age" 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 process for other weight and then for both weights. When governor weights are removed, be sure to 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 "105" to the governor spindle "102". This spindle is in turn connected to a self-aligning ball bearing "111" located in the governor spindle thrust bearing housing "113" and held in place by the retainer "114". The motion of the thrust bearing housing and retainer is transmitted to the governor lever through the retainer bolt "115". The governor lever "97" is pivoted at the fulcrum pin "14". The lower portion of the governor lever connects to the governor valve through a yoke in which a spool "94" is carried which is screwed on the governor valve stem "91". Below this yoke on the lever "97" is a handle for resetting the lever after the overspeed trip has functioned.

The thrust bearing "111" is lubricated by the grease cup "112". This bearing should receive an ample supply of grease and the small oil hole on top of the supporting case should be oiled occasionally.

It will be noted that the governor valve stem spring "92" tends to eliminate lost motion by the constant application of a force in one direction.

To Take Apart Governor Linkage

To take apart the governor linkage, lift off the turbine bearing cover "43" and loosen governor spring nut "124", to its fullest extent so that the governor weights may be taken out. Pull spring "123" towards the governor thrust bearing and take out governor spindle pin "105". Drive out fulcrum pin "14". Unscrew valve stem spool nut and pull governor linkage straight back. The operation of taking apart the governor thrust bearing housing is

Steam Chest

The steam chest "182" is located below and to one side of the governor housing and is bolted to the cylinder base. The steam chest also holds the governor poppet valve cage "99" in place and likewise centers it. The steam chest cover "152" is bolted directly on the end of the steam chest and forms a support for the valve stem "91". This cover is bushed by brass bushings "153" and "154" which have a small clearance between themselves and the poppet valve stem. At the center a space is left between the two bushings 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 which 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, it should be taken out and a reamer should be run through the bushing to make sure that the bushing is not burred. The stem should be inspected for galled spots and tested for straightness.

Governor Poppet Valve

The governor poppet valve "98" is located in the steam chest "182". It is of the double seated type and is held in a horizontal position by the valve stem "91". The governor valve "98" is pinned on the valve stem "91". The valve stem "91" is supported by the bearing in the valve cage "99" and the two bushings "153" and "154" in the steam chest cover "152".

The valve cage "99" is pressed into place in the steam chest. The steam chest cover "152" is centered in the steam chest by a spigot fit and bolted in place. The bushings "153" and "154" and the bearing in the valve cage "99" should be reamed in position to insure alignment for the valve stem.

The valve stem spring "92" besides taking up lost motion prevents spinning of the governor valve.

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 governor. 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

In case a valve leaks too badly, it must be removed and reseated. In reseating, do not bevel seats indicated as sharp, but face off these seats to maintain line contact.

Setting the Governor Poppet Valve

Reference to Figure 2 shows the position of the poppet valve and 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 "98" remove the nut "93" and push the valve stem forward with the hand until it is felt that the valve has seated. Measure the distance from the spool to the contact of the governor lever "97" and adjust the spool by screwing it backward or forward to give the correct valve travel. This travel should be approximately 3/16″ but this dimension will vary with different steam conditions.

Nozzles and Reversing Chambers

The nozzles "161" and the reversing chambers "162" are located in the cylinder base. When making any setting on the turbine, set the rotor centrally before making any adjustment on the machine. After setting the rotor centrally, adjust the thrust bearing to hold the rotor in this position.

The nozzle "161" is bolted to the steam chest body "18".

The reversing chamber "162" is bolted to cylinder base "58". The reversing chamber should be flush with the nozzles and in such a position as to catch all steam emerging from the blades.

Bearings

The bearings are the single oil ring; horizontally split type of babbitted bearing. The bearing next to the coupling is known as the coupling end bearing, the one next to the governor, the thrust bearing. Both bearings are the same in general, the thrust bearing having the faces of the ends babbitted and grooved for oil passage being the only difference. The thrust bearing should be set for end play clearances (.002″ to .005″). This clearance may be adjusted by screwing the thrust collar "146" on the thrust screw "147". It is essential that these clearances be properly set in order to get good results.

to shape. This packing "87" is followed by a packing ring "89" which is held in position by the plate "90". The gland packing on this turbine requires no adjustment. If steam leakage becomes excessive the packing has lost its life and should be renewed.

Foundation

This turbine may be bolted directly to the bedplate supporting the machine it is to drive, or it may be mounted on a separate soleplate. In either case the two legs which are cast integral with the turbine cylinder base are dowelled and bolted to the foundation plate.

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 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.

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.

If the position of the driven apparatus is to be determined by pipes to which it connects, be sure that this point is checked up at this time. Check also the exhaust and inlet on the turbines 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. After carefully pulling down on all foundation bolts, the final alignment of the outfit should be checked.

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

Piping

On connecting the turbine to a steam inlet 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 expansion 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 to match the bolt holes. After installing piping heat up to full working temperature, break joints at the turbine 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 a pipe 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.

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 upon the turbine.

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 the 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 cap is full of grease. Pull back governor lever "97" until the edges of the latch plates "6" and "15" are engaged. Trip automatic stop by means of hand tripping device. This is accomplished by striking knock-off lever "5" sharply. Reset auto stop as indicated above.

Open drains on steam inlet and exhaust lines. Open exhaust valve. Crack the steam valve and when live steam appears at the drains close them. Bring the turbine slowly up to speed 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 steam valve wide.

With the unit under way, check the speed by means of a tachometer or speed counter. This may be accomplished at the outboard end of the driven apparatus. If the speed is not correct it should be made so at this time. To decrease the speed screw back on the governor spring adjusting nut "124", to increase the speed tighten up the adjusting nut. Run the turbine under observation until temperature of the bearings has ceased to rise.

To Shut Down

Strike the knock-off lever "5" sharply which will close the governor valve and indicate that the automatic closing device is working properly. Close the steam valve and when this is totally closed reset the automatic trip. Close exhaust valve; open steam and exhaust drains.

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. Oil, governor thrust bearing housing, through oil cup occasionally.
5. Wash out bearing cavities with kerosene and refill with clean oil every three or four months.
6. If steam is contaminated with boiler compound or sludge, clean off governor valve stem as often as necessary to keep it working freely.
7. Before starting a unit that has been idle for some months, dismantle governor and governor valve linkage to see that all parts are free.
8. Bearings should be inspected occasionally to see that they are not wearing excessively.
9. The automatic stop should be tripped occasionally to see that it is in working order.
10. Inspect coupling frequently.
11. Check speed of machine at least once a week as this is a good indication of possible trouble.

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.

Operating Troubles

Governor Hunting

1. Too great a travel of governor valve.
2. Sticking of governor valve stem in bushings.
3. Sticking of governor spindle.
4. Bent valve stem.
5. Broken governor weight knife edge.
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. Nozzle throat plugged by foreign matter.
4. Governor speed set too low.
5. Too small valve travel.
6. Too much water in steam.

Glands Leaking Steam

1. Packing worn out.
2. Gland joint improperly made up.

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 too loose.

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 the 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 parts are most needed.

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

1—Set of Bearings.
1—Governor spindle thrust bearing.
1—Governor spindle with pin.
1—Governor valve stem with spools and bushings.
1—Knock-off lever with latch plates.
1—Governor valve and cage.
1—Set of gland packing.

List of Parts

Item	Name
5	Turbine Auto Stop Governor Knock Off Lever.
6	Turbine Auto Stop Governor Knock Off Lever Latch Plate.
9	Turbine Auto Stop Governor Lever Rod.
10	Turbine Auto Stop Governor Lever Rod Clevis.
12	Turbine Auto Stop Governor Lever Rod Collar
14	Turbine Auto Stop Governor Lever Rod Fulcrum Pin.
15	Turbine Auto Stop Governor Lever Rod Latch Plate.
17	Turbine Auto Stop Governor Lever Rod Spring.
18	Turbine Auto Stop Governor Retainer.
19	Turbine Auto Stop Governor Retainer Lock.
20	Turbine Auto Stop Governor Spring.
21	Turbine Auto Stop Governor Weight.
23	Turbine Bearing (Upper Half) (Coup. End).
24	Turbine Bearing (Lower Half) (Coup. End).
25	Turbine Bearing Bracket (Coup. End).
26	Turbine Bearing Bracket Cover.
27	Turbine Bearing Bracket Cover Sight Hole Plug.
30	Turbine Bearing Bracket Cover Taper Dowel (Bracket).
31	Turbine Bearing Bracket Oil Gauge with Drain Cock.
32	Turbine Bearing Bracket Oil Ring (Upper Half), (Coup. End).
33	Turbine Bearing Bracket Oil Ring (Lower Half), (Coup. End).
36	Turbine Bearing Oiling Ring.
40	Turbine Bearing (Upper Half) (Gov. End).
41	Turbine Bearing (Lower Half) (Gov. End).
42	Turbine Bearing Bracket (Gov. End).
43	Turbine Bearing Bracket Cover.
44	Turbine Bearing Bracket Cover Oil Cup.
45	Turbine Bearing Bracket Cover Sight Hole Plug.
48	Turbine Bearing Bracket Cover Taper Dowel.
49	Turbine Bearing Bracket Oil Gauge with Drain Cock.
50	Turbine Bearing Bracket Oil Ring (Upper Half), (Gov. End).
51	Turbine Bearing Bracket Oil Ring (Lower Half), (Gov. End).
54	Turbine Bearing Oil Ring.
58	Turbine Cylinder Base.
61	Turbine Cylinder Base Tap Bolt (Brg. Brkt.), (Coup. End).
62	Turbine Cylinder Base Tap Bolt (Brg. Brkt.), (Gov. End).
69	Turbine Cylinder Cover.
71	Turbine Cylinder Cover Relief Valve.
74	Turbine Cylinder Cover Taper Dowel.
87	Turbine Cylinder Gland Packing.
89	Turbine Cylinder Gland Packing Ring.
90	Turbine Cylinder Gland Packing Plate.
91	Turbine Governor Valve Stem.
92	Turbine Governor Valve Stem Spring.
93	Turbine Governor Valve Stem Nut.
94	Turbine Governor Valve Stem Spool.
95	Turbine Governor Housing.
96	Turbine Governor Housing Weight Fulcrum Block.

List of Parts—Continued

Item	Name
97	Turbine Governor Lever.
98	Turbine Governor Valve.
99	Turbine Governor Valve Cage.
100	Turbine Governor Weight.
102	Turbine Governor Spindle.
105	Turbine Governor Spindle Pin.
111	Turbine Governor Spindle Thrust Bearing.
112	Turbine Governor Spindle Thrust Bearing Grease Cup.
113	Turbine Governor Spindle Thrust Bearing Housing.
114	Turbine Governor Spindle Thrust Bearing Retainer.
115	Turbine Governor Spindle Thrust Bearing Retainer Bolt.
116	Turbine Governor Spindle Thrust Bearing Retainer Bolt Bushing.
123	Turbine Governor Spring.
124	Turbine Governor Spring Adjusting Nut.
125	Turbine Governor Spring Seat.
126	Turbine Governor Spring Seat Toe Block.
133	Turbine Rotor.
135	Turbine Rotor Blade.
136	Turbine Rotor Blade Pin.
140	Turbine Rotor Shaft.
141	Turbine Rotor Shaft Key.
142	Turbine Rotor Shaft Lock Washer.
143	Turbine Rotor Shaft Nut.
145	Turbine Rotor Shaft Thrower.
146	Turbine Rotor Shaft Thrust Collar.
147	Turbine Rotor Shaft Thrust Screw.
152	Turbine Steam Chest Body Cover.
153	Turbine Steam Chest Body Cover Bushing (Outer).
154	Turbine Steam Chest Body Cover Bushing (Inner).
160	Turbine Steam Chest Body Taper Dowel (Cyl. Base), (Inlet Flange).
161	Turbine Nozzle Block.
162	Turbine Reversing Chamber.
182	Turbine Steam Chest Body.

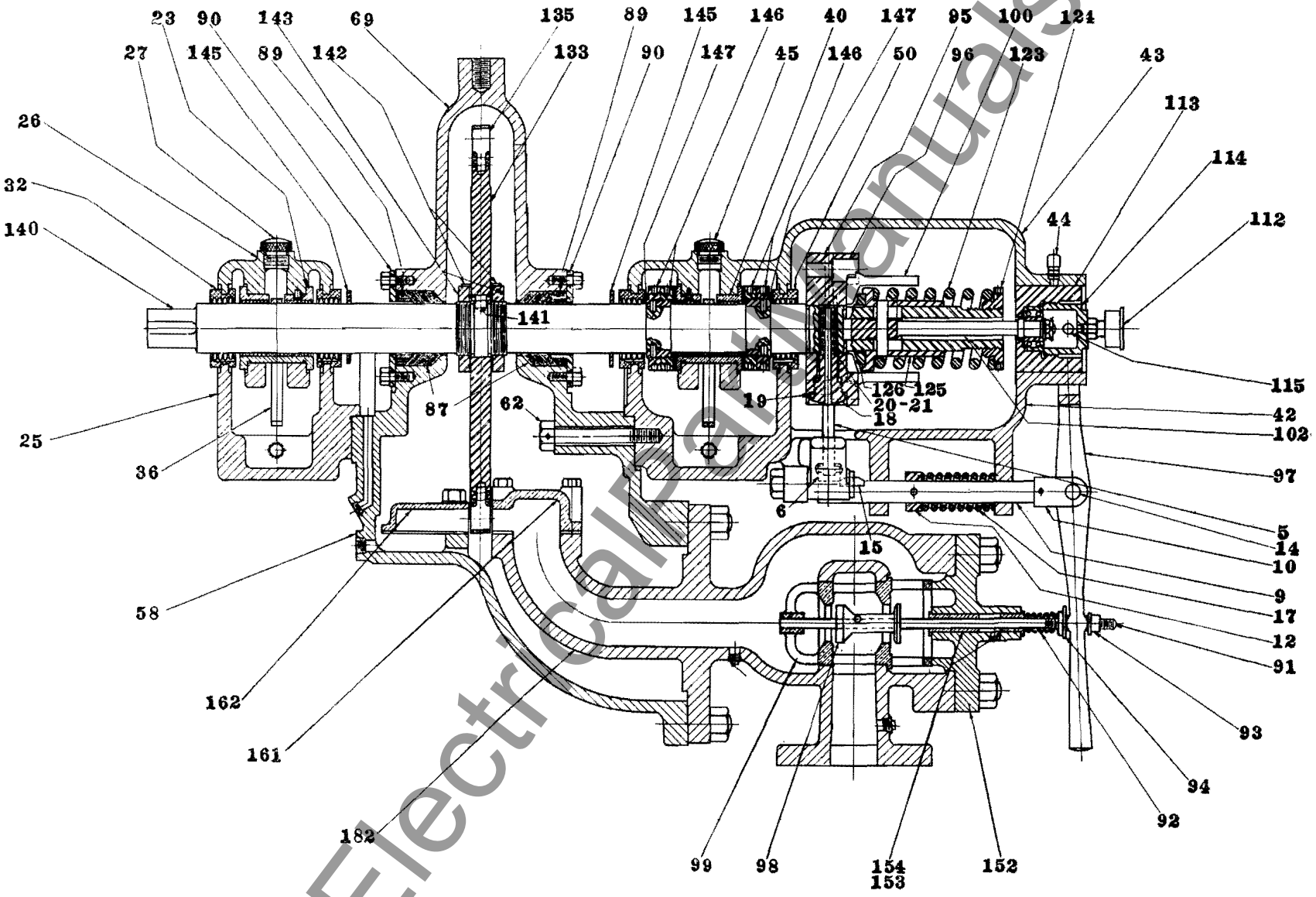

Fig. 2