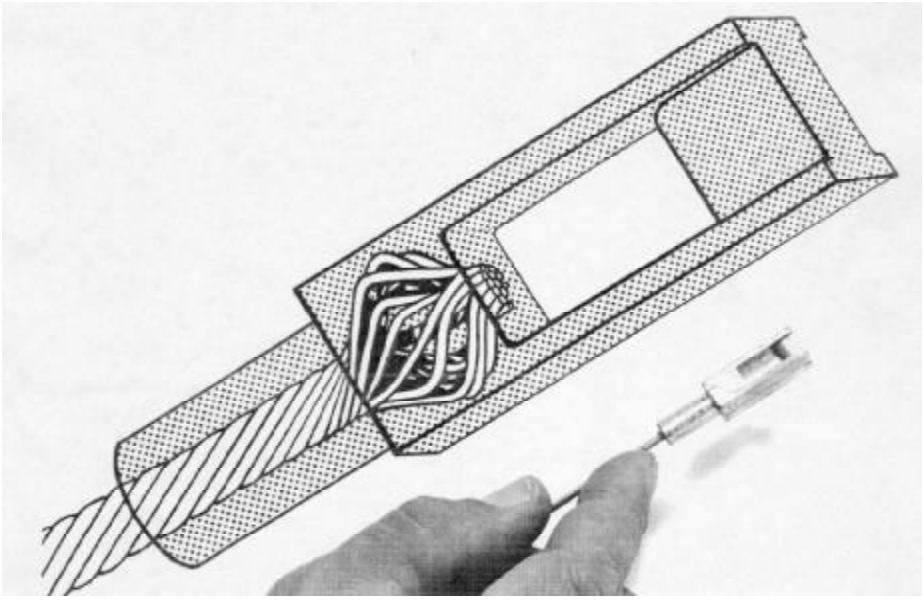
SECTION A: INTRODUCTION

Overview of the Injected Metal Assembly (IMA™) process

Fishertech's Injected Metal Assembly process combines assembly techniques with specialized die casting technology to increase the production rates and the quality of cable or wire products.

The IMA process eliminates the need to assemble a pre-manufactured feature to wire or cable with a fastening process such as crimping. The features are die cast in zinc alloy onto cable or wire.

The cable or wire is loaded into the cavity of the tooling, which is in the shape of the feature being cast. Molten alloy is injected into the cavity under pressure. The feature does not bond to the cable or wire, but rather, shrinks onto it as the alloy cools and solidifies. This creates a mechanical interlocking of the injected metal alloy and the cable or wire. Depending on the pull-off strength required for the end terminations, the cable or wire ends may have to be upset prior to termination. The upset increases the strength of the interlocking action, as the alloy can shrink onto the individual strands.



Zinc alloy shrinks onto the cable upset as it solidifies

Heat from the molten alloy is dissipated very quickly, because the cycle time is short, the amount of alloy is small, and the cavity tooling is cooled by circulating coolant. This ensures that the cable or wire is not damaged, even those coated with a plastic or fibre covering.

Zinc alloys used in the IMA process

The Zamak family of high grade zinc alloys can be used in the CPM-1 system. The most commonly used is Zamak 3, but Zamak 2, Zamak 5 or ZA-8 can be used to increase the strength of the component itself. The choice of zinc alloy will depend on the mechanical and strength requirements of the cable or wire assembly being produced.

Introduction to the CPM-1 Injected Metal Assembly system

The system

The CPM-1 Cable Processor Module (Option 1) is a semi-automatic operating head for Fishertech's Injected Metal Assembly system which die casts zinc alloy features of virtually any shape directly onto a wide variety of cable or wire products.

These can include bare or coated conduit, single wire or multi-strand cable, flexible shafting and wire rope, with or without, a fibre core. The system can also be used to cast a zinc alloy hub to assemble small components.

IMA system components

The Machine

- contains the melt pot for holding the molten alloy and a system for injecting it into the tool.

The CPM-1 Cable Processor Module

- holds the tooling and presents it to the injection system.

The Tooling

- is unique to each product as it contains the cavity which is in the shape of the feature to be formed.

Operation

The operator loads the cable or wire into the tooling and closes it. The cable or wire is sensed in the cavity, and molten alloy is injected, forming the die cast feature on the cable or wire. The tooling opens, and the processed cable or wire is automatically ejected from the cavity. The operator then manually removes the cable or wire and trims the runner.

Production rates vary depending on the type of cable or wire being processed, the size and complexity of the termination, or the complexity of the tooling. These rates range from approximately 500 to 700 assemblies per hour. The actual assembly time (the time the tool is closed until it opens again) is less than one second. The rest of the cycle time involves loading and unloading the cable, and opening and closing the tooling.

Safety features

During operation, IMA systems are interlocked to provide maximum safety for the operator. If the equipment is operated and maintained as recommended, molten alloy will not escape the cavity or area of injection. The CPM-1 system has four safety switches to prevent an injection if conditions are not correct. Safety devices also guard against pinch points.

Fishertech's cable termination equipment

A large portion of Fishertech's business is with the cable industry. Fishertech manufactures four basic types of cable termination systems.

Horizontal Cable system

Fishertech's manually operated, basic machine and operating head combination for cable terminations is called the Horizontal Cable system - so named because the operating head is, (for the most part), in the horizontal plane. This system is best suited for small, simple terminations. It does not lend itself well to eyelet type terminations, as it does not have an ejector system. There are no provisions for upsetting the cable or automatically placing the cable in the cavity. The Horizontal Cable operating head is capable of making in excess of 600 parts per hour.

CPM-1 system

One step up from the Horizontal Cable system is the CPM-1 Cable Processor Module (Option 1) system. This operating head incorporates an ejector system allowing it to cast virtually any type of cable termination. This makes the CPM-1 system more versatile than the Horizontal Cable system. This system still relies on a separate upsetting operation and does not have any provisions to place the upset cable into the tooling. The operator must place each cable into the tooling in exactly the same manner. This operating head incorporates a Cable-In-Place switch which prevents the injection unit from activating if a cable is not in position. The CPM-1 is more robust that the Horizontal Cable system, but typical cycle rates are comparable with the Horizontal Cable system.

CPM-5 system

The CPM-5 Injected Metal Assembly (Option 5) system resembles the CPM-1 system, but incorporates a cable upsetter and transfer unit. The operator only needs to load a cable into the cable upsetter, and the system does the rest. The cable is automatically upset, the system checks that the upset is correct, the termination is cast and finally, a small runner is removed from the termination. The advantages of the CPM-5 system are numerous. Every part has a correct upset. The transfer unit positions every cable in exactly the same position in the cavity - ensuring consistent pull-off strength. Upsetting the cable in the CPM-5 system eliminates a separate operation. Cycle rates vary from 500 to 700 parts per hour - depending on the type of termination being made. The CPM-5 system incorporates the latest in programmable logic control and operator interface. The system uses considerable feedback to simplify troubleshooting and setup.

Automatic Cable Termination Processor system

The Automatic Cable Termination Processor system, also known as the CAFE system (Cable Automatic First End), uses the CPM-5 system and adds an automatic cable de-reel and cut system. The CAFE system is completely automatic, taking the cable from a reel, pulling it to length, cutting it and then loading the cable into the cable upsetter. The cycle is then the same as the CPM-5 system, except that the cable assembly is automatically removed from the system after the termination is complete. The CAFE system is suited for high volume applications.

Production rates for a CAFE system are largely dependent on the length of the cable being terminated. CAFE systems will make cables from approximately 500 to 4000 mm (20 to 157 inches) in length. Production rates from 500 to 700 parts per hour can be expected.

General equipment warranty

Fishertech-Division of Fisher Gauge Limited warrants equipment as follows:

- 12 months on all Fishertech designed and/or manufactured components with the exception of injection units and thermocouple components which are in continuous contact with molten alloy.
- All catalogue items incorporated into the equipment carry manufacturers' warranty.
- Heating elements do not carry a manufacturers' warranty.
- The warranty period will begin with start up of the equipment or 1 month after delivery of equipment, whichever comes first.

Should parts fail during the warranty period because of obvious defect in workmanship or material, they will be replaced at the discretion of Fishertech.

Warranty limitations

- The warranty will be void in the event of improper use or installation of parts or equipment.
- The warranty will be void if the Programmable Logic Controller program is altered or tampered with in any way by anyone except an authorized Fishertech technical representative. The program is proprietary information, belonging to Fishertech-Division of Fisher Gauge Limited.
- The warranty will be void if renewal parts are used which are not authorized by Fishertech.
- Use of non-certified alloy may void the warranty.

Those tooling parts which are in sliding contact with the components to be assembled are considered wear parts; designed to be easily and economically replaced. Tooling wear parts are not covered under this warranty. All other tooling parts are warranted for a period of 12 months.

Equipment return procedure

For prompt service of equipment returned to Fishertech for repair, use the following procedure:

United States and Canada

Before returning equipment, please contact the Fishertech Sales Department at (705) 748-9522, and be prepared to provide the following information:

1) Part number (or description) and quantity of equipment being returned.
2) Machine and/or operating head serial number.
3) Original purchase order number.
4) Reason for the return.

Upon receipt of this information, a Returned Goods Report number (RGR number) will be issued. This RGR number must be referenced on all paperwork accompanying the returned equipment and also be visible on the outside of the shipping container.

Except for warranty repairs, the equipment should be returned prepaid to:

Fishertech-Division of Fisher Gauge Limited
310 Armour Road
Peterborough, ON K9H 1Y6
CANADA

Warranty repairs may be returned collect to the above address.

Outside United States and Canada

Before returning equipment, please contact your local Fishertech representative and be prepared to provide the following information:

1) Part number (or description) and quantity of equipment being returned.
2) Machine and/or operating head serial number.
3) Original purchase order number.
4) Reason for the return.

Your Fishertech representative will provide details for the return of the equipment.

Terminology pertaining to your IMA system

Assembly
The finished cable or component assembly is referred to as an assembly.

Basic operating head
The primary portion of the Cable Processor Module. Additional sub-assemblies such as the cable upsetter and transfer unit can be incorporated to form a complete CPM-5 Cable Processor Module.

Birdcage
See Upset.

Cable-In-Place sensor
A device which will prevent the injection of alloy if a cable/component is not properly inserted into the cavity tool portion of the assembly tool.

Cable Processor Module
A type of operating head designed to combine mechanical control cable processing operations in one unit. Various types of Cable Processor Modules are available, from a basic CPM-1 unit up to an CPM-5 Cable Processor Module, which incorporates a cable upsetter, an upset sensor, a transfer unit and a means of removing the runner from the die cast termination.

Cable Processor Module Closed proximity switch
The portion of the Cable Processor Module that senses the CPM is closed - that is, the movable tool and fixed tool are in contact with one another. Also called the Head Closed switch.

Cam roller
Roller which bolts to the main slide and rides in the cam slot.

Cam slot
The slot in which the cam roller rides in the main slide cam.

Cavity
The hollow portion of the tool that gives the cable termination, or cast hub, its shape. The cavity fills with injected alloy during the assembly process.

Cavity tool
One portion of a set of tooling for use in a Cable Processor Module. The cavity tool consists of upper and lower die blocks which contain the cavity, ejector pins, ejector pin retainer, safety pin and possibly core pin(s).

Close

The linear motion of the main slide that brings the movable tool and the fixed tool together. Also see Open.

Close/Open cylinder

The Cable Processor Module pneumatic actuator that opens and closes the main slide.

Cold flow

Surface roughness of the injected metal cable termination that occurs when molten injected metal comes into contact with cool cavity surfaces.

Component

A discrete part to be joined together with other components during the Injected Metal Assembly process.

Contraction

See Shrinkage.

Control power

The Control On illuminated push button turns the Master Control Relay on. Activating the E-Stop illuminated push button turns the control power off.

Cycle

The complete sequence of operations within a system, including the loading of components, which results in the production of a termination or assembly.

Die

See Tool. In this manual, the terms die and tool are used interchangeably.

Die blocks

The portion of the cavity tool which contains the cavity. Die blocks are generally configured in upper and lower halves. Die blocks may hold cavity inserts, or may actually contain the cavity themselves.

Draft

The taper given to cores and other parts of the tool to facilitate ejection of the assembly.

Drag

The term used to describe the situation where an assembly ejects from the cavity leaving score marks on the injected metal joint.

Dross

An impurity, usually an oxide, formed on the surface of a molten metal alloy.

Dry cycle

The term used to describe a cycle during which the injection unit is intentionally not allowed to operate. Running a dry cycle before production of assemblies will verify that the system is operating correctly.

Ejection

The term used to describe the mechanical removal of the assembly from the tool.

Ejector mechanism

The portion of the tool/operating head used to eject the completed assembly.

Ejector pin

A portion of the tool used to eject the completed assembly by pushing on a suitable surface on the termination.

Ejector pin retainer

The portion of the tool which holds and controls the motion of the ejector pins.

Emergency Stop illuminated push button

The E-Stop illuminated push button shuts the Master Control Relay off. This quickly expels the pressurized air from the machine and de-energizes all outputs from the Programmable Logic Controller. All movement of the Cable Processor Module and moving mechanism will stop.

Fill gap

The distance between the bottom of the fill slot and the bottom of the plunger when the injection unit is in the fully retracted position.

Fill slot

The hole in the gooseneck and sleeve through which molten alloy flows to refill the shot chamber after an injection.

Fixed tool

See Tool.

Flash

A thin layer of excess alloy, usually along the parting line of a joint, which forms when injected alloy leaks between sealing surfaces of the tool.

Flow control valve

A valve which controls the motion of a cylinder. The air is controlled as it exits the cylinder.

Gate
The passage for molten alloy connecting the runner with the cavity.

Gooseneck
The portion of the injection unit which is immersed in the molten alloy in a hot chamber die casting machine.

Growth
The expansion of tool parts due to heat; or the expansion of the injected metal joint due to ageing or intergranular corrosion.

Guide bushing
A bushing which engages with a guide pin to align tool halves or tool parts.

Guide pin
A pin which engages with a guide bushing to align tool halves or tool parts.

Head
See Operating head.

Hinge Pin-In-Place proximity switch
This proximity switch senses the moving mechanism hinge pin and stops the cycle if the pin is not installed.

Hot chamber die casting
A die casting process in which the gooseneck is immersed in the molten alloy.

IMA
See Injected Metal Assembly.

Incomplete fill
The condition of the injected metal joint caused by an insufficient amount of molten alloy being injected. Also called a short-shot.

Injected Metal Assembly
The Fishertech process of using a die casting technique to assemble components or terminate cable. Abbreviated IMA.

Injection
The term used to describe the pumping of molten alloy by the plunger from the melt pot into the cavity.

Injection unit

The mechanism within the Injected Metal Assembly machine which pumps molten alloy from the melt pot into the cavity.

Intergranular corrosion

The localized attack occurring along the crystal boundaries of a metal or alloy. Also known as inter-crystalline corrosion.

Key selector switch

The key selector switch allows the key holder to put the machine in setup mode or run mode. This allows maintenance to “lock out” unauthorized personnel who should not operate the equipment.

Machine

The portion of an Injected Metal Assembly system that holds and controls the motion of the Cable Processor Module and tool combination during the assembly process, as well as provides a means for holding, heating and injecting the molten alloy.

Main slide

The portion of the Cable Processor Module on which the movable tool is mounted. The motion of the main slide usually closes and opens as well as locks and unlocks the tool.

Main slide spacer

The spacer located on the end of the main slide. Adjusting the thickness of the main slide spacer allows the shut height to be easily set.

Melt pot

The portion of the Injected Metal Assembly machine that holds and heats the alloy to be injected.

Movable tool

See Tool.

Moving mechanism

The portion of the Injected Metal Assembly machine that advances or retracts the Cable Processor Module and tool combination onto and off of the nozzle.

Moving mechanism advance

The motion of the operating head and tool combination onto the nozzle during the Injected Metal Assembly process. See also moving mechanism retract.

Moving Mechanism Advance/Retract cylinder

The portion of the moving mechanism that provides the motive power to move the operating head and tool combination onto and off of the nozzle.

Moving Mechanism Advanced limit switch

The portion of the machine that senses that the moving mechanism is fully advanced. With a proper setup, the nozzle seat will be firmly and completely in contact with the nozzle when the Moving Mechanism Advanced limit switch is closed.

Moving mechanism retract

The motion of the Cable Processor Module and tool combination off of the nozzle during the Injected Metal Assembly process. See also moving mechanism advance.

Nozzle

The portion of an Injected Metal Assembly machine that provides a passage through which the molten alloy flows from the injection unit into the tooling and thereby into the cavity.

Nozzle heater

The portion of an Injected Metal Assembly machine that supplies additional heat to the nozzle.

Nozzle seat

The portion of the fixed tool that comes into contact with the nozzle during the Injected Metal Assembly process.

Open

The linear motion of the main slide that totally separates the movable tool and the fixed tool prior to the ejection of the assembly. See also Close.

Operating head

The portion of an Injected Metal Assembly system that holds and controls the motion of the tool during the assembly process.

Part

See Component.

Parting line

The place on the termination where the mating surfaces of the fixed tool and the movable tool meet and also where the mating surfaces of the components meet the tooling.

Plunger

The portion of the injection unit used to pump molten alloy out of the gooseneck and into the cavity.

Porosity

Voids or pores, resulting from air being trapped in the injected metal joint. See also Suck-back and Void.

Runner

A passage in the tool, generally connecting the nozzle seat to a gate through which molten alloy enters the cavity. Runners are generally designed to be easily removed from the joint at the gate.

Sealing pin

A pin, generally spring driven, designed to plug an access hole in the tool when a component has not been loaded. The sealing pin or safety pin is both a mechanical sealing pin and an air sealing pin for the Cable-In-Place switch.

Shot

The volume of alloy pumped by the injection unit into the cavity during a single cycle.

Shot chamber

The portion of the gooseneck from which molten alloy is forced into the cavity by the plunger.

Shrinkage

The contraction of the injected alloy in the cavity during cooling and solidification.

Shut height

The linear dimension on the Cable Processor Module between the fixed tool mounting surface and the movable tool mounting surface, when the CPM is in the locked position (ie. when the cam roller and cam slot are in their locked position).

Sleeve

The cylindrical portion of the gooseneck in which the plunger moves during the injection of molten alloy.

Suck-back

The term used to describe the defect of the injected metal cable termination caused by retraction of the plunger before the runner has solidified. A porous termination can be caused by suck-back. See also Porosity and Void.

System

The combination of machine, Cable Processor Module and tool arranged to cast terminations on the end of cable using the Injected Metal Assembly process.

Tail

The small portion of the runner which freezes into the nozzle. It is “pulled” out of the nozzle when the Cable Processor Module/tooling combination retracts. The tail length will vary depending on

the heat balance between the nozzle and the tool.

Tool

The portion of an Injected Metal Assembly system that holds the cable in the precise location in relation to the cavity (termination shape) during injection. The tool is comprised of two halves: the fixed tool and the movable tool. The fixed tool is firmly fastened in the Cable Processor Module. The movable tool is mounted on the end of the main slide and closes and opens on the fixed tool during the process. The tool contains the cavity into which the injected alloy is pumped.

Tool mounting surfaces

The Cable Processor Module surfaces onto which the fixed tool and movable tool are mounted.

Upset

The term used to describe the deformation of the end of a mechanical control cable prior to the formation of an IMA termination. The ends of cables are upset to provide a suitable feature for the injected alloy to shrink onto, thereby increasing the retention of the termination on the cable. When upset, the cable is often referred to as having a birdcaged end.

Void

A large pore or hole in the cable termination usually caused by trapped air or gas. See also Porosity and Suck-back.