INSTRUCTIONS FOR THE

INSTALLATION, CARE AND OPERATION

OF

ELLIOTT TYPE YR

MECHANICAL DRIVE TURBINES

INSTRUCTION BOOK No. 100-A

NOVEMBER 1949

ELLIOTT COMPANY

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ELLIOTT TYPE YR
MECHANICAL DRIVE TURBINE

YOUR Elliott turbine has been carefully designed, accurately built, thoroughly tested and inspected. Every effort has been made to place this unit in your hands in perfect condition so that you may receive the many years of troublefree service that have been built into it.

When this turbine reaches you, it is expected that you will assume your full responsibility by adequately protecting it during any period of storage, by providing skilled workmen for moving the unit to and upon its foundation, by aligning and piping it up correctly, by having it checked over carefully before and during start-up and by providing proper attendance for routine operation. This instruction book provides such cuts and text as will best illustrate and describe how the above may be accomplished. These recommendations are based on many years of turbine building experience and should be followed as closely as possible to obtain the best operating results from your Elliott turbine.

SPECIAL NOTICE

Your turbine is protected against corrosion for the period of shipment and installation only. Remove slushing oil before starting up. Provide turbine casing drainage.

IF NOT USED IMMEDIATELY

Store in clean dry place, free from temperature extremes, in an approximately level position, and without distortion.

Open turbine, slush the rotor all over. (Refer to Section II, page 8, item "Casing") or spray slushing oil through inlet and exhaust openings.

Slush all finished exterior and interior parts with heavy, non-corrosive oil.

Open packing cases, remove carbon rings, slush packing case interior thoroughly.

Inspect periodically and renew slushing oil where necessary.

Before putting unit into operation, clean thoroughly with lint-free rags and remove any corrosion carefully with fine emery cloth.

SECTION I—GENERAL INSTRUCTIONS

GENERAL

All persons concerned with the operation or maintenance of Elliott turbine driven apparatus should be thoroughly familiar with the details of the equipment involved. This instruction book is intended to convey all necessary information for installation, operation, and maintenance, as well as a description of the construction and adjustment of the various parts of the turbine and its accessories. Numbered sectional drawings and parts lists are included for identification purposes.

NOTE: Special attention should be given to precautionary instructions emphasized in this book, to avoid operation and maintenance difficulties.

FACTORY TESTS

Prior to shipment, the turbine is completely assembled and tested.

During these shop tests, design conditions are maintained as nearly as is practicable. The turbine governors, overspeed trip mechanism and valve gear are properly adjusted. If at any time it is necessary to disturb these adjustments, all parts should be marked so they can be returned to the original setting.

Performance, balance and general mechanical operation are determined to be satisfactory during these tests.

SHIPMENT

These turbines are shipped as a complete unit, mounted on substantial skids and covered with an open framework of light crating. The purpose of the latter is to indicate to the riggers the outside limits of the turbine and to provide a means of visually identifying the contents of the crate. The crating is not considered to be a protective casing. All vital parts of the turbine are protected by the skids and adjacent members. Exterior machined unpainted surfaces are slushed with non-corrosive oil or compound.

UNPACKING

If possible, all equipment with protective coverings in place, should be moved to where the equipment is to be installed and allowed to attain room temperature.

Remove the crating and check all parts to insure that no parts are missing or damaged. When unpacking and erecting, handle parts carefully to avoid damage. Remove external slushing compound with kerosene and clean all parts thoroughly with lint-free rags when erecting.

STORAGE

If turbines are taken out of service for an extended period, instructions given on page 1 are recommended for best protection. This involves opening the turbine casing before going back into service (the flange joint is not made up and the bolts are not tightened during storage). Alternate methods adapted to duration of storage period and atmospheric conditions are:

1—Use light oil for internal slushing, replacing carbon rings after slushing the shaft, remake the steam joint or otherwise leave the machine ready to go into service on short notice.

2—For short storage periods of a few weeks (or longer, if atmospheric conditions are favorable), a light turbine oil may be sprayed over the internal parts through the various openings in the turbine casing.

FOUNDATION

No attempt is made in this book to give complete details of foundation requirements, as local conditions, floor elevations, etc., vary widely. The principal requirements of a foundation are adequacy against deflection and vibration under the severest static and dynamic loadings; provision for accessibility to all parts of the unit and its auxiliaries during operation and for inspection; provision for ample floating to prevent settling. The certified outline drawing of the unit gives necessary dimensions, pipe connection locations, and clearances required for dismantling and inspection, etc.

INSTALLATION

Installation requires a specialized knowledge of the equipment and the ability and judgment developed by previous experience with similar apparatus. For this reason, competent personnel should be employed to make the installation.

Correct installation and alignment are absolutely necessary for good operation. Study the outline drawing and note all outside connections to be made, read all notations and be guided by them. The coupling should be mounted in accordance with the instructions furnished with it.

Driving the coupling on or off with a hammer should never be attempted, as the force of the hammer blows will damage the turbine thrust bearing.

Move the turbine upon its foundation, and set it level and in alignment with the driven apparatus by aligning at the coupling halves. Refer to Fig. 1. Shim under the pedestal (521) and under the support (505) to bring the turbine to the proper height, level and in alignment with the driven machine. Allow .004" to .008" for expansion of pedestal when at operating temperatures and take into account anticipated expansion of the driven machine. With the turbine at the proper height and in alignment, "slug up" the foundation holding-down bolts and dowel the pedestal (521) to the foundation. Turbines and driven machines should always be lined up cold and checked when at operating temperature. When the turbine is at operating temperature, a straight edge must lie flat across the top and sides of both coupling hubs, and the thickness gage or feelers must show the same distance between coupling faces at all points.

PARTS LIST

500—Eye Bolt
501—Sentinel Valve
502—Cover, Steam End, and Exhaust End
505—Support
511—Packing Case
512—Carbon Ring, Spring, and Stop
521—Pedestal and Cap
522—Bearing Liner (Lower Half)
523—Bearing Liner (Upper Half)
524—Cooling Tube Assembly
525—Gasket
526—Combining Stud
527—Pin
536—Bearing Case and Cap
537—Pipe Plug
538—Oil Filler and Sight Cup
539—Oil Level Indicator
540—Thrust Bearing Spring
551—Hand Wheel
552—Jam Nut
553—Lock Washer
554—Hand Valve Assembly
555—Follower
556—Packing
558—Gasket
601—Nozzle Ring
602—Lock Washer
603—Spacer
604—First Bucket Holder Assembly
605—Second Bucket Holder Assembly
606—Lock Washer
621—Shaft
622—Snap Ring
623—Thrust Bearing
624—Oil Ring
627—Key
630—First Disc Assembly
631—Second Disc Assembly
632—Third Disc Assembly
645—Sleeve
646—Set Screw

Note: Chrome-Molybdenum (SAE 4140) bolting used throughout.

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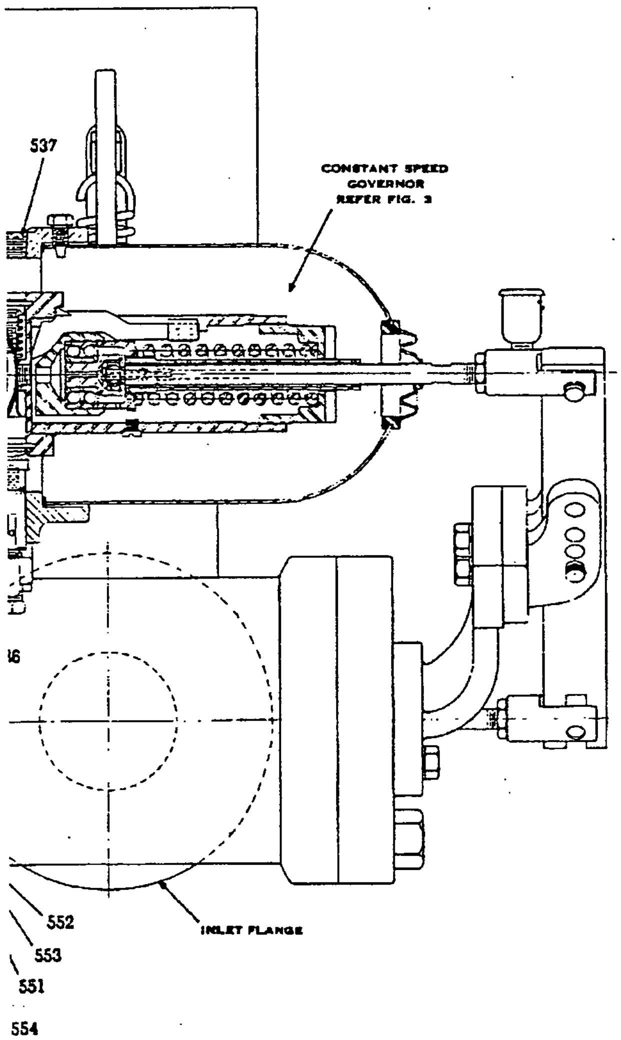

3 G. 1—SECTION THROUGH "YR" TURBINE

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All units assembled on the baseplate with the driven apparatus at our factory are carefully lined up and doweled before shipment with 1/8" shim pads under the turbine. If the baseplate could be depended upon to stay absolutely rigid, the unit could be set over the foundation, the baseplate leveled up properly and the unit would be in perfect alignment. This cannot be depended upon, however, as the strongest baseplates are to some degree subject to deflections. It is always advisable to thoroughly check alignment.

Should the unit be found out of line, place shims or chock blocks under the baseplate edges alongside of the foundation bolts (being sure to leave the required space between the top of foundation and bottom of baseplate for grouting or shimming). Refer to outline drawing furnished with the unit. Place shims or chocks also at fairly long unsupported distances between foundation bolts. Put wedges alongside of these shims or chocks and level up the baseplate by these wedges. Then shim and knock out the wedges, drawing the foundation bolts down tight. Check again for level, at the same time checking for alignment at the coupling or couplings.

If the unit is out of line sideways, it can usually be corrected by "throwing" the baseplate (if not grouted), using wedges placed as required. If grouted, the turbine and driven machine must be shifted sideways and redoweled.

If the unit is out of line up and down (coupling too high or too low), this also can be corrected by "throwing" the baseplate as described above. If grouted, the correction must be made by shimming under the supporting feet as required.

ATMOSPHERIC RELIEF VALVE

A relief valve should be installed between the turbine exhaust flange and the first shutoff valve to protect the turbine casing. This relief valve should be of ample size to pass the maximum quantity of steam flowing through the turbine without the pressure rising above the maximum allowable turbine exhaust pressure. Relief valves are furnished and installed by the purchaser.

The sentinel valve (501), furnished on the turbine casing (502), serves only as a warning that excessive pressure exists within the casing. This valve operates at a pressure above the maximum for which the atmospheric relief valve is adjusted.

The turbine should not be started unless the atmospheric relief valve has been installed and is in operating condition.

STEAM PIPING

No part of the turbine installation is more important for future successful operation, than well-designed and well-executed piping. There are two definite objectives for good piping:

1—To prevent the heated piping from imposing strains on the turbine casing and thus affecting the alignment.

2—To so connect and drain the turbine inlet and exhaust lines that dry steam is furnished to the turbine and that water accumulation in these lines is prevented.

A stop valve is recommended in the steam line, preferably at a convenient accessible location in the turbine room, between the steam header and the turbine inlet, to allow working on the turbine without shutting down the boiler.

The turbine casing must be protected from piping weight or piping expansion strains. The weight of piping should be separately carried by suitable supports. Expansion joints or bends should be provided adjacent to the turbine flanges. Connections between the piping flanges and turbine flanges are to be made without forcing the pipe line in any direction whatever in order to make a satisfactory joint. Connections may be considered entirely satisfactory if the connecting pipe lines, when heated to operating temperature, do not shift out of line with the turbine flanges when the bolting is withdrawn. Fig. 2 illustrates recommended steam and exhaust piping arrangement.

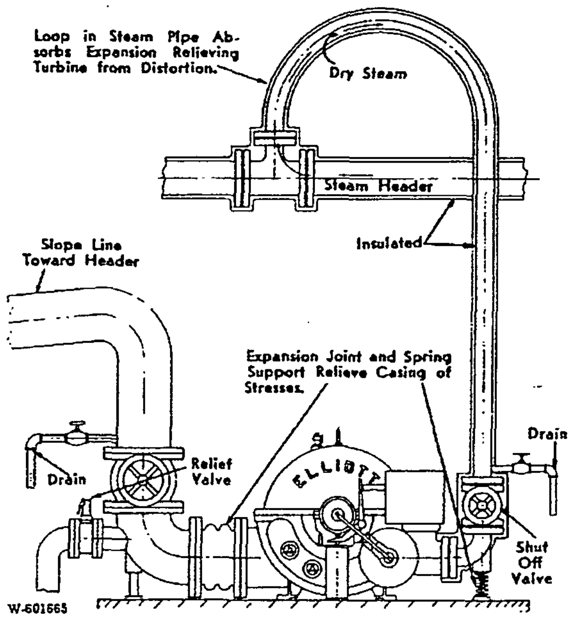

FIG. 2 RECOMMENDED STEAM AND EXHAUST PIPE ARRANGEMENT

STEAM SUPPLY

Steam should at all times be free from moisture and preferably be superheated. A receiver type separator with ample drains should be provided ahead of the stop valve to prevent slugs of water from damaging the turbine. When a separator is not provided, a blowoff valve or continuous drain should be connected to the lowest point of the steam inlet piping.

The strainer (568), furnished with the turbine, is suitable for protection against large particles of scale, welding beads, etc. This strainer does not guard against abrasive matter, boiler compound or traces of acid or alkaline substances, which may be carried over in the steam. These substances may corrode, erode, or form deposits on the steam parts, reducing efficiency and power, and causing valve seats to leak. It is imperative that feed water treatment and boiler operation be carefully controlled to insure a supply of clean steam at all times.

LUBRICATING OIL

The importance of using the highest grade turbine oil for the lubrication of turbines cannot be too strongly emphasized. Although the first cost of the best grade of oil may be considerably greater than that of an inferior grade, the additional cost is more than compensated for by longer service, less danger of damage to bearing surfaces, and elimination of serious shut-downs due to improper lubrication.

Turbine oils are produced by so many manufacturers and under so many different trade names and brands, that Elliott Company finds it impossible to thoroughly investigate all of them and to maintain a complete list of those suitable for turbine use. For this reason, Elliott Company does not recommend any specific brand of oils for use with Elliott turbines. Purchasers of turbines and turbine driven units are urged to consult with the representatives of reliable refineries regarding their lubricating oil requirements, and to insist that the oil purchased shall be suitable for the service intended, bearing in mind the general considerations stated below, which will serve to identify the types of oil required for the different classes of Elliott turbine equipment.

Basic requirements of a good TURBINE OIL are as follows:

1—Properly refined, highly filtered pure mineral oil, free from acid, alkali, water, sediment, soap, resins or any substance which in service will prove injurious to the oil or to turbine and accessory parts coming in contact with the oil.

2—Best possible ability to separate rapidly from water and least tendency to emulsify or foam when agitated with air or water.

3—Least tendency to break down or form sludge when agitated at normal operating temperatures and mixed with air or water. (See tabulation for normal temperatures.)

4—Reasonably high Flash and Fire Points, bearing in mind the probable operating temperatures and unavoidable proximity to high temperature steam surfaces.

5—Viscosity and Viscosity Index, (relationship between viscosity and temperature changes) commensurate with the service intended. (See tabulation for recommended viscosity.)

	Pressure Circulation	Ring Oiled
Viscosity (Saybolt Universal Seconds) at 100 degrees F	140-170	280-325
Viscosity (Saybolt Universal Seconds) at 210 degrees F	42-44	49-55
Minimum Operating Oil Tank Temperature, degrees F	130	130
Minimum Oil Temperature before starting, degrees F	50	60
Normal Bearing Temperature, degrees F.....	140-170	150-190

RING OILED SYSTEM is a system in which oil rings only are depended upon to carry oil to the bearings from the oil reservoir. Standard water cooling is used in this system. Non-water-cooled bearings are not recommended, but if specifically permitted by conditions of an individual application, a carefully selected oil, containing a minimum of tallow or carbon and sludge-forming ingredients should be used.

PRESSURE CIRCULATION SYSTEM is a system in which an oil pump forces oil through cooler, strainer, etc., to bearings, governor, and other parts, returning the warm oil by gravity to an oil reservoir. Oil rings are included only for starting and idling operation.

CARE OF OIL—All oil should be maintained in first class condition by the elimination of moisture, dirt and other impurities. For pressure circulation system, filter or purify the oil frequently or employ the continuous by-pass system of removing impurities.

Refer to the lubrication manufacturer for recommendations as to employing rust inhibitors when the initial charge of new oil is placed in the system or for proportions of new oil to be added when replenishing the old.

STARTING AND STOPPING

(Refer to Figs. 1, 4, & 5)

Prepare the turbine for the initial start-up as follows:

1—Disconnect coupling between turbine and driven machine.

2—Blow out all steam piping, disconnecting at turbine inlet flange if necessary.

3—Remove bearing case cap (536) and pedestal cap (521) carefully, to prevent distorting oil rings (624) which are held in place by upper half bearing liners (523). Remove upper half bearing liners and roll out lower half liners by rolling away from the locating lugs so as not to damage them. Inspect and clean bearing liners.

4—Carefully clean both bearing oil reservoirs and journals. Roll lower half bearing liners into place. Locating lugs on liners must be correctly positioned in locating grooves in the bearing case.

5—Fill reservoirs to overflow height with the proper grade of turbine oil (see section on Lubricating Oil). See that lower halves of bearing liners are flooded with oil and that the ball thrust bearing (623) is likewise flooded with oil.

6—Replace upper half bearing liners around shaft journals and under the oil rings. Upper half bearing liners should be lined up with lower half bearing liners, which are already in place, to insure that the locating lip on upper half liner is located properly in the bearing case cap and pedestal cap when they are replaced. Replace pedestal and bearing case caps, insert dowels, and pull bolts securely into place. *Turn unit over by hand to see that* everything is functioning properly.

7—Remove governor hood (680) and thoroughly clean all governor parts of dirt, paint, rust, and slushing compounds; lubricate well and reassemble being careful to replace correctly. Fill governor spindle lubricator (656) with "light" turbine oil.

8—Open steam chest and casing drains and see that all traps are operating. Be sure that the valve in the turbine exhaust line is open. If the unit operates condensing, see that the vacuum is up.

9—Open stop valve in the steam line and set resetting lever (927). Keep all drain valves open until all water is drained from the system. Close all drain valves and listen for unusual sounds. Check oil rings (624) through sight cups (538) to see that they are rotating and picking up oil. If pressure circulation oil system is used, see that the oil pump primes and builds up the proper pressure. Turn cooling water into the oil cooling system.

10—After the turbine has been thoroughly warmed up, shut down the unit by striking the hand trip lever (935) Fig. 5. Close stop valve and check the piping and coupling alignment.

11—Reset the hand trip lever. Open the stop valve in steam line. Check oil rings (pressure in forced feed bearings) and take speed readings to see that the governor holds the turbine at no load speed, which is slightly above the full load speed. (The full load or rated speed is given on the nameplate.)

12—For condensing operation, adjust the sealing steam valve so that a small amount of condensate or vapor will be discharged from the leakoff lines.

13—Check the overspeed governor trip speed with one operator reading speed and the other firmly grasping both ends of the governor lever (671) Fig. 4 and pushing in on the governor spindle and pulling out on the governor valve stem. This will cause the turbine to speed up, operating the overspeed governor and tripping the turbine. The trip speed should be approximately 15 per cent above the maximum rated speed. (Refer to contract for exact conditions.)

14—Reset overspeed trip valve and again bring turbine up to speed. Allow unit to run for approximately one hour, checking bearings and making other general observations, as noted above. After this period, load can be applied and the turbine is ready for service.

15—Routine starting is accomplished by checking oil levels, opening drain lines and bringing turbine up to speed and on the governor. *Close drains when steam is bled instead of* water.

16—When shutting down, overspeed the turbine by hand to check the overspeed governor mechanism, close the stop valve and open all drains.

17—If turbine is used with a reduction gear and/or with special equipment, follow instructions pertaining to those particular items.

OPERATION, ROUTINE INSPECTION

These machines require a minimum of operating attention. Providing adequate lubrication is the one really essential and important operating detail. However, any routine system of inspection which anticipates possible operating difficulties before they reach serious proportions is manifestly desirable, and such a routine system is outlined below. The adoption of this system of routine inspection with such modifications or amplifications as are necessary to fit it into the operating schedule of your particular unit is recommended.

DAILY INSPECTION

1—Check oil level on all bearings.

2—Fill governor oil cup once every 8 hours.

3—Check bearings for lubrication and excessive temperature.

4—Check smoothness of operation and note any change.

5—Note any unusual noises or conditions and check frequently.

6—Check speed of unit.

7—If shutdown is made daily, trip overspeed governor valve by striking hand trip lever.

WEEKLY INSPECTION

1—If *not* on continuous running schedule, trip overspeed governor valve by overspeeding the turbine by hand as previously described.

2—If *on* continuous running schedule, the operation of the overspeed governor valve may be checked by tripping the hand trip lever which allows the trip valve to close. Immediately reset the hand trip lever. This can be done as soon as the turbine speed has dropped approximately 15 to 20%.

3—Remove hood over overspeed governor valve "top-works" and lubricate linkage sparingly with high temperature "Silicone" grease. (DC-710 Dow Corning Corp.)

MONTHLY INSPECTION

1—Change bearing oil and clean oil reservoirs as required.

2—Remove governor hood and bearing caps and make visual inspection of governor parts and bearings. Clean as necessary.

3—Check governor linkage and overspeed governor linkage for lost motion.

4—Check coupling between turbine and driven apparatus for looseness, alignment and wear. If this is a lubricated coupling, check the lubrication.

YEARLY INSPECTION

1—Before disassembling or assembling any of the various parts of your turbine, carefully read Section II of this book.

2—Check all clearances and adjustments as directed under Section III. Replace any wearing parts that may be worn.

3—Remove steam strainer and clean it. If very dirty, do this every six months.

4—Dismantle governor and linkage (Fig. 4), and check for lost motion or worn parts. Clean thoroughly, lubricate and reassemble. Adjust for correct speed.

5—Examine governor valve and valve seat (651 and 567, Fig 4) and clean. Grind in valve if unevenly worn. Check governor valve stem ring packing (573) and replace if necessary. Be sure packing does not bind when reassembled.

6—Check turbine thrust bearing (623, Fig. 1) for end play. Flush out with a pressure stream of clean oil.

7—Dismantle overspeed governor and linkage shown in Fig. 5. Check for ease of operation; clean and lubricate sparingly with high temperature "Silicone" grease. (DC-710, Dow Corning Corp.)

8—Clean stem of overspeed governor valve (917, Fig. 5).

9—Check carbon rings for wear and see that they are not fouled by an accumulation of scale or rust in the packing cases. Carefully remove rings, clean, and reassemble. CAUTION: Read Section II.

10—Lift casing and inspect both the moving and stationary blading; clean out any accumulation of scale and dirt between the blading.

11—Check operation of sentinel valve (501, Fig. 1).

12—When again in operation check turbine speed, tripping speed, and general operation.

NOTE—It is recommended that an Elliott service engineer inspect your turbine once a year.

RENEWAL PARTS AND SERVICE FACILITIES

The Elliott Company maintains a staff of service engineers to supervise the installation and starting up of new units. They are also available for inspecting, adjusting, and supervising or installing repairs on older units. Their services are available at any time, usually on very short notice. In case of emergency their expert knowledge may be of great assistance in getting the unit back in service without delay.

Order repair parts preferably through the nearest District Office. In emergencies, parts may be ordered from Elliott Company, Repair Order Department, Jeannette, Pennsylvania.

When ordering repairs or spare parts, or when writing concerning any part, always give the following information:

1—Serial number of machine.

2—Instruction book and figure number.

3—Name of part, part number from parts list in instruction book, and quantity required.

4—Name of purchaser.

5—Complete address and shipping instructions.

STORAGE OF SPARE PARTS

Spare parts should be stored in a clean, dry place and finished surfaces should be slushed with a heavy non-corrosive oil.

Frequent inspections should be made and any corrosion or rust removed and the parts re-slushed.

Parts should be carefully tagged or marked so that they can easily be identified.

SECTION II
DISASSEMBLY AND ASSEMBLY

GENERAL

Disassembly and assembly of the various parts of your turbine should be a familiar subject to your operating and maintenance personnel, so that they may do routine inspection and be capable of checking and adjusting the parts which may require this service.

Most of the design of this unit is so clearly shown in the cuts that no description of disassembly or assembly is considered necessary. In general, only such descriptive matter is given under this heading as is necessary for future replacement of a wearing part or the checking and adjustment of clearances. Any future major replacement, such as wheels, buckets, shaft, etc., or any future major overhaul should be done under the supervision of an Elliott Company service engineer, or at the factory.

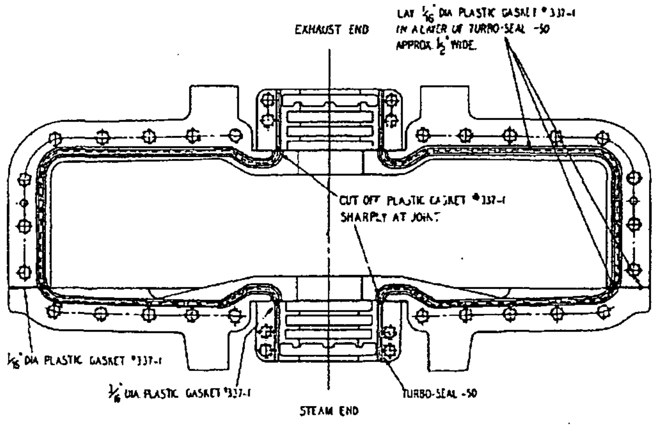

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FIG. 3—"YR" HORIZONTAL JOINT DETAIL

CASING AND MISCELLANEOUS STEAM JOINTS

All steam joints of the turbine have been carefully made up at the factory to insure that they are steam tight. Anchor Packing Company joint sealing-compounds are used to make up all steam joints. Three types of compounds are used, namely, "Threadex," "Plastic Gasket No. 337-1," and "Turbo Seal-50."

"Threadex" is used on the following joints:

(a) Nozzle Ring (601) to casing steam end (502).
(b) Steam Chest Body (566) to casing steam end (502).
(c) Steam chest governor valve cover assembly (572) or (575) to steam chest body (566).
(d) Overspeed governor valve cover (569) to steam chest body (566).
(e) All casing and packing case bolt threads as an anti-galling compound.

"Turbo Seal-50" is used on the packing case (511) horizontal joint as shown in Fig. 3.

"Turbo Seal-50" and ***"Plastic Gasket No. 337-1"*** made up in "strings," are used in combination, as shown in Fig. 3 on the following joints:

(a) Lower half casing assembly vertical joint between steam end and exhaust end.
(b) Casing horizontal joint between cover and lower half steam end and exhaust end.
(c) Packing case (511) vertical joint to casing assembly (502).

The Anchor Packing Company sealing-compounds and pressure guns for their application may be purchased directly from the Elliott Company. It is our recommendation that these sealing-compounds be used because of the superior joint seal that results. However, if these recommended sealing-compounds are not available, any high grade steam sealing-compound, applied according to manufacturer's recommendations, may be used to make up the steam joints.

PACKING CASES AND CARBON RINGS

To remove the carbon rings (512) Fig. 1, lift the upper half packing cases (511) by removing both the vertical and horizontal bolting. Break the joints by striking sharply with a lead hammer and pry the joints apart under the "pry ears" provided on the upper halves. Carefully lift the cases straight up until they clear the carbon ring assemblies. Unhook and remove the circular spring assembly surrounding each three-piece carbon ring, after which the separate pieces of the carbon ring may be removed by rolling around the shaft.

CAUTION: Keep the three parts of each ring and spring assembly of each ring together so that they may be placed together in the same packing groove from which they were removed.

Before reassembling, clean out packing case grooves thoroughly, particularly the bottom halves. Blow them out with air if it is available. Clean the shaft and rings with kerosene. Place springs around shaft and hook ends together. Starting with the segment of the ring into which the ring stop fits, force the proper segments under their respective springs.

CAUTION: Be sure that those sections which abutt each other are marked with similar markings so that they are reassembled mark to mark.

Reassemble packing cases. Press 3/16" diameter string of "Plastic Gasket No. 337-1" into the groove provided in the vertical flange face. Make certain that this "string" of sealer does not overhang the horizontal joint. Coat the vertical flange face, outside the bolt circle, and also the horizontal flange face as shown in Fig. 3 with "Turbo Seal-50."

CAUTION: Do not allow sealer to run down into the carbon ring chambers as it will prevent the carbon rings from sealing on the side walls.

Place upper halves in position and pull up on vertical flange bolting until snug. Tighten up horizontal flange bolting and then tighten up vertical flange bolting.

CASING

The casing cover (502) Fig. 1 must be lifted to inspect the turbine rotor or the interior of the turbine. The top halves of the packing cases must be removed as explained above before the casing cover can be removed. Remove the casing cover horizontal joint dowels and bolting; break the horizontal joint and lift the cover vertically with eyebolt (500) until the cover clears the rotor disc assemblies.

To reassemble:

1—Scrape and carefully clean all exposed joints on both the upper and lower halves of the turbine casing (502) as well as those on the upper and lower halves of the packing cases (511). Do not allow scrapings to fall into the lower halves of the packing cases between the carbon rings and walls. Blow out with air if available.

2—Apply a continuous 1/16" dia. "string" of "Plastic Gasket No. 337-1" laid on approximately 1/2" wide strip of "Turbo Seal-50" on the horizontal flange of the lower half turbine casing as shown in Fig. 3.

CAUTION: Do not allow "string" of sealer to be too near bolts as clearance holes in cover may expose them. Be sure that 1/16" dia. "string" of sealer ends sharply at the packing case flange face groove at both steam end and exhaust end.

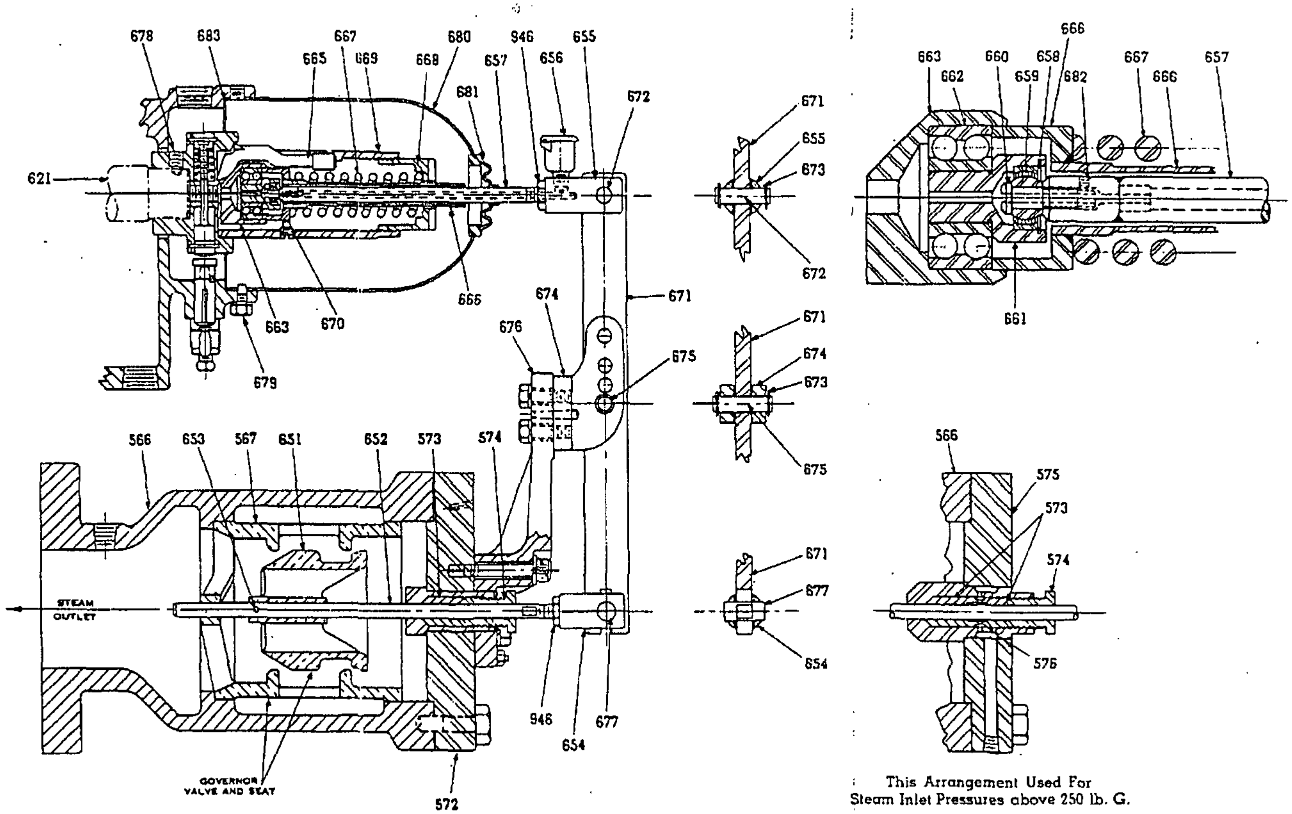
3—Lower the upper half casing over the turbine rotor to a solid seating. Insert dowels and pull down on the horizontal flange bolting starting nearest the shaft on both sides.

BEARING LINERS

Removal of the bearing liners (523) Fig. 1, is readily accomplished by removing the pedestal cap (521) and bearing case cap (536). Remove the dowels and the bolting in the horizontal joints. Break the joints by striking sharply with a lead hammer and pry the joints apart under the "pry ears" provided on the caps. Raise caps sufficiently to unsnap upper

PARTS LIST

Reference Number	Description
566	Steam Chest Body
567	Valve Seat
572	Cover Assembly
573	Packing
574	Follower
575	Cover Assembly
576	Gland
621	Shaft
651	Valve
652	Stem
653	Pin
654	Connection
655	Connection
656	Lubricator
657	Spindle
658	Internal Retaining Ring
659	Spindle Bearing (Heim)
660	Bolt
661	Bearing Case
662	Ball Bearing
663	Bearing Case
665	Weight Assembly (Set of 3)
666	Spring Seat
667	Governor Spring
668	Adjusting Nut
669	Governor Case Assembly
670	Stop Screw
671	Lever
672	Pin
673	Crescent Retaining Ring
674	Fulcrum Bracket
675	Pin
676	Bracket
677	Pin
678	Set Screw
679	Bolt
680	Hood
681	Seal
682	Set Screw
683	Gasket
946	Jam Nut



This Arrangement Used For Steam Inlet Pressures above 250 lb. G.

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FIG. 4–SECTION THROUGH CONSTANT SPEED GOVERNOR, VALVE AND LINKAGE

halves of bearing liners (523) to release oil rings (624). Caps should be raised carefully to prevent distorting oil rings which are held in place by the upper half bearing liners. Remove the upper halves of the bearing liners and then completely remove the pedestal cap and the bearing case cap. Roll out the lower halves of the liners by rolling away from the locating lugs so as not to damage them. When the bearing liners are removed, the rotor shaft will rest in the packing cases.

When replacing liners make sure that oil rings are correctly replaced and are free to turn and that the shaft journal and liners are completely clean and flooded with oil. Roll lower half bearing liners into place. Locating lugs on liners must be correctly positioned in the locating grooves in the bearing case and the pedestal. Place upper half bearing liners around shaft journals and under the oil rings. Upper half liners should be lined up with lower half liners, which are already in place to insure that the locating lip on the upper half liner is located properly in the bearing case cap and pedestal cap when they are replaced. Replace pedestal and bearing case caps, insert dowels, and tighten bolts securely into place.

CAUTION: Bearing liners should not be scraped under any condition.

CONSTANT SPEED GOVERNOR AND LINKAGE

This mechanism is shown in complete detail in Fig. 4. Before disassembly, check governor valve travel as described in Section III under "Adjustments."

Disconnect the governor spindle connection (655) from the governor lever (671) by removing crescent retaining rings (673) and tapping the pin (672) upward. Remove crescent retaining rings (673) and tap fulcrum pin (675) upward. The governor lever can now be removed by withdrawing it from connection (654) and pin (677).

Unsnap the neoprene grommet seal (681) and remove spindle lubricator (656). Remove governor hood (680) by removing bolts (679) and drawing forward over the spindle (657) and connection (655). Remove gasket (683). The complete governor assembly is now exposed. Remove adjusting nut (668) and governor spring (667) and unscrew three stop screws (670) from the governor case assembly.

CAUTION: Before removing adjusting nut (668) measure the distance from the end of this nut to a convenient point on the governor case assembly (669) so that on reassembly the nut can be put back to its previous location thus duplicating previous governor setting.

The governor spindle assembly consists of spindle (657), internal retaining ring (658), spindle bearing (659), shoulder bolt (660), bearing case (661), and ball bearing (662). This assembly may be taken apart for inspection or replacement of parts by grasping spindle (657) and pulling outward. This will also allow the removal of weights (665) and spring seat (666) and bearing case (663). Spindle bearing (659) may be removed by further disassembly of the governor spindle assembly. Remove ball bearing (662) from bearing case (661) and remove bearing case (661). Remove set screw (682) and unscrew shoulder bolt (660). This will release spindle bearing (659).

NOTE: Upon reassembly of bearing (662) and bearing case (661), the inner race of the bearing should be prick punched to lock it with the bearing case.

Before reassembly, clean all parts carefully. If any burrs are present they should be removed. As the various parts and bearings are reassembled, be sure that they turn freely and that no perceptible end play is present.

Reassemble the governor spindle assembly and slide ball bearing (662) into bearing case (663). Slide this complete assembly into the governor case assembly (669) and manipulate the three governor weights (665) into position. All scale or rust should be removed from the weight knife edges and the knife edge seats in governor case (669). Insert spring seat (666), governor spring (667), and pull up several turns on adjusting nut (668). Pry up outer end of each governor weight with a fulcrumed screw driver and let go sharply to see that all parts spring into position each time and that governor operates freely. Screw up adjusting nut to the setting which was previously registered by measurement. Replace three stop screws (670) and lock in place by prick punching.

Replace gasket (683), hood (680) and secure with set screws and replace neoprene seal (681). Assemble remaining governor linkage parts in reverse of the order of removal, replacing to marked or measured positions.

CAUTION: After governor linkage has been disassembled and reassembled, check governor valve travel as described in Section III under "Adjustments."

ROTOR ASSEMBLY

The rotor assembly consists of the shaft sleeves upon which are mounted the disc assemblies, sleeves, carbon rings, ball thrust bearing, constant speed governor, over-speed trip governor, and the coupling. (See Fig. 1.) It should be noted that the rotor assembly may have two or three separate disc assemblies (630, 631, 632) or may have one disc with two rows of rotating buckets, depending upon the speed of the turbine.

To remove the rotor assembly from the casing, disconnect the turbine from the driven machine at the coupling and remove the pedestal cap (521), the bearing case cap (536), the upper halves of both packing cases (511), and the casing cover (502). These parts should be removed in accordance with instructions given under "BEARING LINERS," "PACKING CASES and CARBON RINGS," and "CASING" all in SECTION II above. Disconnect governor lever (671) and remove hood (680) as described above under "CONSTANT SPEED GOVERNOR AND LINKAGE." Remove upper halves of bearing liners (523) as described above under "BEARING LINERS."

PARTS LIST

Reference Number	*Description*
536	Bearing Case and Cap
541	Set Screw
552	Jam Nut
566	Body
568	Strainer
569	Cover
570	Bushing
571	Hood
916	Valve
917	Stem
918	Pins
919	Connection Block
920	Bushing
921	Spring Seat (Upper)
922	Spring
923	Spring Seat (Lower)
924	Washer
925	Jam Nut
926	Block
927	Lever (Resetting)
928	Spring (Resetting)
929	Anchor Bolt
931	Pin
932	Retaining Ring
933	Knife Edge
934	Knife Edge
935	Latch
936	Plunger Assembly
937	Adjusting Nut
938	Trip Pin
939	Weight
940	Trip Spring
941	Washers
942	"U" Lock Staple
943	Shoulder Bolt
944	Retaining Ring
945	Jack Screw
946	Jam Nut
947	Spring
948	Jam Nut
949	Resetting Lever Assembly
950	Spring
951	Set Screw
952	Set Screw

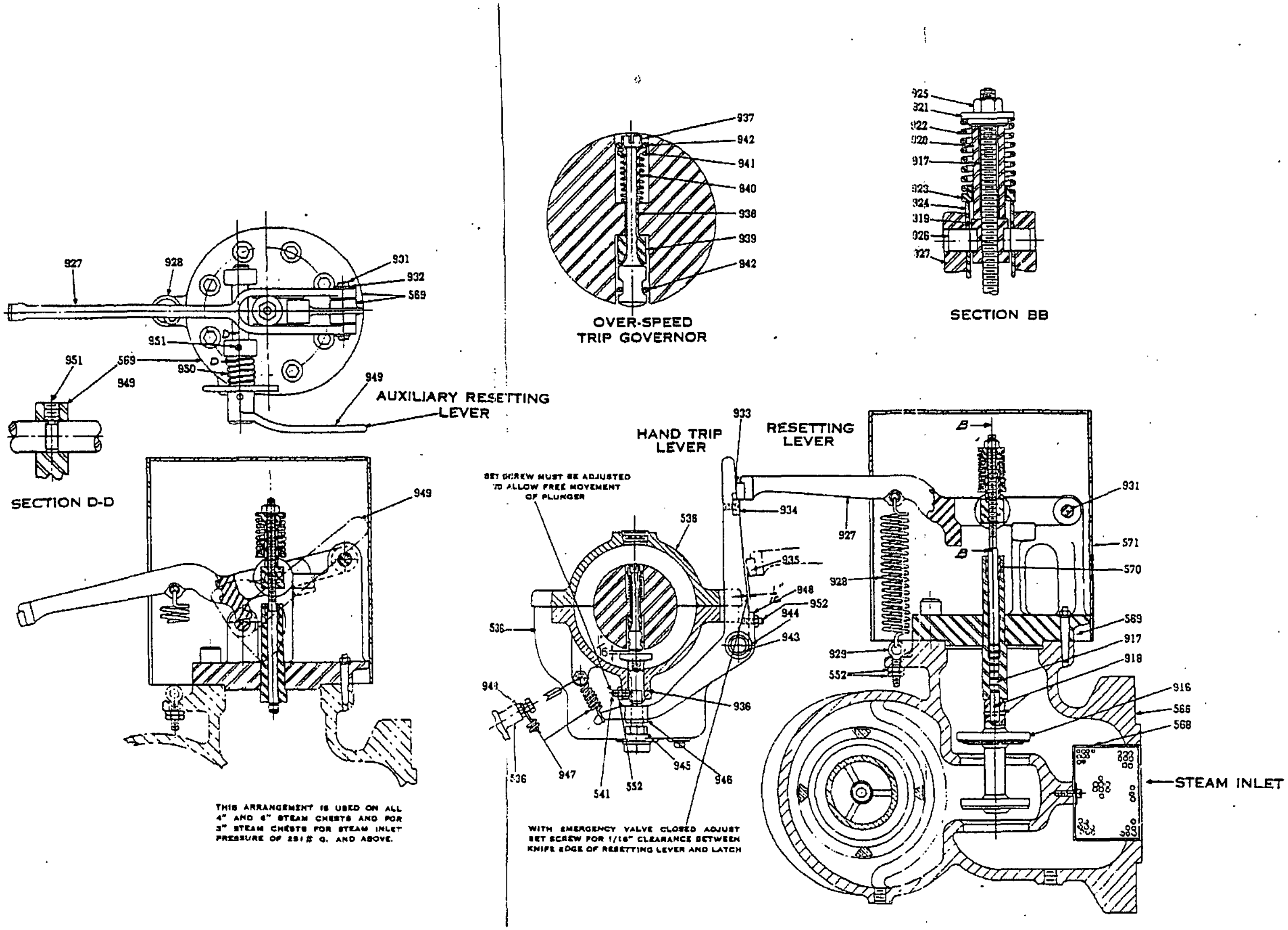

FIG. 5—SECTION THROUGH OVERSPEED GOVERNOR, VALVE AND LINKAGE

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Slowly lift rotor assembly straight upward being sure to protect shaft journals and carbon rings from damage. After rotor assembly has been raised a short distance move oil rings (624) along the shaft until they clear the bearing supports cast into the lower half of pedestal (521) and lower half of bearing case (536). Lower half of bearing liners (523) can now be unsnapped and removed and oil rings will be cleared for removal. The rotor assembly can now be removed by lifting straight upward. Lay rotor assembly aside and prevent from rolling by blocking under the discs.

CAUTION: While rotor is out of casing, keep ball thrust bearing tied up in clean lint-free rags to prevent the entrance of dirt.

When lowering rotor back into position, shake lightly so that discs will not engage the bucket holder assemblies (604 and 605) while descending. Cease lowering when carbon rings are about to enter their respective slots. Be sure that rings and slots are lined up before final lowering and the slots are free from scale or rust. Move oil rings (624) along the shaft and into place over the bearing supports cast into the lower half of the pedestal and bearing case. Replace lower halves of bearing liners (523) into position.

CAUTION: See that the thrust bearing spring (540) is in place and that the clearance between the first disc assembly shroud (630) and the nozzle ring (601) is approximately 1/16 in.

Replace casing cover (502), bearing liners (523), bearing case cap (536), pedestal cap (521), and the upper halves of packing cases (511). Replace gasket (683), hood (680) and reconnect governor lever (671) and reset governor to original setting.

BALL THRUST BEARING

The ball thrust bearing (623) Fig. 1, is assembled on shaft (621) with the shield toward the governor and is located against the shaft shoulder and held in place axially by a beveled snap ring (622). Axial location in bearing case (536) is maintained by an accurately machined groove. The outer race of the thrust bearing is prevented from rotating by the flat spring (540).

CAUTION: The beveled face of snap ring (622) must be away from the ball thrust bearing. See enlarged detail Fig. 1.

To remove the thrust bearing, the rotor assembly must first be removed as previously described. Also remove the constant speed governor spindle assembly as described.

Refer to Fig. 5. Remove the overspeed governor trip pin (938) by first removing U-lock staples (942) located at each end of the trip pin, then unscrew adjusting nut (937) after which trip spring (940) and trip pin (938) will come out. If auxiliary weight (939) or washers (941) are used, these may now be removed.

Having removed all parts of the governor assembly, remove governor case set screw (678) Fig 4. The governor case assembly (669) is shrunk onto the shaft (621) and must be removed by heating around the hub. This can be done by evenly heating with a torch after which governor case may be easily drawn off.

CAUTION: Extreme care must be exercised to prevent heating the thrust bearing. The bearing should be shielded by wrapping with asbestos sheeting. Also, in heating the governor case hub, avoid heating the shaft as much as possible.

The jackscrew, which is supplied with the turbine, may be used to draw the governor case from the shaft while heating the governor case. The jackscrew should be threaded into the governor case assembly (669) up against the end of the rotor shaft (621). Should a "puller" be used, the pull should be applied on the hub rather than at the end of the governor case.

Remove the thrust bearing beveled snap ring (622) with special pliers provided and now the thrust bearing can be tapped off the shaft.

When replacing the thrust bearing, tap it into place by means of a sleeve which strikes the shaft race of the ball bearing. Drive the bearing into a solid seating against the shaft shoulder. Replace the beveled snap ring, ***making certain that the snap ring is seated in the beveled groove provided in the shaft.*** Then heat the governor case hub slightly and slip it on the shaft. Be sure that the set screw drillings in both hub and shaft line up. Replace the set screw (678) and prick punch it to hold in place. Replace the overspeed governor trip pin parts, and the constant speed governor parts. Replace the rotor assembly and reassemble the constant speed governor linkage.

CAUTION: Keep the thrust bearing clean and flood with oil before use.

NOZZLE RING AND BUCKET HOLDERS (Fig. 1)

These parts form the high pressure steam path through the turbine. The bucket holders (604 and 605) and nozzle ring (601) may be removed, after the rotor assembly has been removed, by working on the inside of the turbine casing. The nozzle ring joint is metal-to-metal with the casing steam end (502) and is made up with "Threadex" Sealer. It should be noted that the nozzle ring is located to the steam end by two fitted bolts which insure correct reassembly and positioning. The nozzle ring is bolted to the steam end. Bucket holders are bolted to the nozzle ring and axial location is maintained by ground spacers (603).

CAUTION: Upon reassembly make sure that lockwashers (602) are replaced under the heads of all nozzle ring bolts and that lockwashers (606) are replaced under the heads of all bucket holder bolts.

OVERSPEED GOVERNOR AND LINKAGE

Refer to Fig. 5 which shows clearly the details of this mechanism. Remove the overspeed governor trip assembly as described above under "BALL THRUST BEARING." In replacing trip pin (938) be sure that washers (941) (when used) are in position since they are part of the adjustment for setting the tripping speed of the turbine. Place U-lock staples (942) in position and with a screw driver placed on adjusting nut (937), press the pin outward sharply to see that it works freely and trips the linkage. Disassembly and replacement of the linkage is clearly shown in Fig. 5 and needs no additional description or explanation. The Auxiliary Resetting Lever (949) is furnished only on units with 4 and 6 in steam chests and 3" chests for steam service of 251 psig. and above. It is used to assist in lifting the overspeed valve (916) off its seat before the resetting lever (927) is raised into the latched position. By this means you are assured of being able to open the overspeed valve and to reset the overspeed governor linkage when your turbine is under full steam pressure.

STEAM CHEST

Refer to Figs. 4 and 5 for sections and Fig. 6 for external view of steam chest.

The steam chest is composed of three chambers through which the steam flows as follows: Steam passes from the steam inlet through the strainer (568), through the overspeed governor valve (916) then through the governor valve (651) and seat (567) into the steam ring section of the casing steam end (502). All of these parts are housed in one casting which is bolted and doweled to the lower half steam end of the turbine.

To inspect the governor valve, remove governor lever (671) as explained under "CONSTANT SPEED GOVERNOR AND LINKAGE" and then remove cover assembly (572) by removing bolting and pulling forward, thus exposing the governor valve. The governor valve may be removed from the cover assembly by removing connection (654) and jam nut (946) and pulling the valve and stem assembly through packing (573). In the event that valve seat (567) is to be removed, it must be pulled out with a puller prepared especially for this service. The valve seat is tack welded to the steam chest body to insure against any possible movement. To reassemble this valve seat, place it in the steam chest and drive it into position with a bar of non-ferrous metal and tack weld to the steam chest to secure the valve seat. The governor valve can be replaced and reassembled by sliding the stem (652) through the packing (573). Reassemble cover assembly (572) noting that this is a metal-to-metal joint and is made up with "Threadex" Sealer, first being sure that the joint surfaces are clean. Dowels are provided in this cover to insure accurate reassembly.

To inspect the overspeed governor valve (916), remove the cover (569) bolts and dowel and draw the whole assembly upward exposing the overspeed valve. The overspeed valve and stem assembly may be removed by removing jam nut (925), spring seat (921), spring (922), spring seat (923), and bushing (920).

CAUTION: Before these parts are removed mark the position of the jam nut (925) with respect to the valve stem (917) and record this setting. This adjustment setting must be maintained to insure proper seating of the overspeed valve when the unit is tripped and also to insure sealing the valve stem when the overspeed valve is open. Unlatch spring (928) and remove retaining rings (932) and drive out pin (931). The resetting lever (927) can then be slid horizontally off blocks (926). Unscrew connection block (919) from valve stem (917) and the overspeed valve and stem assembly can be withdrawn from cover (569). Reassemble in the reverse order.

The final adjustment of spring (922) should be made with jam nut (925) and this setting must agree with the recorded measurement before disassembly. Replace the complete cover assembly and place dowel in position and pull down strongly on the holding down bolts. It should be noted that this is a metal-to-metal joint with the steam chest and is made up with "Threadex" Sealer, first being sure that the joint surfaces are clean.

MISCELLANEOUS PIPING CONNECTIONS

Refer to figure 6 for the miscellaneous piping connections to the standard turbine. All of these connections are identified and their uses are described below. Refer to your outline drawing for the specific sizes of all connections and for their exact locations. All connections are brought outside the lagging when the turbine is insulated and lagged.

"M"— CASING DRAIN — Connect through suitable valve to open drain. Open prior to starting turbine; close when casng is fully drained. Open when turbine is shut down and exhaust valve is closed.

"X-1" and "X-2" — STEAM CHEST DRAINS — Connect through high pressure piping and suitable valves to open drain. Open prior to starting turbine to drain water from steam chest. Close when water ceases to emerge from drain line. Open when turbine is shut down.

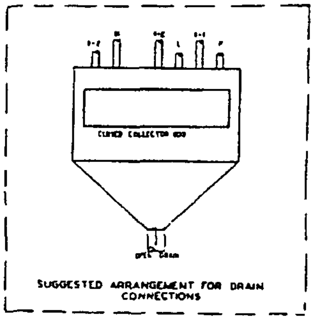
"L"—SHAFT PACKING GLAND LEAK-OFF—Connect to open drain *without* valve. Be sure that no back pressure is applied to this line.

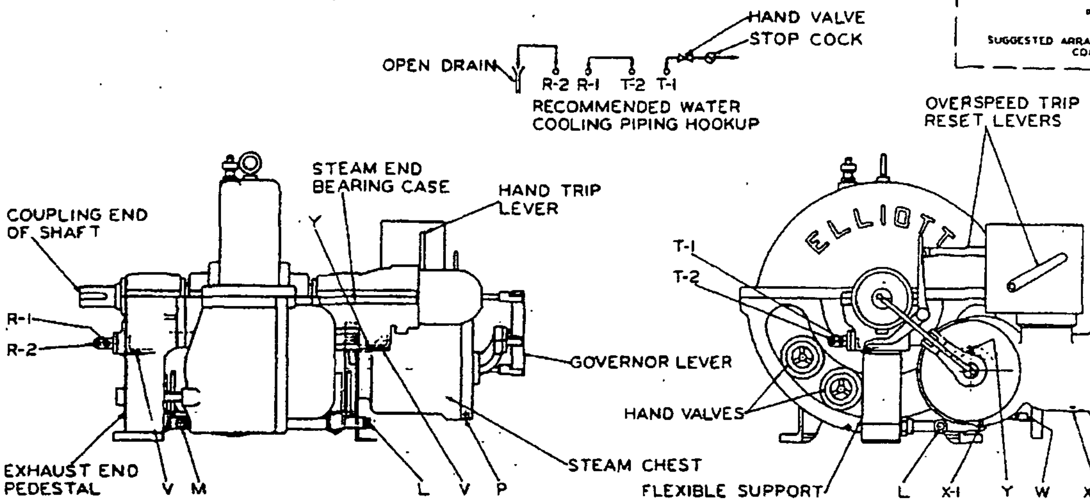
"T" and "R" — WATER COOLING CONNECTIONS TO BEARING CASES—Located on left side of turbine when facing governor end. Connect to maximum 85°F water through a stop cock and hand valve into T-1; out of T-2; into R-1; out of R-2 through a one-foot head loop to an open drain. Adjust stop cock to pass approximately 2 gpm of water to the open drain when the valve is wide open. ***Note:*** Pressure of cooling water must not exceed 50 psig. When bearings are designed for pressure lubrication, these connections are not furnished.

"W" — SHAFT PACKING GLAND SEALING STEAM CONNECTION — ***Furnished only when turbine is operated under vacuum.*** Connect to a high pressure steam supply through a throttle valve. Admit steam to glands until a wisp of steam leaks out of "L." This prevents air leakage into turbine casing.

Reference Number	Description	Reference Number	Description
M	Casing Drain	W	Shaft Packing Gland Sealing Steam Connection
X-1 & X-2	Steam Chest Drains	P	Valve Stem Leakoff
L	Shaft Packing Gland Leakoff	V	Oil Drains
T & R	Water Cooling Connections to Bearing Cases	Y	Pipe tap for nozzle ring gauge connection

Note: Refer to outline drawing for connection sizes and specific locations.





W-601256 **FIG. 6—"YR" MISCELLANEOUS PIPING CONNECTIONS**

"P"— VALVE STEM LEAKOFF — ***Furnished only when inlet pressure to turbine exceeds 250 psig and/or inlet temperature exceeds 500°F.*** Connect to open drain ***without*** valve. Be sure that no back pressure is applied to this line.

"V"—OIL DRAINS—These openings are to be plugged at all times and are provided for draining the bearing cases.

GENERAL—Considerable attention should be given to the installation of miscellaneous piping. Poorly planned and installed piping will greatly detract from the appearance of your installation. All lines should be installed in a neat and orderly fashion. Drain lines should be grouped and brought to a common drain arrangement. A suggested arrangement for open drain connections is shown in figure 6. All the open drain connections are brought into a common closed collector box with a glass window allowing the operator to visually check the discharge from the drain lines.

SECTION III
ADJUSTMENTS AND CLEARANCES

CARBON RINGS (512, Fig. 1)

Adjustments: The shaft under these carbon rings is spray coated giving a hard non-corrosive surface which makes possible very close running clearances. All rings, when newly installed, must be "run in" slowly to achieve the highly polished, glossy surface required for maximum life. These rings are impregnated with oil for lubricating during the "run-in" period and may smoke considerably during the first 24 hours of operation. This condition need give the operator no concern.

The following procedure is recommended for initial start-up of the turbine and for "run-in" of newly installed carbon rings:-

(a) Operate turbine for ten to fifteen minutes at 500 rpm with atmospheric exhaust pressure. If no smoke appears, increase speed slowly until smoke is visible, and hold at this speed for approximately five minutes.

(b) Reduce speed to 500 rpm and operate at this condition for approximately five minutes. This allows the shaft to cool.

(c) Increase turbine speed to approximately 500 rpm above previous maximum speed and operate at this speed for approximately five minutes and then reduce speed 500 rpm for another five minute period to allow shaft to cool.

(d) Gradually increase and reduce speed by 500 rpm steps, alternately until rated speed is obtained without undue smoking of rings or heating of shaft.

(e) If continuous operation at rated speed causes excessive smoke and shaft heating, reduce turbine speed and repeat the above sequence.

Note: To get a more effective seal when running in rings, the rings can be jarred against their side sealing faces by lightly tapping the packing cases.

(f) When operation at atmospheric exhaust pressure appears to be satisfactory, gradually increase the exhaust pressure until the turbine is operating at rated exhaust pressure and speed.

At times steam leakage along the shaft is caused by improper seating of the ring against the sides of the packing case grooves due to deposits of foreign material between the rings and their side seats. The only remedy is to clean out this foreign matter.

To correct leakage due to worn rings, so-called "fitting" of carbon rings in the field, the operation wherein the butt ends of the segments of a ring are filed down to reduce the bore of the complete ring, cannot be accomplished satisfactorily. The only satisfactory correction is to replace the ring with a new one.

Clearances: The cold clearance between new rings and the shaft is .001 to .0035 in. Worn-in clearances may be considerably higher with satisfactory results. Measurements of ring clearances are unreliable without recourse to proper "go" and "no-go" gages. In the final analysis ring fits are always satisfactory if steam does not leak out of the packing case along the shaft.

HAND VALVES (554, Fig. 1)

Adjustments: Extra banks of nozzles, when ordered, are furnished under control of a hand valve to carry normal full load with reduced steam pressure, or for part-load economy. Operation with hand valves should be either full-open or full-closed. For maximum efficiency operate with hand valves as specified. Keep packing tight by adjusting with follower (555).

Clearances: None requiring checking.

BEARING LINERS (523, Fig. 1)

Adjustments: These bearing liners are interchangeable. Bearing halves are positioned relative to each other by locking and positioning lips on the horizontal split. These lips position the bearings in grooves located in the caps and lower halves of the pedestal and bearing case. These bearing liners do not require scraping or adjustment and none should be attempted.

Clearances: The bearings are factory fitted to give a cold clearance of .0055 to .0085 in. larger than the shaft. Check at long intervals (unit not running) by placing a short strip of fuse wire, radially, in center of bearing on top of shaft and clamp bearing into position. Measure flattened fuse wire by micrometer. The bearing clearance can also be checked by measuring the bearing bore with the bearing clamped in place and the rotor removed.

Excessive bearing clearance may lead to vibration. Clearances greater than .015 in. are generally considered excessive. If bearing clearance is excessive, replace bearing liner.

When putting a new bearing liner in service, place in position and clamp bearing cap into position. Run for five to ten minutes and remove and inspect bearing to see that operation is satisfactory.

BEARING CASE SHAFT SEALS (Fig. 1)

Adjustments: Sleeve (645) is part of the shaft seal which prevents the in-leakage of dust, grit and steam to and the out-leakage of oil from the bearing cases. Sleeve (645) is locked in place on the shaft by two radially opposite set-screws (646). To give maximum performance, this sleeve must be adjusted to maintain equal axial clearance with the bearing case and equal radial clearance with the bearing case. Axial clearance should be maintained between a maximum of .064" and a minimum of .054". Radial clearance should be maintained between a maximum of .0145" and a minimum of .010".

CONSTANT SPEED GOVERNOR (Fig. 4)

Adjustments: The turbine nameplate shows the rated speed at which your turbine should operate under full load and contract steam conditions. Any substantial variation from these conditions should only be attempted after consulting the nearest Elliott Company District Office.

Minor variations of speed adjustment to suit minor changes in operating loads are obtained by tightening adjusting nut (668) for an increase in speed, and slacking off on this nut to decrease speed.

Ball bearing (662) and spindle bearing (659) are designed to take the thrust of the governor valve. These bearings must rotate freely at all times and the end play should be very slight. If this end play becomes appreciable, the operation of the governor will be affected. There are no adjustments on these bearings, thus, if the end play becomes appreciable, bearings should be replaced.

All possible precautions should be exercised to keep these bearings clean. It is advisable to inspect and clean bearings on initial start-up and on periodic inspection shutdowns.

Clearances: Pin (672) should be an easy fit in governor lever (671) and connection (655). Governor weight assemblies (665) should always be well seated and no clearance should exist between the weights and bearing case (663). The slightest motion of the weights should be transmitted to the spindle assembly without any play.

GOVERNOR LEVER (671, Fig. 4)

Adjustments: None.

Clearances: Lever pins (672, 675, 677) and connections (654, 655) should be kept clean and well oiled. A good sliding fit should be maintained at all times and when wear is excessive parts should be replaced.

It should be noted that fulcrum bracket (674) has a series of holes giving various governor lever ratios. This selection of lever ratios affords the selection of proper governor spindle travel with respect to governor valve travel for each application and thus gives optimum speed regulation for the design conditions of the unit.

Caution: Proper lever ratio and valve travel on your unit has been set at the factory. Upon disassembly and subsequent reassembly, extreme care should be exercised to replace pin (675) in its original position.

GOVERNOR VALVE (651, Fig. 4)

Adjustments: The travel of the governor valve should be the minimum required to enable the turbine to carry full load under the contract steam conditions. The maximum valve travel should not be greater than 7/16 in.

Valve setting may be determined and recorded as follows: With the unit standing still, measure from the inside face of valve stem jam nut (946) to the face of gland follower (574) and record this dimension. Loosen jam nut (946) and turn valve stem (652) clockwise until the valve seats. With the valve in this seated position, screw jam nut (946) up against connection (654) and again take the measurement as above. The difference between these two measurements is the governor valve travel. Reset valve to original position.

Clearances: Valve stem (652) must at all times move freely in packing (573). After adjusting follower (574) to take up on packing, try movement of the valve stem to insure free movement.

BALL THRUST BEARING (623, Fig. 1)

Adjustments: Not adjustable. This thrust bearing locates the axial position of the rotor assembly with respect to the stationary parts of the unit. It carries no radial load and is located hard up against the accurately machined shoulder on the shaft. Note that the thrust bearing is of the single shield type. Correct assembly of the bearing is with the shield toward governor and with the bevel on snap ring (622) away from the bearing.

Clearances: Large radial clearance (carries no radial load) and negligible axial clearance or end float.

NOZZLE RING (601, Fig. 1)

Adjustments: None.

Clearances: Normally 1/16 in. between nozzle ring (601) and the shroud of the first disc assembly (630).

Minor variations in this adjustment are permissible. This clearance is obtained by feeler gage measurement and should be checked whenever rotor assembly, nozzle ring, or bucket holder is removed from the turbine and is reassembled.

OVERSPEED GOVERNOR AND LINKAGE (Fig. 5)

Adjustments: The turbine speed at which trip pin (938) flies out and closes the overspeed valve (916) may be adjusted by removing "U" lock staple (942) and resetting adjusting nut (937). Loosening this nut decreases the trip speed and tightening increases the trip speed. Should adjustment of the adjusting nut fall short of the desired increase in speed, washers (941) must be added. Clearance between trip pin (938) and plunger assembly (936) can be adjusted with jack screw (945) and jam nut (946). ***The jam nut must be locked in place under all conditions of operation.***

Overspeed valve (916) must be adjusted so that the upper end of the valve is seated in the guide in cover (569) when in the reset position and against the valve seat in the steam chest when it is in the tripped position. The overspeed valve is kept seated against the guide in cover (569) by means of spring (922), thus insuring sealing of the valve stem and preventing leakage. Jam nut (925) must always lock bushing (920) between spring seat (921) and connection block (919) as this controls the spring load on the overspeed valve when it is in the reset position. To adjust the positions of lever (927) and overspeed valve (916) disconnect spring (928) from lever (927) and unlock jam nut (925). When the bottom of the resetting lever knife edge (933) is 1/8 in. below the top of the hand trip lever knife edge (934), the overspeed valve (916) must be seated in the guide in cover (569). The position of the overspeed valve is adjusted by turning it in the threaded connection block (919) to raise or lower it.

Tension spring (928) insures the closing of the overspeed valve when the turbine is tripped. To insure sufficient closing force, anchor bolt (929) must be drawn against the flange by means of jam nuts (552).

Auxiliary resetting lever (949) facilitates the opening of overspeed valve (916) when the turbine is under full steam pressure. This lever must be returned to the position shown in Fig. 4, by torque spring (950). The torque in this spring may be increased by taking additional turns on spring.

Clearances: The 1/16 in. clearance shown between trip pin (938) and plunger assembly (936) must be maintained.

Valve stem (917) clearance in bushing (570) is .007 to .009 in. and valve stem clearance at the lands between the guide bushing is .0035 to .005 in. Valve stem and bushing should be kept clean and free from scale to prevent valve from sticking. Linkage pins (931), shoulder bolt (943), block (926) and connection block (919) are to be free sliding fits. A clearance of 1/16 in. should be maintained between block (926) and connection block (919).

WATER COOLING OF BEARINGS

Bearing oil in standard ring oiled units is cooled by means of cooling tubes (524) as shown in Fig. 1. The oil surrounds the outside of these cooling tubes and the cooling water passes through the inside of the tubes. Fig. 5 gives the recommended water cooling piping hookup. The pressure of the cooling water must not exceed 50 psig. Approximately 1 gpm of water at 85°F. maximum is required per bearing for proper cooling.

COLD CLEARANCES

Fig. 7 gives the various cold clearances between rotating and stationary elements of the turbine. These clearances should be maintained to get optimum performance from your turbine. Whenever adjustments are made, worn parts replaced, or general overhaul made, check all clearances against values given in this diagram

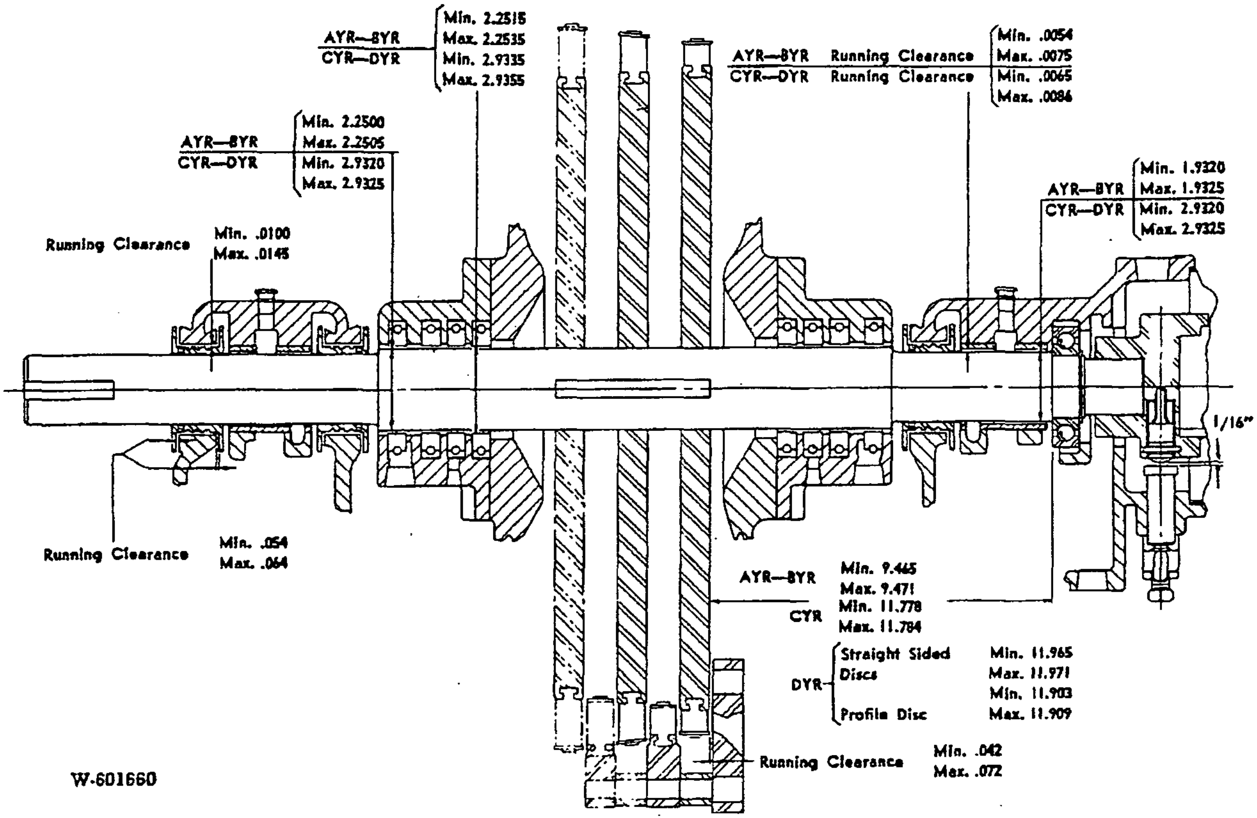


FIG. 7—COLD CLEARANCE DIAGRAM

SECTION IV—RECOMMENDED SPARE PARTS LIST

(Standard Turbine Only)

In order to insure long periods of uninterrupted service, freedom from long shutdowns due to mishaps of operation, it is recommended that the following spare parts be carried:

Name	Part Number	No. Required Per Turbine
Bearing Liner—Lower Half	522	2
Upper Half	523	2
Bearing (Thrust)	623	1
Snap Ring	622	1
Carbon Ring with Spring and Stop	512	8
Governor Valve Stem Packing	573	1
Spindle Bearing (Heim)	659	1
Spindle Bearing (Ball)	662	1
Pin	672	1
Pin	677	1
Pin	675	1
Retaining Ring	673	4
Trip Pin	938	1
"U" Lock Staple	942	2

The basic design of the "YR" turbines gives maximum economical inter-changeability of wearing parts. Users having installations of several units may find it desirable to operate a central store room and stock a more extensive list of maintenance parts than given above.

To assist in determining the inter-changeability of parts of the various standard turbines, forms 1119 and 1120 have been made up by the Elliott Company and are available upon request. Form 1125, available in all District Offices, describes these forms and their use, giving illustrations and instructions.

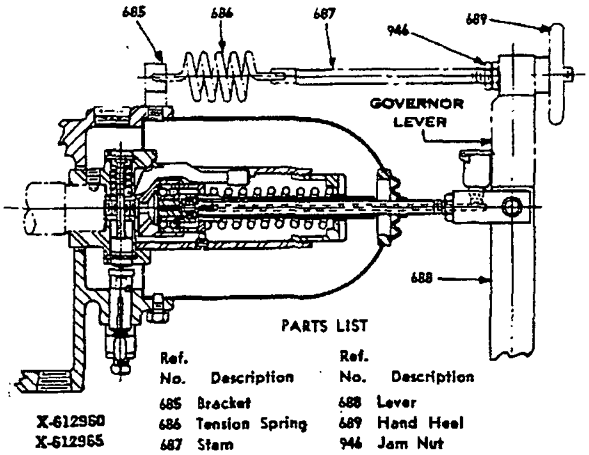


FIG. 8—HAND OPERATED SPEED CHANGER

HAND OPERATED SPEED CHANGER

(Refer to Figure 8)

The hand operated speed changer permits accurate speed adjustment of 20 percent of the maximum full load turbine speed while the turbine is running. The constant speed governor retains accurate speed control over the entire operating speed range of the turbine.

The speed changer assembly is attached to the steam end bearing case through bracket (685) on one end and to the governor lever on the other end. The speed changer is adjusted at the factory to give the specified range of speeds and should not require further attention. If, however, it has to be dismantled or disturbed, record the position of nut (946) and reassemble to this setting. The speed changer gives a fixed speed range of operation and should any required operating speed fall outside the range, the compression in the main governor spring must be adjusted.

The constant speed governor should always be set for the minimum desired full load speed with hand wheel (689) backed off so that by turning the hand wheel clockwise, the turbine speed is increased. Nut (946) is pinned to stem (687) and acts as a stop, limiting the maximum speed of the turbine. The speed changer should not be set beyond this set position as undue strain will be placed on the governor spindle bearing adversely affecting its life.

On dual drive turbine units, adjust the speed changer to give a turbine no-load speed slightly less than the motor speed at full load. If the motor fails and the turbine takes the load, bring the turbine speed up to the normal full load speed with the speed changer. When the motor again takes the load, reduce the turbine speed with the hand speed changer.

MOTOR AND HAND OPERATED SPEED CHANGER

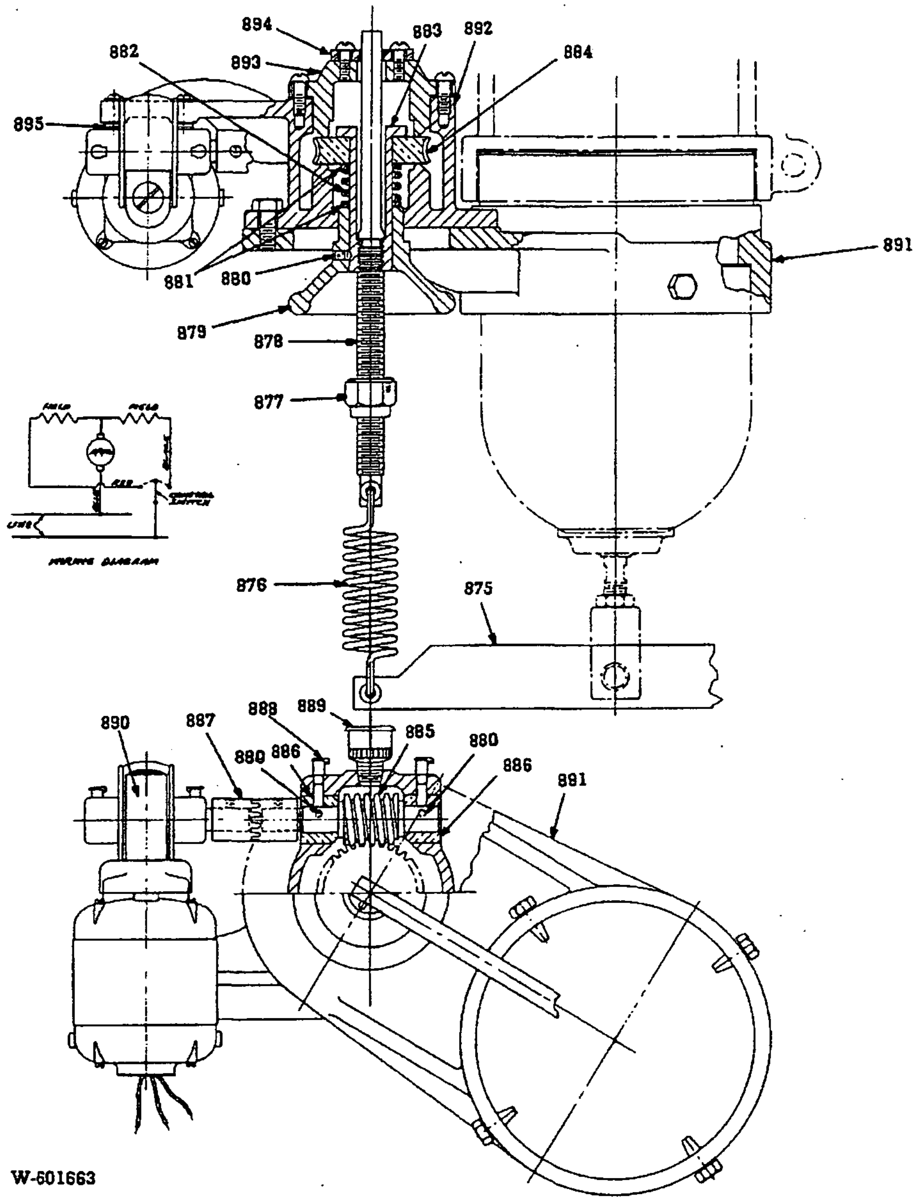
(Refer to Figure 9)

The motor and hand operated speed changer is used to adjust the turbine speed when the turbine is operated alone, or to synchronize and adjust the load when the turbine is operated in parallel with the other units. Increasing the tension in spring (876) by turning handwheel (879) counterclockwise, raises the speed or in case of parallel operation increases the load at constant speed. Turning the handwheel clockwise decreases the speed or in the case of parallel operation decreases the load at constant speed. The speed can also be increased or decreased from the switchboard by means of motor speed reducing unit (890) which drives the handwheel and worm wheel shaft (883) through the worm gear built into the motor, coupling (887), a second worm (885) and worm wheel (884), friction clutch spring (882) and spring seats (881). The motor can be rotated in either direction by means of a reversing switch on the switchboard. Stop locknut (897) on stem (878) limits the speed changer travel and resultant tension in spring (876). Should the speed changer motor be allowed to run after contact of stop locknut (877) with outer face of handwheel (879), the friction clutch will slip and thus prevent damage to the speed changer motor. The motor is a direct current, split field, series wound type having three connection leads and is wired as shown by the wiring diagram in Fig. 9.

The speed changer assembly is attached to the steam end bearing case through bracket (891) which is rabbeted into the end of the steam end bearing case and is held in position by four bolts. The speed changer assembly housing (892), which is bolted to the adapter bracket, carries all the speed changer parts and also the bracket to which the speed reducing unit is bolted. Fig. 9 shows clearly the actual details of construction and no further description is deemed necessary.

To disassemble, unhook spring (876) and remove stop locknut (877). Before the locknut is removed, record the distance from the locknut face to the handwheel face. Reassembly should be made to this dimension. Screw a standard ⅝"—11 nut over stem (878) down against the face of the handwheel. Remove set screw (880) which locks the handwheel to worm wheel shaft (883). Note that the standard nut screwed on the stem prevents the friction clutch from flying apart. Loosen the standard nut on the stem and clutch spring (882) will force the handwheel off the worm wheel shaft. Remove the standard nut and handwheel. Rēmove guide (894) and stem (878) can be unscrewed from the worm wheel shaft. Remove cover (893) and the worm wheel and shaft may be taken out. Reverse procedure for assembly

Caution: Position of stop locknut (877) is set on test at the factory and this position should always be maintained. The constant speed governor must always be set for the minimum desired full load speed with the speed changer stem backed off and practically no tension in spring (876). This procedure permits proper adjustment of the constant speed governor and also prevents overloading the



PARTS LIST

Reference Number	Description
875	Lever
876	Spring
877	Stop Locknut
878	Stem
879	Handwheel
880	Set Screw
881	Spring Seat
882	Spring
883	Worm Wheel Shaft
884	Worm Wheel
885	Worm
886	Bearing
887	Coupling
888	Oil Cup
889	Oil Cup
890	Speed Reducing Unit
891	Adapter
892	Housing
893	Cover
894	Guide
895	Shim

FIG. 9—MOTOR OPERATED SPEED CHANGER

constant speed governor spindle bearing. Oil cups (888) and (889) and those on the motor and built-in speed reducer should be filled with engine oil once each week.

VARIABLE SPEED ORIFICE TYPE GOVERNOR

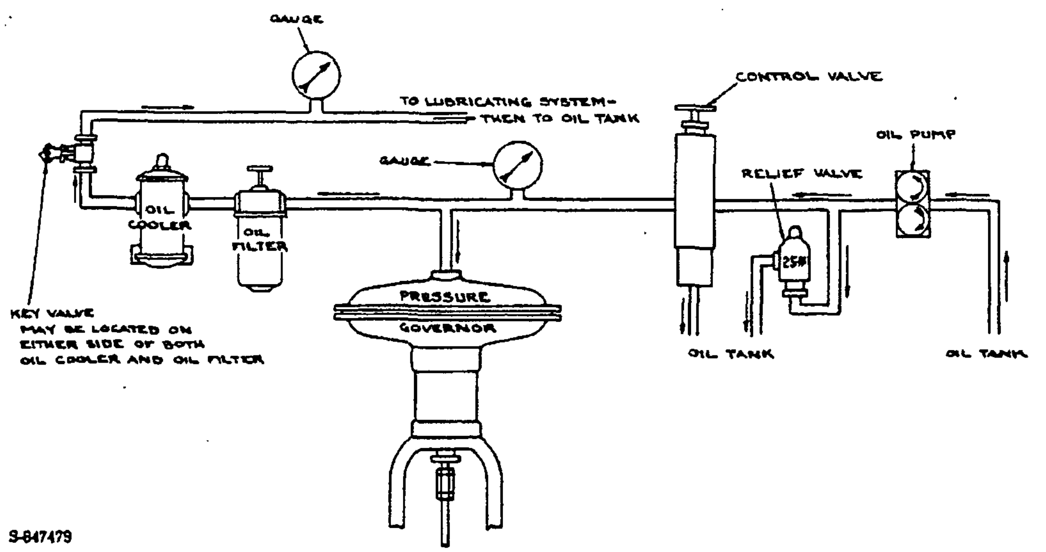
(Refer to Figs. 10 & 11)

GENERAL

This governor is a modification applied to the standard turbine, replacing the standard constant speed mechanical shaft governor. It is used in the speed range of 800 to 6000 rpm and gives a steady-state speed regulation of 8 percent at maximum speed and 20 percent at minimum speed. A speed adjustment of 3:1 can be obtained while the turbine is running.

Figure 10 shows the general arrangement of the oil piping for this type of governor. The oil pump takes the oil from the oil tank and pumps it to the relief valve (always set for 25#), through the control valve to the pressure governor, and through the oil filter, oil cooler and key valve, and into the turbine lubricating system and back to the oil tank. The key valve is used to adjust the pressure in the lubricating system to 5# (5# to 7# is satisfactory).

Figure 11 shows the general arrangement of the governor. The oil pump is usually driven from the front end of the turbine shaft. On geared turbine units, the oil pump may be driven from the gear shaft and, in this case, the steam end bearing case arrangement is different. Both arrangements are shown in Figure 11. In some cases, an air operated remote control arrangement is used with this type governor and this arrangement is shown in phantom.



S-847479

FIG. 10—PIPING DIAGRAM FOR VARIABLE SPEED ORIFICE GOVERNOR

The variable speed orifice governor is of the direct acting orifice type and is made up of four major parts:

1—Positive displacement oil pump

2—An enclosed diaphragm which is connected to the turbine governor valve through a bell crank

3—An adjustable type orifice referred to as the control valve

4—An oil distribution system (See figure 10).

The rate of discharge from the oil pump is directly proportional to the pump speed and is therefore directly proportional to the turbine speed. For any given load on the turbine, a definite governor valve opening is required. The required governor valve opening is obtained at the equilibrium position where the oil pressure on the top side of the diaphragm is balanced by the spring compression on the bottom of the diaphragm. The oil pressure on the top of the diaphragm is regulated by the control valve which by-passes oil directly to the oil reservoir.

The turbine speed will remain constant for any fixed setting of the control valve and any fixed load. The turbine speed may be brought to any desired value within a fixed speed range by opening or closing this valve. Closing the control valve decreases the turbine speed and opening the control valve increases the turbine speed. It should be noted that in effect the control valve is the speed changing device. The upper limit of the control valve opening ***must always*** be set for the maximum full load speed of the turbine (see nameplate). Thus the speed change is always downward from this setting.

A relief valve is connected between the pressure side of the primary oil system and the oil reservoir to prevent an excessive pressure being built up in the diaphragm chamber and thus rupture the diaphragm. This relief valve should not discharge oil unless pressure exceeds 25 pounds.

DISASSEMBLY AND ASSEMBLY

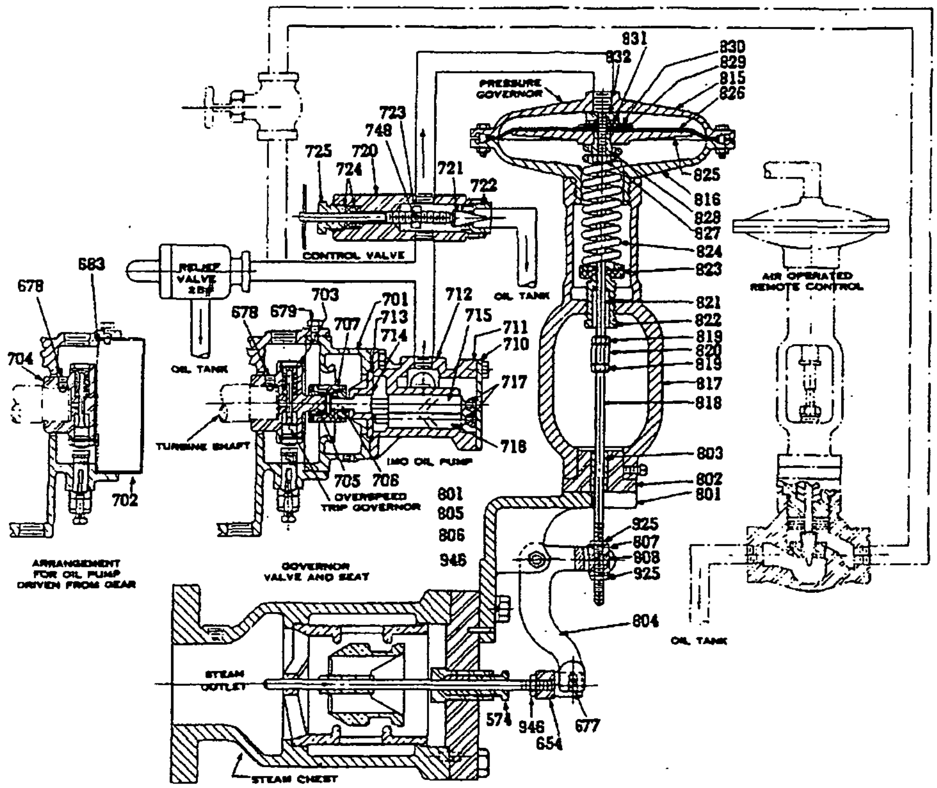
The pressure governor is fastened to adapter (802) through yoke (817) with set screws. Adapter (802) is bolted to bracket (801), which in turn is bolted and doweled to the steam chest governor valve cover assembly. Stem (818) is guided in bushing (803) which is pressed into adapter (802). Any movement of stem (818) is transmitted through connection (807) to blocks (808) to bell crank (804), and then from the bell crank through pin (677) and connection (654) to the governor valve stem and valve. Bell crank (804) is pivoted on shoulder bolt (805) in bracket (801). To mount the pressure governor with adapter (802) on to bracket (801), slide stem (818) into the slot in the top of bracket (801) and guide blocks (808) into connection (807) and bolt adapter (802) to the top face of bracket (801). Disassembly of this mechanism is accomplished in the reverse order.

To replace diaphragm (826) in the pressure governor, proceed as follows: Remove the oil line and relieve the spring compression by backing off adjusting nut (822) in the yoke. Take off upper diaphragm casing (815) by removing the bolts. Hold the diaphragm rod (821) and remove travel stop nut (832), seal washers (830 and 829), and rubber washer (831). Lift off the diaphragm from diaphragm head (825) and replace. Reassemble in the reverse order. Reset the oil pressure on the diaphragm to 17 pounds by adjusting nut (822) (turning clockwise lowers the pressure).

When the oil pump is driven from the front end of the turbine shaft, it is bolted to adapter (701) which in turn is bolted (679) to the steam end bearing case. The pump is located in adapter (701) by a rabbet and the adapter is located in the bearing case by a closely machined turn. The pump is driven from the turbine shaft through trip body (703) which is coupled (707) to the pump shaft. The trip body is shrunk onto the turbine shaft and held in place by set screw (678). The trip body also

PARTS LIST

574—Follower
654—Connection
677—Pin
678—Set Screw
679—Bolt
683—Gasket
701—Adapter
702—Cover
703—Trip Body
704—Trip Body
705—Woodruff Key
706—Woodruff Key
707—Coupling Assembly
710—End Cover
711—Gasket
712—Pump Case
713—Gasket
714—Cover
715—Power Rotor
716—Idler Rotor
717—Thrust Shoe
720—Valve Body
721—Needle Valve
722—Control Valve Seat
723—Nut
724—Packing
725—Follower
748—Set Screw
801—Bracket
802—Adapter
803—Bushing
804—Bell Crank
805—Shoulder Bolt
806—Lock Washer
807—Connection
808—Block
815—Upper Diaphragm Casing
816—Lower Diaphragm Casing
817—Yoke
818—Stem
819—Stem Connection Locknuts
820—Stem Connection
821—Diaphragm Rod
822—Adjusting Screw
823—Lower Spring Seat
824—Diaphragm Spring
825—Diaphragm Head
826—Diaphragm
827—Diaphragm Locknut
828—Upper Spring Seat Spud
829—Seal Washer (Lower)
830—Seal Washer (Upper)
831—Rubber Washer
832—Travel Stop Nut
925—Jam Nut
946—Jam Nut



Note:—

Oil Pump—Replacement parts not available. Only complete replacement pumps will be furnished.

Air Operated Remote Control Valve—Construction details and replacement parts list furnished by valve manufacturer. Give valve serial number when requesting information.

FIG. 11—VARIABLE SPEED ORIFICE TYPE GOVERNOR

X-412970A
X-412970B
X-412970C
X-413128

houses the overspeed trip governor.

The oil pump can be removed by removing the oil lines to the pump and removing the bolts in the pump flange and withdrawing the pump. The pump half of coupling assembly (707) will come off with the pump. To disassemble the pump, remove the coupling half and remove cover (714). Pump rotors (715 and 716) can now be easily withdrawn. Reverse the above procedure for reassembling.

ADJUSTMENTS AND CLEARANCES

1—*Governor Valve Travel*—With the turbine standing still and without pressure on the pressure governor, put sufficient compression on spring (824) to force the diaphragm (826) to its uppermost position. Adjust upper and lower jam nuts (925) until upper bell crank arm (804) is approximately level and lock jam nuts. Release jam nut (946) on governor valve stem and turn governor valve stem clockwise until the governor valve is firmly on its seat. Mark the valve stem where it emerges from follower (574). Turn the governor valve stem clockwise until this mark is 1/16" from the follower and lock it in position with jam nut (946).

2—*Relief Valve*—The relief valve should be set to relieve at 25 pounds, and may be tested with air or water.

3—*Pressure Governor Diaphragm*—The oil pressure on diaphragm (826) is to be adjusted to 17 to 18 pounds at full rated load on the turbine. This adjustment corresponds to 19 to 20 pounds at no load on the turbine. The diaphragm adjustment is made by adjusting nut (822). Turning this nut clockwise lowers the pressure and turning counter-clockwise raises the pressure. *Note:* It is important to have the system free of air or vapor at all times. Turn handle of the oil filter to relieve trapped air and vapor and bleed the system at frequent intervals through the petcock located in the diaphragm chamber piping.

Readjust the secondary oil pressure to 5 to 7 pounds with the key valve and reset the control valve to give full operating speed on the turbine.

4—*Control Valve*—The locknut adjustment (723) for setting the upper limit of the control valve travel is inside the valve and can be reached by removing the pipe plug in the valve body (720). To readjust the valve, the turbine must be shut down. Remove the pipe plug and turn the valve handle until set screw (748) is opposite the pipe plug hole. Insert wrench and loosen set screw but do not remove the set screw. Allow wrench to stay engaged in the set screw and turn needle valve (721) to the closed position. This action will put the lock nut at the upper end of the needle valve threads. Leave set screw loose and remove set screw wrench, replace pipe plug and start turbine up slowly. Open the control valve slowly until the upper limit of speed is obtained. Shut turbine down, remove pipe plug and turn valve handle to bring set screw (748) opposite hole. Tighten set screw securely on lock nut and replace the pipe plug.

The rate of flow through the control valve varies with the oil temperature and viscosity and therefore all final settings must be made with the oil up to operating temperature.

When an air operated remote control valve is used in conjunction with the manual control valve, the isolating valve ahead of the air operated valve must be closed before making the adjustments described in this section. Likewise when adjusting the air operated valve, the manual control valve must be closed. For details of adjustment, construction and operation of the air operated control valve, refer to instructions furnished by the valve manufacturer.

5— *Oil Pump* —During the initial starting or after the turbine has been shut down for a protracted period or the pump has been dismantled, it is of prime importance to see that pump and suction pipe are completely filled with oil. Air or vapor trapped in the suction piping or pump will cause failure of the pump to prime, resulting in damage to the oil pump and the turbine. A vent connection is provided in the discharge side of the pump to vent any air or vapor as the pump is started. If the pump does not build up pressure, it should be primed and tried again. If the pump does not pick up oil immediately after priming, there may be a leak in the suction line or the trouble may be traced to excessive suction lift caused by some obstruction in the line.

6—If the governor shows a tendency to hunt, check the following points: Hunting may be due to one of the stems rubbing in a sleeve or to lost motion between the governor and the governor valve. The bell crank should be checked to see that there is no play and lost motion. Gland followers should not be screwed up too tightly to cause stems to stick. Bushing (803) should be checked for signs of hard rubbing and should be relieved if necessary. The relief valve should be set to open at not less than 25 pounds prssure.

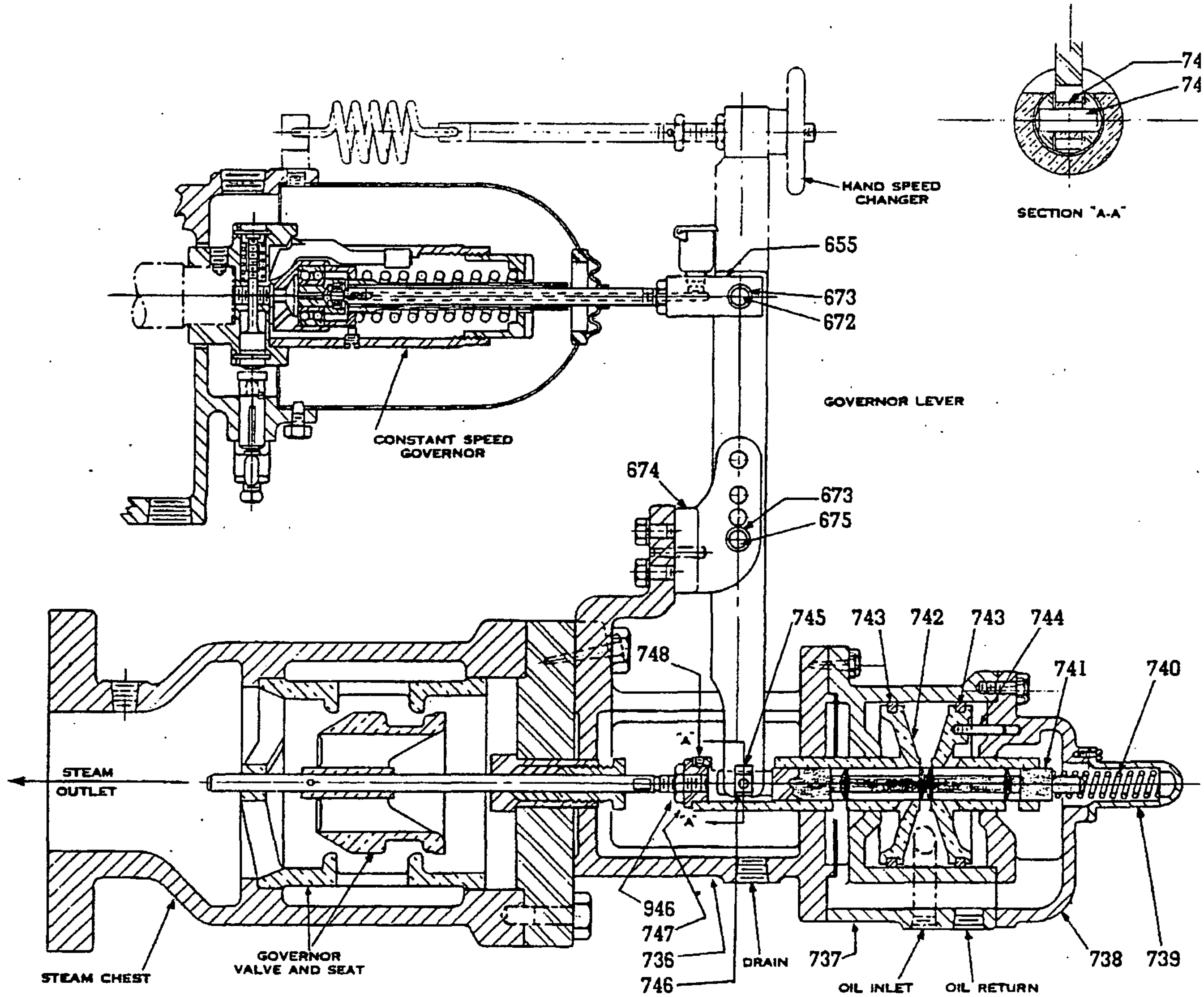
CONSTANT SPEED OIL RELAY TYPE GOVERNOR

(Refer to Figure 12)

GENERAL

The constant speed mechanical shaft governor meets the requirements of the large majority of mechanical drive turbines. However, there are some applications of these turbines that require more sensitive governor action and closer regulation of speed under variable load conditions and the constant speed oil relay type governor is used for such applications. This governor (Figure 12) is a modification to the standard turbine and is used in the speed range of 1000 to 4500 rpm and gives a steady-state speed regulation of four percent for gradual changes of full rated load. A hand operated speed changer (Figure 8) is adaptable to this governor and is furnished when required.

This governor consists of the standard constant speed governor which operates the governor valve through an oil pilot mechanism



X-612960

PARTS LIST

655—Connection
672—Pin
673—Retaining Ring
674—Fulcrum Bracket
675—Pin
736—Bracket
737—Cylinder
738—Cover
739—Cap
740—Spring
741—Pilot Valve
742—Piston
743—Piston Ring
744—Stop Pin
745—Pin
746—Block
747—Nut
748—Set Screw
946—Jam Nut

FIG. 12—CONSTANT SPEED OIL RELAY TYPE GOVERNOR

which is bolted and doweled to the steam chest cover through bracket (736). The lower connection of the governor lever to pilot valve (741) is made through block (746) which is pinned to the pilot valve. Block (746) is held in place in the end of the pilot valve by pin (745). Spring (740) is provided to take up any lost motion in the pilot valve attachment to the governor lever. The governor valve and stem is secured to piston (742) by nut (747), jam nut (946), and set screw (748). The valve stem is threaded into nut (747) which in turn is threaded into the end of piston (742).

As the turbine comes up to speed, the governor weight assemblies are forced outward by centrifugal force against the compression of the governor spring. As the governor weights move out, the governor spindle is moved out. This movement is transmitted through the governor lever to the central pilot valve (741). Oil under pressure is admitted continuously to the inside of hollow piston (742) from a gear oil pump (driven by worm and gear from the turbine shaft on direct connected turbines or from the idle end of the low speed gear shaft on geared turbine units). The relief valve in the oil system is adjusted so that a pressure of 30 to 40 pounds per square inch is maintained on the governor. As the turbine comes up to speed, pilot valve (741) moves to the left and admits oil to the outer end of the oil cylinder (737) and allows oil to be discharged from the inner end of the cylinder. The resulting excess of oil pressure at the outer end of the cylinder causes the oil piston to follow the pilot valve simultaneously to the left, moving the governor valve toward the valve seat, until the proper speed is obtained and the governor valve passes the amount of steam required to carry the existing load. Slots are provided in piston (742) to allow the pilot valve and governor lever to move relative to the piston.

ADJUSTMENTS

The governor, the oil pilot mechanism, and the governor valve are adjusted and set at the factory to give the desired speed and these settings should not be changed unless absolutely necessary.

The construction and the adjustment of the governor and the governor linkage is described in Section II and III under ***"Constant Speed Governor and Linkage."*** It may, at times, be necessary to adjust the governor with the governor spring adjusting nut to meet some particular operating condition. It should be noted that such adjustment should be made to take care of comparatively small speed changes only, say, 10 percent to 15 percent. Should greater speed variations be required, consult Elliott Company, since sometimes changes in governor weights and springs are necessary.

Adjustment of the governor valve is secured by loosening jam nut (946) and turning the valve stem in or out of nut (747) with a small wrench on the squared part of the valve stem. Jam nut (946) must be tightened after adjusting the valve.

To check the setting of the governor proper, as received from the factory, or after any change in valve setting has been made, proceed as follows:

With the turbine shut down and the governor weights in their innermost position remove oil cylinder cover (738). Move oil piston (742) by hand until the inner edge of the slotted discharge port at the outer end of the piston is in line with the inner edge of the narrow enlarged part of the pilot valve. This position is shown in Figure 12 and corresponds to the full open position of the governor valve.

Measure and record the distance from the end of governor spring adjusting nut to the outer face of the governor lever, at a point opposite the centerline extension of the governor spindle. Next remove pin (672) and crescent retaining ring (673) and move the governor valve to its closed position, again lining up the pilot valve and piston as directed above.

Again measure the record the distance from the end of the governor spring adjusting nut to the outer face of the governor lever as before. The difference between these two measurements gives the governor spindle travel required to move the governor valve from its open or full load position to its closed or no load position. This spindle travel must not exceed ½" in any case. Should the spindle travel exceed, ½" the full load valve opening must be decreased by backing the governor valve stem out of nut (747) and the governor spindle travel must be rechecked. Replace oil cylinder cover (738).

In case it is determined by trial that the full valve opening is not required to carry full load with normal steam conditions, it is sometimes advantageous to utilize the outer range of the total swing of the governor weights, rather than the inner range. In order to adjust the governor to use the outer range, swing the governor lever out of the way by removing pins (672 and 675). Loosen jam nut (946) on the governor spindle and turn connection (655) further onto the threaded governor spindle by the required amount. Tighten jam nut (946) and replace governor lever and pins. Recheck the governor setting as described above to make sure that the limiting total spindle travel has not been exceeded and that the governor does not come up against the governor stop screws before the governor valve is entirely closed. Also oil piston (742) should not come in against the bottom of the oil cylinder before the governor valve is closed.

Improper or erratic governor operation is usually caused by lost motion due to worn parts or by sticking or binding in the steam chest, pilot valve, oil piston, or in the governor itself. If such operation is encountered, shut the turbine down and look for worn pins and blocks in the governor lever connections. Remove the oil cylinder cover (738) and move the oil piston and the governor valve in and out. If the piston moves freely, it would indicate that the trouble is elsewhere. If lost motion is felt, see if governor valve is worn loose on the valve stem. If binding is felt, see if the valve stem packing is too tight, and also see if valve stem moves freely in its guides. These guides may be scaled over. Block (746) and pin (745) should be kept clean and free and well lubricated with high temperature "Silicone" grease (DC-710, Dow Corning Corp.). Replace all worn parts, keep everything free and use plenty of light engine oil on all moving parts. Be sure that oil feed and return lines are clean and free from all obstruction.

BUILT-IN PUMP TYPE GOVERNORS

GENERAL

For certain applications, such as boiler feed pump drives it is desirable to automatically control the turbine speed so as to maintain a constant pump discharge pressure or a constant pressure differential at the pump discharge. The ***Built-In Constant or Differential Pump Governor*** is used for such applications. This type of governor is a modification to the standard turbine, and is used in the speed range of 0 to 4500 rpm. Pressure adjustment is dependent on the pressure governor design. Figure 13 shows a typical ***Constant Pressure Pump Governor*** and Figure 14 shows a typical ***Differential Pressure Pump Governor***. These pressure governors supplement the standard constant speed governor and control the turbine speed, as a function of the governor pressure, by direct action on the turbine governor valve. The standard constant speed governor, which is set at a speed slightly higher than the normal full load operating speed, acts as a pre-emergency device to prevent the turbine overspeeding and tripping out the overspeed governor in case the pressure governor fails or is out of service.

CONSTANT PRESSURE TYPE

(Refer to Fig. 13)

DISASSEMBLY AND ASSEMBLY

NOTE: The pressure governor is selected for each specific installation, thus construction details may vary for each unit. For complete information on your installation refer to instructions furnished by the manufacturer.

The pressure governor consists essentially of the following parts: housing (A), within which is the controlling diaphragm; yoke (B), which contains the adjusting spring (C) and the adjusting nut (D). Connection (E) at the top of the governor is connected to the control pressure line. The control pressure operates on the top of the diaphragm against the adjusting spring (C). The pressure governor is fastened to adapter (802) through yoke (B), with set screws. Adapter (802) is bolted to bracket (801), which in turn is bolted and doweled to the steam chest governor valve cover assembly. Stem (F) is guided in bushing (803), which is pressed into adapter (802). Any movement of stem (F) is transmitted through connection (807) to blocks (808) to bell crank (804), and then from the bell crank through pin (677) and connection (654) to the governor valve stem and valve. Bell crank (804) is pivoted on shoulder bolt (805) in bracket (801).

Parts are assembled on stem (F) in the following order: jam nuts (925), connection (807), upper spring seat (809), spring (810), spring (811), lower spring seat (809), and lower jam nuts (925). Blocks (808) are assembled in upper arm of bell crank (804). To mount the pressure governor with adapter (802) on to bracket (801), slide stem (F) into the slot in the top of bracket (801) and guide blocks (808) into connection (807) and bolt adapter (802) to the top face of bracket (801). Disassembly of the mechanism is accomplished in the reverse order.

ADJUSTMENTS AND CLEARANCES

To adjust the pressure governor, proceed as follows:

(1) With the turbine standing still and without controlling pressure on the pressure governor, put sufficient compression on spring (C) to force the diaphragm to its uppermost position.

(2) Adjust upper jam nuts (925) until upper bell crank arm (804) is approximately level and lock jam nuts.

(3) Release lower jam nuts (925) until springs (810 and 811) are free. Compress springs (810 and 811) ¾" from free length by means of jam nuts (925) and set jam nuts up tight.

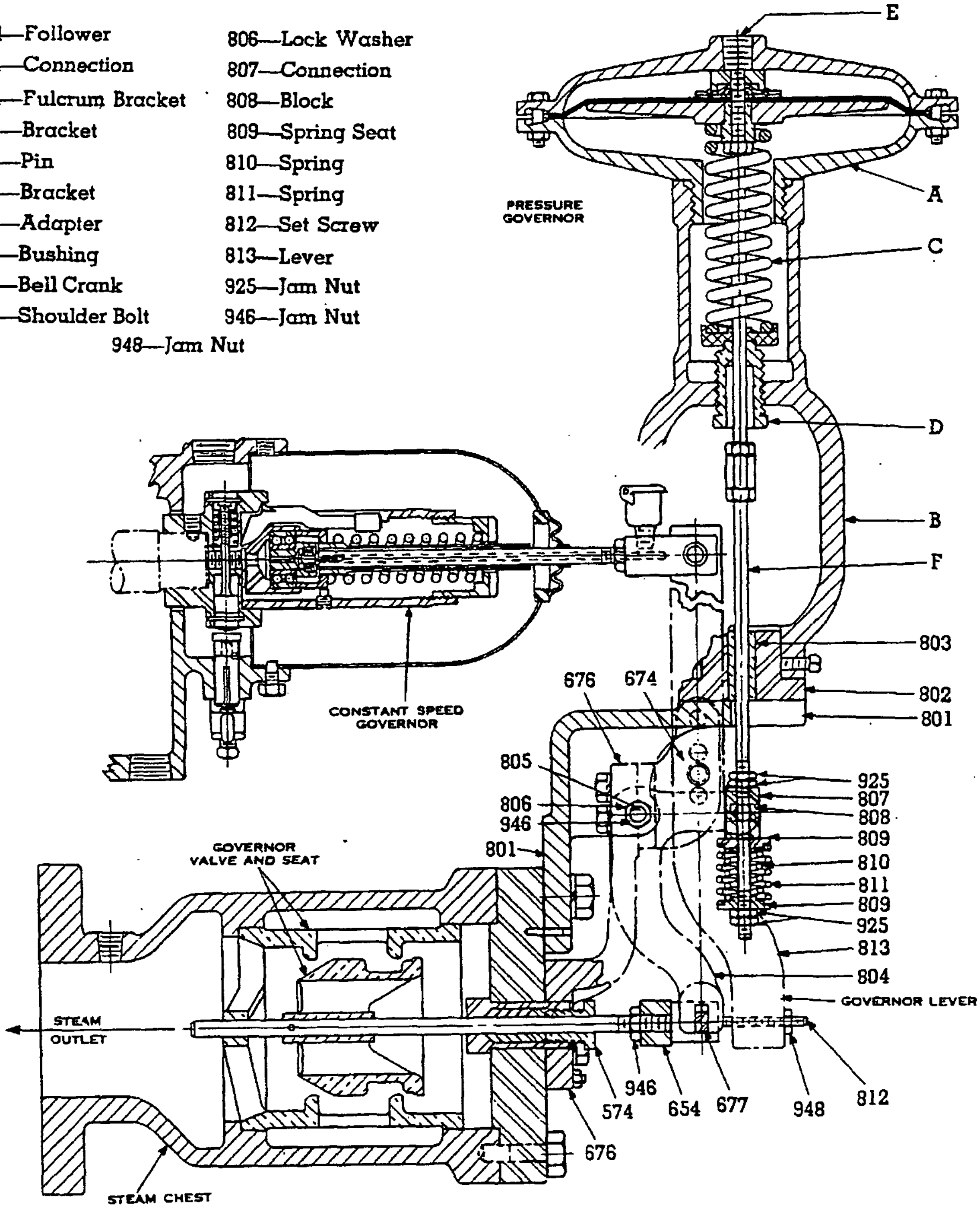
(4) Release jam nut (946) on governor valve stem and turn governor valve stem clockwise until the governor valve is firmly on its seat. Mark the valve stem where it emerges from follower (574). Turn the governor valve stem counterclockwise until this mark is 1/16" from the follower and lock it in position with jam nut (946).

(5) Release jam nut (948) and adjust set screw (812) in the governor lever to give 1/16" clearance between the end of the set-screw and the face of bell crank (804). Lock set screw in place with jam nut (948).

(6) Start turbine up slowly without controlling pressure on the pressure governor. Note the operation of the ***Constant Speed Governor***.

PARTS LIST

574—Follower
654—Connection
674—Fulcrum Bracket
676—Bracket
677—Pin
801—Bracket
802—Adapter
803—Bushing
804—Bell Crank
805—Shoulder Bolt
806—Lock Washer
807—Connection
808—Block
809—Spring Seat
810—Spring
811—Spring
812—Set Screw
813—Lever
925—Jam Nut
946—Jam Nut
948—Jam Nut



Note:—Pressure governor construction details and replacement parts list furnished by manufacturer. Give serial number when requesting information.

FIG. 13—BUILT-IN CONSTANT PRESSURE PUMP GOVERNOR

X-612960
X-612966
X-612970A

When the turbine has reached full load, check the speed. The speed should be slightly higher than the normal full load speed of the unit. (See Nameplate.) Reduce the load gradually and note that the set screw (812) in the end of the governor lever contacts the face of bell crank (804) and thus prevents the turbine overspeeding and tripping out.

(7) When starting the turbine under the control of the pressure governor, bring the turbine up to speed gradually on the throttle and adjust the controlling pressure as the speed increases. Applying the controlling pressure to the pressure governor suddenly, may result in damage to the pressure governor mechanism. Continue this adjustment process until the desired operating conditions are reached.

DIFFERENTIAL PRESSURE TYPE

(Refer to Fig. 14)

DISASSEMBLY AND ASSEMBLY

NOTE: The pressure governor is selected for each installation, thus construction details may vary for each unit. For complete information on your installation refer to instructions furnished by the manufacturer.

The differential pressure governor consists essentially of the same parts as the constant pressure governor. The connection (E), at the top of the pressure governor, is connected to the discharge side of the pump and connection (J), on the underside of the governor diaphragm, is connected to the steam line. Both of these connections are made through needle valves as shown. Both of these lines must be connected by an equalizing line with a needle valve (K), to protect the governor diaphragm against excessive pressure on one side. The pressure differential between the pump discharge pressure and the steam line pressure operates the diaphragm against the adjusting spring (C).

The construction of the operating mechanism for this type governor is the same as that used for the constant pressure governor. For disassembly and assembly of the differential pressure pump governor, follow instructions as given for the constant pressure pump governor.

ADJUSTMENTS AND CLEARANCES

The adjustment and clearances of the differential pressure pump governor is the same as that used for the constant pressure pump governor, and the same instructions and precautions should be used and followed.

To start up a turbine with a differential pressure pump governor, without the controlling pressures on the pressure governor, follow the instructions as given for the constant pressure pump governor.

When starting the turbine with a differential pressure pump governor and under the control of the pressure governor, open the valve in the pump discharge pressure control line (E), open the equalizing valve (K), and close the valve in the steam pressure control line (J). When the pump discharge pressure has reached the desired setting, close the equalizing valve (K) and open the valve in the steam pressure control line (J). When stopping the turbine, the equalizing valve (K) should be opened and the other two valves should be closed.

These directions must be followed to prevent damage to the pump governor operating mechanism.

SOLENOID-OPERATED TRIP

(Refer to Fig. 15)

This remotely controlled electrical trip is a modification applied to the standard turbine. Figure 15 shows the arrangement of this mechanism. The energized or de-energized coil (as specified) actuates the trip lever, thus closing the overspeed governor valve. ***The overspeed governor valve must be manually reset before the turbine is restarted.***

The solenoid assembly (841) is bolted to bracket (842) which in turn is bolted to the steam end bearing case. Spring seat (843) is pinned (844) to the solenoid plunger. Link (846) is bolted to the end of spring seat (843) and engages the welded pin or latch (847). The solenoid plunger works against the compression of spring (845).

Two types of arrangements are available: 1—Push type solenoid and 2—Pull type solenoid. In the push type, when the solenoid is energized, the solenoid plunger extends the spring (845) maintaining latch (847) in the reset position. When the solenoid is de-energized, spring (845) returns the solenoid plunger to the left and moves latch (847) to the tripped position. In the pull type, the solenoid is de-energized when latch (847) is in the reset position. For this condition the spring holds the solenoid plunger in the proper outward position, the plunger travel being limited by bolt (848) when the solenoid is energized, the solenoid plunger is pulled to the left against the compression of the spring and the latch is moved to the tripped position.

Figure 15 clearly shows the adjustments and required settings for both types of solenoids. The proper settings are maintained and held in place by jam nuts (849).

EXHAUST PRESSURE TRIP

(Refer to Fig. 16)

The exhaust pressure trip is a modification applied to the standard turbine. Figure 16 shows the general arrangement. When the turbine exhaust pressure exceeds a predetermined value, the mechanism closes the overspeed valve and stops the steam flow to the turbine. Steam to the operating cylinder comes from the turbine casing, through the relief valve which discharges into the operating cylinder and forces the piston to the left until the dis-

PARTS LIST

574—Follower
654—Connection
674—Fulcrum Bracket
676—Bracket
677—Pin
801—Bracket
802—Adapter
803—Bushing
804—Bell Crank
805—Shoulder Bolt
806—Lock Washer
807—Connection
808—Block
809—Spring Seat
810—Spring
811—Spring
812—Set Screw
813—Lever
925—Jam Nut
946—Jam Nut
948—Jam Nut

Note:—Pressure governor construction details and replacement parts list furnished by manufacturer. Give serial number when requesting information.

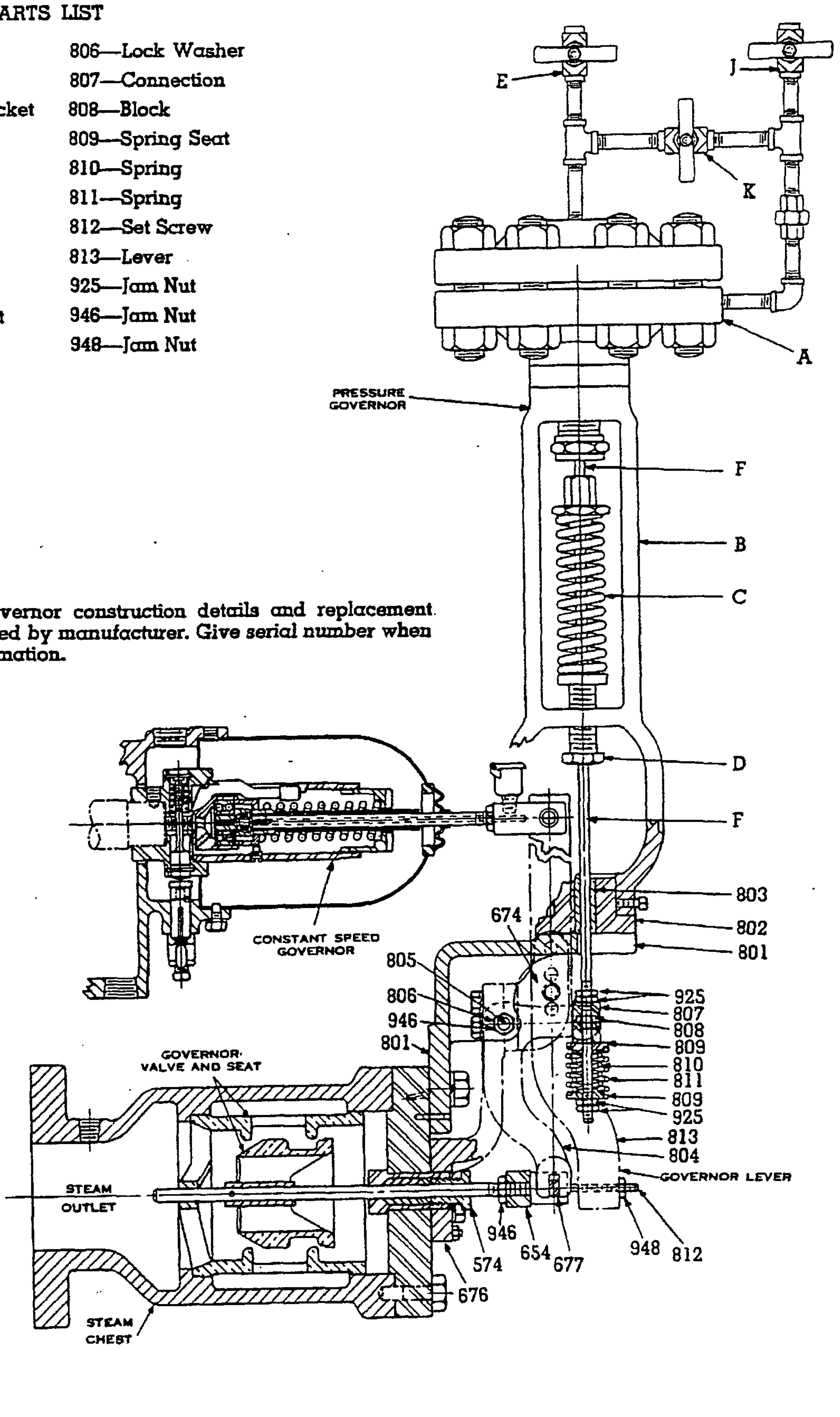


FIG. 14—BUILT-IN DIFFERENTIAL PRESSURE PUMP GOVERNOR

PARTS LIST

Reference Number	*Description*
841	Solenoid Assembly
842	Bracket
843	Spring Seat
844	Pin
845	Spring
846	Link
847	Latch
848	Bolt
849	Jam Nut

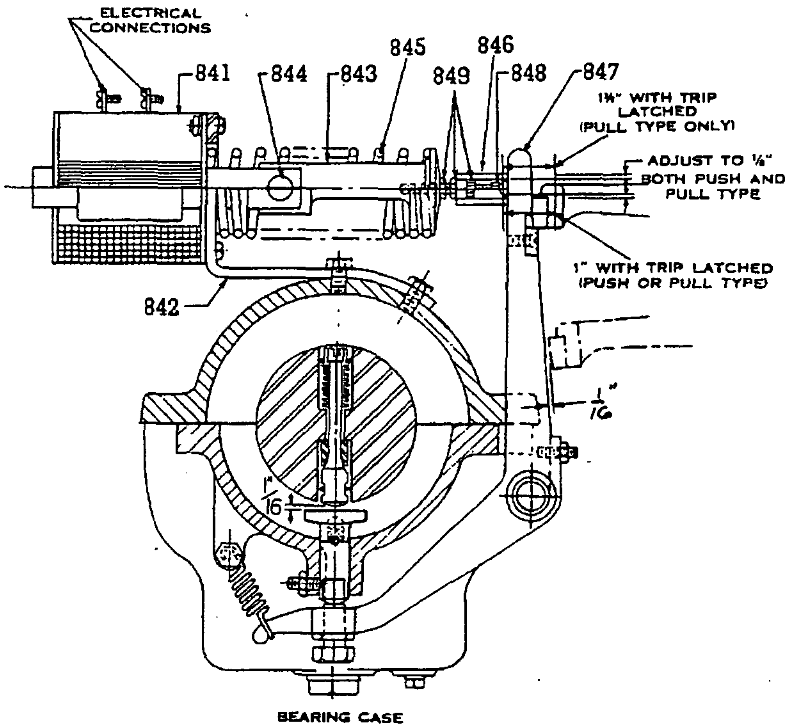


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FIG. 15—SOLENOID OPERATED TRIP

charge port in the cylinder is uncovered. This action moves the latch lever to the left and trips the overspeed valve.

The mechanism assembly is supported by bracket (860) which is bolted to the bearing case cap (536) as shown in Fig. 16. Cylinder (861) is supported by and bolted to bracket (860). Piston (862) strikes cross-pin (863) which is attached to yoke (864) and held in place by retaining rings (673). Yoke (864) is fastened to link (866) by set screw (805). Jam nuts (925) lock yoke (864) in position. Link (866) engages latch lever (935) through the pin attached to it.

Adjustment of the mechanism is to be made as follows: With latch lever (935) in the unlatched or tripped position, adjust set screw (865) so that it is against cylinder (861) and there is a clearance of $\frac{1}{16}$" between the resetting lever (927) knife edge and the striking face of latch lever (935). Refer to Fig. 16. Then with latch lever (935) in the latched or reset position, adjust position of yoke (864), with jam nuts (925), to give $\frac{1}{16}$" clearance at "A" as shown in Fig. 16. In making this adjustment, the previous adjustment of set screw (865) should not be disturbed. It should be noted that in some cases, it may be necessary to increase the clearance at "A" to compensate for manufacturing tolerances to get satisfactory operation.

The piping, from the outlet of the relief valve to the inlet of the operating cylinder, is furnished with a $\frac{1}{16}$" drain hole at the low point of the piping to prevent accumulation of water in the line. This drain hole is to be kept open at all times. The discharge from the operating cylinder is to be connected to an open drain.

CAUTION: It should be noted that this mechanism cannot be reset, after it has tripped, if the relief valve is discharging steam, i.e., while the exhaust pressure is too high.

SECTION VI
TURBINE FRAME MODIFICATIONS
"EYR" FRAME

(Refer to Fig. 17)

This frame is particularly adaptable for normal condensing operation and for high heat drop conditions operating non-condensing.

Figure 17 shows a section through this type turbine. It should be noted that this frame incorporates two, two-row velocity stages. The general arrangement and construction is the same as that incorporated in the other turbines described in this bulletin.

The complete casing assembly (502) consists of a lower half steam end casing, a lower

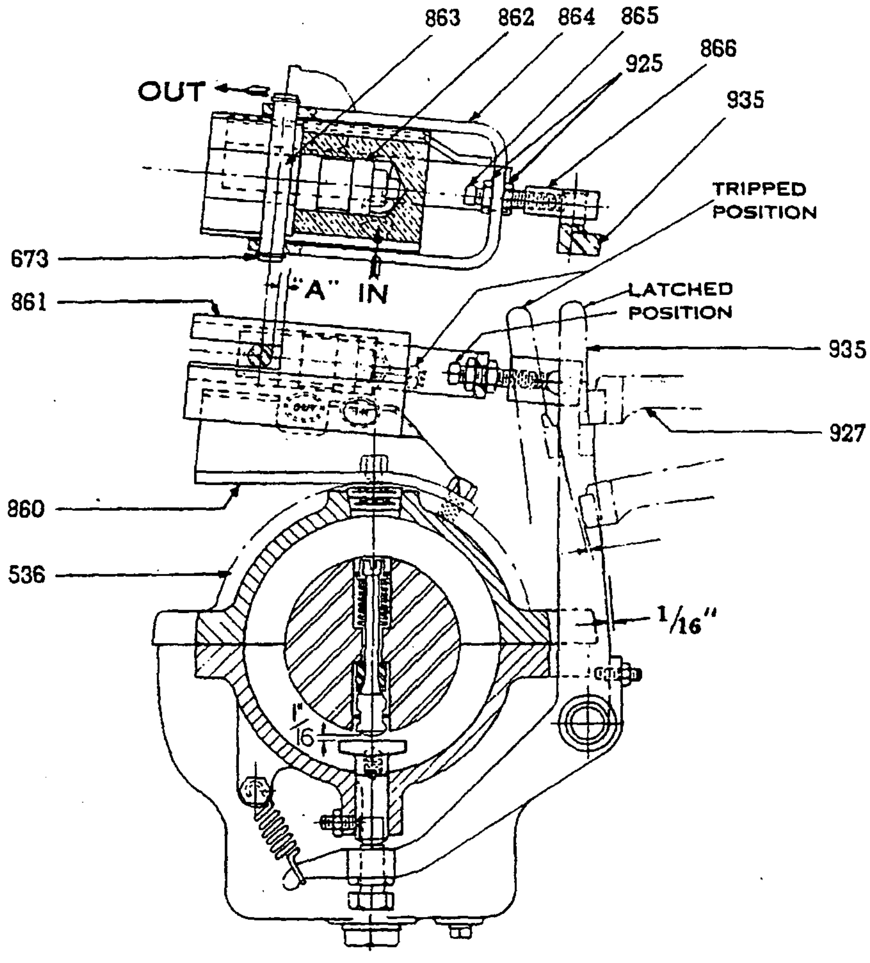

FIG. 16—EXHAUST PRESSURE TRIP

PARTS LIST

536—Bearing Case and Cap	864—Yoke
673—Retaining Ring	865—Set Screw
860—Bracket Assembly	866—Link
861—Cylinder	925—Jam Nut
862—Piston	927—Lever
863—Pin	935—Latch

half exhaust end casing and a two-piece upper half casing cover. The lower half steam end and exhaust end are bolted together through a metal to metal vertical flange. This joint is made up as described in Section II under "Casing and Miscellaneous Steam Joints" and as shown in Figure 18. A ¼" diameter thread of Plastic Gasket No. 337-1 laid on approximately ½" wide strip of Turbo Seal-50 is placed on the flange on either side of the flange bolt circle. The two-piece upper half casing cover is also bolted and doweled through the metal to metal vertical joint which is made up the same as the lower half vertical joint. The upper half cover assembly is bolted and doweled to the lower half casing assembly through the horizontal joint. This joint is made up as shown in Figure 18. The same precautions and care should be exercised in making up the casing joints as are outlined in Section II under "Casing."

Diaphragm assembly (607) is turned to a slightly smaller diameter than the casing groove in which it is inserted. The diaphragm is made in two pieces, an upper half and a

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PARTS LIST

Reference Number	Description	Reference Number	Description
500	Eyebolt	556	Packing
501	Sentinel Valve	558	Gasket
502	Cover, Steam End, Exhaust End	601	Nozzle Ring
505	Support	602	Lock Washer
511	Packing Case	604	First Bucket Holder Assembly
512	Carbon Ring, Spring, and Stop	605	Second Bucket Holder Assembly
521	Pedestal and Cap	605	Second Bucket Holder
522	Bearing Liner (Lower Half)	606	Lock Washer
523	Bearing Liner (Upper Half)	607	Curtis Diaphragm Assembly
524	Cooling Tube Assembly	621	Shaft
525	Gasket	622	Snap Ring
526	Combining Stud	623	Thrust Bearing
527	Pin	624	Oil Ring
536	Bearing Case and Cap	625	Oil Slinger
537	Pipe Plug	626	Slinger
538	Oil Filler and Sight Caps	627	Key
539	Oil Level Indicators	630	First Disc Assembly (1st Curtis)
540	Thrust Bearing Spring	631	Second Disc Assembly (1st Curtis)
551	Hand Wheel	633	First Disc Assembly (2nd Curtis)
552	Jam Nut	634	Second Disc Assembly (2nd Curtis)
553	Lockwasher	645	Sleeve
554	Hand Valve Assembly	646	Set Screw
555	Follower	650	Carbon Ring, Spring, and Stop

Note: Chrome-Molybdenum (SAE 4140) bolting used throughout.

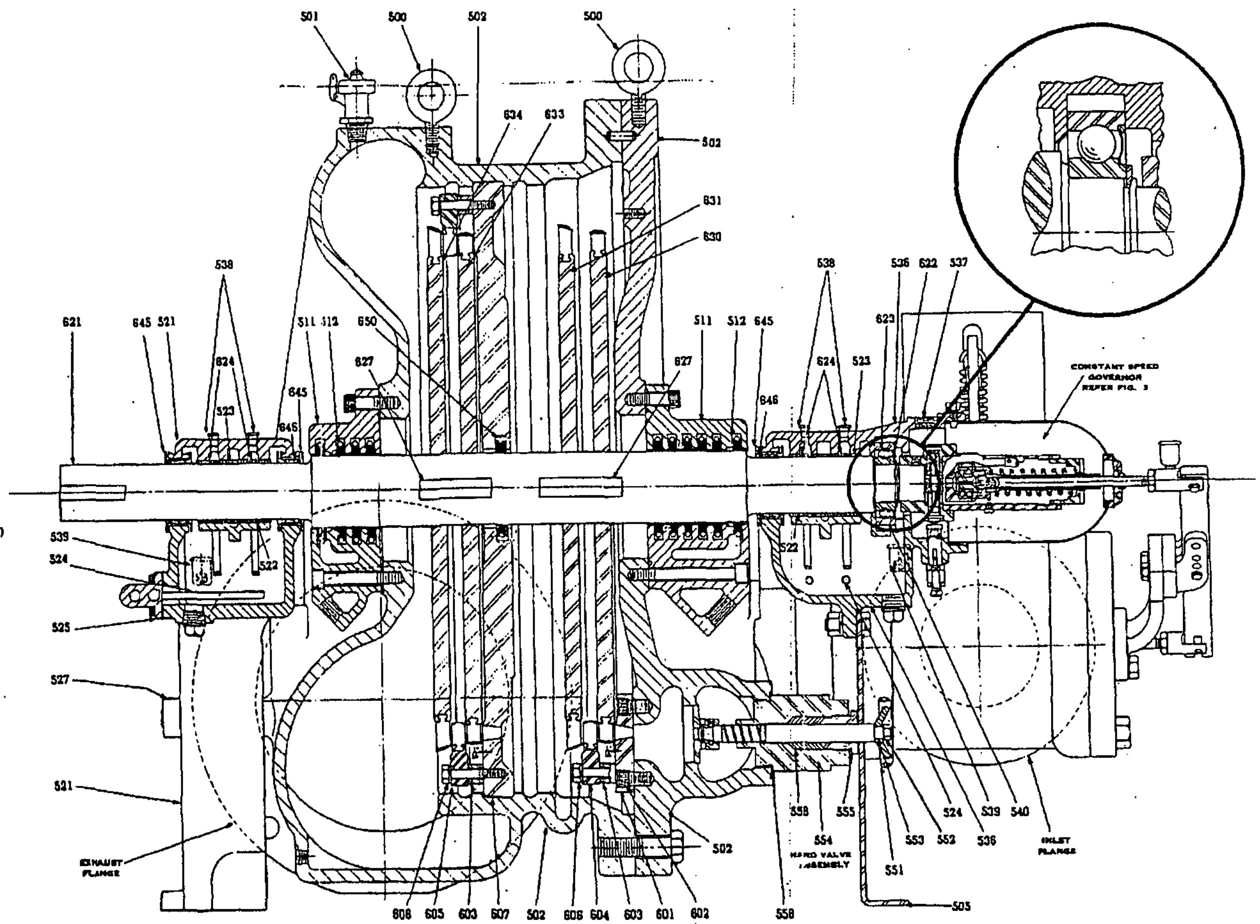

FIG. 17—SECTION THROUGH "EYR" TURBINE

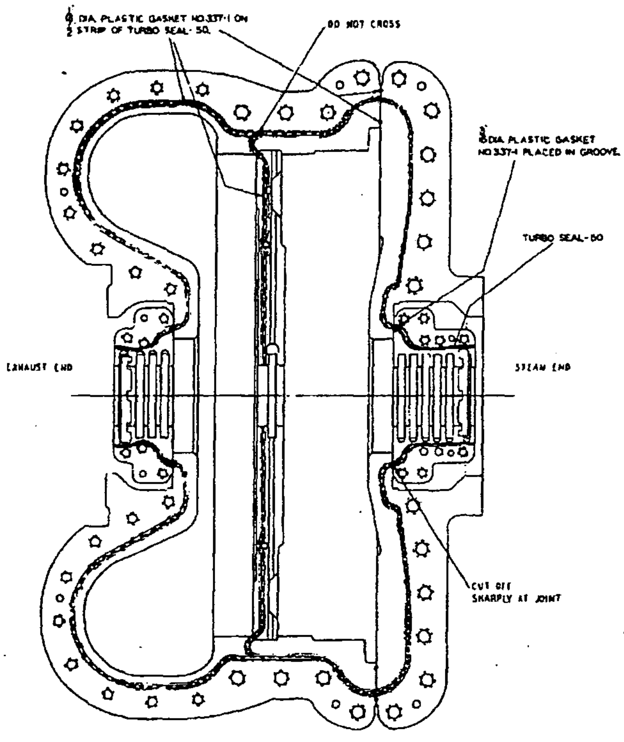

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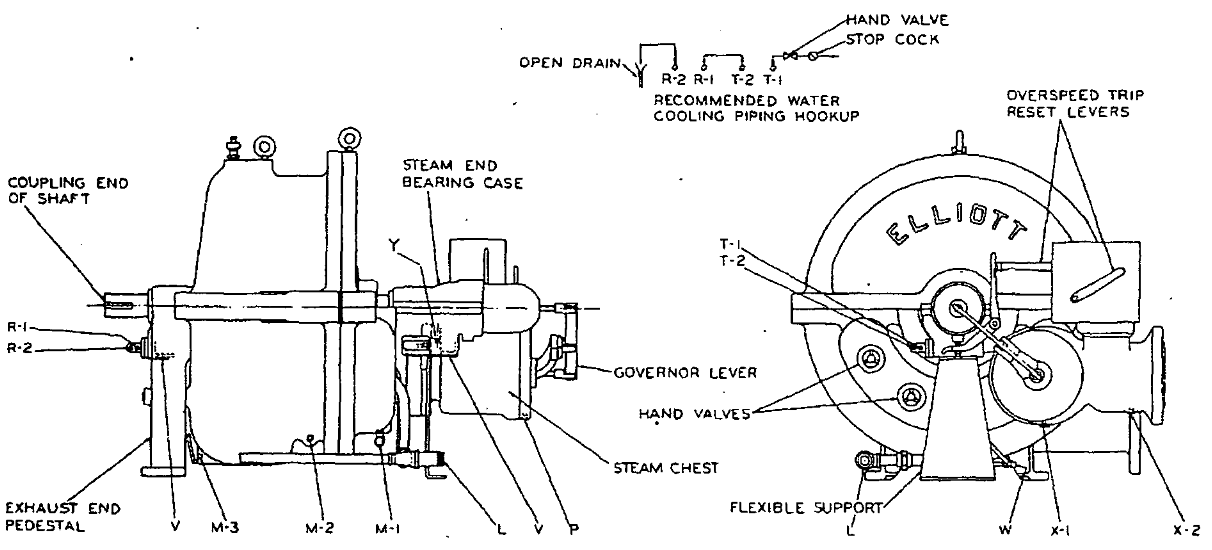
FIG. 18—"EYR" HORIZONTAL JOINT DETAIL

lower half, and these two halves are held in correct relationship by an integral key in the lower half and a keyway in the upper half. When the diaphragm is assembled in the lower half casing, shims are placed in the casing groove to bring the diaphragm horizontal joint flush with the casing horizontal joint. The top half diaphragm is fastened into the upper half casing by locking bolts at either end of the horizontal joint. As will be noted, the diaphragm has a bored recess in its hub for carbon ring assembly (650). The construction of this carbon ring is the same as rings (512) in the packing cases. It is necessary to remove the upper half casing (502) in order to inspect or replace carbon ring assembly (650). The procedure previously outlined for removing carbon rings from the packing cases (Section II—Packing Cases and Carbon Rings) should be followed for removing carbon ring assembly (650).

The second velocity stage bucket holder (605) is fastened to diaphragm assembly (607) in the same way that the first velocity stage bucket holder (604) is fastened to nozzle ring (601).

Reference Number	*Description*	*Reference Number*	*Description*
M-1 & M-2	High Pressure Casing Drains	W	Shaft Packing Gland Sealing Steam Connections
M-3	Low Pressure Casing Drain	P	Valve Stem Leakoff
X-1 & X-2	Steam Chest Drains	V	Oil Drains
L	Shaft Packing Gland Leakoff	Y	Ring Pressure Gauge Connection
T & R	Water Cooling Connections to Bearing Cases (Ring Oiled Bearings Only)		

Note: Refer to outline drawing for connection sizes and specific locations.



W-601470 FIG. 19—"EYR" MISCELLANEOUS PIPING CONNECTIONS

Assembly and disassembly, adjustments and clearances of all other parts should be made *in accordance with instructions previously* given in Section II and Section III of this instruction book.

Refer to Figure 19, where all miscellaneous piping connections are identified. It should be noted that connections "M-1," "M-2," and "M-3" are the only ones that differ from those given for the standard turbine in Figure 5 and described in Section II under "Miscellaneous Piping Connections." Refer to these for complete description of these connections and also for ***recommended water cooling piping hookup and for suggested arrangement for drain connections.*** In addition, note the following:

"M-1" and "M-2" — HIGH PRESSURE CASING DRAINS—and "M-3"—LOW PRESSURE CASING DRAIN — Connect through suitable valve to open drain. Open prior to starting turbine; close when casing is fully drained. Open when turbine is shut down and exhaust valve is closed.

HEAVY DUTY 2 BYRH FRAME

(Refer to Fig. 20)

This frame is a modification of the standard 2 BYR frame and is used for heavy duty, high exhaust pressure units up to a maximum of 250 psig. The casing and packing cases are specially designed extra heavy construction made to withstand the high exhaust pressures and temperatures and to seal the shaft against steam leakage. Standard steam chests, valves, governor parts, bearings, bearing cases, and exhaust pedestals are used with this frame. All modifications of the standard frames previously described are also adaptable to this heavy duty frame. Reference to Figure 19 will show that the general arrangement and construction of this frame is similar to the standard frames.

Because of the high exhaust pressures and resultant temperatures under which this frame operates, particular precautions are taken to seal the steam joints of the casing assembly. The casing assembly consists of the steam end and exhaust end bolted together through the vertical flange. For higher exhaust pressure this joint is seal welded on the inside to assure a completely steam tight joint. Once this joint is made up there are no conditions under which this joint should be broken. The casing cover is bolted through the horizontal flange to the steam end and exhaust end. It should be noted that a 3/16" seal groove is machined into the cover flange and this seal groove is fed by three tapped connections through which additional sealing compound is forced into the seal groove. The following procedure, used at the factory in making up this horizontal joint, is strongly recommended.

Anchor Packing Company "Turbo-Seal-50" and "Plastic Gasket No. 337-1" made up in "Strings," are used in combination. The seal faces of the horizontal flange are coated with Turbo-Seal-50 and a 3/16" diameter thread of Plastic Gasket No. 337-1 is placed in the seal groove of the cover flange face. After the joint has been pulled up tight and put under steam pressure and temperature, additional Plastic Gasket No. 337-1 in a pressure gun is forced into the seal groove through the three tapped holes in the cover flange to force out any entrained air and to insure a continuous seal. Our experience shows that this procedure results in a trouble-free, exceptional steam tight joint.

Anchor Packing Company sealing compounds and pressure guns for their application, may be purchased directly from the

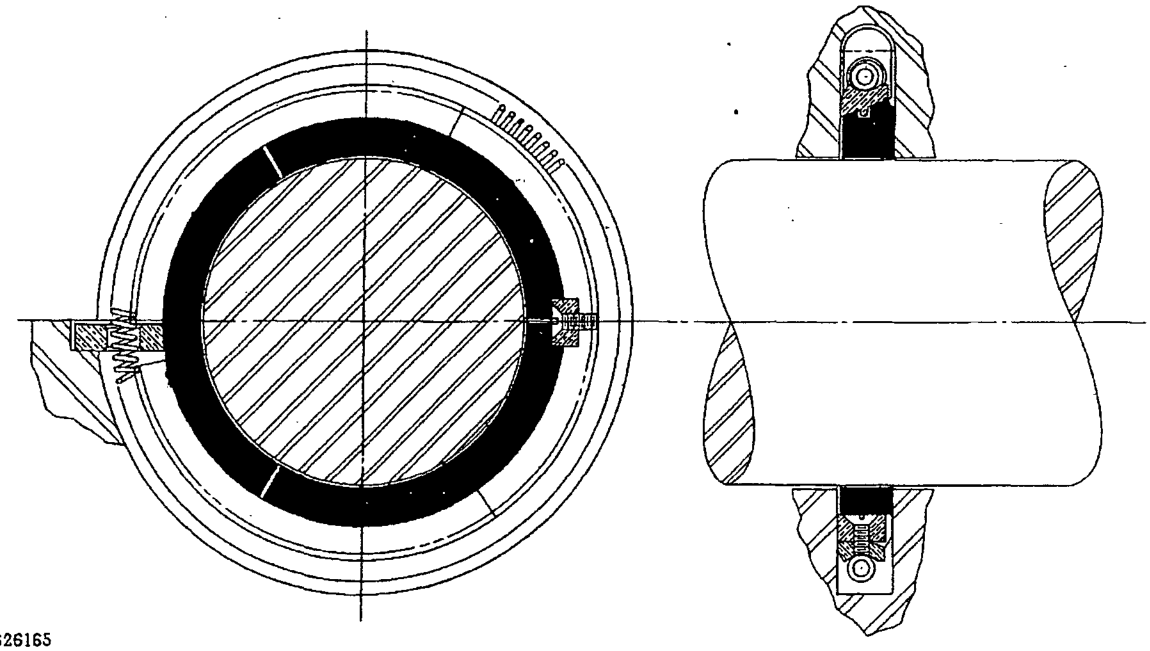


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FIG. 21

Elliott Company. If these recommended sealing compounds are not available, a high grade steam sealing compound, applied in accordance with manufacturers' recommendations, can be used to obtain a satisfactory steam-tight joint.

The general arrangement of packing cases and carbon rings is similar to the standard line but are specially designed extra heavy construction to withstand and seal against the high exhaust pressures. The procedure previously outlined for removing packing cases and carbon rings (Section II—Packing Cases and Carbon Rings) should be followed. This section also gives the instructions for making up the packing case vertical and horizontal flange steam joints. It should be noted that a total of eight carbon rings are always used in each packing case. These rings may be either of the standard type construction previously described or of the Huhn type illustrated in Figure 21. The type of ring used depends upon the exhaust pressure for which the particular turbine is designed. Standard type rings and Huhn type rings are interchangeable in the same packing case design. The following combinations of carbon rings are used for the indicated exhaust pressure ranges:

Up to 150 psig:

8 Standard type rings per packing case.

151 psig to 250 psig:

2 Standard type rings (these are the two outer seal rings) and 6 Huhn type rings per packing case.

Figure 19 illustrates the construction of the Huhn type carbon ring assembly. The assembly consists of a three-piece carbon ring which is held together by a three-piece bronze retainer ring. The carbon ring stop prevents the ring from rotating with the shaft. To remove this type ring from the packing case, unhook but do not remove the circular spring assembly. The spring will prevent the retainer ring and carbon ring segments from dropping down in the packing case ring groove.

First remove the bronze retainer ring segments and then the carbon ring segments by rolling around the shaft. Parts of each ring and spring assembly should be kept together so that they may be placed together in the same packing groove from which they were removed. When reassembling rings, be sure that those sections which abutt each other are marked with similar markings so that they are reassembled mark to mark. The same care and precaution must be followed for initial startup and for run-in of newly installed carbon rings of either the standard or Huhn types as is recommended for the standard line of turbines. For these recommendations, refer to Section III—Adjustments and Clearances under Carbon Rings.

SECTION VII—EMERGENCY AND MAINTENANCE HINTS

Your turbine was completely checked at the factory and was shipped in perfect operating condition. The following brief notes are added for handy quick reference if your turbine is not operating properly.

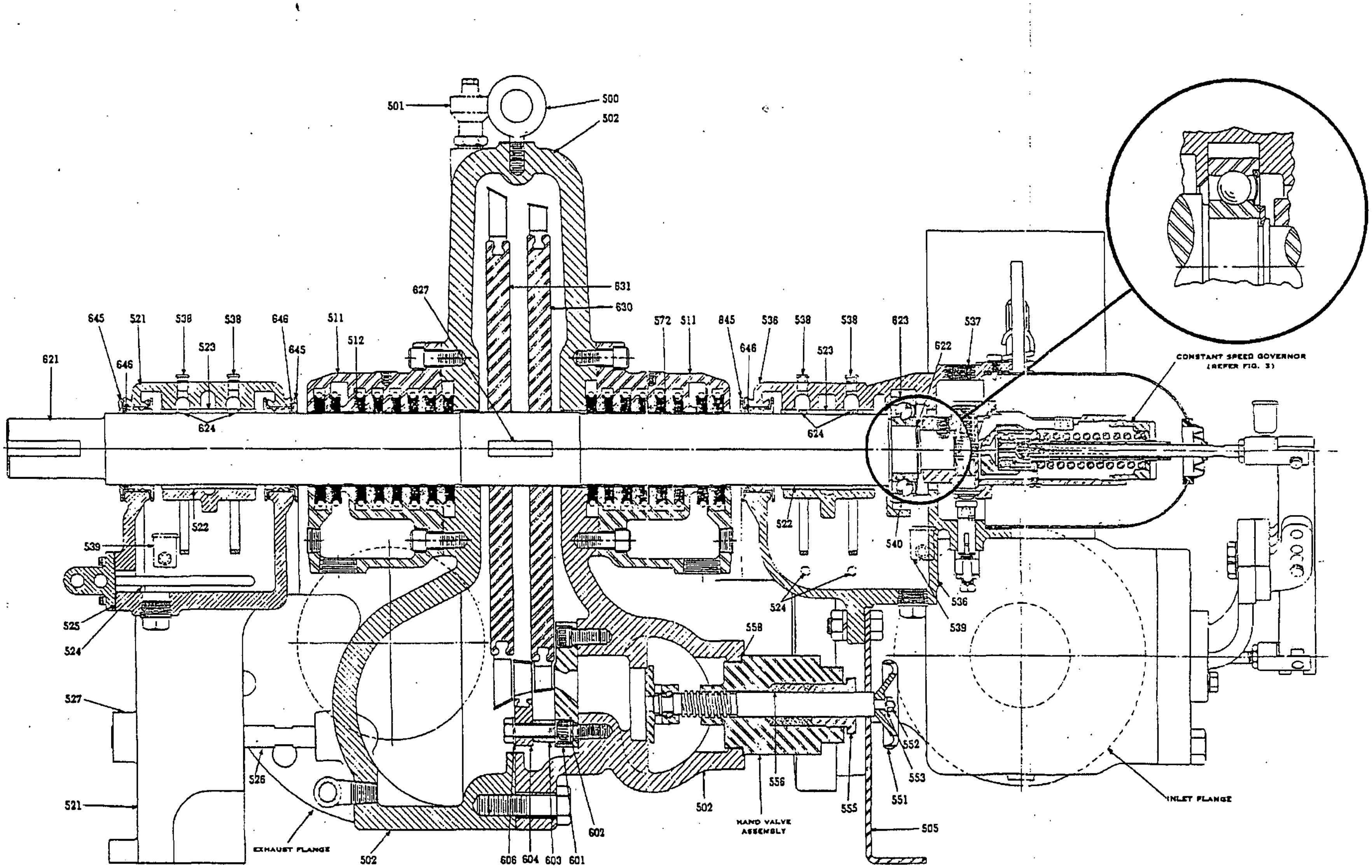
VIBRATION—Should your turbine begin to vibrate, the cause may be:

(1) Misalignment with driven machine.
(2) Worn bearing liners having clearance in excess of .015". Bearing liners should be replaced.
(3) Worn coupling developing play. If coupling is of a type which cannot be repaired, it should be replaced.
(4) Tight carbon rings. In refitting, these rings may have been made tight on the shaft. Recommended cold clearance between rings and shaft must be maintained. Old rings may be carefully rebored or new rings should be installed.
(5) Shaft misalignment. This is most likely caused by excessive steam inlet or exhaust piping strains. Correct piping to relieve strains and realign unit.
(6) Unbalanced rotor. This occurs if buckets or shrouds have been damaged. If damage cannot be corrected readily, the rotor should be returned to the factory for rebucketing and rebalancing. Non-uniform scale deposits and incrustrations from dirty steam conditions may also cause rotor unbalance.
(7) Clogged carbon ring grooves in packing case. Dismantle and clean.

GOVERNOR HUNTING—Should the governor hunt, the cause may be:

(1) Worn or sticking governor parts. Dismantle the governor and clean all parts and inspect for wear. Worn parts should be replaced.
(2) Worn or sticking governor linkage. Dismantle and clean all parts and inspect for wear. Worn parts should be replaced.
(3) Sticking governor valve stem. Valve stem packing may be fouled or drawn up too tight or stem may be coated with scale from boiler compounds. Dismantle, clean and inspect all parts. Clean valve stem and replace stem packing.
(4) Leaky governor valve. This may be caused by scale deposits or other foreign matter. Remove valve and remove scale from valve and valve seat. Particular care must be taken not to damage seats. Valve may also leak due to improper governor adjustment.

OVERSPEEDING—The overspeed governor shutting the turbine down is not positive evidence of overspeeding. Improper adjustment of the overspeed governor will cause the turbine to trip out. Dismantle the governor, clean and check for smooth operation without binding. Reset governor and linkage and check tripping speed with an accurate tachometer. If tripping speed is 10% or more above the maximum operating speed, the following



W-601214 FIG. 20—SECTION THROUGH "BYRH" TURBINE FIG. 20

should be checked:

(1) Governor valve stem for sticking and binding.
(2) Tightness of governor valve and seat (does the valve leak?).
(3) Will speed governor close governor valve with some travel left in the governor.

OVERSPEED GOVERNOR SHUTS TURBINE DOWN AT ABOUT NORMAL SPEED —This may be due to the following:

(1) Clearance between trip pin and plunger assembly too small. Adjust to recommended clearance.
(2) Worn knife edges on resetting and latch levers. Remove and replace.
(3) Improper adjustment of overspeed governor. Reset and lock in place.
(4) Excessive vibration.

OVERSPEED GOVERNOR DOES NOT FUNCTION AT 10% OVERSPEED — This may be due to the following:

(1) Trip pin assembly bound and gummed up. Remove, clean, and readjust.
(2) Clearance between trip pin and plunger assembly excessive. Inspect parts for wear, if worn replace. Adjust to recommended clearance.

OVERSPEED GOVERNOR FUNCTIONS PROPERLY BUT VALVE DOES NOT CLOSE—This may be due to the following:

(1) Valve stem sticking and binding. Remove, clean, and inspect. Stem may have been bent. Stem and bushing may be worn giving excessive clearances and insufficient guiding. Stem may be binding due to scale deposited from boiler compounds.
(2) Latch lever may be corroded or may have too much engagement. Clean and readjust.

CARBON RING GLAND LEAKAGE: This may be due to the following:

(1) Broken or damaged rings on assembly. Remove, inspect, and replace.
(2) Worn rings. In an emergency this can be corrected by removing a small amount from the ends of each ring segment. At best, this procedure is only a "patch up" arrangement. Recommend installing new rings.
(3) Leakage may be between ring face and corresponding face in the packing case. This is usually caused by dirt or scale from boiler compound or joint sealing compound. Clean faces but do not damage surfaces.

VALVE STEM LEAKAGE—If steam leak past the emergency valve stem when valve is open is objectionable, it may be due to improper seating of the auxiliary seal at the bottom of the stem guide or it may be due to a restricted leakoff pipe where a stem leakoff is used. Leakoff pipes should be of ample size and open to atmosphere. If steam leakage increases, it is due to wear of stem or bushing. Replace worn parts. Steam leak past the constant speed governor valve stem is caused by worn or incorrect packing. Replace, using correct packing.

EXCESSIVE BEARING WEAR—This may be due to the following:

(1) Lack of proper lubrication. On ring oiled bearings, if oil rings are not a true circle, rings will not carry sufficient oil to the bearings. Also, if oil level is not as prescribed, oil rings will not carry sufficient oil to the bearings. On forced feed bearings, dirt and obstructions in the oil feed lines cause lack of lubrication.
(2) Excessive rotor vibration may pound out the bearings. The unit should be kept in balance and running smoothly at all times.