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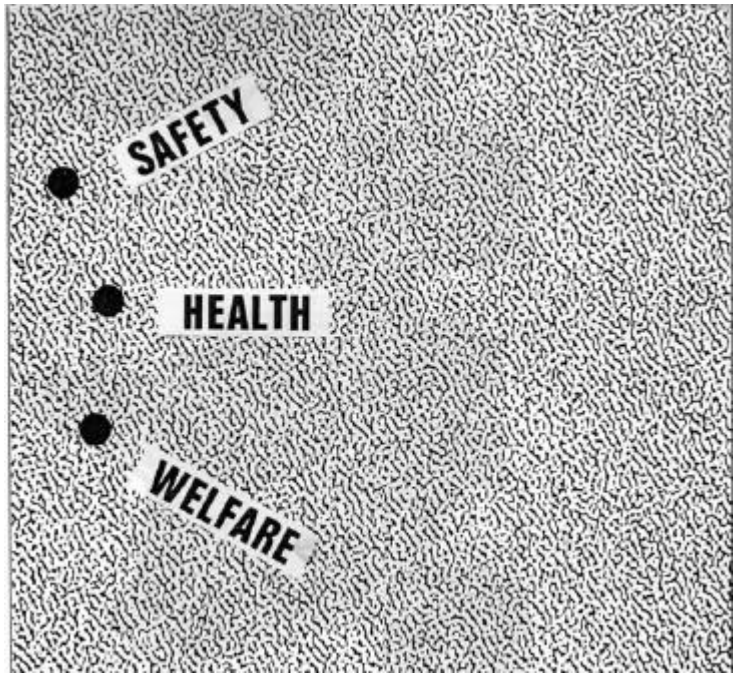

Blow Moulding Machines – Safety Principles

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DEPARTMENT OF LABOUR

GUARDING OF BLOW MOULDING MACHINES (PLASTICS INDSUTRY)

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FOREWORD

During recent years the development of the plastics industry in this country has resulted in a substantial and continuing increase in the number of blow moulding machines being brought into use to manufacture a wide range of products.

As the number of blow moulding machines has risen, so regrettably has the number of accidents due to persons being trapped by the moulds or platens.

The problem here has been to prevent entry to these dangerous parts when they are in motion, and also to prevent a dangerous trapping movement from occurring unexpectedly when the moulds are open and the trapping zone is exposed.

The Machinery Act 1950, which is administered by the Department of Labour, provides for the secure fencing of dangerous parts of machinery. The purpose of this booklet is to acquaint blow moulding machine owners and users with their statutory obligations under the Machinery Act 1950, and to show examples of some methods of guarding these machines.

The fitting and maintenance of effective guards on a blow-moulding machine is a skilled job and a sound knowledge of the machine together with the cause of accidents will be necessary to give practical effect to the recommendations in the booklet.

It is possible that some users of blow moulding machines will experience difficulty in giving full effect to the recommendations and thus not provide for all the points to be fully met in the design of guards. The Department's officers are available, at all times, to assist in resolving any problems that are encountered in the provision of adequate guards. At the same time industry may be able to find a way to assist such users.

The information contained in this booklet is not intended to be the last word on the subject of guarding blow moulding machines. It is produced in order to show what can and has been done in the hope that manufacturers and users will be stimulated to further development.

The booklet has the support and agreement of the Plastics Institute of New Zealand and the Department appreciates the assistance of its members in preparation of its contents.

Chief Inspector of Factories.

GUARDING OF BLOW MOULDING MACHINES (PLASTICS INDUSTRY)

INTRODUCTION

Blow moulding is a method of forming using thermoplastic materials.

Basically, blow moulding consists of using a gas or fluid to stretch then harden a plastic against a mould. There are two general methods of doing this type of thermoplastic moulding. The direct method and the indirect method.

Each of these has variations.

In the direct method a tube or parison of molten thermoplastic material is formed into the rough shape of the desired finished product. This shape is then inserted into a female mould and air blown into the plastic, as into a balloon, to force it against the sides of the mould. The formed material is then cooled before removal from the mould.

In the indirect method, a thermoplastic sheet is first heated then clamped between a die and a base plate. Air pressure forced through an aperture in the base plate forces the material into contact with the die which has the contour desired in the finished product.

In New Zealand the process is generally confined to the direct method, a process in which molten or softened plastics material is subjected to internal pressure causing it to assume the hollow shape of a mould. It is used extensively to produce bottles and containers of all kinds and although any thermoplastic material is capable of being blow moulded, most of the production in New Zealand is based on low or high-density polyethylene.

There are three current methods of blow moulding as follows:

(I) Injection Blow Moulding

In this process the material is fluxed in a conventional injection-moulding machine and injected into a temperature controlled mould containing a hollow core known as a blow stick. This stick, with semi-molten plastic material adhering to it, is then transferred to a second, larger mould or cavity and air is blown through the blow stick to expand the material to the shape of the second mould. The blow stick is then withdrawn through the neck of the finished moulding and reused, while the cooled moulding is ejected from the mould.

(II) Extrusion Blow Moulding

This is the method by which, at the present time, most blow mouldings in New Zealand are produced. It consists of extruding the plastics material as a tube, known generally as a parison, encompassing the tube by a cold mould and blowing it to the shape of the mould.

Twin-headed moulding units operating off 50 to 75 mm diameter extruders can produce 500 to 1,000 articles per hour, each weighing 28 g, and increased production can he achieved by using rotating tables holding several mould assemblies.

The technique of moulding large bottles and containers by the extrusion method is called big blow moulding.

(III) Blow Moulding Preformed Parisons

A development of method (II) in which tubing is produced by conventional extrusion methods in a variety of thermoplastics and in almost any variation of colour, diameter, and cross-section for supply to moulders who, using required lengths, reheat the sections of tube and blow them to shape in cold moulds. It is claimed that the technique enables the moulder to produce a variety of different coloured mouldings from the same mould, to carry out intermittent mouldings without having expensive extrusion equipment lying idle, and to employ different materials for certain applications without recourse to expensive cleaning operations.

DEFINITION

The term "blow moulding" refers simply to the entrapment of a hollow tube in a mould chamber. By introducing air under pressure into the trapped tube the hot plastic parison takes the shape of the mould. There are a number of variations but basically blow moulding developed from this concept.

ACCIDENT CAUSES

Within recent years rapid development in the technique of blow moulding of plastics has resulted in a substantial and continuing increase in the number of blow moulding machines brought into use to manufacture, quickly and efficiently, a wide range of products.

As the number of blow moulding machines has risen, so have the number of accidents due to persons being trapped between or behind halves of the mould when moving.

REQUIREMENT OF MACHINERY ACT 1950

The Machinery Act 1950 requires that every part of any transmission machinery and every dangerous part of any machinery be securely fenced, unless the parts are in such a position or of such construction as to be as safe to every person employed or working on the premises as they would be if securely fenced.

These requirements can be met in respect of blow moulding machines by:

(a) Complete enclosure of the prime mover and transmission.
(b) Fitting a guard which will prevent a worker from coming into contact with the platen or moulds when the mould is in motion.

PRIME MOVER AND TRANSMISSION

The prime mover of the individual electric-motor type is usually completely enclosed except for the shaft end on to which the transmission pulley is secured. The enclosure of the shaft end becomes synonymous with enclosure of the transmission and the transmission should be securely fenced in terms of the Department's leaflet Guarding of Transmission Machinery.

DANGEROUS PARTS-PLATEN, MOULDS

The prevention of accidents on blow moulding machines and the problem, as in other industries employing hydraulically and pneumatically operated machines with moulds which close under high pressure, is to prevent a dangerous trapping movement from occurring unexpectedly when the moulds are open and the dangerous area is exposed.

The British Plastics Federation, who were among the pioneers in the field of fostering the technique of accident prevention in their industry, published recommendations in 1965 and extracts from these recommendations have been included for the guidance of manufacturers and factory occupiers.

The moving platens of blow moulding machines are normally operated by hydraulic or pneumatic cylinders controlled by solenoid-operated valves. A dangerous area exists between the platens when closure of the moulds takes place and behind these platens when the mould opens. These areas should be securely fenced to prevent access while the platens are moving.

This area can best be guarded by means of an interlocking fixed guard having moving screens. The interlocking arrangement of such guards should be arranged so that:

(a) When the guard is open no pressure can be applied to the platen closure cylinder; and
(b) If the guard is opened during the closing stroke, the motion of the platen is either arrested or reversed; and
(c) Where there is a danger of residual motion of the platen after the guard has opened, means are provided in the air or hydraulic system to prevent further movement to closure.

Interlocking may be achieved by the hydraulic or pneumatic system either through the main hydraulic or air supply to the rear of the die closure cylinder or through the pilot system. Electrical interlocking should only be considered as a secondary means.

Any other dangerous parts should be securely fenced where it is not necessary to obtain access to them during the normal working cycle of the machine.

On machines where the component is formed and ejected automatically and where no access is required to the tool area during each cycle, interlocking fixed guards are adequate. Any aperture to allow the delivery of the component from the machine should be so designed as to prevent access to any dangerous part.

Guards must be securely held in guides or runners so that they cannot be bumped or wrenched loose, thus causing them to release switches and valves to the operating position.

Guarding arrangements on the front of the machine must be such as to prevent access into the mould or platen when the guard is closed.

APPLICATION

The following illustrations show the methods of interlocking the guard on blow moulding machines.

Fig. 1 shows the interlocking guard interlocked directly with the main, hydraulic line.

A two-way valve, actuated by the guard, is connected in the line between the platen control valve and the closing side of the platen cylinder. The act of opening the gate depresses the stem of the two-way valve shutting off the pressure flow and connecting the closing side of the platen cylinder to tank.

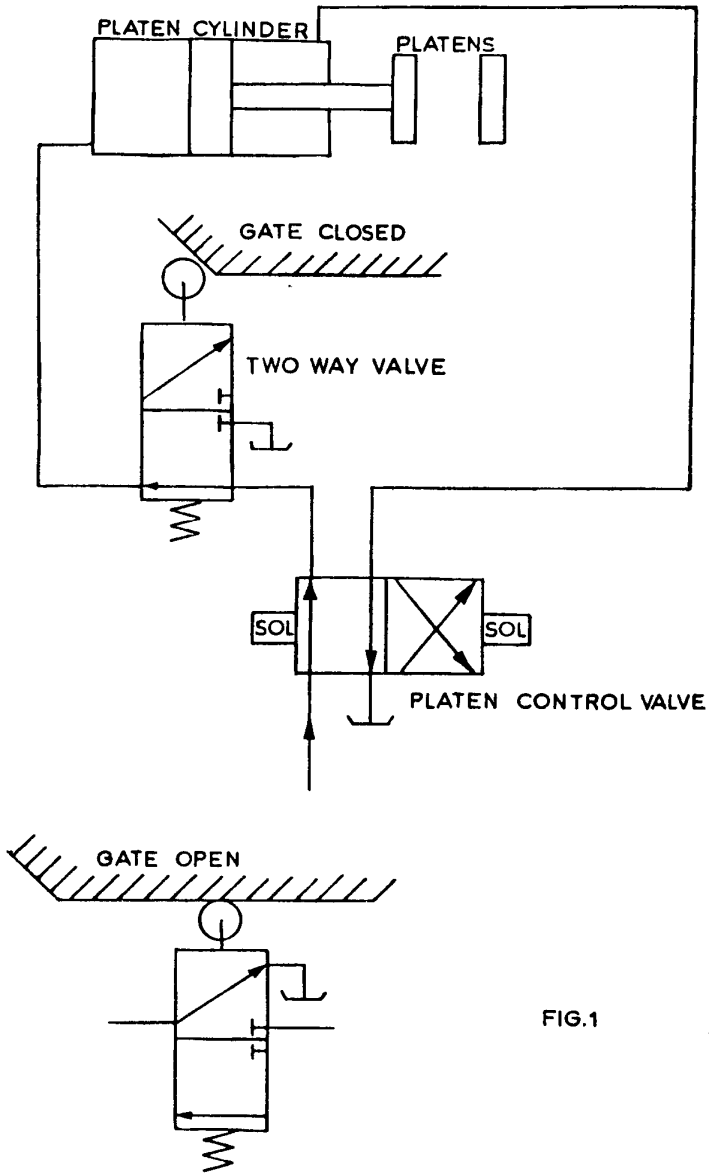


FIG.1

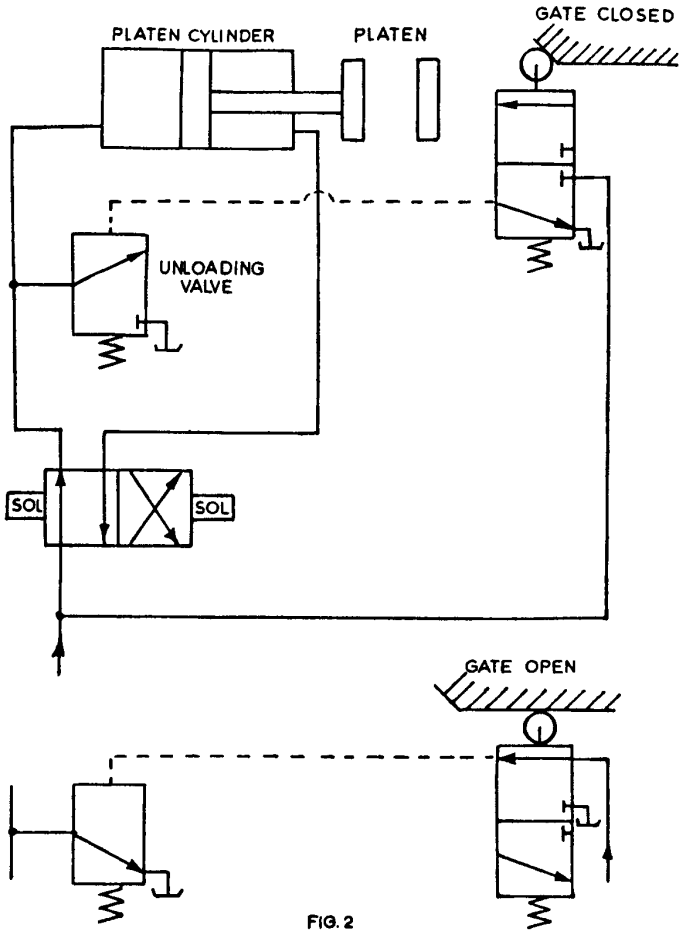


FIG. 2

Fig. 2 shows a method of interlocking the guard with the pilot hydraulic system using a two-way valve and an unloading valve.

When the guard is open pilot pressure is directed to the unloading valve which opens to tank, thereby relieving pressure from the closing side of the platen cylinder. It is important that the parts of the unloading valve are sufficiently large to relieve immediately the pressure in the cylinder and to pass the maximum volumetric output of the pump without building up sufficient pressure in the platen cylinder to move the mechanism of the machine.

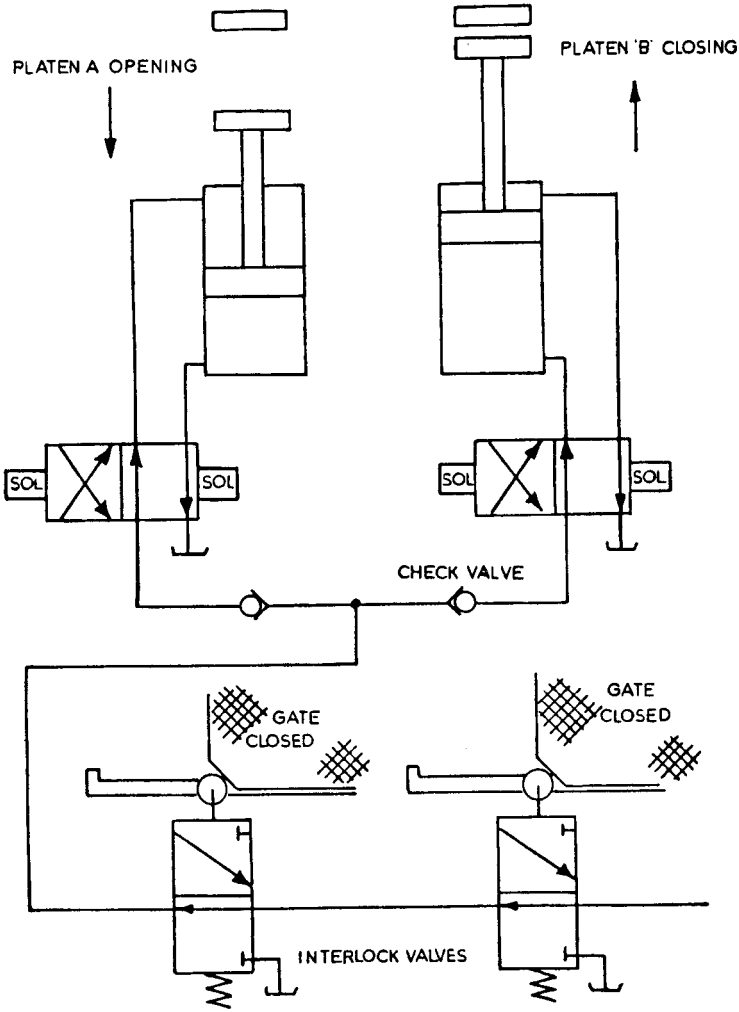


FIG. 3

Fig. 3 shows a method of interlocking two sliding guards with the hydraulic system of a twin mould blow-moulding machine. The spools of the interlocking valves are held depressed by the guards when they are open or partially open.

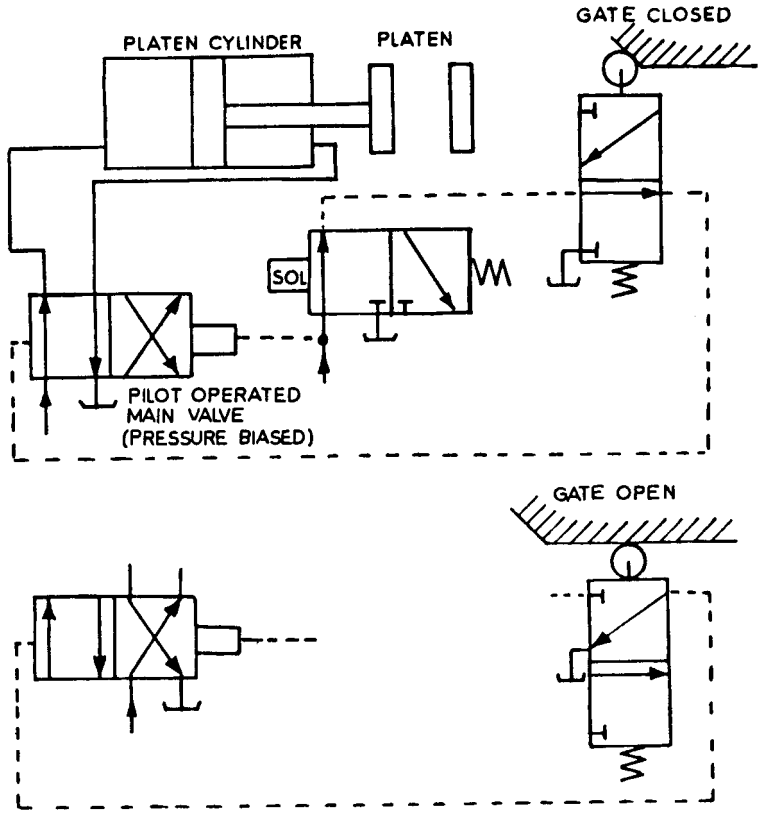
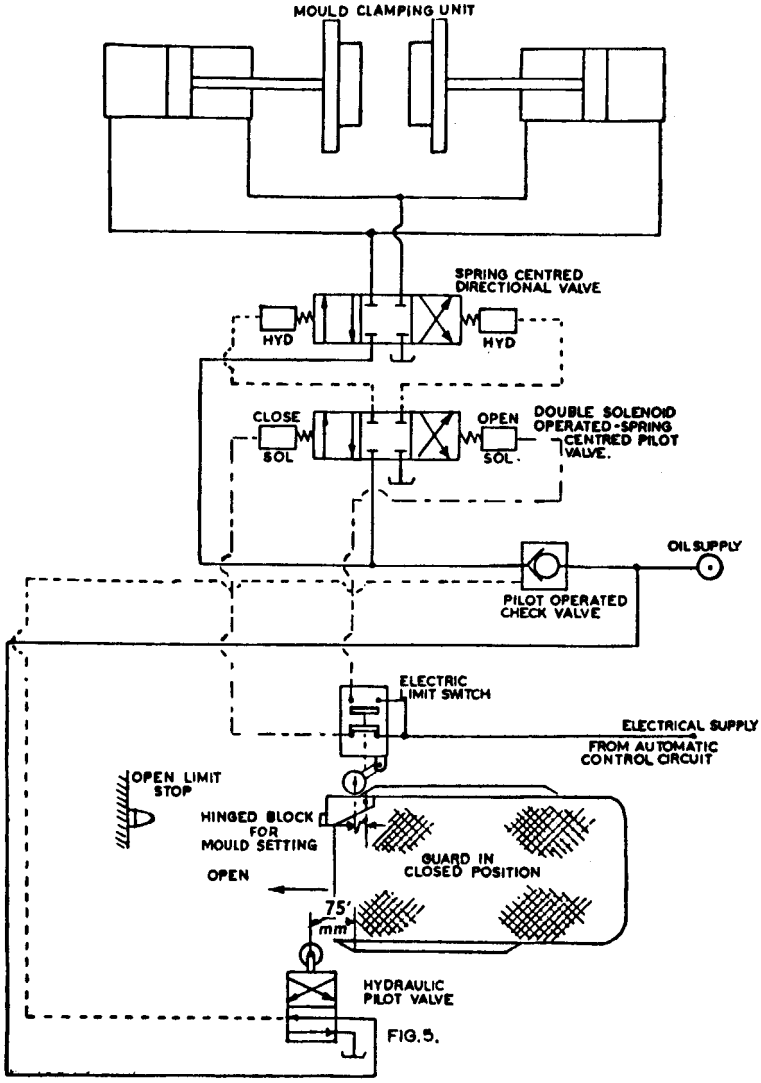


FIG. 4

Fig. 4 shows a system where platen movement is sometimes controlled by a valve which is operated by differential pilot pressure (pressure biased valve). Pilot pressure is maintained at one connection and alternatively applied and released at the other connection to actuate the valve spool. By means of a two-way valve the guard can be interlocked with the pilot line to the main valve so that the act of opening the guard causes the platen to open.

On some blow moulding machines there is a risk of trapping behind the platen as the platen moves to the open position with the guard open. A method to overcome this danger which was developed by Plastic Products Ltd., Hamilton, is shown in fig. 5.



This guard operates both electrical and hydraulic interlocks and will prevent operation of the moulds when the guard is opened sufficiently to allow entry to the danger area.

When the guard is opened 25 mm the electrical limit switch is operated; this removes the power from the automatic circuit and energises the mould open solenoid. If the guard is held at this position, the moulds and platen will continue to open until they operate the mould open limit switch (not shown) or reach the outer limit of travel.

Opening the guard a further 75 mm operates the hydraulic interlock pilot valve. This valve removes the pilot pressure from a pilot operated check valve in the main oil supply line to the mould operating directional valve. This allows the main oil supply pressure to close the check valve and prevent any movement of the moulds. Note here that it is not sufficient in this case to remove the pilot supply only from the directional valve, which is spring centred, as a spring failure will cause a dangerous condition.

Both the hydraulic pilot valve and the electrical limit switch are so arranged that the breakage of a return spring will prevent the machine from operating and both are pushed to the "off" or safety position by the positive action of the linear cam of the guard and only spring to the "on" position when released by this cam. The pilot operated check valve is still closed and held closed by the main oil supply pressure when pilot pressure is removed. All valves and limit switches therefore "fail to safety".

PNEUMATIC EQUIPMENT

Fig. 6 illustrates a system of guarding a semi-automatic pneumatically operated blow-moulding machine.

When either of the sliding guards are opened a linear cam attached to the lower edge of the guard depresses the stem of a pneumatic valve exhausting the system and bringing the moulds to rest.

In order to prevent violent movement of the piston when the air pressure is again applied to the cylinder, a unidirectional airflow regulator is fitted to both cylinder connections, which allows air to flow into the cylinder without restriction, but the flow to exhaust is controlled.

The spools of the interlocking valves are spring loaded so as to hold their stems in contact with the guards when they are in any position other than fully closed.

Due to the very nature of compressed air, most supplies contain a certain amount of water and the air is not generally lubricated and can be contaminated with harmful foreign matter.

It is therefore essential that in the supply line to each machine a filter or strainer should be fitted to remove effectively, air moisture and solid foreign

matter such as corrosion scale. Any piping situated beyond the point where moisture and solid foreign matter is removed should be made of a material which is not subject to corrosion.

A lubricator should also be fitted to provide an oil fog or mist to ensure lubrication of valves or other working parts of the machine control system.

To avoid time lag and prevent waste of air machine operating valves should be placed as close as possible to the operating cylinders. They should not depend for support on connecting pipes, but should be adequately secured either to the machine or other fixed structure in order to avoid vibration which may affect both valves and piping.

Operating valves should be of a type that when in the non-operating position leakage of air past the inlet valve will escape to atmosphere sufficiently freely to prevent a build up of pressure in the operating cylinder. Exhaust parts and piping should be of sufficient capacity to ensure prompt release of air.

All valves for interlocking of guards should be mechanically operated and the arrangements for the restoring of the valves to free exhaust or safe position should be positive in character depressing the valve plunger when the sliding guard is in any position other than closed.

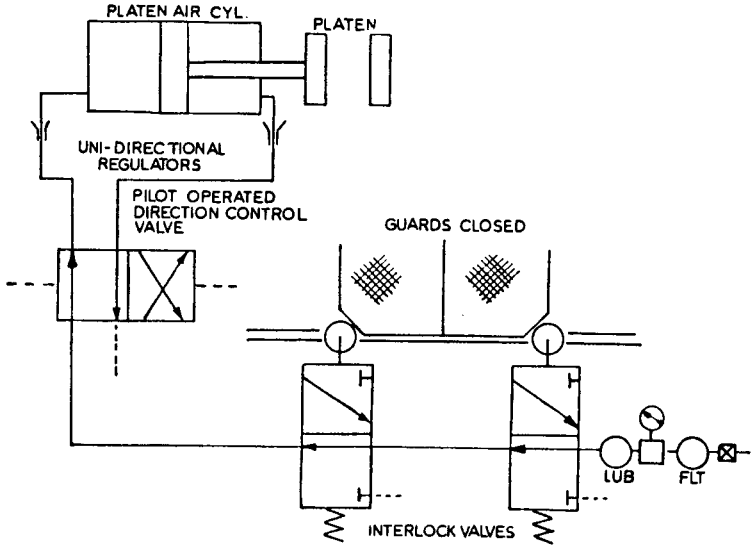


FIG. 6.

MOULD SETTING

Statistics show that trapping accidents occur during mould setting, a stage of blow moulding in which normal guarding arrangements may have to be dispensed with.

When moulds are being set up or changed, there is the danger that the moulds may close or a platen move forward inadvertently resulting in trapping between the platen or moulds.

It is important that the protection which the interlock guard affords the operator of a blow-moulding machine should be extended to the mould setter, whose work necessarily places him in a position of greater danger.

While it is appreciated that the use of a guard during the setting and try-out period is some times inconvenient and time consuming, it should be emphasised that these reasons alone are not sufficient to absolve the user from the legal requirements to securely fence the dangerous parts of machinery.

The circumstances under which it may be permissible for a mould setter to have a guard not in position while the moulds are closed under power are restricted by the terms of section 18 of the Machinery Act 1950.

The essential prerequisite is the existence of a necessity to make an examination or adjustment. To meet such needs and to enable a guard to be operated independently of the machine control, for setting purposes, an arrangement which automatically puts the guard back in operation is shown in fig. 5 where for the removal or fitting of moulds it is necessary to allow the mould setter to move the platen with the guard open.

In normal production, the hinged block fixed to the guard strikes the guard open limit stop when the guard is open. For mould setting this hinged block is lifted to allow the gate to override the hydraulic interlock. The amount of lift is controlled by a stop to be limited to 135 degrees so that, in fact, the stop, when let &o or released, will automatically fall by gravity to its original operating position. By lifting the stop this allows the guard to be opened approximately 23 mm further and the hydraulic pilot valve runs off the operating linear cam. The hinged block being designed as explained automatically falls back into place once the guard is again moved forward.

It is recommended that the following practices should be adopted in all blow moulding, and it should be noted that in making these recommendations, nothing which is said below must be taken as absolving owners from the requirement of the Machinery Act 1950 in relation to dangerous parts of machinery (sections 17 and 18).

RECOMMENDATIONS

(a) All men who are required to set up a blow-moulding machine should be effectively trained, both with regards to the actual technique of mould setting, and the safety precautions to be observed. Training should also include instructions in the importance of keeping machines clean and free from oil and the area around machines free from obstructions. No person under the age of 18 years should be allowed to engage in mould setting unless he is under close supervision.

(b) Sharp edges should be removed from outer edges of moulds to avoid possible laceration to the hands.

(c) Adequate provisions should be made for handling the moulds in and out of the machine. Mechanical aids not only facilitate this work but also help to prevent the trapping of fingers by slipping moulds, or injury to the feet caused by falling moulds. It must be emphasised, however, that any method for lifting moulds can in itself be dangerous; for example, if there is faulty slinging or inadequate provision of eyebolts, or misunderstanding between the person operating the lifting device and the mould setter. All tools, slings, pulleys, etc., should be clearly marked with their weights so that adequate lifting apparatus can be used.

(d) As a general principle, the power should be switched off except when it is necessary for a movement of the platen to be made.

(e) Each machine should be provided with means to move the platen at a slow speed and so arranged that the operator can stop the movement immediately by the release of an inch button or equivalent device.

(f) All the setting-up procedure up to the point where preparations are made to take a mould should be undertaken at reduced speed of movement and under inching control.

(g) A normal stroke such as would be undertaken during moulding should not be made except when the guard arrangements are in position.

(h) If it is necessary for setters to climb on to a machine, safe footholds should be provided.

SOLENOIDS

Solenoid operated valves should be arranged to operate in such a direction as to impose no undue frictional resistance on the solenoid plunger.

Solenoids should be so enclosed as to prevent the entry of dust or other foreign bodies sufficient to interfere with the working of the apparatus.

Means should be provided to permit manual operation of the valve if necessary for test purposes without removal of the cover of the solenoid.

ELECTRICAL EQUIPMENT ASSOCIATED WITH GUARDING SYSTEMS

Where a guarding system is associated with the use of electrical equipment the guard operated switch or switches is termed the interlock switch and the current so controlled is referred to as the interlock circuit. As soon as the guard starts to open the interlock switch should be open and the interlock circuit de-energised.

The interlock and control circuit should be one that has been designed and constructed to prevent the formation of any transient over-voltages due to the action of inductive or capacitive circuit elements, such as contactor coils, power factor capacitors, that might impair the operations of the circuit. Opening of the guard should remove electrical supply from closing valve solenoids.

LIMIT SWITCHES

Switches intended to terminate a cycle should be operated positively by cam or other appropriate mechanical action and should "fail to

Limit switches should be arranged so that the roller or cam or other device is adequately proportioned and made of suitable materials to withstand wear which may affect the operation of the limit switch.

The means of operation of the switch and the switch itself should be maintained in their correct relationship. Adequate stops should be fitted to prevent over travel of guard screens.

Where it is considered that the operating levers or rollers which are incorporated in limit switches are not adequate for cyclical working, separate mechanical linkage should be provided.

Limit switches should not rely on a spring to open the switch to the open circuit position. The switches should be selected so that the action of finally opening the contacts is mechanically positive. The electrical contacts should be of liberal rating so as to provide adequate safeguard against fusion.

Micro-gap switches commonly called micro-switches are not suitable for safety switch requirements.

Electrical conductors should be sufficiently rigid, supported and spaced so that short circuits will not occur by arc-over and should be so insulated as to prevent "tracking" due to creepage.

Switches should be of a type that prevents entry of dirt, moisture, dust, fumes, oil, and other foreign material of an extent likely to interfere with the

proper working of the switch. They should be mounted to withstand vibration which might interfere with their proper working. They should provide a liberal degree of over travel.

When the limit switch is operated by a cam, the cam should be so designed that reverse rotation will not damage the limit switch.

HEATERS

Heaters on small blow moulding machines are at times in close proximity and easily accessible to the operator. In such circumstances guarding should be considered.

This guarding may take the form of open mesh screening situated at a reasonable distance from the heater casing to allow dissipation of heat.

ADDITIONAL INFORMATION

District Offices of the Department of Labour will supply any further information that may be required. Offices are located at:

Whangarei	Hastings	Nelson
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