EQUIPMENT FOR DECOILING AND STRAIGHTENING COIL STOCK

Stock decoilers, straighteners, feeders, part handling as well as scrap removal systems are known as press auxiliary equipment. Other examples of auxiliary equipment may include robots and dedicated die change carts. Like any pressworking equipment subject to movement, appropriate safeguarding measures are required to prevent injury to personnel.

There is a variety of commercially available coil handling, decoiling, straightening, and feeding equipment used in coil-fed die operations. The equipment, available from many manufacturers, can be used interchangeably in a variety of configurations.

In some cases, the entire system is delivered as a turnkey package by the press builder or equipment supplier. However, it is very common to find a mixture of used equipment working as an integrated system. Cost conscious stampers often retrofit older equipment with modern drive systems and controls at a fraction of the cost of new machinery.

Figure 1. Coil line consisting of a nonpowered reel, powered stock straightener, roll feeder, press and scrap chopper. Cooper Weymouth Peterson

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Example of Coil Feeding Auxiliary Equipment

Figure 1 shows the essential equipment of a double crankshaft driven roll feeder; powered stock straighter and non-powered decoiler, together with the stamping press fed by the equipment. The external scrap chopper is also considered auxiliary equipment. External choppers are seldom used. Cutting scrap into easily handled pieces is normally incorporated in the die. However, in this case a double roll feeder is used for close control of the strip movement through a progressive die in the press. Safety guarding and necessary electrical controls are not shown.

Decoiling Systems

The stock must be decoiled (unwound) from the stock reel in a smooth manner. Uneven stop-go operation may cause kinks in the stock that can result in variations in the parts being produced. Both power and non-power driven systems are used.

Powered Decoilers and Stock Straighteners

Figure 2. Powered decoilers and stock straighteners feeding several precision progressive die operations. P/A Industries
The Advantages of Non-Powered Decoilers
Non-power driven systems have the advantage of simplicity and low cost. They are only recommended for light-duty applications. Smooth operation is very important. A mechanical drag brake may be used to prevent excessive stock being fed out. In the example illustrated in Figure 1, a non-powered decoiler is used. Should the use of a non-powered decoiler result in kinked stock, or an overload of the pulling capacity of the stock straightener or feeder, a powered decoiler is needed.

Simple Powered Decoilers
Powered systems should incorporate controls to insure smooth decoiling action. Powered systems that use on and off motor controllers have the advantage of simplicity and low cost. However, these systems may pay out too much stock. The result may be that the stock will contact the floor and become contaminated. Kinked material may also result. The inertia of the driving motor armature, the stock reel and stock will feed out stock after the decoiler stop signal shuts off power to the motor.

Operator Loading Coil into Powered Cradle Decoiler

Figure 3. An operator changing a coil in a simple powered coil cradle with an overhead crane. Note that a spare coil is at the decoiler. W. C. McCurdy Company
On/off or discrete control systems may be satisfactory if simplicity and low cost of the decoiler control system are important factors. Generally, they are adequate for strip payoff where a start stop action does not kink the stock.

**Variable Speed Decoiler Drives and Proportional Controllers**

Many modern press decoiling and straightening systems incorporate variable speed drive motors. Usually, either variable speed DC drive motors or variable frequency AC induction motors are used.

Avoiding abrupt stop/go motion is highly beneficial in smooth even payout and straightening of the material. Figure 2 shows powered decoilers and stock straighteners feeding several precision progressive die operations. In applications of this type, it is important to maintain the stock loop between the straightener and press roll feeder with the correct amount of material to insure smooth feeding.

### End of Coil Shut off Device

![End of Coil Shut off Device](image)

**Figure 4.** A simple end of coil shut off device fabricated by the diesetters at an innovative contract stamping shop. When the coil runs out, the counterweighted finger pivots upward making contact with a spring that insinuated from the machine frame. This sends an electrical signal to stop the press. *W. C. McCurdy Company*

**Quick Coil Change**
A rapid means to band and remove a partial coil of stock left over from the job being removed is an important feature. Time is saved if the new coil is pre-staged at the decoiler as shown in Figure 3. It is important to have the next coil ready. During many production runs, quick coil changes can save more time than quick die change.

Cradle type decoilers may be mounted on a movable track to center different widths of stock on the press centerline. Here, markings of the correct settings should be provided to avoid trial and error adjustment.

**End of Coil Shutoff Device Signaling the Coil Ran Out**

![End of Coil Shutoff Device Signaling the Coil Ran Out](image)

*Figure 5.* The end of coil shutoff device shown in Figure 4 after the coil runs out. The counterweighted finger contacts the spring sending an electrical signal to stop the press.

*W. C. McCurdy Company*

**End of Coil Shutoff**

Many coil fed operations utilize die sensors to detect misfeed and part ejection problems. This permits one operator to tend several presses. As the end of coil is approached, it is a good idea to alert the operator, and in some cases stop the press.
Having the operator present to observe the end portion of the coil being run into the die is to prevent part defects and die damage. Often the end of the coil has defects that require it to be scrapped. For example, the tail end of the coil may have kinks known as coil breaks. Some coil end damage may occur when the strip is started on the winding arbor at the steel mill or processor’s plant.

Figure 4 shows a simple end of coil detector fabricated by the diesetters at an innovative contract stamping shop. When the coil runs out, the counterweighted finger pivots upward making contact with a spring that insinuated from the machine frame. This sends an electrical signal to stop the press. Figure 5 illustrates the end of coil shutoff device shown in Figure 4 after the coil runs out. The counterweighted finger contacts the spring sending an electrical signal to stop the press.

**Double Spindle Decoilers**
Decoilers having double arbors permit a new coil to be loaded while production continues is a good way to improve up time. The decoiler base rotates 180 degrees. This permits a new coil to be loaded or an old coil removed while production runs.

**A Double Spindle Decoiler That Pivots 180°**

![A double spindle decoiler. The decoiler pivots 180 degrees. This permits a new coil to be loaded while the press is running out the coil on the opposite side of the decoiler. *R. Olsen Company*](image)

*Figure 6.* A double spindle decoiler. The decoiler pivots 180 degrees. This permits a new coil to be loaded while the press is running out the coil on the opposite side of the decoiler. *R. Olsen Company*
An added feature of the decoiler shown in Figure 6 is a coil-loading car. This is shown in Figure 7 together with another coil ready to be loaded onto the car. Note the new coils are covered with protective paper to avoid corrosion while in transit and storage.

**Shoes or Inserts for Expanding Arbors**
Decoilers having expanding arbors may require shoes or inserts to accommodate widely differing coil inner diameters. All changeover parts and needed tools should be ready as part of the pre-staging or external dieset activity.

**A Coil Loading Car to Place the New Coil on the Arbor**

![A Coil Loading Car to Place the New Coil on the Arbor](image)

_Figure 7._ A coil loading car or carrier which moves on a track to place the new coil on the arbor of the decoiler shown in Figure 6. The carrier platform pivots 90 degrees to the left to place the coil on the decoiler arbor. A second coil pallet is on the floor ready to be loaded onto the carrier with a fork lift truck. _R. Olsen Company_

**Horizontal Decoilers for Multiple Coils of Palletized Stock**
Figure 8 illustrates a horizontal decoiler for multiple coils of palletized stock. The decoiler table rotates under automatic control to supply stock at the correct rate. Horizontal decoilers of the type shown in Figure 8 are especially well suited to relatively light coils of narrow material. The roller arm serves to lift the stock toward the straightener or press feeder and actuates the motorized rotating table to pay out the stock at the correct rate.
A Horizontal Decoiler for Coils of Palletized Stock

Figure 8. A horizontal decoiler for multiple coils of palletized stock. The decoiler table rotates under automatic control to supply stock as needed. P/A Industries

Horizontal decoilers find widespread application in medium to high-speed progressive die work. The same pallet on which the stock was shipped is usually placed directly on the center of the table with a fork truck. This greatly simplifies coiled stock handling. The likelihood of damage to the coiled stock is also minimized.
Stock Straighteners

When the stock is unwound from the coil, a normal curvature or coil-set often remains. It insures smooth feeding, and to reduce product variation, coil set and minor material flatness problems are usually removed by a stock straightener. This is done by subjecting the stock to a series of up and down bends as it passes through a series of rollers. The bending action must exceed the yield point of the stock as the outer fibers of the metal are alternately stretched and compressed.

Figure 9. A simple example of how a powered stock straightener functions. The first pair of powered rolls feeds the stock into a series of seven straightening rollers. A second set of powered rollers operating in synchronism with the first set acts to pull the stock evenly through the straightener. Smith & Associates

Figure 9 illustrates the principle of operation of a powered stock straightener. Depending upon the application, a greater number of straightening rollers may be used, e.g. nine, eleven or seventeen.

For normal operation, the straightening rollers on the entry end of the machine are set to bend the stock more severely than those on the exit end. When correctly adjusted, the stock will exit the machine with an equal amount of residual stress on both sides of the neutral axis and be very straight.

Other Stock Leveling Methods
Stock straighteners incorporating simple leveling rolls can do little to correct problems such as stock camber material and crowning. Specialized leveling equipment incorporating adjustable back-up rolls is required for such applications.
Precision Roll Straightner with Dial Indicators

Figure 10. A precision roll straightner. Dial indicators are used to set the exact depth of engagement of the upper and lower leveling rolls on each end of the straightner. This permits precise adjustment and accurate repeatability of previous settings based on job setup records. *P/A Industries*

**Tension Leveling at the Steel Mill or Supplier**

One method used to correct a lack of flatness by steel mills and coiled material suppliers is *tension leveling*. In this process, the material is decoiled and recoiled under tension. A slight elongation occurs.

Typically the elongation is under 0.5% to no more than 2%. If excessive stretching occurs, the yield point is increased and the amount of available elongation reduced. This can reduce the formability of the material which can cause fractures if the material is used for severe forming and deep drawing applications.

**Quick Setup Considerations for Roll Straighteners**

Rapid adjustment of the stock straightener roll depth settings to the correct values is another way to reduce setup time. The adjusting mechanisms should have built in position scales, turn counters or position transducers to permit presetting the straightener to values that are known to be correct based on the history of previous runs of the job.
Figure 10 illustrates a precision roll straightener having dial indicators used to set the exact depth of engagement of the upper and lower leveling rolls on each end of the straightener. This permits precise adjustment and accurate repeatability.

Two Position Transducers for Remote Readout

![Two Position Transducers for Remote Readout](image)

Figure 11. Two linear position transducers mounted on a roll straightener. This arrangement permits remote readout and setting of the roll engagement by means of power driven adjustment motors. R. Olson Company

The settings can be made automatically from a computerized data file kept at the press or in the pressroom in a file cabinet for ready reference. An increasingly popular way to automatically accomplish many pressworking setup parameters is with computer integrated manufacturing. ³

Figure 11 shows two linear position transducers mounted on a roll straightener. This arrangement permits remote readout of the roll engagement. In this case, power driven adjustment and computerized control permit automatic adjustment by entering the data from a computer.

Roll Straightner with Hydraulic Actuated Crop Shear

Figure 12. View of the output end of the roll straightner shown in Figure 11. Note the hydraulically actuated crop shear, which is used to cut off the coil. R. Olson Company

Crop Shears
Crop or cropping shears are often installed on coil fed pressworking equipment to permit cutting off the coil and removing it if desired. They can be installed in several places that include:

1. At the decoiler, especially in the case of coil fed operations that are intended to handle very wide or heavy stock.

2. On the roll straightner as shown in Figure 12.

3. Some clever progressive die designs incorporate a cutoff knife engaged by a gag bar in the first station of the die. This takes advantage of the tonnage of the press and minimizes material waste should the coil need to be removed.

Computer Integration of Pressworking Processes is Not Always Easy
Figure 13 shows an overview of the computer integrated pressworking operation at the R. Olson Company Seguin, Texas facility. A number of different suppliers had to cooperate in order to make the project come together.
Computerized Setup of Press Operating Parameters

Figure 13. An overview of a straightside press showing the operator’s console. Nearly all setup parameters are stored in the industrial personal computer shown to the right of the main control console.  R. Olson Company

The press supplied by Niagara has a Link Systems control package. Toledo Transducers furnished the tonnage monitoring equipment. Hinterman Integrated Systems equipped the press with an early version of their automatic counterbalance adjuster. Juster & Juster supplied the computer and software needed to accomplish integrating the equipment.

In any project of this type, there are always some problems to work out. For example, the plungers in position transducers shown in Figure 11 would jump whenever the crop shear (Figure 12) was actuated, giving a false signal that shut down the system. A software fix was possible in this case. The transducers were muted whenever the crop shear was actuated.
Roll Straighteners Are Not Always Necessary

In the author’s experience, many roll straighteners are not used as intended by the equipment manufacturer or plant layout engineer. In conducting plant audits, the following conditions are often found:

1. When sighting through the roll straightener, daylight is observed between the rolls indicating that the rolls are not performing any straightening action.

2. Roll straighteners are installed on simple feeding jobs where the stock is severely deformed. Here, a straightening operation is often unnecessary.

3. The roll straightener is adjusted with the output rolls set deeper than the input side rolls. This is often done to deliberately cause a curvature in the stock to lessen a feeding problem in a progressive die.
Cases Where Coil Set May Not Be a Problem
One modern metal processing technology is to tension level the stock after slitting. Tension leveling minimizes steel defects such as waviness and camber. Other coil processing methods include special roller leveling and conditioning equipment. If the material is then carefully coiled without exceeding the material yield point, the stock will come off the decoiler flat and with little or no camber. In such cases, a stock straightener is not needed.

Formula for Determining the Bend Radius That Will Produce Coil Set
The following formula is based on elementary strength of materials. The greatest uncertainty in using this formula is the actual yield point of the material.

\[ R = \frac{E \cdot t}{2 \cdot \sigma_y} \]  
Equation 1

Where:  
\( E \) = Young’s Modulus  
\( \sigma_y \) = Yield Strength  
\( t \) = Material Thickness

Applying the Minimum Bend Radius Formula to Inside Coil Diameters
Some processes such as slitting, prepriming and prepainting involve decoiling stock that has no coil set for processing. In other cases, a leveling process is performed prior to the slitting, prepriming or repainting operation.

Hot dip galvanizing is best performed with level stock. Electrogalvanizing has especially high flatness requirements in order to obtain proper spacing from the plating electrodes. If the current density in the plating bath is uneven, the coating thickness will vary across the width of the sheet. Selective precious metal plating for electrical contacts is an especially critical application.

Quick Die Change and Quality Considerations
If the coil has no coil set and is flat when decoiled, there is no need for a roll straightener. In the case of prefinished materials, not using a roll straightener removes a variable from the process. There is less likelihood to mark the stock. In addition, changeover time is reduced. Another benefit is that less floor space is required for the operation.

Table of Steel Coil Minimum inside Diameters to Avoid Coil Set
Table 1 lists minimum inside coil diameters that can be used without producing a coil set or curvature in the stock when decoiled. The table was derived from equation 1. Several assumptions are made including that there is very little tension when winding the strip and that the minimum yield strength is accurate.
The table assumes a Young’s Modulus of Elasticity of 30,000,000 psi for steel. It can be seen that some inside diameters for thick low yield materials such as deep drawing quality steels would have excessive large inside diameters for ease of handling. However, thinner high strength materials fall in a range of practical decoiling arbor diameters. The inner diameter is not a problem with pallet decoilers.

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Table 1. The minimum inside coil diameters that can be used without producing a coil set or curvature in the stock when decoiled. Several assumptions are made including no pull when winding the strip and accurate minimum yield strength. Dimensions are in inches. Smith & Associates

This table is intended as a comparative guide. Factors such as substantial tension when the material is coiled and lower than expected minimum yield strengths can result in stock curvature or coil set.

There are Jobs Where Stock Curvature is Necessary
In some cases, it is necessary to produce stampings having a slight curvature in a nearly flat finished part. This is very difficult to accomplish in a pressworking operation. There is no simple ways to obtain an even amount of overbend. Coining a slight radius requires high forces to being the entire thickness of the part up to the yield point.
It is sometimes possible to deliberately produce the correct amount of curvature by deliberately misadjusting the roll straightener. However, this is much easier to accomplish with a simple three-roll fixture.

The principle of operation is the same as roll benders that are used to form flat stock into curved sections. The three roll-bending fixtures can be placed ahead of the feeder or incorporated into a progressive die if desired.