Westinghouse

Carbon Pile Speed Matching Regulator

INSTRUCTION BOOK

Westinghouse Electric & Manufacturing Company

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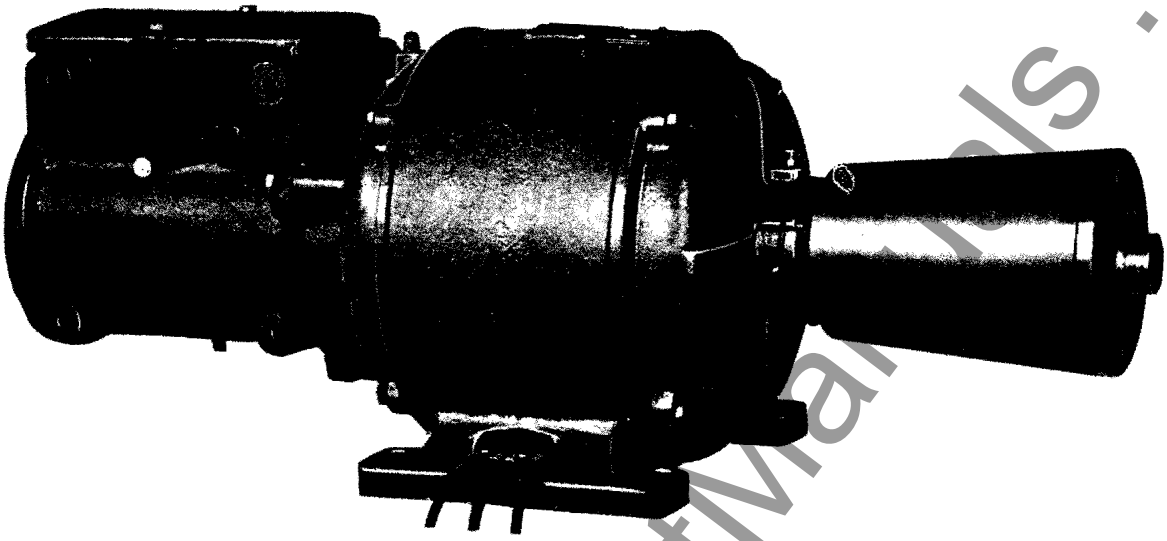

FIG. 1—SECTIONAL DIFFERENTIAL ASSEMBLY—SYNCHRONOUS MOTOR TYPE

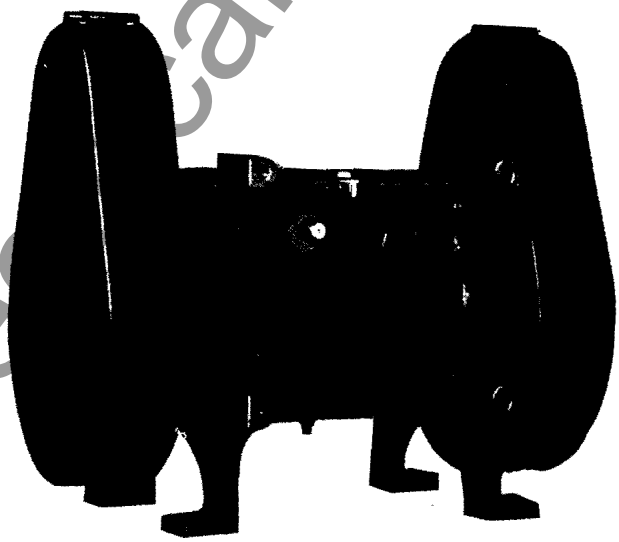

FIG. 2—MASTER DIFFERENTIAL ASSEMBLY—MECHANICALLY DRIVEN TYPE

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Carbon Pile Speed Matching Regulator

Principle

1. The principle of the Carbon Pile regulator is that the resistance of the pile varies with the pressure applied to it. An increase of resistance is produced by a decreased pressure.

Description

Synchronous Motor Driven Type

2. The carbon pile speed regulator consists of two distinct units, namely the mechanical unit and an electrical unit. The mechanical unit consists of a synchronous motor, a cone pulley, and a mechanical differential. The outline drawings of the two types of speed matching regulators are illustrated in Figures 4 and 5.

3. The electrical unit consists of a separate panel containing the control mechanism which is mounted on the mechanical unit, as outlined in Figures 4 and 5.

4. The synchronous motor supplied with this type of regulator is of the enclosed type with a squirrel cage salient pole rotor. The shaft of this motor is hollow so that an internal shaft can be connected between the cone pulley and the differential. This motor is equipped with ball bearings with provision for lubrication arranged to be very accessible. The motor end bracket which supports the differential housing has been designed in such a way as to permit the mounting of a motor in any quadrant of a circle at right angle to the axis of the shaft.

5. The cone pulley is mounted on the hollow shaft extension concentrically aligned by means of two ball bearings. The face of the cone pulley is pinned to the internal shaft connected to the differential clutch.

6. The mechanical differential consists of a worm and nut, a clutch and a lever system. The worm and nut detect any angular displacement between the hollow shaft and the internal shaft of the motor and transforms this to a rotating motion through a yoke lever. The clutch is provided to allow slippage between the shafts when the worm approaches the end of its travel. The differential housing is so designed as to allow a small angular adjustment in order to insure an upright position of the control element when the motor is mounted on the device to be controlled.

7. The control element consists of two carbon piles supported from a common frame, two levers acting upon the carbon piles, two dashpots and two coils with cores connected to the levers, and a differential arm which is mounted on the shaft extending from the differential housing through the panel of the control element. These various items are all mounted in a compact manner and enclosed with a sheet metal cover making the control element splashproof. The differential housing and panels are so designed as to permit the panels to be mounted on either right or left hand side of the differential housing. All parts are common for this service except the base which must be specified.

Mechanical Differential (Synchronous Motor Driven Type)

8. Referring to Figure 6 the construction of the differential is as follows: A worm 1 is free to

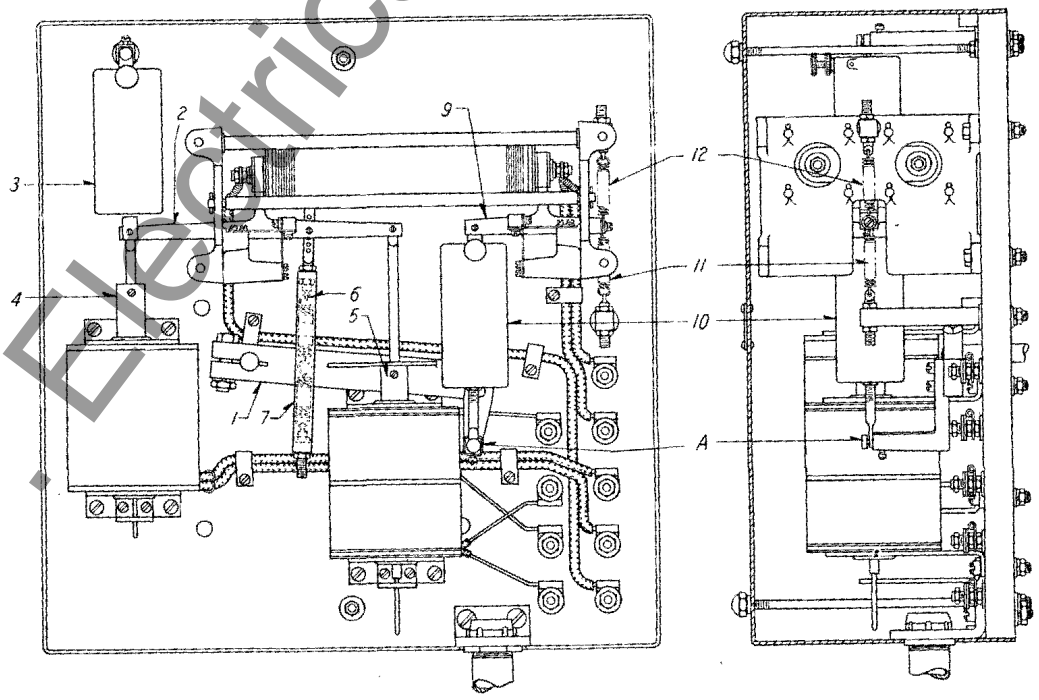


FIG. 3—CONTROL ELEMENT

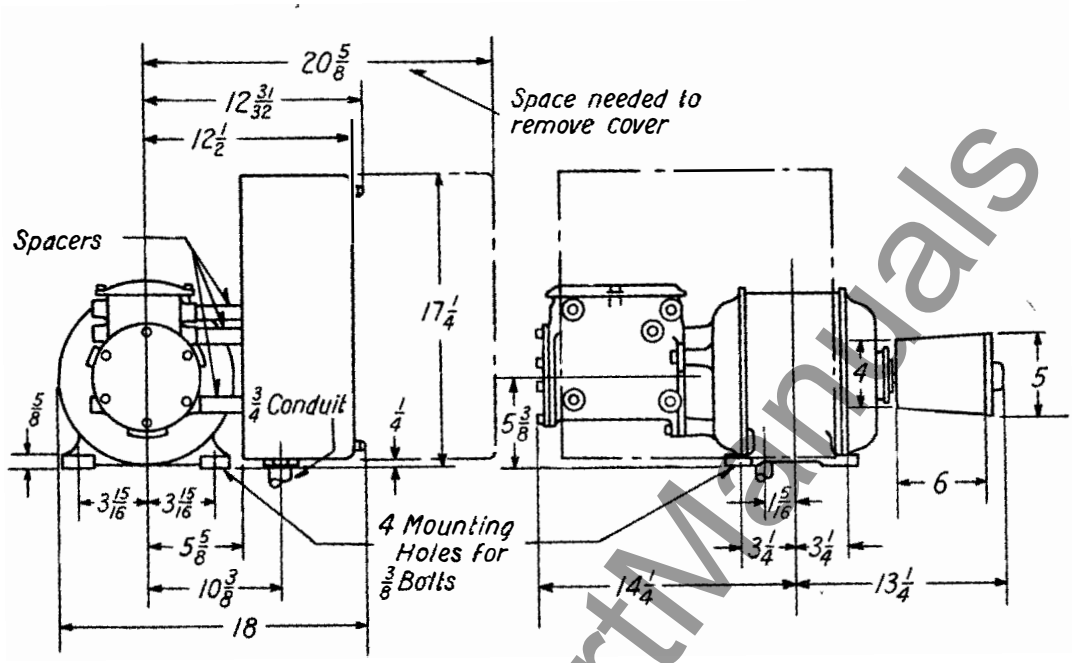


FIG. 4—OUTLINE VIEW OF SECTIONAL DIFFERENTIAL AND REGULATOR

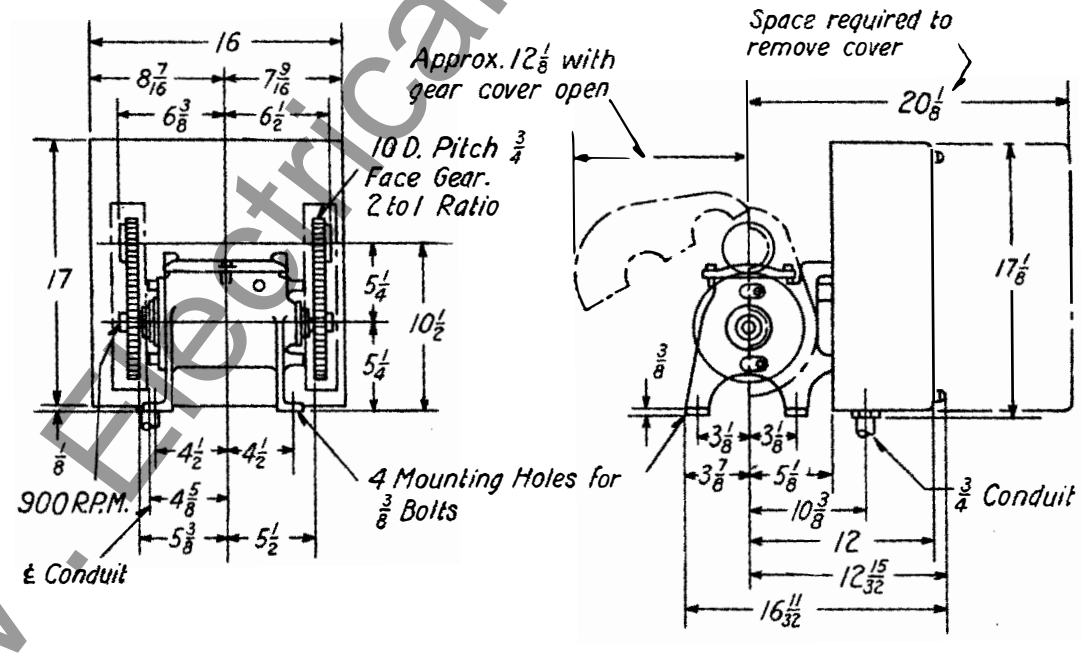


FIG. 5—OUTLINE VIEW OF FREQUENCY GENERATOR DIFFERENTIAL AND REGULATOR

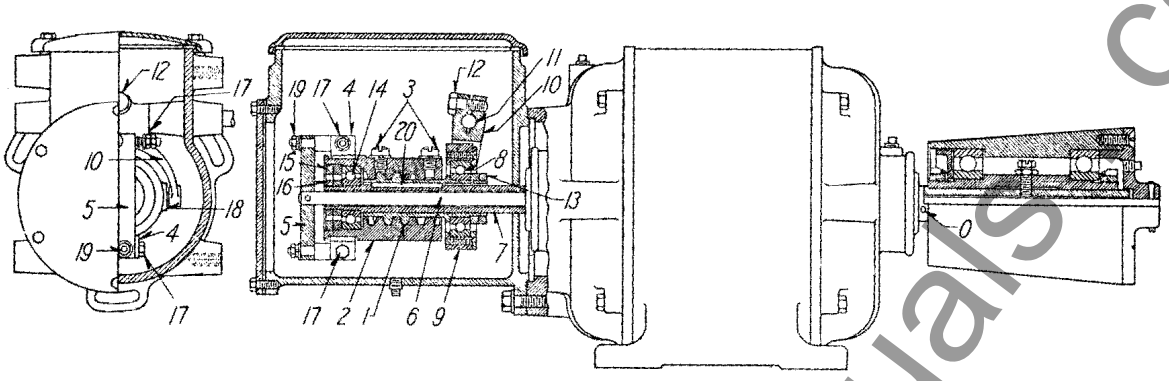


FIG. 6—SECTIONAL VIEW OF DIFFERENTIAL AND CONE PULLEY SYNCHRONOUS MOTOR TYPE

move longitudinally along the hollow shaft 7 but held by a spline key 20 which holds the worm in an angular position with the hollow shaft. The worm nut 2 is held in a definite position to the hollow shaft by means of the bearing 14 and ring nuts 15 and hex. nuts 16. The stop screws 3 are so located in the worm nut that the worm is allowed to travel ½ inch. The cone pulley drives the inner shaft 6 to which a support 5 is pinned, carrying the two clutch bands 4. A bearing 8 is mounted on the external end of the worm which supports a housing 9. The housing is so machined as to receive two shoes 18 so that they are free to move on a vertical axis but not on the horizontal axis. The shoes 18 fit into the yoke arm 10 which clamps to a shaft 11 by means of a clamp bolt 12.

Control Element

9. The control panel is assembled as per Figure 3. Referring to Figure 7, the lever 2 is connected to the differential arm 1, through the springs 6 and 7. At the right extremity of lever 2, the core of the armature coil is connected by a pin. At the left extremity, the core of the field coil is connected on the lower side of the lever and the upper side is connected to the plunger of a dashpot 3. The core and dashpot plunger are connected to the lever by the same pin connection. The lever 9 is held in horizontal position by the springs 11 and 12. The right extremity is connected to the cylinder of dashpot 10. The plunger of dashpot 10 is pinned to the end of lever 1.

Operation

Mechanical Differential

10. During normal operation the worm and nut of the differential are in some position between the two stop screws. The hollow shaft and the internal shaft are rotating at the same speed and in the same direction. Should the motor speed up, the cone pulley will then tend to be rotating in the opposite direction assuming an instantaneous change, that is, the relative directions of rotation are opposite to each other. Therefore, the worm is forced to travel out of the nut due to the fact that the nut is held in a definite position along the axis of the hollow shaft. If the speed of the motor is not brought to synchronism within the travel of the worm, the worm will strike against either of the stop screws and the clutch will slip. The movement of the worm transforms the amount of slip or phase displacement into a rotating motion of the shaft 11 As either a right hand or left hand worm and nut may be used, it will be considered that the right hand worm is used for descriptive purpose. The rotation of the shaft 11 is transmitted to the control element lever system which in turn changes the

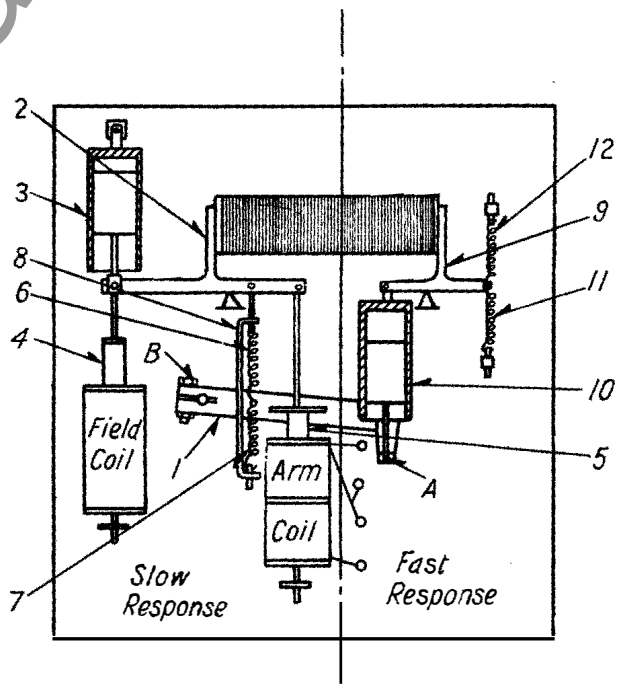


FIG. 7—CONTROL ELEMENT

field excitation to correct the error in speed.

Control Element

11. The operation of the control element consists both of a mechanical and an electrical operation. First, the mechanical operation will be described. The shaft 11, Fig. 6 is clamped to the differential arm 1, Fig. 7. As the arm 1 moves in either direction, it unbalances the spring 6 or 7, thereby changing the position of the lever arm 2, compressing or opening the carbon piles. For a slow change in speed in either direction of the main motor being regulated, the dashpot 10 has little reaction. Should the differential arm move at a rapid rate, the reaction of the dashpot 10 will then tend to move lever 9 against the springs 11 and 12. For this reason and for the purpose of explanation, the control element has been divided into two separate parts as indicated by the center line of Figure 7, namely, the "Fast Response" and the "Slow Response". The connections of the regulator are more or less different for the machines on which they are to be used. Therefore, for the purpose of describing the operation of the control panel, we will only consider the fact that the carbon piles are connected in series with the field coil and motor field circuit. The armature coil, we will consider as being connected across the series winding of the motor. The actual connections of the regulator will be described under the paragraph of "Wiring".

12. Assume that the motor is running at some speed with the regulator in service. In this case, the lever will be in some position, probably lever 2 is slightly tilted to the left, and the differential arm 1 is possibly in the horizontal position. The cores will also be in some balanced position if normal operation is assumed.

13. First assume that the load has been increased at a slow rate. Differential arm 1 will then tend to move upward at a slow rate to correct for the change in load. This will reduce the tension on spring 6 and increase the tension of spring 7, thereby causing the lever 2 to open the pile. As the pile is opened, the resistance is cut into the field

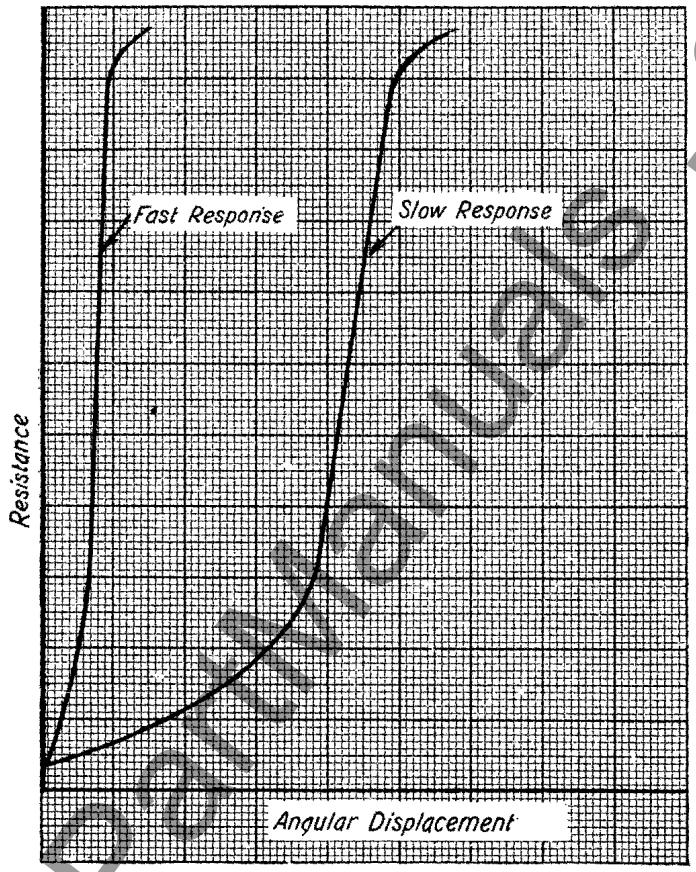


FIG. 8—CURVE SHOWING RESPONSE

circuit. Resistance being cut into the field circuit of the motor, the field current is reduced, therefore, the field coil will lose some of its initial pull, which in turn will allow more tension on spring 7 causing lever 2 to compress the piles restoring the field current slightly. Also when the field current of a motor is weakened, the motor tends to speed up drawing a greater amount of current from the line. Therefore, the armature coil would tend to pull down lever 2 compressing the carbon piles. This action tends to restore the field current to the previous value. This action of the coils provides the anti-hunting to a change of setting of the regulator. The dashpot 3 acts as a damping action to the response of the armature and field coils. When the speed has been properly matched between the cone pulley or regulated motor and the synchronous motor, the differential arm will cease to move and all working parts will be in a position relative to the load change. The speed of the regulated motor and synchronous motors being matched, the levers of the control element will not be in motion.

14. Assuming a load change in the same direction as above mentioned, but that a quicker load change has occurred. The differential arm will now tend to move upwards at a faster rate. Therefore, the reaction of dashpot 10 will open the pile through lever 9, instantaneously increasing the resistance of the field circuit at a value corresponding to the rate of change. At the same time the dashpot 10 has been operating, lever 2 has also been changing and when near the point of the matched speed, will gradually correct the error and act as a vernier of the fast response end. Curve, Figure 8 shows the amount of resistance inserted by "Fast Response" and "Slow Response" in respect to degrees of revolution of the cone pulley to the synchronous motor rotor.

Installing the Regulator

15. The synchronous motor and differential assembly as shown in

Figure 1 is supported by the synchronous motor base. The assembly should be mounted on or near the apparatus to be regulated so that all leads will be as short as possible. Having mounted the synchronous motor and differential assembly proceed as follows in mounting the control element when same is shipped separate.

a. Remove the sheet iron cover from the control panel and inspect the control element for damage.

b. Remove the pin (A) in Figure 7 so that the plunger of dashpot 10 can be removed. Note—BE CAREFUL that the inside of the cylinder and the surface of the piston does not come in contact with oil or dirt. KEEP FINGERS OUT OF DASHPOT CYLINDER AND OFF THE CYLINDRICAL SURFACE OF PISTON. Do not handle except by the outer surface in case of the dashpot cylinder or the stem of the piston.

c. Unscrew the clamp bolt marked (B) Figure 7 and remove the bolt which supports the differential arm to the panel.

d. Place the spacer provided over the differential shaft and then slide the panel over the shaft, taking care not to damage the lever system and slide the differential arm on to the shaft. Insert the four spacers provided for the mounting bolts in between the lugs of the differential housing and the rear of the panel and insert the bolts and tighten panel to the differential housing.

e. Place the differential shaft in the full field position as follows. Place a screw-driver between the inner part of the cone pulley and the motor bracket so that the hollow shaft of the motor can be held while rotating the cone pulley by hand. Rotate the cone pulley in the direction of rotation of the main motor or in the direction which the cone pulley should rotate. This corresponds to the motor running faster than the synchronous motor and tends to turn the differential shaft to the "Full field position," which is reached when the worm strikes the stop screw. The differential being in the "Full field position," place the differential arm about $\frac{5}{16}$ to $\frac{3}{8}$ inch away from the panel and bring the arm down to within $\frac{1}{16}$ inch of the armature coil bracket. At this position clamp the bolt "B" securely.

f. Replace the dashpot plunger and the pin "A" taking care that a little play is allowed between the end of the differential arm bracket and the head of the pin.

g. Check all the levers for freedom of operation; see that the cores 4 and 5 are free in the respective coil.

h. If the control element is not in a vertical position, it can be so aligned by loosening the three screws mounting the differential housing to the motor bracket and rotating the housing.

i. A bracket is provided on the panel for supporting the conduit which houses the leads to the regulator. After panel has been mounted in place, the conduit should be clamped to the bracket provided and the leads fastened to the terminals indicated by Figure 9.

j. In cases where forced ventilation is required, the air pipe should be supported by the second bracket, allowance being made for 1" movement of the differential unit for belt tightening.

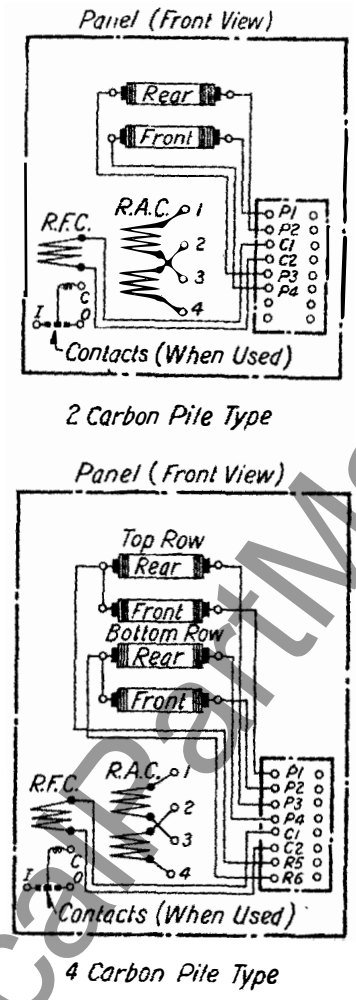


FIG. 9—WIRING DIAGRAMS

Wiring

16. The control element should be wired according to the drawing provided with the apparatus. The connection of all regulators will be in general as outlined in Figure 9. The leads running from the series winding of the motor to the armature coil of the regulator should be of heavy wire and as short as possible. All connections with respect to the field circuit and armature coil should be very secure.

Putting Regulators Into Service For First Time

17. The regulator does not require any adjustment after leaving the factory, however, it is desirable to check the various elements to insure their satisfactory operation after shipment. Test the friction of the worm and nut by rotating the cone pulley by hand holding the hollow shaft as per (Par. 15e). The worm should run from one stop screw to the other without a noticeable amount of torque on the hollow shaft. The clutch tension should be such as to operate the control element from one extreme to the other before it slips. A heavy grade of machine oil is furnished with each regulator for use in the differential mechanism. Before putting the regulator into service be sure that this oil is placed in the differential housing and that it fills the housing to the oil level. A **line indicating**

the oil level is found on the inside of the differential housing.

18. Move the lever of the control element by hand to test for friction and reaction of the dashpots. Should a dashpot be found to be sticking remedy as follows:

1. Remove the dashpot from the lever system and hold the cylinder in one hand and spin the piston with the other with the valve closed. The piston should spin freely on the air cushion formed both at the open end of the dashpot and at the bottom.
2. If the piston does not meet this requirement, clean the cylinder with a clean cloth as well as the outer surface of the piston.

Caution—Do not use any grid paper on the inside of the cylinder wall or on the piston.

3. Place the piston in the cylinder after the spinning fit has been obtained and insert the dashpot allowing the piston to drop out due to its own weight against gravity. The dropout time should be between 90 and 120 seconds.

19. The approximate setting of the cores with the levers in the horizontal position is 1¼ inches measured from the end of the core to the top of the coil brackets. The valve of the dashpot should not be changed from the factory setting unless it is found necessary as outlined in a later paragraph. The normal setting of the valves for the dashpot 3 and 10 are 1 turn and 1½ turn respectively.

20. The regulator is now ready to be put in operation, wiring having been checked, place an ammeter in series with the field leads entering the control element and check for continuity of the field circuit.

21. Start the master set and then close the synchronous motor contactor on the sectional panel and check the rotation of the synchronous motor of the regulator. The rotation of the synchronous motor should be in the same direction as the cone pulley or section motor.

22. It is now necessary to have a stroboscope to indicate the phase displacement of the section in respect to the synchronous motor of the regulator. The marks on the face of the cone pulley are spaced approximately 22½° apart so that with the stroboscope it is very easy to determine the angular displacement of the section motor. If the rheostat in series with the carbon pile circuit is conveniently near the regulator it can be used to vary the speed of the motor to cause a corrective force of the regulator. If the rheostat is not conveniently near the regulator, the speed can be varied by moving the levers of the control elements by hand allowing the regulator to settle the change. If a stroboscope is not available, the differential arm 1 (Fig. 7), provides a reliable check providing the speed reference source is constant.

23. With the section motor running at normal speed, first vary the speed of the section motor a slight amount by either the rheostat in series or by moving the lever by hand so that the change is small. With this small change in speed, the regulator should correct immediately through the "Slower Response" end and dashpot 10 should not have much effect on lever 9. Figure 7. Vary the speed a slight amount above and below normal, checking the phase displacement and noting the time of settling. Should the coils set up a vibrating motion, dampen their action by closing the valve of dashpot 3. The above action of the regulator being adjusted to a minimum time required to settle the speed of the section motor, vary the speed rapidly by compressing or opening the lever 9 by hand so that a rapid change in speed is made. With this change of speed, the regulator should operate through dashpot 10. The setting of dashpot 10 will be very critical. The combination of adjustments of the valve of dash-

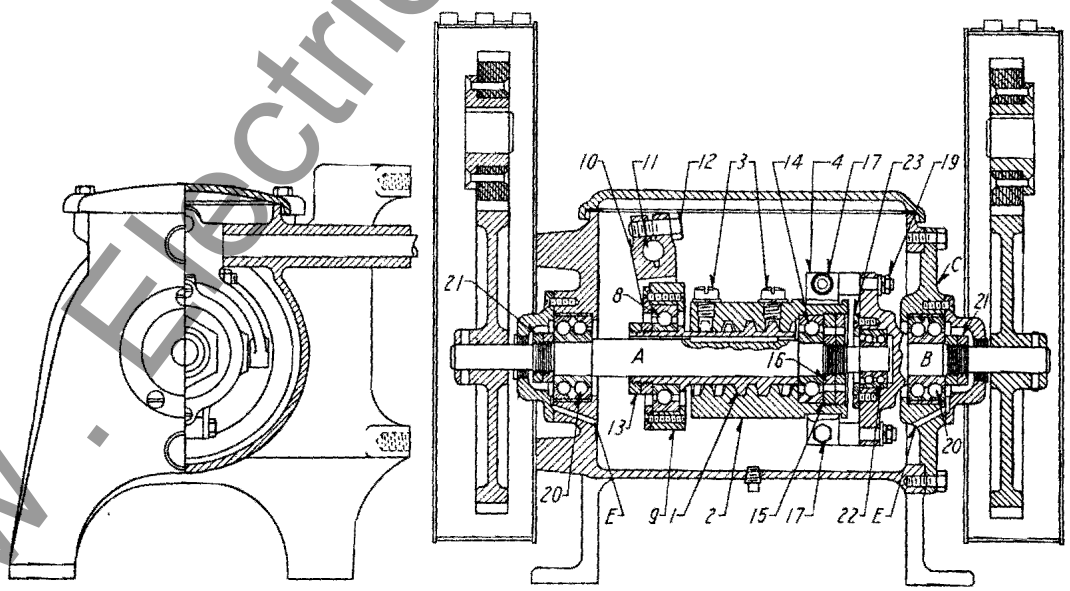


FIG. 10—SECTIONAL VIEW OF DIFFERENTIAL, MECHANICALLY DRIVEN TYPE

pot 3 and the value of dashpot 10 will result in order to prevent the regulator from being too sensitive to small changes and insensitive to large changes of speed. The dashpot reaction of 10 dashpot should not be great enough to operate lever 9 when there is a small change of speed above or below normal. Select the minimum time required to settle the speed of the machine and lock the dashpot valves in this position. After these adjustments have been made, set the rheostat in series with the field circuit of the motor to a position which places the differential arm 1 Figure 7, in a position slightly above the "Full field position" when the motor is operating at normal speed and no load. On variable voltage applications set as above at high voltage normal or no load operation. Mark this position of the rheostat so that it can be always returned to this value.

Operation of the Master Differential or Mechanically Driven Type

24. The master differential is essentially the same as the section differential except that the worm and nut assembly are mounted on a shaft driven through a spur gear by the pilot motor and held by an internal fit in a ball bearing supported by a second shaft which is driven through a spur gear by the master motor. Referring to Figure 10 the construction consists of a shaft (A) supported by a ball bearing in the differential housing at one end and at the other end by a male fit into the ball bearing of shaft (B). Shaft (B) is supported by housing plate (C) which in turn is closely fitted to the bore of the differential housing. The worm and nut assembly is identical to the section differential but the clutch is supported from the shaft (B). Any angular displacement between the two shafts is readily detected by the worm and nut mechanism and transmitting to the differential shaft 11. The lubrication of this mechanism depends upon the splash system, the oil being splashed about the differential housing by the clutch bands which dip in the oil. The bearings are lubricated by the flow of the oil around the shafts (A) and (B) into the bearing journal and returns to the drain duct (E).

Preparing the Master Differential for Service

25. The master differential should be tested for friction and clutch torque the same as the sectional differential. See paragraph 17. The machine oil furnished with regulator should be poured into the differential housing to the oil level as marked on the inside of the differential housing. The unit is now ready for service. The control element for the master regulator is adjusted as in paragraphs 15 a to 20 under the section differential.

Dismantling the Differential Units

26. To dismantle the section differential proceed as follows:

a. Remove the top cover and the end plate from the differential housing after draining off the oil in the case.

b. Remove the nut 19 Figure 6 which releases the brake support stud and drive out the tapered pin which holds bar 5 to the inner shaft 6.

c. Pull the bar 5 from the shaft 6 through the end of the housing.

d. Remove the lock nuts 16 from the hollow shaft 7 by using the socket wrench furnished with the units and the spanner wrench for the hollow shaft.

e. The differential assembly is now free to be pulled through the end of the housing. Unscrew the clamp bolt 12 in the yoke lever 10, pull the assembly through the end of the differential housing with one hand and with the other hand rotate the yoke arm in the direction of which the assembly is being pulled in order to allow the shoes 18 to slide out of the slots in housing 9.

f. Swing the yoke lever 10 up to the top of the differential out of the way.

g. The worm 1 can now be removed from the nut 2 by removing the stop screw 3 at the yoke end of the nut.

h. If it is necessary to remove the ball bearing assembly 8 from the housing 9, proceed as follows:—In order to prevent injury to the thread of the worm, screw the worm into the worm nut and replace the stop screw 3. The worm nut can now be held in a vice and the lock nuts 13 holding the ball bearing 8 in place can be removed. In this manner the stop screws are acting as a wrench against the end of the worm, thereby, preventing damage to the worm thread. The bearing housing 9 and the bearing 8 can now be removed from the shaft by tapping the end of the worm on a hard block of wood.

i. The clutch assembly is removed from the worm nut by removing the lock nuts and bolt 17.

j. To remove the guide bearing in the worm nut, it is necessary to remove the jam nuts 15 and gently tap the nut on a piece of hard wood in order to jar the bearing loose from the bore of the nut.

Assembling the Differential

27. Before assembling the differential be sure that all parts are thoroughly cleaned, particular care being taken to see that the threads of the worm and nut are free from dirt and also that the ball bearings spin freely. Assemble the worm, nut, clutch, and housing 9 before replacing on the hollow shaft. To replace the assembly in the housing proceed as follows:

a. Set the hollow shaft so that the key is at the top and then slide the assembly on to the hollow shaft. When the assembly is approximately 1/3 the way on the shaft, swing the yoke lever 10 down into position and fit the shoes 18 into the slots of housing 9. The assembly can now be pushed on to the hollow shaft and the lock nut 16 can be replaced. All the parts being replaced and all nuts and pins being tight it is now necessary to place the differential in the full field position with respect to the control element.

Note—Place guide post of housing 9 into slot of yoke lever 10.

b. To place the differential in the full field position insert a screw-driver between the inner part of cone pulley between the cone pulley and the motor bracket. This prohibits the motor shaft from rotating. Rotate the cone pulley in the direction of rotation until the clutch slips. This determines the "Full field position." Referring to paragraph 15-e under Control Element, set the differential arm in the full field position and then clamp the yoke lever 10 by means of bolt 12. Replace the oil to the oil line in the differential housing and the regulator is now ready for service.

Master Differential

28. To dismantle the master differential it is necessary to remove the master set from the bedplate. To remove the worm and nut assembly from the differential housing, proceed as follows:

a. Remove the gear from shaft (B) by driving out the taper pin. Remove all the cap screws in plate (C). Remove the top cover and the nuts 19 from the clutch support studs of shaft 2. The plate (C) can now be removed from the differential housing by tapping the inner surface and then pulling it along the axis of the shaft. The worm and nut assembly is dismantled as in above paragraph 27 under the sectional differential. All bearings can be removed by removing the bearing cap of the respective bearings.

b. Removal of the worm and nut assembly does not require the shaft (A) to be removed from the differential housing. However, if the shaft (A) must be removed from the differential housing, it is only necessary to remove the three flat head screws in the bearing cap and then push the shaft (A) out of the differential housing in the direction of the gear.

c. In assembling the unit, take every precaution to fit all the parts together without binding in any way. The parts are so machined as to be assembled by ordinary push-fit so that if any part should bind, the repairman will know that he has not properly entered the corresponding part. After the differential has been completely assembled, refill with clean oil to the oil level and replace on the bed plate. The differential is now ready to be placed in the full field position.

d. To place the master differential in the full field position, hold the pilot motor armature from rotating while the master is rotated in the direction of rotation. This runs the worm in the full field position at which point the yoke lever can be clamped to the differential arm shaft 11 as described in paragraph 15-e under Control Element.

Carbon Pile Control Element With Contacts

This type of regulator is used in conjunction with rheostatic type control and differs from the other type of carbon pile control element only in that it has two stationary contacts and one moving contact.

The adjustments for the control element with contacts are the same as outlined in paragraphs 15 to 19, 22-23. In general, the contacts are used to operate a motor operated rheostat in the main motor field circuit to assist the regulator over a wide range of speed. The rheostat should be operated by means of the contacts to insure that the rheostat is running in the proper direction to assist the regulator, i. e. if the piles compress to slow down the motor speed, the rheostat should run to the "Out" position when the contacts make by the downward movement of the differential arm 1, Fig. 7. With the differential arm in the extreme position at either end of its travel, the contacts should make with just enough contact pressure to insure operation of the rheostat motor. The stationary contacts should be carefully adjusted to insure this contact pressure especially when the rheostat motor is of a rather high speed.

With the rheostat motor circuit disconnected, adjust the carbon pile control element as in Paragraphs 15 to 19-22-23 to meet the booster requirements as outlined in special instructions or as tabulated on data sheet of this book. Start the motor to be regulated and run at some desirable speed and bring the regulator in control by hand operation of the motor operated rheostat. With the regulator in control and the contact circuit disconnected, vary the speed slightly within the limits of the regulator and observe the swings of the differential arm or by the use of a stroboscope as explained in above reference paragraphs. Having thus adjusted the regulator, place the contacts in control of the rheostat motor and cause the regulator to swing the main motor over a wider speed range, and observe the number of swings required to settle the speed to normal. If the regulator tends to oscillate from one contact to another, it will possibly be due to the fact that too much contact pressure is applied. If adjustment of the contact for a slight pressure has been made to the point where the contact is not positive in operating the motor rheostat, it will be necessary to slow down the speed of the rheostat motor. The rheostat motor speed which is normally used for this application is about 30 seconds from "All In" to "All Out" positions.

Synchronous Motor

The synchronous motors S 675186 and S 675216 which are used in conjunction with the synchronous motor driven differential should be operated under the following conditions. The motors are good for a frequency range of 60 cycles to 10 cycles, and will hold in step down to 1 or 2 cycles with a voltage equal to 3.6 volts per cycle applied.

Reeves Transmission

The Reeves variable speed transmission used in conjunction with the synchronous motor type of differential is a compact and self-contained unit, simple in construction and op-

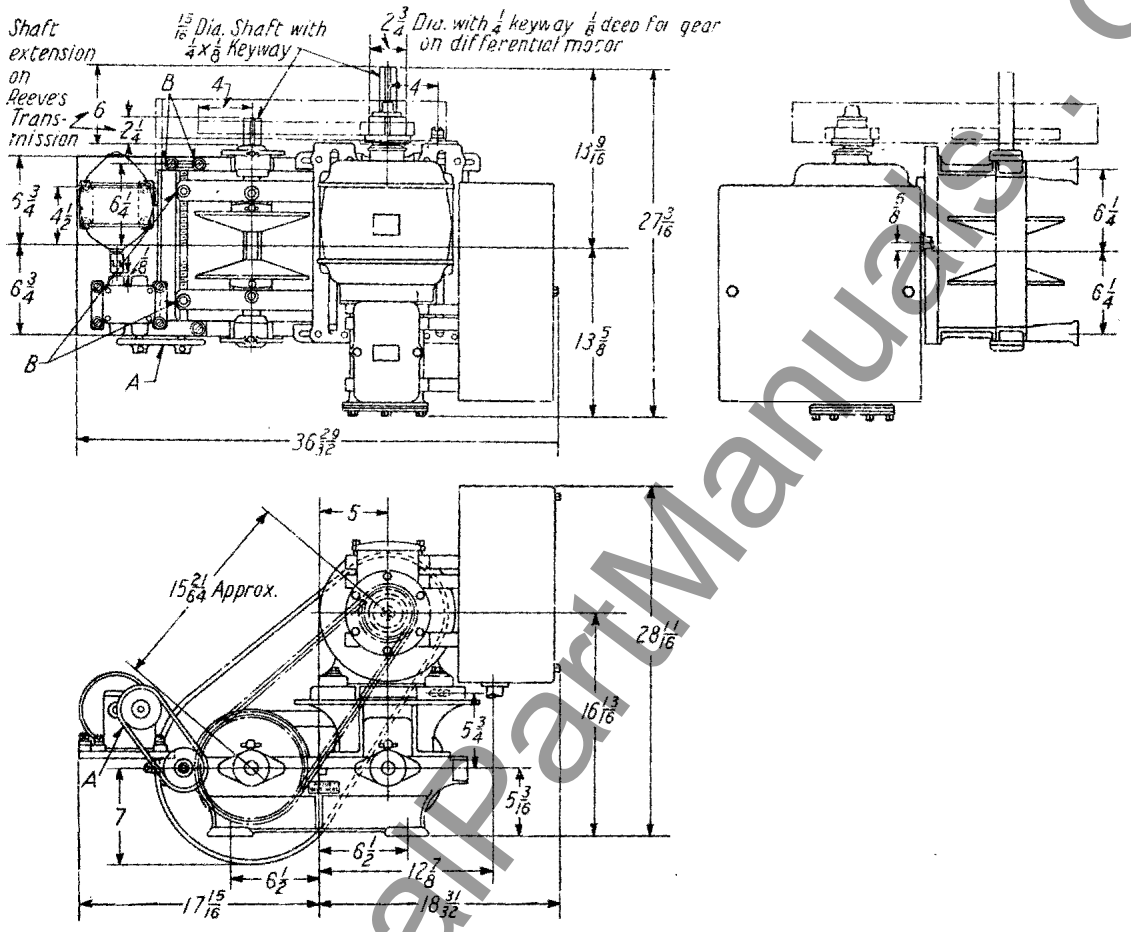
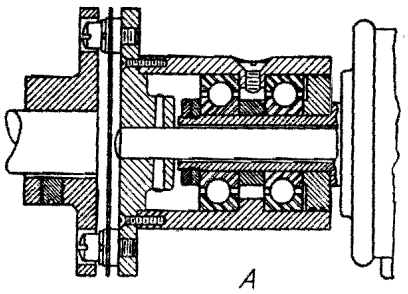


FIG. 11—VARIABLE SPEED TRANSMISSION WITH REGULATOR MOUNTED

erating principles, and designed to provide adjustable speed over a wide range, between its driving and driven shafts.

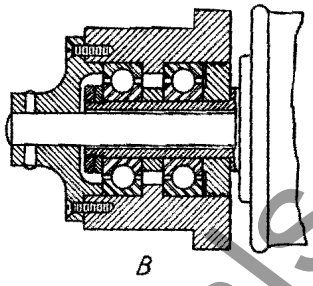
Two pairs of conical shaped discs mounted on parallel shafts and connected to suitable lever mechanisms so that when a worm thread spindle is turned, the one pair of discs close in while the other pair open out. A split belt consisting of several wooden blocks equally spaced on a rubber canvas strip, with the ends of these blocks beveled to conform to the contour of the discs, connect the two pairs of discs together. The ends of the wooden blocks of the belt have leather plates fastened to them to provide a substantial gripping surface to the discs. The one shaft of the reeves transmission known as the constant speed shaft drives the inner shaft of the carbon pile speed regulator differential by means of a chain with a suitable sprocket mounted on the regulator synchronous motor shaft. Therefore, if this shaft is considered as running at a constant speed and the shifting screw is turned to change the relative position of the two pair of discs, the diameters of contact which the belt makes with these are varied, consequently varying the speed of the second shaft. The function of the Reeves transmission when used with the regulator is to change the ratio of the motor speed with respect to the constant speed of the regulator unit, thereby, actually recalibrating the regulator to operate the motor at a higher or lower speed. A motor is provided to operate the speed adjusting screw automatically.

The Reeves transmission is to be installed and the speed changing motor wired as per drawing and diagram supplied with each application. The complete unit consisting of the Reeves transmission and the regulator should be thoroughly aligned to the machine to be regulated and lubricated with a good grade of grease. The Reeves transmission should be run so that the belt tension can be adjusted as well as the speed changer mechanism. With the transmission running the belt should run with just a small amount of slack. The belt tension is adjusted by means of a screw which is accessible from either side of the reeves plainly marked by a plate. The speed changing motor and mechanism should be next adjusted as follows:—The speed changer motor through a gear unit drives the speed changing worm shaft by a round leather belt so that when the spreader bars are at their extreme positions the belt will slip. This should



FLEXIBLE COUPLING

FIG. 12



UTILITY HUB OF PINION

be carefully checked so that the belt A, Fig. 11 will slip as soon as the spreader bars reach the end of their travel. The belt tension is adjusted by loosening the bolt B, Fig. 11 and sliding the motor and mechanism along the frame of the transmission to give the proper belt tension.

Very little maintenance is required on the Reeves transmission aside from periodic lubrication of the bearings and inspections made of the belt and discs to see that grease does not collect.

Flexible Coupling and Utility Hub

(a) The flexible coupling connection supplied with the synchronous motor driven type differential is used when two synchronous motors are furnishing the reference speed between the two main motors being matched for speed and for other forms of direct connection to motor being regulated. To dismantle the flexible coupling it is first necessary to drive the taper pin from the clutch support bar 5, Fig. 6 which holds the inner shaft. Remove screws from end place of coupling and pull out the inner shaft. (See Fig. 12-A).

(b) The utility hub is used on the same type of unit as the flexible hub, but is for the purpose of mounting gears, pulleys, and any other special type of drives, such as the Reeves transmission mounting. If gears or sprockets are provided by other suppliers, care should be taken that the center of the gear face is on the center of the hub face. For construction refer to Fig. 12-B.

Cone Pulley Mechanism For Reversible Service

This design of cone pulley was purposely made for mechanical connection between the two sources of speed to be matched, which in turn are to be reversible.

Aside from proper alignment of the mechanism in respect to the driving source, there are practically no adjustments to be made.

In order to replace the belt the spring B, Fig. 13 of the idler pulley should be removed and the guide bracket B removed by loosening the screws D. The belt can now be slipped toward the speed adjusting hand wheel end of the pulley. Remove the bolts E and drive out the pad A. The belt can now be lifted from the end of the pulley and the new belt replaced.

Periodic greasing of the ball bearings should be made, but care should be taken not to have the bearings filled excessively with grease.

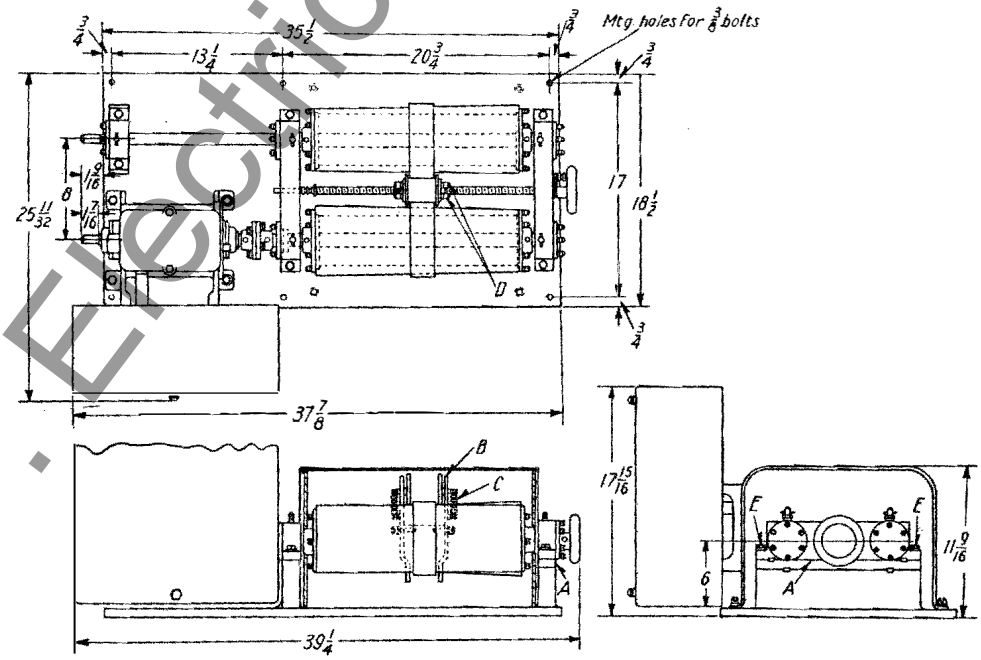


FIG 12—CONE PULLEY ASSEMBLY WITH BELT SHIFTING SCREW

Differential Parts Common to Sectional and Master Regulators

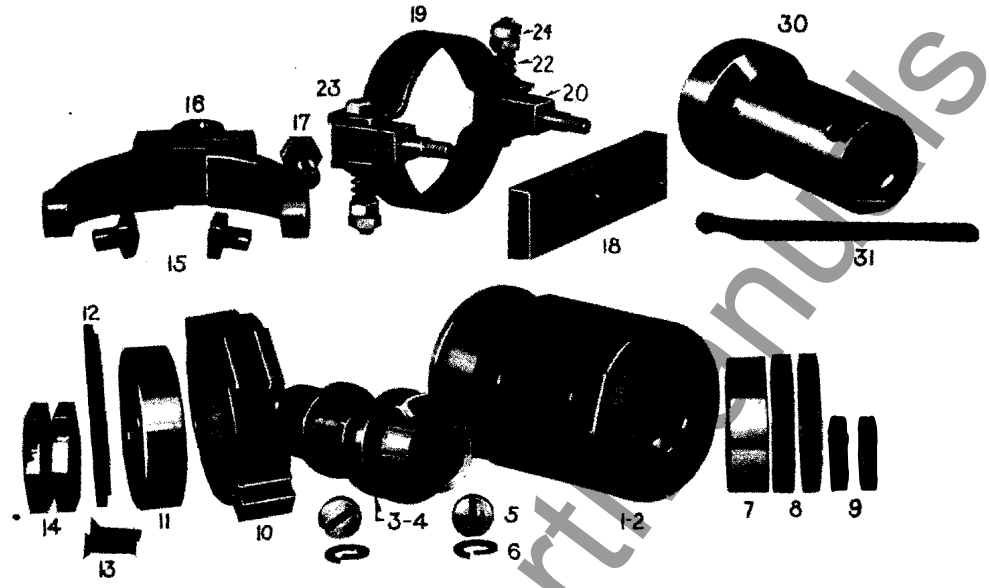


FIG. 14—WORM AND NUT, WITH TOOLS

Ref.	No. Req. per Unit	Name
*1	1	R. H. Worm Nut
*2	1	L. H. Worm Nut
*3	1	R. H. Worm
*4	1	L. H. Worm
5	2	Stop Screw
6	2	Stop Screw Lock Washer ⅜ S. A. E.
7	1	Worm Nut Guide Bearing
8	2	Bearing Jam Nut
9	2	Bearing Lock Nut Hex.
10	1	Thrust Bearing Housing
11	1	Thrust Bearing
12	1	Thrust Bearing Retainer
13	2	Thrust Bearing Retainer Screw 10-32 x ½ Ft. Hd. M. S.
14	2	Thrust Bearing Lock Nut
15	2	Thrust Bearing Shoe
16	1	Yoke
17	1	Yoke Clamp Bolt ⅜-16 x 1 M. B. Tap Bolt
18	1	Clutch Support Bar
19	2	Clutch Band
20	2	Clutch Band Post
21	2	Clutch Band Post Nut ¼-20 Hex.
22	2	Clutch Band Spring
23	2	Clutch Band Bolt ¼-20 x 1¾ M. B. Tap Bolt
24	4	Clutch Band Bolt Nut
25	4	Clutch Band Lock Washer
26	4	Clutch Band Washer
27	1	Taper Pin #0
28	1	Key
°30	1	Socket Wrench
°31	1	Spanner Wrench

*Only 1 of items 1 and 3 or 2 and 4 per unit.
°One of each supplied with complete drive comes with master regulator assembly.

Control Element

Ref.	No. Req. per Unit	Name
1	1	Base R. H. Mounting for Sectional Regulator
2	1	Base L. H. Mounting for Sectional Regulator
3	1	Base R. H. Mounting for Master Regulator
4	2	Pile Support Bracket
5	8	Pile Support Rod
6	8	Pile Support Rod Insulator
7	16	Pile Support Insulator Washer (Asbestos)
8	16	Cotter Pin 1/16 x ½"
9	14	Pile Support Bracket Bolt (¼-20 x 1-⅜ M. B.)
10	4	Pile Support Bracket Nut (¼-20 Hex.)
11	4	Pile Support Bracket Washer
12	4	Pile Support Bracket Lock Washer
13	1	Carbon Arm Coil End
14	1	Carbon Arm Spring End
15	8	Carbon Arm Pivot Spring
16	16	Carbon Arm Pivot Spring Screw (4-40 x 5/16 Fil. Hd. I. M. Sc.)
17	16	Carbon Arm Pivot Spring Lock Washer
18	16	Carbon Arm Pivot Spring Washer
19	8	Carbon Arm Pivot Spring Screw (8-32 x ½" Fil. Hd. I. M. Sc.)
20	8	Carbon Arm Pivot Spring Lock Washer
21	8	Carbon Arm Pivot Spring Washer
22	4	Carbon Compressor
23	4	Carbon Compressor Insulating Washer
24	4	Carbon Compressor Insulating Tube
25	2	Carbon Compressor Insulating Plate
26	1	Carbon Compressor Connector
27	4	Carbon Compressor Washer
28	4	Carbon Compressor Nut
29	3	Carbon Compressor Crimp Washer

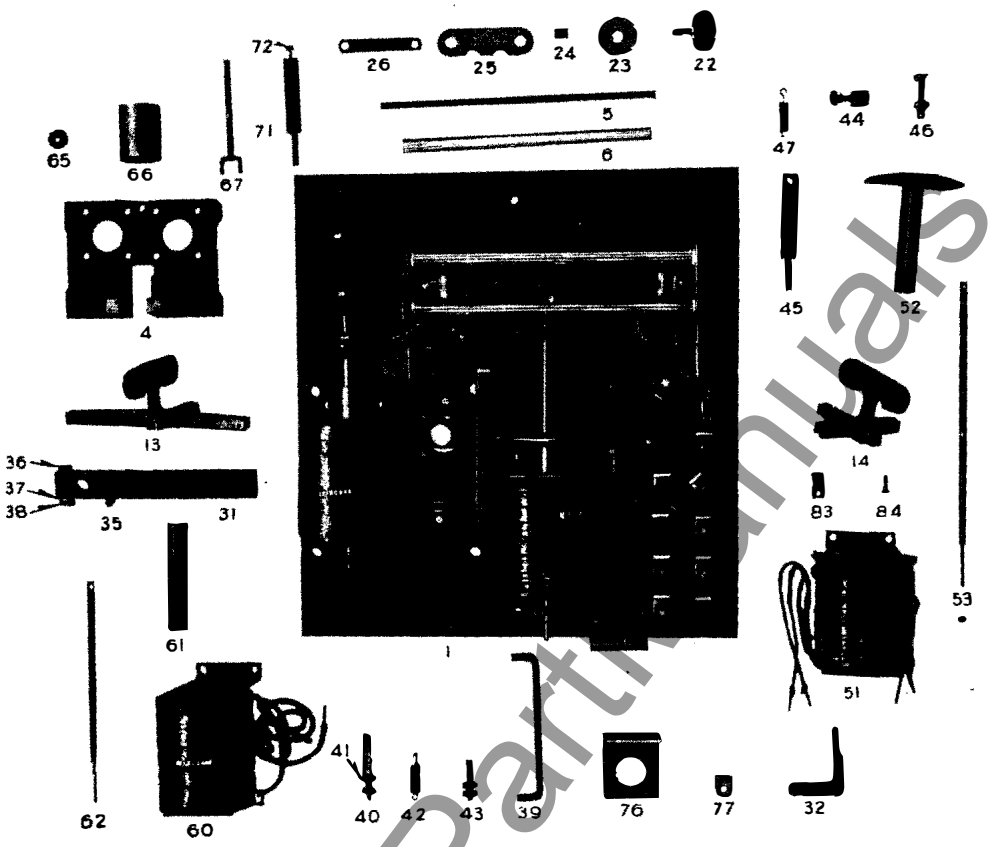


FIG. 15—CONTROL ELEMENT

Ref.	No. Req. per Unit	Name
30	3	Carbon Compressor Lock Washer
31	1	Differential Arm
32	1	Differential Arm Bracket
33	2	Differential Arm Bracket Screw (10-32x ¾ Fil. I. M. S.)
34	2	Differential Arm Bracket Lock Washer
35	1	Differential Arm Pin
36	1	Differential Arm Clamp Bolt
37	1	Differential Arm Lock Washer
38	1	Differential Arm Nut
39	1	Differential Arm U Bar
40	1	Differential Arm Link
41	2	Differential Arm Link Nut (¼-20 Hex.)
42	2	Differential Arm Spring
43	1	Differential Arm Spring Stud
44	1	Spring Support Post (Short)
45	1	Spring Support Post (Long)
46	2	Spring Adjusting Stud
47	2	Spring
48	1	Spring Support Post Washer
49	2	Spring Support Post Lock Washer
50	2	Spring Support Post Unit (¼-20 Hex.)
*51	1	Armature Coil
52	1	Armature Coil Core
53	1	Armature Coil Core Stem
54	2	Armature and Field Coil Core stem Guide Bracket
55	4	Core Set Screw
56	8	Coil Mounting Screw (¼-20 x 1-¼ Fil. Hd.)
57	8	Coil Mounting Screw Washer
58	8	Coil Mounting Screw Lock Washer
59	8	Coil Mounting Screw Nut (¼-20 Hex.)
*60	1	Field Coil
61	1	Field Coil Core
62	1	Field Coil Core Stem
°63	2	Dash Pot
64	2	Dash Pot Valve
65	2	Dash Pot Valve Lock Nut
°66	2	Dash Pot Piston
67	1	Dash Pot Piston Stem (Coil End Dash-pot)
68	1	Dash Pot Piston Stem (Spring End Dash-pot)
69	2	Dash Pot Piston Stem Washer
70	2	Dash Pot Piston Stem Nut
71	1	Dash Pot Support Post
72	2	Dash Pot Support Pin
73	3	Lever Connection Pin (Short)
74	1	Lever Connection Pin (Long)
75	4	Lever Connection Cotter Pin
76	1	Conduit Support Bracket
77	9	Terminal
78	9	Terminal Stud (¼-20 Fil. Hd. B. M. S.)
79	27	Terminal Stud Nut (¼-20 Hex. Brass)
80	9	Terminal Stud Washer (Brass)
81	18	Terminal Stud Lock Washer
82	4	Terminal Stud Link
83	3	Wire Clamp
84	3	Wire Clamp Screw

*Specify number on coil and name plate data of regulator.
°Order these items together as they are not interchangeable.

General Data

For General Application

1—Voltage range of main D-C. Generator ....

2—Voltage range of Variable Voltage (small) Exciter ....

3—Normal voltage of Constant Voltage (large) Exciter ....

4—Res. in series with Pilot Motor Field ....

5—Res. in series with Master Motor Field ....

6—Res. in series with A-C. Gen. Field ....

7—Speed of D-C. master and pilot motors at 250 volts ....

8—Master A-C. gen. voltage at speed given in (7) ....

The direction of rotation of the synchronous motors when viewed from the end connected to the cone pulleys and certain data on the carbon pile speed regulators are given below.

Carbon Pile Speed Regulators

Section	Dir. of Rotation	Dir. of Thread	Estimated Speed at Min.	Av.	Max.
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....
....	C. Clockwise	....	....	....	....

General Data

For Paper Mill Application

1—Voltage range of main D-C. Generator.....

2—Voltage range of Variable Voltage (small) Exciter.....

3—Normal voltage of Constant Volt (large) Exciter.....

4—Res. in series with Pilot Motor Field.....

5—Res. in series with Master Motor Field.....

6—Res. in series with A-C. Gen. Field.....

7—Speed of D-C. master and pilot motors at 250 volts.....

8—Master A-C. gen. voltage at speed given in (7).....

The direction of rotation of the synchronous motors when viewed from the end connected to the cone pulleys and certain data on the carbon pile speed regulators are given below.

Carbon Pile Speed Regulators

Section	Dir. of Rotation	Dir. of Thread	Estimated Speed Min.	Av.	Max.
Couch	C. Clockwise				
1 Press	C. Clockwise				
2 Press	C. Clockwise				
3 Press	C. Clockwise				
4 Press	C. Clockwise				
1 Dryer	C. Clockwise				
2 Dryer	C. Clockwise				
3 Dryer	C. Clockwise				
4 Dryer	C. Clockwise				
1 Calendar	C. Clockwise				
2 Calendar	C. Clockwise				
3 Calendar	C. Clockwise				
1 Sm. Press	C. Clockwise				
2 Sm. Press	C. Clockwise				
3 Sm. Press	C. Clockwise				
1 Brkr. Roll	C. Clockwise				
2 Brkr. Roll	C. Clockwise				
3 Brkr. Roll	C. Clockwise				
1 Reel	C. Clockwise				