OPERATING MANUAL

BIRD SOLID BOWL, CONTINUOUS CENTRIFUGAL

BIRD

BIRD MACHINE COMPANY
SOUTH WALPOLE, MASS.

FOREWORD

The purpose of this manual is to help you make the most of your Bird Continuous Solid Bowl Centrifugal. Much of the information it contains may already be familiar to you, but we have included it with the thought that it may prove useful as a reference or instruction to anyone concerned with installation, operation and maintenance of this machine. If the manual lets you obtain better overall performance, or saves you time, labor, and money, it will have accomplished its purpose.

In endeavoring to cover every angle and to anticipate every problem, we may give you the impression that the Bird Centrifugal is a difficult machine to install, operate and maintain. The experience of users provides ample evidence to the contrary. The Bird Centrifugal, by contrast with the equipment it often replaces, is unusually simple and sturdy, and requires a minimum of attention. A clear understanding of its mechanics, and its way of functioning is all that is necessary to obtain long sustained efficiency, economy, and satisfaction.

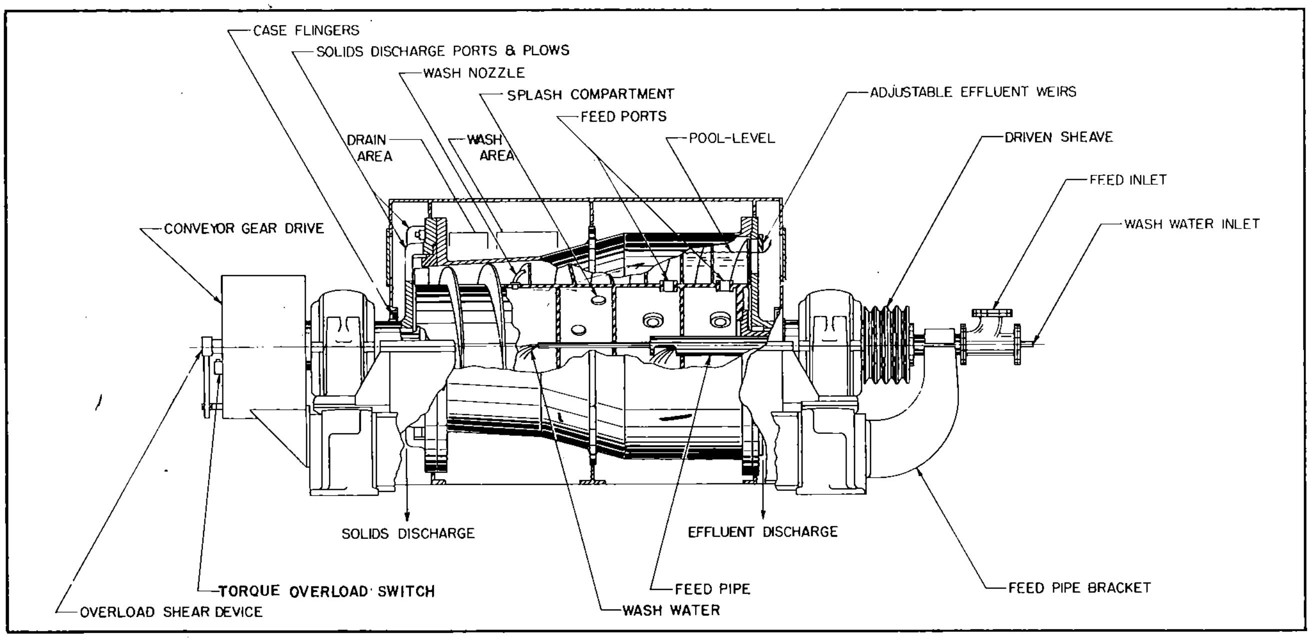


Fig. 1 Typical cross-sectional view of solid bowl centrifugal

WHAT THE BIRD IS AND HOW IT WORKS

Simply stated, the Bird Solid Bowl Centrifugal is a settling vessel with overflow weir and drainage deck, containing a conveyor which continuously picks up settled solids and discharges them from the vessel by way of the drainage deck. The settling vessel is made to rotate at high speed. Thus the settling forces acting on the solids particles can be some thousand times gravity and insure a thorough separation of solids from the suspending liquid.

Figure 1 shows the conformation and disposition of the two principal machine elements — the bowl and the conveyor. In the illustration, the bowl consists of a cylindrical section and two truncated cones of different cone angle. In practice, the contour of the bowl is varied to suit the service for which the machine is intended. It may be entirely cylindrical or entirely conical, or a combination of a cylindrical section and one or more truncated cones. The conveyor usually has the same contour as the bowl and the clearance between the conveyor flights and the inner bowl wall is held to a practical minimum. The exception is, of course, a design in which the bowl is cylindrical, and in which a bed of accumulated solids thus forms its own "bowl contour." The conveyor is supported in two bushings located in the bowl trunnions, and is rotated at a speed different from that of the bowl. The difference in speed between bowl and conveyor is accomplished by gearing. The hub to which the conveyor helix is attached also acts as feed distributor, the feed slurry passing from the hub into the bowl through one or more sets of feed ports. A stationary feed pipe, supported by the feed pipe bracket and overhanging into the inside of the conveyor hub, directs feed slurry to whatever feed compartment has been selected. Mounted to each end of the bowl are the two bowl heads with integral trunnions. These trunnions are supported in the main ball or roller bearings and thus carry the entire rotating assembly. As shown in Figure 1, the bowl head at the effluent end of the bowl has openings with adjustable weirs for discharge of clarified liquid. These weirs are positioned so that a portion of the bowl in the solids discharge area is not submerged, thus providing a drainage deck on which the solids, as they are conveyed across it, may also be washed before final drainage. The bowl head located at the small diameter has large ports for discharge of dewatered solids. Suitable partitions in the machine case form compartments for receiving discharged solids and effluent guiding them into their respective hoppers which are attached to the flanged case bottom.

The machine shown in Figure 1 is a typical design. Variations of this design are available for specific applications. For instance, in some machines, the feed pipe enters through the solids-discharge end and the gear unit is located at the effluent end. Designs are also available with pressure tight cases, skimmer type effluent discharge, and other special features.

Operation of the Bird Solid Bowl Centrifugal is simple and requires no skilled supervision. After the machine has been brought up to full operating speed, as chosen to obtain desired performance, slurry is delivered at constant rate to the centrifuge feed pipe. To insure proper operation and good performance, and to prevent exceeding machine capacity in terms of either solids or liquid throughput, it is necessary to provide means for reasonably accurate control of the feed volume. The feed pipe directs the slurry to the selected feed compartment in the conveyor hub from which it is distributed through the feed ports into the bowl. Centrifugal force holds the slurry against the bowl wall substantially in the form of a hollow cylinder. As slurry is fed into the bowl the inner diameter of this cylinder will decrease or, in other words, the "level" of the slurry in the bowl will rise until it reaches the circle of effluent weirs in the bowl head. At this point clarified liquid will begin to overflow out of these weirs into the effluent chamber of the case and the level of slurry in the bowl will, of course, stop rising. The overflow from the weirs continues just as long as feed is coming in. Centrifugal force meanwhile acts on the solids suspended in the slurry and causes them to settle out onto the inner wall of the bowl. As the solids become sufficiently compacted, they are transported by the conveyor helix in the direction of the solids weirs and onto the drainage deck where centrifugal force will separate out entrained liquor and make it flow back into the slurry "pool." As mentioned previously, the solids may be washed while moving across the drainage deck and before discharging into the solids compartment of the case. All wash liquors will drain back into the slurry pool and thus cannot be kept separate from the mother liquor.

The above refers to operation of the centrifuge in dewatering or clarifying service. The solid bowl centrifugal is equally effective classifying solids on a particle size (particle mass) basis. In this kind of application, the solids are usually all the same product with the same specific gravity; for example, suspensions of titanium dioxide, clay, etc. In classification service, the principle employed is to control operating conditions in such a manner that only the coarse fraction settles out and discharges as cake product, and that the fine fraction remains in suspension. Mechanical factors which determine or have bearing on the particle size at which the separation is made are bowl contour, location of slurry feed ports, differential speed between bowl and conveyor, pool depth, and centrifugal force. Volume of slurry throughput, temperature, (determining viscosity of

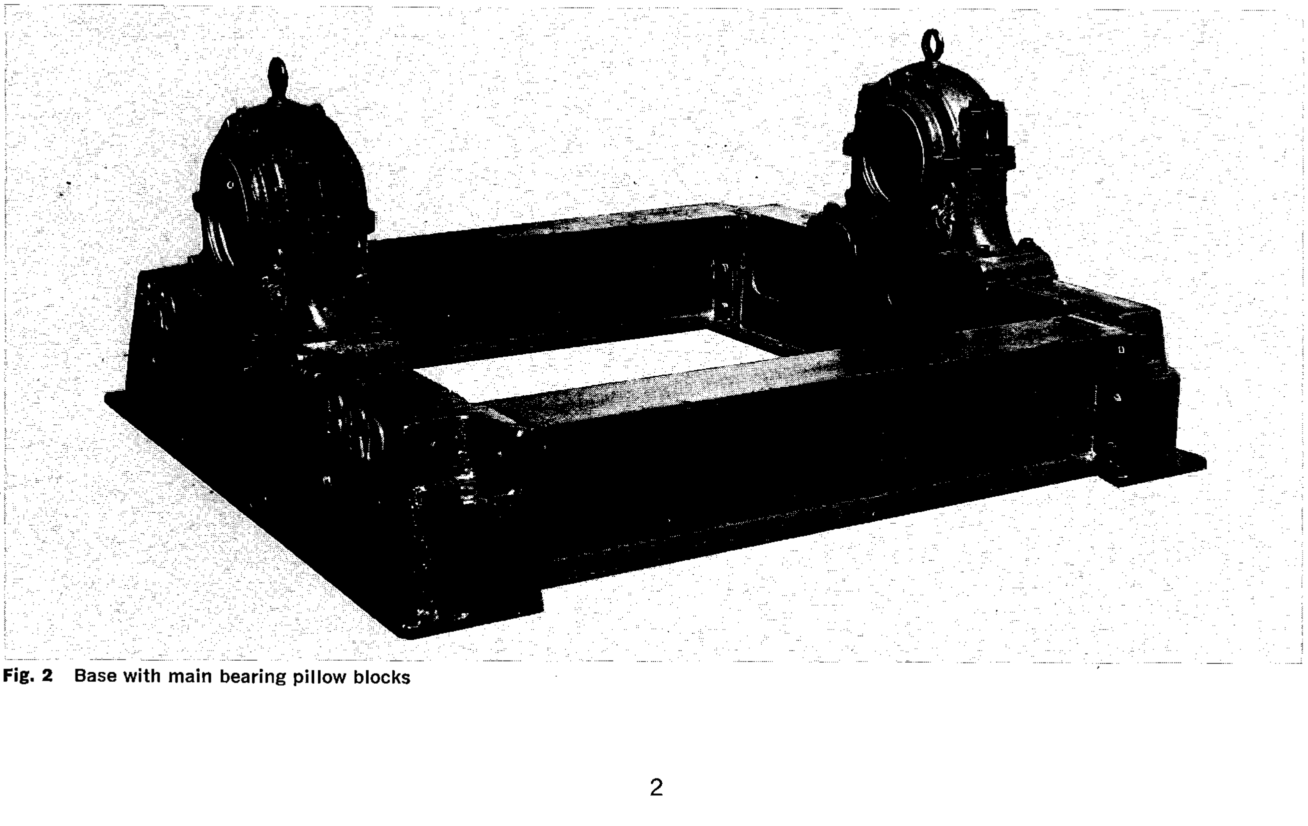


Fig. 2 Base with main bearing pillow blocks

suspending liquid), chemical dispersion, solids concentration in feed, and other operating factors also have to be taken into account in classifying applications. In general, the Bird Solid Bowl Classifier is used when making size cuts at 20 microns or finer although in some cases good classification at 200 mesh can be accomplished.

THE BIRD CENTRIFUGAL IS CUSTOM-BUILT FOR EACH SPECIFIC APPLICATION

Each Bird Centrifugal is designed and constructed for the application designated by the customer. Details of construction can vary quite widely, depending upon the separation desired. For instance, if the centrifuge is primarily intended to produce a clear effluent; that is to separate out fine solids, then the bowl is provided with a long, cylindrical section and a relatively short drainage deck. On the other hand, when the objective is dewatering (and washing) relatively coarse crystals and discharging these as dry as possible, then the cylindrical (sedimentation) section of the machine can be quite short, with the drainage and washing sections taking up the major portion of the bowl length. It is important that you know the detailed construction of your centrifuge. If in the future you should change your plans and decide to use the centrifuge for another duty, then we suggest you consult with the Bird Machine Company and make certain the machine is suited to this new application.

DETAILS OF CONSTRUCTION

Your Bird Centrifugal is constructed of materials specified by your Engineering or Purchasing Department. When corrosion resistant materials must be used, all parts which come in contact with either the solids or liquids are constructed of the specified alloy. Parts such as the base, bearing housings, etc., are always made of steel, cast iron, or whatever other metal has the required physical properties.

BASE

The base of the Bird Solid Bowl Centifugal is either a gray iron casting or a combination of cast and fabricated construction. Certain areas of the base form machined pads which act as supports for the main bearing pillow blocks, the case and the feed pipe bracket. The underside of the base is also machined. Cored holes are provided for anchoring the machine to its foundation. These holes are spaced as shown on the outline and foundation drawing with a tolerance of ± ¼″ from the centerline.

CASE

The case of the solid bowl centrifugal is fabricated of the metal specified by the customer. Inside surfaces exposed to product may be rubber-lined but this type of construction usually does not offer a price saving unless an extremely expensive alloy such as Hastelloy is the alternative. The use of clad steel material also can be justified only when thicknesses of ½″ or over are required.

The purpose of the case is to contain and direct the solids and liquid discharge from the bowl, to act as a protective guard and to provide complete enclosure with either standard or pressure-tight construction. The case bottom is flanged for attachment of effluent receiving hopper and solids chute. In certain designs

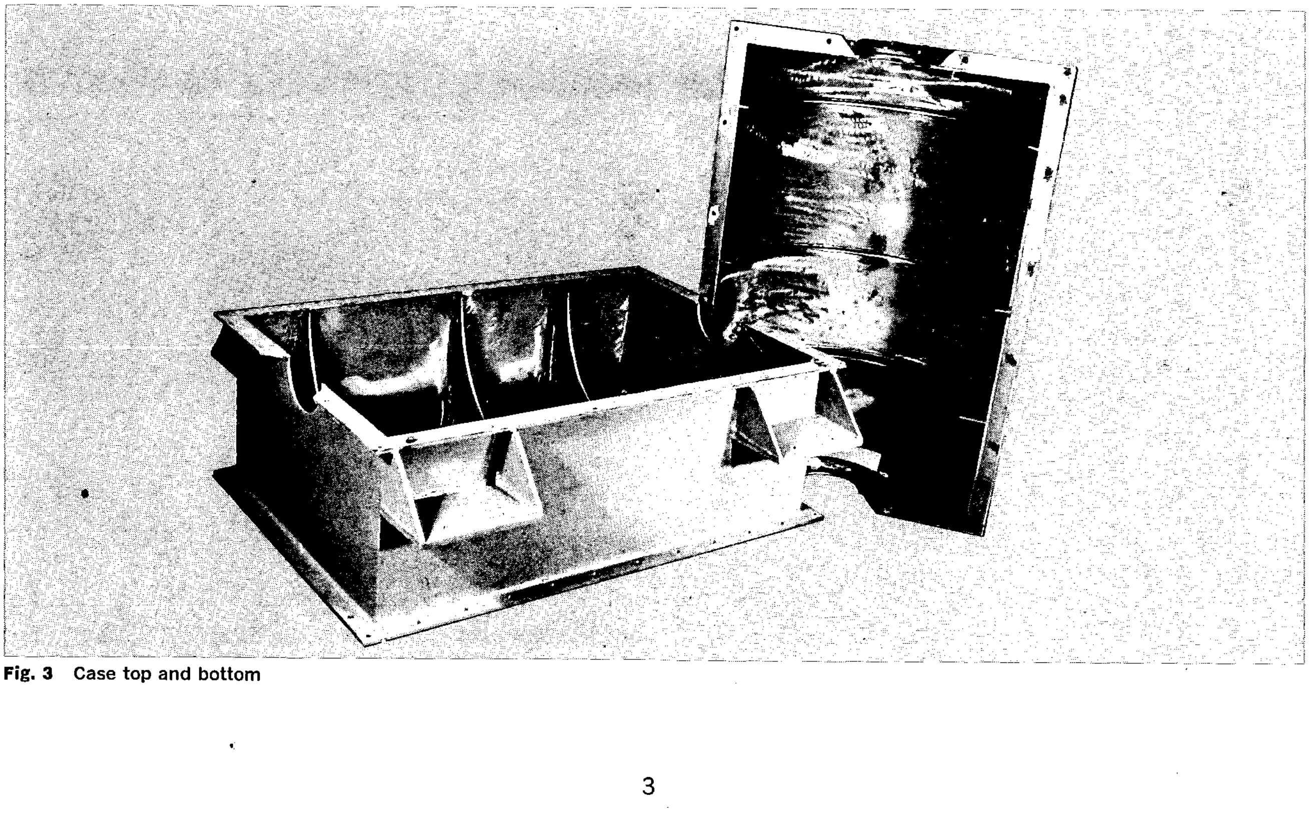


Fig. 3 Case top and bottom

hand holes are provided so that the centrifuge can be inspected and adjusted without removing the top half of the case. The case is partitioned into solids and liquid receiving compartments. The baffles forming these compartments register with corresponding hoops or flanges on the bowl and are machined for minimum practical running clearance. If specified, the case may be provided with repulp and wash-out connections and replaceable liners in areas subject to abrasive wear. Special gutters can be mounted in the case to minimize solids buildup in the solids discharge compartment.

BOWL

In the smaller machine sizes, the bowl may be either cast or fabricated. In the larger sizes, it is always fabricated. (Aside from meeting corrosion requirements, the material used must also have the required physical properties for fabrication and for centrifugal service.) The bowl may be in the shape of a truncated cone, a cylinder or a combination of cones and cylinder. Selection of the proper bowl contour for a given application is based on the characteristics of the product to be handled. Since the bowl has to contain the slurry, a leak-tight connection must be made between the bowl heads and the bowl. For certain applications the inner wall of the bowl may be equipped with guide strips and may also have a smooth or polished surface. With this latter type of construction it is important to maintain the recommended clearance between conveyor flights and strips and finish of the bowl surface.

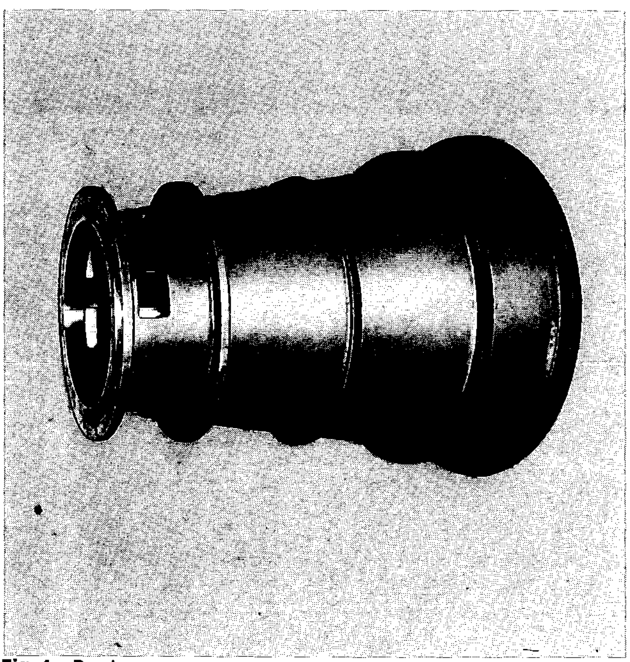


Fig. 4 Bowl

BOWL HEADS

The bowl is attached to the bowl heads with their integral trunnions. The effluent end bowl head is usually provided with weirs allowing for adjustment of the pool depth. One of the two main bearings is mounted on the effluent end trunnion and the other main bearing is mounted on the solids discharge end trunnion. The bushings which support the conveyor and in which it rotates, are pressed into each bowl head trunnion. They are isolated from contact with the product by lip seals located in the bowl head trunnions.

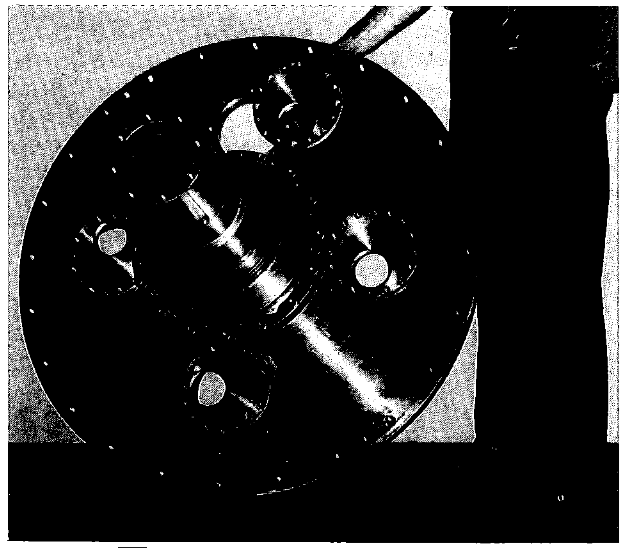


Fig. 5 [redacted] EFFLUENT END BOWL HEAD

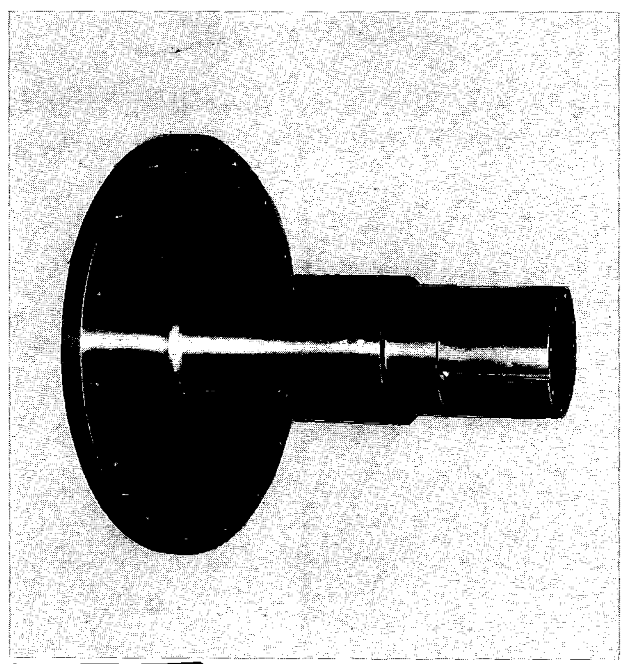


Fig. 6 [redacted]
SOLIDS END BOWL HEAD

CONVEYOR

The conveyor assembly consists of the conveyor hub, with its feed ports and wash nozzles, the two trunnions and the conveyor helix. The conveyor assembly is always constructed of metal. Rubber or other coatings have not been found practical. If the machine is intended for processing abrasive product, the feed ports in the conveyor hub and the conveyor blades are provided with an abrasion-resistant material. The kind of hard surfacing alloy used, the area of the helix which is to be covered, and the amount of finish grinding to be done all are influenced by the nature of the application and the abrasive characteristics of the product. The trunnion at the feed end is hollow in order to accommodate the feed pipe. The trunnion at the gear end of the conveyor is splined for connection to the output shaft of the gear unit. Usually the inside of the conveyor hub has a number of baffles to provide two or more feed compartments and the operator can select the feed compartment which gives the best results. When required, a separate wash compartment nearest the solids discharge end is supplied for admitting wash liquor. It usually is separated from the feed compartment by a "trap" or drain compartment to prevent feed slurry from splashing into the wash section. The wash compartment of the hub usually has drilled and tapped holes throughout its length. This permits installing nozzles in those locations which provide the best washing while plugging those which are not used. Conveyors are furnished with either single or multiple leads. Choice of pitch and lead depends on the operation which is to be performed. For example, in a 40 x 60″ machine, the conveyor pitch might be as small as 5″ or as great as 18″. In operation, the conveyor always rotates at a speed slightly slower than the bowl. This speed differential is obtained by means of a gear reduction unit mounted to a support flange on the bowl trunnion. The conveyor in a sense is a measuring device having a maximum solids handling capacity for a given speed differential. If the centrifugal is overfed, the conveyor may therefore choke and make it necesary to shut off the feed and clean out the machine. When reasonable care is used to control solids throughput, plugging will not occur since Bird centrifuges always have a conveying capacity considerably in excess of stated requirements. On the solids discharge end of the conveyor a reverse plow is installed. This has two purposes. One is to gather up and discharge such solids as deposit on the lands between the solids discharge ports in the bowl or the bowl head. The other is to act as a balance weight support. Balance weights are always attached so that they are not immersed in the slurry and do not interfere with solids conveying.

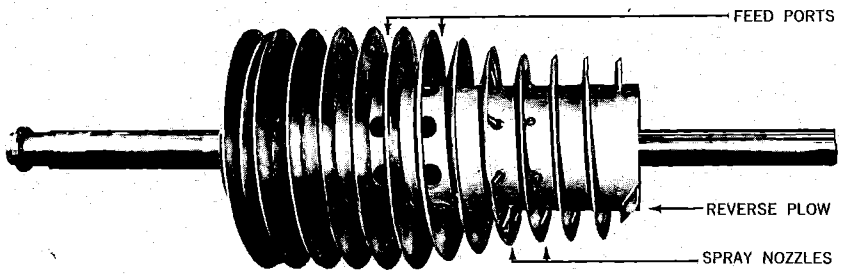


Fig. 7 Typical conveyor with wash nozzles

FEED PIPE

The feed pipe is clamped in a bracket mounted to the machine base. Its size is limited by the inside diameter of the main bearing at the feed end of the machine. The feed pipe is baffled off at its discharge end and a slot is provided in the side of the pipe so that the slurry will be directed radially towards the ports. If the centrifuge is equipped for washing, the wash pipe is supported within the feed pipe. If the feed location is to be adjusted, this is done by loosening the holding clamp and pushing the pipe in or out for the distance required to let it discharge into the alternate compartment.

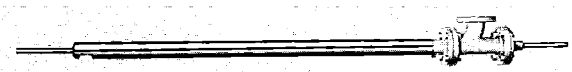


Fig. 8 Feed and wash pipe assembly

PRODUCT WASH

The pipe through which wash liquor may be introduced into the wash compartment is concentric with the conveyor. The nozzles which direct the wash liquor onto the solids being processed are located in the conveyor hub and as near to the face of the conveyor blade as practical. The wash nozzles are mounted in threaded "bosses" welded to the conveyor hub. These bosses extend into the hub so that their inner openings all are on the same diameter. This assures even distribution of wash liquor to all nozzles. The bosses extending into the conveyor hub also make a trap for any solids which may be contained in the wash liquor. For certain operations, the conveyor helix may be of the interrupted blade type. With this type of construction the wash liquor is distributed onto the solids through spray nozzles which may have a flat or cone spray. Spray nozzles frequently have a relatively small orifice and make it important that the wash liquor be filtered so that foreign material cannot get into the wash compartment and cause the orifices to plug.

BEARINGS

Two main bearings support the entire rotating assembly. On the smaller size machines these are ball bearings, on some of the larger machines spherical roller bearings are used. The bearings are housed in pillow blocks which are mounted on the machine base. Trust imposed on the conveyor is taken by a pair of thrust bearings. These are installed in the driven sheave which forms the bearing housing. Correct installation of the thrust bearings is very important. The conveyor is supported in bronze bushings which are pressed into the bowl head trunnions.

GEAR UNITS

The function of the gear unit is to drive the conveyor at a fixed speed relative to the bowl. The reduction ratio of the gear unit and the speed of the bowl determine the difference in speed between bowl and conveyor. Ratios as low as 28:1 and as high as 145:1 are available. The machine is supplied with the highest practical gear ratio; that is, the slowest relative conveyor speed sufficient to handle the required solids throughput and consistent with good results. To determine the relative speed between the bowl and the conveyor, divide the bowl RPM by the reduction ratio. For instance, with a gear reduction ratio of 80:1, and a bowl speed of 1000 RPM, the screw will rotate at 1000 divided by 80 or 12.5 RPM slower than the bowl. The gear unit is a completely self-contained drive and can be replaced as a unit. The reduction ratio of the gear unit may be changed by installing different gears, usually in the first stage. A new gear support-cage will then also be required. Lubrication of the gear unit is either by built-in circulation in which case the gear unit housing acts as oil reservoir, or by independent pressure circulation serving both gears and main bearings.

For test or pilot plant installations it is sometimes desirable to vary the "effective" gear ratio while the machine is operating; that is, to determine what performance can be obtained at different conveyor speeds. The relative conveyor speed can be varied without installing new gears by permitting the input shaft of the unit to rotate (slip) in the same direction but at a slower speed than the bowl. The 6" x 12" machine is available with a hydraulically controlled, infinitely variable "slip-device" for this service. It is not recommended to operate larger production equipments with such a device.

MECHANICAL OVERLOAD PROTECTION

The conveyor in the Bird centrifugal must rotate at relatively low speeds with reference to the bowl. The gear unit, therefore, has a correspondingly high reduction ratio and this means it can exert considerable leverage or torque. In order to protect the conveyor and other parts from being damaged by torsional overload, a shear device is mounted on the input shaft of the gear unit. It will release when the maximum allowable torque is exceeded. A shear device is furnished on all solid bowl centrifugals. The shearing member is a pin having a shear section of predetermined diameter. One end of this pin is held by means of the torque coupling to the normally stationary input shaft of the gear unit, the other end by the torque arm. The moment the pin shears, the input shaft of the gear is free to turn and bowl and conveyor will rotate together. This action will also trip an overload switch interlocked with the holding coils of the main motor control. It is good practice also to interlock into this circuit whatever means are provided to shut off slurry feed.

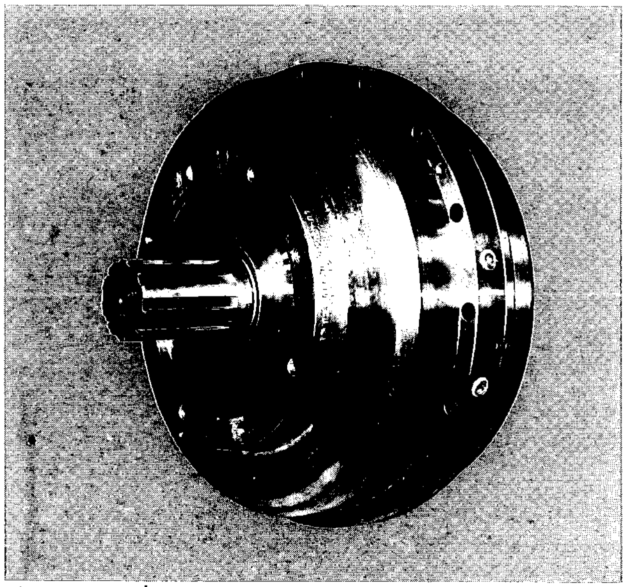


Fig. 9 Gear Unit showing splined output shaft

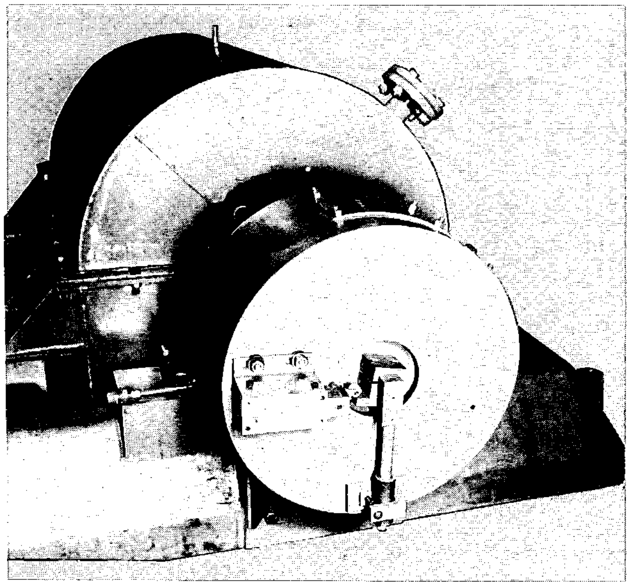


Fig. 10 Torque arm and shear device

ELECTRICAL LOAD CONTROL AND RECORDER

The power required to discharge solids; that is, to rotate the conveyor with respect to the bowl is in direct proportion to the amount of solids passing through the machine. An instantaneous reading and continuous recording of solids throughput is thus possible by measuring the force required to hold the torque arm stationary. This measurement is obtained by the use of a "strain bar" as a stop for the torque arm. The load exerted on the bar by the torque arm is transmitted electrically to the recorder which gives a direct reading and record in pounds. Incorporated in this recorder are relays controlled by two adjustable cut-off points. The lower point is set so that when the load approaches the maximum value at which it is desirable to run for performance reasons, then a relay closes and actuates the means used to shut off or divert feed slurry. When the overload dissipates, the relay opens and the feed automatically resumes. If, however, after shutting off the feed, the load should continue to increase and approaches the value at which shear member failure will occur, then a second relay goes into action, and shuts down the main drive motor. The shear device with overload switch is furnished as an additional over-riding safeguard, even when a recording instrument is used. A signal or alarm is recommended to alert the operator when the machine has been shut down by the shear device or electrical load control.

DRIVE BELTS AND PULLEYS

Bird Continuous Centrifugals are driven by V-belts. Usually, motor sheaves and belts come with the machine even though the motor and its control may be furnished by others. Motor sheaves are supplied for the proper speed range of your machine in the application specified. Do not install larger sheaves without consulting the Bird Machine Company.

MAIN MOTOR

The rotating elements of solid bowl centrifugals have a relatively high moment of inertia and motors must have starting characteristics suitable for these loads. Secondly, machine operation being continuous, the motors must be sized to carry the operating load in continuous service. Usually, squirrel cage induction motors with special high thermal capacity rotors are used to drive the centrifugals. Squirrel cage motors must be designed to withstand near lock-rotor current during a substantial portion of the accelerating period. They must further be designed to have torque characteristics which will provide acceleration of machine to operating speed in reasonably short time (to avoid overheating). The accelerating period will vary with machine speed and to an extent with machine size. Smaller machines operating in a moderate speed range should be up to full speed in from 30 to 45 seconds. In the case of large centrifugals or machines operating at high speeds, acceleration will require from 60 to 90 seconds. The following table lists typical acceleration time and WR^2 values for the different sizes of Bird centrifugals. It will be of assistance to those motor manufacturers not already familiar with motor requirements of Bird centrifugals.

TABLE 1 Moment of Inertia (WR^2) of Rotating Assembly and Typical Acceleration Time

	Lb Ft 2	
6 x 12″	10	10 - 20 seconds
18 x 28″ Conical	350	35 - 50 seconds
18 x 28″	590	
18 x 40″	800	
24 x 38″	1400	
24 x 60″	2600	50 - 60 seconds
32 x 50″	6400	60 - 70 seconds
36 x 50″ Conical	5500	
36 x 72″	12800	70 - 90 seconds
36 x 96″	14500	
40 x 60″	12000	
54 x 70″	33000	

Table 2 below suggests wire sizes when wiring an installation which is driven by a squirrel cage induction motor.

TABLE 2 Recommended Wire Sizes to Allow for Current Demand During Acceleration

Motor HP	220 volt Size of Wire	440 volt Size of Wire	550 volt Size of Wire
5	#10	#12	#12
7½	#8	#12	#12
10	#8	#10	#12
15	#4	#8	#10
20	#4	#8	#8
25	#2	#6	#6
30	#1	#4	#6
40	#0	#2	#4
50	#000	#2	#2
60	#0000	#0	#1
75	#0000	#00	#0
100		#00	#00
125		#0000	#000
150		#0000	#0000
200		400,000	400,000

NOTE: Size of Wire based on 100 foot Distance between Motor and Power Source and Full Voltage Starting.

It is entirely satisfactory to drive the centrifugal by means of a wound rotor AC motor although this may mean the total cost of motor and control will be somewhat greater. With a slip ring motor, it is important that the starting resistor is designed for continuous duty. Compound wound DC motors, hydraulic drives, turbines, etc., also can be used. With these drives acceleration time is of course not critical. It is recommended that such special installations be designed in consultation with the Bird Machine Company.

A typical wiring diagram of a starter used with a squirrel cage motor is shown in Figure 11. The starter is a two-circuit, single direction, non-reversing, across-the-line magnetic contactor with overload relays and ammeter working in the run circuit only. The transfer from start to run can be accomplished manually with the use of a three button pushbutton station, or automatically by a timer, the timer being set for the recommended acceleration time of the centrifuge. Reduced voltage starters should not be used without first consulting Bird Machine Co. All machines should be equipped with an ammeter, located where it can be readily observed. The ammeter will show the motor load, and act as a guide to indicate the quantity of slurry being fed to the centrifuge. The operator should make certain that the machine has reached operating speed before slurry is introduced.

The overload-switch (torque-switch) shown on the wiring diagram is for the purpose of providing overload protection to the machine. It should be connected in series with the holding coil circuit of the main motor so that when the shear device is actuated, the circuit opens and the centrifuge cannot be operated until the shear member has been replaced and the switch reset. It is good practice to provide for a visual or audible alarm to go into action whenever the holding coil circuit has been opened by the overload switch. It is also desirable to wire the installation so that when the shear device is released, the feed slurry is stopped from entering the centrifuge. No brake is provided on the centrifuge. Thus, when shear member failure occurs, the machine will coast to rest. Usually the larger centrifuges are equipped with a Foxboro Dynalog Recorder previously described. The chart from this instrument is helpful in operating the machine to best advantage and also is an excellent record of operating conditions. The recording instrument is usually equipped with protective devices arranged to keep loading within specified limits, and in case of overload, to automatically shut off the feed. Some machines are equipped with circulating oil systems for the main bearings and gear units. If so, the lubricating pump motors should be electrically interlocked, so that the oil system must be functioning before the filter can be started. Bird Machine Company will recommend control schemes and provide suggested wiring diagrams if requested.

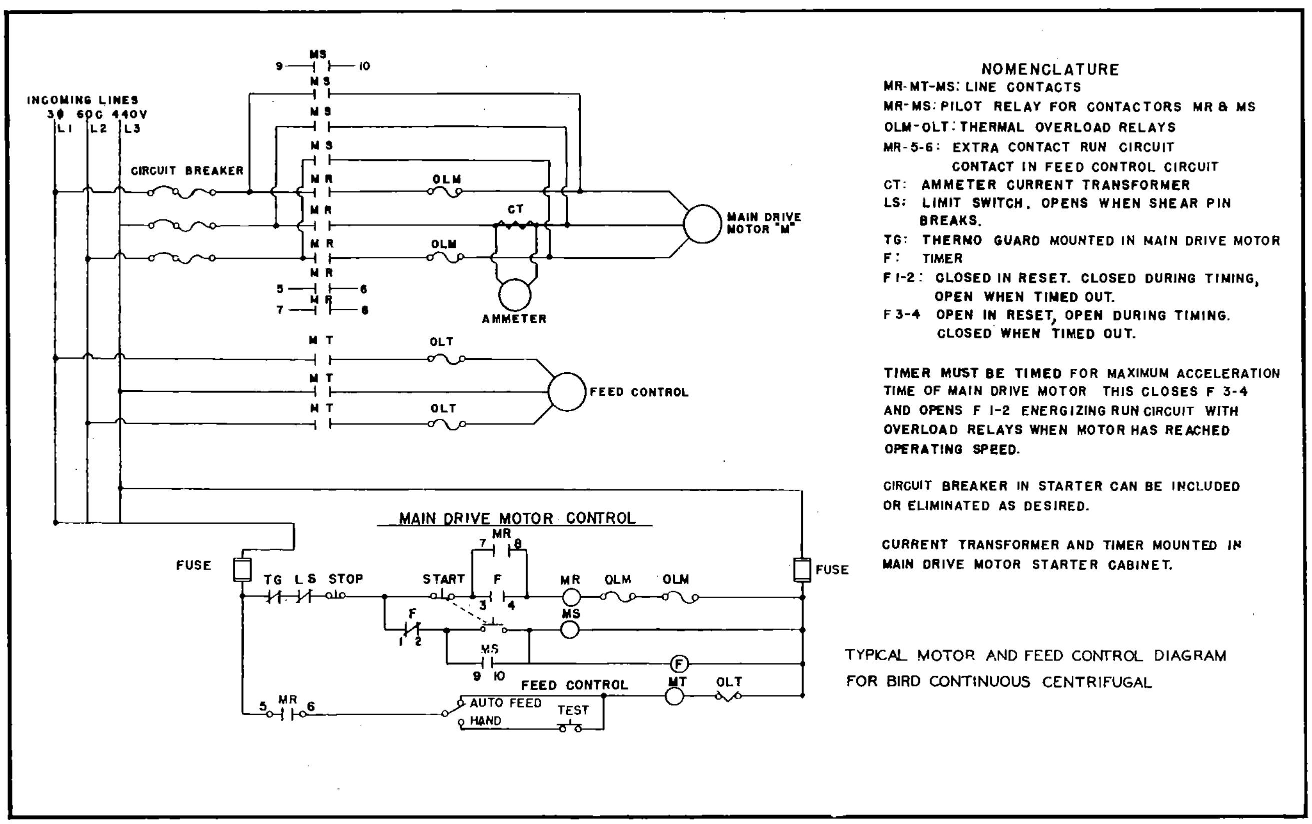
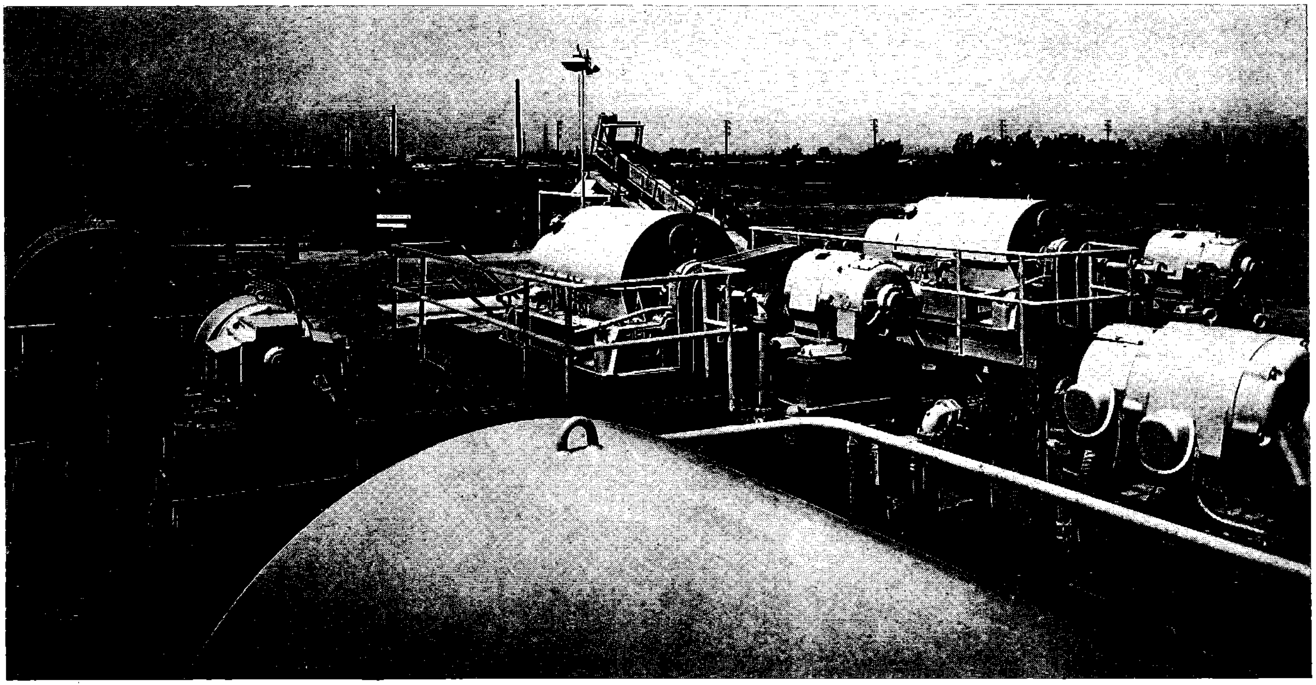
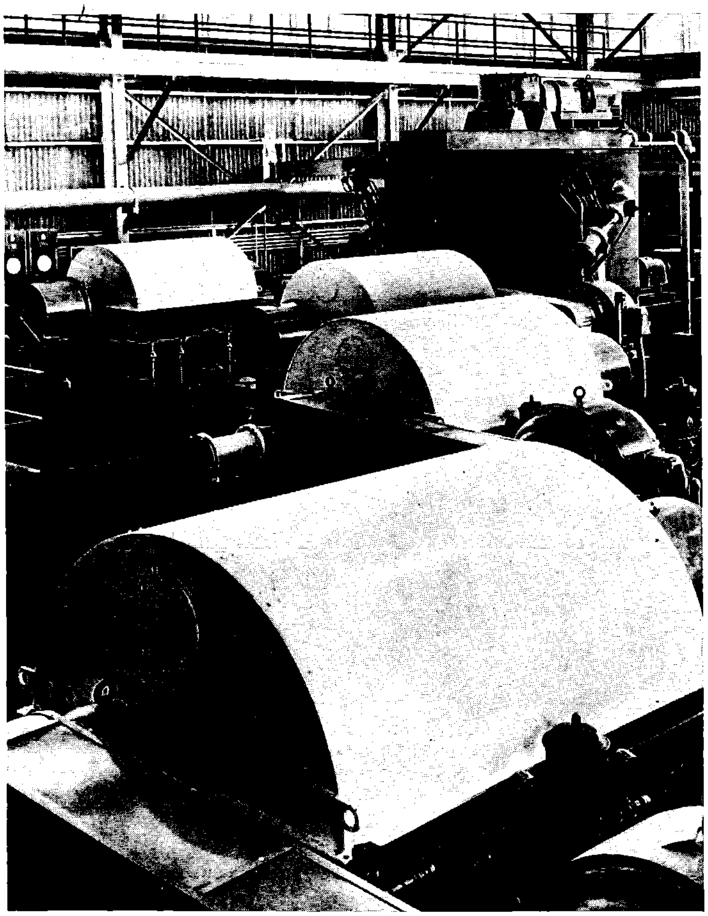
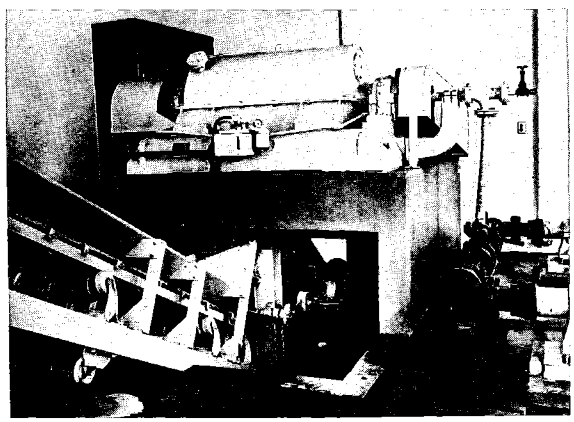


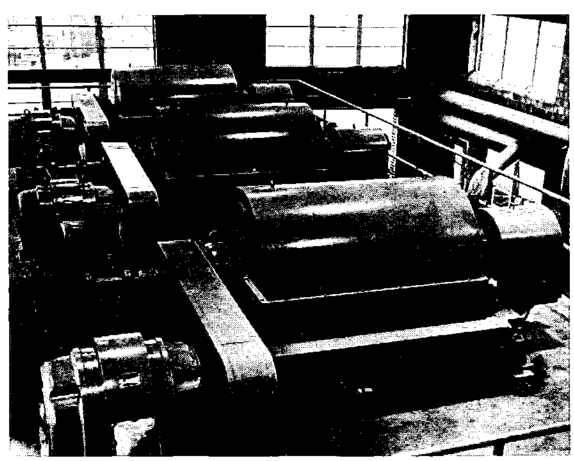
Fig. 11 Typical wiring diagram of two circuit starter

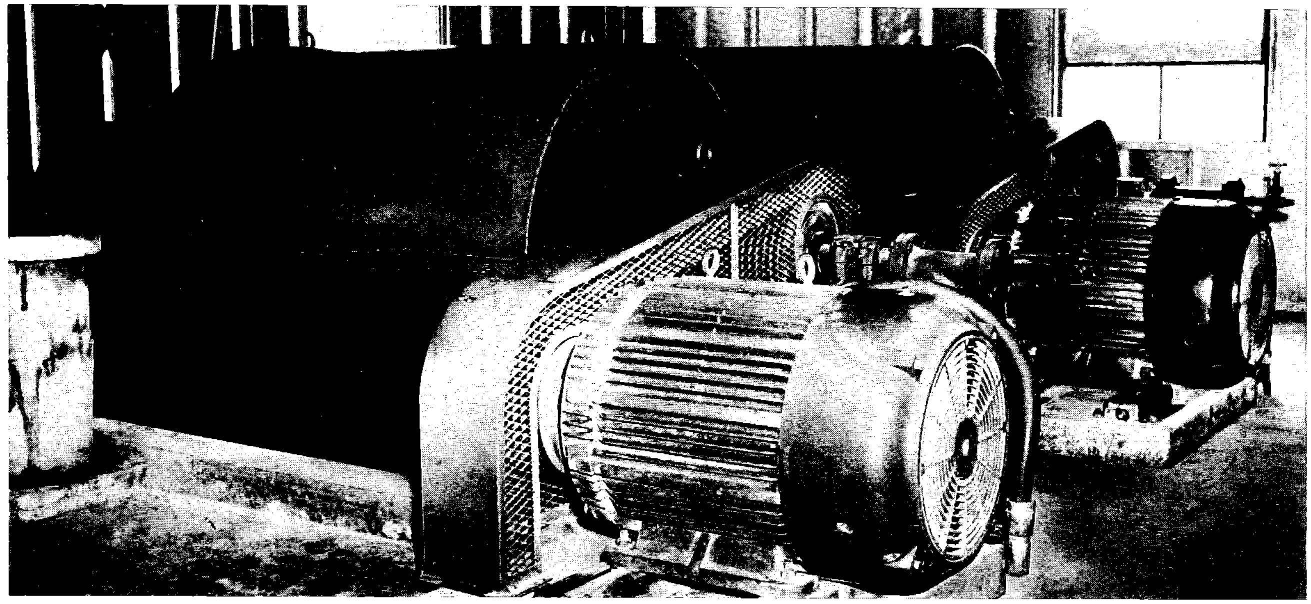
TYPICAL BIRD CENTRIFUGAL INSTALLATIONS

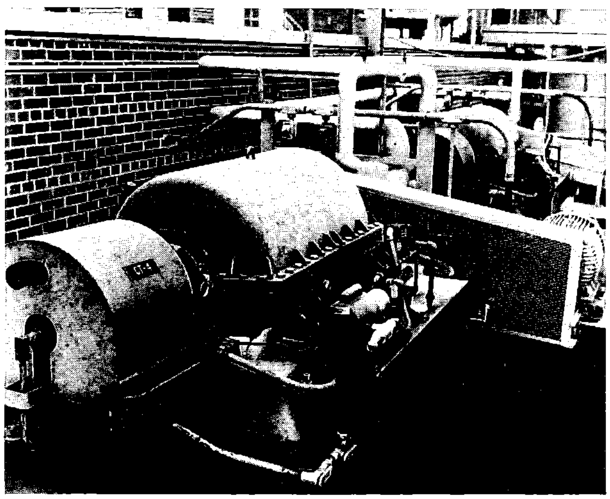


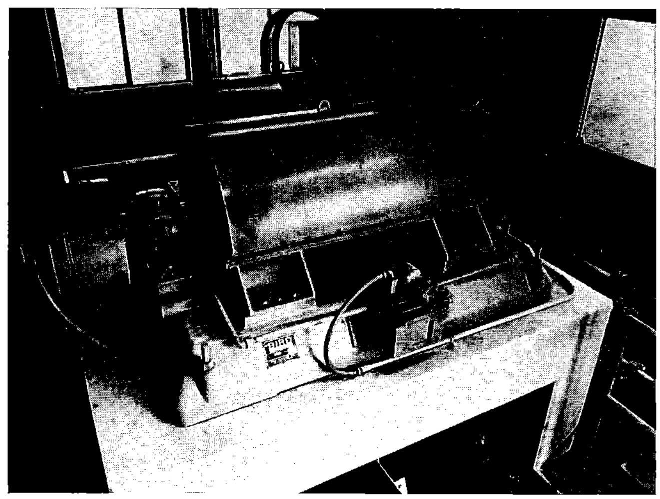


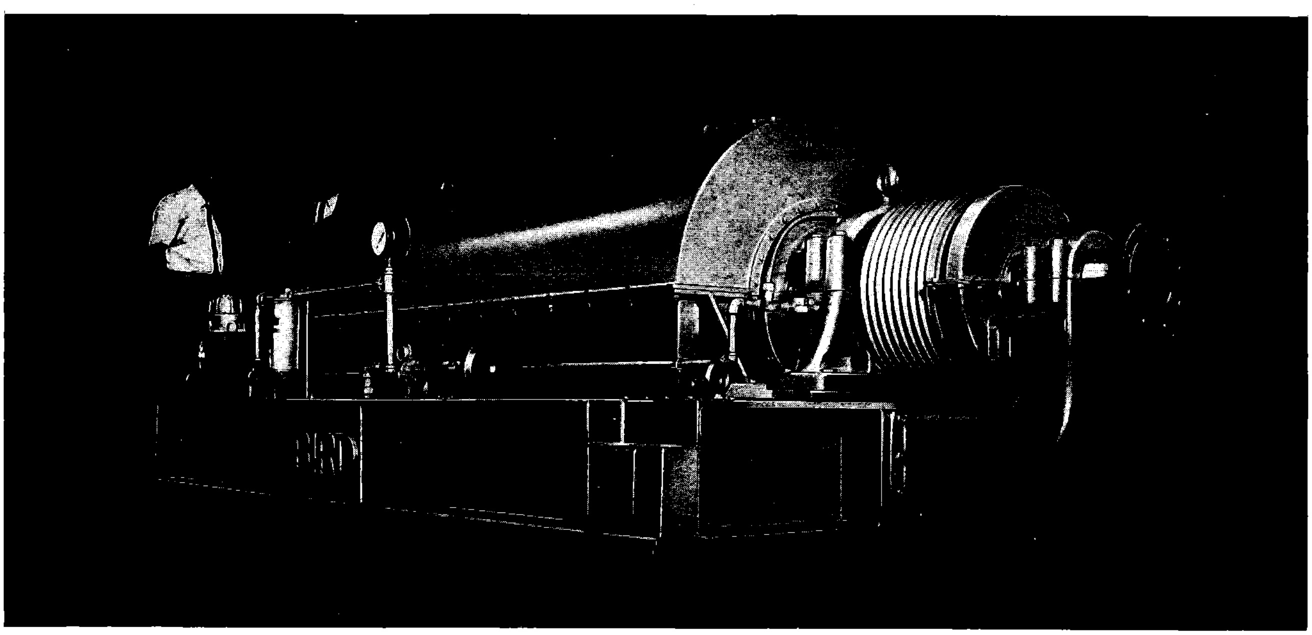












INSTALLATION

The Bird centrifuge is shipped as a completely assembled unit, except that the feed pipe will have been withdrawn. Accessory equipment may include motor, motor base, motor control, pushbutton stations, ammeter, drive sheaves, vibration isolators or sub-bases, and torque control station. These items are boxed separately. If a circulating oil system is included with the centrifuge, this may also be furnished separately for mounting at installation.

The machine should be installed exactly as received. Partial disassembly for installation is not necessary or desirable. The Bird centrifuge is sturdily built, requiring only the reasonable care one would accord any valuable production equipment. Do not attempt to lift the machine by the eyebolts on the bearing housings or on the case. These are provided only to sustain the weight of the individual part. When the entire machine is to be lifted, a sling should be fastened around the base. If this is not feasible, slings can be looped around the trunnions near each bearing housing. If this latter method is employed for lifting then use padding between the cables and the trunnions. Set the machine in place on its foundation or supports, and level it. Then rotate it by hand to make sure that the rotating assembly will turn freely. If the unit was handled roughly during shipment or installation it is possible that the case, even though doweled, may have shifted and would rub against the bowl in operation. Should this occur, the case should be properly relocated before hoppers are attached. After setting the machine in place, the feed pipe is installed in the position shown on the foundation drawing or in accordance with the recommendations of the Bird field engineer.

GUARDS

A gear unit guard is provided with all machines. If, for any reason, the purchaser decides not to use the guard supplied and to manufacture his own, it should be constructed so that ample air circulation around the gear unit is assured. Belt or shaft guards are usually not furnished because of the varying requirements and standards involved in each specific case.

PULLEYS

Two or more motor pulleys may be supplied with Bird centrifugals when they are to be driven by a constant speed motor. At startup, it is usually advisable to first try the smallest motor pulley furnished. Larger pulleys can be installed if it is found necessary to operate at higher forces. It is immaterial whether the tight side of the belts is top or bottom, but the machine must rotate in the proper direction as indicated by the direction arrow on the case.

BELTS

If the centrifuge is intended to handle volatile solvents or other hazardous materials, sparkproof belts can be furnished. Belts are supplied in "matched sets" and should be so used. Adjust belts sufficiently tight that there will be minimum slippage during acceleration.

DRAWINGS

Certified outline and foundation drawings are furnished in advance of shipment. If you are supplying the drive motor, it will be necessary that we have a certified motor dimension sheet for preparing these foundation drawings. The drawings will include information showing location of anchor bolts, size and location of all openings in the case bottom, size and location of the feed and wash water connections required, and motor center distances for the pulleys supplied. No certified drawings are furnished for hoppers, pumps or other auxiliary equipment. The motor can be located in any of the four possible positions; that is, on either side of the centrifuge and with the motor shaft pointing towards or away from the machine.

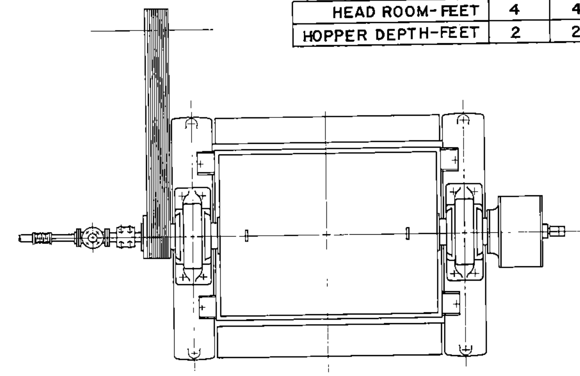
INSTALLATION LAYOUT

Careful consideration should be given to the location of the Bird centrifuge with particular reference to the equipment which precedes or follows it. The centrifuge requires relatively small space. However, there must be room enough for convenient operation and maintenance. Disassembly will be made easier if it is possible to withdraw the feed pipe before lifting the rotating assembly. Space required to withdraw the feed pipe is indicated on the foundation drawing. The connections to the machine for feeding and taking away the product may affect its performance and require careful thought. These points are covered in detail under their individual headings. In all instances it is suggested that before the actual installation is made, layout drawings showing machine supports and connections be forwarded to the Bird Machine Company for review and comment. Typical layouts are shown in Figures 12 and 13.

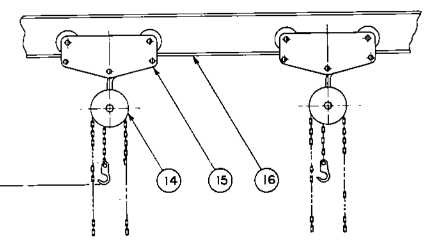
FOUNDATION

The Bird centrifuge is carefully balanced and under normal conditions runs without vibration. However, occasionally unbalanced loads may build up in operation due to the properties of the process material or because of wear and similar mechanical reasons. The foundation therefore should be capable of withstanding such vibration as may develop. The Bird centrifuge is manufactured in many sizes and the foundation requirements will vary depending upon the size. There are two broad categories of foundations to be considered: rigid and non-rigid.

	18x28	18x42	24x38	24x60	32x50	36x50	36x72	36x96	54x70	40x60
HEAD ROOM-FEET	4	4	5	5	7	7	7	7	9	7
HOPPER DEPTH-FEET	2	2	2.5	3	3	3	3	4	4	4



INDEX	
1	CASE TOP
2	GEAR UNIT
3	DRIVEN SHEAVE
4	DRIVE MOTOR
5	FEED PIPE CONNECTION
6	CENTRATE HOPPER VENT PIPE
7	CENTRATE HOPPER
8	CENTRATE EXIT PIPE
9	CENTRATE HOPPER DROP CURTAIN
10	SOLIDS HOPPER
11	SOLIDS CONVEYOR
12	TORQUE BAR
13	BOWL-ROTATING ASSEMBLY
14	CHAIN HOISTS
15	TROLLEYS
16	TROLLEY BEAM



NOTES:

A FEED SLURRY MAY BE PUMPED OR GRAVITY FED TO MACHINE.

B PROVIDE FLEXIBLE COUPLING IN FEED PIPE AT THE MACHINE.

C PROVIDE WASH LIQUOR LINE INCLUDING FLEXIBLE COUPLING.

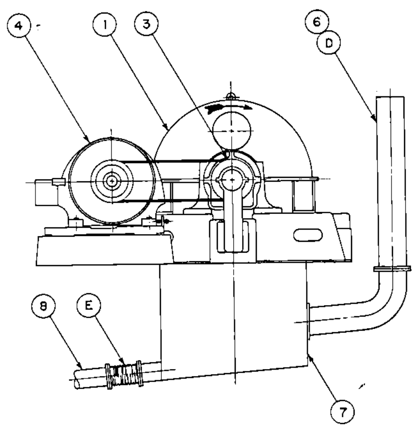
D VENT PIPE TO BE EITHER EXTENDED ABOVE FLOOR LINE AS SHOWN OR TAKEN OUT OF BUILDING.

E PROVIDE FLEXIBLE COUPLING IF PIPE DISCHARGE AS SHOWN IS USED.

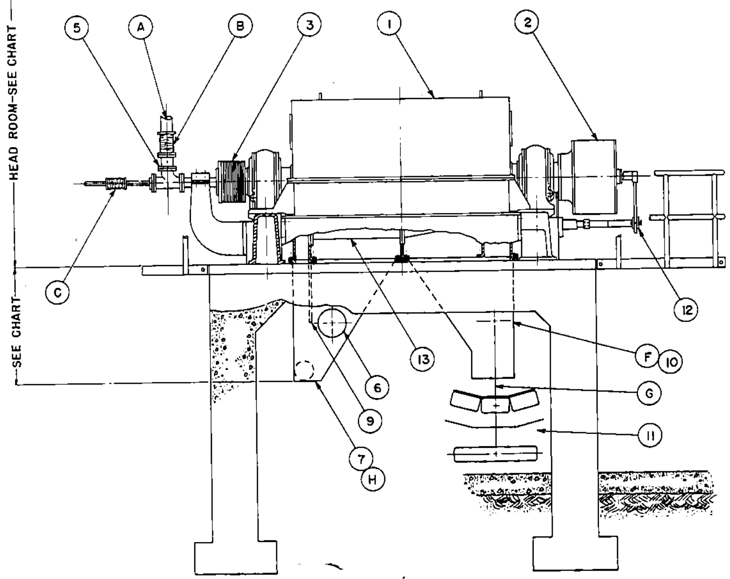
F IT IS PREFERRED THAT SOLIDS DISCHARGE HOPPER HAVE VERTICAL SIDES, SIDES MAY BE FLARED OUT BUT NOT TO BE CONSTRICTED AND WITH OPEN BOTTOM DISCHARGE.

G CENTER LINE OF MACHINE SOLIDS COMPARTMENT AND CENTER LINE OF SOLIDS CONVEYOR TO BE COMMON WITH AXIS OF ROTATION OF MACHINE AT RIGHT ANGLES TO CONVEYOR.

H CENTRATE MAY DISCHARGE THRU OPEN BOTTOM HOPPER INTO LAUNDER IN WHICH CASE THE VENT MAY BE OMITTED.

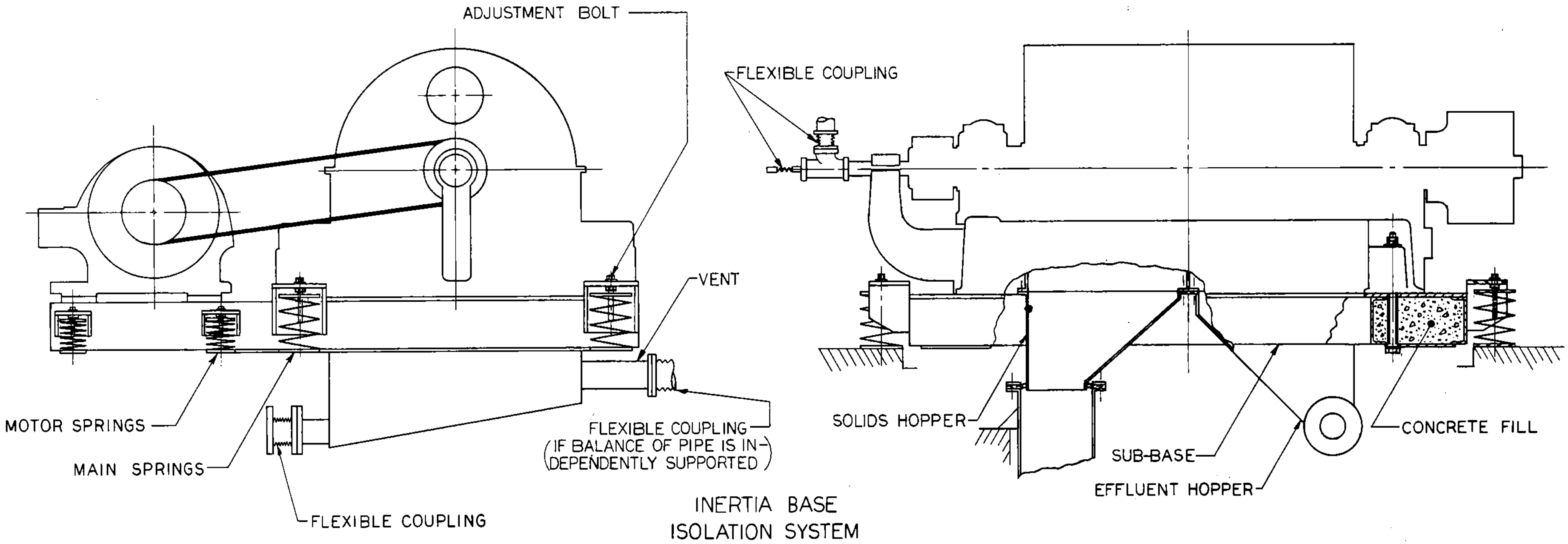


NOTE:
ROTATION IS ALWAYS CLOCKWISE AS VIEWED FROM EFFLUENT END.



THIS INSTALLATION LAYOUT IS INTENDED TO ACT ONLY AS A GUIDE. VARIATIONS MAY BE MADE TO MEET FIELD AND CONSTRUCTION CONDITIONS.
FINAL LAYOUTS SHOULD BE CHECKED WITH A REPRESENTITIVE OF THE BIRD MACHINE COMPANY.

Fig. 12 Centrifugal supported on concrete foundation



NOTE: CENTRATE PIPING SHOULD BE DESIGNED TO PREVENT HEAD BUILD-UP IN CENTRATE HOPPER

MACH. SIZE	MAX. HOPPER WEIGHT EACH *
18	- 200#
24	250#
32	350#
36	350#
40	400#
54	500#

* APPLIES ONLY TO SPRING MOUNTED MACHINE & WHERE HOPPER IS NOT INDEPENDENTLY SUPPORTED

Fig. 13 Centrifuge supported on inertia base

Concrete piers form a satisfactory rigid foundation for the Bird centrifuge. Piers should extend to solid footing and have a *mass* approximately equal to four times the dead weight of the machine. In addition, all natural frequencies of the foundation in the plane of the dynamic load should not lie within 30% of the operating speed of the machine. The piers should be designed to support a minimum equivalent static load 2½ times machine weight.

A firm concrete foundation is desirable but not essential. In cases where the machine must be mounted on structural steel and/or on upper floor levels, transmitted forces should be held to a minimum. If with this type of mounting it is not practical or economical to meet the requirements as stated in the previous paragraph, or if a multiple machine installation is involved, then an isolated support is the alternative. Commercial spring isolators are frequently used in mounting solid bowl centrifuges and obviate the need for providing a substantial mass at the machine and a highly rigid supporting structure. Steelwork nevertheless must be sufficiently rigid to give the isolators the required solid support. Specifically, the supporting or connected steel structure should include no members having a natural frequency less than 600 cycles per minute. Further when isolators are used the steel work should be designed to support the static load plus a dynamic load equal to 15% of the static load. The addition of floor mass is helpful in improving the efficiency of the isolators but little is gained by adding a mass greater than the machine weight. If required Bird Machine Company will supply or specify standard isolators suitable for centrifugal installations.

Machines designed for clarifying applications; that is having a relatively long pool may develop more than average vibration when passing through the critical frequency of the isolators. With installations of this type a Bird inertia base again supported on spring isolators will tend to uncouple rocking modes and thus stabilize the centrifuge during acceleration or deceleration. The inertia base is also properly applied if isolation is required in the horizontal plane, i.e. in the case of installations in tall structures having minimum lateral bracing.

PIPING

Ordinarily there are only two or three piping connections to the centrifuge. Flexible connections are preferred in the case of solidly mounted machines and required when machines are mounted on isolators. Flexible connections may also simplify adjustments of the feed pipe when experimenting with various feed port settings. When product wash is employed a rotometer or similar device is recommended as a check on the quantity of wash water delivered. Wash water should be strained in order to avoid a build-up of solid matter in the wash compartment and eventual clogging of wash nozzles. When a product wash is not employed, it is still desirable to provide for rinse-out water. Rinse water can enter the machine through the feed pipe. Water may also be required to permit flushing out of the case, particularly the solids discharge section. In certain applications the discharged solids are to be dissolved or reslurried. In these instances, the repulp water can be introduced directly into the solids compartment of the centrifuge. When specified, a flanged connection is provided for this repulp liquor. The feed and wash pipe are usually adjustable as to position and provision should be made so that these can be inserted or withdrawn as required for best opera-

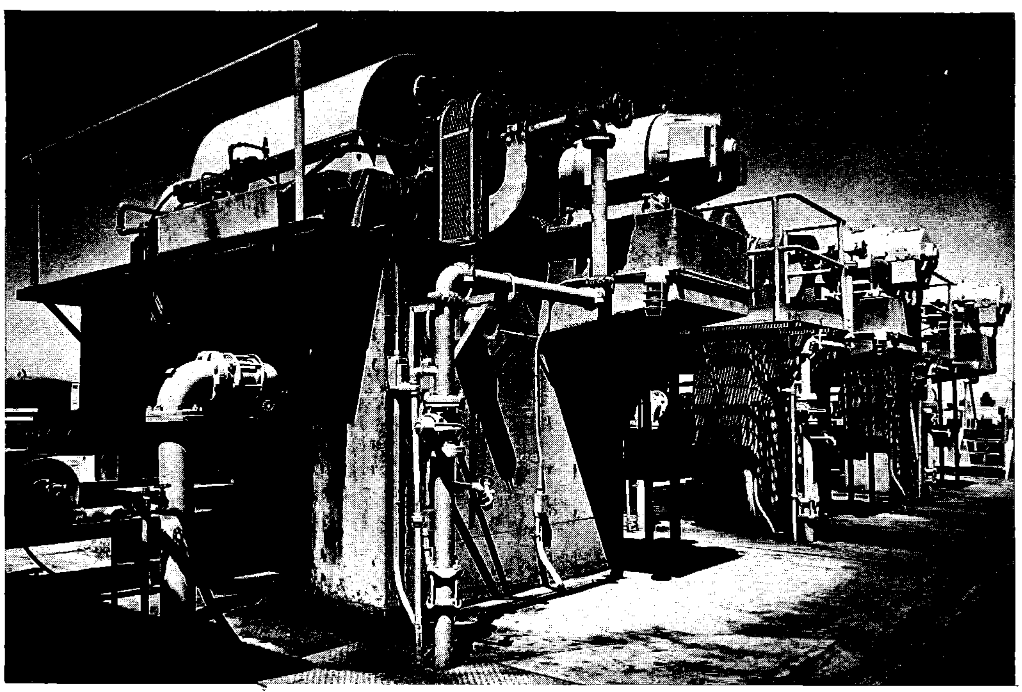


Fig. 14 A representative installation on a concrete foundation

Fig. 12 Centrifugal supported on concrete foundation

tion. Clearances necessary for these adjustments are shown on the certified foundation drawing.

HOPPERS

The usual method of handling centrate or solids is to discharge them into hoppers and chutes that attach to the flanged bottom of the centrifuge case. That portion of the flange which frames the case bottom has drilled holes for securing with bolts. The transverse case partition flanges are tapped and cap screws are employed for this connection. (If the case is rubber-covered the partition flanges are fitted with studs.) It is preferable not to hang the full weight of the effluent hopper or the solids chute onto the case bottom. If these are supported independently there is no danger of distorting the case. This applies particularly to larger machines with relatively heavy hoppers. The effluent hopper should have adequate depth which will vary with the size of the centrifuge. (See Figures 12 and 13.) If the centrifuge is to handle relatively large volumes of effluent it is advisable to mount a "skirt" to the case partition forming the effluent chamber. The function of the "skirt" is to contain splash and spray and keep it from reaching the solids discharge end.

Preferably the effluent hopper should be pitched towards the effluent connection with the latter located on that side of the machine towards which the effluent stream is directed. In certain designs, effluent is removed by a paring or skimming device. With this construction the effluent will discharge under pressure and effluent hoppers as described above are not used. Rather the effluent piping is then directly connected to the discharge openings provided in the machine case, all as shown on the installation drawing.

The solids chute should be free of all obstructions or restrictions. If possible, the opening at the bottom of the chute should be vertically below and have the same dimensions as the opening of the solids compartment in the top half of the case. This will prevent solids from building up on the sides and ends of the chute. In certain instances, solids which will discharge freely from the centrifuge case may nevertheless tend to collect in the chute itself. This may be particularly true if an unusually long chute is necessary. In such cases provision should be made so that the operator can observe and if need be remove the solids accumulation periodically. Vibrators or air hammers will often take care of this condition.

VENTING

In the case of machines not provided with fume or pressure seals, it is essential that an adequate vent be installed in the effluent hopper to provide for the discharge of a relatively large volume of air. Effluent hopper vent is not required if the hopper is open at the bottom. The size of vent will depend upon the size of the centrifuge, with minimum dimensions about as follows. 18″ diameter machines — 6″; 24″ diameter machine — 8″; 32″ and 36″ diameter machines — 10″; 40″ and 54″ diameter machines — 12″. There is a separate recommendation for the 6″ machine which is covered in special instructions.

It is necessary that the vent be installed in the hopper rather than in the case, and that it have a vertical leg of sufficient length so that mist is not discharged into the building. Usually this leg will not need to extend beyond the centerline of the machine. If the slurry produces objectionable or corrosive fumes, the vent should be carried to the outside of the building or to a stack. Fume or pressure-tight machines do not usually require vents.

FEED ARRANGEMENTS

Feed is introduced into the Bird Centrifugal through a stationary feed pipe supported by a bracket which is mounted to the base. It extends through the conveyor trunnion and into the feed compartment of the conveyor hub. The type of pump or other feeding means used to introduce the slurry into the machine is usually not critical. However, it is recommended that the volume can be regulated so that the feed is reasonably uniform. This is especially important in classifying applications. For suspensions of very fine solids such as pigments, chemical precipitates, etc., diaphragm, displacement or centrifugal pumps have been found to be satisfactory. For slurries containing coarse or heavy solids, the feed may be drawn off a circulating feed supply line. Avoid excess circulation especially when employing a centrifugal pump as this may result in degrading solids, thus producing moisture-holding fines. The control valve in the feed line can be a manually operated plug valve or a valve with power adjustment tied into the torque control, if such is employed. A gate valve is usually unsatisfactory because its orifice is often a narrow slit which encourages plugging. The hydraulic head required to overcome the friction in the feed pipe generally is only a matter of a few feet. Because of this, it is possible when desired to feed the machine through a funnel attached directly to the feed pipe. Such an arrangement permits easy sampling of the feed and observation of the rate of flow. Constant head tanks, weir boxes, ferris wheel feeders and similar gravity feed controls are also suitable under proper conditions.

EFFLUENT DISPOSITION

Centrate continuously spilling out from the effluent ports of the bowl will impinge against the walls of the case and produce a considerable amount of spray and mist. Carefully designed baffling prevents this spray from reaching the solids compartment and a flinger mounted on the bowl trunnion stops its escape to atmosphere. As indicated previously, the effluent receiving hopper must be of proper design and dimensions to collect and contain it effectively. The means employed to carry centrate away from the machine will be governed by what is to be done with it. If centrate goes to a waste sewer or disposal line located below the machine, then this can be accomplished by gravity flow. If the effluent is to discharge directly into a tank, then the tank should be covered and the connection between it and the effluent hopper completely closed. As an alternate, the effluent discharge line may be submerged below the liquid level in the tank. If these precautions are not taken, spray may escape to atmosphere and make for a messy installation. If the centrate is to be pumped away, the pump must be of adequate capacity and the usual provisions made to prevent it from becoming air bound. It is not advisable to carry any liquid head in the centrate hopper. Bird centrifugals equipped with a paring device will require a different effluent handling procedure. (Check with Bird Machine Co.)

SOLIDS HANDLING

Most solid bowl centrifugal installations are in dewatering service calling for a "dry discharge." Suitable equipment must be provided to convey the solids from the machine, that is from the solids chute to the dryer, stockpile or other disposition. If the solids go to a dryer, most operators prefer to install the centrifuge at a level above the dryer, so that it will not be necessary to elevate the centrifuge product. If it is necessary to elevate the solids, then conventional equipment for the purpose can usually be used, the selection depending upon the angle of the elevation and the abilities of the conveying equipment itself. The direction of the solids conveyor should be at right angles to the axis of the machine for balanced distribution and efficient transfer of solids. If fine solids are contained in the centrifuge discharge, then there may occur some buildup in the case or in the chute which may periodically break away. Should this cause an operating problem, special design solids gutters are available to correct the condition. If it is necessary to wash out the solids compartment and chute from time to time, then the wash water can be introduced through the repulp connection. This wash-out water will, of course, drop into the solids system. Should this be objectionable, then a swinging gate or other diversion means ahead of the dryer must be provided. In the case of "wet discharge" applications; that is, when the solids are to be dissolved or repulped, the repulp liquid is introduced into the top half of the case. Avoid directing high pressure, high velocity repulp liquor at the solids ports. Doing so will cause repulp liquor to enter the bowl and discharge with the effluent. While effective repulp can be accomplished in the machine case, it is often desirable to do some additional reslurrying in a holding tank equipped with some agitating device. The reason for this is that conceivably a slug of solids might be discharged and this would cause plugging of the pump used to carry the slurry away. One detail to watch is the gland water in the pump. With some pump designs gland water will leak into the pump housing and mix with the repulped slurry. This can cause difficulty if the slurry may not be diluted.

FUME SEALS

If the Bird Solid Bowl Centrifugal is to handle volatile solvents or hazardous materials, or if the machine is intended for a pressurized operation, then special case and feed pipe seals are provided. Detailed information regarding these seals and their operation and maintenance is contained in separate instructions. The seals are of the mechanical contact type, available from commercial sources specializing in this field. Needless to say, when contact seals are used, it is essential that all flanged connections to hoppers, etc., are completely tight. The usual vents are not necessary or desirable on sealed machines. However, in certain instances, safety releases are provided or hoppers vented to a condenser or similar recovery system so that excessive pressure is not built up in the machine case.

DRIVE

Bird Solid Bowl Centrifugals are driven through V-belts. Electric motors or other drives should be mounted on bases designed to permit adjustment of belt tension. If it is required to use Diesel or gasoline engines, steam turbines or hydraulic motors, it is recommended that you review the design of the drive with the Bird Machine Company.

LEVELING

The centrifuge should be mounted level so that proper bearing lubrication is obtained. The level can be checked on the machined surfaces on the base. Extreme accuracy of leveling is not required.

OVERHEAD HANDLING FACILITIES

It is desirable to have permanent overhead handling facilities so that the centrifuge can be disassembled and serviced in minimum time. It is recommended that if possible a rail be installed over the centerline of the machine. The rail should be so designed that the rotating assembly when lifted from the base can be moved to an area where it can be worked on conveniently. Table 3 shows the weights of the complete machines and the heaviest pieces which may have to be lifted.

TABLE 3 APPROXIMATE WEIGHT OF MACHINES AND MAJOR COMPONENTS

Size	Machine Less Motor	Case Top	Gear	Rotating Assembly with Gear & Bearings	Conveyor
6″ x 12″	410	55	75	270	17
18″ x 28″	2800	155	260	1184	170
18″ x 42″	4275	190	260	1780	230
24″ x 38″	5400	388	275	2527	555
24″ x 60″	6500	460	275	3400	690
32″ x 50″	12000	800	1221	5000	1200
36″ x 50″	13000	870	1221	4870	1120
36″ x 72″	17250	1020	1221	7900	1500
36″ x 96″	22000	1220	1221	11000	2000
40″ x 60″	15500	940	1221	8500	2000
54″ x 70″	32000	2500	3000	18000	4600

LUBRICATION

The Bird Continuous Centrifugal is designed for high rotational speeds in heavy duty service. To insure uninterrupted, trouble-free operation, it is essential that a careful program of proper lubrication procedures be followed. This insures maximum life of bearings, bushings and other mechanical parts. The following will familiarize you with the lubrication requirements of Bird Continuous Centrifugals.

MAIN BEARINGS

Lubrication of main bearings is either circulating or non-circulating. The non-circulating system makes use of bath lubrication; that is, the bearings are partially immersed in a pool of lubricant contained within the pillow blocks. The circulating system requires accessory equipment; i.e., pump, filters, relief valves, etc., which are normally mounted on the machine base.

When *bath lubrication* is employed, the proper level to be carried in the pillow blocks is indicated by a sight gauge or a petcock. In either case, the oil levels should be checked frequently and regularly. Add oil as necessary to insure that the level maintained is always at the centerline of the lowest ball or roller. Extension pipes to sight gauge or petcock may become plugged and this will prevent true level indication. Sight gauge vents must always be kept open for the same reason. These items should be checked whenever oil is changed. It is suggested that bearing oil be replaced at least every three months under average operating conditions and oftener in dusty or steamy locations. The bearing housing should be flushed when oil changes are made in order to remove any residual matter which may contaminate the fresh oil.

To flush out bearing housings properly, use clean hot flushing oil at 180 to 200 deg. F. or kerosene at 110 to 125 deg. F., while slowly turning the rotating assembly by hand. This will wash out dirt, grit and sludged oil. Continue to turn the rotating assembly slowly while draining to insure the most complete removal of flushing oil and contaminants.

Kerosene or light transformer, spindle and flushing oils are suitable for cleaning bearings. However, anything heavier than light motor oil (SAE10) is not recommended.

Circulating oil systems for Bird Centrifugals differ in detail for the various size machines. However, in principle the systems are similar. Generally, they consist of a reservoir, a circulating pump, filters or strainers, flow indicators, pressure gauges, alarm device, pressure relief valves and in some cases, heat exchangers to cool the lubricant. *In all cases, the starter for the circulating pump motor should be interlocked with the main drive motor control so that oil is circulating whenever the centrifugal is running.* Make sure oil flow and/or temperature switches are wired into the alarm circuit and properly adjusted.

In the 18 x 28" and the 24 x 38" centrifugals, the circulating pump is of the gear type, immersed in

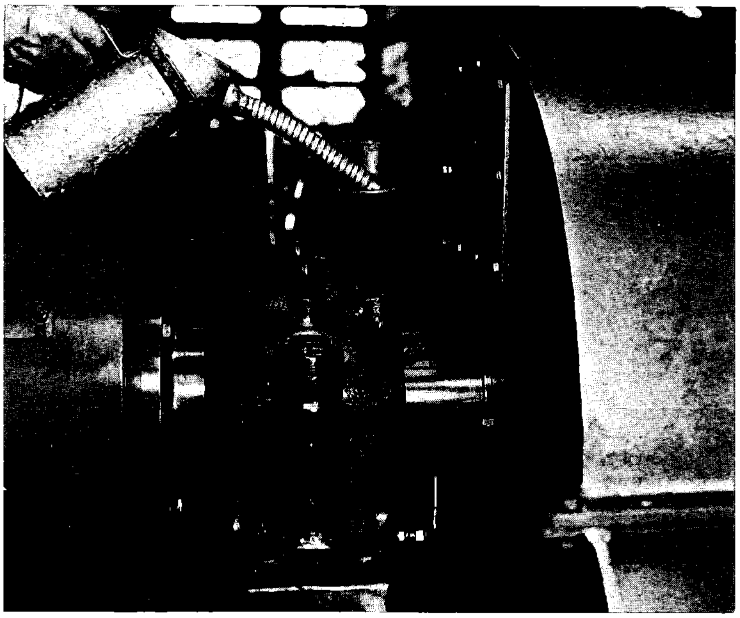


Fig. 15 Adding oil to Main Bearing

the oil reservoir and driven by a fractional horsepower motor. The oil is forced through a filter equipped with a 15 micron tube, and then goes to the main bearings, the rate being controlled by the sight feed oilers. The filter element should be checked periodically for cleanliness and replaced when oil changes are made. Proper flow rate is reached when a visible stream is seen through the sight glass of the oilers. The 32 x 50″ and larger Bird centrifugals make use of gear pumps which are capable of delivering up to 1.5 GPM of lubricant. The oil passes through a strainer (its element should be cleaned at intervals based on operating experience), flow indicator, and into the main bearing housings. The correct rate of flow is obtained when a stream approximately ⅛″ in diameter (½ pint per minute) is seen through the sight glass of the oilers.

The 24 x 60, 36 x 72 and 36 x 96 centrifugals use high speed spherical roller bearings which require forced feed, dry sump circulating oil systems. These bearings will produce higher temperatures than ball bearings under the same running conditions; therefore, more care must be taken during the initial stages of operation to insure adequate lubrication. Under normal circumstances an oil in the range of AGMA #2 is a suitable lubricant. The oil should be cooled prior to entering the bearings by use of the heat exchanger supplied with the oiling system. If ambient and/or process temperatures are unusually high, field adjustments may be necessary to correct the factory set conditions. To check the adequacy of lubrication, the temperatures of the oil in the pillow block drain lines should be taken and compared with the temperature viscosity chart of the oil which is being used. (Most AGMA #2 oils have 100 SSU in the 150°F to 160°F temperature range.) A water coolant rate of 2 to 3 GPM should be passing through the heat exchanger at this time and the machine must have been running a minimum of four hours under normal process conditions. The viscosity of the oil at the return line temperature must not be less than 100 SSU. Field adjustments to keep the viscosity above 100 SSU include: (1) increasing water coolant rate through heat exchanger (2) increasing oil flow to bearings by adjusting pressure relief valve (3) replacing the oil with one of higher viscosity.

The 54 x 70″ centrifugal incorporates a circulating oil system which differs from all other types in that it supplies the gear unit as well as the main bearings. Oil is circulated by a pump through a filter, heat exchanger, flow indicator with alarm connections, and sight feed oilers. The oil flow is split prior to entering the main bearings and a portion is diverted to the gear unit. Forty gallons of oil will fill the reservoir and system to the required level indicated on the oil tank gauge. The level will drop about 4″ when the machine is operating and the gear unit becomes filled.

IMPORTANT — The oil level in the reservoir should be checked weekly and periodic checks made on the condition of the lubricant and filter.

The following procedures should be followed when starting a 54 x 70″ centrifugal if both the machine and oil system have been shut down.

Start oil pump and run cooling water through heat exchanger (2 GPM coolant is usually sufficient). The main drive motor should run only when oil is passing through the alarm device in the oil supply line. Do not start the machine until oil returns from the gear unit into the reservoir. This will take 2 to 3 minutes, depending upon oil temperatures. When starting a cold system (below 70 deg. F.) oil pressure readings will be relatively high. However, it is not necessary to delay operating the machine until normal pressure and temperature have been reached.

Normal running temperature of the oil is 140 to 150 deg. F. Thermoswitches located in the main bearing housings and gear unit oil case should be wired to actuate the alarm system when the temperature exceeds 175 deg. F.

Turn the external handle of the filter periodically

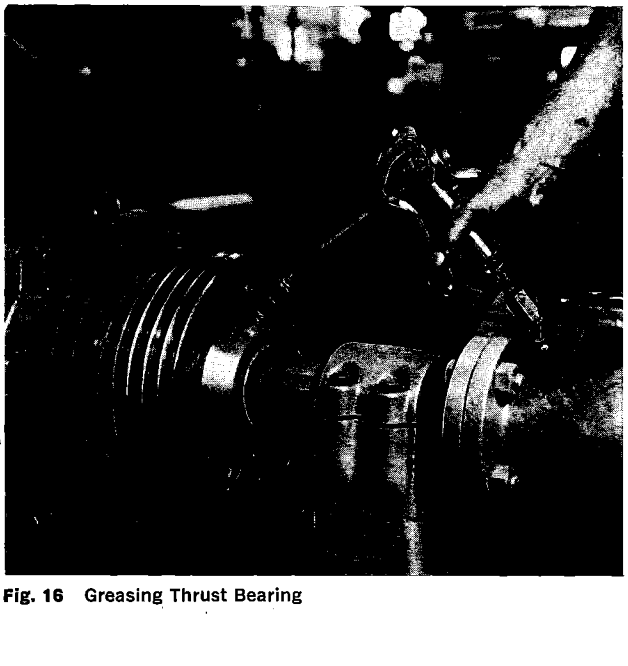


Fig. 16 Greasing Thrust Bearing

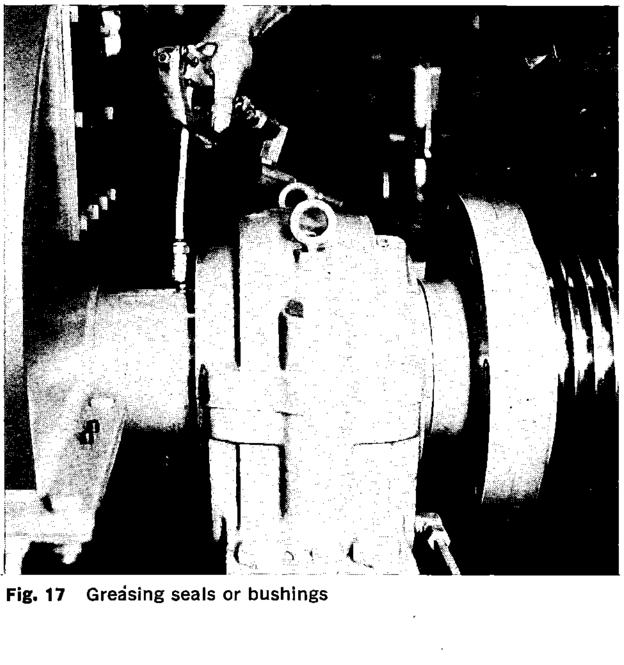


Fig. 17 Greasing seals or bushings

to remove accumulated dirt from its element. Further instructions on the operation of the oil filter will be found on the instruction tag attached to the handle.

Due to the cleaning action of the filtering devices, the circulating oil system generally requires less frequent oil changes than does the bath type system. In most cases, the oil may be changed on a yearly basis and the bearing housings flushed and cleaned at that time. Oil is subject to gradual deterioration from dirt, moisture and oxidation and should be scheduled for yearly replacement regardless of actual operational time.

A satisfactory lubricant for main bearings on all sizes of Bird centrifugals employing ball bearings is one meeting AGMA #3 specifications. This oil has a viscosity of 600-650 SUS at 100 deg. F., and is in the approximate range of SAE40 oil.

THRUST BEARINGS

The thrust bearings, mounted inside of the driven sheave, are grease lubricated. To lubricate them remove both plugs from the bearing cap and attach a grease fitting to one opening. Then force in a small amount of grease until grease exudes from the opposite opening. Wipe off excess grease and replace plugs. Normally a small amount of grease added once a month should be sufficient. These bearings are packed with NLG1 #2 grease containing a lithium base suitable for anti-friction bearings. A continued use of this type grease is recommended.

CONVEYOR BUSHINGS

There are two plugs, 180 deg. removed, on each of the bowl head trunnions marked "bushing." To grease, remove both plugs, attach a grease fitting to one hole. Force in a small amount of grease until grease exudes from the opposite hole, then replace plugs. Lubrication should be performed monthly with an NLG1 #2 type grease. The 18″ and 24″ diameter machines are equipped with graphite lubricated bushings and do not require greasing at these locations (except 24″ x 60″ machine which is grease lubricated).

SHAFT SEALS

The procedure for lubricating shaft seals is identical with that for conveyor bushings. The plugs marked "seal" are located adjacent to the "bushing" plugs and greasing should be done at the same time that the bushings are lubricated. An NLG1 #2 type grease is recommended. Note that the 18″ and 24″ diameter machines require greasing at this location.

GEAR UNIT

Gear units on all Bird centrifugals except the 54 x 70″ size have self-contained lubrication systems. The 54 x 70″ machine has a pressure circulating system supplying gears and main bearings. It is important that gear units are provided with adequate lubricant of proper quality.

Gear units for all machines except the 54 x 70″ are shipped filled with an SAE80-90 multipurpose type gear lubricant with extreme pressure additive for use as "break-in" oil. The 54 x 70″ gear units are shipped empty and must be filled at installation.

The "break-in" oil should be left in the system for 500 hours of actual operating time under load. After the break-in period, the oil should be drained completely and replaced with regular service oil. This should be equal to AGMA #4 superior quality, 900-1000 SUS at 100 deg. F. with rust and oxidation inhibitors. To drain the self-contained unit, the drain plug should be removed and the opening located in the 6 o'clock position. The fill plug, which is then diametrically opposite in the 12 o'clock position, should be removed and (clean, dry) air pressure applied to it to force draining. Remove oil from gear units while warm and fluid. *Do not use flushing compounds in a gear unit* unless it is to be completely disassembled. After draining, the gear unit should be re-filled with the regular service oil to the prescribed level. Oil heated to approximately 150 deg. F. is easier to handle and pour. All gear units which have self-contained lubrication should have oil levels maintained so that not more than one quart has to be added at any time.

The gear housing has fill and level plugs in the end cover, made accessible by an opening in the gear guard. For checking level and filling, both plugs are removed and oil added until it comes up to the hole in the 11 o'clock position while filling through the hole in the 12 o'clock position. *Do not overfill.*

The oil level should be checked frequently during the first weeks of operation and thereafter as often as necessary based on the experienced rate of consumption.

SPLINE LUBRICATION

The spline coupling connecting the gear unit and conveyor should be packed with grease every 6 to 8 months or whenever the gear unit is removed. A heavy duty grease such as an NLG1 #2 with an MOS additive is recommended for this service.

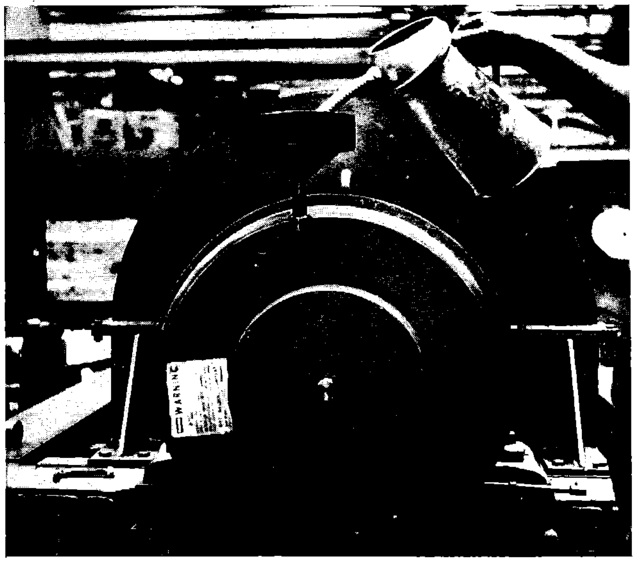


Fig. 18 Adding oil to Gear Unit with self contained lubrication

OPERATION

The Bird Solid Bowl Centrifugal is used to process a wide variety of products. Solids may range in particle size from 1 micron or less to ½″ or more. Their shape, specific gravity, fragility, abrasiveness and other physical characteristics may also differ greatly from case to case. The liquid phase of the slurry is, of course, equally subject to variation in terms of density, viscosity, volatility, corrosiveness, etc.

The Bird Centrifugal you are putting into operation is designed and built for the service you specified. This chapter contains information which will help you obtain the performance of which it is capable under the conditions of your partciular application.

MECHANICAL CHECK

In most cases a Bird service engineer will visit your plant to check the installation and assist in startup. If this is not possible or desired, then the following procedure is recommended.

1. All Bird Centrifugals are test-run at our plant before shipment. Your machine is therefore properly lubricated when received by you. (Circulating oil systems will require filling.) It is good practice nevertheless to make a thorough lubrication check before startup, especially if machines have been stored or idle for some time prior to going into service. (See Lubrication Instructions.)

2. Your Bird Centrifugal is shipped to you with the effluent port setting (pool depth) expected to give required performance. The setting can of course be changed if indicated during actual operation. The feed and wash pipe assembly on the other hand has to be installed in the field. If there are two or more feed compartments (see assembly drawing) it should be positioned to discharge into that compartment which will give optimum performance for a given effluent port setting. The third major machine adjustment is speed. It is recommended to select the smallest motor pulley (lowest speed) in starting up. The lowest speed which will give satisfactory performance is the best speed from the standpoint of power and maintenance.

3. Make sure the centrifugal rotates freely. Smaller sizes can easily be turned over manually (by pulling belts); 40″ and larger machines may require use of a bar to get sufficient leverage. If there is no sign of interference or rubbing then the machine can be turned over with the motor. Check to see its direction of rotation is as indicated by arrow at centrate end of case top.

4. It is recommended to run the machine at operating speed without product feed for a period of at least 3 hours. This will afford an opportunity to observe bearing temperatures and no load ammeter readings. Power demand will drop gradually as gear and bearing lubricants level off to operating temperature. It is not recommended to feed water into the machine at startup. With certain bowl conformations, doing so may set up unbalances which would not occur when feeding slurry containing solids.

INTRODUCING FEED SLURRY

On start-up, it is advisable to begin feeding at relatively low rates, gradually increasing to required throughput as the operator becomes familiar with the technique of feed control. A frequent source of difficulty encountered by those unfamiliar with the Bird Centrifugal is over-feeding. It should always be kept in mind that a conveyor having a given pitch, number of leads and rotational speed cannot transport more than certain quantity of solids. The table shown below indicates conveyor capacity in cubic feet per minute for various machine sizes at certain speeds and gear ratios. Capacities in the table for the 6″, 18″ and 24″ sizes are based on single lead — the balance on double lead. To adjust these values for other gear ratios, multiply the cubic feet per minute by the ratio in the table, and divide by the actual ratio to be used. To adjust for other machine speeds, divide the cubic feet per minute by machine speed in the table and multiply by actual speed. Maximum throughput may under circumstances be limited not by transport capacity but by gear loads, clarifying ability, and other factors.

TABLE 4 CONVEYOR-SOLIDS-HANDLING CAPACITIES

SIZE UNIT	LEAD	MACHINE SPEED	GEAR RATIO	NOMINAL CFM
6 x 12	1.0″ single	4000	80:1	0.1
18 x 28	2.5″ "	2000	80:1	0.7
18 x 40	2.5″ "	3000	80:1	1.0
24 x 38	3.0″ "	1800	80:1	1.5
24 x 60	4.5″ "	2500	80:1	2.0
32 x 50	10″ double	1200	80:1	5.6
36 x 50	10″ "	1200	80:1	5.2
36 x 72	12″ "	1200	80:1	5.2
36 x 96	12″ "	1200	80:1	5.2
40 x 60	12″ "	1200	80:1	12.2
54 x 70	18″ "	600	20:1	30.5

Capacity figures are nominal only and subject to solids characteristics, bowl design and machine adjustments.

It is important to know the percentage of solids present in the feed slurry, and to control the feed rate accordingly. Your Bird Centrifugal will have been designed with a conveying capacity substantially greater than was specified for the job. This should allow for reasonable fluctuation in slurry solids content and volumetric throughput. If the material being processed is to be washed, then a rotometer or other measuring device should be used to provide accurate control of the wash liquor volume. If no fixed quantity of wash liquor has been specified, a good rule is to use ½ pound of wash liquor per pound of solids. Let us repeat and re-emphasize that the principal thing to look out for and the most important factor in getting off on the right foot is to avoid the danger of overfeeding the machine. If, because of inadequate control, an excess quantity of material is delivered into the centrifuge, this will almost certainly trip the shear device and automatically cut off the feed. It is important that the feed slurry is cut off immediately if the shear device is actuated, otherwise it may be necessary to dismantle the centrifuge and clean it out.

It is of course also undesirable to overfeed the centrifugal in terms of liquid volume. Doing so will result in poor clarification (or classification), overloading of drive motor and in extreme cases, spill-back along the feed pipe.

OBSERVING RESULTS

After the machine is in balanced operation, obtain samples of the effluent and solids to see whether these meet your requirements. In this connection remember that the Bird has been designed to accomplish one or more of the following objectives. Produce solids of maximum dryness or effluent of maximum clarity. Wash the solids to reduce impurities. Classify the solids at a pre-determined particle size (with the fine fraction passing off in the effluent). The adjustments that may be necessary will depend upon which of the above objectives have not been met. Let us consider each adjustment in turn.

1. IMPROVING SOLIDS DRYNESS

To obtain lower moisture one or more of the following adjustments may be required.

(a) *Speed*

Usually the easiest step in the direction of lower moisture is to increase machine speed. Unless your Bird Centrifugal is specially equipped with a variable speed drive, this involves changing the motor pulley. It should be kept in mind, however, that with some products lower moisture may be obtained by coming down in speed. Fragile solids which degrade into fines of vastly greater surface area fall into this category. Other types of solids tend to pack under high centrifugal force and thus will drain more thoroughly at lower speeds. It is therefore good practice during the startup period to compare moisture results at both high and low speed (using pulleys supplied with equipment). Doing so affords operation at optimum centrifugal force.

(b) *Drainage Time*

With some products variation of speed has no appreciable effect on the moisture content of the centrifuged solids. Should this prove to be the case, an alternate means of reducing moisture is to increase the length of the drainage deck and thus the time in which liquid can drain away. This is accomplished by "lowering" the effluent dams or ports; that is, by decreasing pool depth. Adjustments should be repeated until the optimum setting has been found. The pool level should not be lowered to the point where effluent clarity becomes unsatisfactory. In machines equipped with a paring device with hand wheel adjustment, level changes can be made while running.

(c) *Location of Feed*

Some Bird centrifugals have two and occasionally three sets of feed ports available from which to select the set which gives best results. Usually lower cake moistures are obtained by feeding through the ports closest to the large end bowl head. Remember, however, that the nearer the feed point is to the effluent ports the more likely very fine material will not have an opportunity to settle out and thus will carry over in the centrate. See instructions on changing location of the feed pipe.

(d) *Location of Wash Nozzles*

The location of the wash nozzles (when supplied) will affect the moisture retained in the cake. The closer the wash nozzles are to the solids discharge ports, the shorter will be final drainage area and time, and the more moisture will be retained in the centrifuge cake. Reversely, the closer the wash nozzles are to the pool, the longer will be the final drainage zone and the drier the solids. The number of wash nozzles used can likewise be reduced and the length of the drainage thus increased. (This may mean some sacrifice in washing efficiency.)

In certain applications a solids wash can also be employed as a means of reducing cake moisture. In other words, if a sufficient quantity of wash liquor is directed into the solids as they emerge from the pool, then the very fine particles will be flushed back into the pool and evenutally come over with the effluent. The resultant coarser solids discharge will thus hold less moisture.

(e) *Feed Temperature*

Feeding a hot slurry will reduce cake moisture to the extent that temperature affects the viscosity of the mother liquor. Usually the hotter the liquor the less viscous, the thinner the film of liquor left on the solids and the less liquor retained in the capillaries.

(f) *Hot Solids Rinse*

If the adjustments so far listed still fall short of producing the desired cake dryness, a hot water solids wash may do the trick. This procedure has been used to advantage even in cases where a wash is not otherwise necessary. The effect of a hot water wash is to displace the more viscous, cold mother liquor, again leaving a comparatively thin film on the particles.

The first four of the variables mentioned above are controlled by adjustments which can be made to the centrifuge. The last two represent process changes. In general, the physical characteristics of the product fed to the centrifugal have a direct bearing on dewatering results. When product dryness is important every effort should be made to produce solids as coarse as possible and/or with the minimum size spread. Also, the viscosity of the liquor should be kept to a minimum; that is, the feed temperature held as high as is possible.

2. PRODUCING EFFLUENT OF MAXIMUM CLARITY

If centrate clarity is the major objective, here are the variables to take into account. Some or all may be subject to adjustment.

(a) *Speed*

As previously stated speed is probably the variable easiest to experiment with. While it is true that the highest available speed will produce the highest centrifugal force acting on the particles, it does not necessarily follow that these high g's will produce the best clarification. High centrifugal forces are effective only in cases where relatively fine solids are involved *and* where the solids will compact into a cake of firm consistency. Some products (for instance activated sewage sludge) will reach a certain state of fluid compression and settle no further, regardless of how much centrifugal force is applied. Moreover, in order to efficiently discharge this type of solids it is frequently necessary to operate at reduced speeds. Higher operating speeds also tend to break up fragile crystals or delicate flocs and promote emulsification and foaming. Stated in very general terms, for maximum clarity, operate at the highest speed compatible with product characteristics and performance requirements.

(b) *Pool Volume*

The effect of adjusting the depth of the pool will vary with the settling characteristics of the solids and the slurry concentration. Increasing pool depth is not usually beneficial in the case of very dilute suspensions, except to the extent that doing so will increase surface area between the point of feed and effluent discharge (at optimum feed pipe location). As the pool depth is increased, the length of the drainage deck is decreased, thus bringing about higher cake moistures. If the machine is equipped with wash nozzles, make sure that the pool depth is not increased to a point where wash liquor is directed into the pool rather than onto the drainage deck. Increase in pool depth may mean relocation of wash nozzles. In many applications it is difficult to forecast the effect on effluent clarity when pool depth is varied. Experimentation must provide the answer.

(c) *Location of Feed Pipe*

The point at which the feed is introduced into the bowl can have considerable bearing on effluent clarity. In general, coarse slurries can be fed at a point close to the effluent discharge without carry-over of solids in the centrate. Slurries containing very fine solids on the other hand should be delivered to the set of feed ports located closest to the drainage deck. When operating at low pool depth, make sure that the slurry does not enter the bowl at a point so close to the drainage deck that it disturbs the solids being conveyed onto it. Should this happen, the very fine solids entrained in the cake are likely to be flushed back into the pool where they will accumulate and eventually carry over with the effluent. In some designs feed pipe location is not adjustable (check your assembly drawing).

(d) *Consistency of Feed Slurry*

In contrast to what is the usual experience with vacuum filters, high solids content in the feed to a centrifugal may work against obtaining good effluent clarity. This of course pertains only to suspensions of relatively fine solids such as clay, pigments, precipitates, etc. A simple test to determine whether "hindered settling" is a factor would be to spin a small sample of the slurry in a test tube centrifuge and observe whether the centrifugally settled solids amount to more than say 30 or 40% of the total volume in the tube. If this is found to be the case, and particularly if the solids are all substantially finer than 400 mesh, then dilution of the slurry is indicated. If it is not practical to dilute with water, recirculation of filtrate will accomplish the same end.

(e) *Temperature of the Feed Slurry*

The clarity of the filtrate will be influenced by the temperature of the feed to the extent that temperature affects the viscosity of the liquor. The less viscous the liquor, the easier for fine solids to settle and the better the resultant clarity.

(f) *Feed Rate*

The residence (settling) time of the slurry in the bowl has a direct effect on the degree of centrate clarity which can be obtained. Decreasing the feed rate will increase residence time and permit a more efficient removal of suspended solids. In the case of extremely dilute suspensions, gravity thickening ahead of the centrifuge will reduce the total volume of slurry that has to be handled and thus size and number of machines required. However, the slurry should not be thickned to the point where hindered settling takes place as described under (d).

(g) *Chemical Treatment of Feed Slurry*

In certain instances the solids suspended in the feed slurry may be in a dispersed state. This makes it difficult to obtain a satisfactory effluent regardless of the centrifugal forces applied or the adjustment of other variables. If this situation exists, flocculation should be considered. If the slurry is on the acid side, then glue may be a satisfactory material to use for floccing. If, on the other hand, the slurry is neutral or alkaline, then lime or lime plus starch can prove effective. Also, there are numerous organic flocculants on the market which, if correctly chosen and applied, often represent an even better solution to the problem.

All of the above mentioned steps to improve effluent clarity are also effective when the centrifuge is used as a classifier, and when it is desired to reduce the size range of the fine fraction coming over with the effluent. In other words, when classifying, means to improve clarity are also means to obtain a finer cut. The exception is the matter of chemical treatment. In classification work, dispersion reagents rather than focculants are used to obtain a sharper cut at a smaller particle size.

3. WASHING OF SOLIDS TO REMOVE SOLUBLES

The following adjustments can be varied to control washing efficiency:

(a) *Location of Wash Nozzles*

If the product wash has been found inadequate, one thing to try is relocation of the wash nozzles. Since these are mounted in the conveyor hub, changing their location requires disassembly of the machine. (Tapped and plugged holes are provided in the hub for alternate locations.) In most all cases it is desirable that the nozzles extend from the junction point of drainage deck and pool-surface in the direction of the solids discharge ports. (Raising or lowering the pool level moves the position of this junction towards or away from the solids discharge ports.) Nozzles should be installed at least in one complete turn of the helix or two turns if the conveyor has a double lead. For better washing efficiency, nozzles are bent against the conveyor blade and tack-welded to it during installation. This same practice should be followed when new nozzles are installed for the purpose of shifting the wash location.

(b) *Quantity of Wash Liquor*

In many applications the maximum quantity of wash liquor that can be used is specified by the customer. Where there are no limits set on the amount of wash liquor, increased quantities will result in improved washing. If the number of nozzles around one turn of the helix is insufficient to pass the required volume of wash liquor, additional nozzles may be installed as necessary. (Check with Bird Machine Co. for the volume that can be handled per nozzle at your operating speed.)

(c) *Wash Liquor Temperature*

Increased washing efficiency usually follows increased temperature of the wash liquor. This is especially noticeable when centrifuging slurries at room temperature and when it is permissible to use a hot wash.

(d) *Particle Size of Solids*

The coarser the solids, the easier it is to realize an efficient wash with a minimum of wash liquor. In other words, the ability of the centrifuge to wash diminishes as solids become finer. In size ranges below 325 mesh this becomes more and more evident to the point where if solids are substantially minus 10 microns it is unlikely that a worthwhile wash will be obtained. With this type of very fine product it will probably be found necessary to repulp the centrifuged cake and follow this with a second dewatering step.

4. CLASSIFICATION

As pointed out earlier, operation and adjustments of the solid bowl centrifugal in classification service follows closely the procedures used to obtain a clear centrate. The only difference is that classification aims at partial clarification; that is at permitting solids finer than a specified particle size to pass off with the effluent. Your Bird solid bowl classifier will be designed to attain this purpose as efficiently as possible with the very minimum of acceptable fines present in the oversize rejects and no coarse material in the fine fraction. The following adjustments are pertinent to obtaining this result.

(a) *Speed*

If inspection of the particles coming over in the centrifuge effluent shows that the size cut is in too coarse a range, then an increase in speed is an easy corrective measure. Make sure, however, you do not increase the speed to a point that a substantial portion of the acceptable fines report with the coarse fraction. While it is reasonable to expect progressively coarser cuts as speed is dropped, there is a practical limit to downward adjustment of centrifugal force. Excessively low speeds adversely affect sharpness of classification.

(b) *Pool Depth*

In general, the effect of increasing pool depth is the same as increasing speed. It is difficult to forecast the optimum combination of speed and effluent port setting. Experimentation is the best solution to this problem. Keep in mind, however, that an increase in pool volume is more effective in cases where a relatively large portion of the solids in the feed are in the coarse fraction. Remember also that the deeper the pool the shorter the drainage deck and thus the less opportunity for extreme fines to drain away from the coarse discharge.

(c) *Location of Feed Pipe*

The trend is that coarser cuts are obtained as the point of feed gets closer to the effluent ports. In some cases, however, and particularly when relatively coarse solids are to be separated from a balance of very fine particles, it may prove beneficial to actually feed on the drainage deck and thus flush away the fines entrained in the coarse fraction.

(d) *Consistency of Feed Slurry*

The solids content of the feed slurry has considerable bearing on the kind and quality of size separation made. In general, for finer cuts, dilute, non-viscous suspensions are required. Remember, however, that the centrifugal classifier is capable of making a sharp cut with slurries considerably higher in solids content than would be possible with gravity classifiers.

(e) *Temperature of Feed Slurry*

The hotter the suspending liquid phase the lower its viscosity. High temperature may be beneficial if finer size-cuts are required. Normally, classification is made with slurries at ambient temperatures and heating is justifiable in unusual cases only.

(f) *Feed Rate*

As feed rate varies, residence time in the slurry pool will vary and the size-cut is thus affected. In classification it is therefore important to make every possible provision to maintain a constant volumetric throughput.

(g) *Chemical Treatment of Feed Slurry*

Frequently solids suspended in the feed to the Bird centrifugal classifier are in a flocced or near flocced state. This makes it impossible to obtain satisfactory classification regardless of the centrifugal force applied or adjustment of other variables. When such a condition is observed chemical dispersion of the slurry is indicated. Usually the required amount of reagents for good centrifugal classification is much less than that for equivalent gravity classification. Avoid "over dispersion" as this may add substantially to the gear unit load over and above the normal loads encountered when discharging dispersed solids.

(h) *Particle Size Determination*

In order to make effective machine or operating adjustments, it is important to know the quality of separation which is being obtained in the Bird Classifier at any one time. There are numerous means of obtaining such data and it is recommended that careful thought be given to selecting the most practical method for a given application.

Screening of coarse or fine fractions in the dry state is most always unsatisfactory because of aggregates which form in drying the solids.

Wet screening is a good but tedious method to obtain a size analysis of plus 325 mesh solids if this is all that is required.

So-called texture tests are widely used in pigment manufacture and entirely adequate for this type of product, even where the pigment (fine fraction) has to be substantially minus 5 microns.

Microscopical examination of solids in the fine fraction is a quick determination but can be quite inaccurate because it is limited to minute samples.

If classification is aimed at separating two solids differing in composition as well as size, then a chemical analysis should be quite satisfactory.

An accurate size analysis in the very fine ranges is weight measurement of solids that settle out in a given time increment. This analysis can be accelerated by centrifugal instead of gravity settling and by using a hydrometer for weight determinations.

HOW TO MAKE ADJUSTMENTS

The following adjustments are those that affect operating results. Depending upon the type and size of the centrifugal they may include:

Locating Feed Pipe

The position of the feed pipe is usually adjustable. (Exceptions: Feed pipe enters through solids discharge end — machine is equipped with internal skimmer — there is only one feed compartment.) If a wash pipe is supplied it will extend beyond the end of the feed pipe and its position can be adjusted to compensate for adjustments to the feed pipe location. The feed pipe is supported in a bracket at the pulley end of the machine. When two or more feed compartments are available in the conveyor hub, loosen the holding cap, and adjust the feed pipe to the desired location by inserting or withdrawing as required. The dimensions governing adjustment are shown on the certified foundation drawing supplied with the machine. The discharge opening in the feed pipe should always point downward. After positioning the feed pipe make sure the wash pipe is set to discharge into the wash compartment.

Adjustment of Effluent Ports

As brought out earlier, it may be necessary to adjust the pool depth in order to obtain drier solids discharge or to improve centrate clarity. Machines equipped with an adjustable effluent paring device permit stepless variation of pool depth from outside of the case and while the centrifuge is running. All other designs require that the equipment be stopped and the adjustment be made after removing the case top. In the 6" and 18" machines, effluent spills from the bowl through one of several sets of ports located on circles of different diameters. The openings are threaded so that those ports on a diameter larger than the openings being used can be plugged and those which are in use can be protected by bushings. The ports located on the smallest diameter are not threaded since they can be left open with any pool setting. In 24" and larger centrifugals, effluent discharges over four weirs. One design provides for clamping the weirs to the bowl head in which case pool depth adjustment is stepless. A second design requires the weirs to be attached to the bowl head with cap screws. This latter type of weir is adjustable in ½" increments.

Locating Wash Nozzles

It has been previously pointed out what factors govern the choice of wash nozzle location and numbers. Your machine was shipped to you with nozzles installed to give you the best wash results in accordance with our previous experience or test information. If, in actual operation of your machine, it develops that a relocation of nozzles seems advisable, then the following information will prove helpful.

The wash compartment in your conveyor is provided with drilled and tapped holes usually over its entire length. In other words, there will be from 24 to 36 positions in which nozzles can be installed. It is generally good practice to use at least eight nozzles per turn of conveyor; that is, sixteen nozzles in the case of a double lead design. The unused holes in the wash compartment should be plugged off, using the plugs provided with the machine. It is not practical to remove a nozzle from an existing location and install it in a new hole. The tip of the nozzle is tack-welded to the adjacent conveyor blade and will become damaged upon removal. New nozzles are readily made from pipe of the same size and material used for the existing nozzles in your machine. The length of the new nozzle should be such that when it is screwed in place and bent over to the conveyor flight, then the clearance from the tip of the nozzle to the tip of the conveyor flight is the same as that for the existing nozzles. Nozzles located in the conical area of the bowl will therefore be slightly shorter the nearer to the solids discharge end and slightly longer the nearer to the effluent end. This length, however, is not critical within 1/8". After the new nozzle has been bent over to the conveyor flight and it has been ascertained that the distance between the nozzle tip and the edge of the conveyor flight is the same as for the existing nozzles, the tip can then be welded to the blade.

HOW TO CLEAN OUT THE BIRD CENTRIFUGAL

There are two principal reasons for washing down the internal portions of your centrifugal. One is that you expect to take it out of service for a period of time (to make adjustments or repairs or because of process interruption). The other is that the machine is running rough as a result of uneven solids buildup in the bowl or conveyor. The amount and frequency of washing necessary depends on the type of product being processed. The greater the tendency of the solids to set up or cement the more thorough the wash required. The following wash-down procedure is recommended.

Shut off feed and the main drive motor and introduce ample quantities of wash water through feed and wash pipes while the machine is coasting down to a stop. (If it is merely desired to wash out the feed compartment in the conveyor hub and the area of the bowl reached by the wash nozzles, then this can be accomplished to a degree without shutting down the machine.) After the centrifugal has come to rest, rotate it by hand in the opposite direction while maintaining the flow of wash-down water. In the case of products requiring relatively frequent or prolonged wash-down a reversing switch in the main motor control circuit will prove helpful. This switch, however, should be used for jogging only up to a maximum speed of 50 RPM. If the above procedure does not suffice, and the machine still shows some unbalance, remove the feed pipe and flush out (or steam out) all feed and drain compartments in the conveyor hub. To wash down machines equipped with internal effluent skimmer, it will be necessary to introduce wash water through the effluent pipe as well.

TROUBLE-SHOOTING

In the preceding paragraphs we have attempted to cover most of the questions which may arise during startup and operation of a Bird solid bowl centrifugal. Here are a few comments on how you may recognize and overcome miscellaneous operating problems occasionally encountered.

(a) *Uneven Solids Discharge*

Spasmodic, surging solids discharge is usually associated with machine vibration. It may occur as a result of the feed being delivered near to or on the drainage deck. If this is the reason, correction can be made by relocating the feed pipe so it discharges into a compartment nearer to the effluent end. Irregular discharge is also possible if solids are too fluid as a result of over-dispersion. Adjusting dispersion and/or increasing pool depth are possible solutions. Another cause for solids not conveying smoothly is roughness of the conveyor helix because of improperly applied hard-surfacing, or possibly corrosion. This condition tends to make solids stick to the helix and thus rotate with it rather than slide along in the direction of solids discharge. The correction is to refinish the conveyor blade areas involved.

(b) *Excessive Power Consumption*

Increase in motor load as read on ammeter without corresponding increase in gear loading most always indicates contact between the bowl and accumulated solids in the centrifuge case. Check the condition of solids discharge plows and look for polished areas on the bowl surfaces. If such polish is observed it may be advisable to apply narrow "wear strips" of hard surfacing to the portions of the bowl or flanges showing wear. Make sure also that the solids discharge freely from the solids chute or hopper. If for some reason the effluent pipe becomes plugged and centrate builds up in the effluent hopper to the point where it contacts the rotating bowl, then a sudden and drastic rise in the ammeter reading will be observed.

A gradual increase in the gear load over what has been normal experience in all likelihood indicates conveyor blade wear. Usually these blades are relieved on the back edge so that only a narrow edge is in contact with the solids. As the blades wear, this edge widens and evenutally repairs may have to be made. It is worth noting that quite frequently the wear pattern is such as to form a dam of solids on the drainage deck which prevents liquid from draining back into the pool and thus causes high cake moisture. Sudden or fluctuating increases in conveying load is usually due to variation in slurry characteristics or throughput.

(c) *Shear Pin Failure*

The shear member in the overload protective device will give way whenever the torque on the gear unit input shaft exceeds designed value. The overload may be for reasons mentioned in the preceding paragraph or because of the following conditions.

(a) Misalignment of gear unit causing wobble of the shear device with consequent fatigue failure.

(b) Torsional vibration of the gear input shaft again resulting in fatigue (see "Vibration").

(c) Bearing, gear or spline failure in the gear unit.

(d) Wear or failure of thrust bearings.

(e) Conveyor contacts bowl, bowl head or strips.

(f) Tramp material has entered bowl through slurry feed ports.

When shear member failures become a problem, it is advisable to determine the nature and magnitude of the load on the gear input shaft. A Foxboro or similar torque measuring and recording device gives this information continuously. If such an instrument is not installed, a temporary measuring device can be rigged as follows:

Fit and set-screw a rod of proper length in place of the torque arm supplied with the machine (Figure 19). As a safety measure make sure the rod is not free to rotate if it should break away from the spring scale to which it is attached. The torque load on the gear input shaft will be the product of length of arm times the pounds load (less tare weight) on the spring scale. Refer to the Bird Machine Company for allowable maximum torque that can be imposed on a gear unit of your size and ratio. If a recording torque control is used, it is recommended that its calibration and accuracy are occasionally checked with a spring scale applied to the strain-bar or other sensing member.

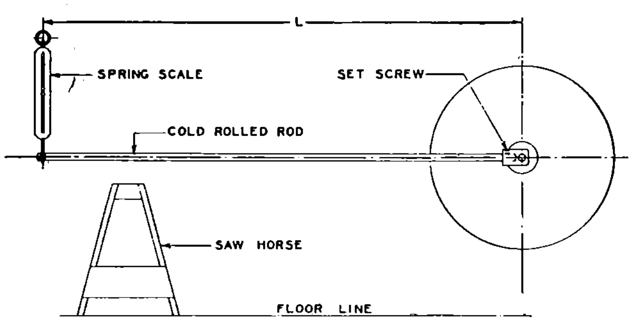


Fig. 19 Diagrammatic Sketch of Temporary Torque Measuring Device

The HP absorbed by the conveyor alone is determined by the following formula:

$$HP = \frac{\text{length of rod in feet} \times 2 \times 3.1416 \times \text{RPM of machine} \times \text{lbs.}}{33{,}000}$$

Lbs. in above formula is determined by subtracting tare weight of arm with machine at rest from the total lbs. pulled.

VIBRATION

Your Bird centrifugal is designed for high speed service and particular care has been taken to assure its vibration-free operation. Each component making up the rotating assembly is individually balanced so that all parts are completely interchangeable without in any way disturbing the balance of the whole assembly. Vibration because of mechanical unbalance can therefore only occur if there has been wear or distortion of certain machine components. Look for worn bushings, uneven wear of conveyor or solids plows, burrs in flanged fits and distorted bowl or conveyor trunnions. The proof of satisfactory mechanical balance is the disappearance of vibration when the machine has been thoroughly washed out. In judging machine balance, it must be kept in mind, however, that there are balancing tolerances just as there are machining tolerances. In other words, minute unbalances not detectable on our balancing machines may under circumstances add up the wrong way in the process of bowl or conveyor assembly. This, in turn, can cause a slight but harmless cyclical shiver whenever — as the conveyor rotates within the bowl — the "heavy" side of one matches up with the "heavy" side of the other. Cyclical vibration of this type is easily recognized in that it coincides with the conveying speed, that is, with the machine RPM divided by the gear ratio.

Cyclic vibration may become quite pronounced, however, when product has accumulated unevenly in one of the feed or wash compartments of the conveyor hub. A thorough wash-down will usually remedy this situation. In extreme cases and particularly if the conveyor helix has become plugged with solids, it may be necessary to dismantle the machine and dig out the accumulated material.

Under certain operating conditions and with certain products, torsional vibration may occur. This tends to be of relatively high frequency and low amplitude. It usually comes to the operator's attention either because of the noise it creates at the gear end of the centrifuge or because of frequent fatigue failures of shear pin or disc. It is not desirable to operate a centrifuge while this type of vibration is present. If torsional chatter occurs for the first time after the machine has run satisfactorily for a period of say six months or more on the identical product, then it is likely caused by conveyor wear or change in the surface condition of the bowl. Repairs are indicated in this case. It is strongly recommended, however, that if torsional vibration is the problem, then the Bird Machine Company be first contacted for instructions and service.

MAINTENANCE

Like any valuable piece of processing equipment, the Bird centrifugal deserves regular inspection and careful maintenance. The frequency and degree of inspection required will vary, depending upon the type of material being centrifuged, and the service conditions. If the product is abrasive, then it is good practice to make the first inspection of the rotating assembly after, say, two or three months of operation. If the product is not abrasive or corrosive, then initial inspection could be delayed until after four or six months of continuous operation. Following this first inspection, you are in a position to set up a permanent schedule that should be closely followed. With a good many products, yearly inspection is all that is required. This of course assumes that the centrifugal has been constructed of the proper materials to withstand damage from either corrosion or abrasion. It is a good idea to request the assistance of a Bird field engineer when the first inspection is to be made.

DISASSEMBLY

When disassembling a standard design Bird centrifugal, the sequence of operations to be followed is as follows:

1. Lock out the drive motor starter.
2. Remove guards from gear unit and belts.
3. Disconnect the feed, wash and repulp piping.
4. Remove cap from the feed pipe bracket, and withdraw the feed pipe. (If necessary, because of lack of space, the feed pipe can be withdrawn after the rotating assembly has been lifted from the base.)
5. Remove bolts that secure case top to case bottom (suitable rigging should be set up prior to starting disassembly. A permanent overhead trolley parallel to the axis of the centrifuge is ideal).
6. Disconnect and remove torque arm on gear unit. Machines not equipped with a Foxboro torque control have one end of the torque arm held to the gear unit guard. If a torque control is used the torque arm is held to the strain bar.
7. Remove the cap screws or other findings that fasten the gear unit to its holding flange. *Caution:* Do not remove gear case covers at spline or torque shaft end of gear before gear has been removed as a unit from machine. The gear unit will not drop when mounting screws are removed because the male spline of the gear unit is held by the female spline of the conveyor trunnion. However, preparation should be made to relieve its weight. Expect appearance of a small amount of oil when gear is removed. This is oil that may have seeped into the coupling. If necessary, use jackscrews to separate the gear from the flange. Tapped holes have been provided for this. Properly balanced in a sling, the gear is easily moved out horizontally, until the splines are disengaged (See Figure 34). Note: It is not required to remove the gear unit in order to work on other parts of the rotating assembly.
8. Loosen the drive belts and remove (or drape them on the feed pipe bracket until reassembly).
9. Loosen the cap screws on the effluent end bowl head and take out all but two that are 180 degrees apart. The bowl can be rotated in the bearings for this work.
10. Remove the cap screws that secure the main bearing pillow blocks to the base. Do not open the pillow blocks unless the bearings require inspection or replacement, and then only in an area where they will not be exposed to dirt or dust.
11. If a circulating oil system is employed, separate all oil feed and drain lines at the unions.
12. Lift the rotating assembly vertically out of the case and place it on open floor area twice the length of the rotor (to facilitate withdrawing the conveyor from the bowl). Blocks may be used to prevent rolling and tipping as the parts are separated.
13. Remove the two remaining screws holding the effluent end bowl head to the bowl flange. This joint is a shouldered fit and jackscrews should be used to facilitate the separation. Tapped holes have been provided for this purpose. As the bowl head separates from the bowl, the conveyor will come with it. The exception is in the case of machines having the feed pipe enter at the solids discharge end of the bowl. In this design, it will be necessary to first follow procedure shown in 15 a, b and c, and to remove the reverse solids plow through the solids ports in order to withdraw the conveyor from the bowl. Be prepared to properly locate the lifting sling, so as to balance the weight of the bowl head and conveyor assembly. A second hoist can be added as the conveyor emerges and before the spline-end trunnion is withdrawn free of its bushing.
14. If the conveyor is difficult to withdraw because of wear and consequent solids buildup on the bowl wall, then it may be necessary first to wash out the accumulated solids. Often the moderate impact of a wooden block against the outer wall of the bowl will free the accumulation.
15. Separate the effluent end bowl head from the conveyor trunnion as follows:

DISMANTLING THE BIRD CENTRIFUGAL

A Picture Sequence

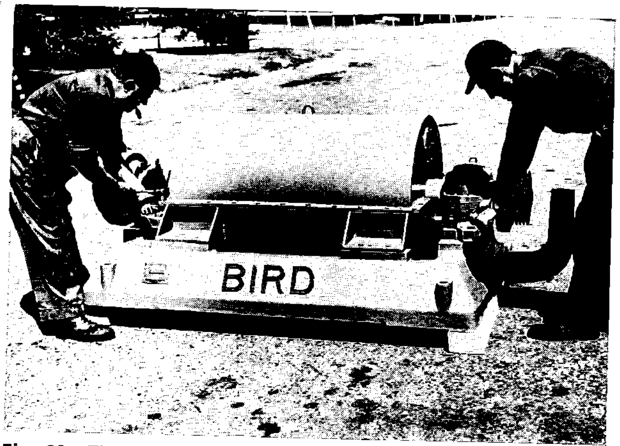


Fig. 20 The feed pipe and the belts have been removed. The gear unit may be left on for quick reassembly if desired. Picture shows removal of bolts so that case top may be lifted off.

Fig. 21 Cap screws fastening pillow block to base are removed. Do not open the pillow blocks unless bearings are to be serviced. All but two of the cap screws that fasten the bowl to the effluent end bowl head are then removed.

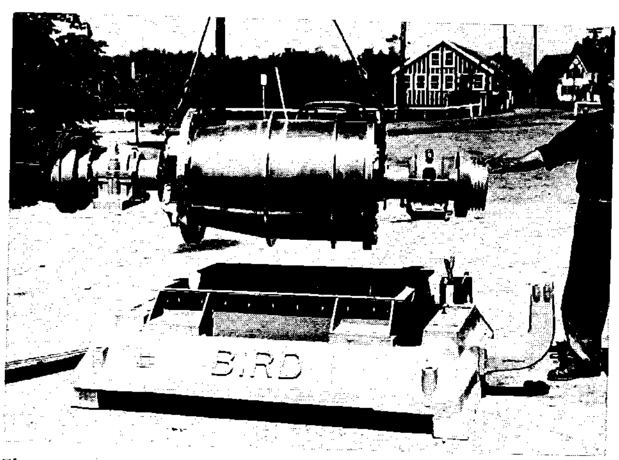


Fig. 22 Rotor is kept level and lifted vertically. It is then lowered to floor blocks so that rigging may be readily relocated.

Fig. 23 Jack screws are used to start joint of bowl and bowl head. Conveyor screw is then withdrawn from bowl a short way. Block under bearing housing permits relocation of rigging to maintain balance and finish withdrawing the conveyor.

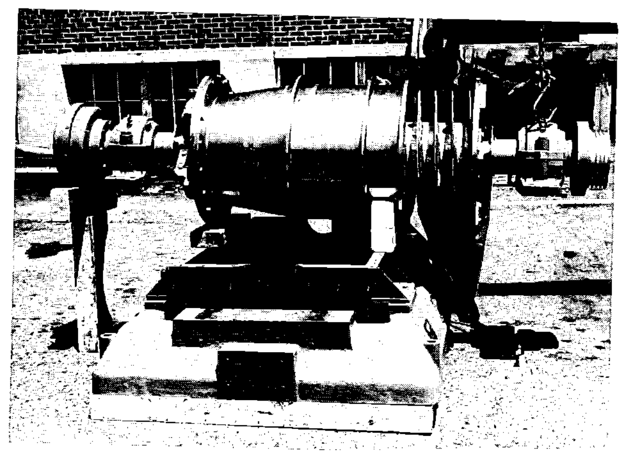


Fig. 24 When dismantling has to be done in cramped quarters the rotor may be placed across the case at right angles, as shown. The conveyor may then be withdrawn as shown in the previous pictures. Blocking should be added for safety.

Rotors may be separated vertically if sufficient head room and handling facilities are available.

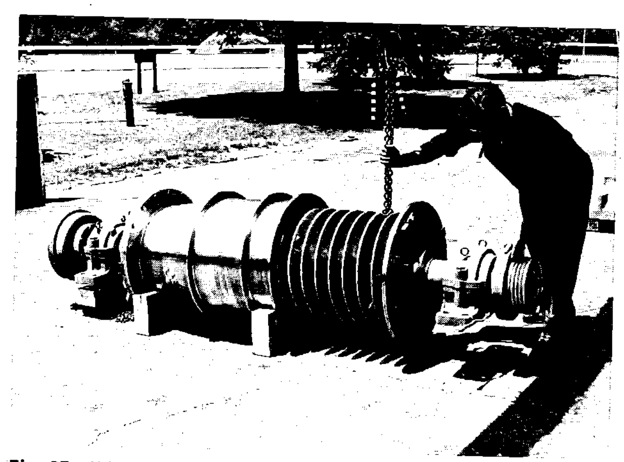


Fig. 25 When rigging and hoist are adjusted to maintain balance, conveyor screw may be safely withdrawn longitudinally from the rest of the bowl assembly.

a. Remove the thrust bearing cap located in the driven sheave. This will uncover two angular contact ball bearings mounted so as to take the conveyor thrust and secured by spanner nut.

b. Disengage the lockwasher from the spanner nut and remove the nut.

c. Pry the conveyor from the inner face of the bowl head.

d. Lift out the thrust bearings and wrap for protection against dust. Be certain that you observe how the thrust bearings were originally installed so they will be reassembled correctly.

GENERAL REPAIRS

Your Bird Centrifugal is an extremely rugged piece of machinery and has been designed and constructed to give troublefree service. Nevertheless, as is inevitable with process machinery, certain parts exposed to product wear or heavy loads will require occasional repair or replacement. It is impossible within the scope of this manual to cover each and every item which may at one time or another call for some kind of maintenance work. However, based on our many years of experience the following maintenance procedures will take care of most of your needs along these lines.

Replacing Shear Member

If your machine is equipped with a shear device employing a pin designed to shear when excess torsion is imposed on the gear unit input shaft, then replacement of the broken pin should be in accordance with the following procedure. As the shear pin breaks, that is, twists off, the torque arm will fall away from its normal position, at the same time tripping the overload switch. The first step in installing a new pin is to loosen the two set screws in the shear pin holder and push out broken half of pin. Loosen screws on split torque sleeve. This will permit removing the other half of the pin. Then insert the new pin and Woodruff key into the shear pin holder so that the grooved shear section is positioned about 1/8" inside the holder. Install the other end of the pin in the torque sleeve and fasten clamping screws. When reassembled, shear pin holder and torque sleeve should barely touch. Make sure that the set screws are all properly tightened over the keys in the shear pin holder. Before re-starting the centrifugal, the overload switch mounted on the gear unit guard should be set in trip position.

If the pin fails while slurry is being fed into your machine the solids in the bowl at the moment of failure will have packed quite firmly by the time the bowl comes to rest. Remove the accumulation by rotating the bowl manually (with wash-water through the feed pipe if needed) before starting up again. If the pin fails not as a result of overfeeding, but rather because of mechanical interference then the necessary correction or repair should be made before going back on stream.

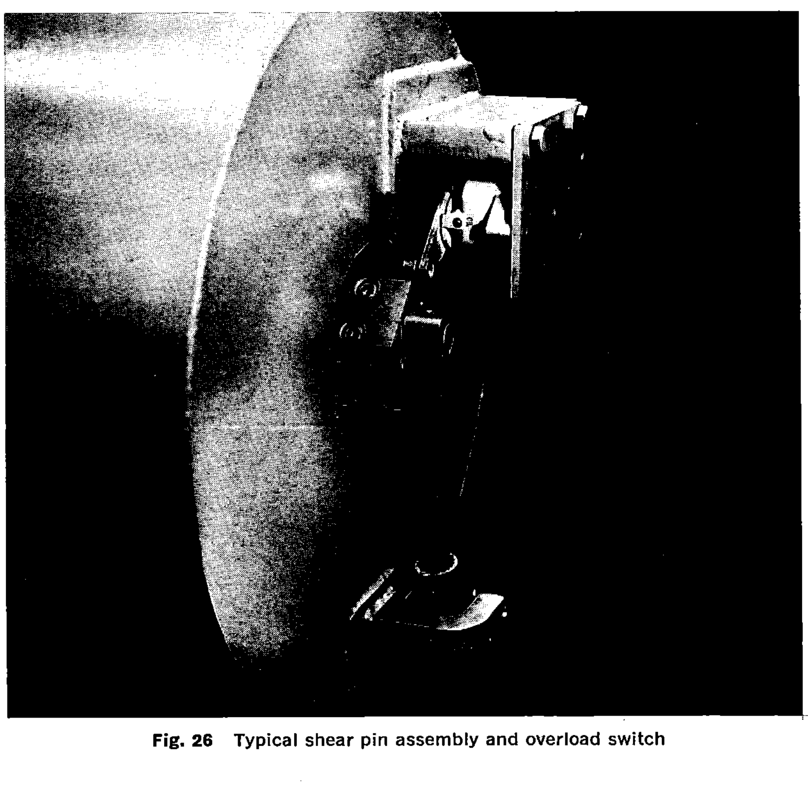


Fig. 26 Typical shear pin assembly and overload switch

Replacing Thrust Bearings

The function of the thrust bearings is to hold the axial position of the conveyor with respect to the bowl. These bearings are thus required to carry the considerable thrust which may develop in operation. It is therefore important that they be properly installed and carefully maintained.

In some designs the bearings used are matched pairs of the angular contact type, mounted face to face. In other words, the narrow face of one outer race must contact the narrow face of the other race. This mounting makes it possible to carry thrust loads in either axial direction. In 32″ and larger diameter centrifugals a matched combination of bearings is generally used, the pair consisting of one angular contact bearing and one deep groove bearing with split inner race. These should be mounted as shown in Figure 29.

The thrust bearing housing (driven pulley) has a bore substantially larger than the O.D. of the outer races and the bearings are not called on to carry any radial loads. The inner bearing races are mounted on the conveyor trunnion with a light press or "interference" fit. It is important that they are brought up snug against the shoulder on the trunnion and then locked firmly in place with the spanner nut. Even more important is the fitting of the outer races for proper endwise freedom. Their combined width may vary slightly since the bearings are "matched," that is, have the faces of outer and inner race of one bearing lapped for accurate contact with those of the other. The combined width of the two outer races must therefore be measured and their actual width taken into account when installing a new set of bearings. The required lateral clearance between the two outer races and their locating shoulders in the housing is about 0.001″. Any substantial deviation from this clearance will diminish the life expectancy of the bearings. If the measured available space between shoulders in the housing is insufficient, machine off the required amount from the shoulder of the cap. If it is excessive, make the necessary correction to the face of its flange (See Figures 28 and 29).

It is not feasible to remove the thrust bearings with the rotating assembly in place. The suggested procedure is to lift the assembly out of the case and then disconnect the feed end bowl head from the bowl. Next remove the thrust bearing cap as well as the spanner nut and lockwasher. The conveyor trunnion can now be forced through the inner races of the thrust bearings to the point where they are free and can be readily pulled out. Before installing a new pair of bearings make sure that the housing is thoroughly cleaned of old lubricant and the seal in the cap is in good condition. Preferably replace all seals for trunnion and bearing cap when installing new thrust bearings.

Replacing Main Bearings

The two bowl trunnions are of relatively large diameter for the reason that they must accommodate the two conveyor trunnions. As a result, the main bearings are substantially bigger than would actually be necessary to carry the load. Failure of main bearings is therefore rare and most always the result of inadequate lubrication, contamination, misalignment stresses or similar factors.

If it is found that a new bearing has to be installed the following procedures are recommended:

Lift the rotating assembly out of the pillow blocks and, depending on which bearing is being replaced, remove either the pulley or the gear unit flange. In the case of 32″ and 40″ machines the pulley is locked to the trunnion with a Tru-Arc retaining ring located behind the thrust bearings. (The bearings have to be removed as described in the previous paragraph.) 18″ and 24″ machines have the pulley mounted to a separate flange pressed on the bowl trunnion. The pulley is held to this flange with cap screws and in order to reach them, it is again necessary to remove the thrust bearings. The gear unit flange on all machines is pressed on the bowl trunnion and held to it with cap screws. To reach these

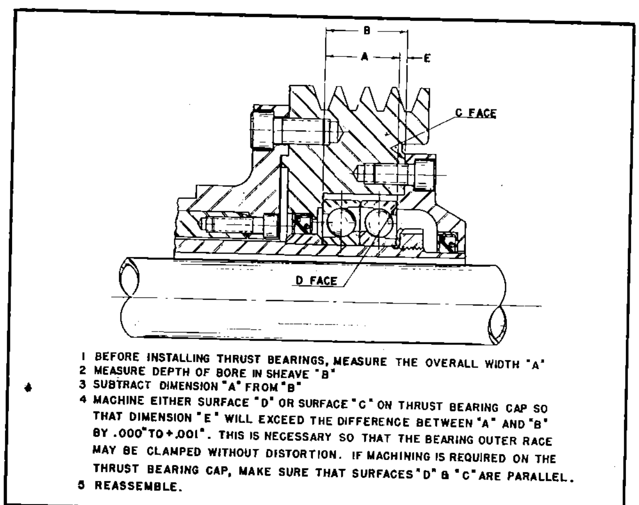


Fig. 28 Installation of angular contact thrust bearings

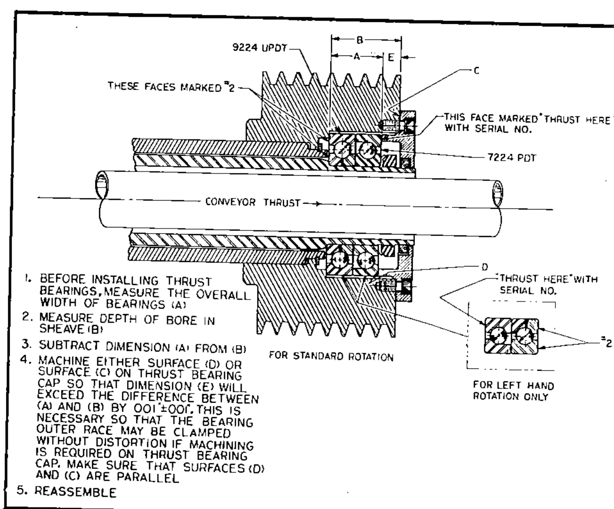


Fig. 29 Thrust bearing assembly having split inner race and angular contact bearings

it is required to remove the gear unit from the flange. Both pulley and gear flange are fitted with tapped holes for application of jackscrews. In some cases, however, careful application of heat may also be needed because of the hard press fit with which these parts are mounted to their respective trunnions. To remove a damaged bearing use a wheel puller as shown in Figure 31 (aided by heating if necessary). If the bearing is serviceable and will be re-installed, pressure should be applied to the inner race only without recourse to heat. Before installing a bearing, its seat and the shaft shoulder against which it fits should be cleaned making sure there are no burrs or other obstructions that might prevent proper seating. To help installation immerse the bearing in oil at a temperature not exceeding 212 degrees F. Trunnion diameters are such that the bearing will slip on easily when heated to slightly above 200 degrees F. Do not scrape or otherwise reduce the diameter of the trunnion for the purpose of facilitating the installation of the new bearing. A hard press fit is necessary for proper bearing life.

Replacing Bushing Seals

Each bowl head is equipped with two lip seals; one directed to exclude product from the bushings, the other adjacent seal directed to retain lubricant. Seals should be inspected whenever the machine is dismantled and replaced at least once a year. To remove seals take off retaining plate screwed to inner face of bowl head and pull out the two seals and seal spacer ring. Tap in new seals and spacer ring making sure the parts fit squarely and without interference. Needless to say, it is equally important that the seals are not injured during reassembly of bowl and conveyor trunnions.

Replacing Conveyor Bushings

The conveyor is supported in bronze bushings which are pressed into the bowl trunnions. The bushings are subject to normal wear and occasionally

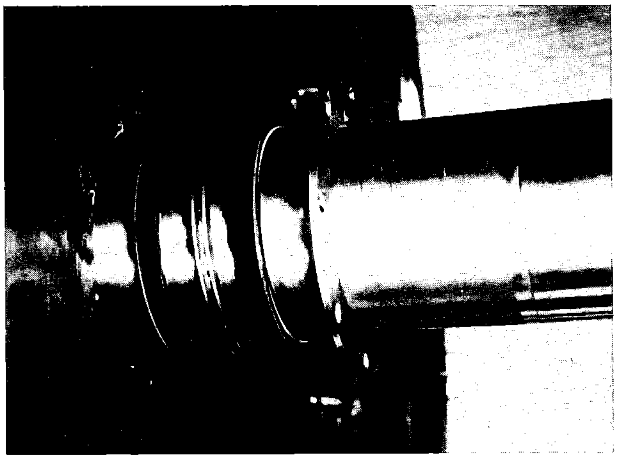


Fig. 32 Component parts of conveyor bushing seals

require replacement. If the machine vibrates even though thoroughly washed out, and if the cause for this vibration cannot be located elsewhere, examine the bushings for excessive wear. At the time of manufacture, the bushing is pressed into position and then machined out so that its bore is greater than the outside diameter of the conveyor trunnion by 0.001" for each inch of trunnion diameter. These clearances should be carefully maintained when field repairs are made. A bushing which has worn to a clearance of 0.010" or, in the case of the 54 x 70" machine, to 0.015", should be replaced even though it may appear to be in serviceable condition. A new bushing should go into place with a hard drive fit, that is to say with a press of about 0.004 to 0.006". Be sure to check the bushing for required clearance after it is in place and ascertain that the journal portion of the conveyor trunnion measures up to proper size and is in good condition.

Replacing Thrust Bearing Seal

The outer thrust bearing seal is located in the thrust bearing cap and can be inspected by withdraw-

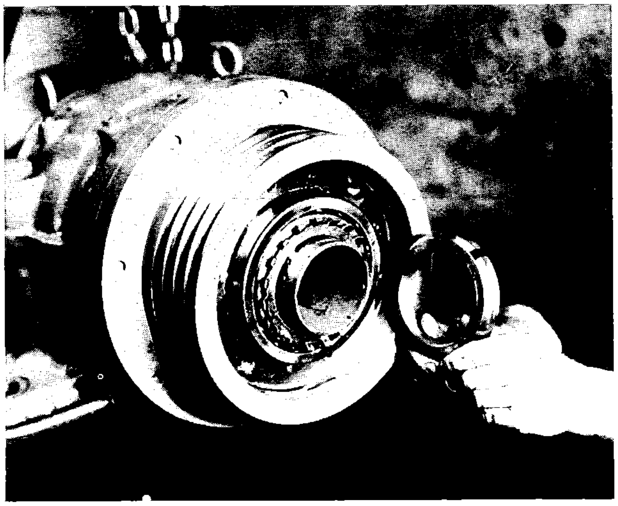


Fig. 30 Removing thrust bearings

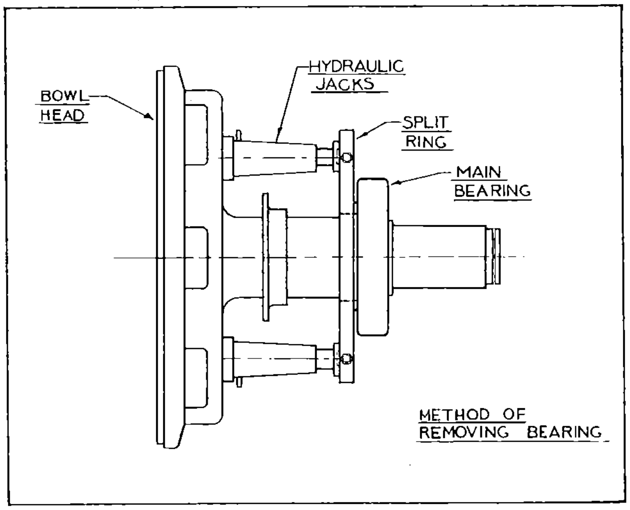


Fig. 31 Removing main bearing which has failed

ing the feed pipe and then removing the cap from the pulley. Care should be taken when installing a new thrust bearing seal as it is possible to damage it by improper assembly.

Repairing or Replacing Feed Ports

The feed ports are mounted in the conveyor hub and may be either fixed or detachable. When handling an abrasive product they are subject to wear and should be inspected whenever the machine is dismantled. Fixed feed ports are of metal faced with abrasion resistant alloy if specified. Detachable ports may be made of abrasion-resistant ceramic. If the ports are of metal and hard-faced, worn portions can be built up again by applying new hard-surfacing. If reasonable care is taken to apply hard-surfacing material evenly, then it will not be necessary to rebalance. When ceramic ports are used, these often can merely be loosened and rotated to expose a new wearing surface.

Repairing Conveyor Blades

The edge and face of the conveyor blades are subject to wear, especially in the portion of the bowl where solids are not submerged. While it is possible to operate the centrifuge satisfactorily even though there may be considerable wear on the blades, it is desirable to effect repairs before the layer of hard-surfacing has actually worn through or the tips of the blades worn off 3/8″. If excessive wear is permitted, performance falls off and repairs are more difficult. It is entirely practical to build up conveyor blades on the job by the application of proper hard-facing material. When doing this, a gauge such as used in the Bird Machine Company shop should be available so that the blades can be ground down to the proper clearance and chamfered off on the back side. It is important that the clearance between the tip of the conveyor blade and the bowl wall be carefully controlled. (Check with the Bird Machine Company for information on the clearance required for best performance of your specific centrifuge.) After applying hard-facing material to the conveyor blade, it is desirable to inspect the alignment of the conveyor trunnions. If runout is found, this should be corrected. With proper care in applying hard-facing, rebalancing of the conveyor will seldom be required. Should wear be greater than that which can be corrected by simple addition of hard-facing (3/8″), then it will be necessary to replace those portions of the conveyor blade. If the wear is more than 3/8″ but less than 1¼″, it is possible to weld on suitable lengths of flat stock of the required width (after the blade has been trimmed down to accept this strip). The flat stock is tacked to the blade, then heated and bent to the proper contour and securely welded in place. The blade is now ready for hard-facing and grinding as described above. It is recommended that the strips be cut about 1/8″ wider than required so as to allow for shrinkage in welding and hard-surfacing. Apply hard-surfacing as moothly as possible for good conveying. Grind off rough spots on face where necessary.

Repairing the Gear Unit

Properly lubricated and maintained, the gear unit requires little attention unless seriously and continuously overloaded. It is good practice, however, to provide periodic inspection at yearly intervals. Should noise or heat develop, frequent and unexplainable shear pin failure occur, or oil checks indicate leakage, contamination, or deterioration, then immediate and thorough inspection should be made. Such an inspection is best made at the factory where necessary repairs may be carried out to assure a sound and smooth running drive. When a gear unit is returned to the factory for inspection and repairs, the oil should not be drained, otherwise rusting may occur. If it is necessary to make field repairs to your gear unit, it is strongly recommended that you request a Bird Service Engineer.

Special Instructions

Separate installation and maintenance instructions covering the 6″ solid bowl centrifugal and machines with contact pressure seals are available.

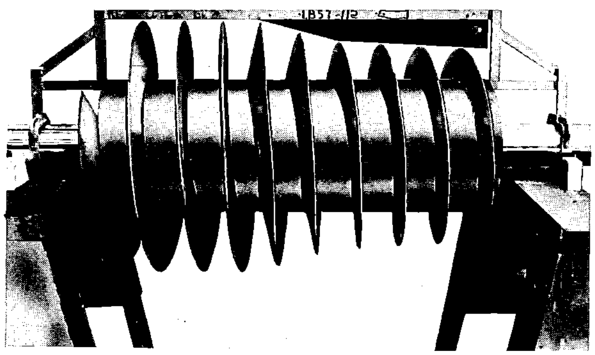


Fig. 33 Employing gauge to check tip clearance of conveyor blades

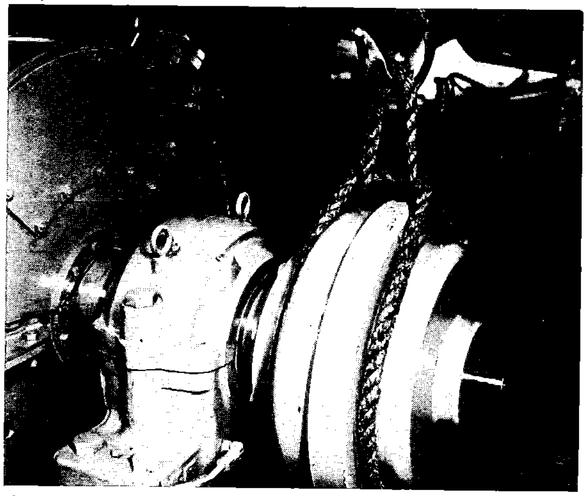


Fig. 34 Method of removing gear unit