small diameter rolls and the strip is very small so that the strip is free to elongate, the Sendzimir mill is capable of reducing material as much as 30 per cent and more per pass on .010" down to .004" gage material and lighter.

The materials commonly handled by the Sendzimir cold strip mill include carbon and stainless steels, non-ferrous metals like brass, copper and aluminum alloys, and, more recently, tantalum.

Work Roll Sizes and Composition

Sendzimir mill work rolls vary from as small as ¼" diameter and 8" long for rolling ultra-thin steel strip to 3" diameter and 48" long. Some typical rolls used in actual installations measure 1½" diameter x 25" long for rolling stainless steel strip; ⅞" diameter x 17" long for rolling Inconel; 2" diameter x 40" long for aluminum alloys, and 2" diameter x 48" long for both low carbon and stainless steels.

The work roll material is generally either a high-speed steel or a high grade tool steel of the high-carbon, high-chromium or high-vanadium variety. Intermediate rolls are usually of the high-carbon, high-chromium type. Cemented carbide work rolls are being used to an increasing extent because of their extremely high productive capacity between regrinds.

Grinding Wheel Recommendations

The wheels used for regrinding Sendzimir mill work rolls will vary somewhat according to the size of the roll and the metal to be rolled which in turn determines the finish required on the roll. The table on next page, showing wheels actually employed on various sizes of work rolls for rolling different materials, may be used as a wheel selection guide.

Intermediate or back-up rolls, usually made of high-carbon, high-chromium steel, are generally reground with a 60 grit CRYSTOLON vitrified wheel such as 37C60-HVK. This wheel will give a good commercial finish which as a rule is considered satisfactory. If a finer finish is desired, a 180 grit wheel such as 37C180-G10V is recommended.

Grinding Hints

To obtain the best possible results in regrinding Sendzimir mill work

Material Rolled	*Work Roll Size (dia. x length) (inches) and Composition*	*Grinding Wheel (D x T x H) (inches)*	*Grinding Wheel Specifications*	*Number of Rolls Ground per 8-Hour Shift and Stock Removed*	*Type of Finish*	*Remarks*
Steel (silicon)	1½ x 27 HiC, HiCr tool steel	14 x 1½ x 5	37C180-H8V	13 rolls .0015″ per roll	Gray (7 rms)	Coolant: sal soda and water. Roll speed 70 rpm
Carbon Steels (as thin as .001″) Stainless Steel (as thin as .002″) Aluminum Alloys (as thin as .006″)	1⅞ x 26 HSS	24 x 2 x 12	37C220-G8B4* (sometimes followed by 37C320-I8E)	13 to 16 rolls .0015″ per roll	Bright (1½ rms)	Roll speed: 50 sfpm. Table traverse 1½′ per min.
High-Carbon Steel (razor blade stock)	⅞ x 18	12 x 1 x 5	37C220-G8B4 (if much stock to be removed, first rough grind with 37C100-JVK	11 rolls .0005″ average per roll	Bright (4 rms)	Wheel speed: 3,500 sfpm (low wheel speed is very important here)
High-Carbon and Stainless Steels	1½ x 27 HSS	26 x 2 x 12	37C120-G8V for rolling HiC Steel; followed by ALA-G7B levigated alumina wheel for stainless steel	13 rolls .0005″ per roll for 37C120-G8V wheel	Gray	Special operating data on ALA-G7B wheel available on request
Carbon Steels	1⅛ x 20 HiC, HiCr tool steel	14 x 1 x 5	39C60-IVK		Gray (10 to 15 rms)	
Aluminum Sheet and Foil	1⅞ x 36 HSS	14 x 1½ x 5	19A60-H8VG (37C320-J9E for a bright 3 rms finish)	.0005″ per roll	Satin (10 to 15 rms)	Wheel speed: 4,000 sfpm
Brass and Copper	2 x 26 HSS (HiV, Mo)	30 x 2 x 12	38A60-I6VBE	13 rolls .004″ per roll	Satin (10 to 15 rms)	Low roll speed of 50 rpm very important
Brass and Copper	2 x 30 HiCr, low V tool steel	14 x 1½ x 5	37C100-IVK for roughing 37C220-IE6 or 37C220-G8B4 for finishing	20 rolls using 37C220-IE6 only and removing .001″ per roll	Blue-black	Low roll speed of 50 rpm very important; also low wheel speed of 3,000 sfpm
Precious metals such as gold and silver for jewelry manufacture	.750 x 12 Moly HSS	22 x 2 x 12	A600-G9B4	28 rolls .001″ per roll	Bright (2 rms)	

*When used alone, this wheel is followed by a belt polishing operation, using a No. 240 grit coated abrasive belt for rolling aluminum strip, or a No. 400 grit belt for a mirror finish.

rolls, the following precautions should be observed:

1. Use a single-point, sharp diamond for truing and dressing.
2. The grinding wheel and sleeve assembly must be in good balance.
3. The grinding machine must be in the best possible condition and free from vibration.
4. Allow the grinding machine to warm up for at least a half hour before starting to grind. Do not attempt to grind while the machine is cold.
5. Use a relatively low wheel speed of 3,000 to 4,000 sfpm. Higher wheel speeds up to 6,500 sfpm are sometimes used with satisfactory results, but are more likely to cause chatter marks on the roll surface.
6. The coolant must be carefully filtered to exclude any foreign particles that could cause scratches. For the same reason, the inside of the wheel guard should be flushed periodically. Two coolant tanks may be desirable, one to be used for rough grinding and the other reserved exclusively for mirror finishing. With this dual tank arrangement, scratches on the roll surface that might be caused by dirty coolant are eliminated.
7. Do not attempt to grind long, slender rolls without steadyrests.
8. Rough grind when .001″ or more stock has to be removed. Leave less than .001″ stock for finish grinding.
9. Some operators apply a Prussian blue coating to the roll preliminary to finish grinding. The film-like coating is removed by taking the lightest possible cuts. This technique calls for skill and judgment on the part of the machine operator.
10. An ammeter on the wheel spindle drive motor is important when regrinding Sendzimir mill rolls in order to maintain a constant pressure between the wheel and the work and thereby insure dimensional accuracy throughout the length of the roll.

Work Rolls for Tantalum Sheet

These are in the smallest size category—¼″ to ½″ diameter and 6″ to 10″ long. They are refinished by the following lapping method to produce the extremely fine finishes and close dimensional tolerances required.

Two parallel copper rolls, one 4″ and the other 7″ in diameter, slightly separated, are rotated at different speeds. The work roll to be lapped is laid between them. Diamond lapping paste diluted with kerosene, linseed or olive oil is brushed on the copper rolls. By exerting pressure on the work roll, it gradually acquires an extremely high finish with very close dimensional tolerances.

Roll Calipering Devices

While the conventional method of manually calipering rolls with a micrometer is largely followed in the regrinding of Sendzimir mill rolls, ultra-precision electrical measuring instruments like the P. & W. Electrolimit

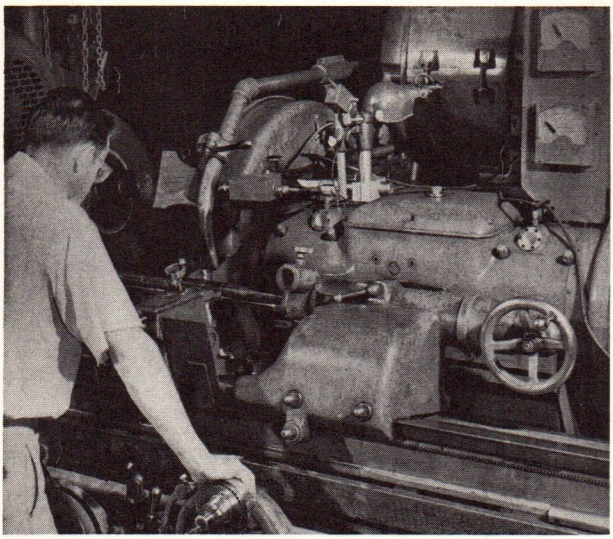

Fig. 3. Regrinding a carbide Sendzimir mill work roll with 1500 grit diamond wheel. Instrument at lower right is wheel load ammeter

Photo courtesy of Wallingford Steel Co.

gage and Dynamaster recorder which measure to millionths of an inch are coming into increased use.

Carbide Work Rolls

Sendzimir mill work rolls of cemented carbide, in spite of their initial high cost, are being used to an increasing extent because of the much greater tonnage that can be rolled between regrinds. They are reground with diamond wheels, generally 12″, 14″ and 24″ diameter by 1″ thick.

The following specifications for regrinding carbide work rolls are recommended, according to the operation and the finish required on the roll surface:

Finishing: D320-L100B (for rolling carbon steels to 5 to 6 rms)

Fine finish: D600-L100B (for rolling razor blade steel strip and carbon steels to 2 to 4 rms)

Ultra-fine finish: D1500-J25B (for rolling stainless steel strip with mirror finish to 1 rms)

Do not use wheels any finer than necessary to produce the finish required on the rolled material. Unnecessarily fine surfaces may cause trouble from roll slippage.

The following data taken from an actual carbide roll grinding job will indicate the procedure followed. The rolls in this case were 3″ diameter x

Operation	*Wheel Speed*	*Roll (3″ dia.) Speed*	*Table Traverse*	*Grinding Pressure*
Rough Grind	4,000 sfpm	100 rpm	60 in./min.	18 to 23 amperes
Finish Grind	4,000 sfpm	100 rpm	Slowest available	Lightest possible

10″ long. The data would apply to any of the previously recommended fine grit sizes of diamond wheels.

Grinding Hints

Clear water is used as a coolant; any soluble oil in the water would cause the wheel face to smear and stop cutting completely. The presence of any chlorine in the water should be noted and steps taken to counteract its pitting action on the carbide roll by adding wood alcohol to the coolant.

A wheel load ammeter, and also a wheel speed tachometer (on D.C. wheel drive), is considered indispensable when using very fine grit diamond wheels to produce mirror finishes in roll grinding. By using this technique of grinding "by instruments" the operator has precise and sensitive control over the action of the grinding wheel at all times.

Figure 3 shows a carbide work roll for a Sendzimir mill being reground. Note the steadyrest used to support the slender roll and the wheel load ammeter (lower right) by which the operator controls the grinding pressure.

The diamond wheel and sleeve assembly must be dynamically balanced, and the wheel must run in almost perfect truth. To prevent feed lines on the roll surface, the work centers must not be scored and the table must move absolutely parallel to the wheel face. Finally, the corners of the wheel face should be rounded slightly.

Very light increments of wheel feed must be taken, as otherwise deep burns may be produced in the roll which would be very difficult to remove.

The rate of production possible in regrinding carbide Sendzimir mill work rolls with diamond wheels is indicated by the report from an Eastern plant where rolls 2″ diameter x 30″ long are ground at the rate of seven rolls per eight-hour shift, using a 1500 grit diamond wheel.

Ring Lapping with Diamond Paste

When thus regrinding carbide rolls that are to be used for rolling stainless steel strip, minute feed lines and traces of chatter marks may show up. To completely eliminate these flaws, however slight, it may be necessary to resort to ring lapping with diamond paste.

This procedure calls for the use of a cast iron circular lap which is made to just fit over the roll. In use, the lap is traversed manually back and forth across the roll with diamond paste for the cutting medium. A relatively coarse size paste such as No. 24 is used for roughing, and a finer size paste, No. 8, for finishing.

The lap must never be allowed to stop on the roll as otherwise the diamond particles may dig in and leave scratches which will be difficult to remove. As compared with grinding, this hand lapping operation is very slow and may take as long as four hours to produce the final 1 rms finish on a 2″ diameter x 30″ long carbide roll. END