COILBOX TECHNOLOGY

Contribution to energy saving and
economical design of hot strip mills

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Abstract:

A fundamental problem of hot rolling is the loss of temperature of the transfer bar as it waits to be rolled in the finishing stands. The Coilbox holds this transfer bar in coil form and presents the tail of the bar to the finishing stands. As a result, temperature rundown can be significantly reduced. With a Coilbox - Hot Strip Mill, increased slab and coil size can be rolled without necessarily requiring extra mill length and increased horsepower for acceleration and high speed rolling. Skid marks tend to soak out. With the use of the coilbox the installed power for the main drives of the finishing train can be reduced by 20 - 30 % and the energy consumption by 5 - 12 % (depending on strip gauge).

Introduction

One of the fundamental problems in hot strip rolling is the temperature drop experienced throughout the transfer bar during the 60 - 90 seconds of rolling through the finishing train. In the hot strip mills built prior to 1960, this problem limited the size of slab and coil (weight per unit width) which could be rolled. In the early 1960's a new generation of hot strip mills known as Generation II were developed which largely overcame this problem by accelerating the finishing train from a thread speed of approximately 9 m/s up to speeds of 15 m/s to 20 m/s. This acceleration and operation at higher speeds resulted in almost doubling the horsepower of finishing stands as well as considerably lengthening the total mill.

Since the Coilbox coils the transfer bar to conserve tail end temperature, the need to accelerate the mill to high speeds is eliminated when temperature rundown is a consideration. It is therefore possible to reduce the finishing train horsepower and the length of the mill delay table. In addition, the runout table length can be reduced because of lower finishing speeds.

This new system of rolling large slabs and coils resulting in a different mill design and operating practise has been termed Generation III.

The coilbox concept was developed by STELCO - Canada and following a full size prototype device installed in the 56 in. mill of STELCO at Hamilton, for the 80 in. mill of JOHN LYSAGHT at Westernport - Australia the first industrial coilbox was built and is working successfully since 1978 (Fig. 1). At present there are under construction three coilboxes in Canada (STELCO-Hamilton, STELCO-Nanticoke, ALGOMA-Sault St. Marie), three coilboxes in Europe (DOMNARVET/Sweden, WUPPERMANN/F.R. Germany, KRUPP/F.R. Germany), and other steel companies are contemplating the introduction of this device in their hot strip mills.

(1) Operation and Description of the Coilbox

The Coilbox is located ahead of the crop shear and consists of entry side guides, three bending rolls, two cradle rolls, a coil positioning roll, a peeler, and a transfer mechanism. These are shown on Fig. 2.

The head end feeds through the bending rolls which form the coil after which it is built up on the Cradle Rolls (Fig. 3). When the tail passes the entry hot metal detector (HMD), the drives are designed to automatically stop and position the tail ready for peeling.

The peeler is designed to descend automatically to flatten the tail end of the coil on the table after which the cradle rolls are reversed and feed the tail of the bar to the crop shear and finishing stands (Figs. 4, 5, 6). It should be noted that the tail of the bar from the rougher has now become the new head end to the finishing mill. This turn around combined with the natural heat retention of the bar in coil form results in significant reduction of temperature rundown into the finishing mill.

After entry to the mill the coil can be automatically transferred to the adjacent uncoiling station and the Coilbox is now ready to receive the next transfer bar. The sequence of events is designed to be automated and can readily be supervised by an existing operator.

It is possible to change from Coilbox to conventional rolling by passing the bar under the bending rolls.

(2) Operating and Engineering Effects of the Coilbox

Mill Entry Temperature

Fig. 8 shows the temperature rundown of a 23 mm transfer bar while feeding into Stelco's 56" Finishing Mill.
Fig. 7 shows a similar transfer bar which was first coiled in the Coilbox and then fed into the Finishing Mill. Temperature rundown varies with the transfer bar thickness, the finishing speed and the product grade and gauge being rolled.

In Stelco's 56" Hot Strip Mill temperature rundown varies from 20°C to 90°C on conventional rolling. With the Coilbox in operation these temperature rundowns were either eliminated or in some cases resulted in a small rise in temperature of 10°C to 20°C with the mill operating at constant speed with no acceleration.

Reduced Horsepower

Since Finishing Mill entry temperatures are virtually constant the mill is not accelerated to higher speeds as it would be for the cooler tail of a conventional transfer bar. Horsepower is therefore reduced because it is proportional to speed and because there is no large temperature difference at the tail end of the bar. Power reductions up to 40 % are predicted through the increased tail end temperature and elimination of acceleration to higher speeds.

Reduced Mill Length

In a new mill, total mill length is reduced through a shorter delay table between the rougher and the finishing stands, and a shorter runout table from the last finishing stand to the downcoiler. The delay table is shortened by allowing the transfer bar to be coiled in the Coilbox while still being rolled in the rougher. The spacing between the rougher and the Coilbox is based on the length of the bar on its third to last roughing pass instead of on its final transfer bar length.

The runout cooling table length is a function of the time the product remains on the cooling table before being coiled. The slower top speed of a Generation III mill provides more time for cooling and hence a shorter runout table and less cooling headers can be used.

Yield

The use of large PIW slabs results in less crop ends at the crop shear (per ton of steel produced) and less head and tail crop losses in the cold mill operations.

There is an expected reduction in yield loss due to kick-overs. In conventional mills, any cobbles in the finishing stands or downcoilers usually result in the loss of both the cobbled bar and the one following it. However, when rolling with the Coilbox the bar following the cobble could complete its cycle in the roughing mill and be coiled and held in the Coilbox. In cases where the cobble is cleared quickly, the next coil could be rolled instead of being kicked over as in the conventional mill.

Increased Slab Size

New hot strip mills can be designed to roll large PIW coils at less capital cost than required for a conventional mill design. Extra mill length and finishing stand horsepowers are not required in designing such a conventional mill.

In the case of a revamp, increased PIW can be accomplished without the need to repower the finishing stands and the re-locating of roughing stands. In many cases, of course, both the downcoilers and the furnaces will have to be modified or rebuilt to accommodate the increased PIW. The merit of increasing PIW is obvious because of the reduced yield losses in the hot strip mill, pickle lines and other cold mill operations.

Conventional mills require sophisticated automatic gauge control to compensate for skid marks caused by the reheating furnace and temperature rundown in the transfer bar.

However, with Generation III the skid marks tend to be soaked out of the transfer bar while it is in coil form, and there is little or no temperature rundown.

In the case of companies selling hot strip mill products on the basis of theoretical minimum weight, yield improvements in the reduction of "give away steel" may be possible.

Increased Product Range

During the Stelco Coilbox trials, the conservation of tail end temperature alone reduced the peak power drawn by the finishing stands up to 13 % for some products. This peak power is available for increases in product width or thinner gauges for a given width and grade. In the case of the Generation III mill, the extra power normally required in the finisher to zoom can be translated into rolling of wider strip or higher strength grades at thinner gauges. The reason for this is that horsepower is proportional to speed and therefore if you can roll the complete coil at 10 m/s instead of accelerating the tail up to 16.5 m/s then for this reason alone there is approximately 40 % horsepower available for increased product range.

Productivity

By designing a Coilbox such that one coil can be rolled in the finishing stands while the second coil is being coiled in the Coilbox, no production bottleneck is caused by the Coilbox. For most gauges the average rolling speed with a Generation III Mill practice is equivalent to the average speed of a conventional rolling practice. In the case of light gauges (less than approx. 2 mm) there will be a slight drop in production rate if no mill acceleration is used.

In the case of the installation of the Coilbox in an existing hot strip mill an increase in productivity is projected. This increase is expected in the Rougher and the Finishing stands. Where the reversing rougher is a bottleneck due to both rolling time and motor RMS horsepower limitations, the transfer bar thickness can be increased in order to improve the productivity in this area. This increase in slab thickness does not affect the loading on the finishing stands because of the temperature conservation of the transfer bar.

Where the finishing train is a bottleneck due to horsepower limitations, the transfer bar thickness can be reduced thus reducing the load on the finishing mills allowing higher speed.

Production increases can be achieved in the furnaces because of better slab thickness profile because more products can be rolled from full size slabs. A mix of slab thicknesses in the furnace reduces the push rate to that of the thickest slab thus reducing productivity when thinner slabs are in the mix.

Increased production can also be achieved by an increased slab size (PIW) giving better mill utilization because of reduced gap time per ton of steel rolled.

Metallurgical

The rolling of the product with a horizontal temperature control and constant speed gives more uniform metallurgical properties from head to tail. The Stelco 56" mill Coilbox trials concluded that there were no adverse effects on Stelco's strip quality.

(3) Actual results at the 56 " - STELCO Hot Strip Mill

PRODUCT kg/mm = 10.2
Coil width = 970 mm
Fin. Gauge = 1.9 mm

ROLLING PRACTICE:

STAND NO.	SPEED m/s	THICKNESS IN (mm)	OUT (mm)	% RED.	kW	OVER-LOAD
F1	1.3	29.2	14.6	49.8	2120	.81
F2	2.3	14.6	8.4	42.8	2211	.85
F3	2.8	8.4	5.1	38.8	3211	1.25
F4	5.3	5.1	3.6	29.2	2405	.92
F5	7.7	3.6	2.5	30.0	1734	.67
F6	10.2	2.5	1.9	25.0	1176	.45

RESULTS: Transfer Bar Thickness (mm) = 29.2
Finishing Speed (m/s) = 10.2
Tonnes/hr. 100 % eff. = 361

CONVENTIONAL ROLLING RESULTS:
Transfer Bar Thickness (mm) = 22.8
Finishing Speed (m/s) = 7.8/9.4
Tonnes/hr. 100 % eff. = 306

PRODUCT: kg/mm = 8.2
Coil Width = 1268 mm
Fin. Gauge = 2.7 mm

ROLLING PRACTICE:

STAND NO.	SPEED m/s	THICKNESS IN (mm)	OUT (mm)	% RED.	kW	OVER-LOAD
F1	1.4	27.9	15.8	43.2	3034	1.16
F2	2.1	15.8	10.0	37.1	3094	1.18
F3	3.2	10.0	6.7	32.5	2975	1.14
F4	4.5	6.7	4.9	27.5	2975	1.14
F5	6.2	4.9	3.5	28.1	2618	1.00
F6	8.2	3.5	2.7	23.9	1547	0.59

RESULTS: Transfer Bar Thickness (mm) = 27.9
Finishing Speed (m/s) = 8.2
Tonnes/hr. 100 % eff. = 538

CONVENTIONAL ROLLING RESULTS:
Transfer Bar Thickness (mm) = 22.8
Finishing Speed (m/s) = 7.4
Tonnes/hr. 100 % eff. = 474

PRODUCT: kg/mm = 10.2
Coil Width = 932 mm
Fin. Gauge = 2.8

ROLLING PRACTICE:

STAND NO.	SPEED m/s	THICKNESS IN (mm)	OUT (mm)	% RED.	kW	OVER-LOAD
F1	1.46	27.1	16.5	39.4	3264	1.25
F2	2.46	16.5	9.8	40.6	2872	1.10
F3	8.96	9.8	6.6	32.4	3002	1.15
F4	5.04	6.6	4.8	27.7	3002	1.15
F5	6.63	4.8	3.6	23.9	1305	0.50
F6	8.62	3.6	2.8	23.0	1566	0.60

RESULTS: Transfer Bar Thickness (mm) = 27.1
Finishing Speed (m/s) = 8.62
Tonnes/hr. 100 % eff. = 391

CONVENTIONAL ROLLING RESULTS:
Transfer Bar Thickness (mm) = 24.1
Finishing Speed (m/s) = 7.5
Tonnes/hr. 100 % eff. = 346

PRODUCT: kg/mm = 8.3
Coil Width = 1237 mm
Fin. Gauge = 3.3 mm

ROLLING PRACTICE:

STAND NO.	SPEED m/s	THICKNESS IN (mm)	OUT (mm)	% RED.	kW	OVER-LOAD
F1	1.3	30.5	18.4	39.7	2879	1.10
F2	2.0	18.4	11.6	26.6	3224	1.23
F3	3.0	11.6	7.8	32.4	2879	1.10
F4	4.1	7.8	5.7	26.5	2721	1.03
F5	5.5	5.7	4.4	24.2	1842	.70
F6	7.2	4.4	3.3	24.4	1778	.66

RESULTS: Transfer Bar Thickness (mm) = 30.5
Finishing Speed (m/s) = 7.2
Tonnes/hr. 100 % eff. = 533

CONVENTIONAL ROLLING RESULTS:
Transfer Bar Thickness (mm) = 22.8
Finishing Speed (m/s) = 6.8
Tonnes/hr. 100 % eff. = 455

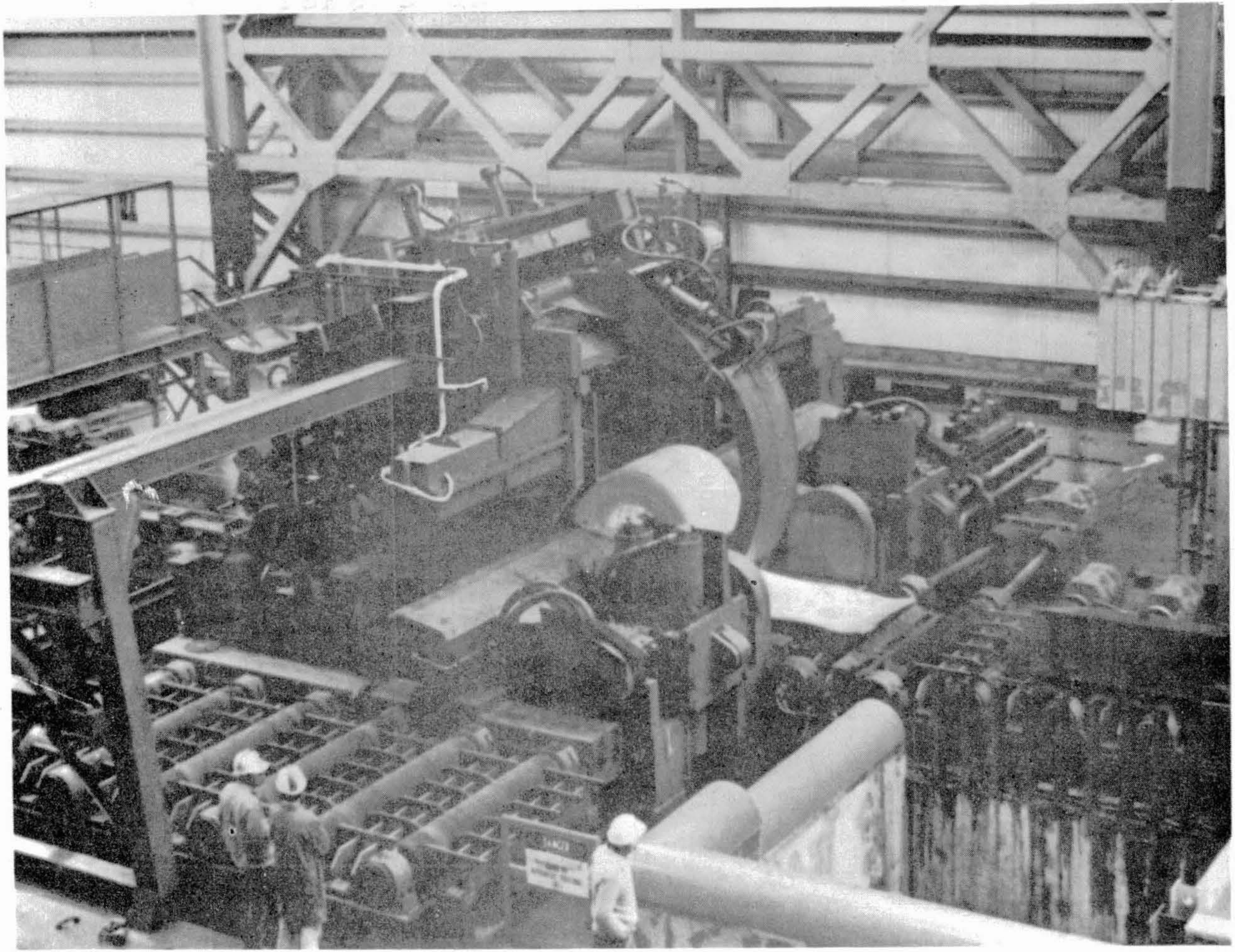


Fig. 1 Coilbox in operation at
John Lysaght/Australia

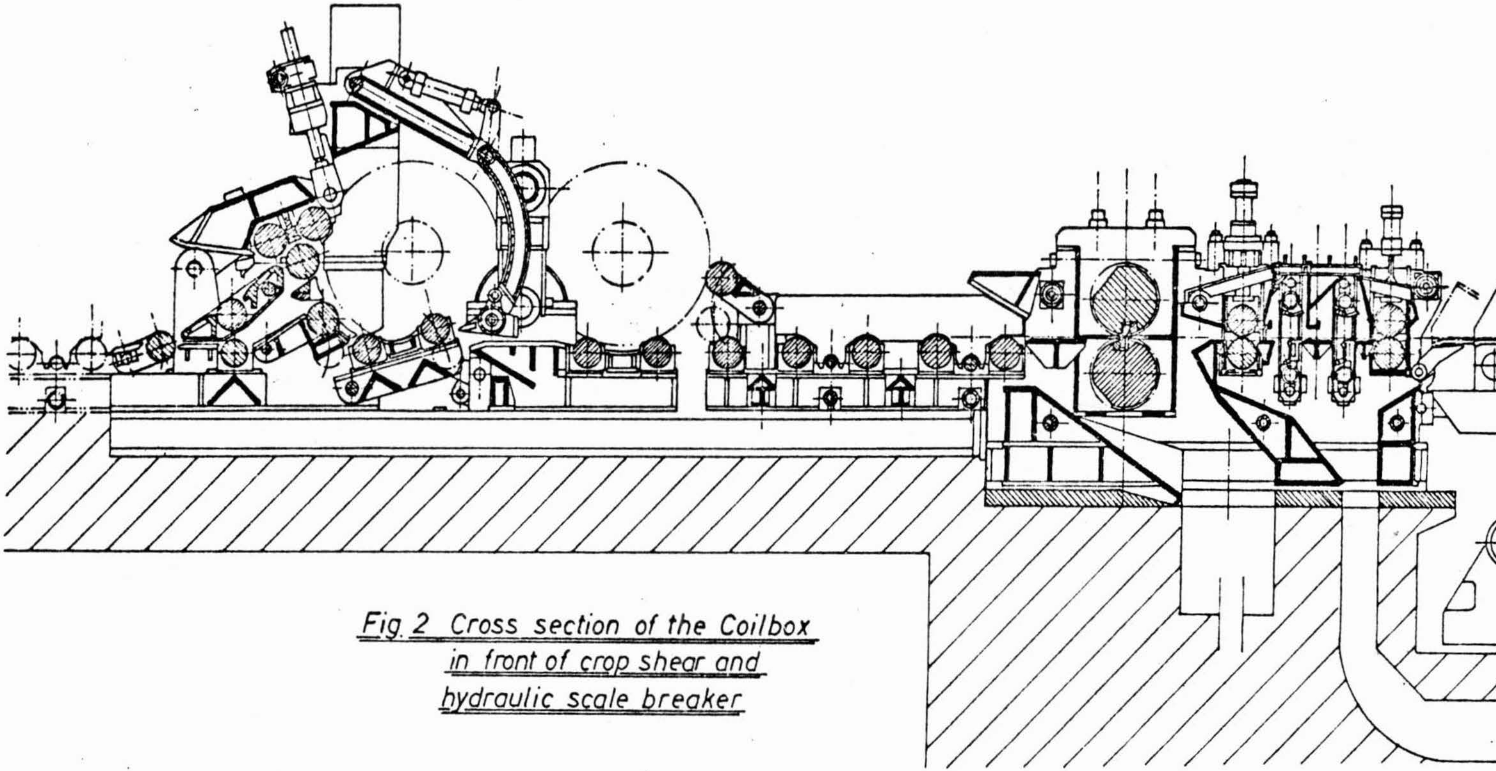


Fig. 2 Cross section of the Coilbox in front of crop shear and hydraulic scale breaker

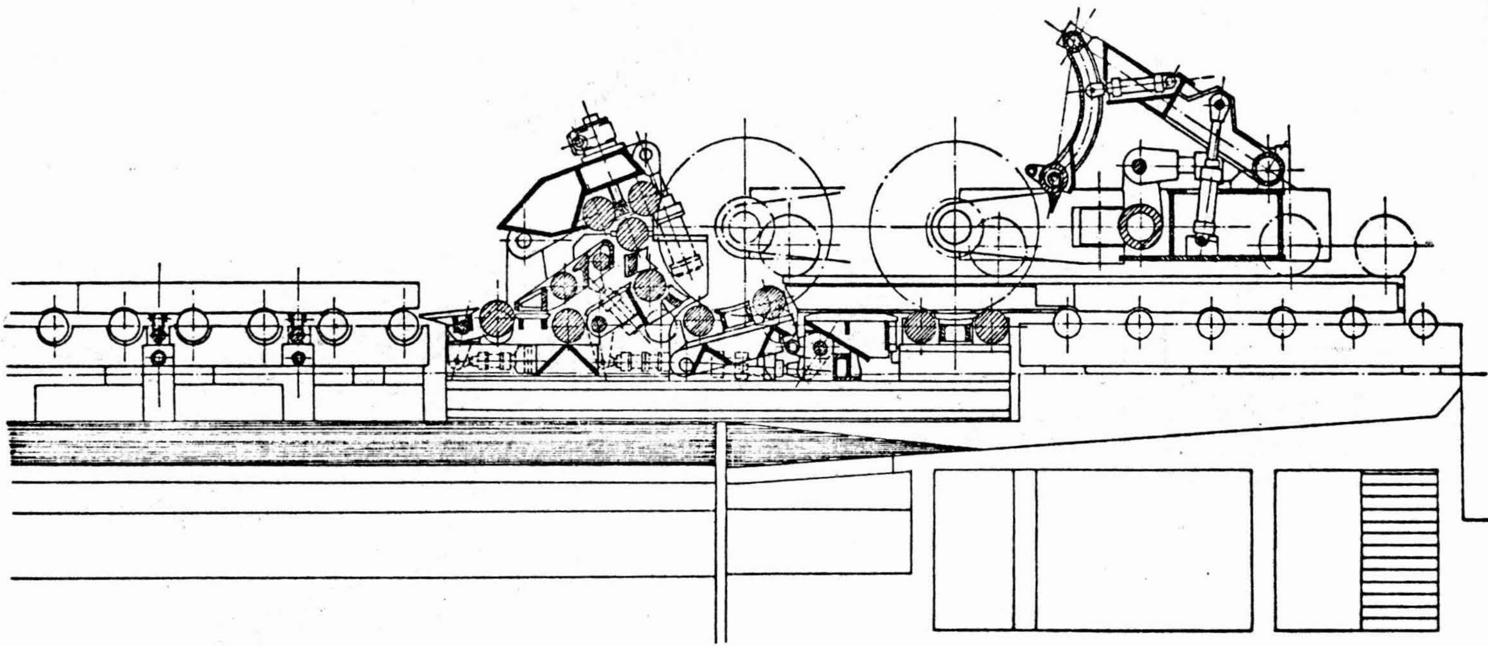


Fig. 3 Cross section of the Coilbox

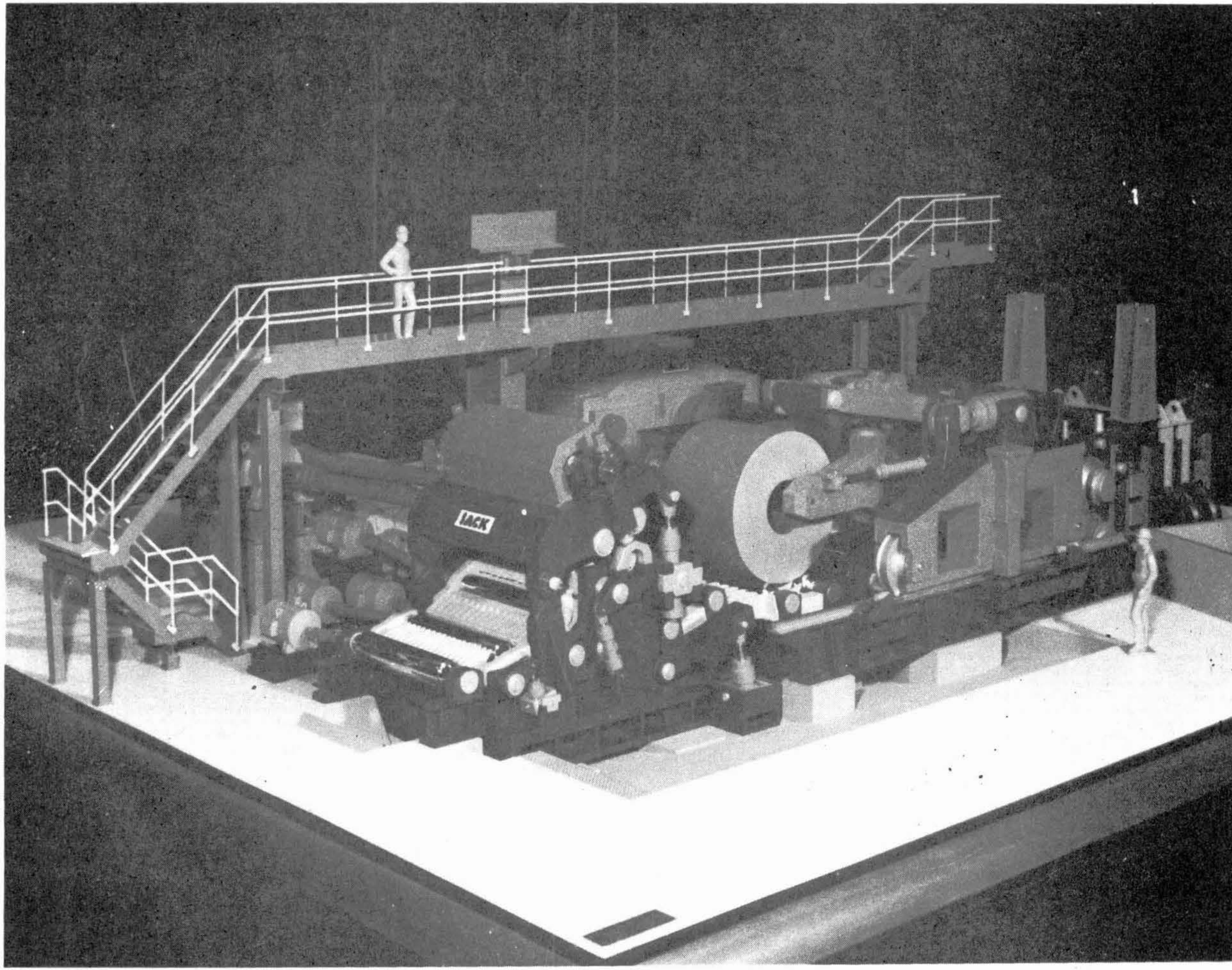


Fig. 4 Model of Coilbox arrangement
with coil transfer car

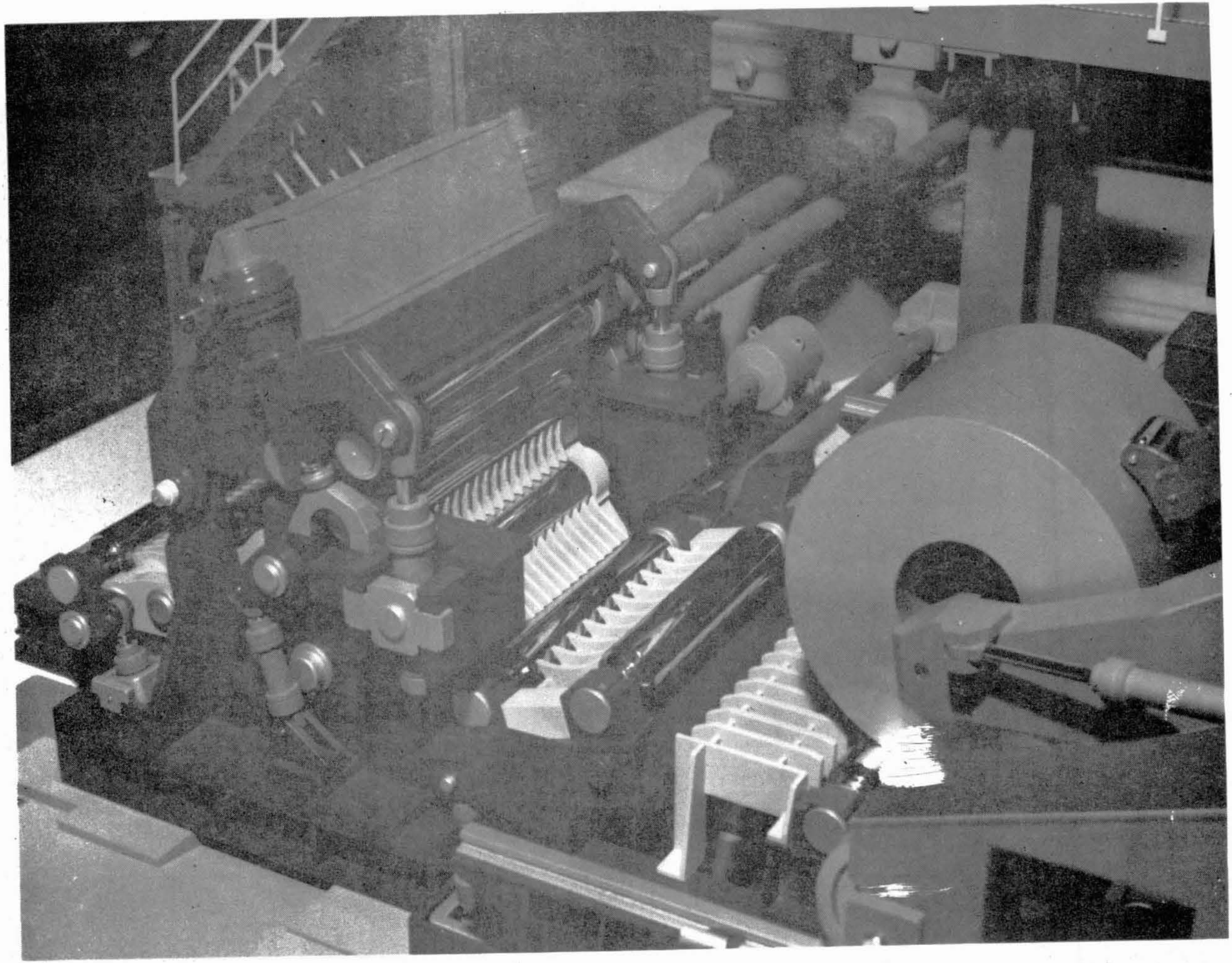


Fig. 5 Model of Coilbox
bending roll arrangement

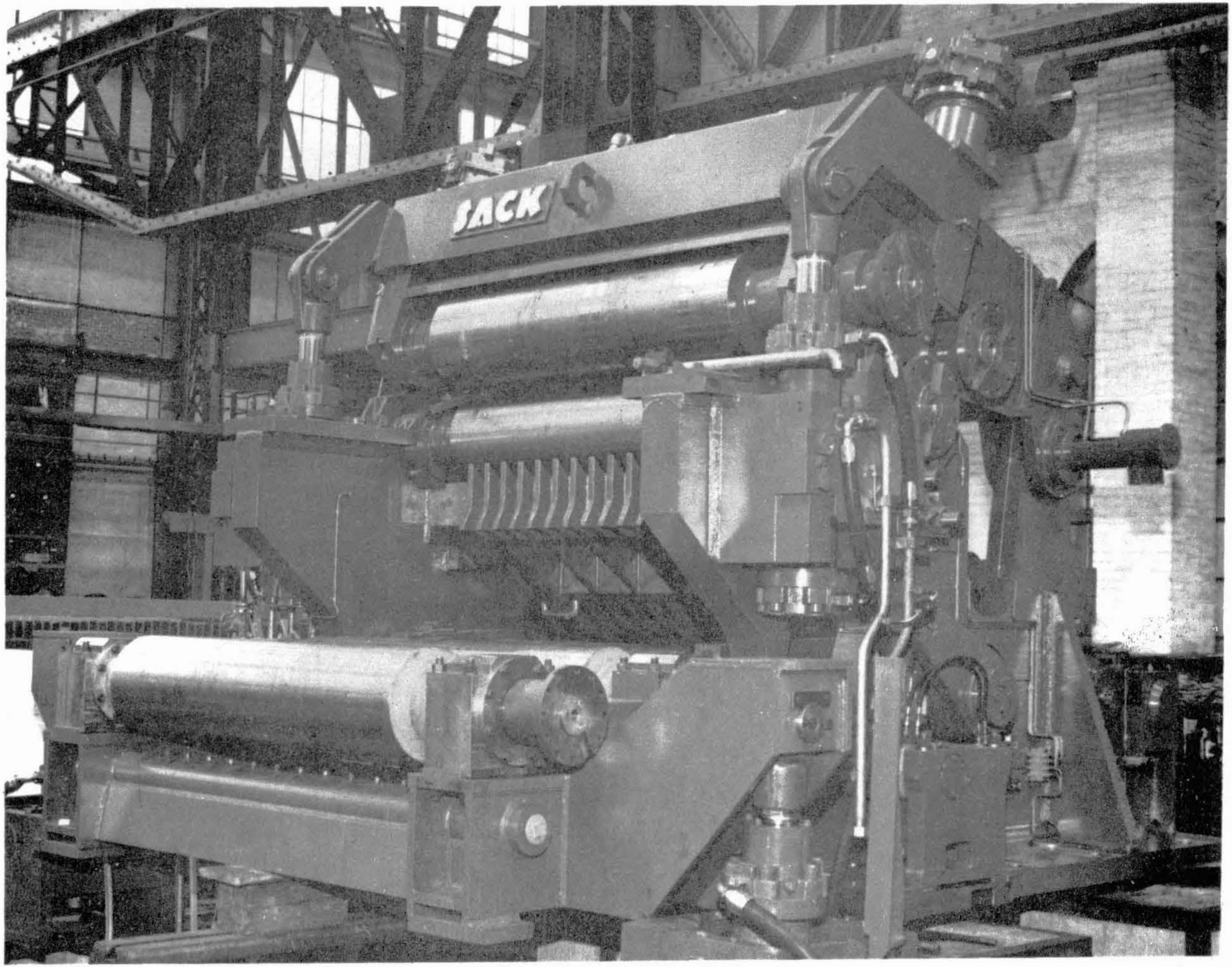
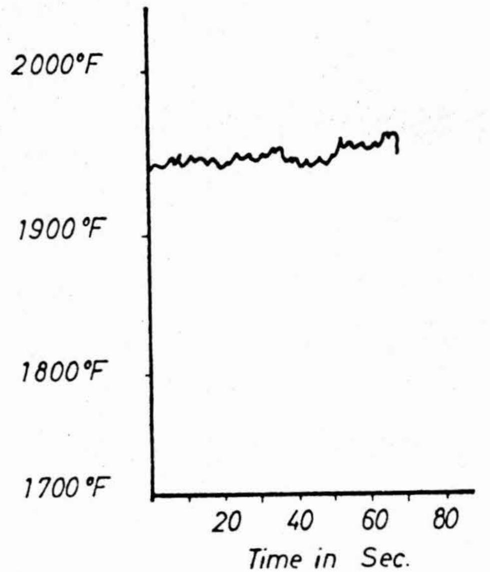
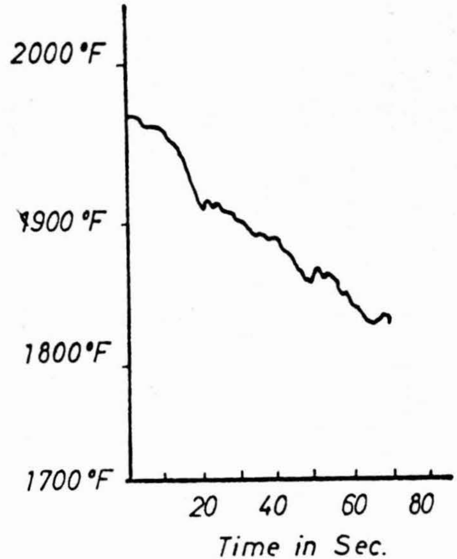


Fig. 6 Work shop assembly of the Coilbox
bending roll arrangement



Mill Entry Temperature of Transfer Bar with Coilbox

Fig. 7



Mill Entry Temperature of Transfer Bar - Conventional Rolling.

Fig. 8