Millbank Extrusion

OPERATORS GUIDE

Steam Extruder
Model BASM-93 SX

BÜHLER MILL BANK EXTRUSION EQUIPMENT IS
MANUFACTURED BY

OPERATORS GUIDE – BÜHLER MILLBANK EXTRUSION MODEL BASM-93 SX EXTRUDER

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1 Extrusion Technology

1.1 Principles of extrusion technology

In simple terms the Bühler Millbank Extrusion extruder consists of a cylindrical barrel containing a helical screw. One end of the barrel is closed off, apart from one or more small apertures. During the extrusion process, raw materials are fed into the open end of the barrel and conveyed by the rotating action of the screw down the length of the barrel and forced through the apertures in the closed end. In Bühler Millbank Extrusion extruders the screw is divided into a number of sections. Between each of these are located circular plates (choke plates) that act as flow restrictions. The conveying action of the screw forces the raw material to flow through the small gap between the choke plates and the inside of the barrel. The mechanical energy of the screw's rotation is converted to heat energy as a result of friction between the raw material and the extruder's parts, and frictional forces within the raw material itself. The raw materials, which in most cases contain significant amounts of starch and/or protein are simultaneously cooked and worked into a viscous dough or paste-like mass.
The attainment of this condition may in some cases be helped by the direct injection of steam or water into the barrel, external heating of the barrel by steam or electrical means or the use of a preconditioning operation. In the process of transforming the raw material to this condition, considerable physical and chemical change occurs in the raw material, principally the result of changes to the starch and protein in the raw material.

Upon being forced through the die or aperture at the barrel end, the now dough-like material is shaped and formed. As the action of the screw inside the barrel creates considerable pressure in the material being processed, exit from the die will typically result in instantaneous boiling off of considerable quantities of moisture in the product. This can result in a substantial lowering of the material's moisture content.
Depending on the chemical make-up of the material and the conditions used in the extrusion process, the material may undergo considerable expansion. Some products may not be formed and exit the die as a discrete meal retaining a particulate nature, while others will retain a highly expanded texture.
A number of extruder barrel and screw configurations exist. The Bühler Millbank Extrusion approach of using a constant barrel diameter and screw root diameter with a constant screw pitch, but variable sized flow restrictions (choke plates) offers the user considerable flexibility at a relatively low cost.

1.2 Advantages of extrusion technology

Extrusion processing typically offers a number of advantages over alternative technologies for the production of many products.
This in many cases is because extrusion combines a number of different unit operations in a single process. Mixing, cooking, forming/shaping and to some extent drying, are all possible with a single extruder.

Further advantages include...

Versatility. A wide variety of products can be produced using the same basic machine. Bühler Millbank Extrusion extruders are designed to allow quick, easy modification for production of a variety of products.

High Productivity. Extrusion is a continuous process and allows high production rates, often requiring less floor space and labour than alternative technologies.

Unique products. Extrusion allows the production of shapes that are often difficult or impossible to produce by other means.

High product Quality. Extrusion can be used as a very effective means of high temperature short time processing, allowing better nutrient retention while effectively modifying the product in a desirable manner or destroying anti-nutritional factors and/or microorganisms.

Energy efficient. Extrusion cooking occurs at lower moisture levels than more conventional technologies and therefore reduces the energy requirements in both the cooking process itself and any subsequent drying operations.

Minimal Effluent. Extrusion processes generate effectively no effluent, a major advantage as modern food and feed manufacturers are faced with increasing pressure to minimise the effect of their activity on the environment.

1.3 Principles of Steam Preconditioning

The use of a steam conditioner unit allows the raw materials to be partially cooked and moistened prior to reaching the barrel of the extruder. This can be achieved by the direct injection of steam or hot water, which is thoroughly mixed with the raw material to ensure a very homogenous moisture distribution in the raw material fed into the extruder barrel.

Steam Preconditioning has several advantages:

1) INCREASED PRODUCTION RATES:

Because the raw materials are partially cooked using steam there is less mechanical energy required to heat the product to the final temperature. Therefore for a given motor size, the production rate is a lot higher than that of "Dry extrusion".

2) GREATER SHAPING CAPABILITIES:

The use of steam allows the moisture content of the raw materials to be increased. This greatly improves the shaping properties and final texture of pelleted products.

3) REDUCED WEAR ON BARREL PARTS:

The life of barrel parts is increased due to the less abrasive nature of the partially cooked raw materials.

4) INCREASED PRODUCT RANGE:

Due to the improved properties which "Steam extrusion" provides, there is the opportunity to produce a wider variety of products.

1.4 Process Variables

Product attributes can be controlled by the manipulation of raw material formulation, selection of process set up and operational conditions.

1.4.1 Formulation

The production of good quality extruded products requires an understanding of how the components in the product interact both during and after extrusion.
The following sections will not attempt to discuss in detail the chemical and physical interactions that occur during extrusion, but rather highlight considerations necessary in the development of formulations for extrusion.

Carbohydrates

Carbohydrates are often functionally very important components in the formulations of many extruded products and some functional carbohydrate ingredients are produced by means of extrusion such as soluble starch.
In extruded products, carbohydrates function as binding agents, suspending agents, viscosity builders and emulsifiers. Carbohydrates are important determinants of many textural and organoleptic properties of the final extruded product.

Starch

Starch is especially important as many extrusion processes cause substantial and irreversible changes to its chemical and physical nature. Gelatinisation, dextrinisation (molecular degradation) and lipid complexing are the important examples.

Both the level and source of the starch in a formulation are major considerations. Starches from different plant sources often show different abilities to expand, have very different binding abilities, produce different colours in products and impart different flavours. The mechanical energy input and the temperatures required to cook different starches can also be quite different.

Fibre

Fibre, which consists of cellulose, hemicellulose, and lignin is used as a bulking agent, to provide nutrients and to assist in the modification of the texture of some products.
The inclusion of small amounts of fibre can improve expansion in some products. Higher levels result in a reduction in expansion.
The expansion characteristics of a fibre are directly related to its purity. The protein and lipid contents of fibre are quite important, as these tend to lessen the amount of expansion.

The particle size of fibre used is also an important consideration. Smaller particle sizes provide better expansion and a finer cell structure in the product. Fibre solubility is also of interest. Soluble fibre can generally be added at higher levels without loss of expansion. During extrusion processing, higher fibre formulations can actually show increases in soluble fibre content.

Sugars

A range of sugars can be used in extrusion. Sucrose and various corn syrups are commonly used.
Functions of sugar can include the modification of flavour, texture, the control of water activity and the promotion of maillard browning.
Sugars have a viscosity thinning effect and at lower levels may increase expansion.

Sugars have a tendency to reduce the availability of water for gelatinisation (cooking) of starch. This has implications for the time temperature regime required to achieve gelatinisation and may have implications for the extruder set-up required.

This tendency to reduce water availability can be utilised in the control of water activity.

Hydrocolloids

The viscosity building and gel forming properties of hydrocolloids can be used to influence the nature of extruded products. Commonly used hydrocolloids include carrageenan, agar, pectins, alginates, xanthan, guar and locust bean gums.
Binding, stabilisation and the modification of textural properties such as firmness, smoothness and integrity can be achieved by their use. In many cases application is best suited to low shear and also low temperature processes.

Proteins

A variety of proteins from both plant and animal sources are often included in extruded products for a variety of reasons. Significant plant proteins include that of many cereal ingredients such as wheat gluten and that of a variety of oil seeds, especially soy. Animal protein sources are also wide ranging. An important consideration in the use of a protein is its prior thermal history. Proteins that have been subjected to heat processing will have to some extent been denatured and lost their functionality.

Proteins may be included in extrusion formulations for nutritional or palatability reasons or for functional reasons. Protein functionality in extruded products can include foaming, emulsification, heat setting, thickening, gelation, adhesion and stabilisation properties.

Denatured proteins will not exhibit such functional properties but may be included because of their nutritional value or improvement of palatability.
The extent of protein denaturation is typically measured by means of Nitrogen Solubility Index (NSI). Lower values of NSI indicate more extensive denaturation.

In many processes, protein characteristics have a significant influence on product attributes. Different proteins can have totally different effects. For example significant behavioural differences exist even between cereal proteins.

Extrusion processing has been widely studied for use in the production of textured vegetable proteins and this technology is becoming more commonly used.

Lipids (fats and oils)

The inclusion of lipids in extrusion formulations can increase the palatability and energy content of a product and modify cell structure and product texture. Higher levels of lipid can decrease expansion, gelatinisation and water solubility. The lubricating effect of lipids will lower the dissipation of mechanical energy as heat and this may have consequences for the type of extruder configuration required for a product. Higher lipid levels also make a product more susceptible to rancidity. It is therefore advisable to add the lipids (if possible) after the extrusion process during the coating process.

Water (moisture) content

Moisture content is a primary parameter in the control of extrusion processes. The initial moisture content of a material for extrusion will influence final product density, its expansion, cooking and rehydration properties.

Vitamins

Any thermal processing of food or feed stuffs can result in vitamin losses. Extrusion processing is typically high temperature short time (HTST) in nature and results in better vitamin retention than many alternative technologies. Vitamin losses do however need to be considered particularly where a feed or food formulation has vitamins added. For some products it may be better to add vitamins after extrusion by processes such as fat coating.
Bühler Millbank can offer consultancy in the development of formulations for extrusion.

1.4.2 Equipment set up

The time temperature regime of a given process will principally be determined by the barrel configuration chosen. The selection of larger choke plates will result in the generation of higher temperatures in the barrel. For a constant shaft speed the number of barrels operated will determine the retention time in the barrel. The operation of a longer barrel can allow the temperature of the product to be built up more gradually over the length of the barrel. This can allow operation with smaller choke plates in the

earlier sections of the barrel and ease entry of product into the barrel. Extruder set-ups capable of imparting more mechanical energy through friction are often required for the extrusion of materials having higher oil contents such as oil seeds.

1.4.3 Operational

Operational variables that may be adjusted during operation to control extrudate attributes include:

Feed rate. The rate at which material can be fed into the extruder barrel may be adjusted by changing the volume feeder speed. Higher feed rates increase the volume of material in the screws. To achieve optimal shaping, the barrel needs to be supplied with adequate material to fill the extruder screw volume. Feed rates that are too low will often cause the product to surge through the die(s) resulting in large variations in product length. Feed rates that are too high may cause blockages in the barrel.

Rate of Water Injection. The adjustment of the water injection rate can have a major influence on the extrudates density, texture as well as its moisture content. High rates of water injection are typically required at start up to initiate flow through the barrel and die(s) but will be decreased once steady state flow is established. Too little water injection may result in inadequate binding. The need for water injection may be greatly decreased by the use of steam conditioning.

Steam flow rate and retention time in the conditioner. These will determine the extent to which the raw material is cooked prior to extrusion and will influence the moisture content, its binding and its uniformity.

Water-cooling and barrel heating. Water-cooling and/or electric (or steam) heating can be used to fine-tune the temperature profile in the extruder barrel.

1.5 Interaction of the extrusion process with auxiliary processes and equipment.

The efficient and economic operation of an extrusion plant is highly dependent on the good design and operation of the entire process line. A typical extrusion plant will also require size reduction, mixing, conveying and storage equipment. Many plants will also require drying, cooling and fat coating equipment. Some auxiliary processes such as steam preconditioning, drying etc. will require plant utilities such as steam and gas. The proper design of these auxiliary processes can have a major influence on the extrusion process itself.
Size reduction processes are especially important and have a pronounced effect on product attributes. However, even with adequate size reduction equipment, problems can arise if mixing and transportation equipment and storage bins are inadequate or allow raw materials to separate into differing particle size fractions.
The nature of the raw material to be processed and the final product are important considerations in the design of auxiliary equipment. High moisture or oil materials are especially susceptible to bridging problems in transport and storage. The design of such equipment needs to consider both present requirements and possibilities in the future.

Protection of equipment.

Raw materials used in extrusion can often contain grossly oversized material and/or foreign material. To avoid damage to equipment or loss of performance it is often well worth installing one or more forms of protection. Screens and magnets may provide cheaper alternatives. Where considerable capital investment has been made, the additional cost of a metal detection system may be justified.

Two of the most important pre-extrusion auxiliary processes are size reduction and mixing.

Size Reduction Processes.

Raw material particle size reduction is arguably the most important pre-extrusion operation. Conventional roller milling, grinding and pulverising is commonly used methods.

A uniform particle size promotes the uniform uptake of moisture and heat (from mechanical energy) by all particles during extrusion processing.

A more uniform particle size in the raw material will therefore ensure that all particles are evenly cooked during extrusion and will avoid the presence of hard, partially cooked particles in the final product. Raw materials containing particles approaching, or greater in size than the die aperture, can cause partial obstruction or plugging of the die, resulting in problems with the product's appearance (especially surface appearance) and a lowering of throughput.
It is a generally acknowledged rule that the particle size should be less than 1/3 of the die aperture.
Particles ground to a smaller size have more surface area relative to their volume, providing more area for inter-particulate binding. This is particularly important in aquaculture feed manufacture where the products stability in water has a large influence on its efficient utilisation and the prevention of environmental pollution.
Finer grind sizes will also reduce wear during extrusion.

Mixing.

Mixing is extremely important. Adequate mixing is essential but over mixing is equally troublesome. Inadequate mixing will result in large variations in behaviour during extrusion and in the product's nature. Over mixing can result in separation of different particle size fractions.
Ribbon mixers are commonly used although alternative technologies do exist. Mixing will occur to some extent during preconditioning operations.

1.6 Record Keeping

The development of a quality assurance programme will be of great advantage to the extrusion processor. Recording information such as extruder configurations, product formulations, mixing times, moisture contents and any measured product or raw material attributes can form the basis of such a system. Such historical information can provide a basis for product and process development and improvement. In more sophisticated operations, such information may lend itself to the application of statistical process control and other techniques for the monitoring and improvement of processes.

Close monitoring of extrusion processes is essential because of the high wear factor in the equipment. Historical information will allow the manufacturer to plan maintenance and parts replacement more effectively.
Run log sheet in appendices.

2 Bühler Millbank Extruder - Features and Descriptions

2.1 Operator Safety

It is strongly advised that management develop a formal health and safety program for plants installing a new extruder. Local government legislation concerning health and safety should be consulted to assist with this. It should be ensured that the following issues are addressed.

HEARING PROTECTION Operation of an extruder is relatively noisy and normally accompanied by noise from auxiliary equipment often noisy in nature. Prolonged exposure to this could result in damage to an operator's hearing. It is advised that operators wear hearing protection.

CUTTER KNIFE The CUTTER KNIFE should not be operated without the CUT OFF KNIFE GUARD in place.

EYE PROTECTION Wearing of eye protection is advised for operation of the machine during start up and shut down.

THE RISK OF BURNS The operation of an EXTRUDER by its nature generates large amounts of heat in the BARREL. After even short periods of operation, all components of the BARREL ASSEMBLY will become dangerously hot. To avoid burns operators should wear heat resistant gloves and protective clothes if handling BARREL COMPONENTS after operation. If purchased, a Bühler Millbank Extrusion TOOL KIT will include a pair of leather gloves for this purpose.

WASH-DOWN/ELECTRICAL HAZARDS Care should be taken to avoid getting water in electrical components during wash down.

MOVING PARTS Moving parts including the extruder screw, force-feed system and internal parts in the steam conditioner all pose a serious hazard to operators if safety procedures are not followed. The STEAM CONDITIONER should not be operated with the door open. If working inside the STEAM CONDITIONER the power supply to the CONDITIONER should be isolated.
Hands must be kept well clear of the SCREW if the EXTRUDER is operated with BARREL INSPECTION HATCH open.

REMOVAL OF BARREL HEAD SECTION When removing the BARREL HEAD SECTION after operation extreme care is needed as there can be substantial residual pressure in the HEAD SECTION. Upon removal, this can blow the HEAD SECTION off with considerable force. Operators should therefore not stand or place limbs in front of the HEAD SECTION when removing it. Operators should also be aware of the possibility of steam being released upon removal of the HEAD SECTION. It is recommended that heat resistant gloves, eye protection and protective clothes be worn. The initial removal of one CLAMP only may allow the safe release of pressure before removal of the second CLAMP.

DISCONNECTION OF COOLING WATER HOSES If the water supply has been terminated after stopping the EXTRUDER, residual heat in the BARREL can heat water remaining in the WATER COOLING JACKETS to dangerously high temperatures, even forming steam. Operators should be wary of this. To avoid the possibility of burns it is advised that the water-cooling continue to be run for some time after stopping the EXTRUDER.

ADJUSTMENT OF NOZZLE PIECE. It is very important that the instructions for this procedure, as laid out on pages 4-3, are fully understood before making any adjustments to the extruder end section and nozzle piece. Failure to do this may result in serious operator harm or machine damage.

2.2 Installation of Bühler Millbank extrusion equipment

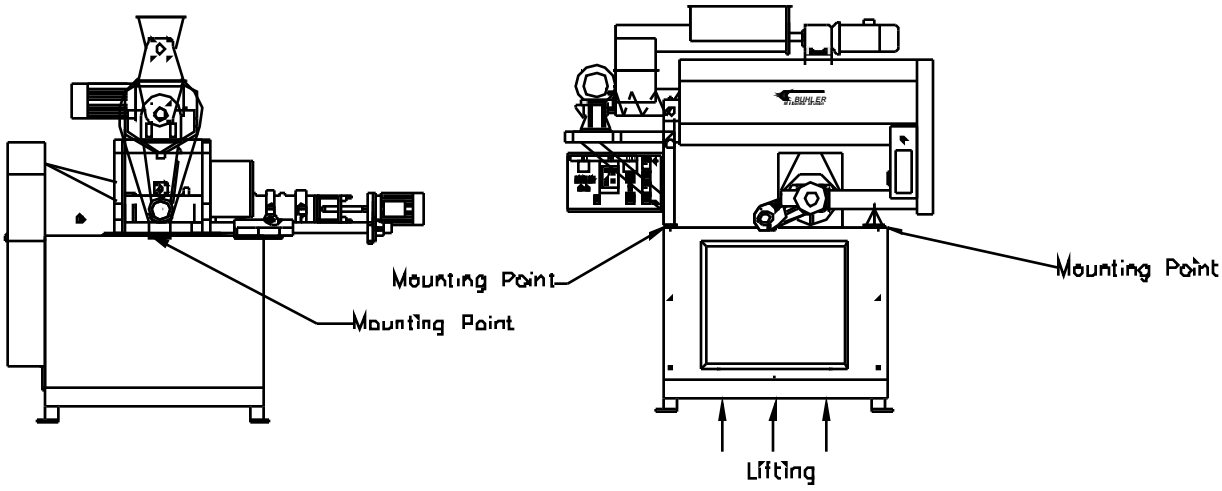
The reader is referred to the appendix for information regarding the dimensions and electrical specifications. Specifications for water and steam supply requirements (where appropriate) are also provided in the appendix.
The EXTRUDER should be mounted on a level floor.

It should be ensured that the FORK-LIFT used (or any alternative lifting device) has adequate lifting capability. To ensure safe lifting, the forks should be inserted under the machine, either from the front or the rear, between the feet as far apart as practical. If lifting from the front of the EXTRUDER, remove the BARREL HEAD SECTION and, if fitted, the MAIN SHAFT EXTENSION PIECE or MAIN SHAFT BUSH and the OUTBOARD CUTTER MOUNTING.

2.3 Remounting of Steam Conditioner

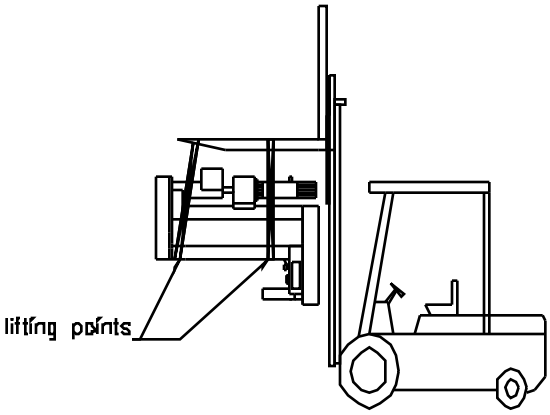
In many cases the STEAM CONDITIONER will have been removed from the EXTRUDER for shipping and will therefore need to be remounted. The CONDITIONER is bolted to the EXTRUDER at four points as shown in figure 2.2.
These mounting points are slotted and allow the CONDITIONER to slide sideways. This will allow the removal of the FEED INTAKE HOUSING after installation, without the need to actually remove the conditioner from the machine.

Figure 2.2 CONDITIONER Mounting points



Mechanical lifting will be required in order to mount the CONDITIONER. This should be carried out using two nylon lifting strops placed as indicated in figure 2.3.

Figure 2.3 CONDITIONER lifting points



CONDITIONER REMOUNTING PROCEDURE

- Lift CONDITIONER onto its mounts and loosely tighten hex bolts.
- Slide the CONDITIONER sideways so that the FORCE FEED (BOTTOM AUGER) tube slides into the FEED INTAKE HOUSING. Fit and tighten the three M8 bolts into the collar of the BOTTOM AUGER (FORCE FEED) tube and the FEED INTAKE HOUSING.
- Tighten the four hex bolts on the mounting points.
- Wire up the A.C MOTOR and check the direction of rotation. If this is incorrect the wires should be reversed.
- Replace the oil bung (plug) on the top of the CONDITIONER GEAR BOX with the BREATHER taped to the CONDITIONER GEAR BOX.

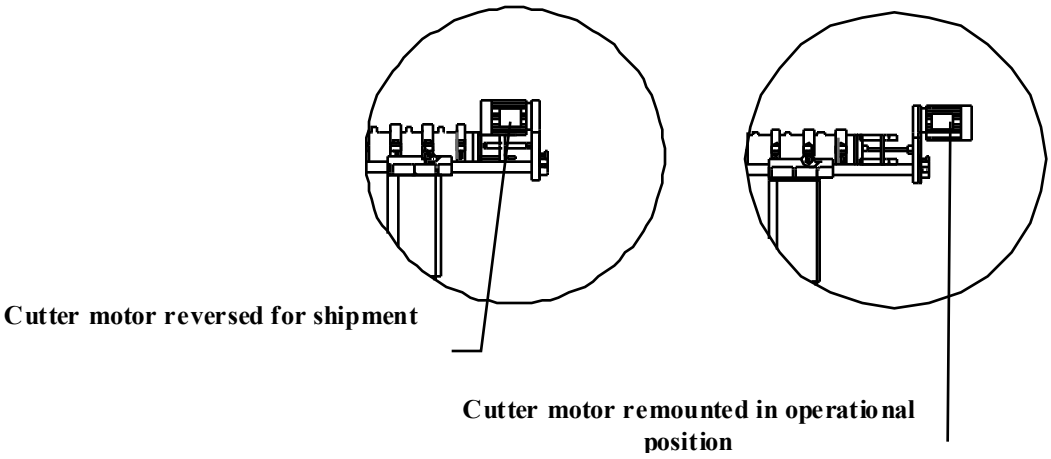
Failure to fit the BREATHER to the CONDITIONER GEAR BOX may result in damage to GEAR BOX.

- Connect water and steam to the respective kitsets as described in chapters 3 and 6.
- Connect the WATER INJECTION KITSET to the WATER INJECTION VALVES on the CONDITIONER and the FEED INTAKE HOUSING. Tube is supplied for this purpose.

Reversal of CUTTER MOTOR

Attention : For shipping purposes, the CUTTER MOTOR on EXTRUDER models supplied with OUTBOARD CUTTERS has been reversed

This must be remounted in the opposite direction to allow normal operation.



2.4 General Description of the Bühler Millbank Extruder

2.4.1 Extruder features

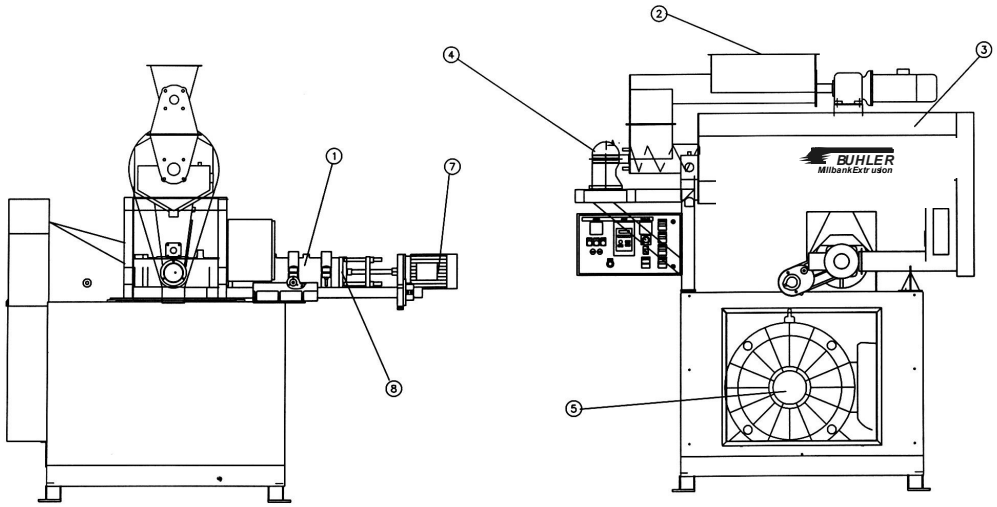


Figure 2.4 Layout of the Bühler Millbank Extrusion 501-SX/1001-SX/2001-SX 500-SX/1000-SX/2000-SX EXTRUDER

1.	BARREL ASSEMBLY	Refer to section 3 of operator's guide
2.	INFEED AUGER	Refer to section 6 of operator's guide
3.	STEAM CONDITIONER	
4.	STEAM CONDITIONER MOTOR	
5.	MAIN MOTOR	
6.	N/A	
7.	OUT-BOARD CUTTER DRIVE	
8.	BARREL HEAD SECTION	Refer to section 4 operator guide

3 General description of the Bühler Millbank Extrusion BARREL ASSEMBLY.

The following section aims to familiarise the user with the basic BARREL ASSEMBLY components and explain how these are assembled for operation.

The term Barrel Assembly collectively refers to components concerned with the SCREWS and BARREL. Bühler Millbank EXTRUDERS utilise a segmented BARREL and SCREW design. The BARREL (cylindrical member around the SCREW) is made up of a number of BARREL OUTER HOUSINGS. These are clamped together to form the BARREL'S length (refer to figure 3.1). Likewise the SCREW is made up of a number of sections which correspond to the number of BARREL OUTER HOUSING SECTIONS. These hollow helical sections fit over the MAIN SHAFT, which drives these via a number of KEYS. At the joins between each section of the BARREL OUTER HOUSING is a sleeve called a WEAR RING and between each SCREW SECTION are restrictions termed CHOKED PLATES. CHOKE PLATES can be a variety of sizes and restrict flow between themselves and the WEAR RINGS creating regions of intense shear and consequently generate heat in the product.

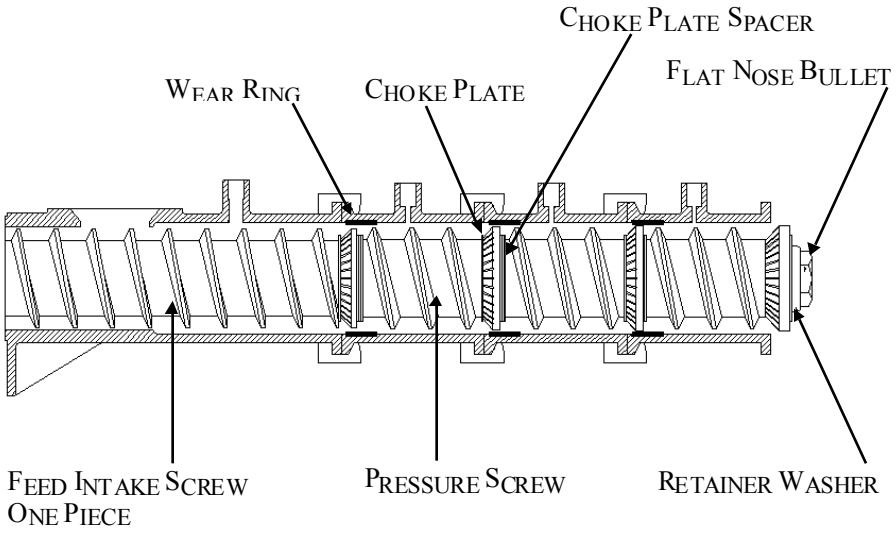
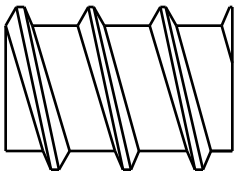


Figure 3.1 Generalised BARREL ASSEMBLY for Bühler Millbank Extrusion ***500 series EXTRUDERS***

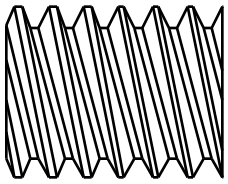
3.1.1 SCREWS (500 series EXTRUDERS)

These come in four types, SINGLE FLIGHT SHORT, SINGLE FLIGHT LONG, DOUBLE FLIGHT LONG and a one piece FEED INTAKE SCREW.

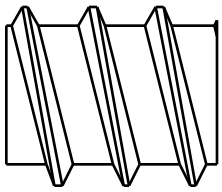
PRESSURE SCREW SINGLE FLIGHT LONG



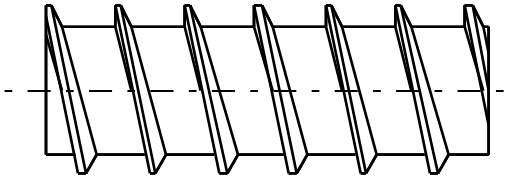
PRESSURE SCREW DOUBLE FLIGHT LONG



SCREW HIGH SHEAR SINGLE FLIGHT LONG



INTAKE SCREW ONE PIECE



PRESSURE SCREWS are used to transfer product through the BARREL of the EXTRUDER, generate heat within it and force it through the DIE. This process occurs through two zones - The first being the feeding zone, the second being the cooking zone. The use of DOUBLE FLIGHT SCREWS will generate more heat in the product, particularly for oily materials.

3.1.2 Feed Zone

This is the area where the raw materials enter the EXTRUDER BARREL.

There are two types of SCREW configurations that may be employed in the feed zone. A single, one piece INTAKE SCREW may be used or a combination of two SINGLE FLIGHT LONG PRESSURE SCREWS (multiple section configuration). SCREWS suitable for operation in both modes may be supplied with machines. Operation of either may have advantages for a particular situation.

Multiple Section SCREW Configuration.

When setting the EXTRUDER up to operate with a multiple section SCREW configuration it should be ensured that the flighting forms a continuous spiral. Should it be found that the flights do not meet, remove a section and turn it around.

One Piece SCREW Configuration

The ONE PIECE FEED INTAKE SCREW has a flat profile and added volume. This profile aids the transportation of material to the cooking section of the BARREL. It also helps the flow of low density products. To allow correct operation this SCREW must be placed on the EXTRUDER SHAFT in the correct orientation. Figure 3.2.1 indicates this.

In order to slide a ONE PIECE FEED SCREW into place its KEY WAY must first be properly oriented with the MAIN SHAFT KEYWAY.

3.1.3 Cooking Zone

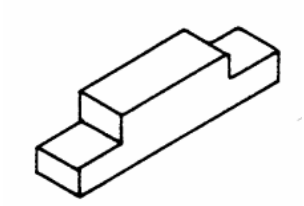
The cooking zone can be set up using DOUBLE or SINGLE FLIGHT LONG PRESSURE SCREWS or a combination of both of these. The choice of SCREW type will depend on the material being processed. In general low moisture/high starch products are best extruded with set ups using SINGLE FLIGHT SCREWS while high moisture/oil products, particularly those requiring high temperature processing, are best extruded with DOUBLE FLIGHT SCREWS.

HIGH SHEAR SINGLE FLIGHT SCREWS have a closer tolerance with the BARREL OUTER HOUSING. This can provide a more positive pumping action.

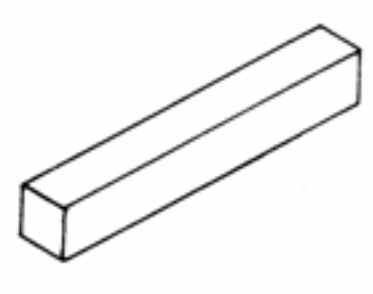
3.1.4 DRIVE KEYS

Three types of drive keys are used to drive the rotation of the screws. To allow insertion of these, the key ways of the screws and the main shaft need to be properly oriented.

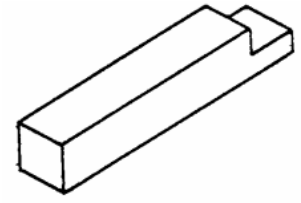
DRIVE KEY SHORT



DRIVE KEY LONG

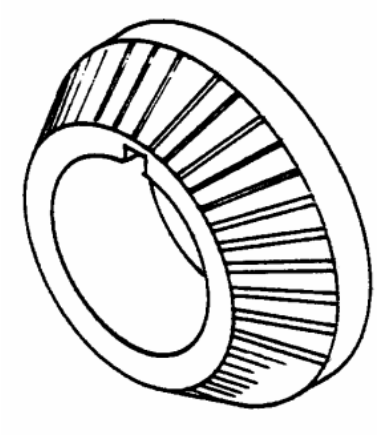


EXTENSION SHAFT KEY



3.1.5 CHOKE PLATES:

The CHOKE PLATES are used to create a restriction to the flow of material down the BARREL of the EXTRUDER. This restriction causes the pressure to increase and the temperature to rise. The larger the CHOKE PLATE, the greater the restriction and consequently the temperature and pressure rise. There are four sizes, the descriptions relate to the overall diameter of the CHOKE PLATE, therefore an 83 is the smallest and a 96S the largest.



CHOKE PLATE 83

CHOKE PLATE 89

CHOKE PLATE 92

CHOKE PLATE 95

CHOKE PLATE 96S

The performance of CHOKE PLATES will change considerably with wear. This is discussed in the section on maintenance.

3.1.6 CHOKE PLATE SPACERS:

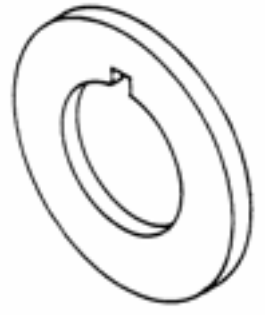
These SPACERS are used to position the CHOKE PLATES in relation to the WEAR RINGS and maintain a fixed distance between the SCREWS. An adequate number CHOKE PLATES SPACERS is required to avoid gaps between SCREWS, CHOKE PLATES and CHOKE PLATE SPACERS (see section 3.2.2).

CHOKE PLATE SPACER

3.1.7 CHOKE PLATE RING:

CHOKE PLATE RINGS should be used if 96S CHOKE PLATES do not generate sufficient heat. When used, they should be positioned immediately after the 96S CHOKE PLATE. It will also be necessary to reduce the amount of CHOKE PLATE SPACERS in the BARREL set-up.

CHOKE PLATE RING



3.1.8 BARREL OUTER HOUSINGS

Barrels are held together by CLAMPS. Four BARREL OUTER HOUSING LOCATION DOWELS are used on each BARREL except for the last one which does not have any. The longitudinal grooves on the internal walls of the BARREL OUTER HOUSINGS help to transport the product while at the same time allowing recirculation to take place. The standard set-up uses two BARRELS, and the use of a MAIN SHAFT EXTENSION KIT allows for a third and/or fourth to be added. There are four types of BARREL HOUSINGS.

3.1.8.1 STANDARD BARREL OUTER HOUSING

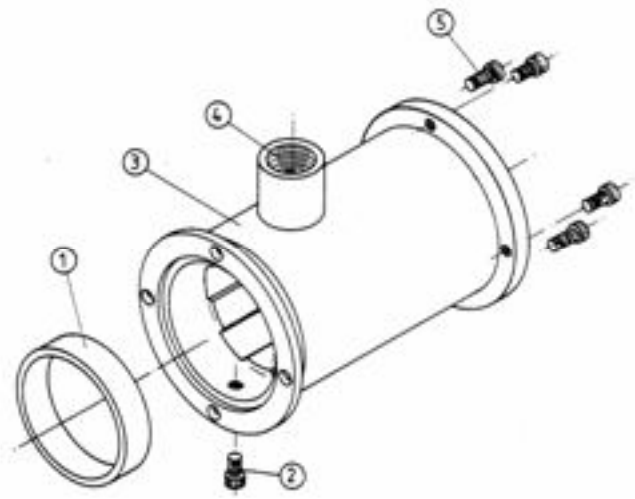


Figure 3.2 Barrel Housing Assembly

1. WEAR RING HARDENED
2. WEAR RING LOCATION DOWEL
3. BARREL OUTER HOUSING STANDARD
4. THERMOMETER PORT
5. BARREL OUTER HOUSING LOCATION DOWELS

3.1.8.2 WATERC OOLING JACKETS

WATER COOLING JACKETS are an option that may have been supplied with an EXTRUDER. These are designed to provide fine temperature adjustment and stabilisation for difficult products. Where a large reduction in process temperature is desired, the use of smaller CHOKE PLATE sizes will probably provide a better first approach, than the use of WATER COOLING.

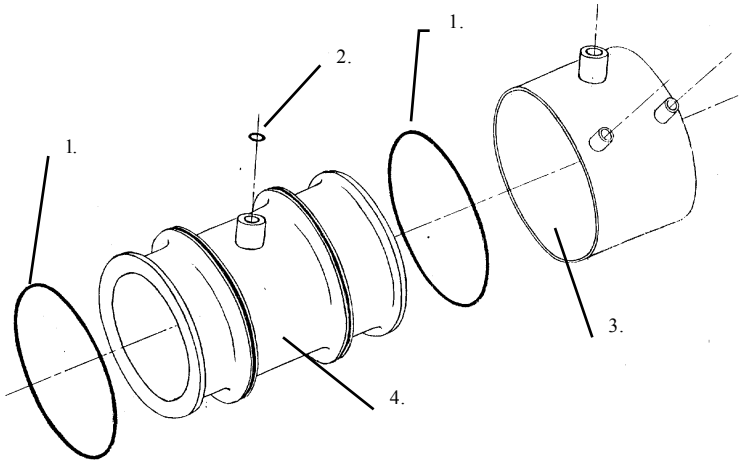


Figure 3.3 WATER COOLING JACKET ASSEMBLY

1. END SEALING "O" RING - E050-BJ002
2. TEMPERATURE PORT "O" RING - E100-BJ003
3. STAINLESS STEEL BARREL JACKET - E050-BJ001
4. BARREL OUTER HOUSING COOLED - E050-BA031

The water supply hoses from the WATER COOLING MANIFOLD are connected to each JACKET by push on quick connectors. These are removed by depressing the tapered release collar (refer to figure 3.1.9 A)

Care should be exercised when removing the COOLING WATER HOSE CONNECTIONS after use, as steam or dangerously hot water may be present.

Figure 3.4 Disconnection of push on quick connectors

The flow rate of cold water into the WATER COOLING JACKET inlets is controlled by the VALVES on the WATER COOLING MANIFOLD. The heated water from the MANIFOLD flows to the outlet MANIFOLD.

It may well be possible for the user to recover the energy in this heated water in some manner, such as diverting this to a boiler header tank or in a water tank prior for water injection into the EXTRUDER and or PRE-CONDITIONER.

If during operation the barrel temperature is hotter than desired, the COOLING WATER CONTROL VALVES should be opened further. It is advisable to do this gradually, allowing time for the system to equilibrate after adjustments. If replacing a BARREL OUTER HOUSING, the WATER COOLING JACKETS may be pressed off and fitted to replacement BARREL OUTER HOUSINGS. The condition of the END SEALING "O" RING should be checked. If in poor condition, this should be replaced to avoid leakage. When fitting JACKETS to new BARREL OUTER HOUSINGS, it is suggested that the "O" RINGS are lubricated before pressing the JACKET on.

3.1.8.3 BARREL OUTER HOUSING heated

These optional BARREL OUTER HOUSING sections have an ELECTRIC HEATER BAND which wraps around the BARREL OUTER HOUSING SECTION. These can be used to supply additional heat and fine tune a process. The actual heater bands are protected with a removable cover. Machines supplied with ELECTRICALLY HEATED BARREL

OUTER HOUSINGS will also have CONFIGURABLE TEMPERATURE CONTROLLERS. These will require some minor programming to set them up for a specific process. The original manufacturers manual will be included with this manual for this purpose. It is strongly advised that the user familiarise them self with the programming information contained within this.

3.1.8.4 Barrel Outer Housing Straight through Flutes

These barrels are very similar to a standard barrel except they do not take a wear ring. Instead grooves run the entire length of the barrel. These barrels are designed for using a screw configuration without choke plates, but utilising a continuos screw arrangement.

3.1.9 FEED INTAKE HOUSING:

Raw materials are auger fed into the feed intake housing and from here water/liquids can be added before the material is transported into the cooking zone of the barrel.

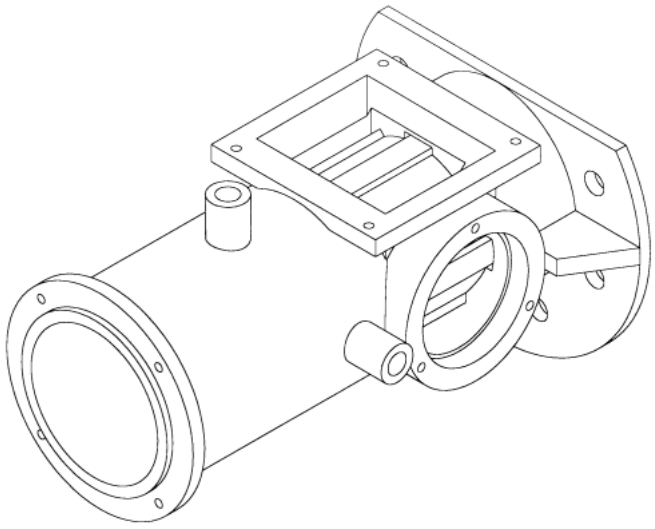


FIGURE 3.5 FEED INTAKE HOUSING R.H. SIDE ENTRY

3.1.10 WEAR RING:

These are specially hardened RINGS which are located in BARREL OUTER HOUSINGS, BARREL END SECTIONS and CUTTER HEADS. When the BARREL SECTIONS are assembled the WEAR RINGS are positioned over the CHOKE PLATES (see Fig 3.1.1). They are held in place by WEAR RING LOCATION DOWELS.

3.1.11 CLAMPS

Pairs of these are used to clamp together the BARREL OUTER HOUSINGS. The two inside edges of the CLAMPS differ, one being flat, the other tapered. These correspond to the collar edges on the BARREL OUTER HOUSINGS. Each pair of CLAMPS are held together by a pair of CLAMP BOLTS.

3.1.12 RETAINER WASHER:

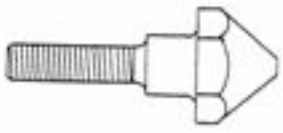
The RETAINER WASHER fits inside the last CHOKE PLATE on the end of the SHAFT and both are held in place by the NOSE BULLET. RETAINER WASHERS are used with either a BARREL END SECTION or CUTTER HEAD. However if a Compression Head is being used then the RETAINER WASHER is replaced by an END RETAINER (see 4.3). For different BARREL HEADS refer to section 4 of this guide.

RETAINER WASHER

NOSE BULLET:

These have left hand threads and screw into the end of the MAIN SHAFT BUSH or EXTENSION PIECE, securing the RETAINER WASHER, CHOKE PLATES and PRESSURE SCREWS. The CONICAL BULLET is used with a BARREL END SECTION and NOZZLE PIECE but can also be used with a CUTTER HEAD.

CONICAL NOSE BULLET



3.2 Assembly of the BARREL

Before attempting to assemble the SCREW and BARREL CONFIGURATION the operator should have decided on the SCREW, CHOKE PLATE and BARREL SET UP to be used. It is advisable to lay this on the floor in front of the machine and check through the parts.

3.2.1 Assembly of the feed section SCREWS.

ONE PIECE SCREW. This must be fitted to the SHAFT with the flat edge of the flights facing forward (out of the FEED INTAKE HOUSING).

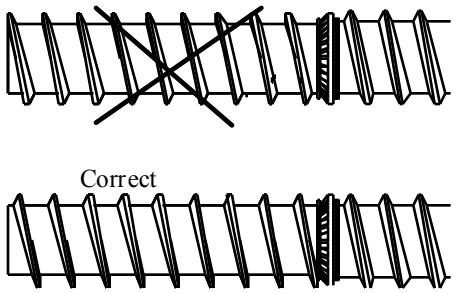


Figure 3.6 Orientation of the ONE PIECE INTAKE SCREW

Slide the SCREW over the MAIN SHAFT and push into the FEED INTAKE HOUSING. Ensure that the KEYWAYS of the SCREW and the MAIN SHAFT are aligned. This will allow the SCREW to slide all the way forward. When in position, the end of the SCREW will sit just inside the BARREL FEED INTAKE HOUSING. If the SCREW protrudes out from the FEED INTAKE HOUSING, then it may not be properly aligned with the KEYWAY or if the machine has previously been operated, the inside of THE FEED INTAKE HOUSING or SCREW may need cleaning. Once the SCREW is in place slide a DRIVE KEY LONG into the MAIN SHAFT KEYWAY and that of the SCREW.

Multiple section SCREW configuration

Figures 8.1 and 8.3 show the multiple section configuration as well as one piece configuration. Place the SCREW sections on the MAIN SHAFT and check that the flights form a continuous spiral along the length of the SCREW before pushing these into the FEED INTAKE HOUSING. It should be ensured that the SHORT DRIVE KEYS are placed between the three sections.

3.2.2 Assembly of the remaining SCREW sections

Figure 3.2.2 shows that located between each SCREW section is a CHOKE PLATE, some SPACERS and a KEY that fits into at least one of the SCREW sections. When assembling, it is easiest to first place the appropriate KEY in the KEYWAY and the last SCREW section fitted, then fit the SPACERS and CHOKE PLATES. Normally one SPACER is fitted in front of the CHOKE PLATE and the remaining CHOKE PLATE SPACERS behind the CHOKE PLATE. However the important thing is that the CHOKE PLATE sits inside the WEAR RING when the BARREL OUTER HOUSINGS are clamped together. The proportion of the CHOKE PLATE SPACERS placed in front or behind the CHOKE PLATES should therefore ensure this. The actual number of CHOKE PLATE SPACERS used does not matter. However enough are required to ensure that the DRIVE KEYS do not force a gap between the SCREWS, CHOKE PLATES or CHOKE PLATE SPACERS.

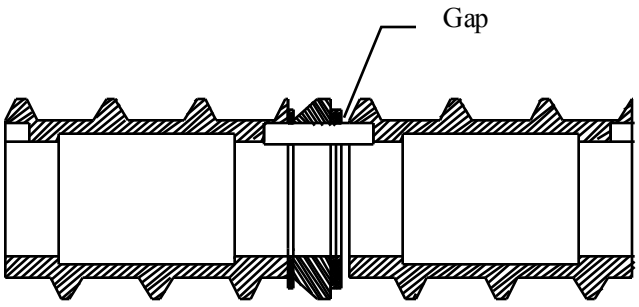


Figure 3.7 Example of too few CHOKE PLATE SPACERS

The last KEY in the MAIN-SHAFT should drive the SCREW placed over the joint between the MAIN-SHAFT and the MAIN-SHAFT BUSH or MAIN SHAFT EXTENSION PIECE if fitted. When tightened, the KEYWAYS of a MAIN-SHAFT BUSH or EXTENSION PIECE will not align with that of the MAIN SHAFT. It should not be attempted to align these. The SCREW section over the joint can therefore be driven with a single KEY only.

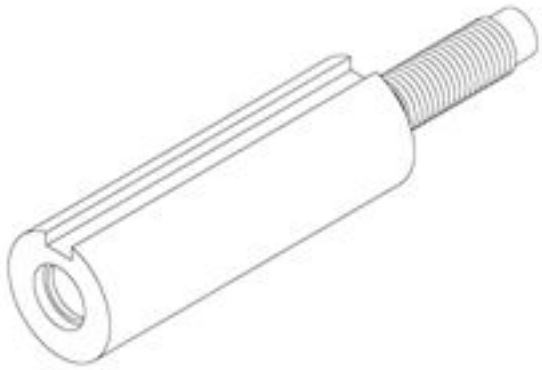
If using a RETAINING BOLT or CONICAL NOSE BULLET, the last SCREW in the SHAFT will be driven at one end only (feed end). If a COMPRESSION HEAD is to be operated then a RETAINING KEY will be needed.

3.3 Extension of the BARREL

For many applications, operation with a SHAFT EXTENSION will provide better performance. Machines may be supplied with either one or two BARREL EXTENSION KITS. Such a kit will include a MAIN SHAFT EXTENSION PIECE of a length appropriate for one or two extra BARREL OUTER HOUSINGS and the appropriate number of SCREWS, BARREL OUTER HOUSINGS and CLAMPS etc to add the extra BARREL CHAMBERS.

The MAIN SHAFT and MAIN SHAFT EXTENSION PIECES are left hand threaded. To prevent damage to the MAIN SHAFT, the "C" SPANNER provided should be used for tightening and loosening these parts.

MAIN SHAFT EXTENSION PIECE



3.4 BARREL Support

Where BARREL EXTENSION KITS are supplied the use of BARREL SUPPORT is advised. This supports the BARREL ASSEMBLY and ensures BARREL HOUSINGS remain properly aligned.

The BARREL SUPPORT UNIT attaches to the third CLAMP PAIR along the BARREL in the manner indicated by the diagram below.

When assembling the BARREL, attach the CLAMP BOLTS (1) to the STAINLESS STEEL LUGS (2.). Move the SUPPORT BOLTS (4.) into the slots on the STAINLESS STEEL LUGS (2.) Finger tighten the NUTS (4.), both top and bottom. Evenly tighten these further with a spanner.

It is important that the NUTS on the SUPPORT BOLTS are tightened evenly. The BARREL SUPPORT UNIT must not push the BARREL up or pull it down

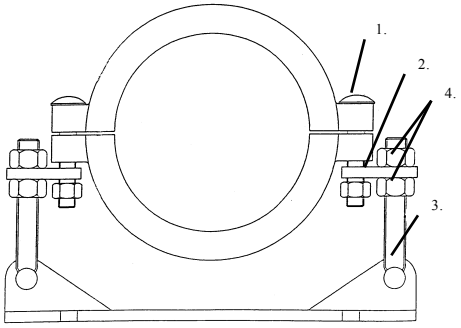


Figure 3.8 BARREL SUPPORT UNIT

3.5 Water Injection

This will need to be connected to mains water via item (1.) in the diagram printed in chapter 12.3 All connections should be made using a thread sealing tape or compound. The water supply pressure should be at least 60 psi with the FLOW METER fully open. For more assembly details see chapter 12.3.

4 Barrel Head section set-ups

The BARREL HEAD section refers to the set-up at the end of the barrel which forms and/or cuts the product.

A variety of BARREL HEAD section set-ups are available. The choice of BARREL HEAD section will depend on the product being made. Products that are formed and cut will require a CUTTER HEAD UNIT using a single or double DIE configuration, while most raw material enhancement processes will require a BARREL END SECTION with a NOZZLE PIECE. All types of BARREL HEAD SECTION set-ups are clamped onto the final BARREL OUTER HOUSING in the same manner that another BARREL OUTER HOUSING would be.

This chapter aims to describe the various set-ups, the components involved and provide a description of how these are assembled and set-up for operation.

4.1 BARREL END SECTION and NOZZLE PIECE Assembly

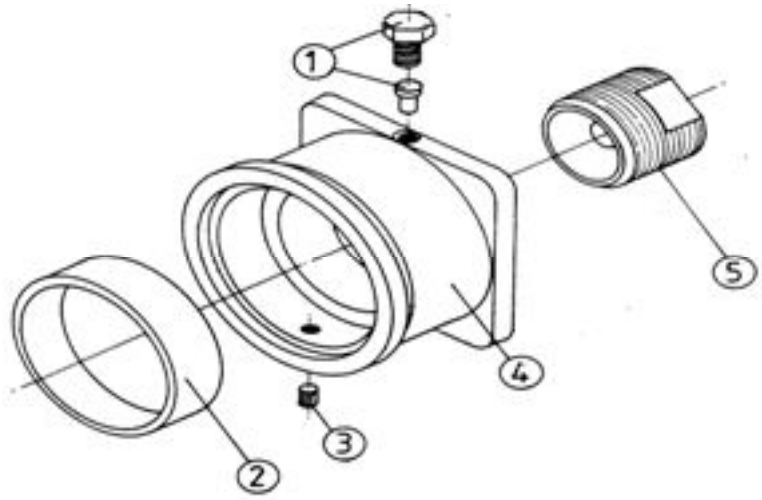


Figure 4.1 Barrel end piece and nozzle assembly

ITEM	DESCRIPTION
1	NOZZLE PIECE RETAINING BOLT/PLUG
2	WEAR RING HARDENED
3	WEAR RING LOCATION DOWEL
4	BARREL END SECTION
5	NOZZLE PIECE 8MM OR NOZZLE PIECE 12MM OR NOZZLE PIECE 16MM (1000& 2000 SERIES)

The BARREL END SECTION and NOZZLE PIECE are generally used for raw material enhancement such as the processing of full fat soya to destroy anti-nutritional factors, and the processing of rice bran for stabilisation etc. During processing material exits the nozzle as a steady stream, but particles do not bind together, the final product being in the form of a meal.

NOZZLE PIECES create heat because they add a final restriction to product flow through the barrel. This restriction can in fact be varied to control the heating of the product being processed

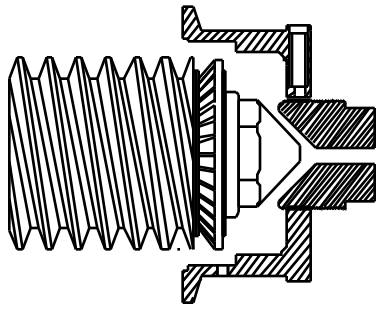


Figure 4.2 Internal configuration of BARREL END SECTION and NOZZLE PIECE assembly

The barrel head assembly used for this type of application appears relatively simple, consisting of a single NOZZLE through which the product is forced. Figure 4.1 shows the BARREL END SECTION assembly. The internal configuration of the NOZZLE and BARREL END SECTION assembly is however slightly more complex than appears. The inside of the NOZZLE PIECE is in fact a conical hollow that corresponds to the conical shape of the CONICAL NOSE BULLET (refer to figure 4.2). The gap between these male and female components presents a restriction to product flow as it is forced through the NOZZLE. The extent to which the product temperature is increased at this point, can be controlled by adjusting this gap. Adjustment is performed by screwing the NOZZLE PIECE further into, or out of the BARREL END SECTION.

Do not attempt to adjust this gap until having thoroughly read and understood the following instructions on the assembly of the BARREL END SECTION, given in the following section.

Assembling the BARREL END SECTION and NOZZLE PIECE.

1. The final PRESSURE SCREW and CHOKE PLATE should be fixed to the MAIN SHAFT by screwing in the CONICAL NOSE BULLET with the RETAINER WASHER.
2. Clamp the BARREL END SECTION onto the final BARREL OUTER HOUSING.
3. Screw the NOZZLE PIECE into the END SECTION until it makes contact with the CONICAL NOSE BULLET. If supplied the Bühler Millbank Extrusion tool kit will include a double ended spanner for this purpose.

Do not attempt this with EXTRUDER running!
Serious injury to operator and damage to the EXTRUDER may result.

4. Wind the NOZZLE PIECE back away from the NOSE BULLET a total of six turns then lock in place by tightening the NOZZLE PIECE RETAINING BOLT/PLUG (refer to figure 4.1).
5. Once the extruder has been started and the flow is stabilised, check that the processing temperatures are in the correct range.

If the temperature is too low:

- Decrease the VOLUME FEEDER speed so that the MAIN MOTOR load falls by about 10 amps.
- Release the NOZZLE PIECE RETAINING BOLT and slowly turn the NOZZLE PIECE towards the NOSE BULLET, a small amount at a time.

NOTE: It is important to count the number of turns so that the NOZZLE PIECE does not touch the CONICAL NOSE BULLET. Serious injury to operator and damage to the EXTRUDER may result if this is allowed to occur.
Travel inwards must not exceed 5 ½ turns. Each time the EXTRUDER BARREL is disassembled the position of the Nozzle should be set back to 6 turns from the NOSE BULLET.

- Lock the NOZZLE in place and adjust the VOLUME FEEDER speed so that the MAIN MOTOR current returns to the desired level.

- If the desired temperatures cannot be reached by adjusting the NOZZLE PIECE, shut the machine down and change the size of the CHOKE PLATES (ie. bigger).

4.2 CUTTER HEAD Set Ups

The production of pelleted and shaped products requires a CUTTER HEAD. It is clamped to the last BARREL OUTER HOUSING in the same manner as a BARREL END SECTION .Figure 4.3 shows a standard SINGLE DIE CUTTER HEAD assembly. The DIE PLATE (item 2) is designed to hold a number of DIE INSERTS. The number, size and shape of these vary from application to application. The aperture in the DIE INSERT acts as the DIE. In some applications the DIE PLATE will contain apertures that are intended to act as the DIES (normally for the production of small diameter and aquaculture feeds). The use of a DIE PLATE and INSERTS allows the use of DIES of different sizes and shapes. The use of BLANK INSERTS to block off some of the die holes allows a reduction in the number of DIES through which the product is forced.
The DIE acts as a final restriction to the flow of material through the barrel and forms it into the desired shape. If too many die holes are open the product may not achieve the desired temperature, shape or density.

As product is forced through the DIES it is cut off by a spinning KNIFE. The length of the pellet can be changed by varying the speed of the KNIFE and/or changing the number of KNIFE BLADES used.
In the case of machines supplied with a FIXED SPEED CUTTER, the only control over extrudate length is the number of blades on the KNIFE. Changing from a TWO BLADE KNIFE to FOUR BLADE KNIFE will for example have a similar effect (but not necessarily the same) as doubling the motor speed on a VARIABLE SPEED CUTTER. To some extent the length of the extrudate can be influenced by the number of DIES and/or the feed rate (capacity). Be aware this could also influence the quality of the end product.

In case the product is not evenly coming out of the die holes (different lengths) a DOUBLE DIE might overcome this problem. (see also figure 4.4) The inner DIE 'guides' the inner product flow towards the outer DIE. It will result in a more uniform shaping and length of the pellets.

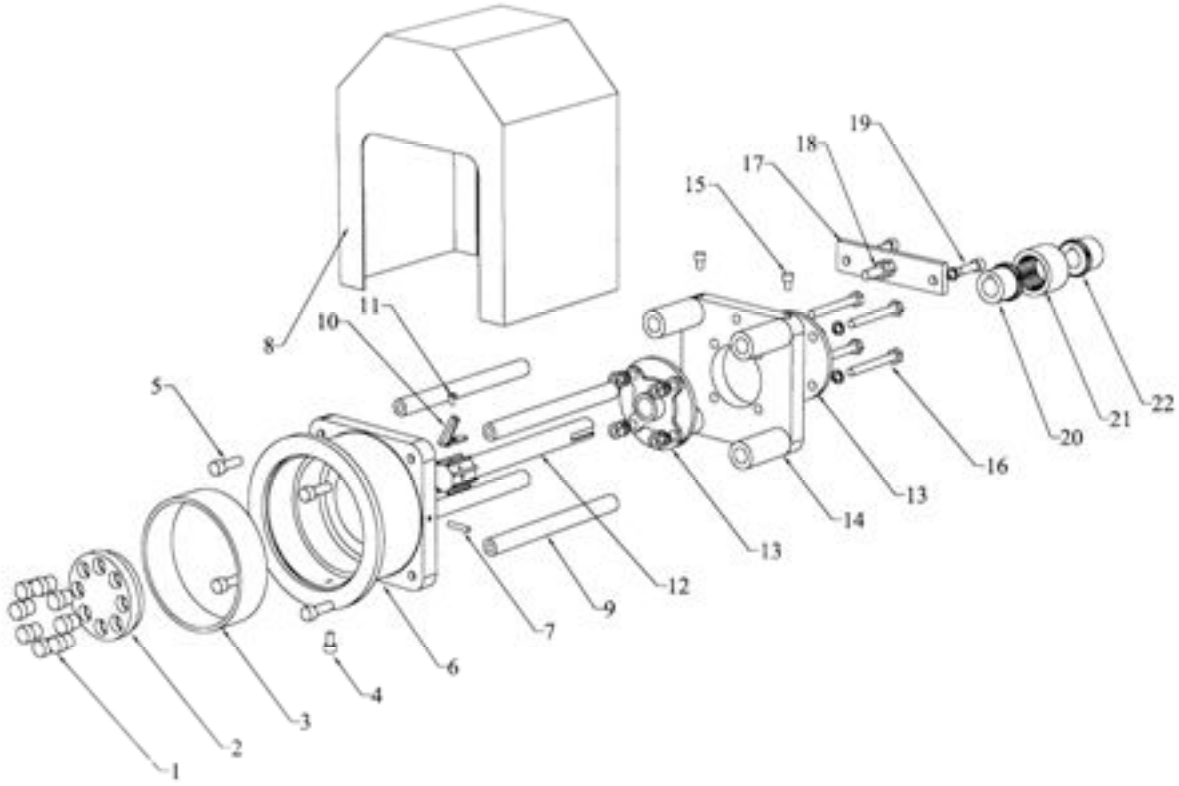


Figure 4.3 CUTTER HEAD setup

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	DIES 5MM DIES 8MM DIES 10MM DIES 12MM DIES BLANK	11	KNIFE ATTACHMENT SCREW
		12	CUTTER SHAFT 8 KNIFE
		13	CUTTER BEARING REAR ADJUSTABLE
2	CUT OFF DIE PLATE 8 HOLE (500 SERIES) CUT OFF DIE PLATE 12 HOLE 130	14	BEARING PLATE REAR ADJUSTABLE
		15	CAP SCREWS M8 X 12
3	WEAR RING HARDENED	16	BEARING MOUNTING STUDS
4	WEAR RING LOCATION DOWEL	17	ADJUSTING BAR
5	SOCKET HEAD CAP SCREW M10X30	18	ADJUSTMENT BOLT
6	CUTTER HEAD HOUSING ADJUSTABLE	19	SOCKET HEAD CAP SCREW M10 X 30
7	GRUB SCREW	20	DRIVE GEAR 25MM
8	CUT OFF KNIFE GUARD ADJUSTABLE	21	COUPLING SLEEVE
9	BEARING PLATE SPACERS ADJUSTABLE	22	DRIVE GEAR 28 MM
10	90 DEGREE KNIFE BLADE		

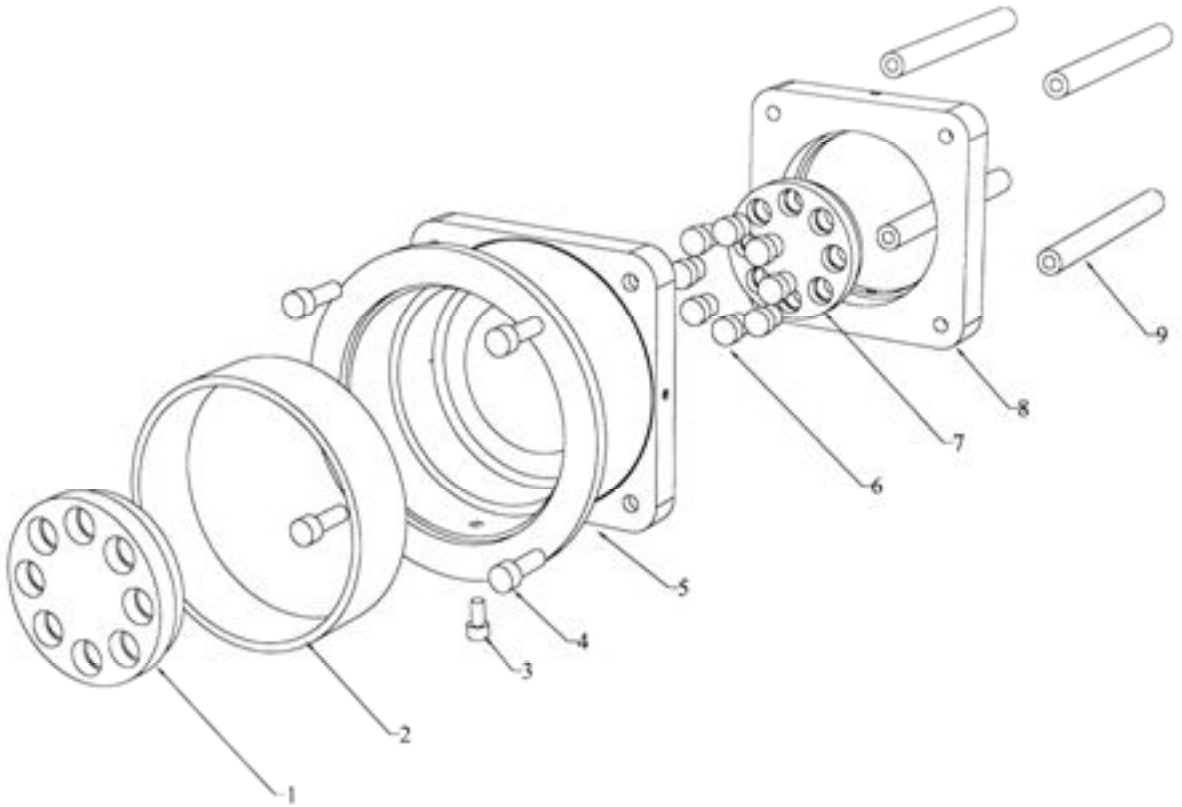


Figure 4.4 Double Die Assembly

ITEM	DESCRIPTION
1	DIE PLATE 8 HOLE
2	WEAR RING HARDENED
3	WEAR RING LOCATION DOWEL
4	10MM SPACER SCREWS
5	DOUBLE DIE HOUSING ADJUSTABLE
6	DIES 5 MM, 8MM, 10 MM, 12 MM, BLANK
7	DIE PLATE 8 HOLE
8	DOUBLE DIE PLATE HOLDER
9	BEARING PLATE SPACERS ADJUSTABLE

4.2.1 Alignment of the Outboard Cutter Unit

Figure 4.5 shows the CUTTER HEAD unit and OUTBOARD CUTTER SLIDE SUPPORT. The OUTBOARD CUTTER SLIDE SUPPORT is used to move the OUTBOARD CUTTER MOTOR into position and move it out of the way for disassembly of the barrel. The MOTOR MOUNT BRACKET allows the motor to be swung into or out of alignment with the barrel.

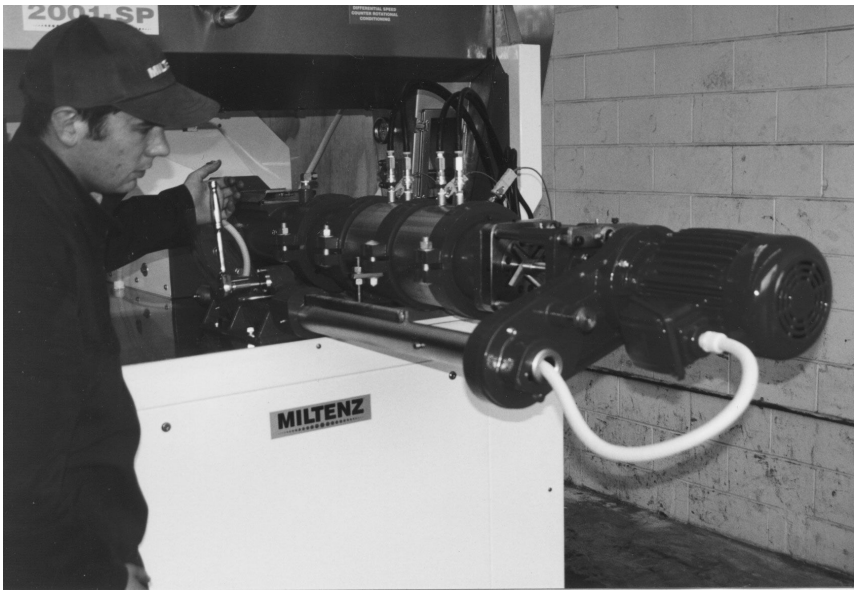


Figure 4.5 Moving the outboard cutter into position

When setting up the CUTTER HEAD unit, it is important that the MOTOR DRIVE GEAR and the CUTTER UNIT DRIVE GEAR are properly aligned both horizontally and vertically. Figure 4.6 provides a guide to alignment. If these are out of alignment, the NYLON COUPLING may be damaged. If the horizontal alignment needs adjustment the bolts holding the OUTBOARD CUTTER SLIDE SUPPORT to the extruder frame should be loosened to allow it to be moved (refer to figure 4.6).

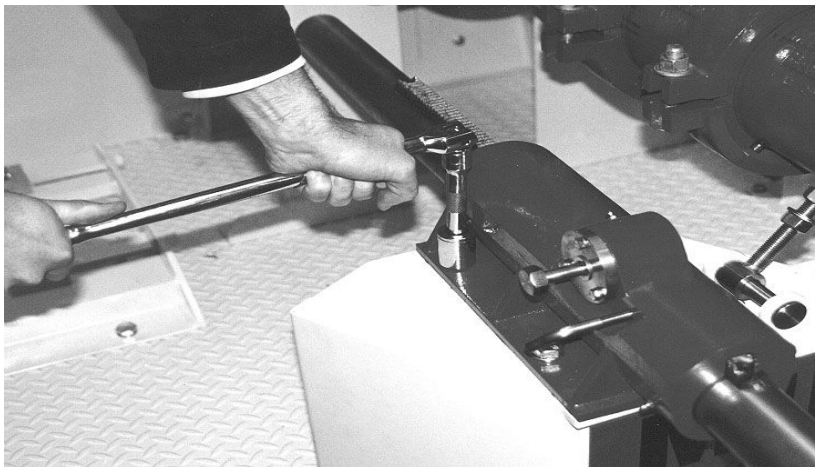


Figure 4.6 Adjustment of outboard cutter horizontal alignment

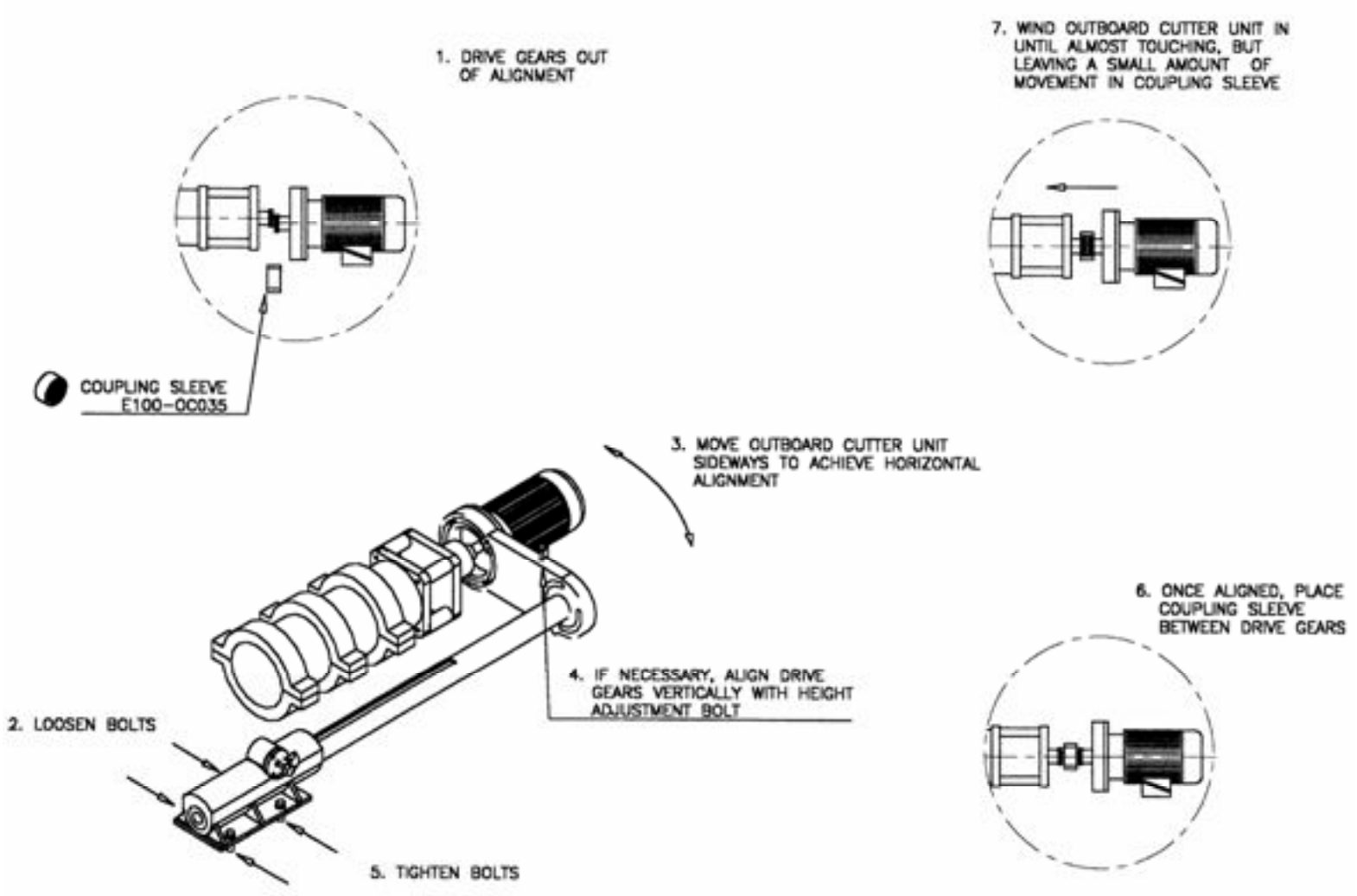


Figure 4.7 Alignment of the outboard cutter assembly

The vertical alignment can be adjusted via the HEIGHT ADJUSTMENT BOLT in the MOTOR MOUNTING BRACKET.

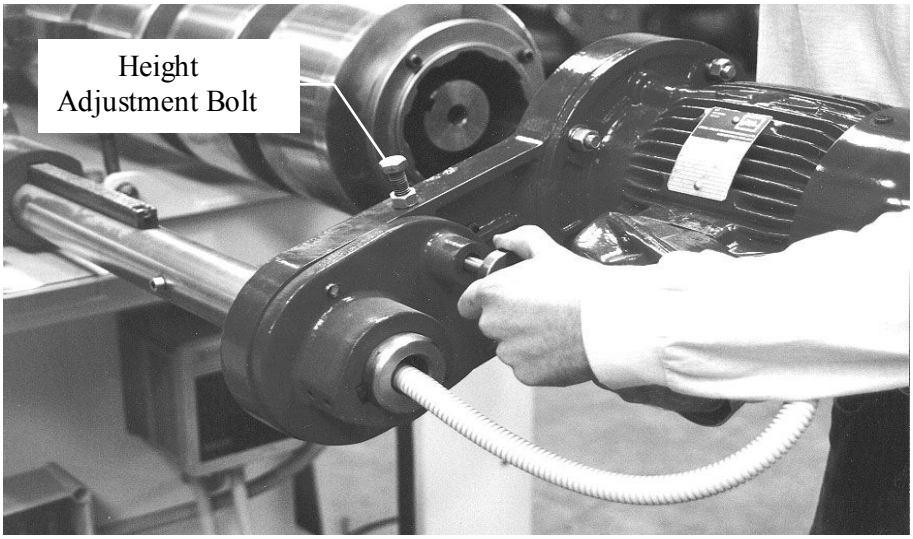


Figure 4.8 OUTBOARD CUTTER MOTOR BRACKET

Assembly of the CUTTER HEAD unit

Having positioned and coupled the OUTBOARD CUTTER DRIVE MOTOR and the CUTTER HEAD itself, the KNIFE position should be adjusted. The gap between the KNIFE and the DIE face is adjusted via the ADJUSTING BOLT on the back of the CUTTER HEAD unit (refer to figure 4.9). Before adjusting ensure that the two CAP SCREWS are turned out. A cleaner cut product will be achieved if the KNIFE is as close as possible to the DIE face. However the KNIFE will be damaged if it is actually scraping the surface of the DIES or DIE PLATE.

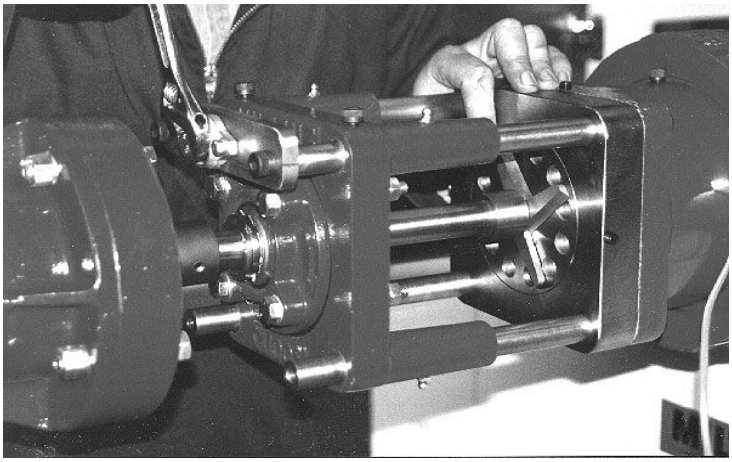


Figure 4.9 Adjustment of the gap between knife and die

Adjustment is best performed by winding the KNIFE in until it touches the DIE face and winding it back until it no longer scrapes when turned by hand. Once the KNIFE is positioned it should be locked in place using the two CAP SCREWS on the top of the CUTTER HEAD unit.

4.2.2 Changing of DIE INSERTS

The changing of DIE INSERTS will be required from time to time when DIE INSERTS become worn or if changing products. If supplied, a Bühler Millbank Extrusion tool kit will include a CUTTER DIE DRIFT. This tool can be used to punch the INSERTS out of the DIE PLATE. The DIES should be pressed out by pushing them from the cutter face side of the DIE PLATE.

When reinserting DIE INSERTS, it must be ensured that the insert holes are clean and clear of product material or metal burrs.

4.3 COMPRESSION HEAD Assembly

For the production of some products (eg aqua-feeds), a COMPRESSION HEAD may be required.

This involves the use of a TAPERED FEEDER SCREW, which is bolted to the end of, and driven by, the MAIN SHAFT or MAIN SHAFT EXTENSION PIECE. This screw compresses the material and forces it into the DIE.

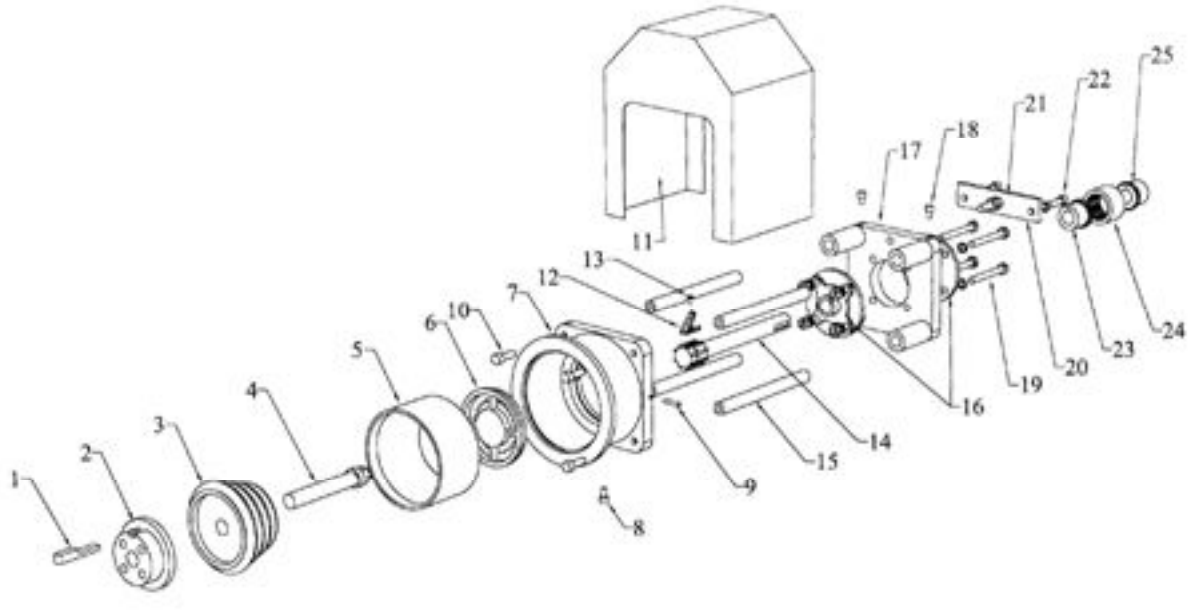


Figure 4.10 COMPRESSION HEAD setup

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	RETAINING KEY	14	CUTTER SHAFT 8 KNIFE
2	END RETAINER	15	BEARING PLATE SPACER ADJUSTABLE
3	TAPERED FLIGHT FEEDER	16	CUTTER BEARING REAR ADJUSTABLE
4	RETAINER BOLT	17	BEARING PLATE REAR ADJUSTABLE
5	HARDENED SLEEVE TAPERED	18	CAP SCREWS M8 X 12
6	DIE PLATE	19	BEARING MOUNTING STUDS
7	END SECTION HOUSING ADJUSTABLE	20	ADJUSTING BAR
8	SLEEVE RETAINER SCREW	21	ADJUSTMENT BOLT
9	DIE PLATE RETAINER SCREW	22	SOCKET HEAD CAP SCREW M10 X 30
10	SOCKET HEAD CAP SCREW M10X30	23	DRIVE GEAR 25 MM
11	CUT OFF KNIFE GUARD ADJUSTABLE	24	COUPLING SLEEVE
12	90 DEGREE KNIFE BLADE	25	DRIVE GEAR 28 MM
13	KNIFE ATTACHMENT SCREW		

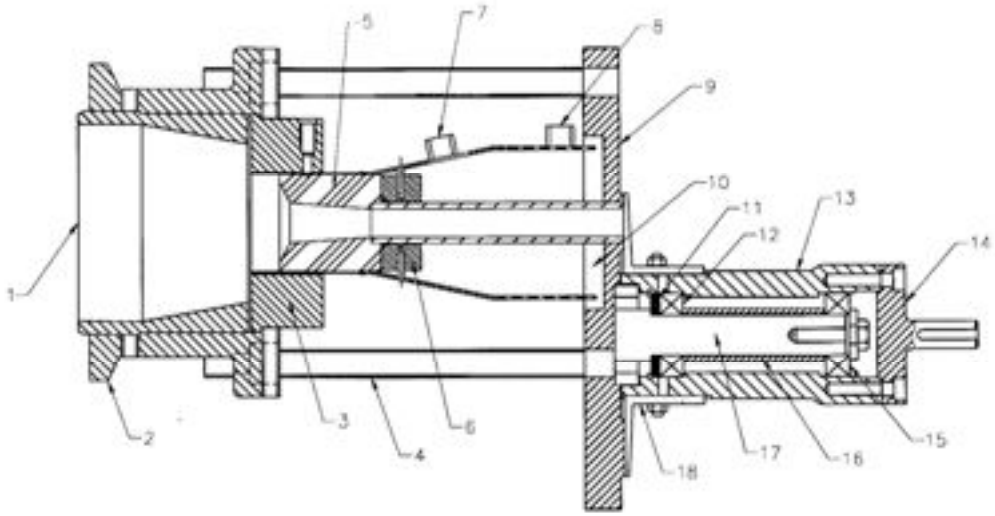


Figure 4.4 Assembly of TSP & TVP Cutting Arrangement

Item No.	Description	Part Number	Item No.	Description	Part Number
1	Hardened Sleeve	E050-CP006	10	End Seal (Teflon)	E050-CU014
2	Compression Head Housing	E050-CP002	11	Seal	E005-CU009
3	Nozzle Insert	E050-CP024	12	Bearing	E005-CU010
4	Support Rods	E050-CP026	13	Cutter Cage	E005-CU014
5	Nozzle End	E050-CP017	14	Cutter Drive Stub	E005-CU012
6	Insulation Plug	E050-CP017	15	Bearing	E005-CU010
7	Water Inlet (1/4” Socket)	-	16	Spacer Sleeve	E005-CU017
8	Water Outlet (1/4” Socket)	-	17	Cutter Shaft	E005-CU011
9	Cutter Plate	E050-CU013	18	Cutting Knives	E100-CU200

5 Drive System

The MAIN SHAFT of the EXTRUDER is driven via six VEE-BELTS from the MAIN MOTOR. Standard machines are supplied with a variable speed MAIN MOTOR to suit any product application.

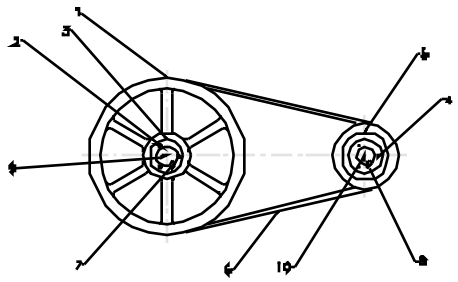


Figure 5.1 DRIVE SYSTEM

ITEM	DESCRIPTION
1	MAIN SHAFT PULLEY
2	PULLEY BUSHING GRUB SCREWS
3	MAIN SHAFT BUSHING
4	MAIN MOTOR BUSHING
5	MAIN MOTOR PULLEY
6	VEE-BELT
7	MAIN SHAFT PULLEY KEY
8	MAIN MOTOR PULLEY KEY
9	MAIN SHAFT
10	MAIN MOTOR SHAFT

The actual components supplied in the drive system will vary from machine to machine according to the local power supply and the machines speed. Refer to the appendix for the part numbers.

5.1 Adjustment of Belt Tension

The position of the MAIN MOTOR can be set using the adjustment system below. This will need occasional adjustment to maintain optimum belt tensions.

Tightening and loosening of the MOTOR ADJUSTMENT SCREWS will move the MOTOR along the MOTOR MOUNTING FRAME. To allow this, the MOTOR hold down brackets will need to be loosened slightly.
When adjusting the position of the MAIN MOTOR, ensure the two PULLEYS remain aligned.

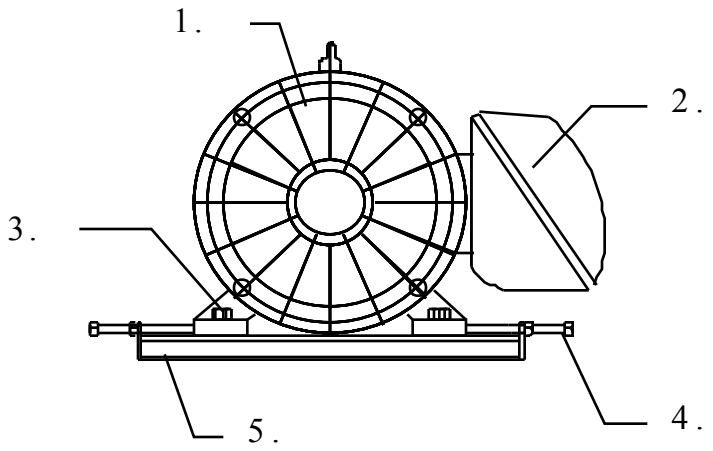


Figure 5.2 Motor adjustment

Item	Description
1.	MAIN MOTOR
2.	JUNCTION BOX
3.	MOTOR HOLD DOWN BRACKET
4.	MOTOR ADJUSTMENT SCREW
5.	MOTOR MOUNTING FRAME

- Ideal BELT tension is the lowest tension at which BELTS will not slip under peak load conditions.
- Check the BELT tension after the first 24 hours of operation of your new extruder or the replacement of BELTS thereafter.
- Keep BELTS free from foreign materials, which may cause the BELTS to slip.
- Make periodic BELT inspections and adjust when BELTS show signs of slip.
- Where adjustment does not eliminate slip, BELTS will need replacement.

5.2 Assembly / disassembly of main-shaft and main motor pulley taper lock bushings.

This operation may be required if the MAIN MOTOR or the MAIN EXTRUDER SHAFT has to be removed and reinstalled.
For these operations refer to the item numbers on *figures 5.1 & 5.2*

5.2.1 ASSEMBLY

1. Clean all parts ensuring that the internal and external faces of the BUSHES and PULLEYS are free of preservative wax and oils. (1, 3, 4, 5)

2. Ensure that both MOTOR and MAIN SHAFTS are clean. (9 and 10)

3. Trial fit the TAPER LOCK BUSHES (3 and 4) to the SHAFTS (9 and 10)

4. Insert the KEYS (7 and 8) into the BUSHES and check that they fit. They should slip in without any side-ways movement.

5. Remove BUSHES and KEYS.

6. Apply a thin film of anti-seize lubrication to the inside of the PULLEYS (1 and 5) and the BUSH (3 and 4)

7. Insert the BUSH into the PULLEY and align the three holes together. Please note that the spare hole in the bushing is for jacking the BUSH out of the PULLEY when disassembly is required (*figure 5.3*)
   The other two are to clamp the BUSH and PULLEY locking them to the shaft

8. Apply anti-seize lubrication to the GRUB SCREWS (2) and insert into the BUSH and PULLEY assembly

9. Slip the BUSH and PULLEY assembly onto the shaft and position. Turn the assembly to align the key ways in the SHAFT and PULLEY assembly

10. Insert the DRIVE KEYS into the key ways (7 and 8)

11. Tighten the GRUB SCREWS (2) using a hexagonal wrench and the BUSH will grip the SHAFT

12. When assembling the last PULLEY to the SHAFT it is very important to check the alignment of the two PULLEYS. Using a straight edge across the side faces of the PULLEYS, check that they are in line and adjust as necessary.

13. Once the GRUB SCREWS are tight in the taper lock BUSHES then the VEE BELTS can be fitted. Ensure that the VEE BELTS are a matched set. This should be indicated on the side belt.

14. Refer to *figure 5.2* – Adjust the motor adjuster (4) until the BELTS are tight. It is recommended that a BELT tension checking tool be used to ensure correct tension. Check the alignment of the PULLEYS again with the straight edge. If the PULLEYS do not align then they will have to be adjusted until they do. Failure to do this will result in premature wear of the BELTS and PULLEYS.

15. To adjust the alignment of the PULLEYS:

a) Remove the GRUB SCREWS from one of the BUSHES

b) Place a GRUB SCREW into the spare hole on the BUSH and PULLEY.
Refer to *figure 5.3*.

c) Tighten the GRUB SCREW and the BUSH will be forced out of the PULLEY

d) The BUSH should now be free of the PULLEY and can now be moved to correct the alignment

e) Reposition and retighten the BUSH to the PULLEY

f) This might have to be repeated several times to correct the alignment

g) Check and adjust the BELT tension if necessary

16. Once the EXTRUDER DRIVE has been run under load for a short period of time, stop and check the tightness of the SCREWS and BELTS

5.2.2 DISASSEMBLY

1. Refer to *figure 5.2*. Loosen the MOTOR PIVOT adjuster (4) until the BELTS are loose enough to be removed

2. Remove the GRUB SCREWS (2) from the TAPER LOCK BUSHES (*figure* 5.1)

3. Place one of the GRUB SCREWS into the spare hole in the BUSH and tighten.

   The bush should be forced out of the PULLEY (*figure 5.3)*

4. Remove the PULLEY and BUSH

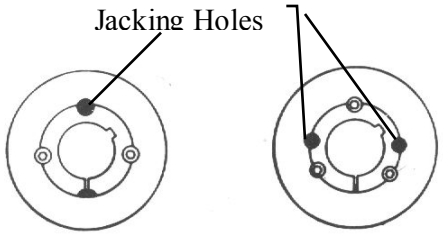


Figure 5.3 Taper Lock Jacking Screw Positions

6 -SX Series Steam Conditioners

This chapter aims to provide an overview of the various components, the set-up and the operation of an SX series STEAM CONDITIONER.

Figure 6.1 shows the external layout of an SX series STEAM CONDITIONER UNIT.

Raw material enters the CONDITIONER through the INFEED AUGER and feeds into the drop
box into the CONDITIONER VESSEL. Live steam is injected into the CONDITIONER VESSEL through the STEAM BOX.

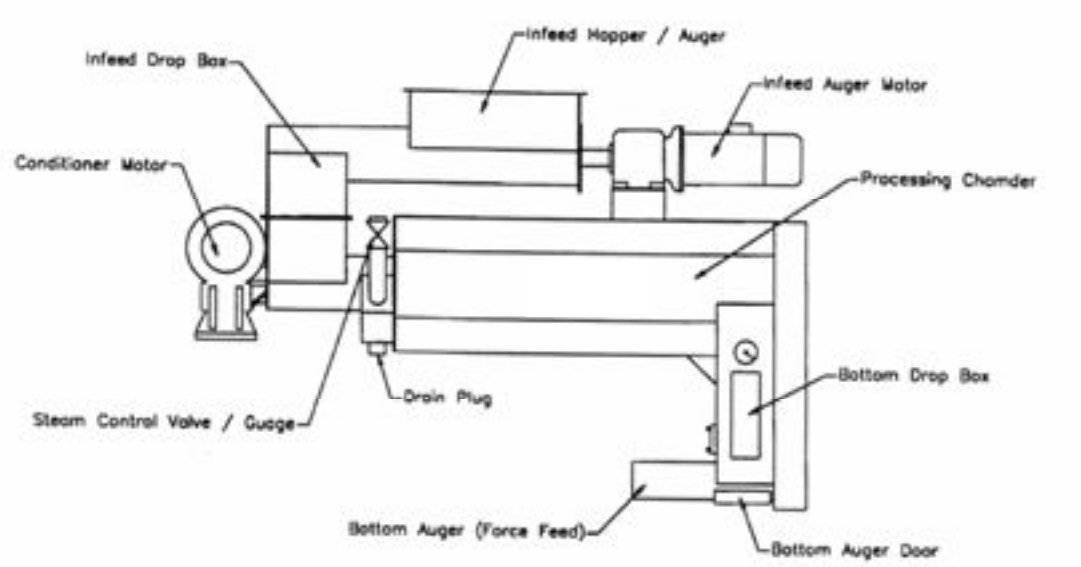


Fig 6.1 –S SERIES STEAM CONDITIONER Layout
With fitted SX feeder

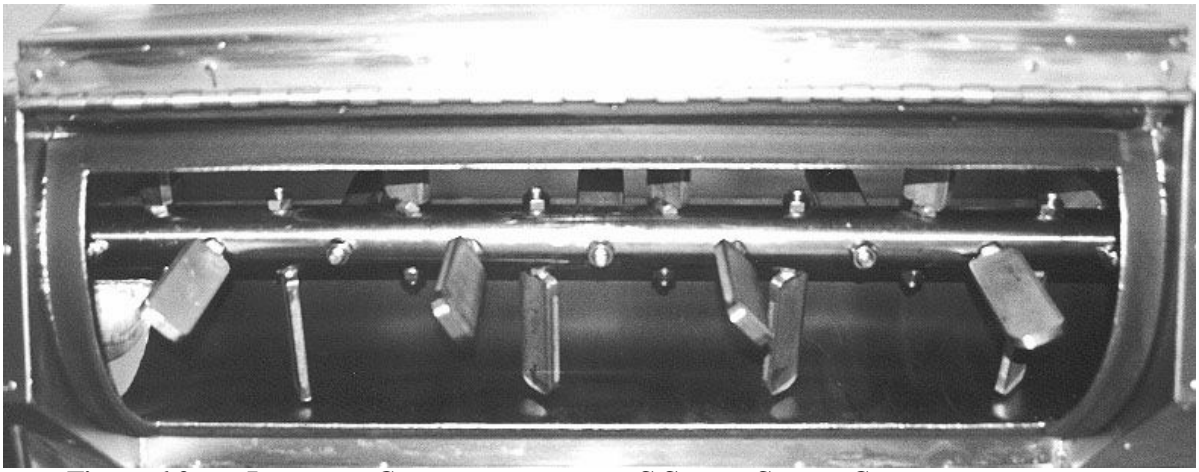


Figure 6.2 INTERNAL CONFIGURATION OF –S SERIES STEAM CONDITIONER

6.1 Adjustment of retention time

At the time of manufacture, the PADDLE CONFIGURATION will be preset at the factory but will need to be fine tuned to particular process needs during commissioning.
Figure 6.3 shows how the CENTRAL SHAFT PADDLE angle will determine the direction in which the product is conveyed. The angle of each individual PADDLE can be adjusted by loosening the nuts securing these to the CENTRAL SHAFT. CENTRAL SHAFT PADDLES can be set at any angle desired.

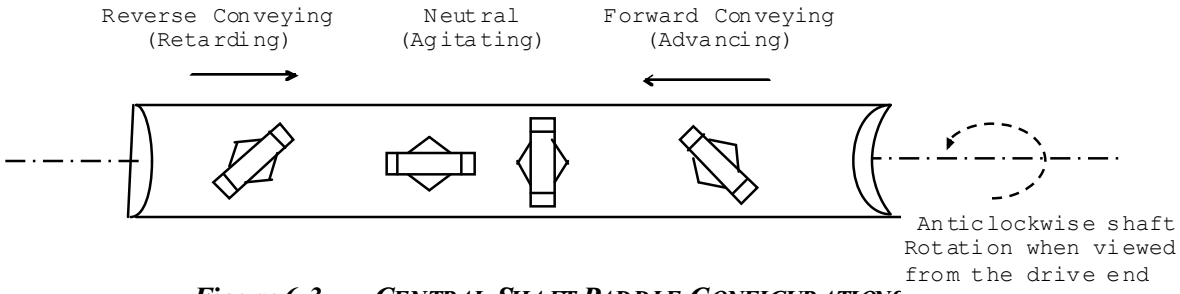


Figure 6.3 CENTRAL SHAFT PADDLE CONFIGURATIONS

For a given CONDITIONER speed the number and angle of forward, reversing and agitating PADDLES will determine the height of material in the CONDITIONER and consequently its retention time. Reverse PADDLES increase the degree of mixing and the retention time.
PADDLES on the MAIN SHAFT will normally be set with the first five/six (in the direction of product flow) set to the forward conveying positions. Near the middle of the SHAFT a PADDLE will be set in the agitating position and the remainder will be a combination of reverse, forward and agitating PADDLES.

6.2 Steam Valve Kitset

It is important that only good quality steam is used in the preconditioning of extruded products.

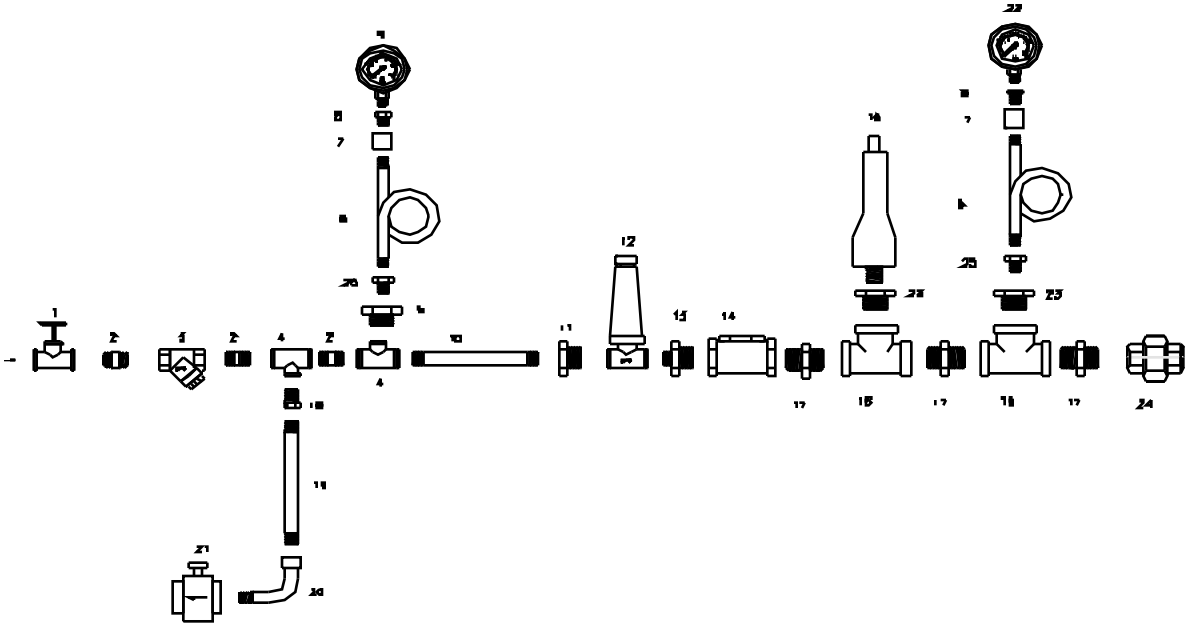


Figure 6.4 STEAM VALVE KITSET

ITEM	PART NO	DESCRIPTION
1	S050-SV002	32MM STEAM ISOLATION VALVE
2	S050-SV029	25 X 50 MM BARREL NIPPLE
3	S600-SV007	32MM STRAINER
4	S100-SV032	32MM STEAM TEE BLACK
5	S600-SV018	32-25MM REDUCING BUSH
6	S100-SV010	10MM PIG TAIL
7	S100-SV013	10MM SOCKET
8	S100-SV014	10-6MM REDUCING BUSH
9	S100-SV009	1000KPA GAUGE
10	S600-SV019	32-150MM NIPPLE
11	S600-SV020	40-32MM REDUCING BUSH
12	S600-SV004	40MM PRESSURE REDUCING VALVE
13	S600-SV032	50-40MM REDUCING NIPPLE
14	S600-SV013	50MM CHECK VALVE
15	S100-SV007	25MM SAFETY VALVE
16	S600-SV012	50MM TEE
17	S600-SC021	50MM HEX TEE
18	S600-SV022	32-15MM REDUCING BUSH
19	S100-SV056	15-100MM LONG NIPPLE
20	S100-SV018	15MM BEND
21	S100-SV003	15MM FLOAT TRAP

22	S100-SV008	600KPA LOW PRESSURE GAUGE
23	S600-SV011	50-25MM REDUCING BUSH
24	S600-SV013	50MM MAC UNION
25	S100-SV021	25-10MM REDUCING BUSH

6.3 Assembly of Steam Valve Kitset – Optional Equipment

The KITSET will arrive partially assembled.

To complete assembly:

Note: The GAUGE SIPHONS should be positioned vertically. It is also desirable for the entire STEAM VALVE ASSEMBLY to be mounted at a height greater than the CONDITIONER.

1. Connect the steam line to the STEAM ISOLATION VALVE (Item 1).
2. Connect a pipe from the MAC UNION (Item 24) on the STEAM VALVE KITSET (fig. 6.4) to the MAIN CONTROL VALVE on the STEAM CONDITIONER of the EXTRUDER (refer to figure 6.1)
3. Connect the FLOAT STEAM TRAP (Item 21) to a condensate return line.

All threaded connections should be made using a thread seal tape or compound.

6.4 Conditioner Steam Box Drain

The DRAIN from the STEAM CONDITIONER should be fitted with a condensate trap and connected to the condensate return line back to the boiler. The drain point, a 40 mm BSP socket, is situated under the steam conditioner at the drive end.

Condensate trap is not supplied with the machine (to be supplied by the customer).

.

6.5 Operating Procedure

Beware of live steam and moving parts when working near the CONDITIONER.

Ensure that the STEAM VALVE KITSET has been correctly assembled and that there are no leaks in the system. The pressure of the steam entering the VALVE arrangement should be no higher than 150 PSI. The pressure of the steam entering the CONDITIONER should be adjusted to approx. 25 PSI using the PRESSURE-REDUCING VALVE.

Before starting the CONDITIONER, drain any excess water from the STEAM MANIFOLD. This allows water to be diverted and also lets you check that steam delivery to the CONDITIONER is stable. As soon as there is a steady supply of good quality steam to the CONDITIONER, turn the MAIN CONTROL VALVE off and close the drains of the STEAM CONDITIONER.

The STEAM CONDITIONER is now ready to start.

The "STEAM CONTROL VALVES" govern the amount of steam supplied to the CONDITIONING VESSEL. During operation these CONTROL VALVES are generally 2 to 3 turns open, depending on the steam pressure and the type of materials being processed. The STEAM VENT can be used as a guide when setting the CONTROL

VALVES. As a general rule there should be an intermittent or small head of steam at the VENT.

To obtain good quality conditioned raw materials prior to the EXTRUDER BARREL, a combination of the right amount of steam, the right quality of steam and process retention time is needed.

How to Alter the Retention Time

The retention time in the CONDITIONER can be adjusted by changing the angle of the PADDLES on the CENTRAL SHAFT of the CONDITIONER and by the way you add your steam! The conditioning can be influenced by the amount of steam that is added through the individual steam INJECTION POINTS.

7 Extruder operation

Before starting the extruder ensure that:

- All bolts are tightened.
- All parts are clean and the DIES are not blocked.
- WATER INJECTION SYSTEM is operational.
- Raw material is available in the VOLUME FEEDER.
- The working area is clear from hazards (Tools, parts etc.)
- Down stream equipment such as steam extractors, driers, coolers, etc are operational.
- The STEAM CONDITIONER is ready to start.

7.1 STARTUP PREPARATION

1) Start the MAIN MOTOR.

2) Start the CUTTER MOTOR (where fitted).

3) The water flow should be started before, or just as, product starts entering the barrel of the extruder.

4) Start the CONDITIONER and steam supply to the CONDITIONER (-SX and -SP models).

5) Start up FEEDER on -SP and -SX models only

6) Once product exits the DIE and a flow pattern has been established, slowly decrease the water flow to the desired level.

7) Increase the feed rate through the conditioner so that the load on the MAIN EXTRUDER MOTOR rises to the desired level (as determined by product quality/ desired capacity etc.).

8) After the barrel temperatures have stopped climbing and the flow

is consistent, check the quality of the product.

- Adjust the water flow if necessary.
  NOTE: As the water flow is decreased, the load on the MAIN MOTOR will rise so it may be necessary to also adjust the FEEDER speed on -SX and -SP Models and the CONDITIONER speed on other models.
- If temperatures are too low, adjust the NOZZLE PIECE if one is used (refer to section 4), or stop the extruder and change the BARREL and/or BARREL HEAD SECTION configuration.
- If the temperatures are slightly higher than required, start flow in the water COOLING JACKETS (where fitted)
- If the COOLING JACKETS (where fitted) are on and the product is still overcooked, stop the extruder and re-configure the barrel.

7.2 STOPPING THE EXTRUDER

1) Switch off the CONDITIONER/and FEEDER where fitted

2) Turn the steam and water off.

3) Keep the EXTRUDER MOTOR and CUTTER MOTOR running and flush out the BARREL using crushed full fat soya, linseed or other high oil material.

4) Once this material has exited the DIE, stop the extruder and CUTTER MOTORS.

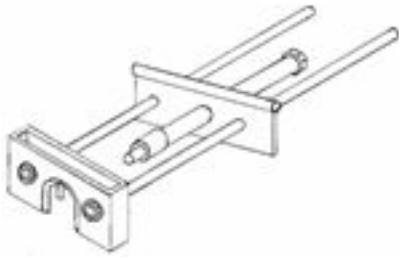
5) Disengage the CUTTER MOTOR and remove the HEAD SECTION.

CAUTION: Because there are large amounts of pressure and steam generated in the cooking process, always take care when removing parts from the EXTRUDER BARREL, especially if the machine has blocked.

6) Start the MAIN MOTOR again so that any material left in the barrel is forced out.

7.3 USE OF THE SCREW PULLER

When SCREWS need to be removed (i.e. to change configuration or replace worn-out SCREWS), it is quite common for the SCREWS to become stuck to the MAIN SHAFT. The SCREW PULLER is especially designed for removing screws in such circumstances without damaging them.



The twin slotted angle plates are fitted over the SCREW to be pulled.

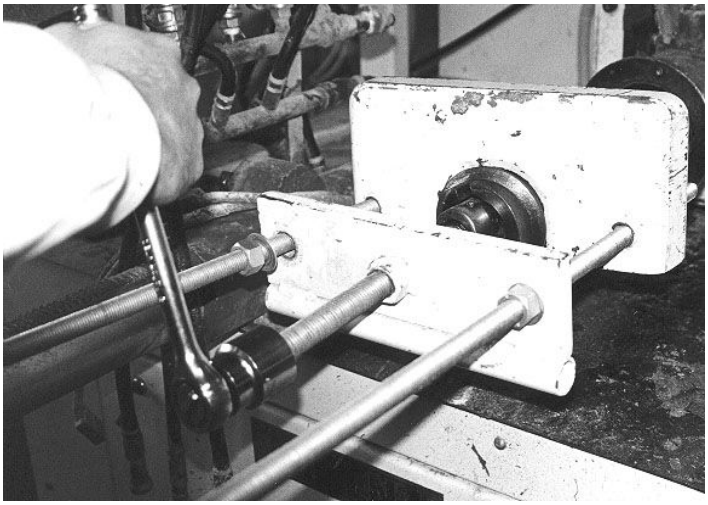


Figure 7.3 Manual SCREW PULLER

8 Typical Set-ups

This chapter aims to provide the user with some indication of the typical BARREL ASSEMBLY set-ups used for the production of some common products. These are given as starting points only. Raw material and other variations may mean further process development work will be required to find the optimum BARREL ASSEMBLY set-up for a given product. It should also be noted that the number of CHOKE PLATE SPACERS indicated by figures 8.1 and.8.3 are an indication only. The actual number of CHOKE PLATE SPACERS required, will vary with the type of HEAD SECTION set-up used. For example the use of a COMPRESSION HEAD with a thick DIE PLATE may necessitate a reduced number of CHOKE PLATE SPACERS. In some cases this might require the shortening of DRIVE KEYS to ensure there are no gaps between SCREWS and CHOKE PLATES. It should also be noted that as extruder parts wear, the performance of the BARREL ASSEMBLY set-up will change.

8.1 Fullfat Soya Processing (for inactivation of anti-nutritional factors)

To achieve effective inactivation of trypsin inhibitor, temperatures of 140-155°C will be required in the final chamber. Laboratory tests should however be undertaken to establish the effectiveness of a process. The specially designed BARREL END SECTION and NOZZLE PIECE should be used. Figure 8.1 shows a set-up recommended as a starting point. Fine adjustment of the process temperature should be made by adjusting the NOZZLE as described in section 4.

8.2 STARCH PRODUCTS

For Starch products and cereals (ie Dog food, extruded maize etc.) the BARREL END SECTION is replaced by a CUTTER HEAD and the end product is shaped into a pellet form. SINGLE FLIGHT SCREWS and small to medium CHOKE PLATES are commonly used. Operating temperatures are about 130°C to 150°C. Figure 8.2 shows a typical set-up.

8.3 AQUA FEEDS

A COMPRESSION HEAD is usually necessary for the production of good quality aqua-feeds. SINGLE FLIGHT SCREWS and small to medium sized CHOKE PLATES are used to produce temperatures of 120°C - 140°C. Figure 8.2 shows a typical set-up.

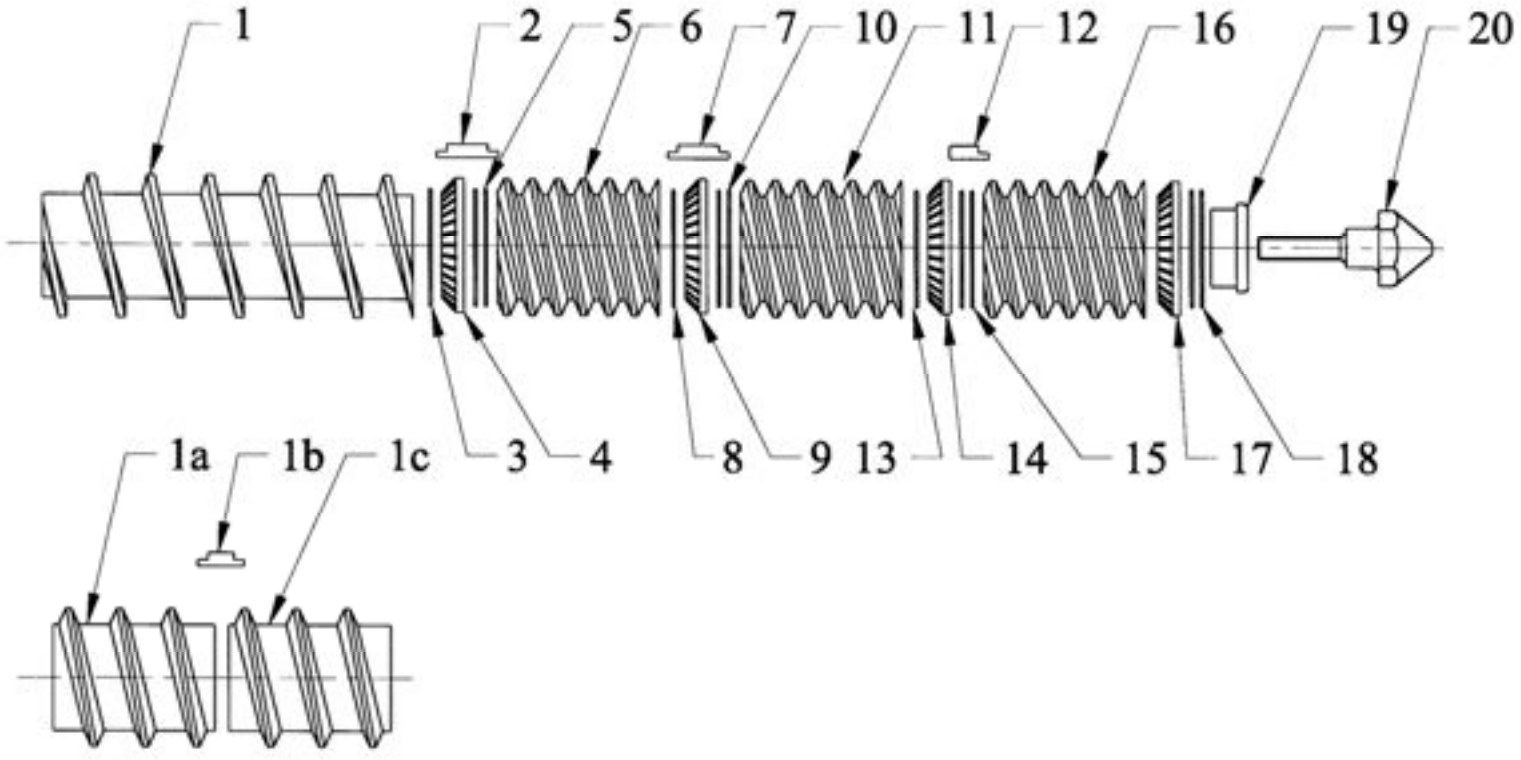


Figure 8.1 Typical internal barrel configuration for Fullfat Soya

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	INTAKE PRESSURE SCREW 1 PIECE	6	PRESSURE SCREW DOUBLE FLIGHT LONG	14	CHOKE PLATE 95
1A	PRESSURE SCREW SINGLE FLIGHT LONG	7	DRIVE KEY LONG	15	CHOKE PLATE SPACERS (2X)
1B	DRIVE KEY SHORT	8	CHOKE PLATE SPACER	16	PRESSURE SCREW DOUBLE FLIGHT LONG
1C	PRESSURE SCREW SINGLE FLIGHT LONG	9	CHOKE PLATE 92	17	CHOKE PLATE 96S
2	DRIVE KEY LONG	10	CHOKE PLATE SPACERS (2X)	18	CHOKE PLATE SPACERS (2X)
3	CHOKE PLATE SPACER	11	PRESSURE SCREW DOUBLE FLIGHT LONG	19	RETAINER WASHER
4	CHOKE PLATE 89	12	EXTENSION SHAFT KEY	20	CONICAL NOSE BULLET
5	CHOKE PLATE SPACERS (2X)	13	CHOKE PLATE SPACER		

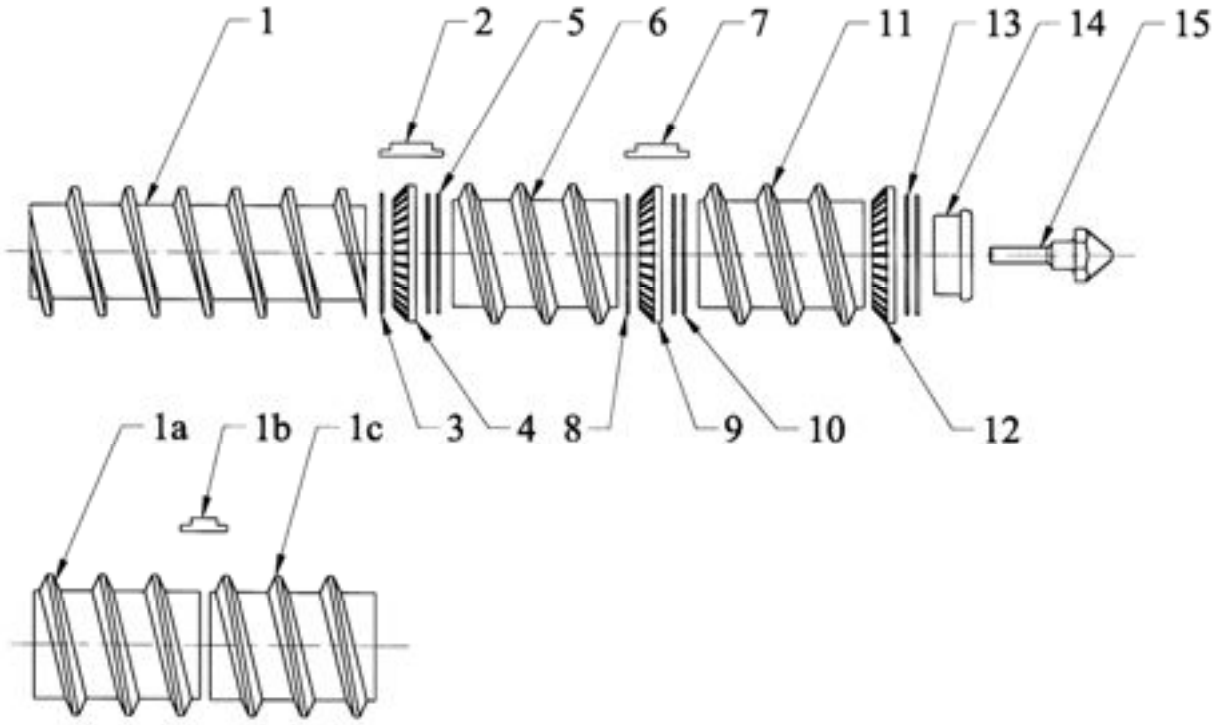


Figure 8.2 Typical internal barrel configuration for starch products

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	INTAKE PRESSURE SCREW 1 PIECE	6	PRESSURE SCREW SINGLE FLIGHT LONG	14	CHOKE PLATE SPACERS (2X)
1A	PRESSURE SCREW SINGLE FLIGHT LONG	7	DRIVE KEY LONG	15	PRESSURE SCREW SINGLE FLIGHT LONG
1B	DRIVE KEY SHORT	8	CHOKE PLATE SPACER	16	CHOKE PLATE 89
1C	PRESSURE SCREW SINGLE FLIGHT LONG	9	CHOKE PLATE 83	17	CHOKE PLATE SPACERS (2X)
2	DRIVE KEY LONG	10	CHOKE PLATE SPACERS (2X)	18	RETAINER WASHER
3	CHOKE PLATE SPACER	11	PRESSURE SCREW SINGLE FLIGHT LONG	19	CONICAL NOSE BULLET
4	CHOKE PLATE 83	12	CHOKE PLATE 83		
5	CHOKE PLATE SPACERS (3X)	13	CHOKE PLATE SPACERS (1X)		

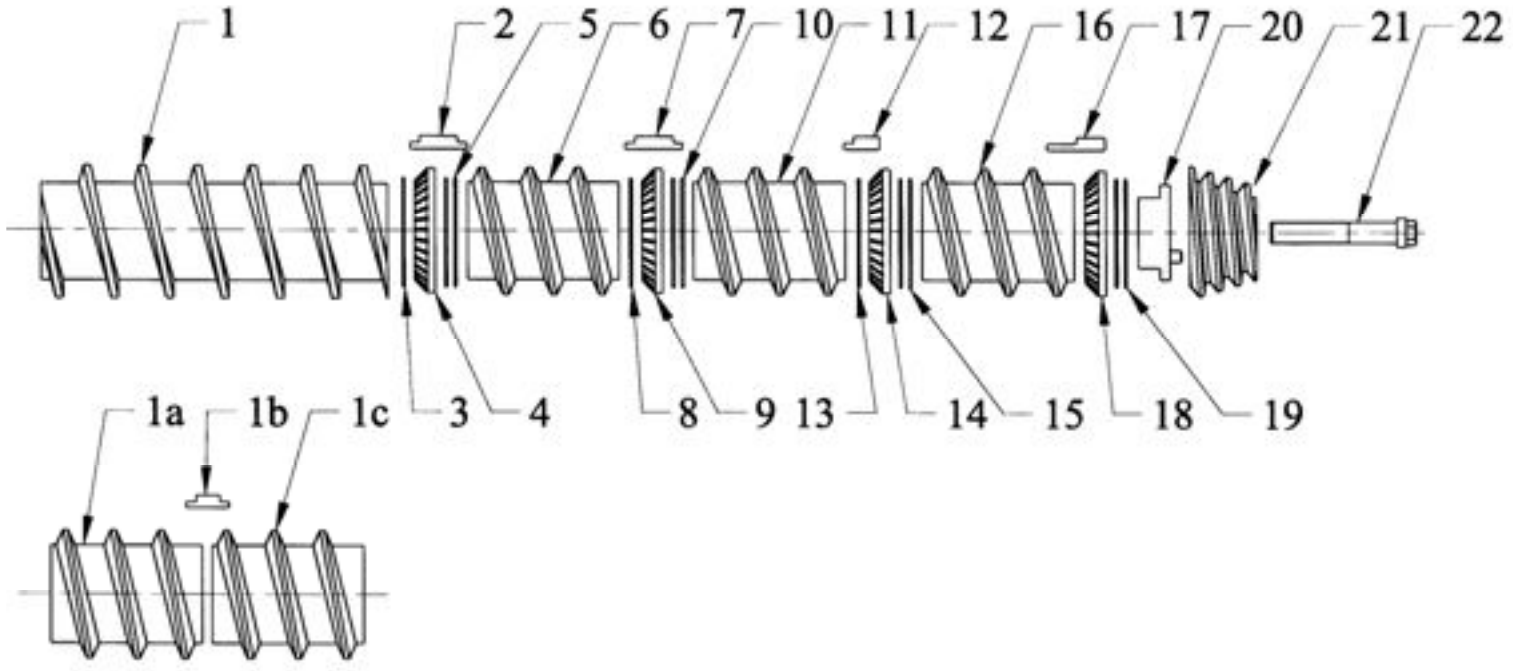


Figure 8.3 Typical barrel configuration for aqua feeds

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	INTAKE PRESSURE SCREW 1 PIECE	7	DRIVE KEY LONG	16	PRESSURE SCREW SINGLE FLIGHT LONG
1A	PRESSURE SCREW SINGLE FLIGHT LONG	8	CHOKE PLATE SPACER	17	RETAINING KEY
1B	DRIVE KEY SHORT	9	CHOKE PLATE 89	18	CHOKE PLATE 89
1C	PRESSURE SCREW SINGLE FLIGHT LONG	10	CHOKE PLATE SPACERS (2X)	19	CHOKE PLATE SPACERS (2X)
2	DRIVE KEY LONG	11	PRESSURE SCREW SINGLE FLIGHT LONG	20	END RETAINER
3	CHOKE PLATE SPACER	12	EXTENSION SHAFT KEY	21	TAPERED FLIGHT FEEDER
4	CHOKE PLATE 83	13	CHOKE PLATE SPACER	22	RETAINER BOLT
5	CHOKE PLATE SPACERS (2X)	14	CHOKE PLATE 92		
6	PRESSURE SCREW SINGLE FLIGHT LONG	15	CHOKE PLATE SPACER (2X)		

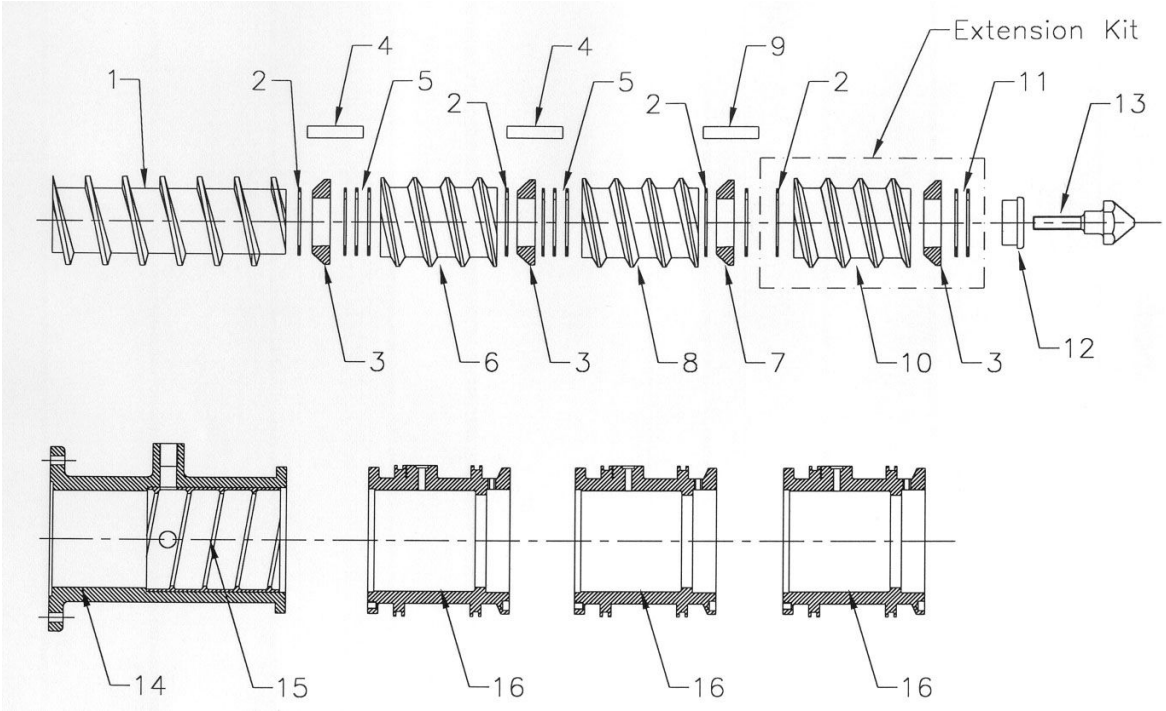


Figure 8.4 Typical barrel configuration for rice processing

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	INTAKE SCREW – E050-BA059	7	CHOKE PLATE 89 – E050-BA052	13	CONICAL NOSE BULLET – E050-BA036
2	CHOKE PLATE SPACER – E050-BA042	8	PRESSURE SCREW – E050-BA061	14	FEED INTAKE BARREL – E050-BA128
3	CHOKE PLATE 83 – E050-BA051	9	EXTENSION SHAFT KEY – E050-BA048	15	HELICAL LINER – E050-BA084
4	DRIVE KEY LONG – E050-BA048	10	PRESSURE SCREW – E050-BA061	16	WATER COOLED BARRELS – E050-BA031
5	3 X CHOKE PLATE SPACERS	11	CHOKE PLATE SPACER – E050-BA042		
6	PRESSURE SCREW – E050-BA061	12	RETAINER WASHER – E050-BA041		

9 Electric and control

The installation of the electrical connections should only be attempted by qualified personnel.

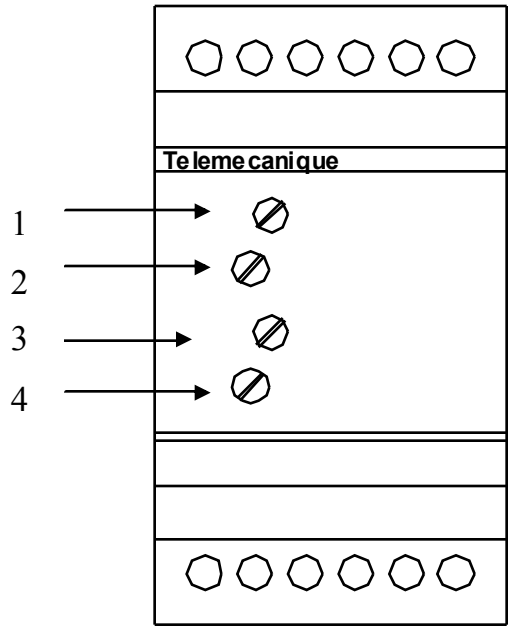
Comprehensive original manufacturers guides will be supplied with this manual where machines are fitted with CONTROLLERS etc. These will provide the user with the information required for any necessary programming.

A detailed electrical wiring diagram is provided in the appendix.

It is strongly recommended that the tightness of all terminal connections is checked before connecting equipment to mains supply. While all terminal connections are tightened at the time of manufacture, the malleability of the metal connections will result some self-relief of tension with time.

9.1 Current Relay

The CURRENT RELAY is located in the CONTROL CABINET. It is used to prevent the MAIN MOTOR overloading and helps to prevent the barrel from blocking. The control circuit is designed so that when the current drawn by the MAIN MOTOR reaches a certain level (set by the threshold adjustment) and maintains above that level for a certain time (set by the time delay adjustment) the RELAY inhibits the FEEDER MOTOR(S), stopping the flow of product into the barrel and allowing the load on the MAIN MOTOR to reduce. Once the load on the MAIN MOTOR has dropped by a certain percentage (set by the Hysterisis adjustment) below the LEVEL setting, the FEEDER MOTOR will start feeding again. The Delay range/Control Type Adjustment allows the selection of under or over amp control as well as setting the delay time range (e.g. 0-10 seconds).



Number	Description
1	Current Threshold Adjustment Potentiometer Graduated in % of Maximum Measurement Range
2	Hysterisis Adjustment
3	Time Delay Adjustment
4	Switch Combining Selection of Time Delay Range and Type of Control ("under" or "over")

The RELAY senses the MAIN MOTOR load through one of the 300/5 Amp current transformers in the STARTER CABINET.

The CURRENT RELAY has been factory set at 5% above the full load current rating of the MAIN MOTOR and is set to restart at 10% under the full load current rating. These settings may need to be fine-tuned to suit individual circumstances. In addition the values need to be checked to comply with the actual voltage being used.

IMPORTANT: Settings should only be changed by qualified persons who have a good understanding of the control relay.

The adjustments are given in percentages of the adjustment range. An Example of the factory settings for a 415V 90kW system is as follows:

Overcurrent threshold ; 151 x 1.05 = 159, 159/(300/5) = 2.65
Output relay time delay ; 5 s
Reset current Threshold ; 151 x 0.9 = 136, 136/(300/5) = 2.3 A

Settings are calculated as follows:

1. (2.65 x 100)/5 = **53%**
2. [(2.65-2.3) x 100]/2.65 = **13%**
3. (5 x 100)/10 = **50%**
4. Set to over amp, range 10 seconds

IMPORTANT: This device is not intended as a control system but rather a safety measure. If the CURRENT RELAY is continually activating, this generally means that the VOLUME FEEDER speed should be decreased.

9.2 A.C SPEED CONTROLLERS

Where fitted, A.C SPEED CONTROLLERS will have been pre-programmed with the correct parameters for your power supply and the controlled motor(s). These have been protected with a password. If for any reason the parameters need to be changed, it will be necessary to obtain the password from BÜHLER MILLBANK EXTRUSION.

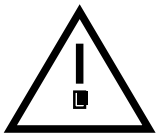
Original manufacturers manuals for these controllers have been included with this manual.

10 Trouble Shooting

10.1 Problem Solving Guide

PROBLEM	SUGGESTIONS
MAIN MOTOR fails to start.	- Incorrect wiring to MOTOR STARTER. - Faulty MOTOR STARTER.
VOLUME FEEDER does not start when switched on.	- Check settings on D.C. CONTROLLER. - MOTOR may be jammed. - Check D.C. CONTROLLER FUSES.
VOLUME FEEDER cuts in and out.	- Main Extruder motor over loading. Reduce feed rate - Check the setting of the CURRENT RELAY.
CUTTER MOTOR not operating.	- Check settings of A.C. CONTROLLER. - KNIFE BLADE may be jammed. - GEARS on the CUTTER HEAD and CUTTER MOTOR may not be aligned. - Worn GEAR COUPLING
Barrel blocks before product exits DIE.	- Particle size of raw material too large for the size of DIE. - Not enough water used to start the product flowing. Check the correct operation of the WATER INJECTION SYSTEM. Increase the initial flow rate and start the water flow before product enters the barrel. - Barrel configuration may not be suitable for the raw materials used. - May need DOUBLE FLIGHT SCREWS - CHOKE PLATES might be too large - There may not be enough open area on the DIE PLATE.

PROBLEM	SUGGESTIONS
Poor product shape.	- Formulation of raw materials not suitable. - Processing temperatures too High/Low. Change the barrel configuration, water cooling, water and steam injection as necessary. - Inconsistent flow through the machine. This may be caused by worn barrel parts, non-uniform mixing of raw materials, fluctuating water/steam flow rates, or incorrect DIE open area. - Moisture content of product too high/low. - Incorrect speed/adjustment of the CUTTER unit. - Worn KNIFE BLADES. - VOLUME FEED rate too high/low for the DIE being used.



IMPORTANT:

To obtain accurate results it is recommended that only one parameter at a time is changed.

All changes and effects should be documented.

11 Extruder Maintenance

CAUTION: Proper precautions should be taken to eliminate risk of injury when carrying out maintenance work. Where possible electric devices should be isolated.

11.1 Run in Period

After the first 100 hours of operation, the extruder should be taken out of operation and all maintenance steps detailed in the regular maintenance schedule performed.

11.2 Regular Maintenance

The steps outlined in the following regular maintenance schedule should be included in a comprehensive preventative maintenance programme.

11.3 EXTRUDER BARREL Wear

Wear of barrel components is an inherent factor in the extrusion process. Drops in operating temperatures and production rates are usually signs of wear. Persistent use of badly worn parts may result in a loss of extruder output and/or product quality.

Wear of SCREWS reduces their overall diameter, resulting in less efficient generation of heat and pressure. Wear of BARREL HOUSINGS occurs on the ridges that aid in the forward transportation of material.

The edge of a WEAR RING facing the product flow will become rounded as it wears, increasing its internal diameter. WEAR RINGS can be reversed (once only) so that the thicker edge faces the product flow.

CHOKE PLATES are critical components in the control of operating temperatures. Generally repositioning them in the barrel can extend the life of partially worn CHOKE PLATES (refer to the table shown below).

Table 11.0 Choke Plate re-use schedule

500 series extruders		1000 & 2000 series extruders	
worn choke plate size	behaves like	worn choke plate size	behaves like
96s	95	141	139
95	92	139	136
92	89	136	130
89	83	130	replace
83	Replace		

11.4 ADDITIONAL NOTES

In case of barrels where liners are not installed, the ridges of the barrels can be reinstated by machining the internal diameter and the barrel smooth and new ridge sections can then be welded back into the barrel.

Note it is important that correct dimensions of the barrel are maintained and that correct welding procedure for cast SG Iron is followed. Failure to follow correct procedure can result in dangerous fractures being created in the barrel casing, which can cause a failure of the casting in operation. The barrels should not be re-built more than two times.

In the case of the split barrel type machine using hardened liners, these liners only need to be replaced when the wear affects the performance of the machine i.e. insufficient heat, poor flow of material through the barrel causing surging or blockages and low production capacities.

These liners are not designed to be reconditioned or reused as they will become brittle and could fail during operation.

11.5 Regular Maintenance Schedule

Maintenance step	Description	Instructions	Frequency
1	Bearing housing oil level check	✓ Check level & add oil if necessary. Oil level should be 1/3-1/2 way up sight-glass ✓ Ensure that there is no oil contamination ✓ Ensure breather plug is clear ✓ Ensure that there are no leaks	Weekly/50 hourly
2	Conditioner gear box oil level check *(-S, -SX & -SP models only)*	✓ Check level & add oil if necessary ✓ Ensure that there is no oil contamination ✓ Ensure breather plug is clear ✓ Ensure that there are no leaks	Weekly/50 hourly
3	Greasing	✓ Grease all points listed on the conditioner greasing schedule ✓ Grease nipple(s) on main motor ✓ Grease all nipples on outboard cutter unit and slide tube support ✓ Use Mobil Mobilith SHC 220 or equivalent high temperature grease. (operating range -35 °C to 175°C)	Weekly/50 hourly
4	Cutter unit knife alignment	✓ Check knife alignment, sharpen knives if necessary	Daily
5	Drive system	✓ Check belt tension, tighten or replace belts as necessary [1]	Weekly/50 hourly
6	Temperature probes	✓ Check for tip wear. Tips should be recessed approximately 2 mm	Weekly/50 hourly
7	Barrel parts	✓ Assess wear of screws, barrel outer housings, wear rings, choke plates[2]	Regular basis
8	Bearing housing oil change	✓ Drain oil ✓ Replace with MOBIL SHC634/ISO grade VG 460 or equivalent. ✓ Oil level should be 1/3-1/2 way up sight-glass ✓ Ensure breather plug is clear	1000 hourly
9	Conditioner gear box oil change	✓ Drain oil	1000 hourly

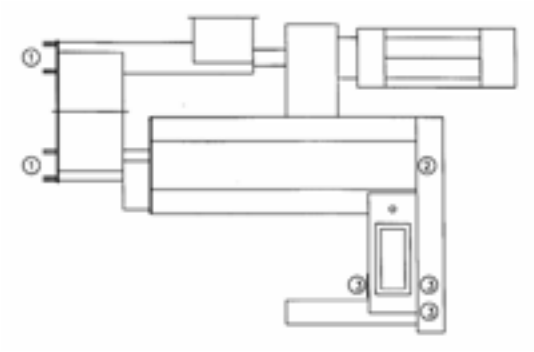
[1] When tensioning or replacing belts ensure that main shaft and motor pulleys remain aligned. Belt tension should allow 12-15 mm of deflection. Also see section 5

[2] See previous section.

	(-S,-SX & -SP models only)	✓ Replace with MOBIL SHC634/ISO grade VG 460 or equivalent. ✓ Ensure breather plug is clear	
10	All fasteners	✓ Check tension of all nuts, bolts etc.	1000 hourly

11.6 Conditioner greasing schedule

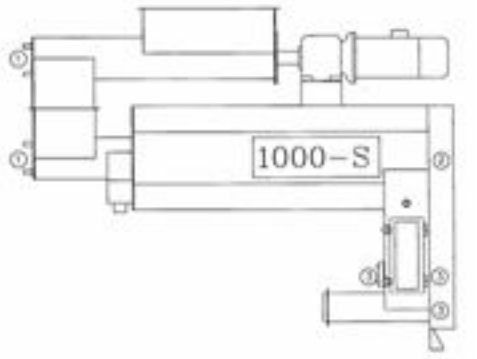
500-S/SX, 501-S



1. S200-SC071 - Intake Auger Bearing
2. S050-SC035 - 30mm Bearing
3. S100-SC026 - 20mm Bearing

Grease BEARINGS and CHAIN every
every 50 hours

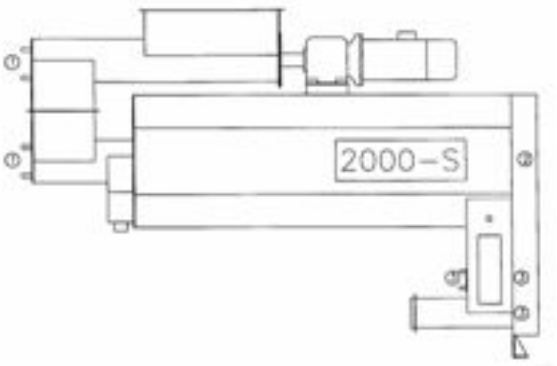
1000-S/SX and 1001-S/SX



1. S100-SC024 - Main Shaft Bearing
2. S100-SC016 - Barrel End Plate Bearing
3. S100-SC026 - 20mm Bearing

Grease BEARINGS and CHAIN
50 hours

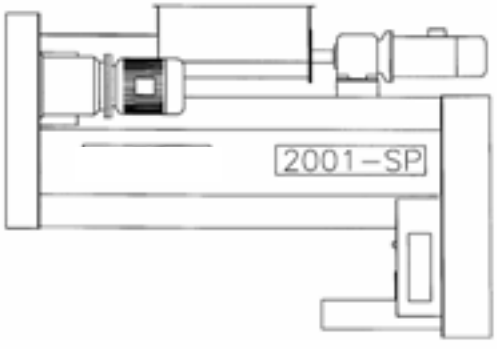
2000-S/SX and 2001-S/SX



1. S100-SC024 - Main Shaft Bearing
2. S100-SC016 - Barrel End Plate Bearing
3. S100-SC026 - 20mm Bearing

Grease BEARINGS and CHAIN every
every 50 hours

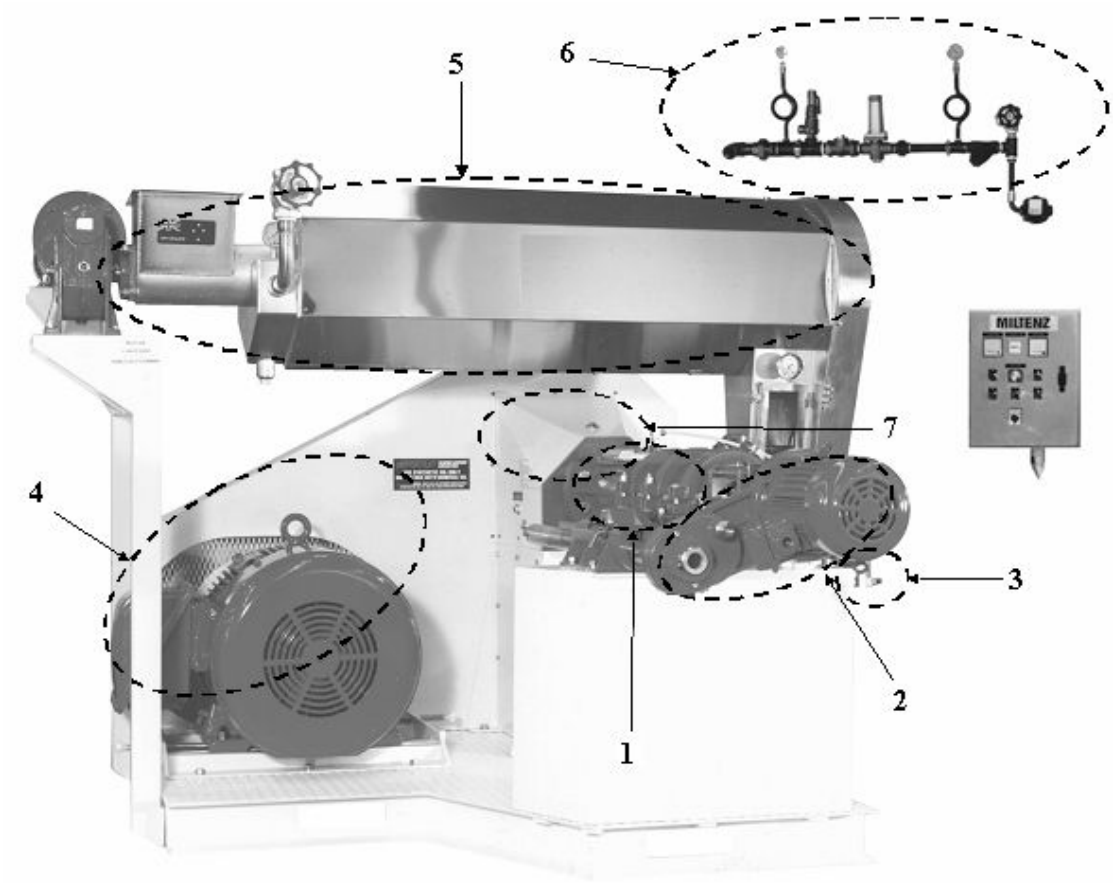
501-SP, 1001-SP, 2001-SP



1. S200-SC070 - Outer Cage Bearings
2. S200-SC071 - Intake Auger Bearings
3. S200-SC072 - Main Shaft Bearings
4. S200-SC073 - Gear Shaft Bearings
5. S100-SC026 - 20mm Bearings

Grease BEARINGS and CHAIN
50 hours

12 Spare Parts List and Drawings



12.1 General Description of the Bühler Millbank Extruder

Figure 12.1 Layout of the Bühler Millbank 500-S extruder

1. BARREL ASSEMBLY	Refer to section 3 and 12.2
2. BARREL HEAD ASSEMBLY	Refer to section 4 and 12.3
3. WATER INJECTION KITSET	Refer to section 3.5 and 12.4
4. DRIVE ASSEMBLY	Refer to section 5 and 12.5
5. STEAM CONDITIONER ASSEMBLY	Refer to section 6 and 12.6
6. **STEAM VALVE KITSET**	Refer to section 6 and 12.7
7. BEARING HOUSING ASSEMBLY	Refer to section 11 and 12.8
8. ELECTRICAL CONTROL CABINET	Refer to section 11 and 12.8

12.2 Barrel Assembly

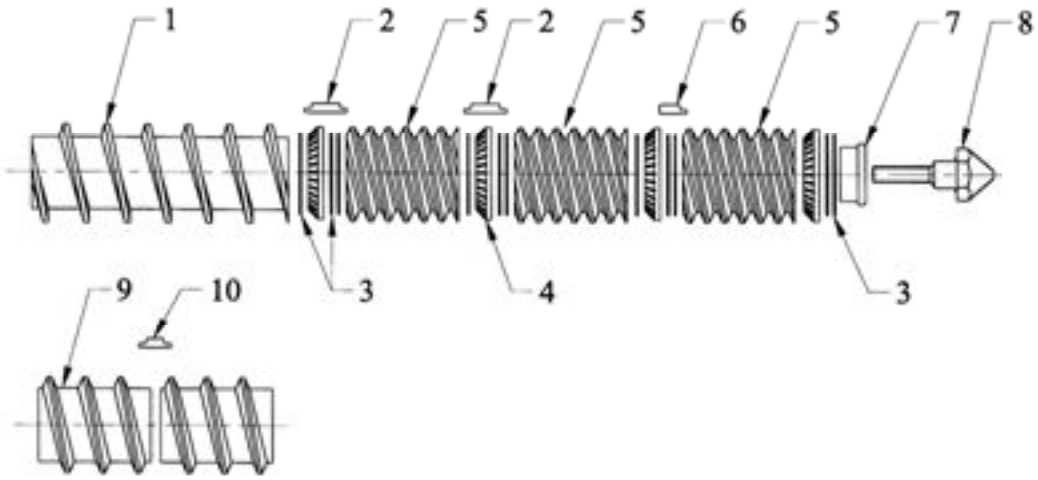


Figure 12.2 Internal Screw Configuration for Full Fat Soya

ITEM	PART NO.	DESCRIPTION
1	E050-BA059	INTAKE PRESSURE SCREW ONE PIECE
2	E050-BA048	DRIVE KEY LONG
3	E050-BA042	CHOKE PLATE SPACER
4	E050-BA051	CHOKE PLATE 83
	E050-BA052	CHOKE PLATE 89
	E050-BA053	CHOKE PLATE 92
	E050-BA054	CHOKE PLATE 95
	E050-BA055	CHOKE PLATE 96 S
5	E050-BA058	PRESSURE SCREW DOUBLE FLIGHT LONG
6	E050-BA049	EXTENSION SHAFT KEY
7	E050-BA041	RETAINER WASHER
8	E050-BA036	CONICAL NOSE BULLET
9	E050-BA057	PRESSURE SCREW SINGLE FLIGHT LONG
10	E100-BA047	DRIVE KEY SHORT
	E050-BA056	CHOKE PLATE RING (NOT SHOWN ON DRAWING!)

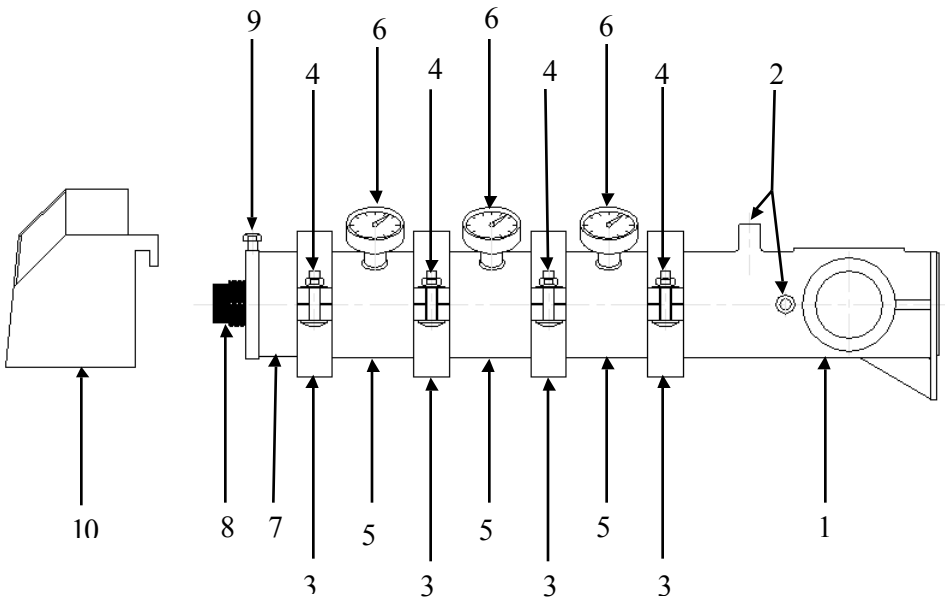


Figure 12.3 External Barrel Configuration for Full Fat Soya

ITEM	PART NO.	DESCRIPTION
1	E050-BA028 E050-BA027	FEED INTAKE HOUSING R.H. SIDE ENTRY FEED INTAKE HOUSING L.H. SIDE ENTRY
2		WATER INJECTION PORT
3	E050-BA034	CLAMPS
4	E050-BA035	CLAMP BOLT
5	E050-BA030	BARREL OUTER HOUSING STANDARD
6	E100-BA059	THERMOMETER
7	E050-BA033	BARREL END SECTION
8	E050-BA038 E050-BA039 E050-BA040	NOZZLE PIECE 8MM NOZZLE PIECE 12 MM NOZZLE PIECE 16 MM
9	E050-BA046	NOZZLE PIECE RETAINING BOLT/PLUG
10	E100-BA064	DOWNWARD DEFLECTOR

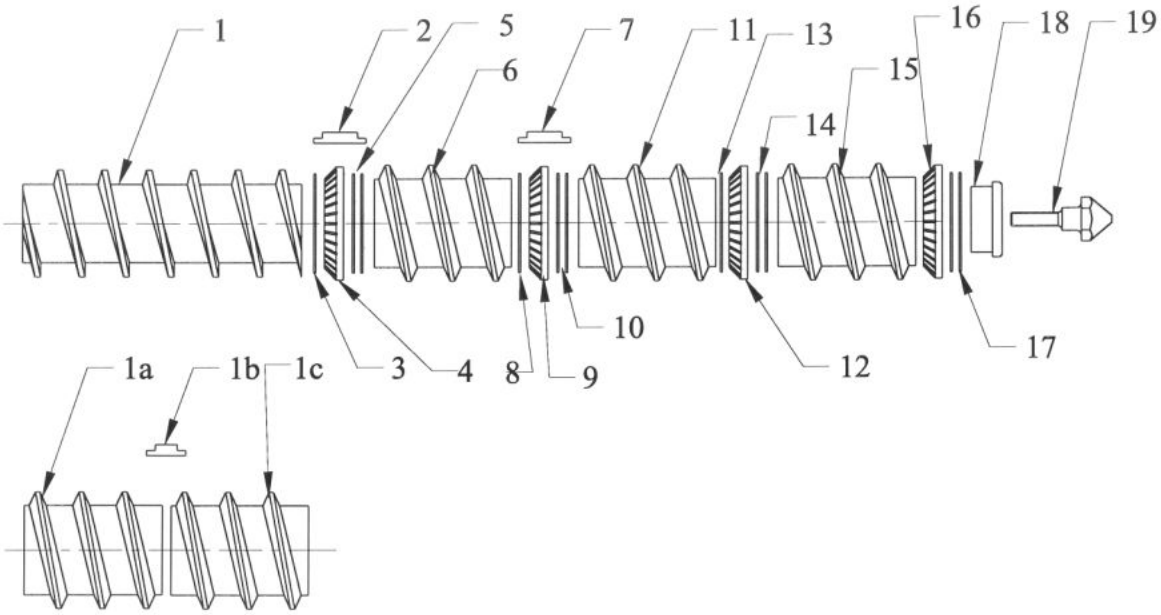


Figure 12.4 Typical Internal Screw Configuration for Starch Products

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	INTAKE PRESSURE SCREW ONE PIECE	11	PRESSURE SCREW SINGLE FLIGHT LONG
1a	PRESSURE SCREW SINGLE FLIGHT LONG	12	CHOKE PLATE 83
1b	DRIVE KEY SHORT	13	CHOKE PLATE SPACER (X1)
1c	PRESSURE SCREW SINGLE FLIGHT LONG	14	CHOKE PLATE SPACER (X2)
2	DRIVE KEY LONG	15	PRESSURE SCREW SINGLE FLIGHT LONG
3	CHOKE PLATE SPACER	16	CHOKE PLATE 89
4	CHOKE PLATE 83	17	CHOKE PLATE SPACER (X2)
5	CHOKE PLATE SPACER (X2)	18	RETAINER WASHER
6	PRESSURE SCREW SINGLE FLIGHT LONG	19	CONICAL NOSE BULLET
7	DRIVE KEY LONG		
8	CHOKE PLATE SPACER		
9	CHOKE PLATE 83		
10	CHOKE PLATE SPACER (X2)		

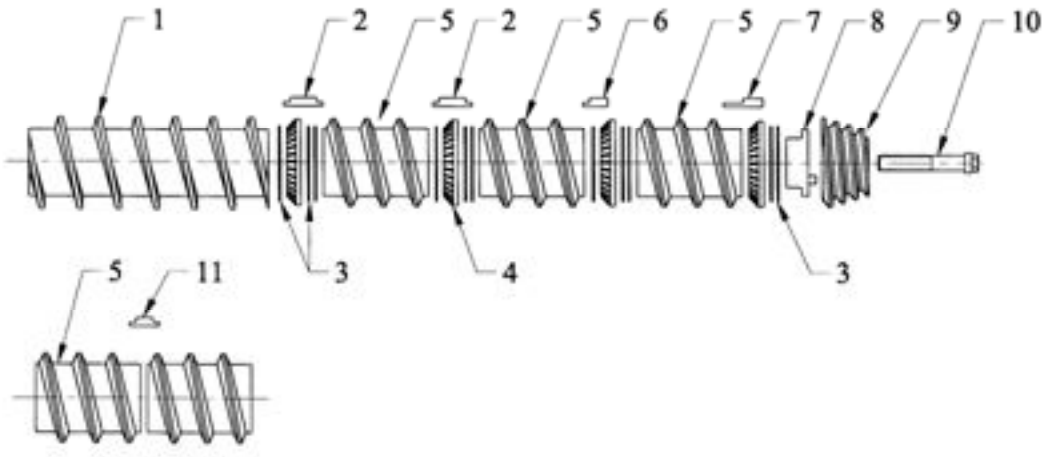


Figure 12.5 Internal Screw Configuration for Aqua Feeds

ITEM	PART NO.	DESCRIPTION
1	E050-BA059	INTAKE PRESSURE SCREW ONE PIECE
2	E050-BA048	DRIVE KEY LONG
3	E050-BA042	CHOKE PLATE SPACER
4	E050-BA051 E050-BA052 E050-BA053 E050-BA054 E050-BA055	CHOKE PLATE 83 CHOKE PLATE 89 CHOKE PLATE 92 CHOKE PLATE 95 CHOKE PLATE 96 S
5	E050-BA057	PRESSURE SCREW SINGLE FLIGHT LONG
6	E050-BA049	EXTENSION SHAFT KEY
7	E050-CP003	RETAINING KEY
8 9	E050-CP004 E050-CP007	END RETAINER TAPERED FLIGHT FEEDER
10	E050-CP005	RETAINER BOLT
11	E100-BA047	DRIVE KEY SHORT

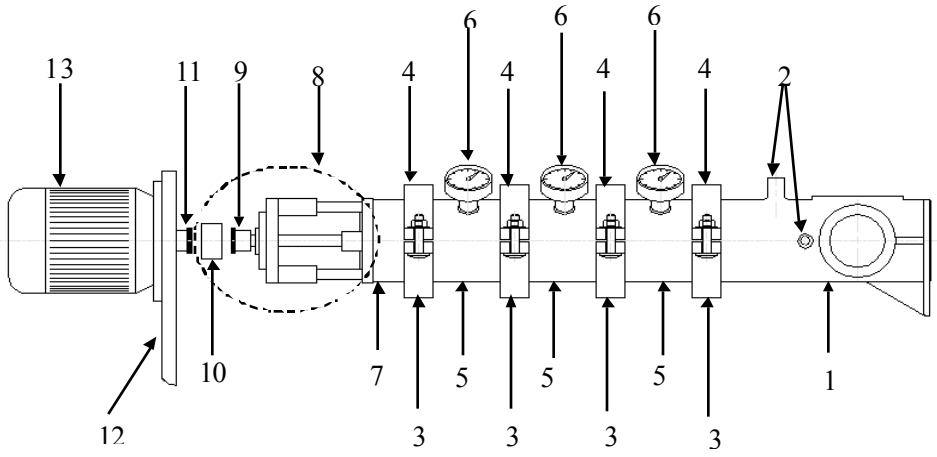


Figure 12.6 External Barrel Configuration with Cutter Head Assembly

ITEM	PART NO.	DESCRIPTION
1	E050-BA028 E050-BA027	FEED INTAKE HOUSING R.H. SIDE ENTRY FEED INTAKE HOUSING L.H. SIDE ENTRY
2		WATER INJECTION PORT
3	E050-BA034	CLAMP
4	E050-BA035	CLAMP BOLT
5	E050-BA030	BARREL OUTER HOUSING STANDARD
6	E100-BA059	THERMOMETER
7	E050-CU002	CUTTER HEAD HOUSING ADJUSTABLE
8	E050-CU V3	CUTTER HEAD NEW KNIFE
9	E100-OC037	DRIVE GEAR 25MM
10	E100-OC035	COUPLING SLEEVE
11	E100-OC034 E100-OC036	DRIVE GEAR 24MM (2.2 KW MOTOR) * DRIVE GEAR 28MM (3.0 KW MOTOR)
12	E100-OC031 E100-OC021	MOTOR MOUNT BRACKET (V2) (2.2 KW) * MOTOR MOUNT BRACKET (V2) (3.0 KW)
13	E100-OC063 E100-OC046	2.2 KW MOTOR 400/440V 50/60HZ 2 POLE * 3 KW MOTOR 380V 60 HZ 4 POLE

* Part no vary depending on the motor used.

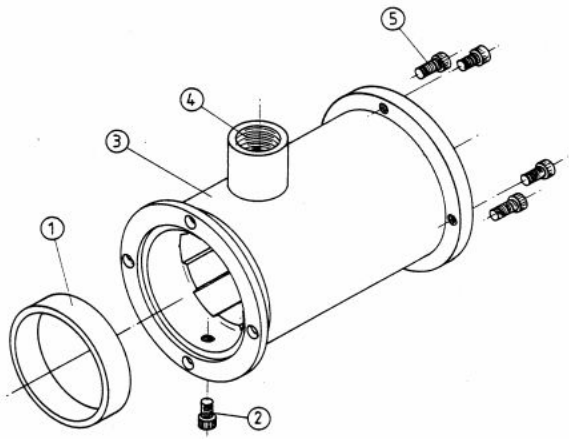


Figure 12.7 Barrel Housing Assembly

ITEM	Part no.	Description
1	E050-BA043	WEAR RING HARDENED
2	E050-BA044	WEAR RING LOCATION DOWEL
3	E050-BA030	BARREL OUTER HOUSING STANDARD
4		THERMOMETER PORT
5	E050-BA045	BARREL OUTER HOUSING LOCATION DOWELS

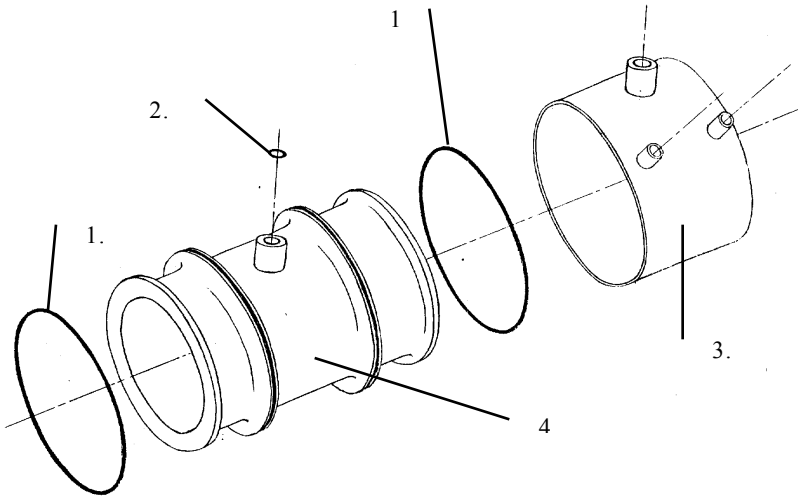


Figure 12.8 Water Cooling Jacket Assembley

ITEM	PART NO.	DESCRIPTION
1	E050-BJ002	BARREL HOUSING "O" RING
2	E100-BJ003	TEMPERATURE PORT "O" RING
3	E050-BJ001	WATER COOLED JACKET
4	E050-BA031	BARREL OUTER HOUSING COOLED

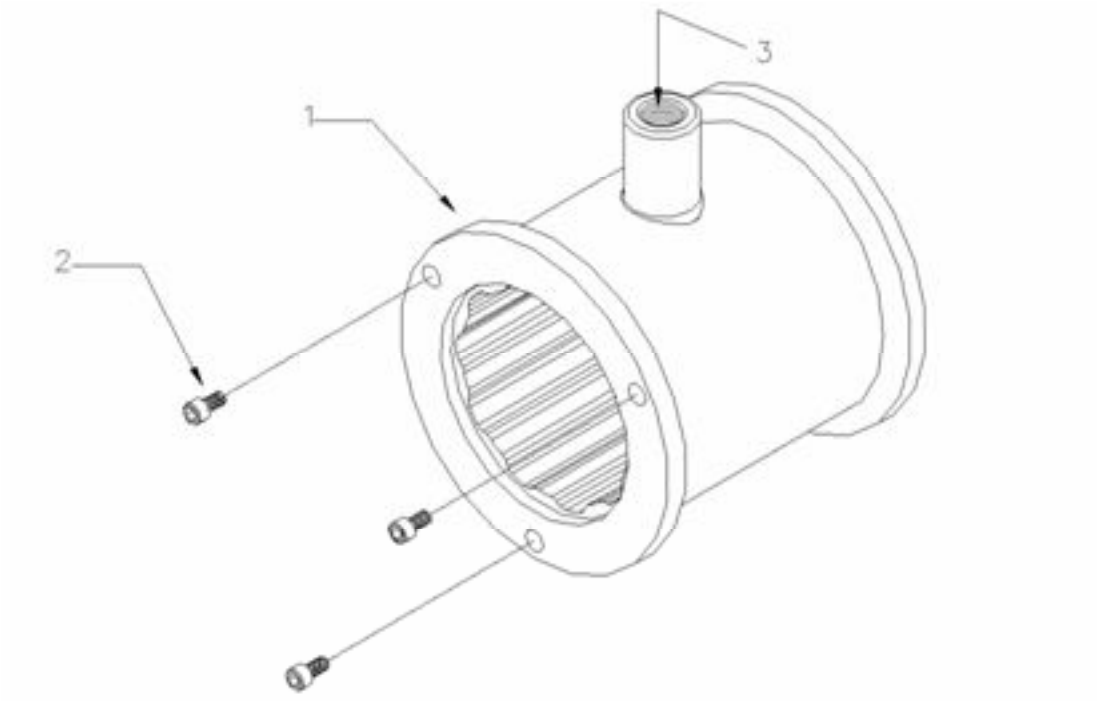


Figure 12.9 straight through flutes barrel assembly

ITEM	Part no.	Description
1	E050-BA130	BARREL STRAIGHT THROUGH FLUTES
2	E050-BA045	BARREL OUTER HOUSING LOCATION DOWELS
3		THERMOMETER PORT

12.3 Barrel Head Assembly

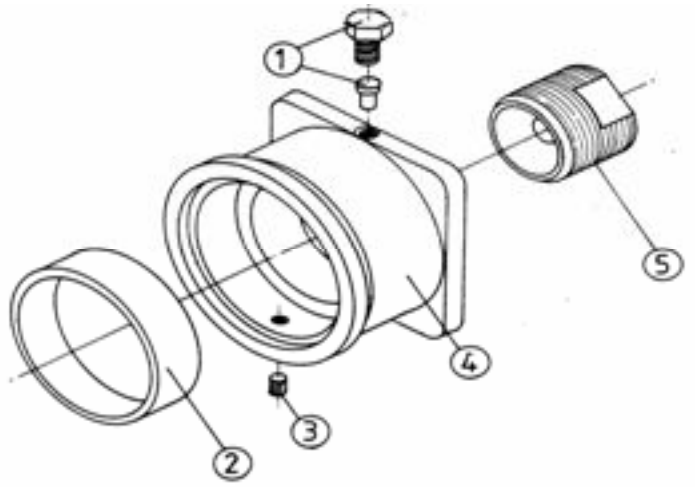


Figure 12.10 Barrel End Piece and Nozzle Assembly

ITEM	PART NO.	DESCRIPTION
1	E050-BA046	NOZZLE PIECE RETAINING BOLT/PLUG
2	E050-BA043	WEAR RING HARDENED
3	E050-BA044	WEAR RING LOCATION DOWEL
4	E050-BA033	BARREL END SECTION
5	E050-BA038	NOZZLE PIECE 8MM
	E050-BA039	NOZZLE PIECE 12 MM
	E050-BA040	NOZZLE PIECE 16 MM

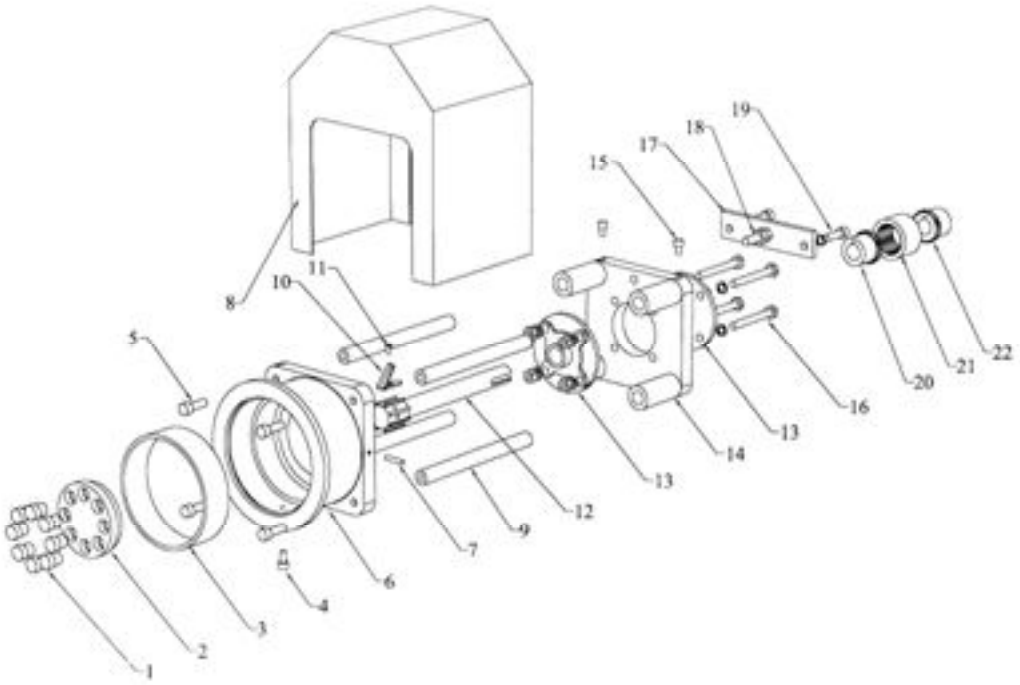


Figure 12.11 Cutter Head Setup Series I

ITEM	PART NO	DESCRIPTION
1	E100-CU031	DIES 4 MM
	E100-CU026	DIES 5 MM
	E100-CU027	DIES 8 MM
	E100-CU028	DIES 10MM
	E100-CU029	DIES 12MM
	E100-CU030	DIES BLANK
2	E100-CU018	DIE PLATE 8 HOLE 19 MM
3	E050-BA043	WEAR RING HARDENED
4	E050-BA044	WEAR RING LOCATION DOWEL
5	E100-CU039	SOCKET HEAD CAP SCREW M10X30
6	E050-CU002	CUTTER HEAD HOUSING ADJUSTABLE
7	E100-CU038	DIE PLATE RETAINER SCREW
8	E100-CU045	CUTTER GUARD
9	E100-CU007	BEARING PLATE SPACERS ADJUSTABLE
10	E100-CU200	90 DEGREE KNIFE BLADE
11	E100-CU205	KNIFE ATTACHMENT STUD, NUT, WASHER
12	E100-CU199	CUTTER SHAFT 8 KNIFE
13	E100-CU042	CUTTER BEARING REAR ADJUSTABLE
14	E100-CU005	BEARING PLATE REAR ADJUSTABLE
15	E100-BA045	BARREL OUTER HOUSING LOCATION DOWEL
16	E100-CU033	SHAFT BEARING MOUNTING STUDS
17	E100-CU043	ADJUSTING BAR
18	E100-CU046	M12X65 HEX HEAD SET SCREW
19	E100-CU039	SOCKET HEAD CAP SCREW M10X30
20	E100-OC037	DRIVE GEAR 25MM
21	E100-OC035	COUPLING SLEEVE
22	E100-OC034	DRIVE GEAR 24 MM
	E100-OC036	DRIVE GEAR 28MM

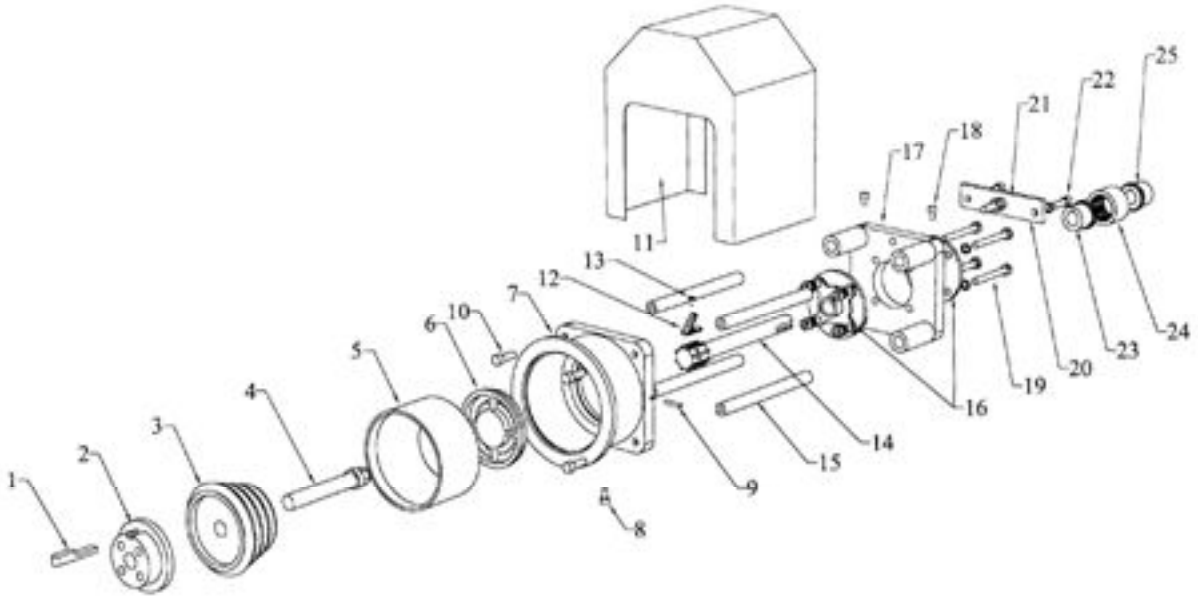


Figure12.12 Compression Head Setup – Series I

ITEM	PART NO	DESCRIPTION
1	E050-CP003	RETAINING KEY
2	E050-CP004	END RETAINER
3	E050-CP007	TAPERED FLIGHT FEEDER
4	E050-CP005	RETAINER BOLT
5	E050-CP006	HARDENED SLEEVE
6		DIE PLATE (PART NO VARY)
7	E050-CP002	COMPRESSION HEAD HOUSING ADJUSTABLE
8	E050-BA044	WEAR RING LOCATION DOWEL
9	E100-CU038	DIE PLATE RETAINER SCREW
10	E100-CU039	SOCKET HEAD CAP SCREW M10X30
11	E100-CU045	CUTTER GUARD
12	E100-CU200	90 DEGREE KNIFE BLADE
13	E100-CU205	KNIFE ATTACHMENT STUD, NUT, WASHER
14	E100-CU199	CUTTER SHAFT 8 KNIFE
15	E100-CU007	BEARING PLATE SPACER ADJUSTABLE
16	E100-CU042	CUTTER BEARING REAR ADJUSTABLE
17	E100-CU005	BEARING PLATE REAR ADJUSTABLE
18	E100-BA045	BARREL OUTER HOUSING LOCATION DOWEL
19	E100-CU033	SHAFT BEARING MOUNTING STUDS
20	E100-CU043	ADJUSTING BAR
21	E100-CU046	M12X65 HEX HEAD SET SCREW
22	E100-CU039	SOCKET HEAD CAP SCREW M10X30
23	E100-OC037	DRIVE GEAR 25 MM
24	E100-OC035	COUPLING SLEEVE
25	E100-OC034 E100-OC036	DRIVE GEAR 24 MM DRIVE GEAR 28 MM

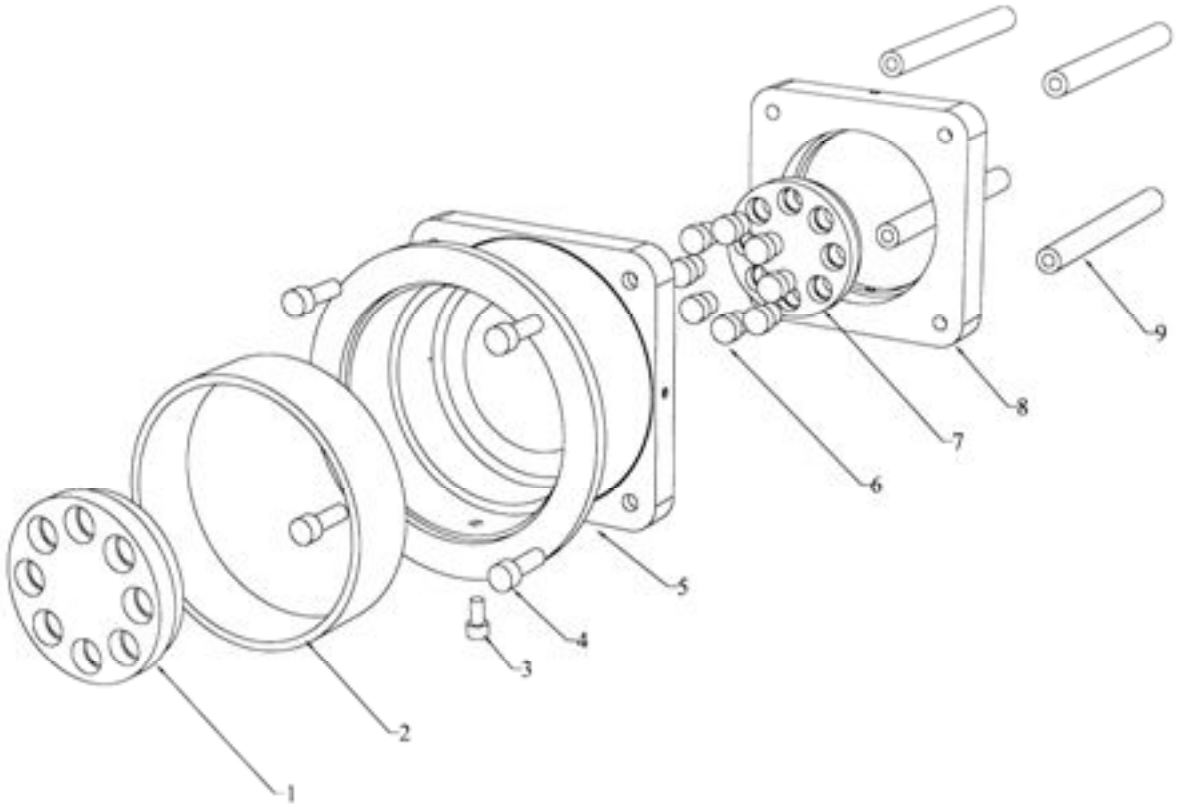


Figure 12.13 Double Die Assembly

ITEM	PART NO	DESCRIPTION
1	E100-CU018	DIE PLATE 8 HOLE 19 MM
2	E050-BA043	WEAR RING HARDENED
3	E050-BA044	WEAR RING LOCATION DOWEL
4	E100-CU039	SOCKET HEAD CAP SCREW M10X30
5	E050-CU002	CUTTER HEAD HOUSING ADJUSTABLE
6	E100-CU031 E100-CU026 E100-CU027 E100-CU028 E100-CU029 E100-CU030	DIES 4 MM DIES 5 MM DIES 8 MM DIES 10 MM DIES 12 MM DIES BLANK
7	E100-CP022	DOUBLE DIE PLATE OUTER 8 HOLE
8	E100-CP020	DOUBLE DIE HOUSING
9	E100-CU007	BEARING PLATE SPACERS ADJUSTABLE

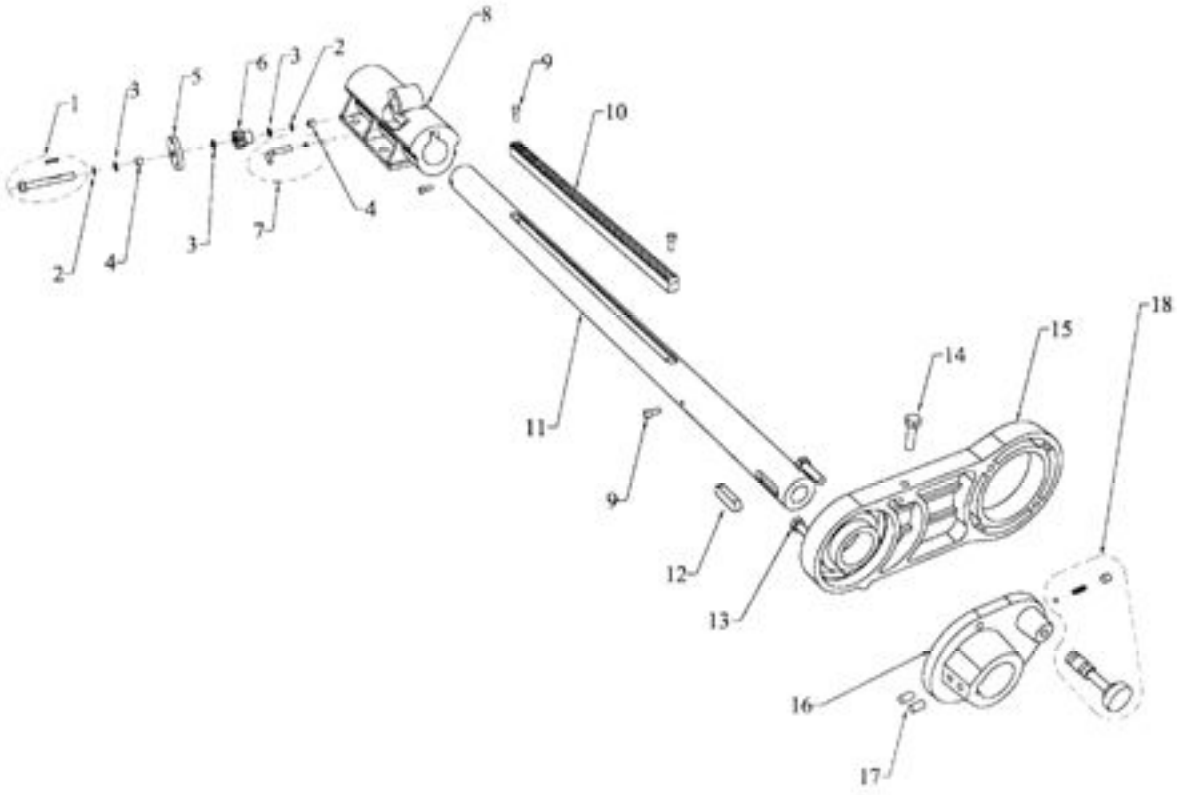


Figure 12.14 Slide Tube Assembly Kit

ITEM	PART NO	DESCRIPTION
1	E100-OC054	CRANK SHAFT AND KEY
2	E100-OC061	CIRCLIP
3	E100-OC058	THRUST WASHER COVER
4	E100-OC059	SHAFT BUSHING
5	E100-OC056	RETAINER PLATE
6	E100-OC053	SPUR GEAR
7	E100-OC057	LOCKING SCREW AND PLUG
8	E100-OC051	CUTTER SLIDE SHAFT SUPPORT V.2
9	E100-OC064	M8X16 SS CAP SCREW
10	E100-OC052	SLIDING ARM RACK
11	E100-OC050	CUTTER SLIDE SHAFT V.2
12	E100-OC028	END FLANGE KEY
13	E100-OC026	END FLANGE BOLT
14	E100-CU046	M12X65 HEX HEAD SET SCREW
15	E100-OC021 E100-OC031	MOTOR MOUNT BRACKET (D100 FLANGE) MOTOR MOUNT BRACKET (D90 FLANGE)
16	E100-OC019	END FLANGE 1001
17	E100-OC027	END FLANGE GRUB SCREW
18	E100-OC022	LOCK PIN KIT

12.4 Water Injection Kitset

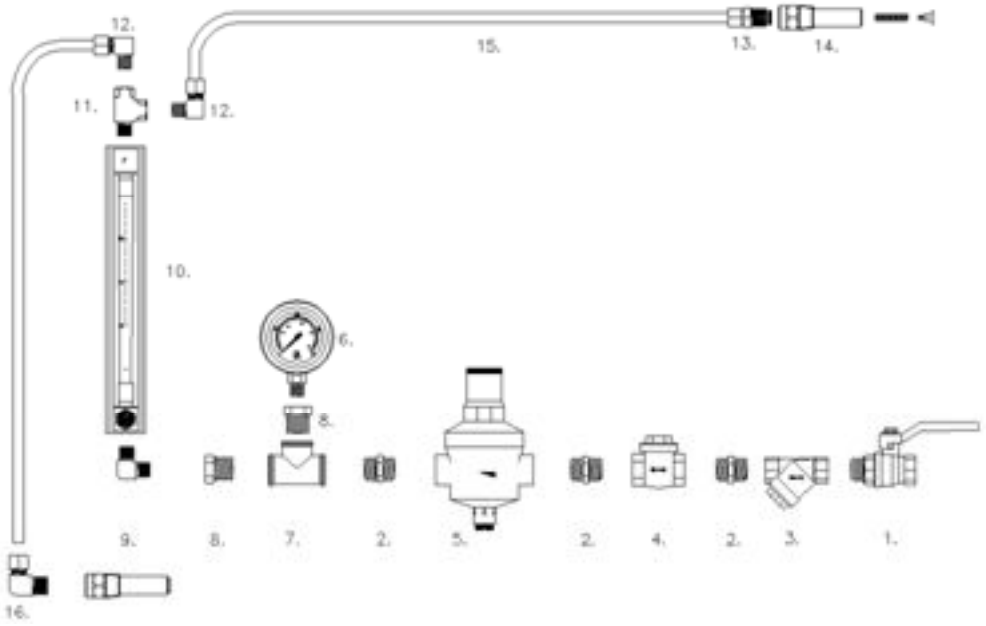


Figure 12.15 Water Injection Kitset

ITEM	PART NO.	DESCRIPTION
1	E100-WI013	ON/OFF CONTROL VALVE
2	E100-WI017	HEX NIPPLE ½"
3	E100-WI012	FILTER VALVE
4	E100-WI016	1/2" NON RETURN VALVE
5	E100-WI014	PRESSURE REDUCING VALVE
6	E100-WI015	PRESSURE GAUGE
7	E100-WI018	1/2" MANIFOLD
8	E100-WI019	1/2" X 1/4" REDUCING BUSH
9	E100-WI020	1/4" MALE ELBOW
10	E100-WI040 E200-WI027	FLOWMETER KROHNE 100 LITRES (500 SERIES) FLOWMETER KROHNE 160 LITRES(1000/2000 SERIES)
11	E100-WI008	MALE/FEMALE TEE
12	E100-WI025	COMPRESSION ELBOW ¼"
13	E100-WI006	COMPRESSION STRAIGHT 3/8"
14	E100-WISA1	WATER INJECTION VALVE COMPLETE
15	E100-WI009	HIGH PRESSURE TUBING
16	E100-WI007	COMPRESSION ELBOW 3/8"

12.5 Drive Assembly

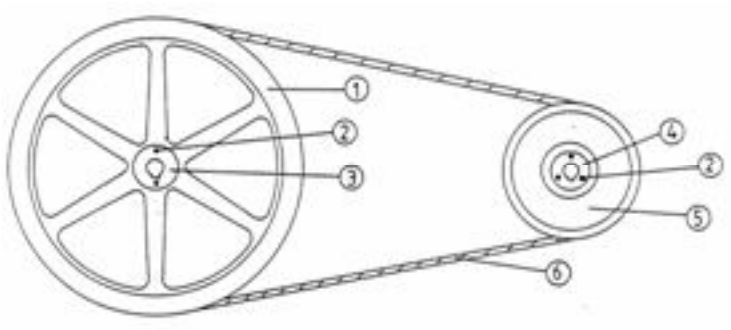


Figure 12.16 Drive System

ITEM	PART NO.	DESCRIPTION
1	E050-DR001	MAIN SHAFT PULLEY
2		PULLEY BUSHING BOLTS
3	E050-DR002	MAIN SHAFT PULLEY BUSHING
4	E050-DR***	MAIN MOTOR PULLEY BUSHING *
5	E050-DR***	MAIN MOTOR PULLEY *
6	E050-DR	VEE BELTS

* Part no vary depending on type of motor used

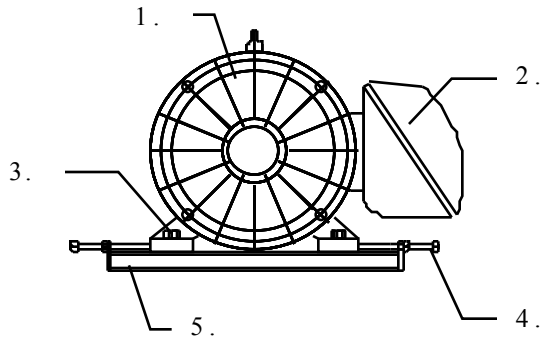


Figure 12.17 Motor Adjustment

ITEM	PART NO	DESCRIPTION
1	E050-DR***	MAIN MOTOR *
2		JUNCTION BOX
3	E050-DR023	MOTOR HOLD DOWN BRACKET
4	E050-DR034	MOTOR ADJUSTMENT SCREWS 500 SERIES
5	E050-DR033	MOTOR MOUNTING BASE

* Part no vary depending on type of motor used.

12.6 Steam Conditioner Assembly

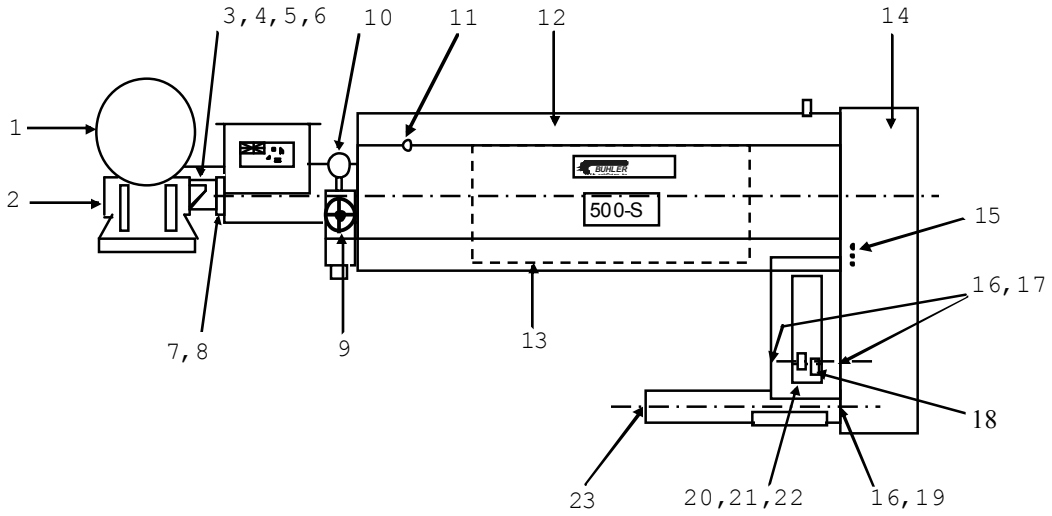


Figure 12.18 S/SX-Type Conditioner

ITEM	PART NO	DESCRIPTION
1	E200-VF040	D.C. MOTOR 1.5 KW
2	S050-SC016	GEARBOX 500-S 1.5 KW DC 25:1 REDUCTION
3	S050-SC020	500–S STEAM CONDITIONER SHAFT
4	S050-SC023	MAIN SHAFT PADDLES S/S
5	S050-SC014	GEARBOX DRIVE KEY
6	S050-SC017	GEARBOX RETAINING WASHER SS
7	S200-SC071	40 BEARING SQUARE
8	S050-SC036	INTAKE HOPPER SEAL (50MM)
9	S050-SV002	32 MM GLOBE VALVE
10	S100-SV008	LOW PRESSURE STEAM GAUGE
11	S100-SC004	STAINLESS PLUG ½" BSP
12	S050-SC001	STEAM CONDITIONER BODY R.H
13	S100-SC028	MAIN BODY DOOR SEAL
14		CHAIN GUARD
15		REMOTE GREASING KIT
16	S100-SC026	20 BEARING SQUARE
17	S200-SC026	AGITATOR TEFLON SEAL 20MM
18	S050-SC048	OUTLET SHUTE AGITATOR
19	S200-SC017	FORCE FEEDER TEFLON SEAL 30MM
20	S050-SC012	INSPECTION CLEARVIEW PANEL
21		INSPECTION COVER SURROUND
22	S100-SC012	INSPECTION DOOR SEAL
23	S050-SC050	FORCE FEED AUGER

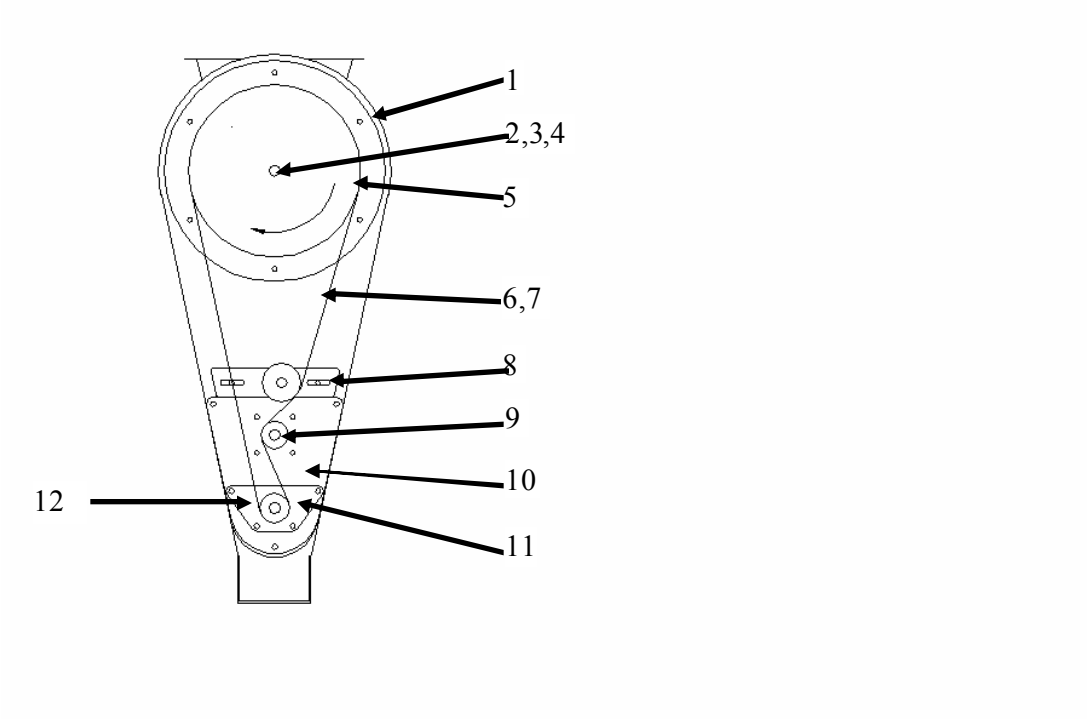


Figure 12.19 S/SX-Type Chain/Sprocket Assembly

ITEM	PART NO	DESCRIPTION
1		BARREL END PLATE
2	S050-SC030	SEAL HOUSING 30MM
3	S050-SC035	30 BEARING SQUARE
4	S050-SC031	TEFLON SEAL 30MM
5	S050-SC019	MAIN SHAFT SPROCKET 95TX3/8"
6	S050-SC025	DRIVE CHAIN 3/8" SIMPLEX
7	S050-SC026	DRIVE CHAIN CONNECTING LINK 3/8"
8	S050-SC021	IDLER TENSIONER COMPLETE
9	S050-SC022	AGITATOR FORCE FEED SPROCKET 15TX3/8"
10		AGITATOR SUPPORT PLATE
11	S050-SC018	DOUBLE BEARING KIT
12	S050-SC024	FEEDER SPROCKET 20TX3/8''

12.7 Steam Valve Kitset

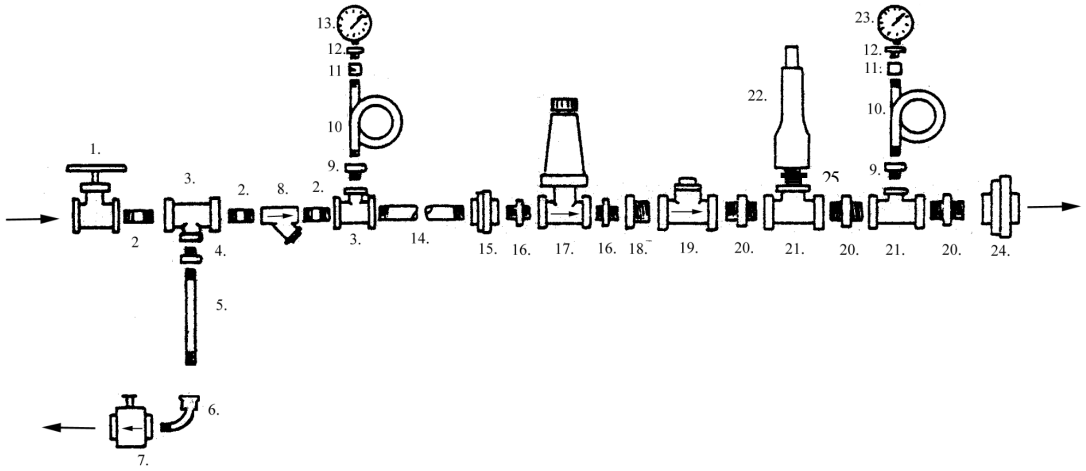


Figure 12.20 Steam Valve Kitset

ITEM	PART NO.	DESCRIPTION
1	S050-SV001	20MM STEAM ISOLATION VALVE
2	S050-SV020	20×50MM BARREL NIPPLE
3	S050-SV016	20MM BLACK STEAM TEE
4	S050-SV015	20×15MM REDUCING BUSH
5	S100-SV017	15×150MM BLACK. BARREL NIPPLE
6	S100-SV018	15MM BLACK STEAM BEND M&F
7	S100-SV003	15MM FLOAT STEAM TRAP
8	S050-SV004	20MM STRAINER
9	S050-SV021	20×10MM BLACK REDUCING BUSH
10	S100-SV010	GAUGE SIPHON PIG TAIL
11	S100-SV013	10MM BLACK SOCKET
12	S100-SV014	10MM×1/4" BLACK REDUCING BUSH
13	S100-SV009	HIGH PRESSURE STEAM GAUGE
14	S050-SV022	20×150MM BLACK BARREL NIPPLE
15	S050-SV023	20MM BLACK MAC UNION
16	S050-SV024	20MM BLACK HEX NIPPLE
17	S050-SV005	20MM PRESSURE REDUCING VALVE
18	S050-SV025	20×32MM BLACK REDUCING BUSH
19	S050-SV006	32MM LIFT CHECK VALVE
20	S050-SV029	32MM BLACK HEX NIPPLE
21	S050-SV032	32×25MM BLACK STEAM TEE
22	S050-SV007	20MM STEAM SAFETY VALVE
23	S100-SV008	LOW PRESSURE STEAM GAUGE
24	S050-SV030	32MM BLACK MAC UNION
25	S050-SV035	25X20 BLACK REDUCING BUSH

12.8 Bearing Housing Assembly

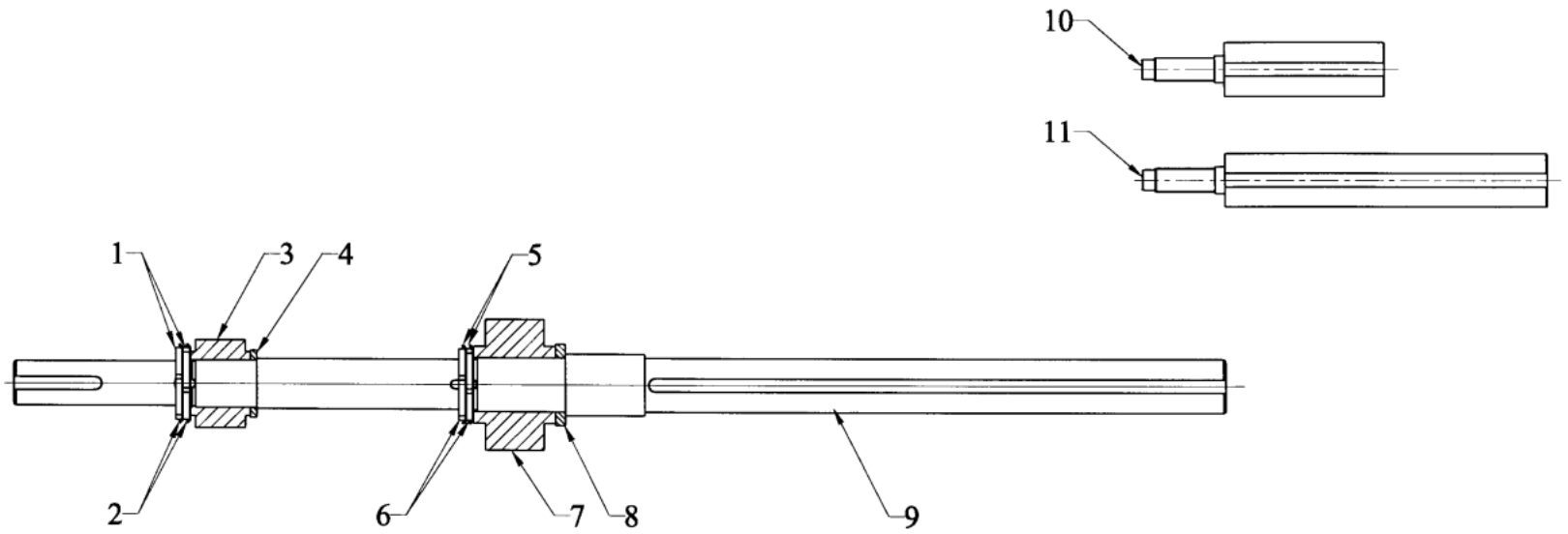


Figure 12.21 Shaft Assembly

ITEM	PART. NO	DESCRIPTION	ITEM	PART NO	DESCRIPTION
1	E050-BA016	REAR BEARING LOCK NUT	7	E050-BA010	FRONT BEARING ASSEMBLY
2	E050-BA015	REAR BEARING LOCK WASHER	8	E050-BA007	FRONT BEARING RING
3	E050-BA014	REAR BEARING ASSEMBLY	9	E050-BA067	HEAVY DUTY MAIN SHAFT
4	E050-BA013	REAR BEARING RING	10	E050-BA025	MAIN SHAFT EXTENSION 1 CHAMBER
5	E050-BA011	FRONT BEARING LOCK WASHER	11	E050-BA075	MAIN SHAFT EXT TWO BARREL
6	E050-BA012	FRONT BEARING LOCK NUT			

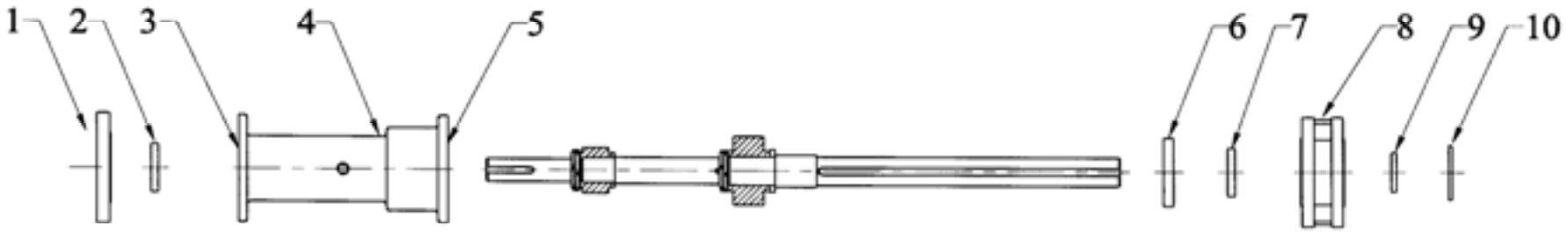
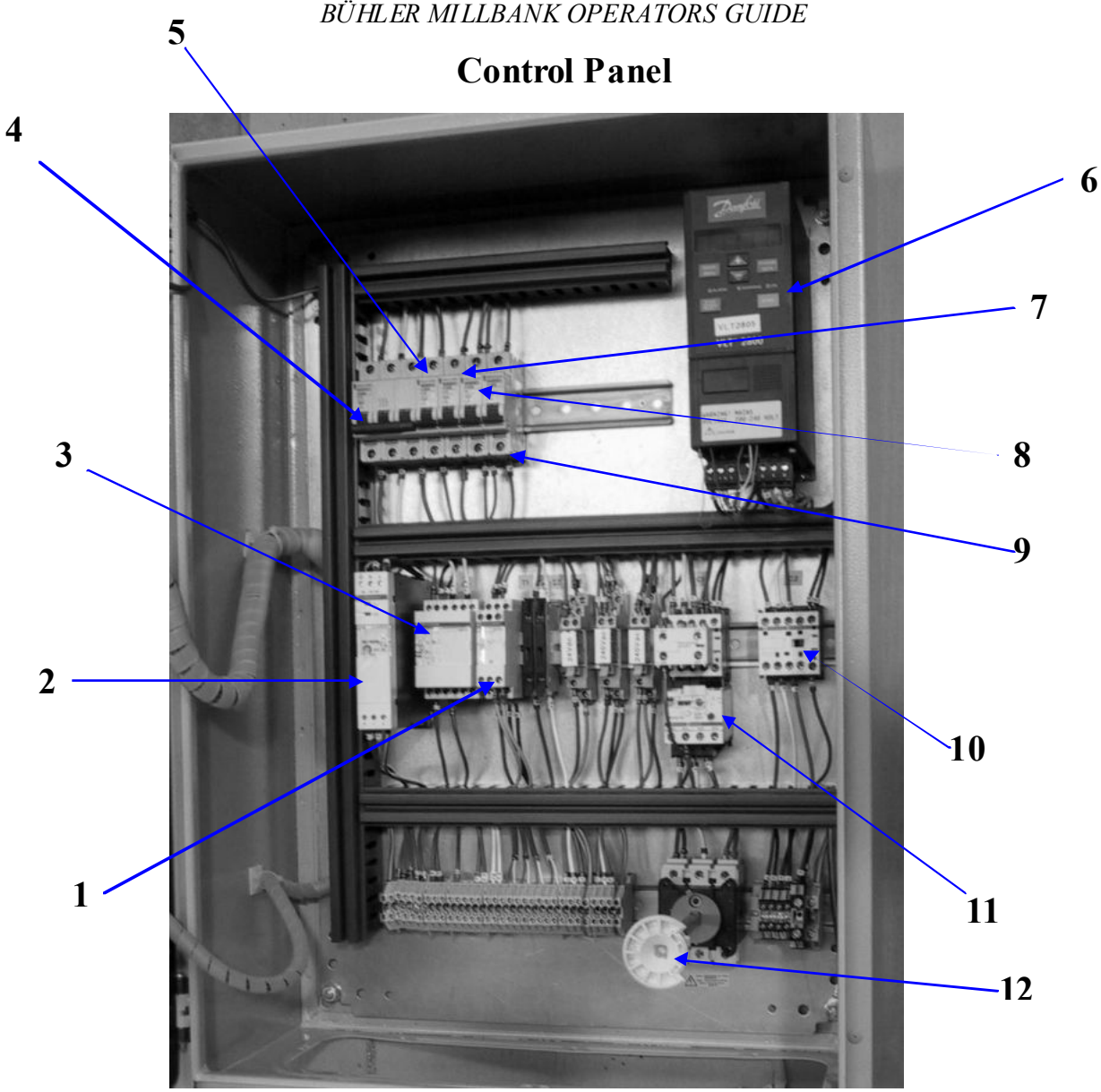


Figure 12.22 Bearing Housing Assembly

ITEM	PART NO	DESCRIPTION	ITEM	PART NO	DESCRIPTION
1	E050-BA003	REAR END PLATE	6	E050-BA008	FRONT BEARING RETAINER
2	E050-BA017	REAR SEAL	7	E050-BA009	FRONT SEAL
3		OIL RESISTANT RTV SILICONE SEALANT	8	E050-BA004	HEAVY DUTY FRONT PLATE
4	E050-BA001	BEARING HOUSING	9	E050-BA064	INNER OIL SEAL PROTECTOR
5		OIL RESISTANT RTV SILICONE SEALANT	10	E050-BA065	OIL SEAL PROTECTOR LOCATION PLATE

APPENDIX

Control Panel



ITEM	DESCRIPTION
1	Timer
2	24V DC Power Transformer
3	Current Relay
4	Preconditioner motor circuit breaker
5	Feeder Motor AC speed drive Drive circuit breaker
6	Feeder Motor AC speed drive
7	Water Pump circuit breaker
8	Control Circuit breaker
9	24V DC Power Transformer circuit breaker
10	Feeder Motor AC speed drive Contactor
11	Preconditioner Motor Contactor
12	Power Switch

Product Component Record

MACHINE DETAILS	
SERIAL NO.	10361 6012
MODEL	**BASM-93 SX**
MAIN MOTOR Size	NOT SUPPLIED
Brand	
STEAM CONDITIONER MOTOR	NOT SUPPLIED
Size	
Brand	
VOLUME FEEDER MOTOR Size	.55kW
Brand	TECO.
	4 POLE
CUTTER MOTOR	
Size	N/A
Brand	N/A
CONDITIONER GEARBOX	
Brand	SITI
Model	MI 80
Ratio	15:1
VOLUME FEEDER GEARBOX	
Brand	MOTOVARIO
Model	NMRV050
Ratio	30:1
CUTTER MOTOR CONTROLLER	
Brand	N/A
Model	N/A
VOLUME FEEDER CONTROLLER	
Brand	DANFOSS
Model	VLT 2800
STEAM VALVE KITSET	
Brand	IMI TAYLORS

Hazard Analysis

Possible Hazard	Possible Injury	Solution or Protection
Main drive belts and pullys	Contact with pulleys, catching belt	Cover with lock out protection
Conditioner bypass chute	Burns ,Contact with rotating shaft	Fit restriction bars, Signage
Conditioner door access	Burns. Contact with rotating shaft	Cut out switch, control panel reset, Signage
Cutter motor	Contact with rotating shaft, Contact with knives	Signage, Removable guard operational requirement
Feed intake cover	Contact with rotating shaft, Burns	Bars in cover to restrict access. Signage
Rotating shafts through bearing housings	Contact with rotating surface	Fit caps to bearing housings
Conditioner Door	Door closing on operator	Fit safety latch
Conditioner drive chains	Contact with chains and sprockets	Fit guard, Signage
Hot surfaces: Steam injection hoses Barrels Conditioner	Burns	 Signage Signage Insulate and cover
Steam conditioner vent	Burns	Signage
Force feeder	Contact with rotating auger	Bolted guard, Signage
Electrical cabinets	Contact with electricity	Door locks, Signage
Volume feeder access cover	Burns from steam, Contact with rotating auger	Cut out switch, Signage
Steam supply lines	Burns	Customer to insulate
Soya nozzle adjustment	Mechanical contact with main shaft	Operational procedure, Locking nut, Ratchet spanner
Volume feeder hopper	Contact with rotating auger	Customer to ensure hopper restricts access.
Barrel and end section removal	Exposure to hot product and steam, Burns	Protective clothing, Operational procedure

August, 09