An Approach to Best Welding Practice : Part – VI

S.K. Gupta, B.E., C.E., FIE., FIIW., MISNT., MAE., MITD.
E-mail : skg1938@gmail.com

"AN APPROACH TO BEST WELDING PRACTICE - Part – VI" is the Sixth Detail Part of **"AN APPROACH TO BEST WELDING PRACTICE"** which was written as a General and Overall approach to the subject matter.

AN APPROACH TO BEST WELDING PRACTICE - Part – VI is particularly focused on the setting up of the equipment and accessories especially for Gas Metal Arc Welding (GMAW) to obtain the best results in shop floor operation

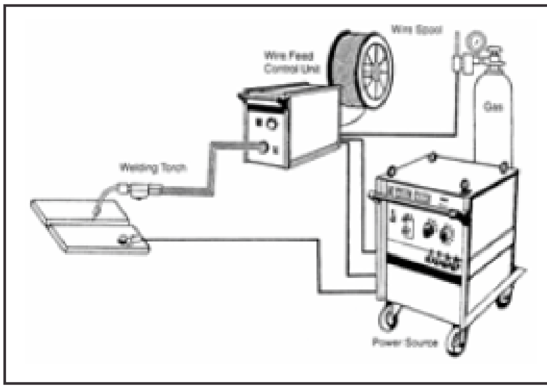
All over the world Gas Metal Arc Welding (GMAW) is mostly and widely used welding process in all types of small, medium and large scale fabrication and manufacturing industries covering a wide range of products – inter continent pipe lines, bridges, ships, buildings, rolling stocks, automobiles. Gas Metal Arc Welding (GMAW) has simplified the process of welding in comparison to other welding processes as less skill is required and easiest to learn and perform. The main reason is because the power source does virtually all the work as it adjusts welding parameters to handle differing conditions.

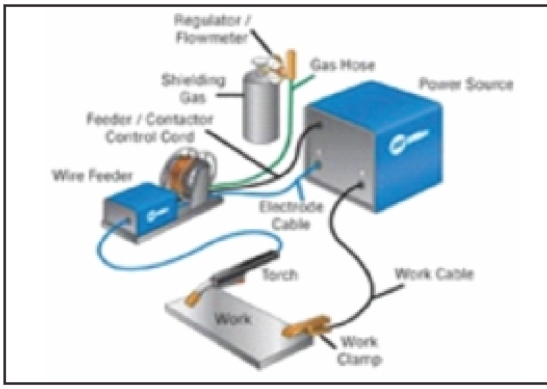
In GMAW the main Equipment used are :

- DC Output Power Source and Welding Control unit
- Wire feed unit
- Welding Torch
- Shielding gas supply.
- Work return welding lead and Cable Connections

In order to get the best out of GMAW process for optimum production and productivity a systematic approach on the setting up of the equipment especially the Power Source, the Wire Feeder Unit and the Welding Torch is necessary. It is obvious to look at the essential setting up and maintenance requirement of the Power Source first, which has been covered in Part – V. In this part the focus is on the Wire Feeder types, systems of wire feeding and control and operating procedure for optimum results.

GMAW ARRANGEMENT





Compact machine Built-in Feeder

Open Feeder

Closed-in Feeder

Suitcase Feeder

WIRE FEEDER

In GMAW, Wire Feeder Unit is a major part of the MIG welding set up. Wire feeders come in many different shapes and sizes that may be Built - in or Closed - in or the Open type as shown as above.

A Built-in wire feeders can be used with MIG torches up to a maximum of 4m (the shorter the better) for hard welding wires and, with great care and a high level of maintenance, up to a maximum distance of 3 m with soft wires like aluminum.

To overcome this limitation the wire feed unit can be made as a separate portable unit so the welder can work at a greater distance from the power source.

Push-Pull Wire-Feed Systems are used for soft welding wires, where the torches have an internal drive mechanism to pull the welding wire in addition to the push drive system in the wire feed unit.

Spool-On-Gun Wire-Feed Systems in which a small spool of wire which is mounted on the torch and a drive system in the handle feeds the wire directly to the point of weld. This provides the method of delivery from the wire feed unit to the point at which welding is required.

In GMAW welding the power source provides Arc voltage control and according to the welding wire size and Arc voltage provided by the power source, a constant rate of wire speed is required which is the basic function of the Wire Feeder. The Wire Feeder Unit in the GMAW system -

A. Controls the speed of the wire electrode and pushes this wire from the feeder through the welding torch to the workpiece.

B. Provides the path for welding current to be passed from the welding power source through the interconnecting lead to the feeder and then to the welding torch.

C. Provides the gas flow control through a solenoid valve. The gas is fed down from the gas regulator to the weld area via the feeder and then the MIG welding Torch.

Different parts of Wire Feeders each has a different function to carry out.

Wire spool holder is designed to hold the spool of the correct wire size in place on the feeder to ensure the wire electrode is on the correct input angle for the drive roller to be able to do its job properly.

The spool holder also has the function to provide brake to the spool whenever required, so that when the rollers stop turning, the wire spool will stop without over-running, otherwise this may cause the wire electrode to tangle up on the spool or run down the side of the spool.

The brake pressure must be set correctly, so as not to put too much pressure on the spool and stop it turning freely when the rollers are turning; but it must have enough tension to stop the wire spool from over-running.

Drive Motor : The wire feeding is done by a DC Motor and most modern wire feed units control the wire feed speed via a DC motor and thyristor control PCB to provide continuous control of Armature volts and hence RPM of motor. The wire feed motor spindle has a feed roller fitted and another pressure roll, adjustable spring mounted to lightly grip the wire and push it up the length of the MIG torch.

MIG welding relies on smooth and constant wire feed. Lower quality machines usually have poor feed systems. The wire drive motor has the job of turning the drive rollers (this can be one or more sets of rollers). Undersize drive motors can result in poor feeding of the wire electrode down the MIG welding Torch. This will have the effect of making the overall performance of the MIG machine sub-standard as compared to a machine with a quality drive system.

Drive Rollers : The drive rollers grasp the wire electrode and continuously feed the wire down the MIG Torch into the welding arc. The rollers need to be selected by -

- the wire size
- the type of wire to be fed. Each type of wire may need a different style of roller groove - e.g. V rollers for steel and other hard wires

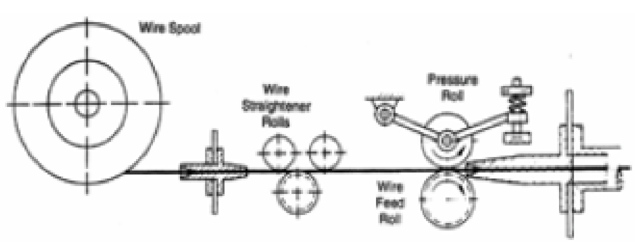
The idea of using the correct roller is to have a good wire drive without crushing the wire. The pressure roller is also used to set the wire tension. This must be set with enough pressure to feed the wire electrode, but not too much tension as to crush the wire.

Different manufacturers of Wire Feeders have different designs of the drive system. The combinations of drive systems normally used by include:

- driven feed roll and pressure driven pressure roll
- driven feed roll and driven pressure roll
- two driver feed rolls and pressure driven pressure roll
- two driver feed rolls and two driven pressure rolls

The variations of the rollers include

- rifled V-shaped feed rolls size dependant grooves
- V-shaped feed rolls size dependant grooves
- U-shaped feed rolls size dependant grooves
- flat, plain pressure rolls
- flat, knurled pressure rolls
- V-shaped pressure rolls size dependant grooves
- U-shaped pressure rolls size dependant grooves



Schematic illustration of a wire feeder with two rail

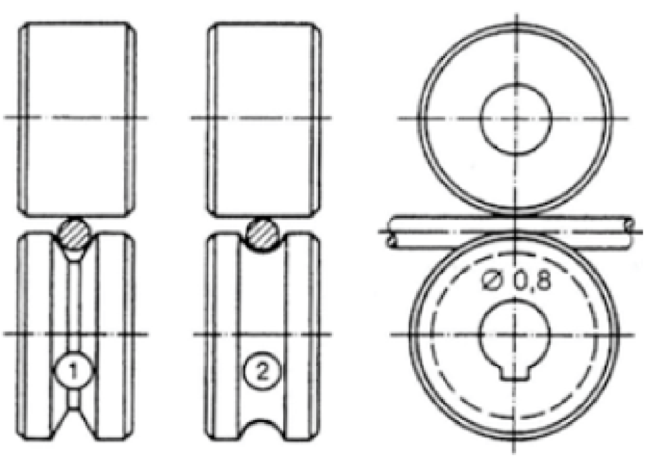
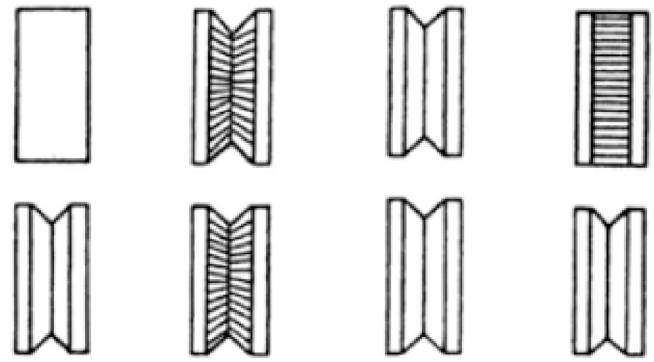


Fig. 14 : Selection of the drive rolls' groove
(1) Drive roll with V-shaped groove for hard wire electrodes
(2) Drive roll with U-shaped groove for soft wire electrodes

In order to obtain correct wire feeding from the contact tips

- All the wire guides on the input and the output side of the rollers must be :
  a. Lined up to feed the wire straight into the rollers,



Wire Sizes Up to .035" (1.1 mm) for Ferrous and Non-ferrous Wires | Wire Sizes 1/16" (1.6 mm) to 1/8" (3.2 mm) for Ferrous Wires | Wire Sizes 1/16" (1.6 mm) to 1/8" (3.2 mm) for Non-Ferrous Wires | Small Diameter Ferrous Wires

Different types of rolls used in wire feeder

  b. Lined up in a way to make sure that the wire is lined up with the grooves in the drive rollers,
  c. All guides must be as close as possible to the drive roller to prevent the possibility of the wire bunching up and kinking.

- Check that the groove size is correct for the wire diameter.
- Always use Vee-groove drive rolls for solid wires.
- U-Grooved for aluminum and other soft wires
- U-Cogged for soft shelled flux cored wires
- Use knurled drive rolls for flux cored and most metal cored wires. Knurled drive rolls typically increase wear on contact tip and liner assemblies and will likely need to be replaced more often.
- Apply the correct pressure on feed rolls. Too much pressure flattens the wire, resulting in feedings problems and higher liner and contact tip wear
- Insufficient pressure may cause wire to slip in the feed rolls, resulting in irregular feeding and possible wire burnback. V-Knurled for Flux cored wire
- Checking accumulation of finer metallic shavings underneath the drive rolls which indicates misalignment or excessive drive roll pressure.

Wire Feed Controls

The wire feeder will have its own built-in control system. The number of controls that will be built into the feeder will depend on the type of feeder (some feeders come with more bells and whistles) but the most common are

A. **Wire speed** – this control is the adjustment for how fast the drive rollers will turn and faster the wire speed for each wire size the more amperage the power source will produce. The wire speed controls can be labelled as wire speed, in inch per minute (ipm) or meters per minute (mpm), or as a percentage from the slowest speed being zero to the highest speed being 100%.

The amperage being set by the wire speed setting will also have an effect on the speed of travel and the deposition rate of the wire (how fast the weld metal is being put onto the weldpiece); with the advantage of, the higher the amperage the thicker the material that can be welded.

B. **Purge switch**. Some feeders have a purge switch. This is to allow the gas flow setting to be set on the gas regulator without turning of the wire feed roller or without any welding power being turned on.

C. **Burnback.** Burnback is the setting of the degree that the wire electrode will melt back towards the contact tip at the completion of the weld. If there is too much burnback the wire electrode will melt back onto the contact tip, possibly damaging it. If there is not enough burnback set, the wire electrode will not melt away from the weldpool and can be left stuck to the weld metal.

D. Spot timers or stitch modes are to be found on some feeders. These controls normally control the time the drive roller will turn for after the trigger contactor has been activated.

MIG Welding Wire Feed Troubleshooting

The major troubles causing poor performance during welding with Wire Feeders are :

1. Wire Slipping
2. Birds Nests.
3. Burnback

The essential key components in the wire feed system to know what to look for in each component for better performance

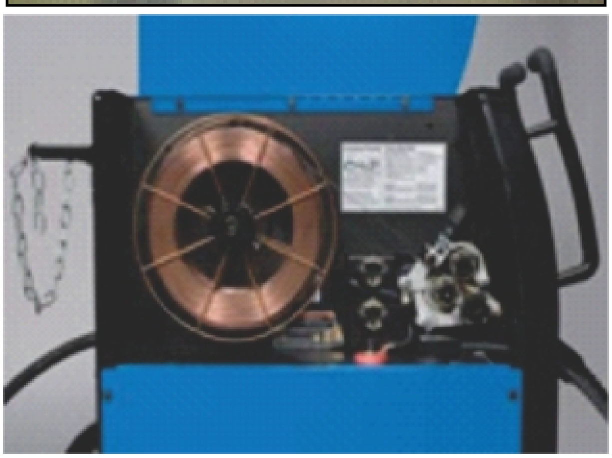
Spool Hub

The first component to check is the source of electrode wire: the spool hub. The inner spring on the spool hub sets the brake tension on the spool of wire. The setting should such so as to prevent the spool from over-spooling when the wire stops feeding. But care should be taken to distinguish the fine line between over-spooling and over-tensioning the spool.

In order to optimize the brake tension by turning the wire feed speed to its maximum and then cycling the trigger with at least

150 mm of run out. The spool should coast so the first loop of wire just starts to loosen on the spool. A general factory setting is having the tension nut flush with the end of the threads, but each hub is slightly different. It must be made sure that when putting a spool in the machine the loose end of the wire is not fed through any of the other loops. This will cause feeding problems.

Wire Drive



For wire feed problems the next check is to be made at the wire drive. There are two main adjustments at the wire drive:

1. the drive roll groove and
2. the drive roll tension.

The first check to make sure is that the diameter of weld wire matches the drive roll groove. It must be made sure that a knurled roll is used for flux core welding and a V-groove roll for solid wire. The knurled groove provides more traction on the softer flux cored wire so the drive doesn't crush the wire, but it will also plug the gun liner much faster as well so its use is not recommended for solid wire.

The other component of the wire drive is the drive roll tension. This is adjusted with the numbered tension knob. High tension is not always the best. Cranking down the tension all the way deforms the wire, causes shaving that plugs the gun liner, and allows the drive to birdsnest.

Low tension will cause wire to slip in the drive rolls and result in inconsistent wire feed speed. Under the hood, it will look like the arc is pulsing.

Wire Drive

The final component of the system is the MIG gun. The first thing to check is that the gun is completely inserted in the drive casting and tightened down with the thumb nut.

The next component to look at is the contact tip. The size of the tip printed on the side, needs to match the diameter of wire. As contact tips wear, that hole will start to become oblong. This will change the current picks up through the tip and potentially cause weld performance issues. If the hole looks out of round, the tip must be replaced.

Even after checking all of these points if the problem still persists with wire feeding, it may be time to change the gun liner. There is a mono coil liner inside the MIG gun that guides the wire from the drive rolls to the contact tip. These may become kinked, plugged, or just worn out over time. As an initial step, compressed air can be used to clean out shavings that plug liners. This should be done on a routine basis to extend the life of the liner.

Liners are consumables of the MIG gun and are relatively inexpensive. New liners need to be trimmed to length so it is needed to remove the contact tip when replacing a liner. Also, it must be noted that it's important to lay the gun out straight when replacing the liner so that It can be cut to the correct length.

Wire Feed Troubleshooting

Sl.No.	Fault Symptom	Possible causes with Remedial Measure
1	Birdsnests	Check and Clean liner with compressed air or change liner Check contact tip for size or obstruction. Check and Adjust drive roll tension
2	Wire won't pass through torch	Check contact tip for correct size Change gun liner
3	Drive roll slips on wire	Check Spool hub tension Check drive roll groove condition Check drive roll tension Correct size contact tip
4	Arc length is inconsistent	Check Spool hub tension Check drive roll groove condition Check drive roll tension Correct size contact tip
5	Burn back (pinned contact tip)	Check spool of wire for binding Check spool hub tension Check Drive roll groove condition Check drive roll tension Correct size contact tip
6	Wire feed starts slow	Check Run-in feature is working (speed will increase when arc is established)

Advances in Wire-Feeder Technology

Advances in digital control, including 50 kHz inverter switching and digital signal processors, enabled power sources to respond to sensor feedback from the arc in fractions of a millisecond, but wire feeders had not had any significant technological updates in years. Their operating speeds were measured in hundreds of milliseconds. The result was that wire feeders limited the performance of welding operations.

New wire feeder technology, combined with digital welding power sources is reducing cycle times through improved start/stop times for arcs, and enhanced reliability and process control..

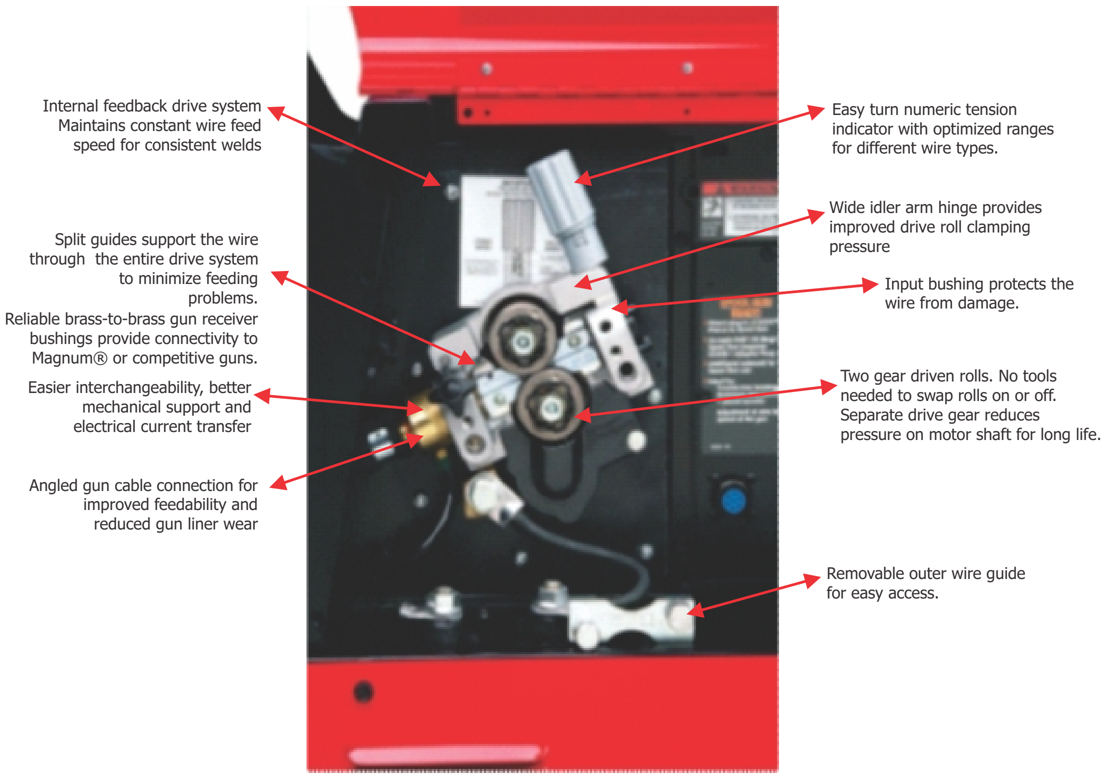
Motor control technology

The use of either four-quadrant motor controls or servo motor technology in wire feeders has produced a ten-fold increase in start/stop performance and accuracy compared with older, semi-automatic feeders. In some Wire Feeders solid-state circuitry have been incorporated to improve reliability and reduce costs.

Another enhancement is the use of digital communications to link motor control boards and feed heads. Digital communication can send more detailed information such as the measurement of motor torque and the amounts of wire used even when the wire feeder is at that distance from the power source.

Also, monitoring the wire feeder motor's revolutions per minute helps to keep track of wire feed speed and allows the controller to count the inches of wire used. A newer feature allows users to save wire and time by specifying the length of wire that will be fed during the wire jog operation.

While welding power sources can respond in micro-seconds, arcs cannot start until the wire feeds across the gap and closes the circuit. Rapid acceleration of the wire shaves milliseconds from each arc start. However, if the wire feed speed is too fast at the start, the arc can be extinguished and violent shorts are created. To avoid this problem, most manufacturers use a lower "run-in" speed to start the arc and rapidly increase feed rates after the arc is established.



A NEW GENERATION WIRE FEEDER

The timing of the wire-feed motor, power source and robot motion must be coordinated to achieve optimum results. Robot controllers usually issue the master task sequence, including where to start and stop and which weld settings to use. Power source or weld controls control the current and voltage and manage the wire feeder. To improve cycle times and application performance, some manufacturers optimize sequencing by implementing algorithms that issue start commands to the power source at a fraction of a second before the robot reaches its targeted starting point.

Another improvement involves synchronizing the wire drives used in push-pull guns for welding aluminum. In these set-ups, a wire drive pushes the wire from the spool to the torch and another wire drive in the torch pulls the soft aluminum wire. Now wire feed speeds can be "pulsed" at high and low rates. In addition, retracting the wire after initially touching the workpiece creates an arc start that is more reliable and produces less spatter in the GMAW process.

The key to better arc starting always has been controlling the end of the wire at the end of the previous weld. More reliable arc starts are created by minimizing the formation of a ball on the end of the wire when a previous arc is completed. Manufacturers have implemented various procedures at the end of the weld to control burnback and reduce molten ball formation. The use of sophisticated current control algorithms triggered by feedback from the arc help to produce low-spatter, short-circuit welding Inward changes

The appearance of wire feeders has not changed much over the years, but there have been changes to how they operate. One change is their weight. Wire feeders are now light enough to mount on a robot arm. This placement reduces the feed distance and improves feeding reliability. Another change involves "tool-less" design to make the changing of consumables easy. Feedrolls also have changed to allow for variations in configuration.

CONCLUSION

In GMAW, the Wire Feeder unit is most important element in the process. Proper selection of an appropriate unit, application and maintenance are the three arms for the approach to better welding. In this article emphasis is given for better understanding of these three arms.