Westinghouse

Turbines

for

Mechanical Drive

Type MD

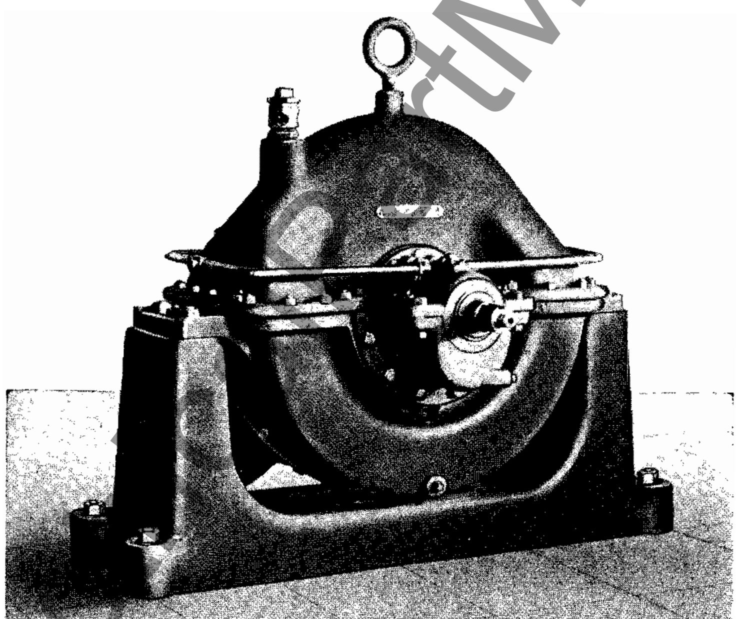

Fig. 1—Side View of Mechanical Drive Turbine Illustrating Center-Support Feature

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Westinghouse

Turbines for Mechanical Drive Type MD

General Description

The Westinghouse steam turbine of the mechanical drive type is essentially a single wheel with blades mounted on its periphery. Refer to Fig. 2. Steam enters the nozzle block "N" through suitable passages in the cylinder casting. The steam expands in the nozzle transforming this heat energy into velocity. Having reached its maximum velocity at the mouth of the nozzle, the steam impinges upon the blades "B" which causes them to move forward, thus revolving the turbine wheel. By the rotation of the wheel the heat energy of the steam is transformed into work at the turbine coupling.

The velocity of the steam at the nozzle mouth is much greater than that of the blades so that after passing through the blades from the nozzle it becomes advantageous to collect the steam in a reversing chamber "R" which redirects the steam against the wheel a second time thereby adding the energy of another pass through the blades to the turbine shaft before the steam escapes into the exhaust.

Turbine Support

The cylinder base is supported in a cradle-like sole plate in such a manner that it hangs suspended at approximately the center of the turbine shaft. With the usual type of support where the feet are cast on the bottom of the cylinder, a considerable rise of the turbine takes place when heated up. This must be compensated for by setting the turbine low when cold, or by taking up the misalignment by means of a flexible coupling.

With the cylinder supported at the center line, it is free to expand upward or downward while the shaft remains in its original position. The position of the coupling, therefore, does not change in going from hot to cold, or vice versa, with the result that misalignment and coupling troubles are reduced to a minimum.

Turbine Casing

The turbine casing is split horizontally, with all pipe connections attached to the base so that a complete inspection may be made by raising the cylinder cover. In raising the cylinder cover it should be lifted straight up to clear the turbine-rotor. Before replacing, scrape joints clean, and make up with

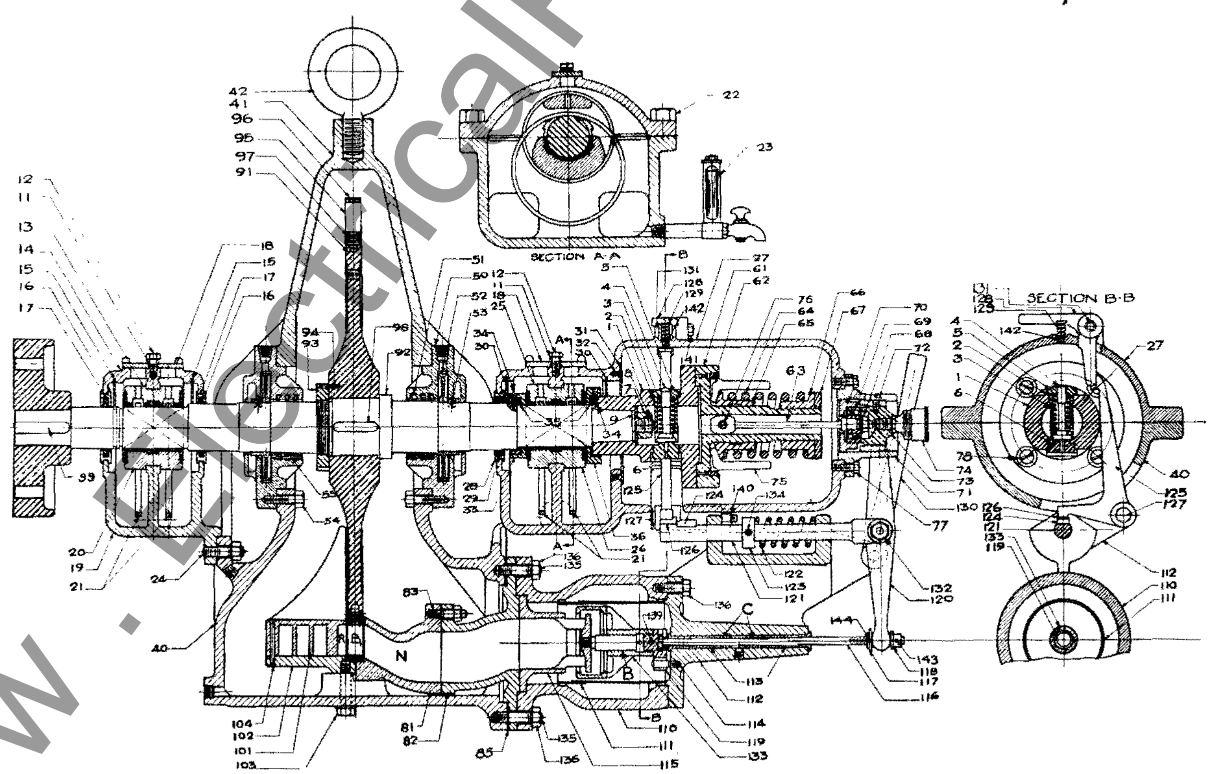


Fig. 2

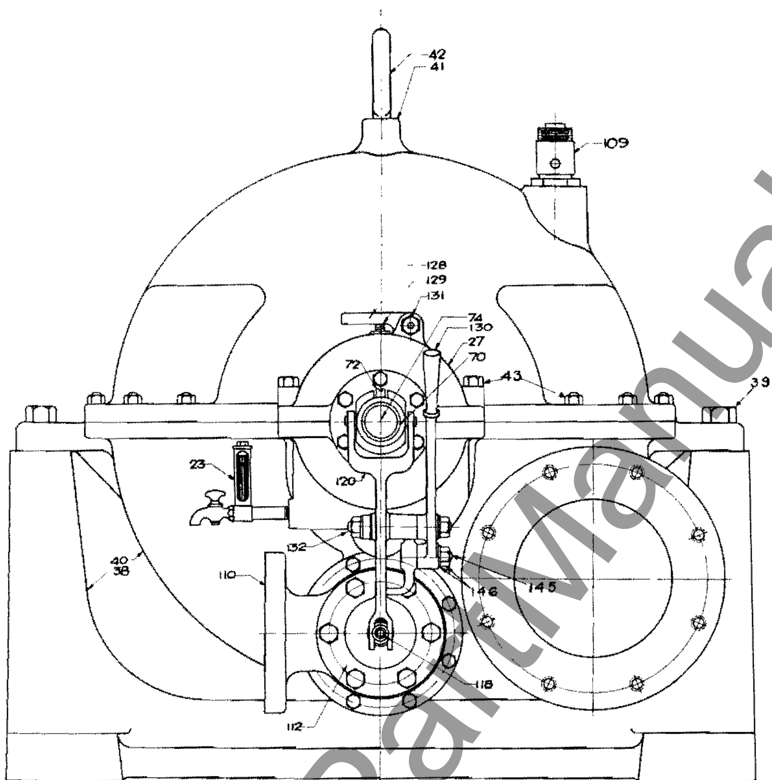


FIG. 3

shellac. Be sure to pull the joint down tight before shellac hardens.

Rotating Element

The rotating element consists of a shaft, carrying the rotor, supported by two ring oiled bearings. The rotor is pressed on the shaft with a tapered press fit and is held in place by nut (93) (Fig. 2) which in turn is locked by set screw (94). A loose rotor may result from overspeeding of the turbine and is evidenced by vibration. If a loose rotor is suspected it should be pressed off the shaft and the fit examined. In putting on a new rotor, be sure that a good fit is obtained. The rotor should slide upon the shaft until it is 1 inch from the hub and must be pressed on the rest of the distance,

One end of the shaft supports the coupling on a straight fit. The key should be well fitted to avoid distortion of the coupling face. If the coupling runs out of true, it should be lightly faced off.

The automatic trip and the governor are supported on the other end of the shaft overhanging the governor end bearing. The governor hub contains the automatic stop device. To take the hub from the shaft, remove the governor by taking out the four screws (78). Bend the auto stop washer (2) back and unscrew auto stop retainer and take entire stop from hole. Insert screw driver in end of hub hole and take out lock screw (8) after which nut (7) may be unscrewed and hub slipped off. No press fit is required on this hub, but a good fit along the shaft must be obtained to insure governor running true.

Auto Stop

The auto stop is located in the governor hub (1) Fig. 2 and consists of a weight (4) which operates against spring (3) held in place by retaining nut (5) and plug (6).

The function of the auto stop is to shut the turbine down, if, for any reason, the main governor should fail to operate and allow the turbine to overspeed.

The auto stop should be set to operate at about 10 per cent above normal speed. If it operates below this speed, remove retainer (5) and add washers at (3). If it operates above the desired speed, remove washer at (3). The amount of washers added or removed must be obtained by trial. Be sure and lock retainer by means of lock washer (2) after final adjustment is made.

The operation of the auto stop is as follows:

The pin (4) (Fig. 2) is forced out by centrifugal force compressing the spring (3) and comes in contact with knock off lever (125) (Sec. B-B) disengaging the latch plates (124 and 126) and allowing the spring (122) which is under compression, to pull the governor mechanism inward, forcing the governor valve (133) hard on its seat (115).

When the turbine slows down, the pin (4) returns to its former position and the governor poppet valve may be opened and the auto stop reset by pulling outward on the hand lever (130) which allows the latch plates (124 and 126) to engage and hold the governor linkage in its running position.

The auto stop may be operated by hand by striking the hand trip lever (128) which will disengage the latch plates (124 and 126) through the knock off lever (125).

Governor

The governor is of the horizontal centrifugal type. It is centered on the governor hub and bolted thereto by four counter-sunk screws. The governor body (61) (Fig. 2) is made in one solid piece and supports the knife edge bearings (62) as shown. Each governor weight is made in one piece, thus eliminating the possibility of dislocation of separate knife edges. The lower toe of the governor weight has the shape of a gear tooth. It is pivoted on the knife edge machined integral with the weight. Both the toe and knife edge are case hardened. The spring sleeve (65) is also hardened and is held against the toe of the governor weight by the tension of the spring (64). This tension is adjusted by means of the adjusting nut, (66).

An elongated slot is machined in the governor spider (61), allowing forward and backward motion of the spring sleeve pin (76) which passes through this slot and fits in a carefully reamed hole in the spring seat (65). This pin is held in place by the governor spring.

As the governor revolves, the ends of the governor weights fly outward, the force of which is transmitted through the knife edges and the toe of the weight in the spring sleeve compressing the governor spring. The movement of the spring sleeve is transmitted through the spring sleeve pin to the governor spindle (63) which, through suitable linkage described later, acts upon the governor poppet valve thus giving the proper speed.

To increase the speed of the turbine, increase the compression of the governor spring (64) (Fig. 2) by means of the adjusting nut (66). To decrease the speed, screw back on the adjusting nut. Always lock the adjusting nut (66) by the lock nut (67) after any change. One full turn of the nut either way should change the speed about 100 rpm.

All moving parts of the governor proper are hardened and require no lubrication.

If hunting occurs, the ball on the end of the governor spindle may be sticking or the spring seat sleeve may be riding on the slots in the governor hub. To remedy, dress down the parts slightly with fine emery cloth. An unstable action of the governor may result from lost motion due to an improper fit between the governor spindle and the pin or the pin and sleeve. This lost motion can only be taken up by replacement of these parts.

In removing the governor spider from the hub, mark it so that it can be replaced in its original position and be sure that the flanges are clean and free from burrs before replacement is made.

To see if governor operates freely, remove governor spring as explained under "Governor Linkage," and press inward on governor spindle at the same time, pulling one weight outward. Release weight suddenly still maintaining pressure on governor spindle. If weight snaps back into place freely, it is correct. If rub occurs, it can be felt. Repeat

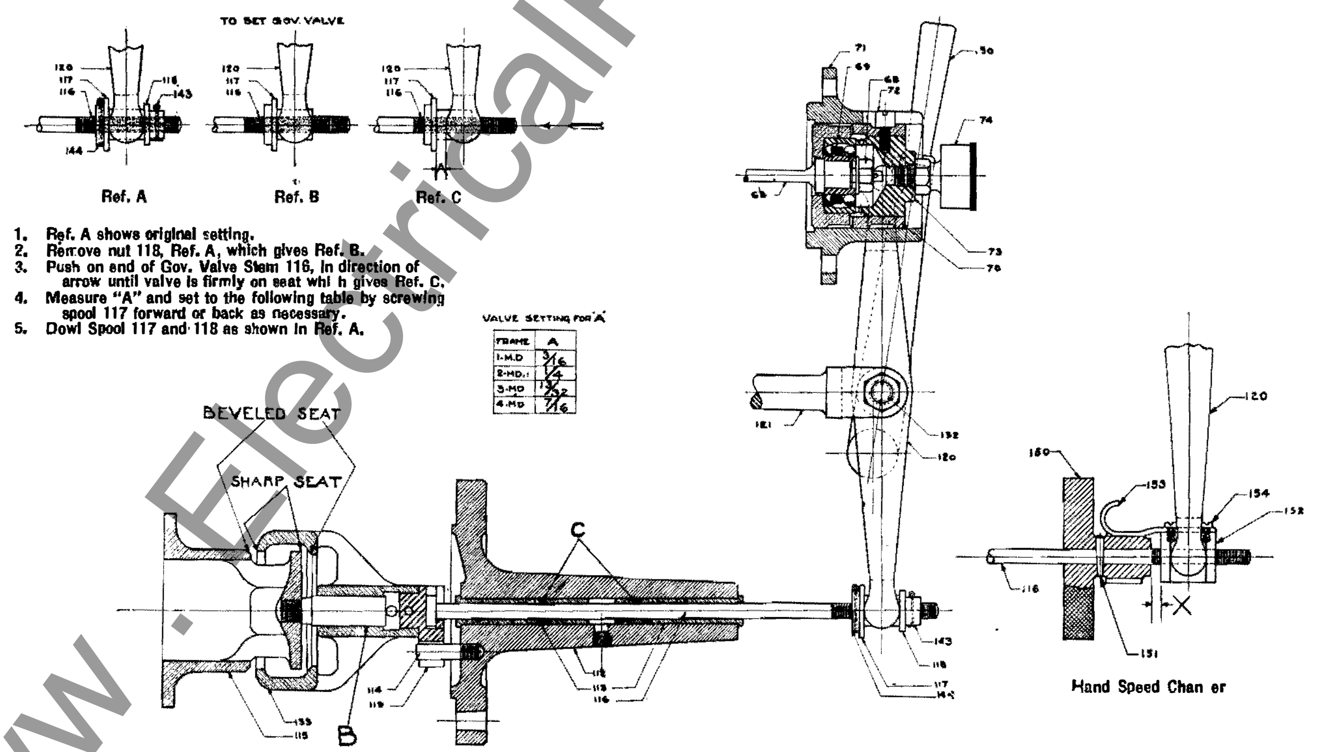


Fig. 4

process for other weight and then for both weights. When governor weights are removed, be sure and replace them in their original position.

Governor Linkage

The governor linkage is the means of transferring the motion of the governor weights to the poppet valve. Inasmuch as the motion of the governor weights must be quickly and accurately transmitted to this valve, it is necessary that there be very little lost motion in all the connecting linkage.

The motion of the governor weights is transmitted through the governor spindle pin (76) (Fig. 2) to the governor spindle (63) (Figs. 2 and 4). This spindle is in turn connected to a self aligning ball bearing (69) located in the thrust bearing case, (70) which in turn is supported by the turbine housing in the thrust bearing housing (71). Referring to (Fig. 4) the main poppet valve lever, (120) has its upper end built in the form of a trunnion, which attaches itself to the lugs on the thrust bearing case (70). On (Fig. 2) it will be seen that the poppet valve lever is pivoted on the automatic stop ram (132). The lower portion of the poppet valve lever is built in the form of a split spherical cam, operating against the poppet valve stem spools (117 and 118) (Fig. 4).

The governor spindle, (63) has a curved surface at the point where it attaches itself to the governor spindle pin, and at this point is held central with the governor spider (61). The other end of the spindle is fastened directly to the self aligning ball bearing (69). It is therefore obvious that this connecting linkage has considerable flexibility, so that if the governor itself runs out of true due to a wearing of the bearings or any other cause, vibration will not be transmitted to the thrust bearing.

The thrust bearing (69) (Figs. 2 and 4) is enclosed in a brass housing, in the end of which is screwed a grease cup to lubricate the bearing. This bearing should receive an ample supply of grease and the small oil hole on the top of the supporting case (71) should be occasionally given a squirt of oil.

It is to be noted that the governor both pushes the poppet valve lever closed, and also pulls it open so that no return springs are needed, thereby lightening the load on the thrust bearing to its minimum point.

Disassembling of Governor Linkage

To disassemble the governor linkage, lift off the turbine bearing cover (27) (Fig. 2) and loosen governor spring lock nut (67). Governor spring nut (66) may then be loosened to its fullest extent so that the governor weights may be taken out. Pull spring (64) toward the governor thrust bearing and take out governor spindle pin (76). Take off auto stop hand lever (130) and drive out poppet lever pivot pin (132). Unscrew poppet valve stem spool nut (143) and pull governor linkage straight back. The disassembling of the governor thrust bearing case is self evident.

In assembling the linkage, be sure that the thrust bearing casing guide pin (72) is in place to keep the thrust bearing casing from revolving. In replacing the linkage, the governor poppet valve travel should be checked as indicated in the following paragraph.

Steam Chest

The steam chest (110) (Fig. 2) is located directly under the governor housing and is bolted to the cylinder base, being centered on the nozzle extension piece (82) at the same time forming a tight joint between the governor poppet valve seat (115) and the nozzle extension piece (82). The steam chest also holds the governor poppet valve seat (115) in place and likewise centers it. Surrounding the governor poppet valve and held by the steam chest casing, is the steam strainer (111) (Fig. 2). The steam chest cover (112) (Figs. 2 and 4) is bolted directly on the end of the steam chest and forms the support for the automatic stop linkage, and for the governor poppet valve stem. This cover is bushed by brass bushing (113) which has a fine clearance between itself and the poppet valve stem (116). At the center of the bushing a space is left open which forms a steam leak off to assist in sealing the steam so that it does not pass out along the poppet valve stem. This passage is tapped with a pipe connection so that a slight leak at this point may be conducted to a point where it is not objectionable. There is no stuffing box on the poppet valve stem, and severe leakage must be taken care of by the renewal of the bushings. Should the poppet valve stem stick in the bushing just described, it should be taken out and the high spots dressed with emery cloth.

The steam strainer (111) may be taken out by removing the steam chest cover (112). This strainer should be removed and cleaned as often as necessary.

Governor Poppet Valve

The governor poppet valve is located inside the steam chest. It is of the double seated type and is held directly against the nozzle extension piece (82) (Fig. 2) by means of the steam chest itself. The joint between the steam chest flange and the nozzle extension piece should be left open so that sealing will occur at the joint between the steam chest and the governor poppet valve and the nozzle extension piece. This joint is hand scraped to make it steam tight. Screwed into the governor valve seat is a guide pin which forms the support for the governor poppet valve itself, so that with distortion of the governor poppet valve seat, the valve will properly center itself. It is essential that the fit between the governor poppet valve and its seat be kept as close as possible, but where the steam contains considerable scale, this fit must necessarily be increased in order to prevent sticking at this point. The governor poppet valve is prevented from turning on this seat by pin (114) screwed into the steam chest cover. It is essential that the fit between this pin and the valve be smooth so that no sticking will occur at this point.

The governor poppet valve coupling (119) (Fig. 4) is made of steel and functions as a flexible joint between the valve and the valve stem. Its construction is readily apparent from the illustration.

To inspect the governor poppet valve, take off poppet valve lever and automatic stop lever. Loosen steam chest cover and pull cover and poppet valve straight out.

The governor poppet valve should never be ground to its seat in order to make a tight joint, inasmuch as the valve will become unbalanced inwardly and will cause hunting of the turbine. A test of whether the valve is leaking too badly for use may be applied as follows: With the valve held firmly on its seat by hand, a full head of steam should be turned on and if the turbine begins to revolve it is evident the leakage of the valve is too great for practical use. If the turbine does not turn over, even though there is considerable leakage, no harm is done by using this valve. In case a valve leaks too badly, it must be removed and reseated. In reseating, do not bevel seats indicated as sharp on (Fig. 4), but face off these seats to maintain line contact.

To Set the Governor Poppet Valve

Reference to Fig. 4 shows the position of the poppet valve and the poppet valve stem as it will be received from the factory. Before operating a machine, the setting of the governor poppet valve should be checked and if any work has to be done on the governor linkage, the valve travel should again be set and adjusted, if necessary. To adjust the governor poppet valve (133) take out the cotter pin (143) from nut (118) which gives a setting as shown in Ref. B. With the hand, push the valve stem forward as shown in Ref. C. Measure the distance from the spool (117) to the contact of the poppet valve lever (120) and adjust the spool by screwing it backward or forward to give the correct valve travel for the proper size frame.

Nozzles and Reversing Chambers

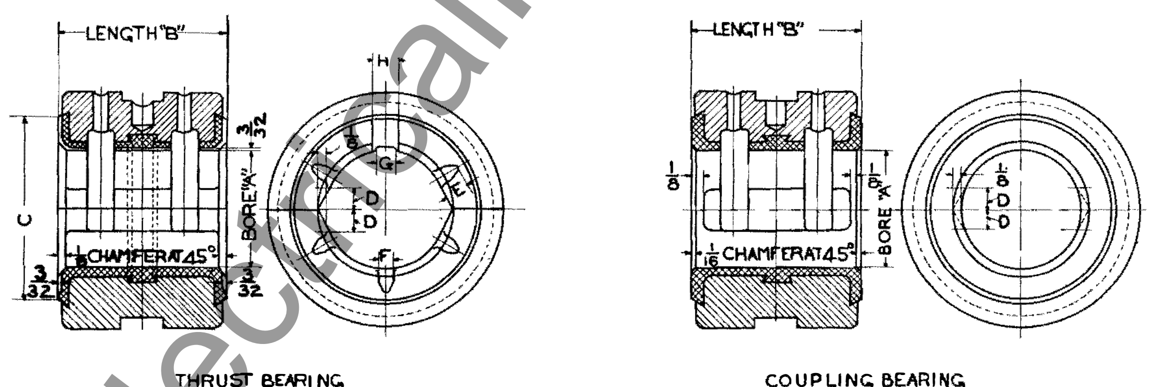
The nozzles (81) (Fig. 2) and reversing chambers (101) are located in the cylinder base. When making any setting on the turbine, adjust the rotor so that there will be one-sixteenth of an inch clearance between the blades and the reversing chamber; in other words, set the turbine rotor centrally before making any adjustment on the machine. After setting the rotor centrally check up the clearance on the gland runners (52) as shown on Fig. 6. With these clearances correct, adjust the thrust bearing to hold the rotor in this position.

The nozzle is flanged to the nozzle extension piece (82). If new nozzle is to be installed it should first be connected to the extension piece and the nozzle set centrally in the cylinder base by means of a liner between the nozzle extension base flanges and the cylinder base flange, as shown at (85) (Fig. 2). In setting new nozzles and reversing chambers, refer to Fig. 2 and note that the reversing chamber should be set as shown so that it will be flush with the nozzle. It is important that the reversing chamber be so set as to catch all steam emerging from the blades.

Bearings

Inasmuch as it sometimes becomes necessary to rebabbitt a bearing in the field, we have prepared Fig. 5 for this purpose. The table given indicates the proper machining of the bearing for each frame and the frame can be readily identified by measuring the journal of the shaft. In rebabbitting a bearing, if care is used to properly groove and machine it in accordance with the dimensions given, the best results should be obtained.

On all direct connected turbines of our make, the bearings are of the two ring oil type, the bearing next to the coupling being known as the coupling end bearing, and the other end bearing being known as the thrust bearing. It is to be noted that while both bearings are made in



FRAME	BORE "A"	BEARING CLEARANCE	LENGTH "B"	C	D	E	F	G	H	THRUST BEAR CLEARANCE ENDWISE
1-MD	1.750 {1.752 1.750}	.003-.006	3	2 7/8	3/8	7/16	1/4	3/8	1/2	.002 TO .005
2-MD	2.125 {2.126 2.125}	.003-.006	3	3 1/4	3/8	7/16	1/4	3/8	1/2	.003 TO .007
3-MD	2.500 {2.502 2.500}	.004-.008	4 1/4	4 1/4	7/16	3/4	3/8	1/2	3/4	.004 TO .008
4-MD	2.500 {2.502 2.500}	.004-.008	4 1/4	4 1/4	7/16	3/4	3/8	1/2	3/4	.004 TO .008

Fig. 5

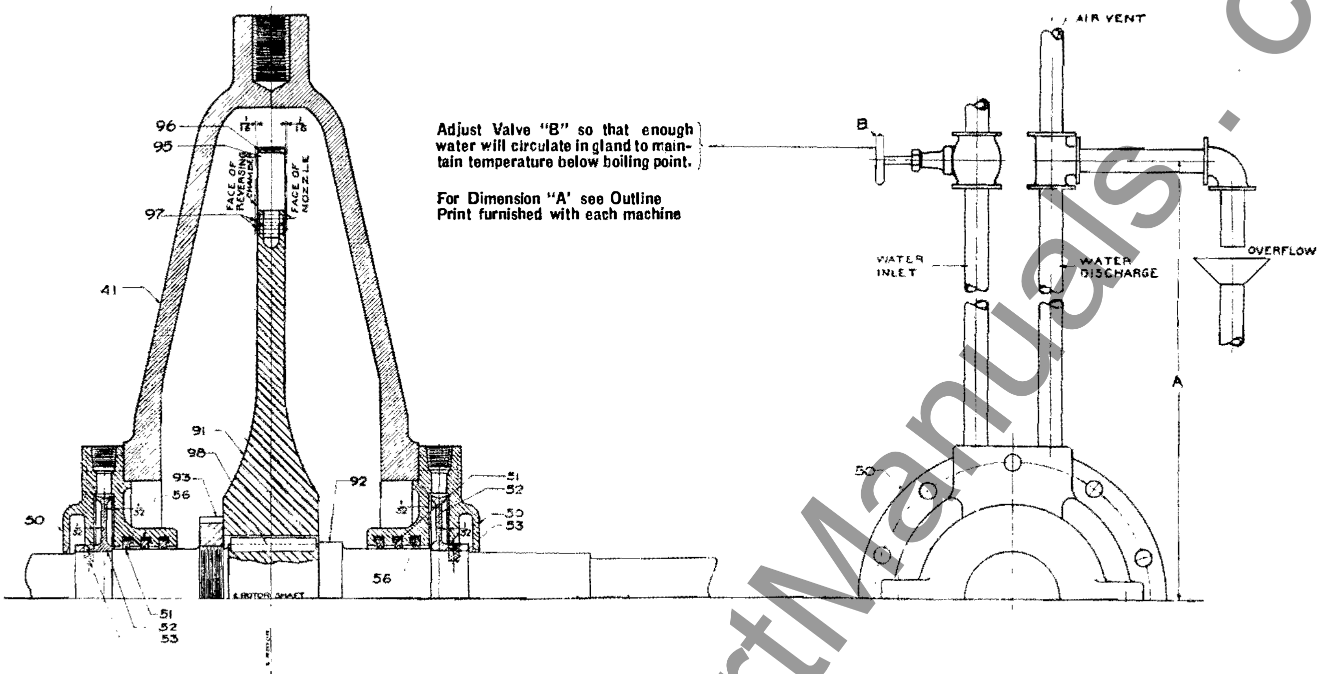


Fig. 6

the same general manner, the grooving is different on the thrust bearing. In order to allow proper lubrication of the thrust face, and on the bearing particularly, it is important that this grooving be properly made. The thrust bearing should be set for end play to the clearances, as given in the table. This clearance may be adjusted by taking out the bearing complete and sliding the collars (33 and 36) (Fig. 2) forward and either putting in or taking out liners at (35). It is essential that these clearances be properly set in order to get good results.

Glands

The glands on this type of turbine shown on Fig. 6 are of the combination labyrinth and water sealed type. The labyrinth packing (51) is placed inside of the gland runners so that for cases of very low speed, where the runner is of little value, the labyrinth packing accomplishes the sealing of the gland. This packing should be very carefully fitted in the gland, allowing it to have about three thousandths of an inch side clearance in its groove so that they may be free to move forward and backward under the action of the shaft and the packing ring springs (56). In making an inspection of the glands, the gland horizontal flange bolts should be removed and the upper half of the gland should be raised with the cylinder cover. In replacing, the joint should be made up with shellac and the joint should be made before the shellac hardens. The water portion of the gland is piped up as shown in the figure and the proper height of standpipe is given in the official outline drawing furnished with each machine.

Valve "B" (Fig. 6) should be so adjusted that enough water will circulate through the glands to maintain a temperature slightly below that of the boiling point.

Excessive water leakage from the gland may indicate that the standpipe is too high and the head on the gland should be reduced. It may also indicate that the gland is not properly set up so that the horizontal flanges inside of the gland cavity do not match up, thus forming a sharp projection, which breaks up the flow of the water. Too close clearance on either side of the gland runner may also give a considerable stoppage of water.

Dual Drive Units

Dual drive units find their application in driving electrical generators for excitation and other purposes, and also for driving jet condensers and pumps. This type of drive is desirable for two reasons: First, that it makes the apparatus more reliable by having a standard unit always at hand, and second that the turbine end offers a ready means of regulating the heat balance of the plant. Fig. 7 shows the turbine and motor being directly connected to the generator. The operation of such a set is as follows:

Under normal conditions the no load speed of the turbine will be set, as nearly as possible, about 1 or 2 per cent below the full load motor speed the motor being used practically all the time as the main driving element. When the motor comes up to speed driving both the generator and the turbine, since the turbine speed is set slightly lower than the motor speed it follows that the governor valve of the turbine will be closed and no steam will pass through it. The turbine will then run idle. If there is a disturbance on the motor circuit, and it should be thrown out of service, the turbine will take the full load at about 4 per cent below the normal full speed of the motor, thereby preventing a shutdown of the exciter.

The function of regulating the heat balance of the plant is accomplished in the following manner: Assume that the motor is pulling the full load with the turbine running idle, and it is desirable to introduce steam into the feed water heater for heat balanced regulation. The hand speed changer, as shown on Fig. 4, may then be brought into operation so that the turbine speed is slightly raised. The speed of the turbineby this speed changer can then be regulated so as to take any portion or all of the load from the motor.

be greater than ½ inch. The reason for being sure that this distance is correct is so that the travel of the governor will not be exceeded when the valve is screwed outward to its furthermost position. In other words, at any position of the adjusting nut lock the governor must have sufficient travel to close the valve.

Foundation

Build the foundation solid and of ample weight. Sleeves around the foundation bolts should have about ½-inch clearance for lining up the bedplate. Leave the top of the foundation at least 1 inch low to provide for grout. The foundation must be rigid, thoroughly settled, and independent of the building as far as possible.

First set the bedplate level, supported upon iron wedges, spaced from 12 to 18 inches apart. Do not depend upon the stiffness of a cast iron bedplate to give or maintain good alignment. Care must be exercised to see that the weight is evenly distributed on the wedges to keep the bedplate from springing. Put the turbine in proper position relative to the driven apparatus. Leveling may be done on any finished projecting pads, which offer a rest for the level.

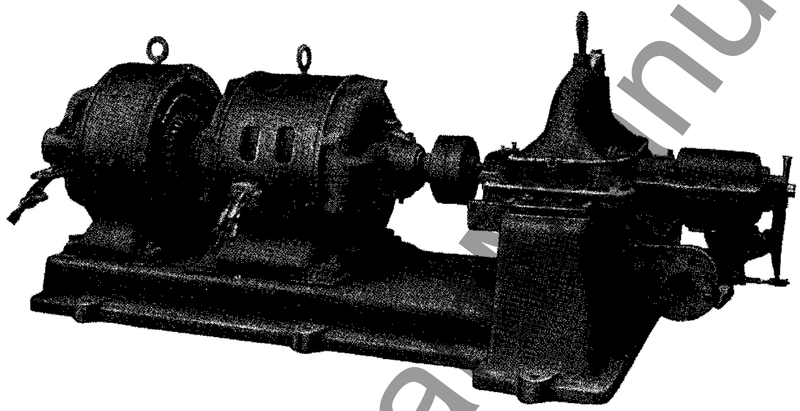


Fig. 7—Dual Drive Unit

The installation and maintenance of a dual drive unit of this type are exactly the same as previously described in this instruction book.

Refer to Fig. 4, Page 5, showing cut of hand speed changer. Adjusting nut lock (152) is dowelled to the poppet valve stem. The adjusting nut (152) is threaded so that the stem may be screwed in to or out of this nut while spring (153) riding in slots in the adjusting nut lock is used for locking the final position.

It is to be noted that the speed of the turbine can be regulated by this hand speed changer while the unit is in operation. If the speed of the turbine is to be decreased, the poppet valve should be screwed nearer to its seat by means of the hand wheel. If the speed is to be increased, the hand wheel should be turned in the opposite direction.

The position in which the adjusting nut lock (150) is dowelled to the stem is of the utmost importance. If a hand speed changer is to be applied on a machine already in service the adjusting nut lock should be dowelled to the stem in such a manner that with the governor poppet valve held firmly on its seat the distance "x" should not

Erection

It is most important that the machine be properly installed. Misalignment, distortion of the bedplate, and errors of this kind will, later, bring about serious operating troubles even though the machine seems to run fairly well at first.

In some cases the turbine and driven apparatus are mounted upon a continuous bedplate and in other cases they are on two separate bedplates. In either case, the method of procedure is the same.

There are three steps in erecting a unit. The first is to grout the unit in as nearly correct alignment as possible. The second is to check the alignment after the grouting has set and make any changes necessary to bring about accurate alignment by moving the turbine on its bedplate. The third is to dowel the turbine and driven apparatus to the bedplate.

If the position of the driven apparatus is to be determined by the pipes to which it connects, be sure that this point is checked at this time. Check also the exhaust and inlet flanges on the turbine and all pipe connections on the driven apparatus to see that they are vertical. If they are not, this would indicate that the preceding work has not been done accurately and should therefore be rechecked.

Next check the alignment of the coupling, making any changes necessary to bring about good alignment.

After this is done, a dam of boards or bricks of sufficient height should be built around the bedplate and the grouting poured. It is recommended that the interior of the bedplate be filled solid with grout. Make grouting thin, using a mixture of one part high grade Portland cement and one part clean, sharp sand,

Allow grouting to become thoroughly set and then slug up foundation bolts tight.

To set on steel work, set bedplate on shims not over a foot apart, and provide against these shims slipping out by screwing them to the steel work. Level up bedplate as previously described and make sure that it sets level on all shims.

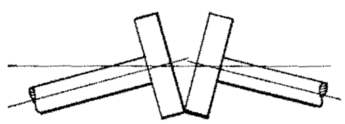


Fig. 8—Showing Two Shafts Which are Concentric but are in Angular Misalignment

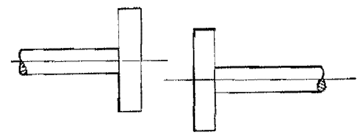


Fig. 9—Showing Two Shafts with no Angular Misalignment but which are not Concentric

After carefully pulling down the foundation bolts, the final alignment should be checked.

Do not run the unit until the final alignment is completed.

Alignment of Coupling

All couplings must be lined up for two conditions namely: **Angular Misalignment and Concentricity.** The two conditions are illustrated in Figs. 8 and 9.

In lining a cold turbine to the driven apparatus, it is customary to set the turbine several thousandths of an inch low to allow for expansion when the turbine becomes heated up. With the Westinghouse construction of supporting the turbine at the center line, this allowance is not necessary. (See description, Turbine Support, page 3.)

Aligning Coupling to Correct Angular Misalignment

Inasmuch as coupling faces are rarely true with their respective shafts, it is necessary to make the alignment by some method which takes care of this condition. This is accomplished by the use of the following method which should be used even though the coupling faces have just been trued up in a lathe:

1. Remove coupling pins or bolts.
2. Mark off two points on the sides of both couplings with chalk as shown below:
3. Measure distance between coupling faces at the chalk marks with a feeler gauge at both A and B (Fig. 10).

Suppose that the following readings are taken:

At A, distance between coupling faces equals .030 inch.

At B, distance between coupling faces equals .013 inch.

Subtracting the two values given, .030 inch—.013 inch = .017 inch.

4. Turn **both** couplings 180 degrees and measure the distance between coupling faces at A and B. (Fig. 11.)

With this condition, suppose that the following readings are taken:

At A (Fig. 11) distance between coupling faces = .049 inch.

At B (Fig. 11) distance between coupling faces = .018 inch.

Subtracting B from A .049 inch—.018 inch = .031 inch.

The couplings then are out of alignment across the diameter A to B by the amount (.031 — .017) ÷ 2 = .007 inch.

On the radius from C to A, or C to B, this amounts to .007 ÷ 2 = .0035 inch.

5. To put the couplings in line when they are in this position, move turbine sidewise so that reading at A (Fig. 11) equals .049 inch—.0035 inch = .0455 inch. Then reading at B (Fig. 11) must be .018 inch + .0035 inch = .0215 inch. The difference then will be .0455 inch —.0215 inch = .024 inch. To check turn both couplings **back** 180 degrees and the difference in readings should be .024.

6. To line up top and bottom repeat this operation in the vertical plane, moving the turbine by adding or removing liners between the turbine supporting flange and cradle bedplate.

Aligning Coupling To Bring the Shafts Concentric

Couplings which are eccentric with regard to their respective shafts, are the most difficult to properly align. This can be checked by means of a dial indicator. If this condition exists, much time can be saved by putting the shafts in a lathe and turning the couplings so that they are round and also of the same diameter.

Consider a coupling as indicated on the sketch Fig. 12. A scale held firmly on top of turbine half of coupling gives a feeler gauge reading at A of .005 inch. A reading at B gives .005 inch. It is evident therefore, that the turbine must be lowered .005 inch. The same process should be used for bringing the shafts central in the horizontal plane.

Consider a coupling as indicated in Fig. 13, when the pump half coupling is .020 inch smaller in diameter than the turbine half coupling and the shaft is again .005 inch high.

In this case, the turbine should be lowered .005 as before, which will give the readings, as shown on Fig. 14. Follow the above procedure in the horizontal plane and bring turbine central by sidewise movement if necessary.

As the alignment of the turbine to the driven apparatus nears completion, the bolts holding the turbine to the bedplate should be gradually tightened. If tightening these bolts throws the turbine out of line, it indicates that either one corner is lower than the other or the clearance holes for the bolts are too small. In the first case, this can be remedied by shimming up the low corner, and in the second, by chipping the clearance hole larger.

After the above work has been satisfactorily completed, the turbine and driven apparatus must be dowelled to the bedplate.

Alignment is not complete until readings are correct with the turbine holding down bolts drawn up tightly.

Piping

In connecting the turbine to steam and exhaust lines, always begin the piping from the connecting line and end at the turbine, making the turbine connection the last one in the line. Never start piping from the turbine, for doing so will undoubtedly distort the casing or spring the turbine out of line, inasmuch as the weight of the piping will hang directly on the turbine.

The steam piping must not impose any strain on the turbine. If screwed fittings are used, the line should be provided with swinging joints. If flanged fittings are used, long radius bends should be put in the piping to take up the ex-

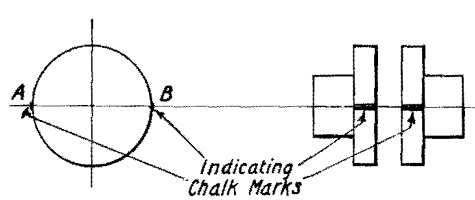


Fig. 10

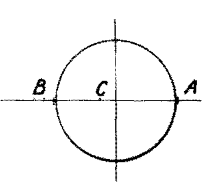


Fig. 11

pansion of the steam line. Support the piping at a point near the turbine in such a manner that the weight of the piping is taken by this support. The piping should be so arranged that the expansion will not have to be resisted by the turbine. Make sure that the flanges are parallel and that no force is necessary to bring the flanges together or match the bolt holes. After installing piping heat up to full working temperature, break joints and check.

The exhaust piping should be provided with an expansion joint located next to the turbine exhaust nozzle. Even though an expansion joint is used the same caution in connecting up should be exercised. Be sure that the expansion joint is light enough to be flexible.

In piping up a turbine, make all pipe supports permanent. Do not expect a block of wood driven under a pipe to take the strain from the turbine. The best method of supporting the piping is to use an adjustable foot under it as near to the turbine as possible. Another method is to hang it from the building by tie rods which connect to the piping near the turbine. These rods, however, to be satisfactory, must be short. Always put in the supports before actually connecting to the turbine.

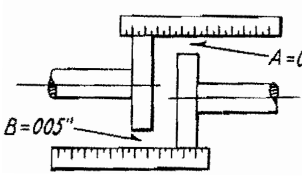


Fig. 12

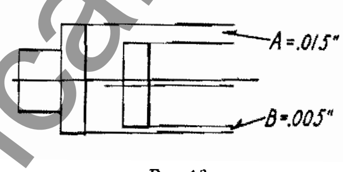


Fig. 13

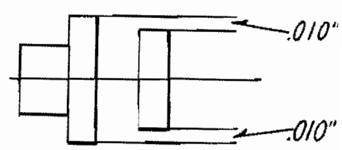


Fig. 14

In all cases where the turbine is to be realigned, disconnect the steam and exhaust piping, and in reconnecting, be sure that the flanges line up without putting a strain on the turbine. If they do, then change the piping.

To Operate

Before starting up, clean the turbine, taking out the bearings so that all dirt may be taken from the bearing cavities, and after replacing bearings, fill cavities with a good grade of clean oil. See that rotor turns freely by hand. Disconnect the governor linkage and make sure that the governor poppet valve can easily be moved in and out without sticking. Clean off all rust and corrosion that may have collected upon exposed parts of the governor mechanism. See that the governor thrust bearing grease cup is full of grease. Pull back poppet valve lever handle (130) (Fig. 2) until the knife edges of the latch plates (124 and 126) (Fig. 2) are engaged. Trip automatic stop by means of hand tripping device. This is accomplished by striking hand lever (120) (Fig. 2) sharply. Reset auto stop as indicated above.

Open drains on steam and exhaust line. Open exhaust valve. Crack the steam valve and when live steam appears at the drains, close them. Bring the turbine up to speed slowly and note that the oil rings are turning in the bearings. When the turbine begins to come up to speed, watch the governor lever arm to see that the governor is functioning properly. When the turbine is up to speed and under control of the governor, open throttle valve wide. Turn on gland water.

Check the speed by means of a tachometer or speed counter. This may be accomplished by unscrewing the grease cup (24) (Fig. 4) from the governor ball bearing, and inserting the end of the speed counter through this hole against the governor spindle. If the speed is not correct, it should be made so at this time To decrease the speed, screw back on the governor nut (117) (Fig. 4) taking care to lock it into place with the jam nut after the setting has been made. To increase the speed, tighten up the adjusting nut. Run turbine under observation until the temperature of the bearings has ceased to rise.

To Shut Down

Shut off gland water. Strike hand trip lever (128) (Fig. 2) sharply, which will close governor poppet valve and indicate that the automatic closing device is working properly. Close throttle valve, and when this is totally closed reset automatic trip. Close exhaust valve; open steam and exhaust drains.

Adjustments

1. Bearing clearances (see Fig. 5) Page 7.
2. Catch on auto stop (126) (Fig. 2) Page 3. Latch plate knife edges overlap $\frac{1}{16}$ inch.
3. Clearance between blades (95) and nozzle (81) (Fig. 2) Page 3.
4. Clearance between blades (95) and reversing chamber (101) (Fig. 2) Page 3.
5. Clearance on either side of gland runners, (52) (Fig. 6) Page 8.
6. Clearance between auto stop pin (4) and knock off lever (125) (Fig. 2) Page 3 should be $\frac{1}{16}$ inch.
7. Clearance between poppet valve stem (116) and bushing (113) at C (Fig. 4) Page 5 should be .002 inch.
8. Clearance between poppet valve (133) and seat guide pin (115) at B (Fig. 4) Page 5 should be .003 to .006 inch.
9. Clearance between poppet valve lever (120) and spool (117) (Fig. 4) Page 5 should be about .005 inch.
10. Clearance between oil baffles (15) (30) (31) and shaft (Fig. 2) Page 3 should be .010 inch on radius.
11. Clearance between oil guards (16) (28) and shaft (Fig. 2) Page 3 should be $\frac{1}{32}$ inch on radius.
12. Gland packing ring (51) side clearance (Fig. 6) Page 8 should be .003 to .005 inch.
13. Clearance between governor spring seat (65) and governor spider (61) (Fig. 2) Page 3 should be .003 to .009 inch.
14. Clearance between governor pin (76) and spring seat (65) (Fig. 2) Page 3 should be .001 inch on dia.
15. Governor poppet valve settings, see (Fig. 4) Page 5.

16. Clearance between governor spindle (63) and hole in governor body (61) (Fig. 2) Page 3 should be .005 to .009 inch.
17. Governor spindle (63) and pin (76) (Fig. 2) Page 3 should be .001 inch on dia.
18. Oil level should be within ½ inch of top of gauge glass.
19. Thrust bearing clearance (Fig. 5) Page 7.
20. To increase speed (see Page 9).
21. To decrease speed (see Page 9).
22. To set governor poppet valve (see Page 7).
23. To adjust speed at which automatic stop operates (see Page 4).

Care of the Turbine

1. Keep machine clean.
2. Keep bearing reservoirs well filled with good quality, clean oil.
3. Keep grease cup on governor thrust bearing well filled and turn occasionally. Do not use graphite in the bearing.
4. Wash out bearing cavities with kerosene and re-fill with clean oil every three or four months.
5. If steam is contaminated with boiler compound or sludge, clean off poppet valve stem as often as necessary to keep it working freely.
6. Before starting a unit that has been idle for some months dismantle governor and governor poppet valve linkage to see that all parts are free.
7. Bearings should be inspected occasionally to see that they are not wearing.
8. The automatic stop should be tripped occasionally to see that it is in working order.
9. Inspect coupling pins and bushings frequently. Keep oil away from the bushings.
10. Check speed of machine at least once a week as this is a good indication of possible trouble.

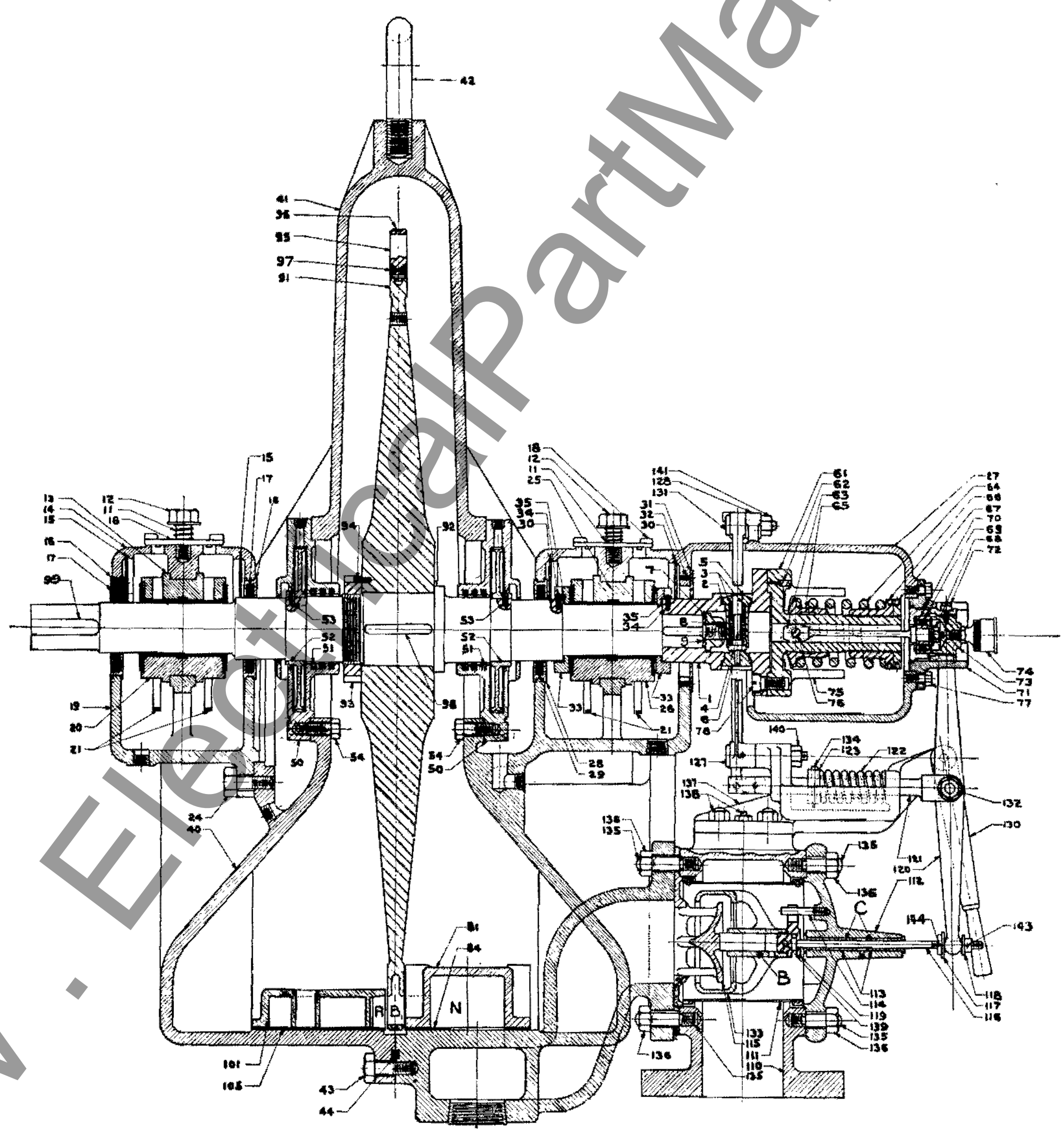


FIG. 15

Inspection

A thorough inspection of all parts of the turbine should be made once a year, renewing such parts as may show undue wear. If heavy wear of any part is evidenced, the cause of the wear should be ascertained if possible, and in any case replacement of the part should be made before failure, as this will be cheaper than a future shut down.

To make complete inspection, see description of part to be inspected.

Operating Trouble

Governor Hunting

1. Too great a travel of governor poppet valve.
2. Sticking of governor poppet valve on guide.
3. Sticking of governor spindle.
4. Bent valve stem.
5. Broken governor weight knife edges.
6. Distorted or bent governor linkage.
7. Weakening of governor spring.

Turbine Fails to Come Up to Speed

1. Low boiler pressure.
2. Steam line clogged.
3. Dirty steam strainer. Remove and clean same.
4. Nozzle throat plugged by foreign matter.
5. Governor speed set too low. (Note action of governor lever).
6. Too small valve travel.
7. Too much water in steam.

Glands Leaking Steam

1. Packing rings stuck in gland.
2. Water passages clogged with dirt or scale.
3. Recesses in gland runners clogged with scale.
4. No water in glands.
5. Gland joint improperly made up.

Glands Leaking Water

1. Too high a head of water on gland.
2. Obstruction or burrs in gland runner passage.
3. Gland runners rubbing on sides of casing.

Vibration

1. Misalignment.
2. Steam and exhaust pipe straining turbine.
3. Bent shaft.
4. Coupling running out of true.
5. Governor running out of true.
6. Bearings are too loose.

To correct vibration troubles, misalignment should be corrected, bearings put in proper shape, and any parts not true should be made so. It may also be necessary to balance the rotor. In severe cases of vibration, the best procedure is to get in touch with the nearest District Service Office and apply for the services of an engineer.

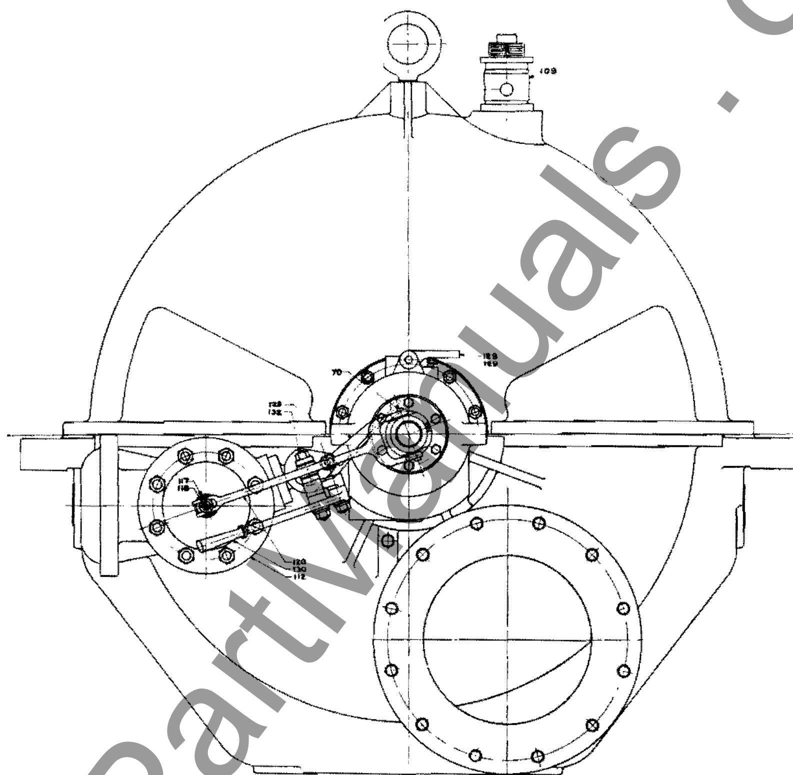


Fig. 16

Repair Parts

The list of parts shown on the following pages are made up for your convenience in ordering repair parts. To order a spare part, give serial number of turbine and name and number of the part desired. Due to the necessity of avoiding interruption in service, it is well to carry a number of spare parts on hand. Carrying such a stock will also avoid a delay in shipment at a time when the parts are most needed.

We recommend that the following spare parts be carried for each machine.

1—Set bearings.
1—Governor spindle thrust bearing.
1—Governor spindle with pin.
1—Poppet valve stem with spools and bushings.
1—Knock off lever with knife edges.
1—Governor poppet valve and seat.
1—Set gland packing rings and springs.

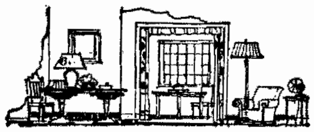
List of Parts

1 Auto stop governor housing.
2 Auto stop governor retaining lock.
3 Auto stop governor spring.
4 Auto stop governor weight.
5 Auto stop governor retainer.
6 Auto stop governor plug.
7 Auto stop governor housing nut.
8 Auto stop governor housing nut lock screw.
9 Auto stop governor housing nut washer.
11 Bearing cover oil hole cover spring.
12 Bearing cover oil hole cover spring bolt.
13 Bearing upper half (coup. end).

LIST OF PARTS—Continued

14 Bearing cover (coup. end).
15 Bearing cover baffle plate (coup. end).
16 Bearing cover oil guard (coup. end).
17 Bearing cover oil guard filler (coup. end).
18 Bearing cover oil hole cover.
19 Bearing bracket.
20 Bearing lower (coup. end).
21 Bearing oil ring.
22 Bearing cover bolt.
23 Bearing oil gauge.
24 Bearing bracket bolt.
25 Bearing upper (governor end).
26 Bearing lower (governor end).
27 Bearing cover (governor end).
28 Bearing cover oil guard (governor end).
29 Bearing cover oil guard filler (governor end).
30 Bearing cover oil baffle plate inner (governor end).
31 Bearing cover oil baffle plate outer (governor end).
32 Bearing cover oil baffle plate screw (governor end).
33 Bearing cover thrust collar (rotor end).
34 Bearing cover thrust collar screw.
35 Bearing cover thrust collar liners.
36 Bearing cover thrust collar (outer end).
38 Bedplate.
39 Bedplate bolt.
40 Cylinder base.
41 Cylinder cover.
42 Cylinder cover eye bolt.
43 Cylinder base bolt.
44 Cylinder base scaling ring.
50 Gland case.
51 ~~Gland case packing ring.~~ → Gland runner
53 Gland case running screw.
54 Gland case bolt.
55 Gland case packing pin.
56 Gland case packing ring spring.
61 Governor spider.
62 Governor spider knife edge bearing.
63 Governor spindle.
64 Governor spindle spring.
65 Governor spindle spring seat.
66 Governor spindle adjusting nut.
67 Governor spindle adjusting nut lock nut.
68 Governor spindle nut.
69 Governor ball thrust bearing.
70 Governor spindle adjusting nut case.
71 Governor spindle adjusting nut housing.
72 Governor spindle thrust bearing case guide.
73 Governor spindle thrust bearing case nut.
74 Governor spindle thrust bearing case grease cup.
75 Governor weight.
76 Governor spindle pin.
77 Governor spindle thrust bearing case housing bolt.
78 Governor spider screw.
81 Nozzle block.
82 Nozzle block extension.
83 Nozzle block extension screw.
84 Nozzle block liner.
85 Nozzle block gasket.
91 Rotor.
92 Rotor shaft.
93 Rotor shaft lock nut.
94 Rotor shaft lock nut screw.
95 Rotor blade.
96 Rotor blade shroud strip.
97 Rotor blade pin.
98 Rotor key.
99 Rotor shaft coupling key.
101 Reversing chamber.
102 Reversing chamber base.
103 Reversing chamber bolt.
104 Reversing chamber pin.
105 Reversing chamber liner.
109 Relief valve.
110 Steam chest poppet valve body.
111 Steam chest poppet valve body strainer.
112 Steam chest poppet valve body cover.
113 Steam chest poppet valve body cover bushing.
114 Steam chest poppet valve stop stud.
115 Steam chest poppet valve seat.
116 Steam chest poppet valve stem.
117 Steam chest poppet valve stem spool.
118 Steam chest poppet valve stem spool nut.
119 Steam chest poppet valve coupling.
120 Steam chest poppet valve lever.
121 Steam chest poppet valve lever rod.
122 Steam chest poppet valve lever rod spring.
123 Steam chest poppet valve lever rod spring adjusting screw.
124 Steam chest poppet valve lever latch plate.
125 Steam chest poppet valve lever knock off lever.
126 Steam chest poppet valve knock off lever latch plate.
127 Steam chest poppet valve knock off lever fulcrum pin.
128 Steam chest poppet valve knock off lever hand trip.
129 Steam chest poppet valve knock off lever hand trip spring.
130 Steam chest poppet valve hand lever.
131 Steam chest poppet valve knock off lever hand trip pin.
132 Steam chest poppet valve lever fulcrum pin, nut and washer.
133 Steam chest poppet valve.
134 Steam chest poppet valve lever rod spring adjusting nut pin.
135 Steam chest poppet valve body and cover stud.
136 Steam chest poppet valve body and cover stud nut.
137 Steam chest poppet valve lever bracket.
138 Steam chest poppet valve lever bracket, bolt and dowel.
139 Steam chest poppet valve coupling pin.
140 Steam chest poppet valve knock off lever fulcrum pin nut.
141 Steam chest poppet valve knock off lever hand trip pin nut.
142 Steam chest poppet valve knock off lever hand trip spring pin.
143 Steam chest poppet valve steam spool nut cotter.
144 Steam chest poppet valve steam spool cotter.
145 Steam chest poppet valve hand lever fulcrum pin.
146 Steam chest poppet valve hand lever fulcrum pin, nut and washer.
150 Speed changer adjusting nut lock.
151 Speed changer adjusting nut lock taper pin.
152 Speed changer adjusting nut.
153 Speed changer adjusting nut spring.
154 Speed changer adjusting nut spring screws.

Westinghouse Products



Homes—Farms

Air Heaters
Auto Engine Heaters
Automatic Irons
Automatic Percolators
Automatic Ranges
Cozy Glow Heaters
Curling Irons
Fans
Hot Plates
Light and Power Plants
Lighting Equipment
Mazda Lamps
Motors for
  Buffers and Grinders
  Ice Cream Freezers
  Ironers and Washers
  Refrigerators
  Sewing Machines
  Vacuum Cleaners
Newel Posts
Panelboards
Radio Equipment
Rectigon Chargers for Automobiles and Radio Batteries
Rectox Trickle Charger
Refrigerators, Electrical
Safety Switches
Sollaire Luminaires
Sol-Lux Luminaires
Solar Glow Heaters
Table Stoves
Tumbler Water Heaters
Turnover Toasters
Vacuum Cleaners
Wall-Type Heaters
Waffle Irons
Warming Pads
Water Heaters

Buildings

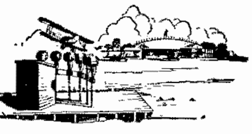
Arc Welding Equip.
Circuit-Breakers
Elevators and Control
Glue and Solder Pots
Instruments and Relays
Kitchen Equipment
  Bake Ovens
  Hot Plates, Ranges
Lighting Equipment
  Brackets, Newels and Lanterns
  Reflectors & Lamps
  Sol-Lux Luminaires
Lightning Arresters
Micarta Trays
Meters
Meter Service Switches
Motor Generators
Motors and Control for:
  Coal and Ash-Handling Equipment
  Compressors
  Elevators
  Fans and Blowers
  Laundry Equipment
  Refrigerating Equip.
  Vacuum Cleaners
  Water & Sump Pumps
Panelboards
Radio Equipment
Synchronous Converters
Safety Switches
Solar Glow Heaters
Stokers
Switchgear
Transformers

City Improvements

Airport Floodlights
Automatic Substations
Constant Current Regulators
Control Apparatus
Elec. Railway Equip.
Lighting Units
Mazda Lamps
Ornamental Standards
Parkway Cables
Street Brackets
Streethoods

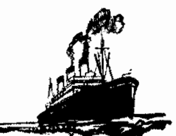
Offices and Stores

Air Heaters
Bread-baking Oven
Elevators and Control
Fans, Desk and Exhaust
Fuses
Lighting Equipment
Mazda Lamps
Meters
Micarta Desk Tops
Motors for
  Adding Machines
  Addressing Machines
Motors for
  Coffee and Meat Grinders, etc.
  Dictaphones
  Envelope Sealers
  Fans and Blowers
  Pumps
  Refrigerating Machines
Panelboards
Safety Switches
Switches
Tumbler Water Heaters



Aviation

Approach, Boundary, Hangar, and Obstruction Lights
Arc Welding Equip.
Floodlight Projectors
Motor-Generators
Reflectors
Transformers
Mazda Lamps
Micarta
  Cabin-lining Plate
  Fairleads
  Hinge Bearings
  Propellers
  Pulleys
  Tailwheels
Radio Equipment

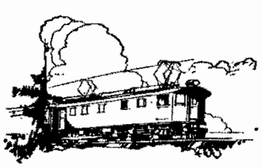


Ships

Circuit-Breakers
Condensing Equipment
Deck Winch Motors
Elec. Heating Appar.
Eng. Room Auxiliaries
Fans and Blowers
Fuses
Generating Equipment
Instruments
Light and Power Plants
Lighting Equipment
Micarta Trays
Motors and Controllers
Ovens, Ranges and Galley Equipment
Panelboards
Propulsion Equipment
  Diesel-Electric
  Geared Turbine
  Turbine Electric
Radio Equipment
Safety Switches
Switchgear

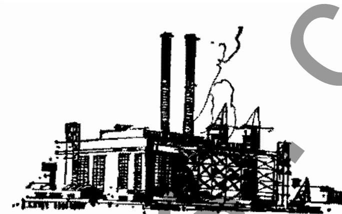
Electric Railways

Arc Welding Equip.
Automatic Substations
Babbitt, Solder & Pots
Baking Ovens
Circuit-Breakers
Elec. Trolley Coaches
Fans
Gas Electric Coaches
Gears and Pinions
Generators
Insulating Material
Insulators
Lighting Fixtures
Lightning Arresters
Line Material
Manual Substations
Mazda Lamps
Meters
Motors and Control
Panelboards
Portable Substations
Relays
Signal Equipment
Supervisory Control
Switchgear
Synchronous Convert's
Transformers
Trolley Poles



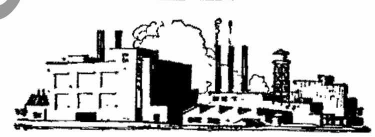
Railroads

Arc Welding Equipment
Automatic Substations
Babbitt, Solder & Pots
Baking Ovens
Battery Charging Equip.
Cars—Multiple-Unit. Gas-Elec., Oil-Elec.
Circuit-Breakers
Control Apparatus
Elec. Heating Apparatus
Fans
Gears and Pinions
Generators
Headlight Equipment
Instruments
Insulating Materials
Insulators
Lighting Equipment
Lightning Arresters
Line Material
Locomotives—Electric Gas-Elec., Oil-Elec.
Manual Substations
Mazda Lamps
Micarta Gears
Motors and Control
Outdoor Substations
Panelboards
Power House Apparatus
Radio Equipment
Safety Switches
Signal Equipment
Stokers
Supervisory Control
Switchgear
Transformers
Yard Lighting Equip.



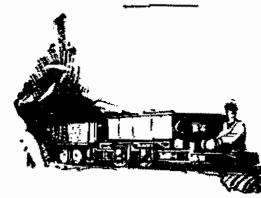
Electric Service Companies

Automatic Switching Equipment
Circuit-breakers
Condensers
Cutouts
Fans
Frequency-converters
Fuses
Generators
Instruments & Meters
Insulating Material
Insulators
Line Material
Lighting Equipment
Lightning Arresters
Micarta
Motors and Control
Motor-Generators
Network Protectors
Network Transformers
Oil Testing and Purifying Equipment
Outdoor Substations
Panelboards
Porcelain Insulators
Relays
Safety Switches
Steam Turbines
Stokers
Supervisory Control
Switchgear
Synchronous Conden'rs
Synchronous Conv'ters
Transformers
Turbine Generators
Voltage Regulators



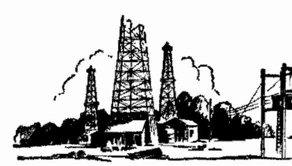
Mills and Factories

Arc Welding Equip.
Automatic Starters and Controllers
Babbitt & Babbitt Pots
Capacitors
Circuit-Breakers
Condensers
Fans, Desk and Exhaust
Furnaces and Ovens
Fuses
Generating Equipment
Insulating Materials
Knife Switches
Larry Car Equipment
Lighting Equipment
Lightning Arresters
Locomotives—Electric Gas-Elec., Oil Elec.
Mazda Lamps
Meters and Relays
Micarta Gears
Motors and Controllers
Panelboards
Pipe Fittings (Struct'al)
Power House Apparatus
Safety Switches
Solder & Glue Pots
Space Heaters
Stokers
Switchgear
Transformers
Turbines



Mines

Arc Welding Equip.
Auto. Feeder Equip.
Automatic Starters and Controllers
Automatic Substations
Battery Charging Equip.
Circuit-Breakers
Clamps
Elec. Heating Apparatus
Fans
Gears and Pinions
Headlights
Insulating Materials
Insulators
Larry Car Equipment
Lightning Arresters
Line Material
Locomotives
Manual Substations
Mazda Lamps
Meters & Instruments
Micarta
Motor Generators
Motors for Hoists, Pumps, Tipples, and Breakers
Panelboards
Portable Substations
Relays
Safety Switches
Switchgear
Synchronous Conv'ters
Transformers
Ventilating Outfits



Oil Fields

Arc Welding Equip.
Change House Heaters
Floodlight Projectors
Gear Units
Insulators
Mazda Lamps
Motors and Control
Panelboards
Reflectors
Rig Lighters
Safety Switches
Small Light Plants
Transformers
Vapor Proof Fixtures

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

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*CINCINNATI, OHIO, 207 W. Third St.
*CLEVELAND, OHIO, 2209 Ashland Rd. S. E.
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ERIE, PA., State and Tenth St.
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FAIRMONT, W. VA., 602 Cleveland Ave.
FERGUS FALLS, MINN., Kadatz Hotel
FORT WAYNE, IND., 1010 Packard Ave.
FORT WORTH, TEX., 2426 Tierney Rd.
GARY, IND., 524 Roosevelt St.
*GRAND RAPIDS, MICH., 507 Monroe Ave. N. W.
HAMMOND, IND., 403 Waltham St.
*HOUSTON, TEX., 218 Main St.
*HUNTINGTON, W. VA., 209 Ninth St.
INDIANAPOLIS, IND., 20 N. Meridian St.
JACKSON, MICH., 212 W. Michigan Ave.
JACKSON, MISS., 519 Hemlock St.
JACKSONVILLE, FLA., 719 W. Forsyth St.
JOHNSTOWN, PA., 47 Messenger St.
*JOPLIN, MO., 420 School St.
*KANSAS CITY, MO., 2124 Wyandotte St.
KNOXVILLE, TENN., 713-715 N. Broadway
*LOS ANGELES, CALIF., 420 San Pedro St. S.
LOUISVILLE, KY., 332 W. Broadway
MADISON, WIS., 508 Edgewood Ave.
MEMPHIS, TENN., 130 Madison Ave.
MILWAUKEE, WIS., 735 N. Water St.
*MINNEAPOLIS, MINN., 2303 Kennedy St. N.E.
NASHVILLE, TENN., 309 Fourth Ave. N.
*NEWARK, N. J., 17-25 Academy St.
NEW HAVEN, CONN., 152 Temple St.
*NEW ORLEANS, LA., 333 St. Charles St.
NEW YORK, N. Y., 150 Broadway
NIAGARA FALLS, N. Y., 205 Falls St.
*OKLAHOMA CITY, OKLA., 128-32 W. Grand Ave.
OMAHA, NEB., 409 17th St. S.
PEORIA, ILL., 104 State St.
*PHILADELPHIA, PA., 3001 Walnut St.
*PHOENIX, ARIZ., 11 W. Jefferson St.
PINE BLUFF, ARK., 2103 Linden Ave.
*PITTSBURGH, PA., 310 Grant St.
PORTLAND, ME., 61 Woodford St.
*PORTLAND, ORE., 83 Sixth St.
PROVIDENCE, R. I., 393 Harris Ave.
QUINCY, ILL., 2314 Broadway
RALEIGH, N. C., 803 Person St. N.
READING, PA., 438 Walnut St.
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SPOKANE, WASH., 428 Riverside Ave.
SPRINGFIELD, ILL., 130 Sixth St. S.
SPRINGFIELD, MASS., 395 Liberty St.
*ST. LOUIS, MO., 411 Seventh St. N.
SYRACUSE, N. Y., 224 Harrison Street
TACOMA, WASH., 1021 Pacific Ave.
TAMPA, FLA., 710 Bell St.
TERRE HAUTE, IND., 915 S. Fifth St.
TEXARKANA, ARK., 503 E. Sixth St.
TOLEDO, OHIO, 245 Summit St.
*TULSA, OKLA., 602 S. Main St.
*UTICA, N. Y., 258 Genesee St.
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WICHITA, KAN., 918 N. Lawrence St.
WILKES-BARRE, PA., 267 Pennsylvania Ave. N.
WILMINGTON, CALIF., 305½ Avalon Blvd.
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YOUNGSTOWN, OHIO, 16 Central Square
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WORCESTER, MASS., 54 Commercial St.

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150 BROADWAY, NEW YORK, U. S. A.

CANADIAN WESTINGHOUSE CO., Limited
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