Using The SUMMARY OF CONNECTION LIST

INTRODUCTION

In the past the wiring diagrams have had serious limitations for customer and service reference. The reason for this was that the internal wiring document was tailored primarily for manufacturing purposes rather than for servicing purposes. Specifically it has always been difficult to relate the physical location of a device as shown on a wiring diagram, to the equivalent circuit or symbol on the electrical schematic. Likewise, if one wished to determine on a wiring diagram the physical location of a circuit shown in the schematic, it required slow, careful search through several pages of diagrams until the device designation was located.

The Buffalo Systems Control Department has been working on a group of computer programs which will enable us to prepare our shop internal wiring instructions in tabular form rather than in conventional diagram form which has been used in the past. These programs are now completed and are being put to use.

When programming for computer wiring manufacturing information (Wiring M.I.*) it became apparent that with a little more computer running time we could eliminate this difficulty. It is accomplished by rearranging the shop information into a second form specifically tailored for optimum reference by servicing personnel. This form now is printed and shipped with the equipment. The purpose of this leaflet is to acquaint you with this new document.

* We no longer use the term wiring diagram for chart type wiring instructions. Instead it is called Wiring Manufacturing Information or Wiring M.I.

DESCRIPTION

The new document is called "Summary of Connections List" and the name literally means just that. The document consists of 8-1/2 x 11 pages listing every terminal on every electrical device in the system. Furthermore all possible information related to each terminal is shown on the same line on the list.

The first three pages of the list contain a detailed list of instructions to the customer and service personnel concerning its use. The first page also contains a key to the wire size and color code symbols used in the lists.

A few sample pages of a Summary of Connection list are shown in this leaflet for your inspection and study. However, it would be well to examine just a few of the principles which make computer wiring possible. In simple language this type of wiring is "wiring-by-the-numbers".

TERMINAL NUMBERS

Most of our devices such as relays and contactors do not have terminal numbers on them. To compensate for this, preprinted adhesive labels have been created and permanently attached to the panels close by each device. Some simple devices such as resistors, capacitors etc. do not have labels. Instead, a standard convention for determining the terminal number is described on the third page of the Summary of Connections list. This simple convention can be memorized quickly.

LOCATION LABELLING

It was recognized early that it would be too cumbersome for the computer to state the equipment location of a connection on a component verbally, such as:

" 10 inches from the left, 70 inches from the bottom, mounted flat against panel area 10, on panel section 6, of shipping section 3 structure 1"

Instead a standard significant digit code number was established to reduce the space required to indicate a location in the system. For instance the above statement code number appears as follows:

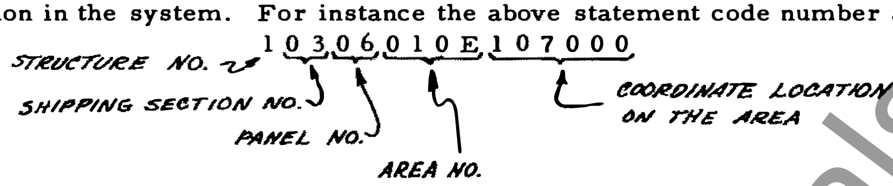


Figure 1 - Key to Definition of Terms for the Location Code System - Multiple Unit Equipment Such As Frames and Cubicles

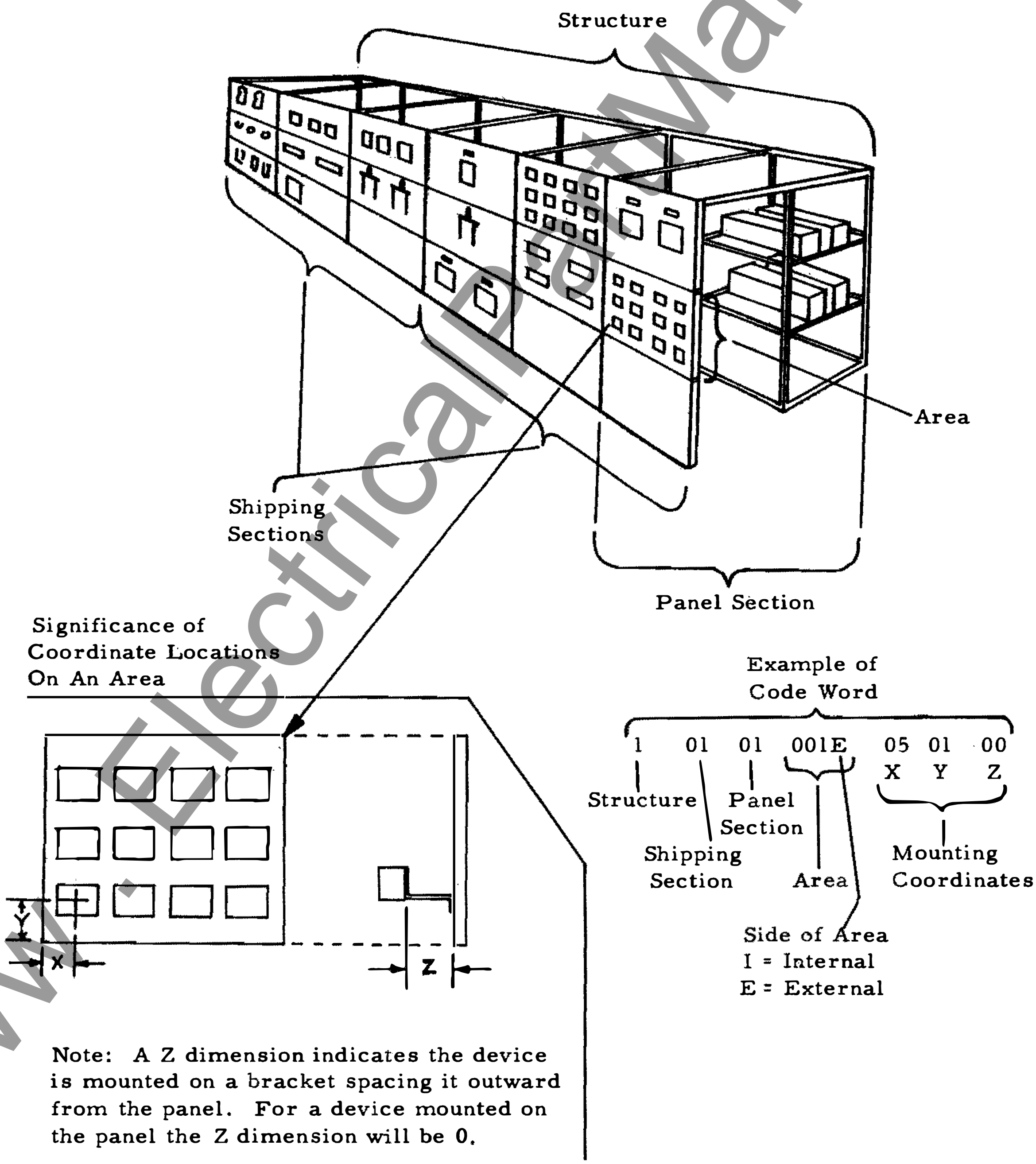


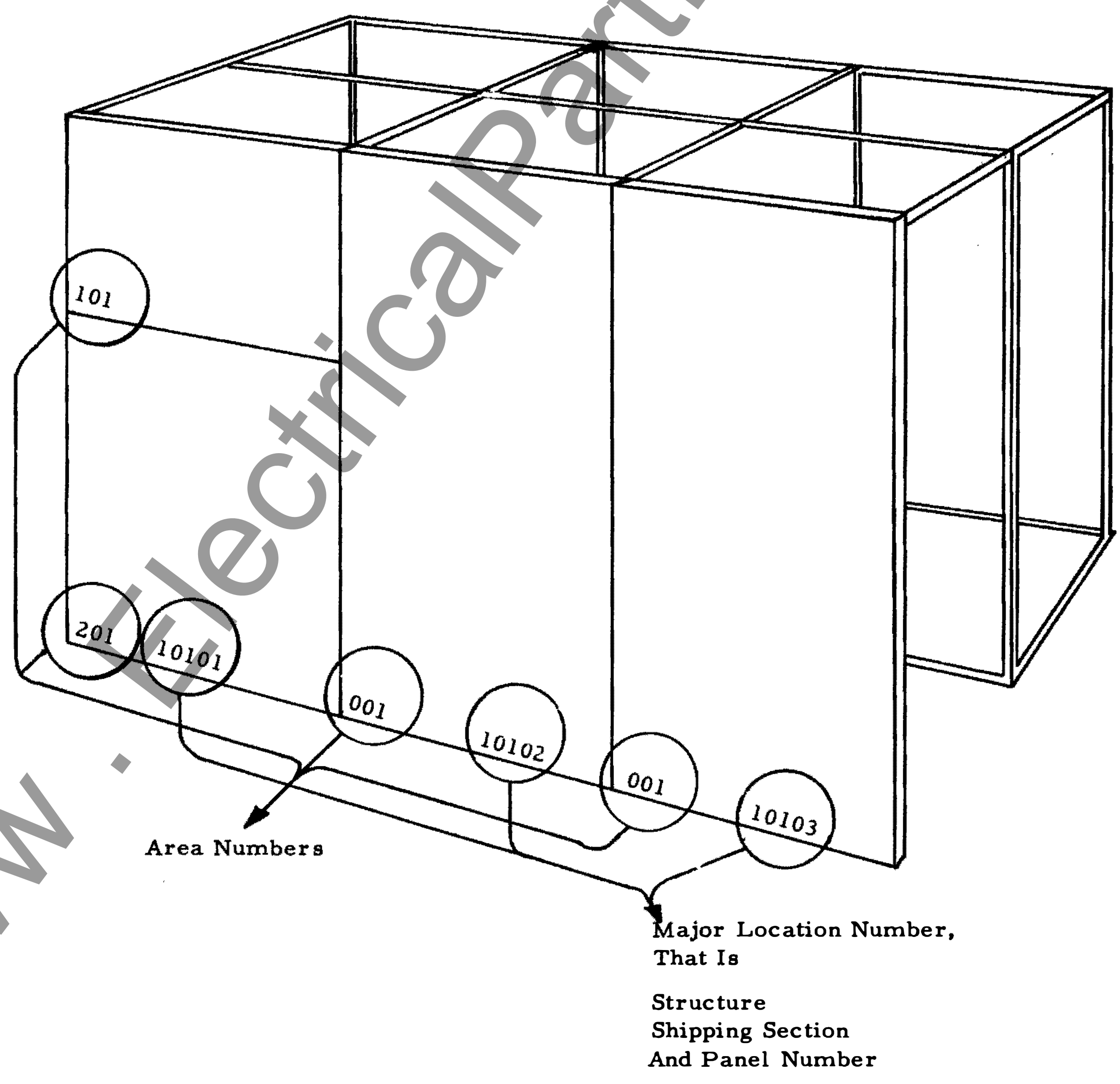
Figure 1 shows more clearly what each of these terms mean.

The code key is discussed in greater detail on the second example sheet shown in this leaflet.

The location number information has been introduced at this point to emphasize that the numbers are physically marked on the equipment. Figure 2 shows how these markings will appear.

Figure 2

Positions of Location Codes on Equipment

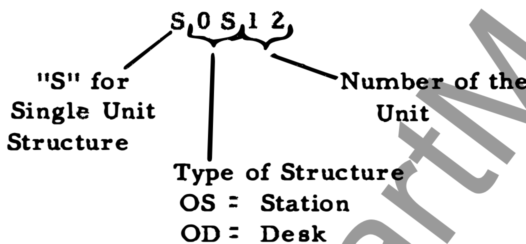


The location code number differs for Operators Station, desks and other small structures. Figure 3 illustrates the key to this code.

Figure 3 - Key to Definitions of Terms For The Location Code System - Single Unit Structures Such as Operator Stations, Desks

The location code number for single unit equipment such as Operators stations and desks, small cabinets, etc.

Code Key:



We now suggest that you proceed to study the example attached.

We firmly believe that the new Summary of Connection List system is a significant advance in the art and an added feature for our customers.

The advantages are:

1. 8-1/2 X 11 reference documents are more easily handled, easier to read and file.

2. The lists provide quick transition from the schematic diagram to the physical location of a terminal point in a system.

3. The lists also allow the reverse of this, that is, to get quickly from the physical location of a terminal to the circuit schematic quickly.

4. Terminal labels on the panels make for quick terminal identification and simplify circuit tracing.

Note: This new system in no way effects the customer interconnection diagram. This diagram remains in the form that it has in the past.

-SUMMARY OF CONNECTIONS LIST-

APPLICATION ______________________________

CUSTOMER ______________________________

G.O. __________ MAIN S.O. __________ C.W.L. NO. __________ INDEX DWG. __________

SCHEME DWG. ______________________________

SHIPPING SPLIT LIST __________ INTERCONN. LIST ______________________________

THE FOLLOWING SUPPLEMENTARY DWGS AND SHEETS ARE REQUIRED TO COMPLETE THE WIRE LIST INFORMATION.

1. INSTRUCTIONS FOR USING "SUMMARY OF CONNECTIONS LISTS" - SHEET NO. 2.
2. DEVICE TERMINAL DESIGNATIONS. - SHEET NO. 3
3. COMPLETE LISTING OF DEVICES AND CONNECTIONS. - SHEET NO. 4 AND AS NEEDED.
4. REVISION & TABULATION SHEET.
5. SIGN OFF SHEET

WIRE CODE TABLE

1A=#22=7-.010 - 12277-3
1B=#22=1-.0253- 12277-3
1C=#18=16-.010 - 12277-3
1D=#14=7-.024-12277-15
1E=#14=41-.010-12277-15
1F=#12=7.0305-12277-15
1G=#12=65-.010-12277-15
1H=#10=7-.0385-12277-15
1I=#8=7-.0486-12277-15
1J=#4=133-.0177-12277-15
1K=#2=259-.016-12277-15
1L=1/0=259-.0202-12277-15
1M=4/0=427-.0223-12277-15
1N=#16=26-.010-12277-15
1P=#6=7-.0612-12277-15
1R=2/0-259-.0227-12277-15
1S=2=#2/0=259-.0227-12277-15*
1T=2=#4/0-427-.0223-12277-15*
2A=#16=19-.0126-7419-13
2B=#14=7-.024-7419-13
2C=#14=41-.010-7419-13
2D=#12=1-.081-7419-13
2E=#12=65-.010-7419-13
2F=#10=105.010-7419-13
2G=#8=7-.0486-7419-13
2H=#6=7-.061-7419-13
2I=#4=7-.0772-4719-13
2J=#2=7-.0974-7419-13
2K=#1/0=19-.0745-7419-13
2L=#2/0=19-.0837-7419-13
2M=#4/0=19-.1055-7419-13
2N=2=#2/0=19-.0837-7419-13*
2P=2=#4/0=19-.1055-7419-13*
2R=#12-1-.081-7419-3

3A=#24=16-.005-12277-4
3B=#22=7-.010-12277-14
3C=#22=1-.0253-12277-14
3D=#20=10-.010-12277-4
3E=#18=16-.010-12277-14
3F=#14=7-.024-12277-14
3G=#22=1-.0253-12277-4
3H=#26=7-.0056-12277-3
3J=#26=7-.0063-62512AB
3K=#20=26-.0063-62512AA
3L=#22=16-.0063-62122KD
3M=#18=16-.010-62121BB
3N=#24=16-.0034-62122KE
3P=#20=26-.0063-62122KE

4A=3040=19-.013-7355-SHFS-3
4B=4497=7-.025-7355-SHFS-4
4C=9016=7.-036-7355-SHFS-9
4D=31480=49-.025-7355-SHFS-26
4E=66380=133-.022-7355-SHFS-66

COPPER BAR
AA=1/8x3/4
AB=1/8x1
AC=1/8x1-1/4
AD=1/8x1-1/2
AE=1/8x2
AF=1/4x1
AG=1/4x1-1/2
AH=1/4x2
AI=1/4x2-1/2

COLOR CODE
BL=BLACK
B =BLUE
BN=BROWN
G =GRAY
R -RED
W -WHITE
Y -YELLOW
W/B-WHITE/BLUE STRIPE
W/R-WHITE/RED STRIPE
B/W-BLUE/WHITE STRIPE
R/W-RED/WHITE STRIPE
G/W-GRAY/WHITE STRIPE

COPPER BAR
1/4x3
1/4x3
1/4x3
1/4x4
1/4x4
1/4x4
1/4x5
1/4x5
1/4x5
1/4x6
1/4x6
1/4x6
1/4x8
1/4x8
1/4x8
1/4x8

*=2 LEADS IN PARALLEL

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO DIV.- CONTROL DEPT.-BUFFALO,N.Y.,U.S.A.

DWG. NO.	SUB.	SH.#	SHEETS

Instructions for Using the "Summary of Connections List"

The "Summary of Connections List" is a complete listing of all the electrical devices and their connections in chart form for a particular control.

On the one hand, this list enables a person observing a particular device on a scheme to quickly ascertain both its physical location and its electrical connections on the panel, or the converse is also true; by means of this list a person observing a particular device on a panel can quickly locate its symbol on the scheme.

There are three sets of columns reading from left to right in this order: "FROM DEVICE", "REFERENCE DEVICE", and "TO DEVICE". The column headed "Reference Device" is the major column, and contains in Alpha-numeric order all the devices used on the job. Note: Changes may not be in Alpha-numeric sequence.

As an example, go to the list shown below. If the wiring information for "9P" is desired, go to the column headed "Device Designation" under the major heading "Reference Device". Device "9P" will be found in Alpha-numeric order with the following information:

a) It is located on Structure 1, Shipping Section 1, Panel Sect. 1, Sub assembly 1, and on the exterior side of area 106. Its location on the area 106 is 10 inches from the left edge of the panel, 14 inches up from the bottom of the panel and 0 inches out from the surface of the panel. See Fig. 1 below.

b) Its terminal number is 1.

c) Its wire number is 69.

d) The circuit is located on zone (area, section or sheet) 2A of the Schematic Diagram.

e) Term. 1 on 9P connects "FROM" terminal 2 on 18R.

f) Term. 1 on 9P connects "TO" terminal 2 on 2P.

g) The wire size for the "TO" connection is wire Code "1C". The preceding sheet contains a table of wire and color codes.

h) The wire color for the "TO" connection is "B" for blue.

This constitutes complete information for terminal 1, device 9P except for the wire and color code for the "FROM" connection (device 18R terminal 2 to device 9P terminal 1). Scan the "Reference Device" column for device 18R, terminal 2. Device 9P, terminal 1 will be located on the same line, and in the "TO DEVICE" column. The wire code and color for this connection will be listed under the "Wire Code" and "Wire Color" column.

Every device terminal will have a minimum listing of at least 2 and possibly 3, once in the "Reference Device" column, and once in the "FROM" and/or "TO" columns. For some special conditions, the number of listings in the "Reference Device" column will be more than one, with a proportional increase in the "FROM" and "TO" columns.

WESTINGHOUSE FORM 25004

SUMMARY OF CONNECTIONS

FROM DEVICE		REFERENCE DEVICE							TO DEVICE			
DEVICE		DEVICE		LOCATION OR DESCRIPTION			SCH. ZONE	WIRE NO	WIRE		DEVICE	
DES	TERM NO	DES	TERM NO	MAJOR	AREA	COORD			CODE	COLOR	DES	TERM NO
		2FU	4	10101	106E	150700	3C	47	1D	R	9 REC	Y1
9P	3	2P	1	10101	106E	100809	2A	67	1C	B		
9P	1	2P	2	10101	106E	100809	1F	69	1C	B		
18R	2	9P	1	10101	106E	101400	2A	69	1C	B	2P	2
*2TS	68	9P	2	10101	106E	101400	2A	68	1C	B		
*2TB	67	9P	3	10101	106E	101400	2A	67	1C	B	2P	1
7X	4	18R	1	10101	106I	051309	2A	70	1C	B	6P	1
5P	3	18R	2	10101	106I	051309	2B	69	1C	B	9P	1

Example

Device Name
Device Terminal Number
2* { 1* { Structure Number
Shipping Section No.
Panel or Cabinet Sect. No. }
Area on Panel or Cabinet Sect.
I - Interior, or E - Exterior Side of Area }

Wire Color
Wire Code Number } See Sheet No. 1 For Table of Wire and Color Code
Wire Or Lead Number
Area or Section of Schematic

Z Coordinate
Y Coordinate
X Coordinate } 2* Dimensions to the Nearest Inch

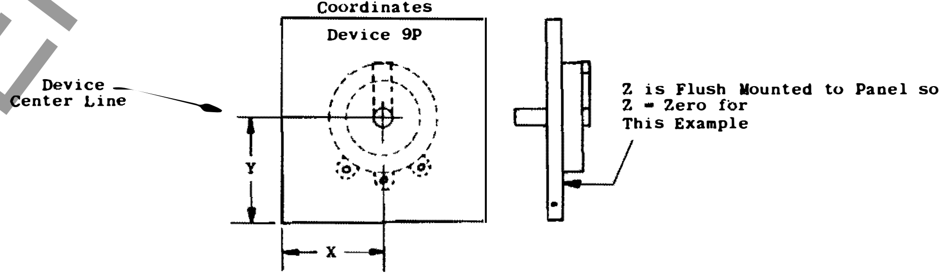


FIG. 1
Significance of Coordinates

1* - For some equipment such as operator stations, the number could be for example, SOSO1 meaning operators station number 1.
2* - For customers external equipment designated by the letter "C" followed by 4 digits, example "C1041", the columns headed "Major", "Area", and "Coordinates" will be filled in with the description of the device for example, "Screw Dn Motor 1". The number "C1041" will appear in the "DEVICE DESIGNATION" columns.
The following sheet contains a set of rules for assigning terminal designations to those devices whose terminals are unmarked.

DWG. NO.	SUB.	SH. NO.	SHEETS
		2	

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO DIVISION — CONTROL DEPT. — BUFFALO, N.Y., U.S.A.

Device Terminal Designations

A. Device terminals have been numbered so that the correct terminal may be easily and quickly located and identified. Previously, it has been necessary to interpret the information from the wiring diagram.

The following methods are used to label or interpret device terminals.

1. The device may be manufactured with its terminal numbers stamped or engraved. Only a small portion of the devices are in this category.

2. An adhesive label may be placed on, or adjacent to the device. This includes the largest portion of all the devices.

3. The small remaining group of devices, those that have only a few terminals, will have their terminal designations interpreted by a few simple rules.

B. Description of the method of terminal identification

1. Stamped or engraved terminal designations. These are usually marked near the terminal on the wiring side.

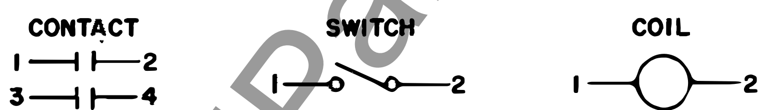
2. Adhesive labels.

The label is a pictorial view of the device whose terminals are tagged and enlarged for easy identification. More than one label may be required for the more complex devices, for instance one label for the front and one for the rear.

In general, a single label describes a family of devices, for example, a four, six or eight pole relay of similar symmetrical construction is described by a label that illustrates an eight pole relay.

3. Assignment of Terminal Identification by a set of rules.

a) Numbering is established by circuit configuration. Each set of contacts is assigned an odd number followed by the next higher ascending even number.
Example:



b) Device terminals are numbered as seen from the front of the device. (The following devices are an exception to the rule in that they are numbered from the wiring side. They are pushbuttons, meters, telephone jacks, pots and rheostats, and indicating lights).

c) Devices that are rotated from the normal position are numbered from the normal position.

d) Terminal numbering sequence, (devices with coils excepted) begins with terminal number 1 at the left, top and nearest panel. The numbering will continue in ascending order by circuit, from top to bottom or left to right.

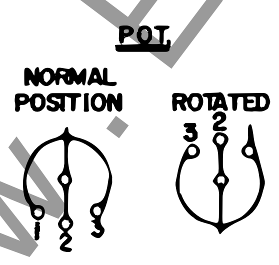
e) Pushbuttons.

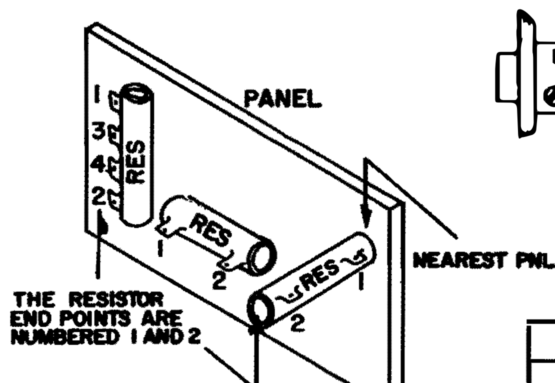
There are two exceptions to the rules for numbering pushbuttons. They are:

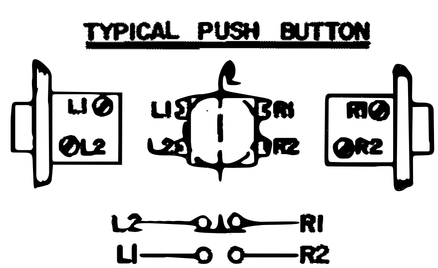
e1) Numbering is determined by terminal configuration and not by circuit configuration.

e2) The terminal number will bear a prefix of "L" or "R" based on it's location in relation to the pushbutton vertical center line.

f) Some examples for the above rules.







Dwg. No.	Sub	Sh.#	Sheets
		3	

Westinghouse Electric Corporation
Buffalo Div. - Control Dept. - Buffalo, N.Y., U.S.A.

WESTINGHOUSE FORM 35009

SUMMARY OF CONNECTIONS

FROM DEVICE		REFERENCE DEVICE							TO DEVICE			
DEVICE		DEVICE		LOCATION OR DESCRIPTION			SCH. ZONE	WIRE NO.	WIRE		DEVICE	
DES.	TERM. NO.	DES.	TERM. NO.	MAJOR	AREA	COORD.			CODE	COLOR	DES.	TERM. NO.
6P	3	2R	1	10101	106I	020609	2A	70	1C	B	12C	1
		2R	2	10101	106I	020609	1A	73	1C	B	7P	1
*5TB	84	3C	1	10101	106E	190600	2F	84	1C	B	1P	2
		3C	2	10101	106E	190600	2F	320M	1C	B	*3TB	320M
4R	2	3P	2	10101	106E	100209	2B	63	1C	B	8C	1
7X	8	3P	3	10101	106E	100209	2B	64	1C	B		
7P	2	3R	1	10101	106I	040309	1B	80	1C	B		
*5TB	81	3R	2	10101	106I	040309	1B	81	1C	B	5C	1
		4P	1	10101	106E	030809	2B	78	1C	B	1R	1
*5TB	77	4P	2	10101	106E	030809	2B	77	1C	B		
*4TB	76	4P	3	10101	106E	030809	2B	76	1C	B		
*3TB	EP	4R	1	10101	106I	080609	2B	EP	1C	B		
		4R	2	10101	106I	080609	2B	63	1C	B	3P	2
3R	2	5C	1	10101	106E	101300	1B	81	1C	B		
*5TB	82	5C	2	10101	106E	101300	1C	82	1C	B		
		5P	1	10101	106E	031409	2B	69	1C	B	18R	2
*3TB	320M	5P	2	10101	106E	031409	2B	320M	1C	B	16R	2
		5P	3	10101	106E	031409	2B	72	1C	B	19R	2
7X	X1	5R	1	10101	106E	011000	3B	52	1C	B		
		5R	2	10101	106E	011000	3C	55	1C	B	1C	1
		6P	1	10101	106E	061409	2B	71	1C	B	19R	1
*3TB	EN	6P	2	10101	106E	061409	2A	EN	1C	B	8C	2
18R	1	6P	3	10101	106E	061409	2A	70	1C	B	2R	1
12R	1	7C	1	10101	106E	031800	3B	56	1C	B	9REC	R
13R	1	7C	2	10101	106E	031800	3B	60	1C	B		
2R	2	7P	1	10101	106E	030209	1A	73	1C	B		
		7P	2	10101	106E	030209	1B	80	1C	B	3R	1
19R	2	7P	3	10101	106E	030209	2B	72	1C	B	12C	2
		7X	10	10101	106E	161400	3B	57	1C	B	*2TB	57
		7X	11	10101	106E	161400	3C	46	1C	B	*2TB	46
		7X	12	10101	106E	161400	3B	62	1C	B	8P	3
		7X	15	10101	106E	161400	1C	83	1C	B	7X	16
7X	15	7X	16	10101	106E	161400	1C	83	1C	B		
		7X	1	10101	106E	161400	2C	79	1C	B	1R	2
		7X	2	10101	106E	161400	2C	84	1C	B	*5TB	84
		7X	3	10101	106E	161400	1C	82	1C	B	*5TB	82

SUMMARY OF CONNECTION LIST
S.O. IND.DWG NO.
CUST.
EQUIP.+APPLIC.MAGAMP PNL

DWG. NO.	SUB.	SH. NO.	SHEETS
424A770		4	

BUFFALO DIVISION — CONTROL DEPT. — BUFFALO, N. Y., U. S. A.

DESCRIPTION • OPERATION • MAINTENANCE

INSTRUCTIONS

MECHANICAL DIFFERENTIAL SPEED ERROR DETECTING UNIT

DESCRIPTION

General. The MECHANICAL DIFFERENTIAL SPEED ERROR DETECTING UNIT (Figure 1) is an electro-mechanical device for speed matching two rotating elements. These elements are usually rotating shafts of electrical machines.

The mechanical differential speed error detecting unit is used with an external amplifier to directly control the fields of either generators or motors. The unit will detect any error in the speed matching of two rotating elements.

Each unit has the following components:

1. Rigid mounting base with slide rails.

2. Basic mechanical differential error detecting unit.

3. Provision for remote draw control.

4. Provision for slack take-up feature.

5. Pilot generator.

6. Position inductor.

7. The necessary gearing and mounting supports.

8. Drip proof cover to completely enclose the components.

9. Synchronous reference motor.

Draw Range. The amount of speed variation possible by using the remote draw control is ± 12 percent maximum by means of the belt shifting mechanism excluding any circuit limitations.

Gears. All gears have been induction hardened to provide minimum wear. Machining has been held to close tolerances to minimize backlash, thus reducing wear and increasing the accuracy of the unit.

Bearings. All bearings are prelubricated sealed ball bearings to provide extreme reliability and long life.

BASIC MECHANICAL DIFFERENTIAL ERROR DETECTING UNIT

The mechanical differential error detecting unit (Figure 2) consists of a drive cone, a differential or driven cone, and a belt coupling between the two cones. A bedplate and a combination housing and bearing provides a support for the components of the unit.

The drive cone shaft is supported at the housing and has attached to it a 15-inch pitch diameter, single groove sheave for belting to the rotating shaft of the controlled machine.

The differential cone contains the planetary gear system which furnishes rotation of the differential output shaft. The differential cone is supported at the housing and obtains its rotation from the drive cone through the belt coupling.

The reference speed is introduced into the unit through the shaft attached to the 56-tooth gear. This 56-tooth gear drives a 72-tooth idler gear which in turn drives a second 56-tooth gear attached to the sun gear shaft. At the opposite end of the differential cone, the 26-tooth sun gear is attached to the sun gear shaft. A 78-tooth ring gear is fitted to the inside of the differential cone in line with the sun gear. A 26-tooth planetary gear revolves on its shaft between the sun gear and the ring gear and is meshed to both of these gears. The planetary gear drives the output shaft through a mechanical crank as shown in Figure 2. A 40-tooth chain sprocket is attached to the output shaft and drives a gear train connected to the position inductor and pilot generator Figure 4.

For the output shaft to remain motionless, the sun gear must rotate exactly three times as fast as, and in the opposite direction to, the ring gear.

Any deviation in the above ratios of speed will cause motion of the output shaft and this motion will persist until the exact relationship is re-established through corrective action of the regulating system.

The relationship of these three gears is such that if the sun gear reference shafts were held motionless, four revolutions of the ring gear would produce three revolutions of the differential output shaft. Conversely, if the cone is held motionless, four revolutions of the sun gear are required to produce one revolution of the output shaft.

The drive cone and the differential cone are identical in external size and shape, but are mounted to the housing with their tapers facing in opposite directions.

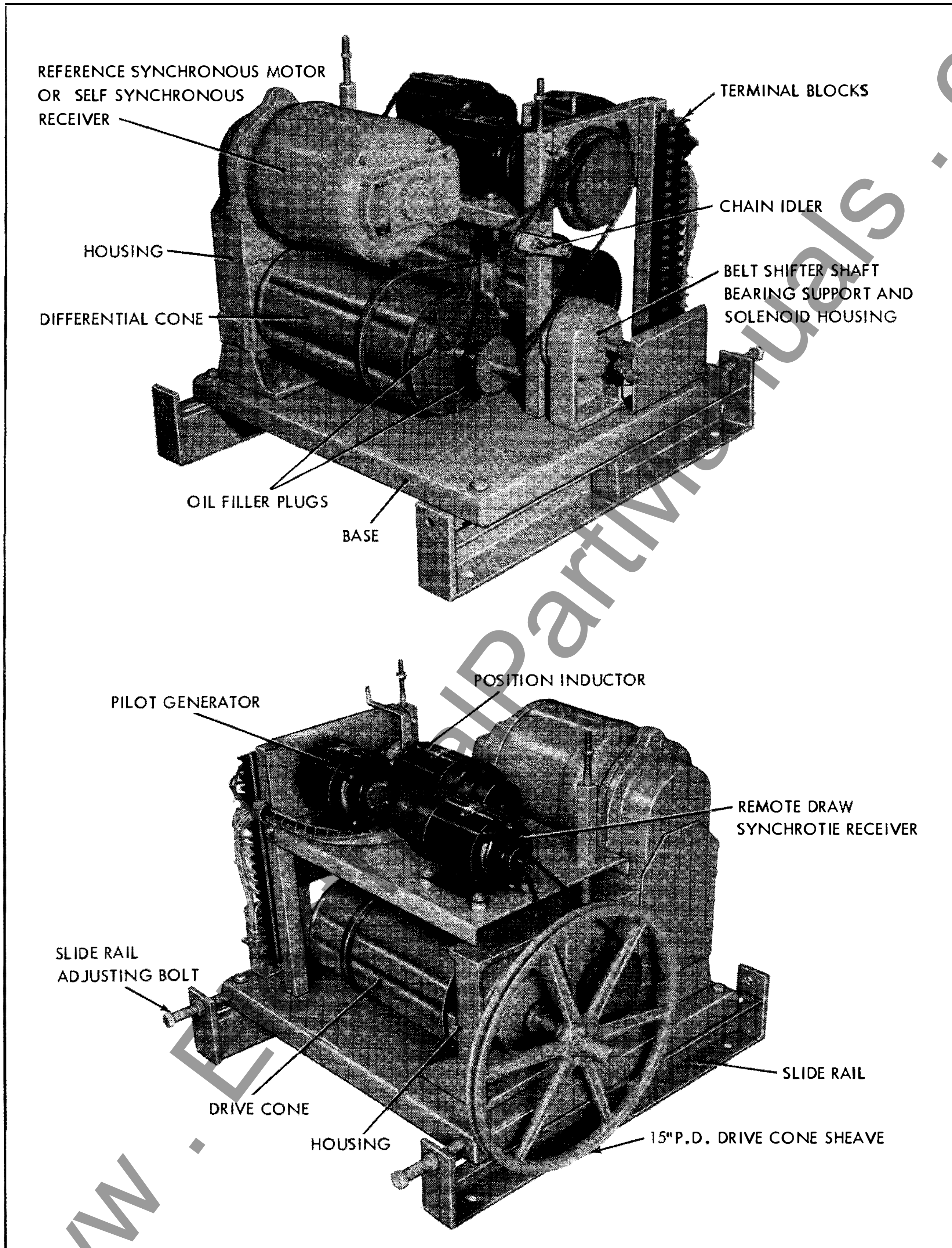


FIG. 1. Mechanical Differential Speed Error Detecting Unit

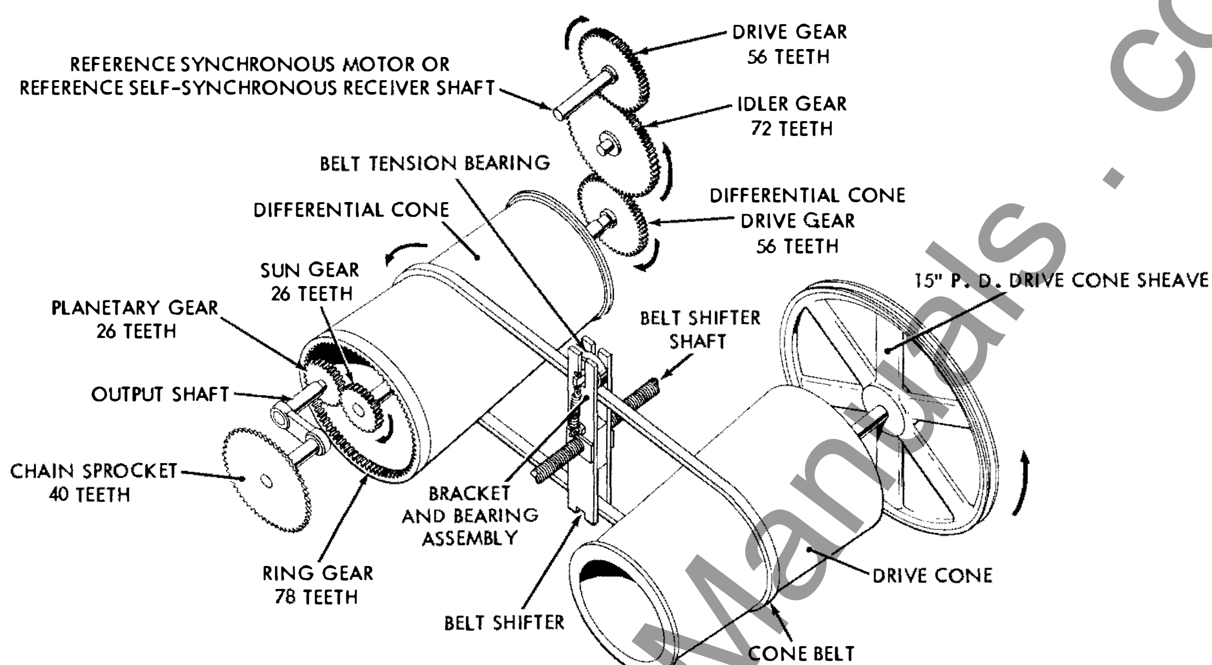


FIG. 2. Basic Mechanical Differential Error Detecting Unit

The ratio at the exact center is one-to-one. Moving the belt to the extreme end towards the housing forces the differential cone to turn faster by the ratio of the drive cone diameter to the differential cone diameter. This is the ratio of $\frac{7.125 \text{ (large end diam.)}}{6.125 \text{ (small end diam.)}}$

Moving the belt to the other extreme end forces the differential cone to turn slower by the ratio of $\frac{6.125}{7.125}$. The overall draw range possible is $\pm 12\frac{1}{2}\%$.

REMOTE DRAW CONTROL

The shifting of the belt along the taper of the cones is performed by the remote draw control as shown in Figure 3. This control consists of a belt shifter, a slack take-up feature, a remote draw Synchrotie receiver mounted to the housing, a remote draw Synchrotie transmitter remotely located in a control cabinet, and a slack take-up pushbutton mounted near the transmitter handle.

The draw adjuster mechanism consists of a belt guide mounted on a threaded shaft. This shaft has 16 threads per inch of length. One revolution of the shaft will provide a resultant change of 0.15 percent in relative speeds of the cones. The shaft is supported at one end by the housing and at the other end by a removable bearing support which also contains a solenoid. A small crank handle is secured to the end of the shaft for manual operation of the belt shifter during installation or adjustment procedures.

The shaft has freedom of movement in the horizontal direction through its bearings. Attached to the shaft $\frac{1}{4}$-inch from the removable bearing support is the slack take-up armature (circular disc). The distance between the disc and the bearing support is maintained by a compression spring. An electromagnet is contained within the bearing support.

The belt shifter consists of two parallel arms secured together at the bracket and bearing assembly. The belt passes over the drums and between the parallel arms. A downward force is applied to the belt at this point by a spring-loaded ball bearing which applies tension as it rides on top of the belt.

The belt guide is limited in its travel along the belt shifter shaft by the limit nuts. The position of these limit nuts prevents the belt from slipping from the drum.

A guide bar, secured to the base and parallel to the belt shifter shaft, prevents the belt shifter from rotating about the shaft axis as the belt is moved along the cones.

The belt shifter shaft which extends through the housing has a chain sprocket attached to it. Mounted above the drive cone on a horizontal plate attached to the housing is a remote draw Synchrotie receiver. The receiver shaft is connected to the belt shifter shaft by a link chain drive.

A remote draw Synchrotie transmitter is mounted in a location convenient to the machine operator. The remote draw transmitter and receiver are duplicate units, providing a one-for-one revolution relationship. Each unit has a 110-volt single-phase primary wound on its rotor, and a 55-volt, 3-phase secondary on the stator. For normal operation, it is excited at 80 to 100 volts on the primary in order to provide long life and reduced temperature operating conditions. Therefore, a direct control of the cone ratios is obtained remotely by the remote draw Synchrotie transmitter and receiver system.

A pushbutton mounted near the remote draw Synchrotie transmitter provides an automatic, momentary slack take-up feature to change the differential cone speed. Depressing the pushbutton energizes the solenoid contained within the belt shifter shaft bearing housing. The magnetic force created by the solenoid attracts the slack take-up armature to the bearing housing. The metal disc moves 1/4 inch which provides a relative speed change of 0.60 percent. This speed change will persist only as long as the SLACK TAKE-UP pushbutton is held depressed.

MECHANICAL DIFFERENTIAL SPEED ERROR DETECTING UNIT

Additions to the basic mechanical differential error detecting unit are shown in Figure 4 and are listed below:

1. A reference synchronous motor or Synchrotie receiver. Provides a mechanical reference input into the differential cone.

2. A position inductor. This inductor supplies voltage proportional to position and is applied to an external amplifier for signal indications.

3. A d-c pilot generator. This generator supplies voltage proportional to the rate of change of position

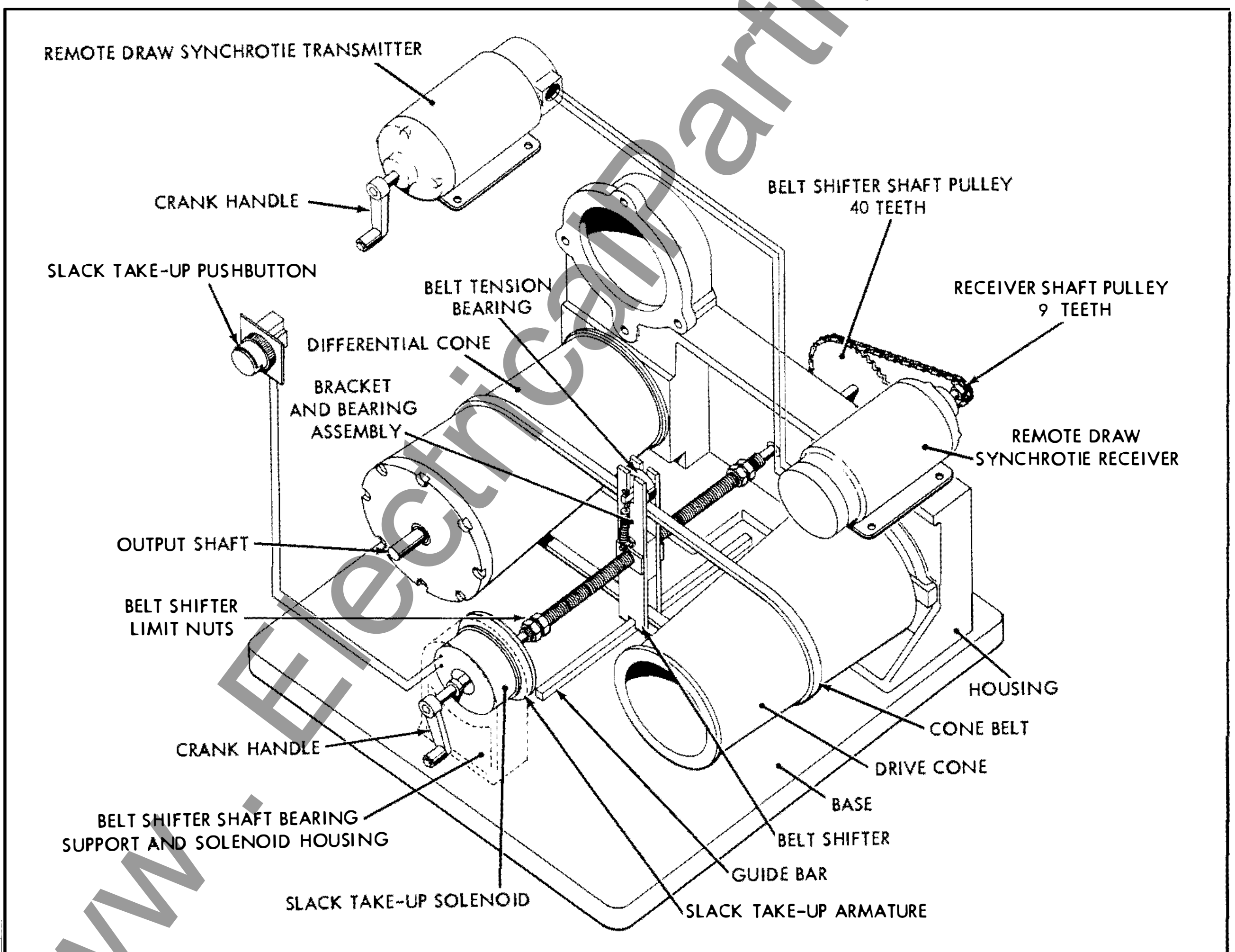


FIG. 3. Remote Draw Control Components

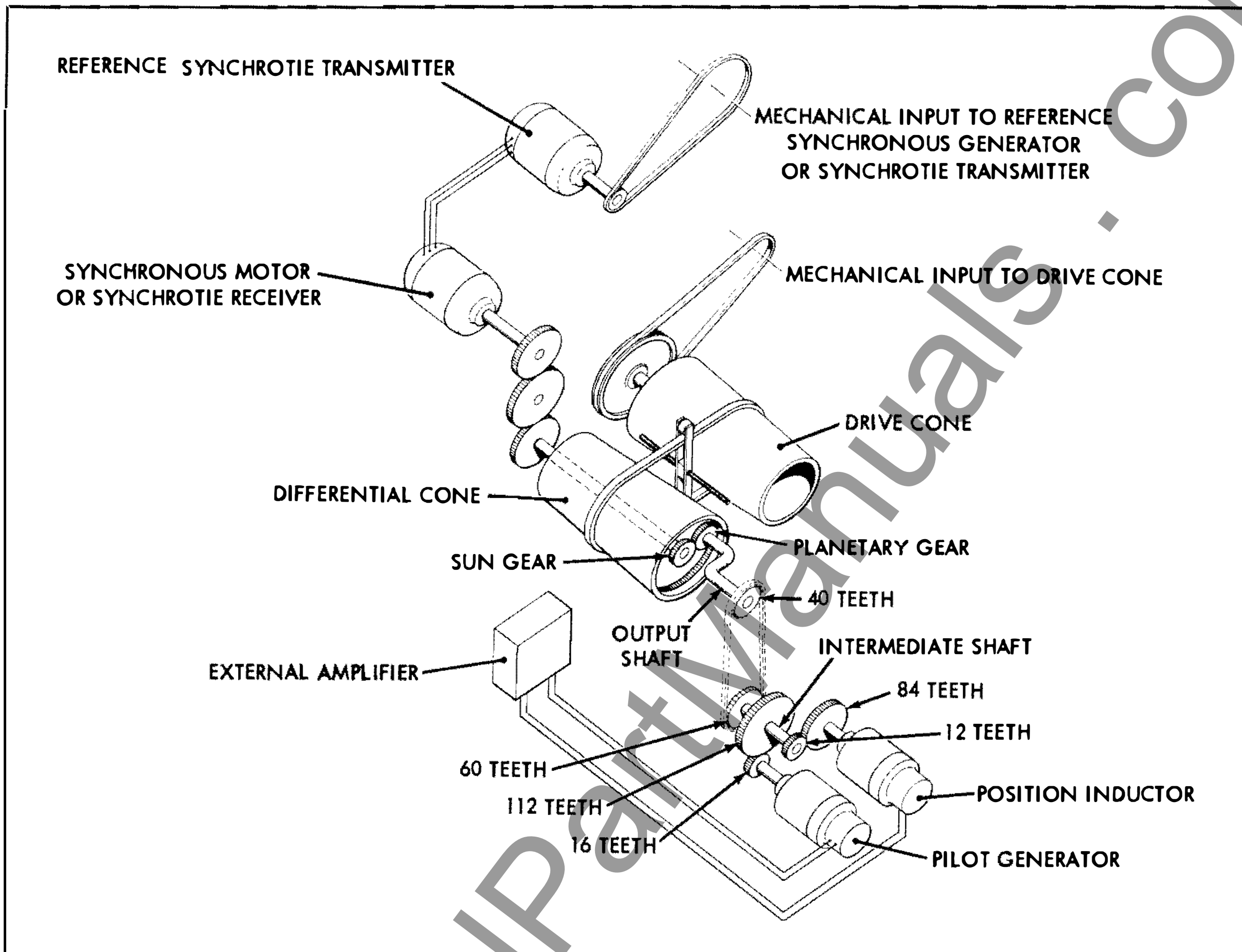


FIG. 4. Simplified Control Circuit Incorporating Mechanical Differential Speed Error Detecting Unit

and is also applied to an external amplifier for signal indications.

A typical simplified control circuit as shown in Figure 4 will be described to illustrate the operation when using the mechanical differential speed error detecting unit.

A mechanical drive input to the reference synchronous generator or Synchrotie transmitter provides the reference speed for the unit. This generator or transmitter supplies power to the reference synchronous motor or Synchrotie receiver. This motor or receiver drives the sun gear of the differential cone at a reference speed.

A mechanical input to the drive cone provides the variable speed to the unit. The drive cone imparts a rotation to the differential cone and its ring gear through the movement of the cone belt. A one-to-one ratio of drive cone speed to differential cone speed will be considered first.

The electrical output of the position inductor and d-c pilot generator can be connected to any conventional voltage or power amplifier; e.g., **magnetic amplifier, electronic amplifier or rotating amplifier** to provide additional gain and control ability.

If the ring gear is rotating at a speed other than one-third the speed of the sun gear, the planetary gear will rotate the output shaft. The chain connection turns the intermediate shaft which rotates the armatures of the position inductor and d-c pilot generator. The movement of the position inductor rotor supplies a change in voltage to the external amplifier in proportion to the new angular position of the output shaft. The rotation of the d-c pilot generator armature supplies a voltage to the external amplifier proportional to the rate of position change of the output shaft.

The amplifier is energized by these two separate signals to change the speed of the machine providing the mechanical input to the drive cone.

The above sequence will take place until the ring gear is rotating exactly one-third as fast as the sun gear. At this point, the mechanical input to the drive cone is speed matched to the mechanical input by the reference.

If it is required to change the speed matching of the reference machine to the controlled machine, movement of the cone belt in the proper direction will accomplish this requirement.

INSTALLATION

The following installation instructions are to be performed before initial adjustments and operation:

1. Check the alignment of the motor mounted or driven mechanical input sheave and drive cone sheave. Alignment of these sheaves should be as perfect as physically possible. True alignment will eliminate sidewise flexing and whip and will increase the belt life.

2. Check the mechanical input and drive cone sheaves for play between sheave and shaft. The sheave must be securely fastened to the shaft. No play, axially or radially, can be tolerated. If play exists between the drive cone sheave and the drive cone shaft, tighten the split taper bushing on the sheave. If play exists between the motor mounted sheave and its shaft, tighten the mounting.

3. Check sheave V-belt tension. The V-belt should be tightened sufficiently to eliminate slippage. Too much tension will overload the bearings of the basic mechanical differential error detecting unit.

NOTE: It is recommended that the purchaser supply a gravity-loaded or spring-loaded roller to maintain tension of the V-belt.

Usually the motor will be coupled to the machine so that this check may be accomplished by trying to turn the drive cone sheave (in the direction the motor will drive it) with the belt in place. Should the belt slip, shift the base support on its slide rails by turning the threaded adjusting bolts in the slide rail ends. If the motor is uncoupled, restrain the armature and check as outlined above.

NOTE: When possible, it is preferable to rotate the drive cone sheave in a direction such that the drive belt is taut on the bottom and slack on the top.

4. Check the V-belt for uniformity of width. The belt should have a uniform width throughout its total length. If the motor is coupled, this check will have to be deferred until the machine is run at slow (inch)speed. Rotate the armature slowly and observe the position of the belt in the sheave slot. The belt rides up and down in the slot if it is not uniform in width. A non-uniformity of a minor nature will not usually affect the operation of the unit, but will cause action to appear erratic. Belts that are uneven or have a permanent set or deflection should not be used.

5. Remove the light coat of oil from the cone surfaces with a suitable solvent. Surfaces must be clean and dry to prevent slippage.

6. Check the cone belt tension bearing. This bearing should be free to move perpendicularly from the mid-point of the bracket slots. The belt tension should be sufficient to eliminate slippage. A deflection of ¼ inch at normal ambient temperature indicates sufficient tightness. Excessive tension will overload or bind the cone bearings. If necessary to adjust the range of the belt tension bearing, loosen the three eccentric bearing mounting bolts (Figure 5). To tighten the cone belt, turn the eccentric bearing in a clockwise direction with a suitable spanner wrench. To loosen the cone belt, turn the eccentric bearing in a counterclockwise direction.

NOTE: Do not remove eccentric bearing clamps from housing.

Tighten securely the three eccentric mounting bolts.

By means of the eccentric mounting bearing the drive cone can be moved a distance of one inch in the horizontal direction to obtain the proper belt tension.

7. Check the differential gear train for binding, backlash and play. Release the chain tightener and remove the drive chain. Hold the differential cone and rotate the differential output shaft. Rotation should be uniform and smooth with no backlash in the gearing.

8. Check the position inductor drive gearing and friction clutch. With the drive chain removed, rotate the 60-tooth sprocket and observe the gear train. Rotation should be smooth and require uniform torque (when the position inductor is in range). The pilot generator and position inductor are mounted in slotted holes to permit adjustment of their position to obtain snug mesh of gears. Backlash in the gearing can be minimized by adjusting the positions of the pilot generator and the position inductor.

CAUTION: When the receiver goes out of range, the friction clutch should slip with little additional applied torque. Check for constant friction in the clutch by rotating it through one complete revolution.

9. Check the oil level. Rotate the differential cone until one of the two filler plugs is directly below the output shaft. Remove the plug and check the oil level. The housing gear case should be filled with SAE-140 or equivalent weight oil until level with the bottom edge of the filler plug hole. Replace the plug. The chain drive idler and gear train should have a light coating of light weight machine oil.

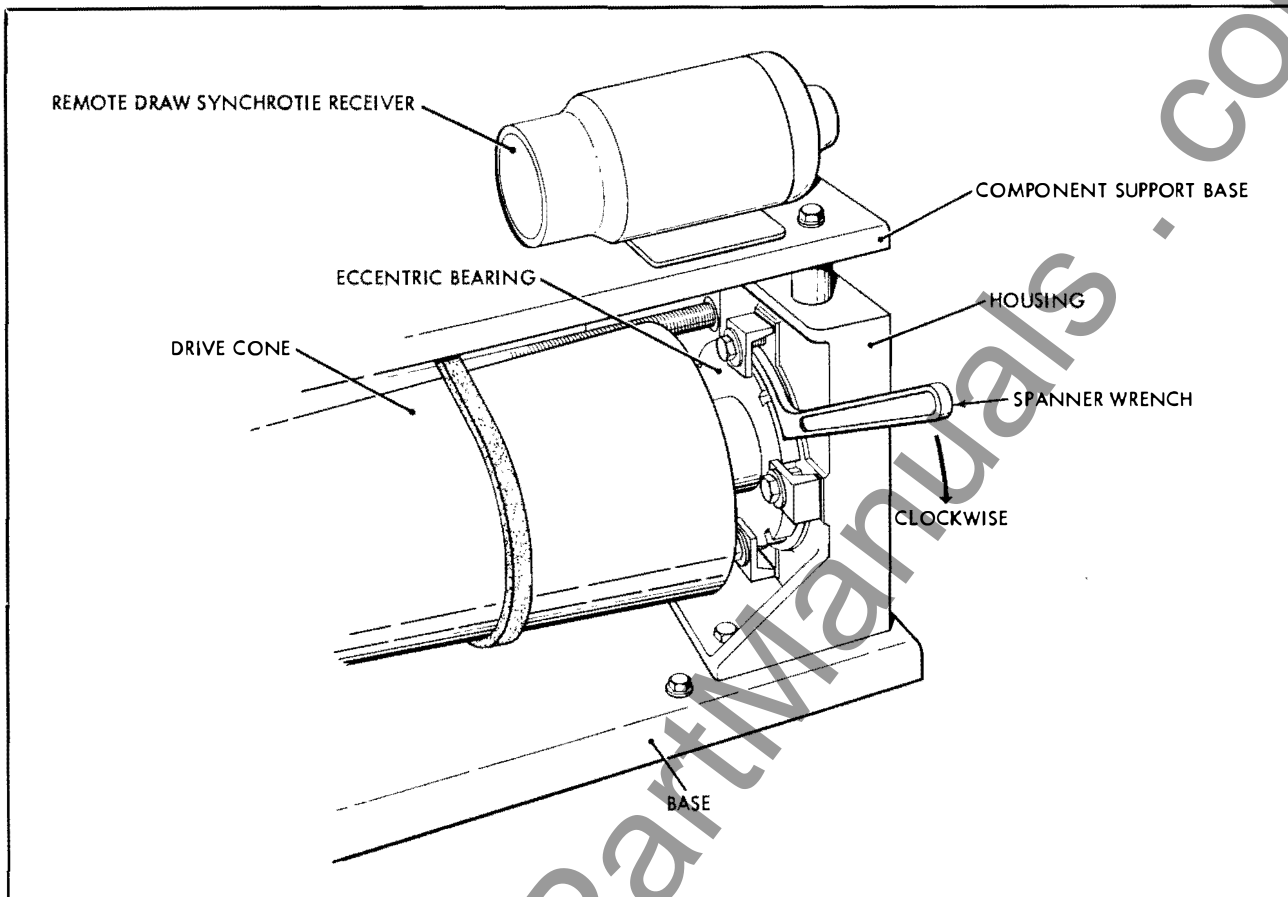


FIG. 5. Adjustment of Drive Cone Eccentric

10. Check the belt shifter for binding and mechanical interference. Rotate the cones and move the belt shifter throughout its complete range by the draw adjusting crank handle. The belt should move freely to the extreme ends of the cones.

11. Slack Take-up. Check the belt shifter shaft for freedom of movement in the horizontal direction.

ADJUSTMENTS

The following adjustments for setting up and/or checking the electrical components of the unit are to be performed before actual operation:

PUot Generator. Check the two brushes for type and fit. They should be No. AGC-10 silver graphite brushes. Move the brushes in and out of the brush holders. **There must be neither binding nor excessive clearance.** Measure the shunt field voltage—this should be approximately 90 to 100 volts. Disconnect the PGP (Figure 6) lead on the pilot generator side of the terminal block and measure the pilot generator armature voltage as the drive cone sheave is turned in the direction the mechanical input sheave will drive it. The PGP lead should be positive. If the polarity is wrong, reverse either the armature or the field leads. With the control circuit deenergized, measure the resistance of the circuit to the external amplifier. (This should be 2 ohms maximum unless the normally closed contact of the Transfer relay (refer to main schematic diagram) is not making good contact.)

Poition Inductor. Rotate the drive cone sheave in the direction that the mechanical input sheave will drive it. Note the direction the pointer moves and mark this side "FAST." Mark the opposite side "SLOW." These designations refer to section motor speed; for example, if the section motor is running too slow, the pointer will move toward "SLOW." Excite the position inductor with the voltage specified by the main schematic diagram and measure the voltage of the phase connected to the external amplifier. When the pointer is in "FAST" position, the a-c voltage should be zero, and should increase as the pointer is moved to the "SLOW" position. If the output is not zero, remove the pointer on the clutch assembly and relocate it so that zero (or essentially zero) volts are obtained when the pointer is in the "FAST" position. The voltage must not reverse as the pointer is moved through its range.

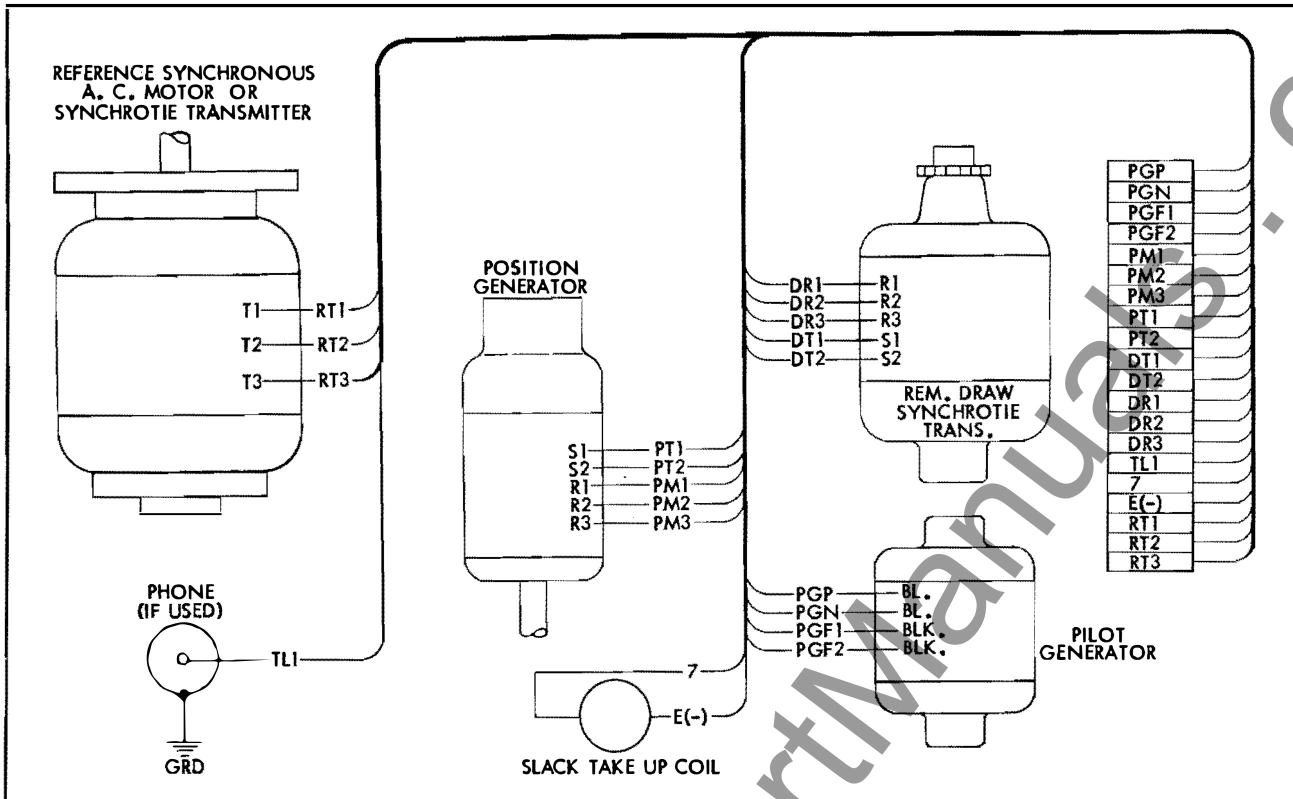


FIG. 6. Wiring Diagram for the Mechanical Differential Speed Error Detecting Unit

Reference Synchronous Motor or Synchrotie Receiver. Energize the reference bus and momentarily excite the reference motor or receiver by manually closing the transfer relay. The pointer should move to the "SLOW" position. If the rotation is wrong, interchange two of the three motor or receiver leads.

Remote Draw Control. With the motor running and the regulator in operation, check the voltage applied to the Remote Draw Control circuit. Refer to the main schematic diagram for the proper voltage. Turn the crank handle of the remote draw Synchrotie transmitter at the operator's station in the direction in which the material is flowing. This should cause the cone belt to move away from the housing of the unit and the section drive motor should increase its speed. If the resultant action is reversed, interchange two of the three stator leads.

Slack Take-up. With the motor running and the unit in operation, depress the slack takeup pushbutton at the operator's control station. The cone belt should move approximately ¼ inch away from the housing of the unit and the section drive motor should increase its speed.

MAINTENANCE

Preventive Maintenance. The mechanical differential speed error detecting units have been designed and constructed to perform satisfactory service for an extended period. To insure efficient operation, it is necessary to accomplish routine mechanical and electrical inspections that will reveal unsatisfactory conditions and prevent disturbances to the control circuits.

SERVICE Weekly	Monthly	
x	x	**Belts.** Inspect for excessively worn, cracked, or frayed belts. Check belt tension.
	x	**Sheaves.** Check condition and alignment of sheaves.
	x	**Chains.** Check for wear and cracked or broken links.
	x	**Sprockets.** Check sprockets for excessive wear, broken teeth, loose mounting and alignment.
x		**Cones.** Check cones for oil, liquids or dirt on external surfaces.
		Oil. Drain and refill when dirty or gritty.

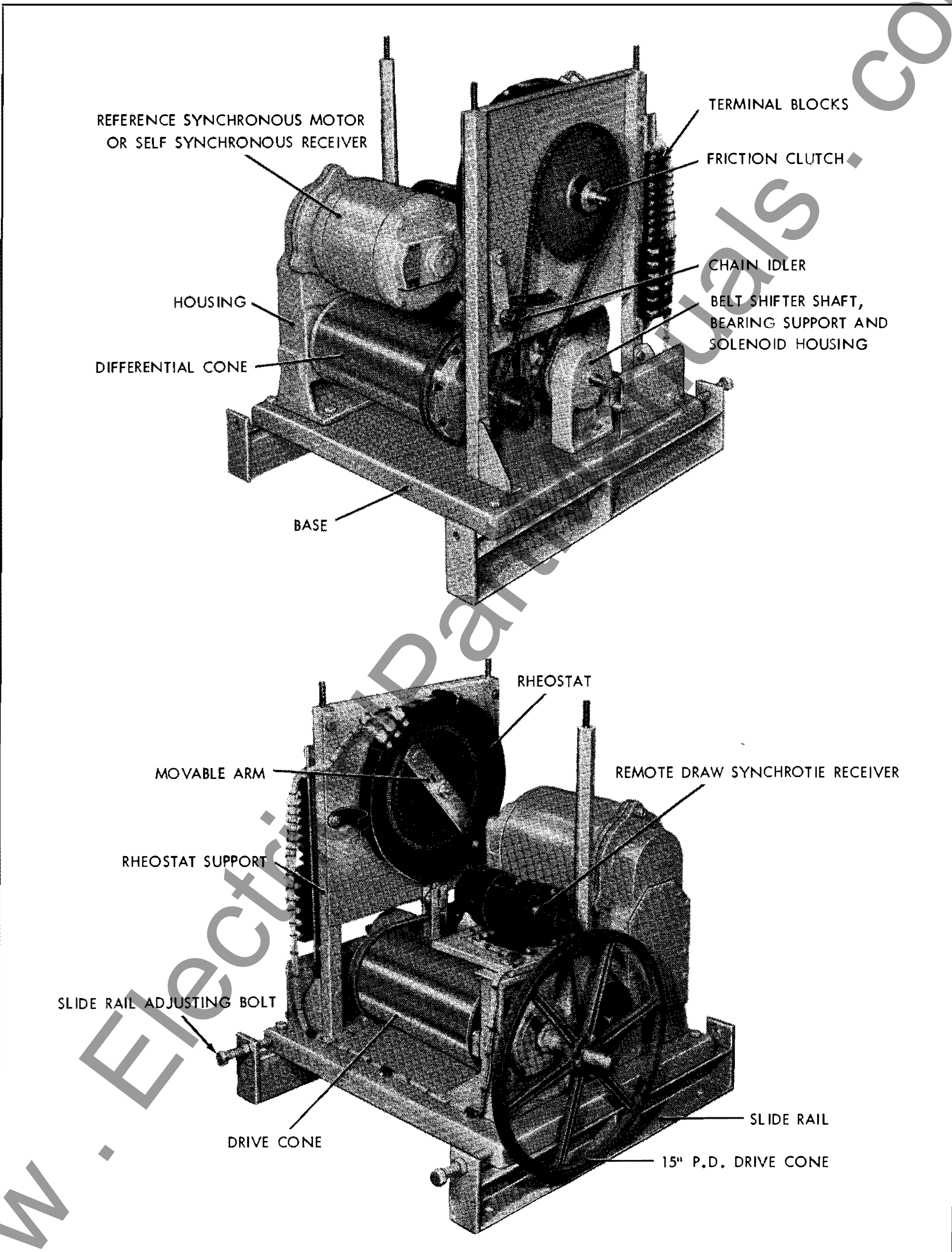


FIG. 7. Mechanical Differential Rheostatic Type Position Regulator

Replacement of Cone Belt. 1. With the drive cone turning, rotate the crank handle until the belt shifter has moved the cone belt to the ends of the cones near the crank handle.

2. Reduce the tension in the belt by turning the drive cone eccentric bearing. (Refer to step 6 under Installation.)

3. Release the chain idler and remove the output shaft drive chain.

4. Remove the belt tension bearing from the belt shifter.

5. Remove the bolts securing the belt shifter shaft bearing support to the base.

6. Remove the belt from the cones and slip the belt under the bearing support.

7. Replace the new belt in a reverse order to that given above.

VARIATION IN DESIGN AND APPLICATION

The basic mechanical differential error detecting unit (Figure 2) and the remote draw control (Figure 3) can be combined with specific equipment to form a Mechanical Differential Rheostatic Type Position Regulator as shown in Figures 7 and 8.

The required equipment is shown in Figure 8 and listed below.

1. A 26-tooth sprocket attached to the output shaft.

2. A variable rheostat whose contact arm is chain-connected to the output shaft of the differential cone.

3. The necessary frame and supports for the variable rheostat.

4. A reference synchronous motor or Synchrotie receiver to provide a mechanical reference input into the differential cone.

The chain connection between the output shaft of the differential and the rheostat provides the proper rotation of the contact arm in relation to the electrical and mechanical requirements.

The 26-tooth sprocket chain-drives a 72-tooth sprocket that is secured to the contact arm of the rheostat. A friction clutch is inserted between the sprocket and contact arm to provide protection for the rheostat and control system in case the arm is stopped at either of its extreme limits of travel.

A typical simplified control circuit (Figure 8) will be described to illustrate the operation when using the mechanical differential rheostatic type position regulator.

A mechanical drive input to the reference synchronous generator or Synchrotie transmitter provides the reference speed for the regulator. This generator or transmitter supplies power to the reference synchronous motor or Synchrotie receiver. This motor or receiver drives the sun gear of the differential cone to provide the reference.

A mechanical input to the drive cone provides the variable speed to the regulator. The drive cone imparts a rotation to the differential cone and its ring gear through the movement of the cone belt.

If the ring gear is not rotating exactly one-third the speed of the sun gear, the planetary gear will receive rotational motion and force the output shaft to rotate. The mechanical connection between the rheostat and the output shaft causes a change in position of the rheostat arm. This action results in a change of voltage across the field of the controlled motor or generator. The resultant effect will change the speed of the machine providing the mechanical drive input to the drive cone.

The above sequence will take place until the ring gear is rotating exactly one-third as fast as the sun gear. At this point, the mechanical input to the drive cone is speed matched to the mechanical input of the reference.

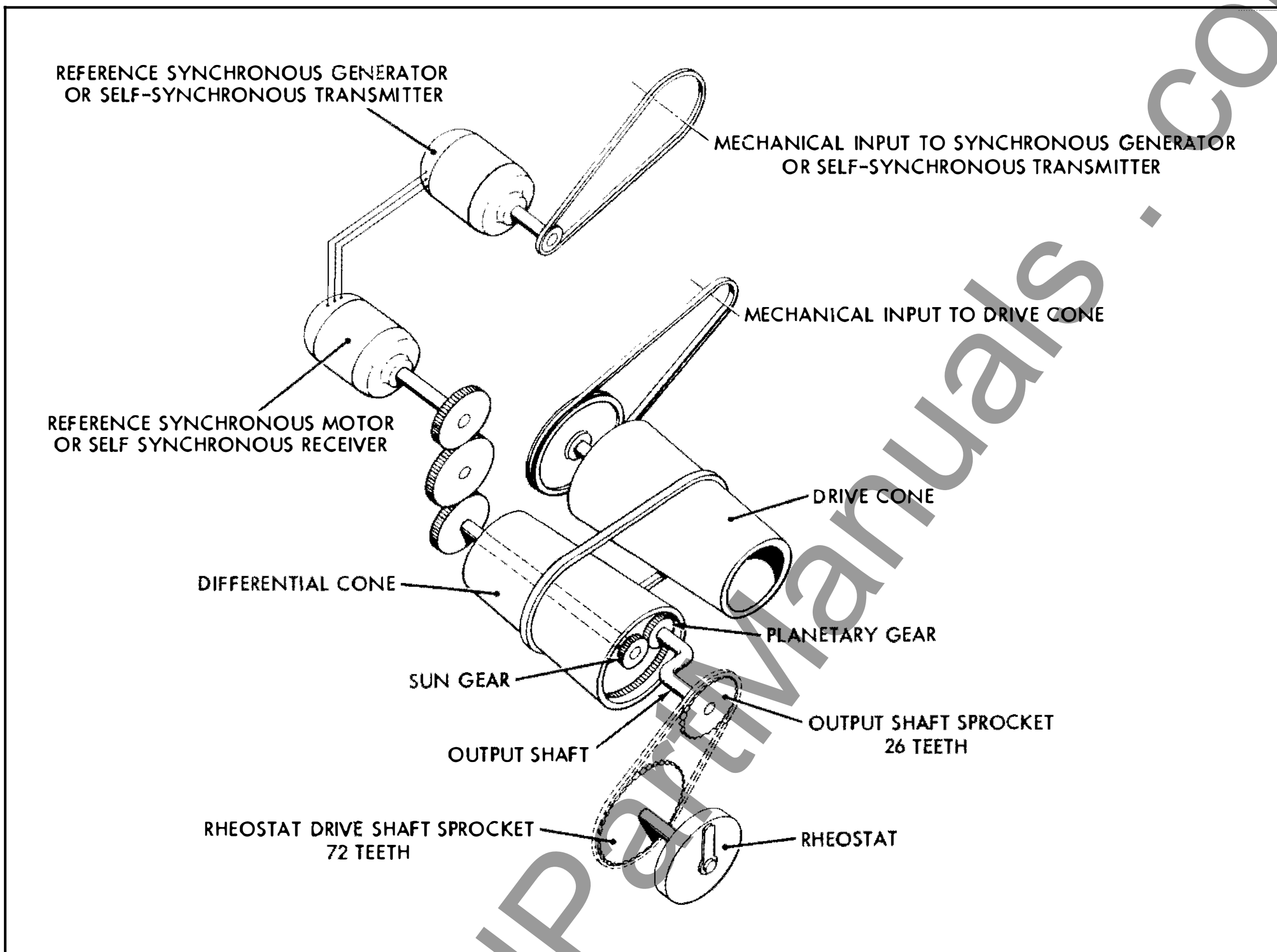


FIG. 8. Simplified Control Circuit Incorporating Mechanical Differential Rheostat Type Regulator

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO PLANT • MOTOR DIVISION • BUFFALO 5, N.Y.

Printed in U.S.A.

Westinghouse

TRANSMISSION GATE

A transmission gate is a bilateral switch for controlling the passage of analog signals. The gate functions as a static relay, so that when the gate is open or conducting, a very small impedance exists thru the gate. When the gate is closed or non-conducting, a very high impedance exists thru the gate. The gate can be switched by any circuit providing a rapid voltage change of 15 - 20 volts in approximately 10 micro-seconds or less. Frequently, Westinghouse NOR logic circuits are used to provide this control signal. In the conducting state, the gate will pass frequencies in excess of 10 kilocycles without attenuation.

The gates are made up of transformers, transistors, diodes and other components mounted on printed circuit boards and made up into a standard Prodac type module frame. The transmission gate modules are designated LG1 and LG2. They are identical except that LG1 consists of one gate, and LG2 consists of two independent gates in one module. The modules require a power supply of 6.3 volts ± 5%, 500 mA, 50/60 cps across the primary of transformer 2T as shown in Figure 1.

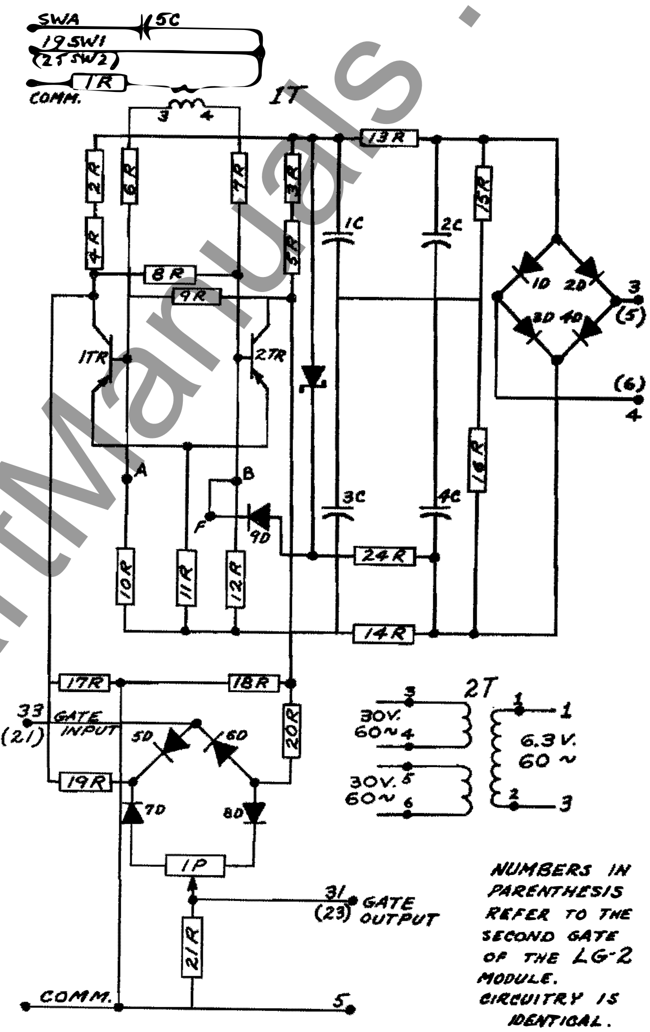


Figure 1 - Schematic Diagram of the Transmission Gate

Driving terminal 19 (or 25) in a positive going direction with respect to terminal 5 (common or PSC) makes the gate non-conductive. A negative going signal makes the gate conductive. The gate can be controlled at rates in excess of 1000 times-per-second with switching rates normally being limited by the relative duration of switching transients with respect to open and closed times. A special input connection, SWA, is provided for non-symetrical operation in which one state of the gate may exist for short periods in the neighborhood of 100 microseconds.

Signals up to ± 10 volts can be gated with output loading up to 1.5 mA maximum. Higher voltages up to ± 20 volts can be gated with less loading. The gate will operate thru a temperature range of at least 0 - 65° C, but temperatures above 55° C should be avoided to obtain the best reliability and longest life of the device.

OPERATION

A. Bridge Circuit

The heart of the gate is a diode bridge as shown in Figure 2.

When terminal A is positive and B negative with respect to common, the diodes are back biased so that extremely high impedance is presented between the input and output of the gate. For this condition the gate is non-conductive as long as the input voltage is sufficiently low that the back-bias voltages across the diodes can be maintained.

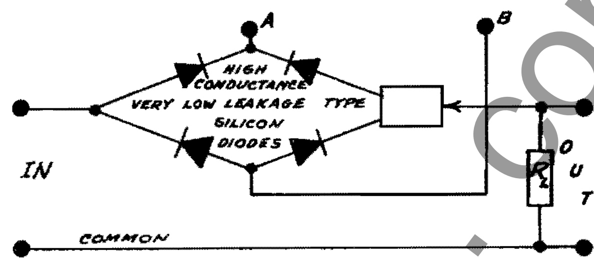


Figure 2 - Simplified Diode Bridge Circuit

When terminal A is negative and B positive, the diodes are forward biased so that very low impedance exists between the input and output of the gate. For this condition the gate is conductive as long as the current through the gate is sufficiently low that none of the diodes loose their forward bias.

In the forward biased condition a diode has a drop of approximately 0. 6 volts. This drop is reasonably independent of the current through the diode. Referring to Figure 2, it can be seen that the forward drops of the diodes tend to cancel across the diode bridge so that a very low voltage drop exists between input and output of the gate. However, since the forward drops of the diodes may not match, a potentiometer 1-P is added to the bridge circuit. 1-P is adjusted so that with zero volts into the gate, the output voltage will be less than ± 0. 4 MV with the gate conducting.

B. Flip-Flop Circuit

The operation of the gate requires that the voltage between A and B of figure 2 be reversible. This reversing voltage is obtained from a bistable flip-flop circuit. Refer to Figure 1. The flip-flop has a d-c power supply with an isolating transformer 2-T. The flip-flop is controlled by a pulse obtained from isolating pulse transformer 1-T. The isolation of the flip-flop permits both positive and negative, voltages with respect to the common, to be applied to the gate bridge as needed for correct operation.

The gate is controlled through pulse transformer 1-T. When the voltage at terminal SW 1 (or SWA) goes positive with respect to common a positive pulse is produced from terminals 3 to 4 of the pulse transformer. This pulse causes transistor 1TR to become conductive and 2TR, non-conductive. For this condition or state of the flip-flop the collector of 1TR is positive and the collector of 2TR negative so that the diode bridge is back biased and the gate is non-conductive. Similarly, a negative going voltage at SW1 (or SWA) makes the gate conductive. The gate is normally controlled through SW1. However, for special applications requiring that the state of the flip-flop be maintained for short time (approximately 100 microseconds) followed by a relatively long reverse state condition, the gate can best be controlled through terminal SWA. This connection is made inside the gate module by connecting the tab connection to SWA instead of SW1.

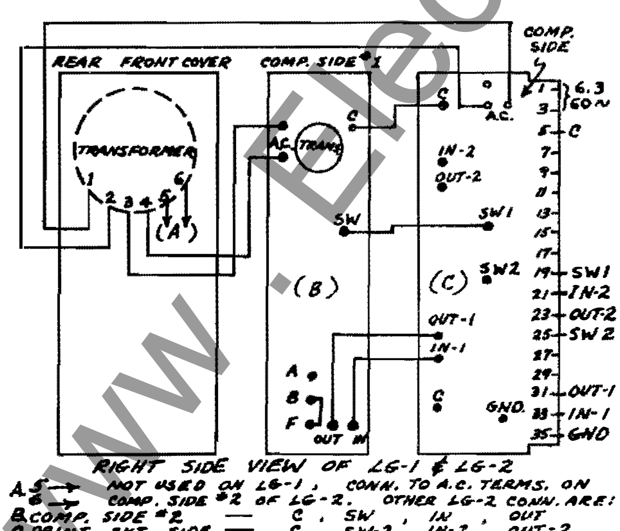


Figure 3 - Internal Arrangement and Interconnections

C. Initial State Circuit

Many applications require that when power is applied to the gate that the initial state of the gate can be predetermined. This feature is accomplished by diodes 9D, 10D and resistor 24R.

When a-c power is applied to the gate, terminal F is initially held more positive than the emitter potential of the transistors because it connects to a more positive point on the power supply filter. As the power supply voltage further increases Zener diode 10D becomes conductive clamping the anode of diode 9D and causing it to become reverse biased. The initial state circuit then becomes isolated from the flip-flop circuit because of the very high impedance of the reverse-biased diode 9D. Terminal F connects to terminal A or B by means of a tab connection inside the gate module. See Figure 3. When the connection is between F and B, 2TR base is held positive when a-c power is applied causing 2TR to be held non-conductive and, therefore, the gate to be initially non-conductive. With the connection between F and A the gate will initially be conductive.

Adjustments

In the conducting state, with zero signal input, the output voltage should not vary from zero by more than ± 0.4 mV. Potentiometer 1-P should be set to give minimum output in this condition. In the non-conducting state, the output normally will not differ from zero by more than ± 0.2 mV.

MAINTENANCE

A. Preventive

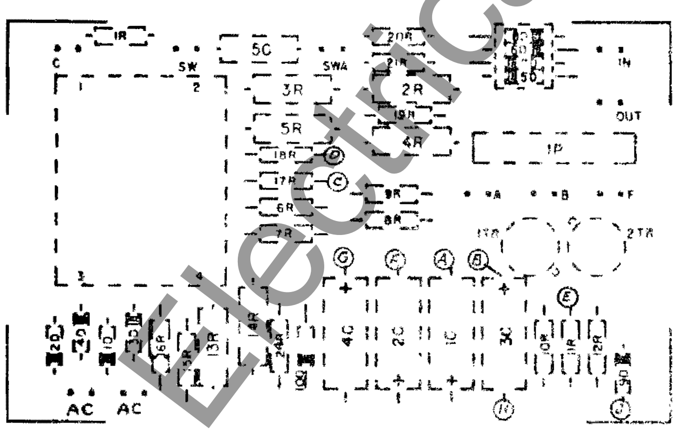
The completely static design of this unit minimizes preventive maintenance to normal cleaning practices and checks for cracking or breakage if the equipment is jarred excessively.

B. Corrective

Plug-in module construction permits the replacement of suspected malfunctioning modules with spares known to be good. If this is not possible and malfunctioning of a transmission gate is suspected, the following operational checks may be performed.

1. Check to see that the gate switches with a 20 volt peak to peak 10 CPS square wave switching signal applied.
2. Check to see that the gate becomes conductive with a negative going switching signal.
3. Check that 1P is properly adjusted as described previously with the input shorted to get zero volts input.
4. Check to see that the initial state of the gate conforms to the internal connection as described under "Initial State Circuit".
5. Check to see that the gate will control ± 15 volts D.C.
6. Check to see that the gate will conduct a ± 20 volt peak A.C. signal without distortion.
7. With the gate non-conducting, check that the gate blocks ± 20 volt peak A.C. signal.
8. Check that the gate will conduct a ± 12 volt peak, 1KC square wave without disturbing the state of the gate.

If the gate fails any of these checks, make a visual check for clean insulation, cracked components or broken connections. Then, localization of the trouble may be undertaken by checking typical point voltages as shown in Figure 4.



	GATE COND.	GATE NON-COND.
A	-12V	-10.7V
B	7V	9.5V
C	- 6V	8 V
D	5.7V	- 8 V
E	5.8V	8 V
F	-21 V	-19 V
G	13.5V	15 V
H	-3 V	-1.4 V
J	-2.2V	-3.2 V

Power Trans. PRI 6.3V AC
SEC 30 V AC

FIGURE 4 - TRANSMISSION GATE BOARD - TEST POINT VOLTAGES TO COMMON

In repairing Transmission Gate modules the first step is generally that of locating the defective sub-assembly. The complete sub-assembly can then be replaced. Limiting repair to the replacement of defective sub-assemblies may prove the most practical procedure although sub-assemblies can be repaired if testing facilities and personnel are available for this type of work.

Using The SUMMARY OF CONNECTION LIST

INTRODUCTION

In the past the wiring diagrams have had serious limitations for customer and service reference. The reason for this was that the internal wiring document was tailored primarily for manufacturing purposes rather than for servicing purposes. Specifically it has always been difficult to relate the physical location of a device as shown on a wiring diagram, to the equivalent circuit or symbol on the electrical schematic. Likewise, if one wished to determine on a wiring diagram the physical location of a circuit shown in the schematic, it required slow, careful search through several pages of diagrams until the device designation was located.

The Buffalo Systems Control Department has been working on a group of computer programs which will enable us to prepare our shop internal wiring instructions in tabular form rather than in conventional diagram form which has been used in the past. These programs are now completed and are being put to use.

When programming for computer wiring manufacturing information (Wiring M.I.*) it became apparent that with a little more computer running time we could eliminate this difficulty. It is accomplished by rearranging the shop information into a second form specifically tailored for optimum reference by servicing personnel. This form now is printed and shipped with the equipment. The purpose of this leaflet is to acquaint you with this new document.

* We no longer use the term wiring diagram for chart type wiring instructions. Instead it is called Wiring Manufacturing Information or Wiring M.I.

DESCRIPTION

The new document is called "Summary of Connections List" and the name literally means just that. The document consists of 8-1/2 x 11 pages listing every terminal on every electrical device in the system. Furthermore all possible information related to each terminal is shown on the same line on the list.

The first three pages of the list contain a detailed list of instructions to the customer and service personnel concerning its use. The first page also contains a key to the wire size and color code symbols used in the lists.

A few sample pages of a Summary of Connection list are shown in this leaflet for your inspection and study. However, it would be well to examine just a few of the principles which make computer wiring possible. In simple language this type of wiring is "wiring-by-the-numbers".

TERMINAL NUMBERS

Most of our devices such as relays and contactors do not have terminal numbers on them. To compensate for this, preprinted adhesive labels have been created and permanently attached to the panels close by each device. Some simple devices such as resistors, capacitors etc. do not have labels. Instead, a standard convention for determining the terminal number is described on the third page of the Summary of Connections list. This simple convention can be memorized quickly.

LOCATION LABELLING

It was recognized early that it would be too cumbersome for the computer to state the equipment location of a connection on a component verbally, such as:

" 10 inches from the left, 70 inches from the bottom, mounted flat against panel area 10, on panel section 6, of shipping section 3 structure 1"

Instead a standard significant digit code number was established to reduce the space required to indicate a location in the system. For instance the above statement code number appears as follows:

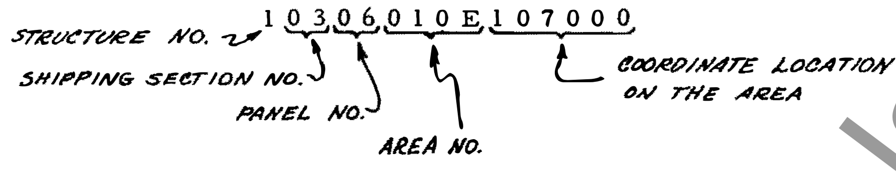
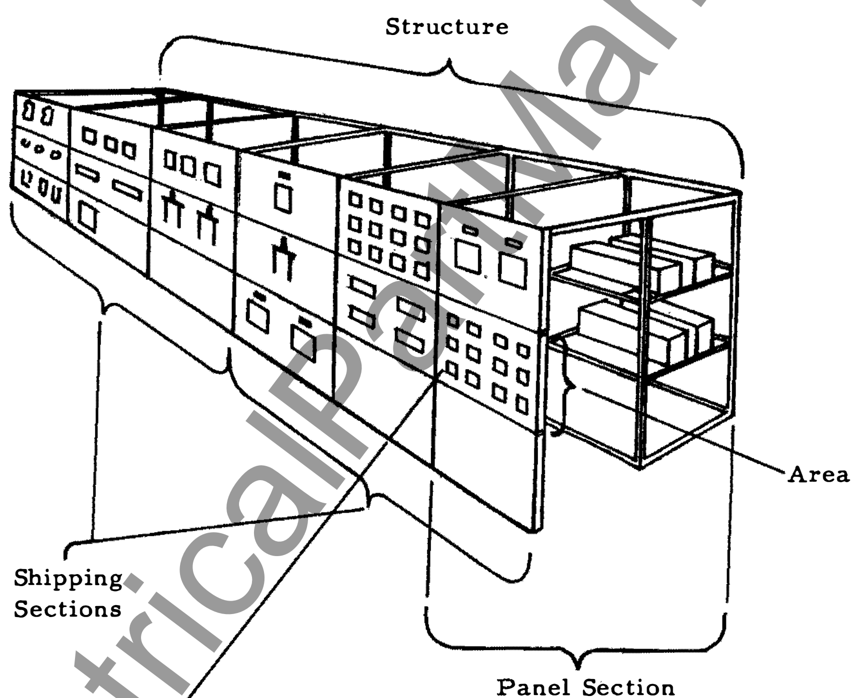
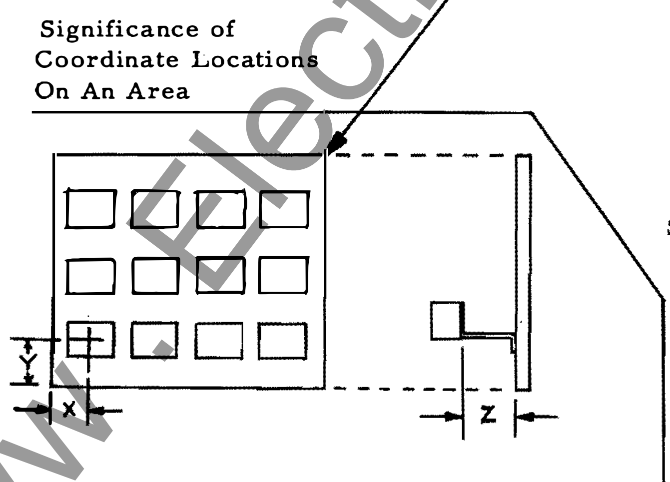
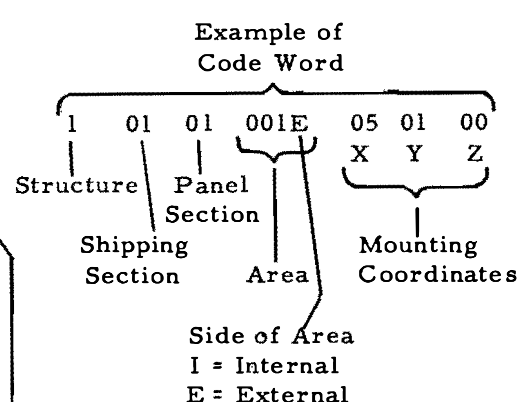


Figure 1 - Key to Definition of Terms for the Location Code System - Multiple Unit Equipment Such As Frames and Cubicles





Note: A Z dimension indicates the device is mounted on a bracket spacing it outward from the panel. For a device mounted on the panel the Z dimension will be 0.



-SUMMARY OF CONNECTIONS LIST-

APPLICATION ______________________________

CUSTOMER ______________________________

G.O. ____________ MAIN S.O. ____________ C.W.L. NO. ____________ INDEX DWG. ____________

SCHEME DWG. ______________________________

SHIPPING SPLIT LIST ____________ INTERCONN. LIST ____________

THE FOLLOWING SUPPLEMENTARY DWGS AND SHEETS ARE REQUIRED TO COMPLETE THE WIRE LIST INFORMATION.

1. INSTRUCTIONS FOR USING "SUMMARY OF CONNECTIONS LISTS" - SHEET NO. 2.
2. DEVICE TERMINAL DESIGNATIONS. - SHEET NO. 3
3. COMPLETE LISTING OF DEVICES AND CONNECTIONS. - SHEET NO. 4 AND AS NEEDED.
4. REVISION & TABULATION SHEET.
5. SIGN OFF SHEET

WIRE CODE TABLE

1A=#22=7-.010 - 12277-3
1B=#22=1-.0253- 12277-3
1C=#18=16-.010 - 12277-3
1D=#14=7-.024-12277-15
1E=#14=41-.010-12277-15
1F=#12=7.0305-12277-15
1G=#12=65-.010-12277-15
1H=#10=7-.0385-12277-15
1I=#8=7-.0486-12277-15
1J=#4=133-.0177-12277-15
1K=#2=259-.016-12277-15
1L=1/0=259-.0202-12277-15
1M=4/0=427-.0223-12277-15
1N=#16=26-.010-12277-15
1P=#6=7-.0612-12277-15
1R=2/0-259-.0227-12277-15
1S=2=#2/0=259-.0227-12277-15*
1T=2=#4/0-427-.0223-12277-15*
2A=#16=19-.0126-7419-13
2B=#14=7-.024-7419-13
2C=#14=41-.010-7419-13
2D=#12=1-.081-7419-13
2E=#12=65-.010-7419-13
2F=#10=105.010-7419-13
2G=#8=7-.0486-7419-13
2H=#6=7-.061-7419-13
2I=#4=7-.0772-4719-13
2J=#2=7-.0974-7419-13
2K=#1/0=19-.0745-7419-13
2L=#2/0=19-.0837-7419-13
2M=#4/0=19-.1055-7419-13
2N=2=#2/0=19-.0837-7419-13*
2P=2=#4/0=19-.1055-7419-13*
2R=#12-1-.081-7419-3

3A=#24=16-.005-12277-4
3B=#22=7-.010-12277-14
3C=#22=1-.0253-12277-14
3D=#20=10-.010-12277-4
3E=#18=16-.010-12277-14
3F=#14=7-.024-12277-14
3G=#22=1-.0253-12277-4
3H=#26=7-.0056-12277-3
3J=#26=7-.0063-62512AB
3K=#20=26-.0063-62512AA
3L=#22=16-.0063-62122KD
3M=#18=16-.010-62121BB
3N=#24=16-.0034-62122KE
3P=#20=26-.0063-62122KE

4A=3040=19-.013-7355-SHFS-3
4B=4497=7-.025-7355-SHFS-4
4C=9016=7.-036-7355-SHFS-9
4D=31480=49-.025-7355-SHFS-26
4E=66380=133-.022-7355-SHFS-66

COPPER BAR

AA=1/8x3/4
AB=1/8x1
AC=1/8x1-1/4
AD=1/8x1-1/2
AE=1/8x2
AF=1/4x1
AG=1/4x1-1/2
AH=1/4x2
AI=1/4x2-1/2

COLOR CODE

BL=BLACK
B =BLUE
BN=BROWN
G =GRAY
R -RED
W -WHITE
Y -YELLOW
W/B-WHITE/BLUE STRIPE
W/R-WHITE/RED STRIPE
B/W-BLUE/WHITE STRIPE
R/W-RED/WHITE STRIPE
G/W-GRAY/WHITE STRIPE

COPPER BAR

1/4x3
1/4x3
1/4x3
1/4x4
1/4x4
1/4x4
1/4x5
1/4x5
1/4x5
1/4x6
1/4x6
1/4x6
1/4x8
1/4x8
1/4x8
1/4x8

*=2 LEADS IN PARALLEL

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO DIV.- CONTROL DEPT.-BUFFALO,N.Y.,U.S.A.

DWG. NO.	SUB.	SH.#	SHEETS

Instructions for Using the "Summary of Connections List"

The "Summary of Connections List" is a complete listing of all the electrical devices and their connections in chart form for a particular control.

On the one hand, this list enables a person observing a particular device on a scheme to quickly ascertain both its physical location and its electrical connections on the panel, or the converse is also true; by means of this list a person observing a particular device on a panel can quickly locate its symbol on the scheme.

There are three sets of columns reading from left to right in this order: "FROM DEVICE", "REFERENCE DEVICE", and "TO DEVICE". The column headed "Reference Device" is the major column, and contains in Alpha-numeric order all the devices used on the job. Note: Changes may not be in Alpha-numeric sequence.

As an example, go to the list shown below. If the wiring information for "9P" is desired, go to the column headed "Device Designation" under the major heading "Reference Device". Device "9P" will be found in Alpha-numeric order with the following information:

a) It is located on Structure 1, Shipping Section 1, Panel Sect. 1, Sub assembly 1, and on the exterior side of area 106. Its location on the area 106 is 10 inches from the left edge of the panel, 14 inches up from the bottom of the panel and 0 inches out from the surface of the panel. See Fig. 1 below.

b) Its terminal number is 1.

c) Its wire number is 69.

d) The circuit is located on zone (area, section or sheet) 2A of the Schematic Diagram.

e) Term. 1 on 9P connects "FROM" terminal 2 on 18R.

f) Term. 1 on 9P connects "TO" terminal 2 on 2P.

g) The wire size for the "TO" connection is wire Code "1C". The preceding sheet contains a table of wire and color codes.

h) The wire color for the "TO" connection is "B" for blue.

This constitutes complete information for terminal 1, device 9P except for the wire and color code for the "FROM" connection (device 18R terminal 2 to device 9P terminal 1). Scan the "Reference Device" column for device 18R, terminal 2. Device 9P, terminal 1 will be located on the same line, and in the "TO DEVICE" column. The wire code and color for this connection will be listed under the "Wire Code" and "Wire Color" column.

Every device terminal will have a minimum listing of at least 2 and possibly 3, once in the "Reference Device" column, and once in the "FROM" and/or "TO" columns. For some special conditions, the number of listings in the "Reference Device" column will be more than one, with a proportional increase in the "FROM" and "TO" columns.

WESTINGHOUSE FORM 35009 — SUMMARY OF CONNECTIONS

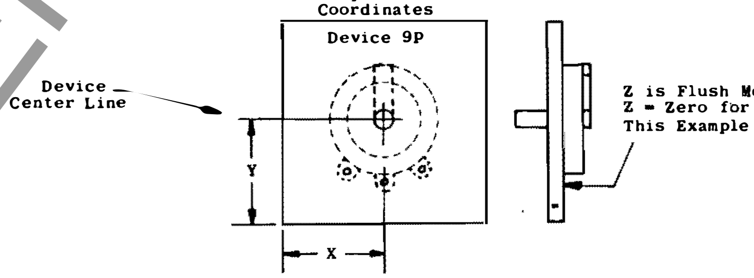
FROM DEVICE		REFERENCE DEVICE							TO DEVICE			
DEVICE		DEVICE		LOCATION OR DESCRIPTION			SCH. ZONE	WIRE NO.	WIRE		DEVICE	
DES	TERM NO	DES	TERM NO	MAJOR	AREA	COORD			CODE	COLOR	DES	TERM NO
		2FU	4	10101	106E	150700	3C	47	1D	R	9 REC	Y1
9P	3	2P	1	10101	106E	100809	2A	67	1C	B		
9P	1	2P	2	10101	106E	100809	1F	69	1C	B		
18R	2	9P	1	10101	106E	101400	2A	69	1C	B	2P	2
*2TS	68	9P	2	10101	106E	101400	2A	68	1C	B		
*2TB	67	9P	3	10101	106E	101400	2A	67	1C	B	2P	1
7X	4	18R	1	10101	106I	051309	2A	70	1C	B	6P	1
5P	3	18R	2	10101	106I	051309	2B	69	1C	B	9P	1

Example

Device Name
Device Terminal Number
2* { 1* { Structure Number
Shipping Section No.
Panel or Cabinet Sect. No.
Area on Panel or Cabinet Sect.
I = Interior, or E = Exterior Side of Area

Wire Color
Wire Code Number } See Sheet No. 1 For Table of Wire and Color Code
Wire Or Lead Number
Area or Section of Schematic
Z Coordinate
Y Coordinate
X Coordinate } 2* Dimensions to the Nearest Inch

FIG. 1
Significance of Coordinates



1* - For some equipment such as operator stations, the number could be for example, SOS01 meaning operators station number 1.
2* - For customers external equipment designated by the letter "C" followed by 4 digits, example "C1041", the columns headed "Major", "Area", and "Coordinates" will be filled in with the description of the device for example, "Screw Dn Motor 1". The number "C1041" will appear in the "DEVICE DESIGNATION" columns.
The following sheet contains a set of rules for assigning terminal designations to those devices whose terminals are unmarked.

DWG. NO.	SUB.	SH. NO.	SHEETS
		2	

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO DIVISION—CONTROL DEPT.—BUFFALO, N.Y., U.S.A.

Device Terminal Designations

A. Device terminals have been numbered so that the correct terminal may be easily and quickly located and identified. Previously, it has been necessary to interpret the information from the wiring diagram.

The following methods are used to label or interpret device terminals.

1. The device may be manufactured with its terminal numbers stamped or engraved. Only a small portion of the devices are in this category.

2. An adhesive label may be placed on, or adjacent to the device. This includes the largest portion of all the devices.

3. The small remaining group of devices, those that have only a few terminals, will have their terminal designations interpreted by a few simple rules.

B. Description of the method of terminal identification

1. Stamped or engraved terminal designations. These are usually marked near the terminal on the wiring side.

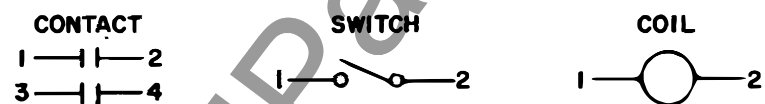
2. Adhesive labels.

The label is a pictorial view of the device whose terminals are tagged and enlarged for easy identification. More than one label may be required for the more complex devices, for instance one label for the front and one for the rear.

In general, a single label describes a family of devices, for example, a four, six or eight pole relay of similar symmetrical construction is described by a label that illustrates an eight pole relay.

3. Assignment of Terminal Identification by a set of rules.

a) Numbering is established by circuit configuration. Each set of contacts is assigned an odd number followed by the next higher ascending even number.
Example:



b) Device terminals are numbered as seen from the front of the device. (The following devices are an exception to the rule in that they are numbered from the wiring side. They are pushbuttons, meters, telephone jacks, pots and rheostats, and indicating lights).

c) Devices that are rotated from the normal position are numbered from the normal position.

d) Terminal numbering sequence, (devices with coils excepted) begins with terminal number 1 at the left, top and nearest panel. The numbering will continue in ascending order by circuit, from top to bottom or left to right.

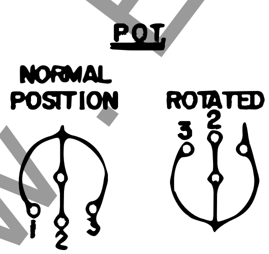
e) Pushbuttons.

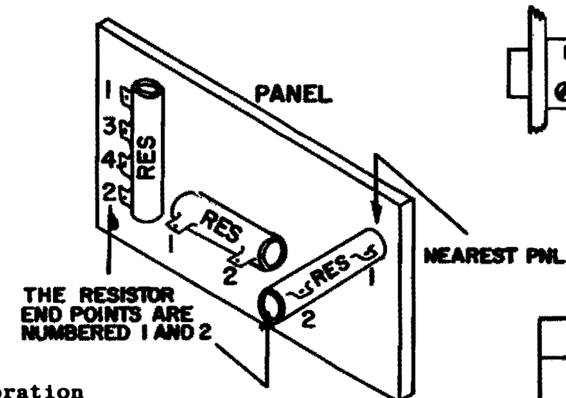
There are two exceptions to the rules for numbering pushbuttons. They are:

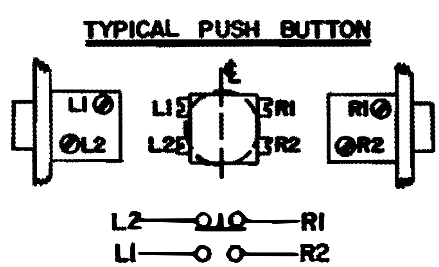
e1) Numbering is determined by terminal configuration and not by circuit configuration.

e2) The terminal number will bear a prefix of "L" or "R" based on it's location in relation to the pushbutton vertical center line.

f) Some examples for the above rules.







Dwg. No.	Sub	Sh.#	Sheets
		3	

WESTINGHOUSE FORM 35009

SUMMARY OF CONNECTIONS

FROM DEVICE		REFERENCE DEVICE							TO DEVICE			
DEVICE		DEVICE		LOCATION OR DESCRIPTION			SCH. ZONE	WIRE NO.	WIRE		DEVICE	
DES.	TERM. NO.	DES.	TERM. NO.	MAJOR	AREA	COORD.			CODE	COLOR	DES.	TERM. NO.
6P	3	2R	1	10101	106I	020609	2A	70	1C	B	12C	1
		2R	2	10101	106I	020609	1A	73	1C	B	7P	1
*5TB	84	3C	1	10101	106E	190600	2F	84	1C	B	1P	2
		3C	2	10101	106E	190600	2F	320M	1C	B	*3TB	320M
4R	2	3P	2	10101	106E	100209	2B	63	1C	B	8C	1
7X	8	3P	3	10101	106E	100209	2B	64	1C	B		
7P	2	3R	1	10101	106I	040309	1B	80	1C	B		
*5TB	81	3R	2	10101	106I	040309	1B	81	1C	B	5C	1
		4P	1	10101	106E	030809	2B	78	1C	B	1R	1
*5TB	77	4P	2	10101	106E	030809	2B	77	1C	B		
*4TB	76	4P	3	10101	106E	030809	2B	76	1C	B		
*3TB	EP	4R	1	10101	106I	080609	2B	EP	1C	B		
		4R	2	10101	106I	080609	2B	63	1C	B	3P	2
3R	2	5C	1	10101	106E	101300	1B	81	1C	B		
*5TB	82	5C	2	10101	106E	101300	1C	82	1C	B		
		5P	1	10101	106E	031409	2B	69	1C	B	18R	2
*3TB	320M	5P	2	10101	106E	031409	2B	320M	1C	B	16R	2
		5P	3	10101	106E	031409	2B	72	1C	B	19R	2
7X	X1	5R	1	10101	106E	011000	3B	52	1C	B		
		5R	2	10101	106E	011000	3C	55	1C	B	1C	1
		6P	1	10101	106E	061409	2B	71	1C	B	19R	1
*3TB	EN	6P	2	10101	106E	061409	2A	EN	1C	B	8C	2
18R	1	6P	3	10101	106E	061409	2A	70	1C	B	2R	1
12R	1	7C	1	10101	106E	031800	3B	56	1C	B	9REC	R
13R	1	7C	2	10101	106E	031800	3B	60	1C	B		
2R	2	7P	1	10101	106E	030209	1A	73	1C	B		
		7P	2	10101	106E	030209	1B	80	1C	B	3R	1
19R	2	7P	3	10101	106E	030209	2B	72	1C	B	12C	2
		7X	10	10101	106E	161400	3B	57	1C	B	*2TB	57
		7X	11	10101	106E	161400	3C	46	1C	B	*2TB	46
		7X	12	10101	106E	161400	3B	62	1C	B	8P	3
		7X	15	10101	106E	161400	1C	83	1C	B	7X	16
7X	15	7X	16	10101	106E	161400	1C	83	1C	B		
		7X	1	10101	106E	161400	2C	79	1C	B	1R	2
		7X	2	10101	106E	161400	2C	84	1C	B	*5TB	84
		7X	3	10101	106E	161400	1C	82	1C	B	*5TB	82

SUMMARY OF CONNECTION LIST
S.O. IND.DWG NO.
CUST.
EQUIP.+APPLIC.MAGAMP PNL

DWG. NO.	SUB.	SH. NO.	SHEETS
424A770		4	

BUFFALO DIVISION — CONTROL DEPT. — BUFFALO, N. Y., U. S. A.

TRANSMISSION GATE

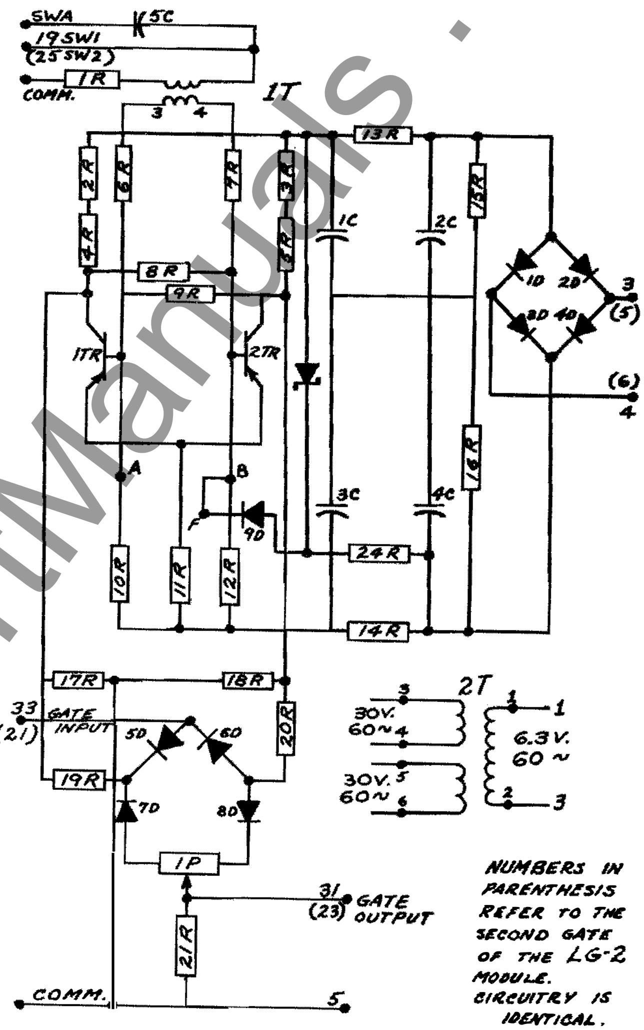


Figure 1 - Schematic Diagram of the Transmission Gate

A transmission gate is a bilateral switch for controlling the passage of analog signals. The gate functions as a static relay, so that when the gate is open or conducting, a very small impedance exists thru the gate. When the gate is closed or non-conducting, a very high impedance exists thru the gate. The gate can be switched by any circuit providing a rapid voltage change of 15 - 20 volts in approximately 10 micro-seconds or less. Frequently, Westinghouse NOR logic circuits are used to provide this control signal. In the conducting state, the gate will pass frequencies in excess of 10 kilocycles without attenuation.

The gates are made up of transformers, transistors, diodes and other components mounted on printed circuit boards and made up into a standard Prodac type module frame. The transmission gate modules are designated LG1 and LG2. They are identical except that LG1 consists of one gate, and LG2 consists of two independent gates in one module. The modules require a power supply of 6.3 volts ± 5%, 500 mA, 50/60 cps across the primary of transformer 2T as shown in Figure 1.

Driving terminal 19 (or 25) in a positive going direction with respect to terminal 5 (common or PSC) makes the gate non-conductive. A negative going signal makes the gate conductive. The gate can be controlled at rates in excess of 1000 times-per-second with switching rates normally being limited by the relative duration of switching transients with respect to open and closed times. A special input connection, SWA, is provided for non-symetrical operation in which one state of the gate may exist for short periods in the neighborhood of 100 microseconds.

Signals up to ± 10 volts can be gated with output loading up to 1.5 mA maximum. Higher voltages up to ± 20 volts can be gated with less loading. The gate will operate thru a temperature range of at least 0 - 65° C, but temperatures above 55° C should be avoided to obtain the best reliability and longest life of the device.

OPERATION

A. Bridge Circuit

The heart of the gate is a diode bridge as shown in Figure 2.

DESCRIPTION • OPERATION • MAINTENANCE

INSTRUCTIONS

MECHANICAL DIFFERENTIAL SPEED ERROR DETECTING UNIT

DESCRIPTION

General. The MECHANICAL DIFFERENTIAL SPEED ERROR DETECTING UNIT (Figure 1) is an electro-mechanical device for speed matching two rotating elements. These elements are usually rotating shafts of electrical machines.

The mechanical differential speed error detecting unit is used with an external amplifier to directly control the fields of either generators or motors. The unit will detect any error in the speed matching of two rotating elements.

Each unit has the following components:

1. Rigid mounting base with slide rails.

2. Basic mechanical differential error detecting unit.

3. Provision for remote draw control.

4. Provision for slack take-up feature.

5. Pilot generator.

6. Position inductor.

7. The necessary gearing and mounting supports.

8. Drip proof cover to completely enclose the components.

9. Synchronous reference motor.

Draw Range. The amount of speed variation possible by using the remote draw control is ± 12 percent maximum by means of the belt shifting mechanism excluding any circuit limitations.

Gears. All gears have been induction hardened to provide minimum wear. Machining has been held to close tolerances to minimize backlash, thus reducing wear and increasing the accuracy of the unit.

Bearings. All bearings are prelubricated sealed ball bearings to provide extreme reliability and long life.

BASIC MECHANICAL DIFFERENTIAL ERROR DETECTING UNIT

The mechanical differential error detecting unit (Figure 2) consists of a drive cone, a differential or driven cone, and a belt coupling between the two cones. A bedplate and a combination housing and bearing provides a support for the components of the unit.

The drive cone shaft is supported at the housing and has attached to it a 15-inch pitch diameter, single groove sheave for belting to the rotating shaft of the controlled machine.

The differential cone contains the planetary gear system which furnishes rotation of the differential output shaft. The differential cone is supported at the housing and obtains its rotation from the drive cone through the belt coupling.

The reference speed is introduced into the unit through the shaft attached to the 56-tooth gear. This 56-tooth gear drives a 72-tooth idler gear which in turn drives a second 56-tooth gear attached to the sun gear shaft. At the opposite end of the differential cone, the 26-tooth sun gear is attached to the sun gear shaft. A 78-tooth ring gear is fitted to the inside of the differential cone in line with the sun gear. A 26-tooth planetary gear revolves on its shaft between the sun gear and the ring gear and is meshed to both of these gears. The planetary gear drives the output shaft through a mechanical crank as shown in Figure 2. A 40-tooth chain sprocket is attached to the output shaft and drives a gear train connected to the position inductor and pilot generator Figure 4.

For the output shaft to remain motionless, the sun gear must rotate exactly three times as fast as, and in the opposite direction to, the ring gear.

Any deviation in the above ratios of speed will cause motion of the output shaft and this motion will persist until the exact relationship is re-established through corrective action of the regulating system.

The relationship of these three gears is such that if the sun gear reference shafts were held motionless, four revolutions of the ring gear would produce three revolutions of the differential output shaft. Conversely, if the cone is held motionless, four revolutions of the sun gear are required to produce one revolution of the output shaft.

The drive cone and the differential cone are identical in external size and shape, but are mounted to the housing with their tapers facing in opposite directions.

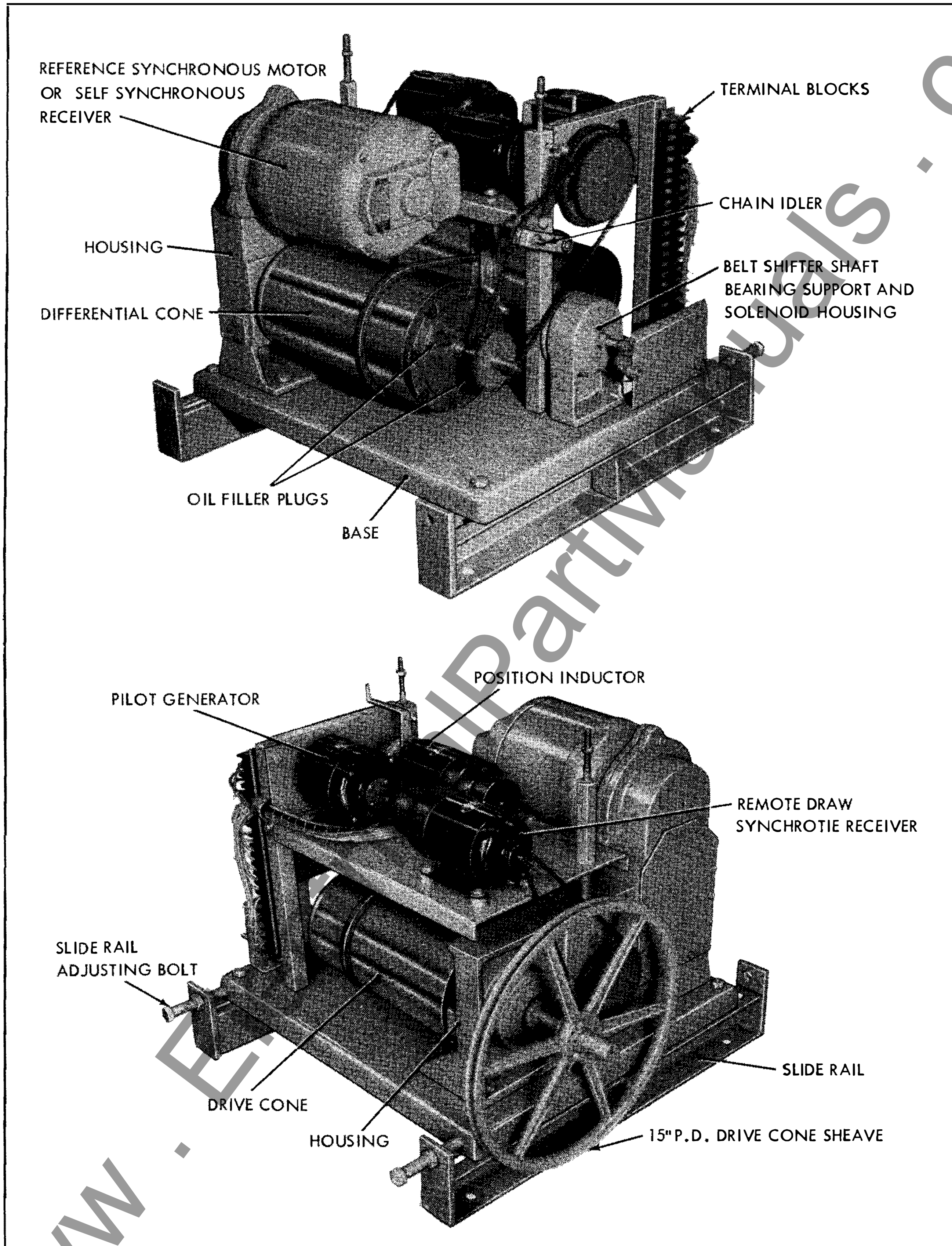


FIG. 1. Mechanical Differential Speed Error Detecting Unit

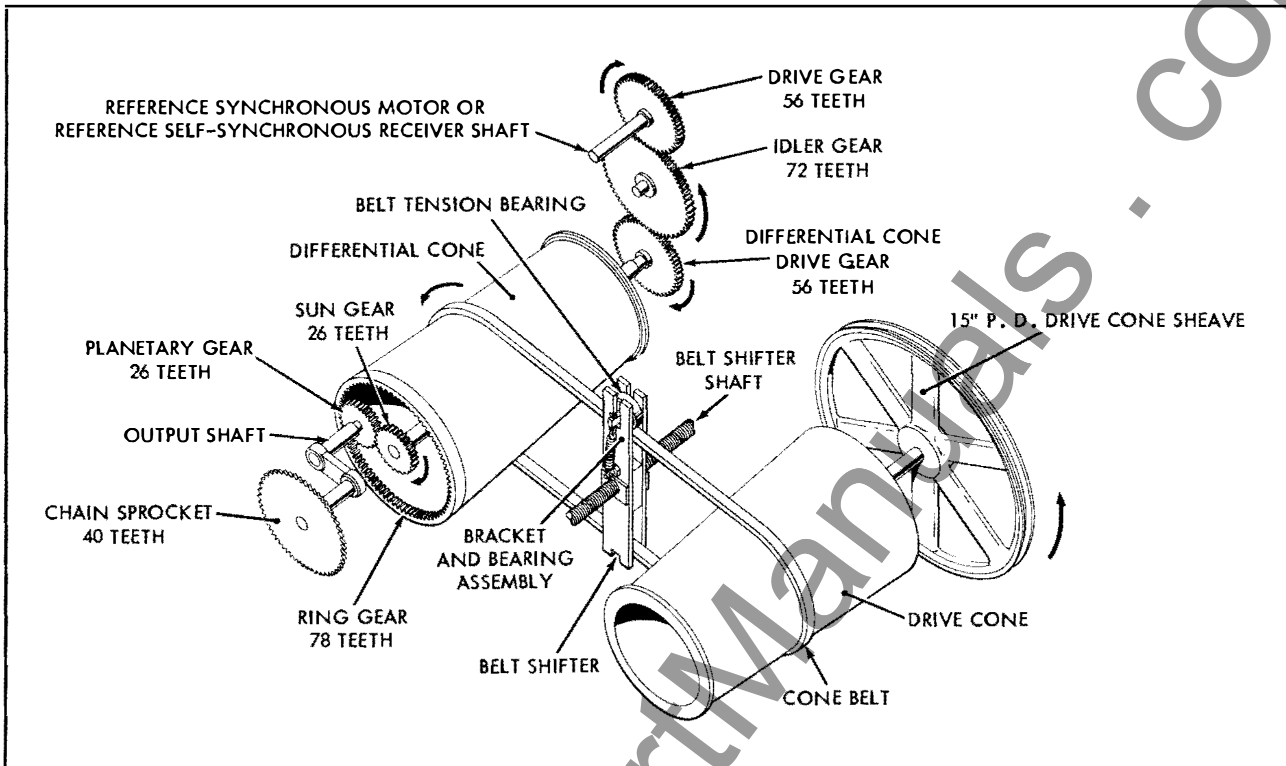


FIG. 2. Basic Mechanical Differential Error Detecting Unit

The ratio at the exact center is one-to-one. Moving the belt to the extreme end towards the housing forces the differential cone to turn faster by the ratio of the drive cone diameter to the differential cone diameter. This is the ratio of $\frac{7.125 \text{ (large end diam.)}}{6.125 \text{ (small end diam.)}}$

Moving the belt to the other extreme end forces the differential cone to turn slower by the ratio of $\frac{6.125}{7.125}$. The overall draw range possible is $\pm 12\frac{1}{2}\%$.

REMOTE DRAW CONTROL

The shifting of the belt along the taper of the cones is performed by the remote draw control as shown in Figure 3. This control consists of a belt shifter, a slack take-up feature, a remote draw Synchrotie receiver mounted to the housing, a remote draw Synchrotie transmitter remotely located in a control cabinet, and a slack take-up pushbutton mounted near the transmitter handle.

The draw adjuster mechanism consists of a belt guide mounted on a threaded shaft. This shaft has 16 threads per inch of length. One revolution of the shaft will provide a resultant change of 0.15 percent in relative speeds of the cones. The shaft is supported at one end by the housing and at the other end by a removable bearing support which also contains a solenoid. A small crank handle is secured to the end of the shaft for manual operation of the belt shifter during installation or adjustment procedures.

The shaft has freedom of movement in the horizontal direction through its bearings. Attached to the shaft $\frac{1}{4}$-inch from the removable bearing support is the slack take-up armature (circular disc). The distance between the disc and the bearing support is maintained by a compression spring. An electromagnet is contained within the bearing support.

The belt shifter consists of two parallel arms secured together at the bracket and bearing assembly. The belt passes over the drums and between the parallel arms. A downward force is applied to the belt at this point by a spring-loaded ball bearing which applies tension as it rides on top of the belt.

The belt guide is limited in its travel along the belt shifter shaft by the limit nuts. The position of these limit nuts prevents the belt from slipping from the drum.

A guide bar, secured to the base and parallel to the belt shifter shaft, prevents the belt shifter from rotating about the shaft axis as the belt is moved along the cones.

The belt shifter shaft which extends through the housing has a chain sprocket attached to it. Mounted above the drive cone on a horizontal plate attached to the housing is a remote draw Synchrotie receiver. The receiver shaft is connected to the belt shifter shaft by a link chain drive.

A remote draw Synchrotie transmitter is mounted in a location convenient to the machine operator. The remote draw transmitter and receiver are duplicate units, providing a one-for-one revolution relationship. Each unit has a 110-volt single-phase primary wound on its rotor, and a 55-volt, 3-phase secondary on the stator. For normal operation, it is excited at 80 to 100 volts on the primary in order to provide long life and reduced temperature operating conditions. Therefore, a direct control of the cone ratios is obtained remotely by the remote draw Synchrotie transmitter and receiver system.

A pushbutton mounted near the remote draw Synchrotie transmitter provides an automatic, momentary slack take-up feature to change the differential cone speed. Depressing the pushbutton energizes the solenoid contained within the belt shifter shaft bearing housing. The magnetic force created by the solenoid attracts the slack take-up armature to the bearing housing. The metal disc moves $1/4$ inch which provides a relative speed change of 0.60 percent. This speed change will persist only as long as the SLACK TAKE-UP pushbutton is held depressed.

MECHANICAL DIFFERENTIAL SPEED ERROR DETECTING UNIT

Additions to the basic mechanical differential error detecting unit are shown in Figure 4 and are listed below:

1. A reference synchronous motor or Synchrotie receiver. Provides a mechanical reference input into the differential cone.

2. A position inductor. This inductor supplies voltage proportional to position and is applied to an external amplifier for signal indications.

3. A d-c pilot generator. This generator supplies voltage proportional to the rate of change of position

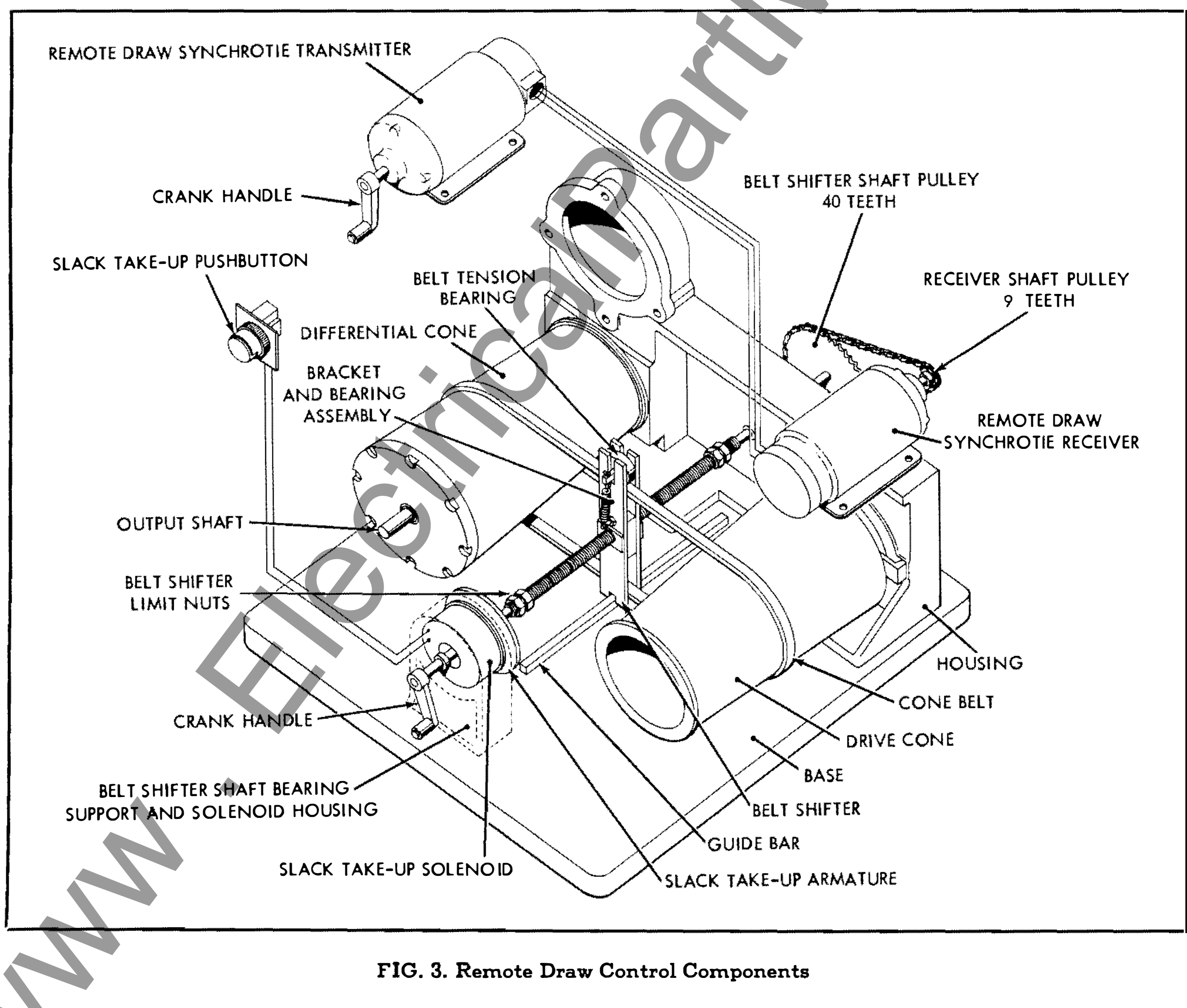


FIG. 3. Remote Draw Control Components

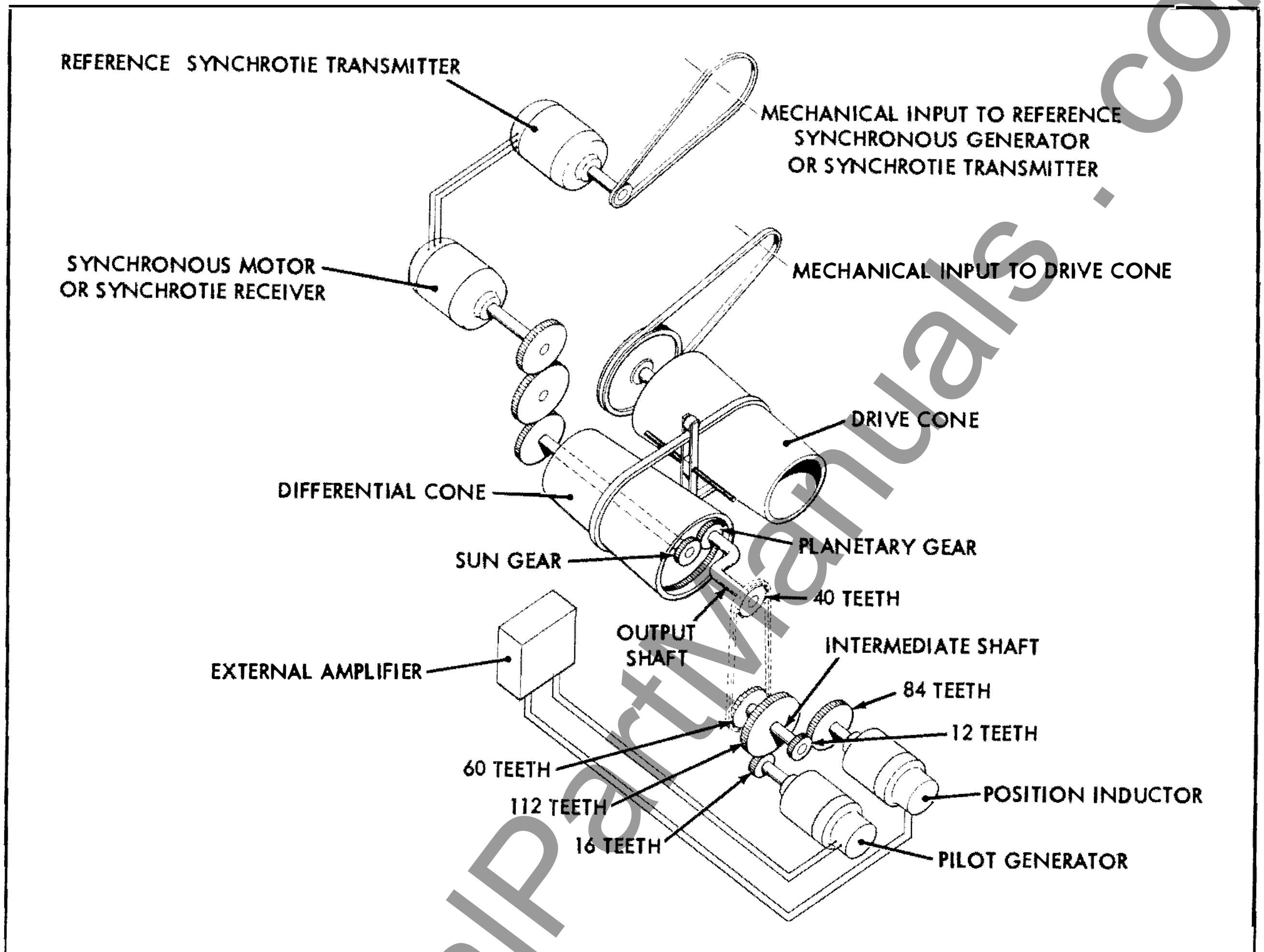


FIG. 4. Simplified Control Circuit Incorporating Mechanical Differential Speed Error Detecting Unit

and is also applied to an external amplifier for signal indications.

A typical simplified control circuit as shown in Figure 4 will be described to illustrate the operation when using the mechanical differential speed error detecting unit.

A mechanical drive input to the reference synchronous generator or Synchrotie transmitter provides the reference speed for the unit. This generator or transmitter supplies power to the reference synchronous motor or Synchrotie receiver. This motor or receiver drives the sun gear of the differential cone at a reference speed.

A mechanical input to the drive cone provides the variable speed to the unit. The drive cone imparts a rotation to the differential cone and its ring gear through the movement of the cone belt. A one-to-one ratio of drive cone speed to differential cone speed will be considered first.

The electrical output of the position inductor and d-c pilot generator can be connected to any conventional voltage or power amplifier; e.g., **magnetic amplifier, electronic amplifier or rotating amplifier** to provide additional gain and control ability.

If the ring gear is rotating at a speed other than one-third the speed of the sun gear, the planetary gear will rotate the output shaft. The chain connection turns the intermediate shaft which rotates the armatures of the position inductor and d-c pilot generator. The movement of the position inductor rotor supplies a change in voltage to the external amplifier in proportion to the new angular position of the output shaft. The rotation of the d-c pilot generator armature supplies a voltage to the external amplifier proportional to the rate of position change of the output shaft.

The amplifier is energized by these two separate signals to change the speed of the machine providing the mechanical input to the drive cone.

The above sequence will take place until the ring gear is rotating exactly one-third as fast as the sun gear. At this point, the mechanical input to the drive cone is speed matched to the mechanical input by the reference.

If it is required to change the speed matching of the reference machine to the controlled machine, movement of the cone belt in the proper direction will accomplish this requirement.

INSTALLATION

The following installation instructions are to be performed before initial adjustments and operation:

1. Check the alignment of the motor mounted or driven mechanical input sheave and drive cone sheave. Alignment of these sheaves should be as perfect as physically possible. True alignment will eliminate sidewise flexing and whip and will increase the belt life.

2. Check the mechanical input and drive cone sheaves for play between sheave and shaft. The sheave must be securely fastened to the shaft. No play, axially or radially, can be tolerated. If play exists between the drive cone sheave and the drive cone shaft, tighten the split taper bushing on the sheave. If play exists between the motor mounted sheave and its shaft, tighten the mounting.

3. Check sheave V-belt tension. The V-belt should be tightened sufficiently to eliminate slippage. Too much tension will overload the bearings of the basic mechanical differential error detecting unit.

NOTE: It is recommended that the purchaser supply a gravity-loaded or spring-loaded roller to maintain tension of the V-belt.

Usually the motor will be coupled to the machine so that this check may be accomplished by trying to turn the drive cone sheave (in the direction the motor will drive it) with the belt in place. Should the belt slip, shift the base support on its slide rails by turning the threaded adjusting bolts in the slide rail ends. If the motor is uncoupled, restrain the armature and check as outlined above.

NOTE: When possible, it is preferable to rotate the drive cone sheave in a direction such that the drive belt is taut on the bottom and slack on the top.

4. Check the V-belt for uniformity of width. The belt should have a uniform width throughout its total length. If the motor is coupled, this check will have to be deferred until the machine is run at slow (inch)speed. Rotate the armature slowly and observe the position of the belt in the sheave slot. The belt rides up and down in the slot if it is not uniform in width. A non-uniformity of a minor nature will not usually affect the operation of the unit, but will cause action to appear erratic. Belts that are uneven or have a permanent set or deflection should not be used.

5. Remove the light coat of oil from the cone surfaces with a suitable solvent. Surfaces must be clean and dry to prevent slippage.

6. Check the cone belt tension bearing. This bearing should be free to move perpendicularly from the mid-point of the bracket slots. The belt tension should be sufficient to eliminate slippage. A deflection of 1/4 inch at normal ambient temperature indicates sufficient tightness. Excessive tension will overload or bind the cone bearings. If necessary to adjust the range of the belt tension bearing, loosen the three eccentric bearing mounting bolts (Figure 5). To tighten the cone belt, turn the eccentric bearing in a clockwise direction with a suitable spanner wrench. To loosen the cone belt, turn the eccentric bearing in a counterclockwise direction.

NOTE: Do not remove eccentric bearing clamps from housing.

Tighten securely the three eccentric mounting bolts.

By means of the eccentric mounting bearing the drive cone can be moved a distance of one inch in the horizontal direction to obtain the proper belt tension.

7. Check the differential gear train for binding, backlash and play. Release the chain tightener and remove the drive chain. Hold the differential cone and rotate the differential output shaft. Rotation should be uniform and smooth with no backlash in the gearing.

8. Check the position inductor drive gearing and friction clutch. With the drive chain removed, rotate the 60-tooth sprocket and observe the gear train. Rotation should be smooth and require uniform torque (when the position inductor is in range). The pilot generator and position inductor are mounted in slotted holes to permit adjustment of their position to obtain snug mesh of gears. Backlash in the gearing can be minimized by adjusting the positions of the pilot generator and the position inductor.

CAUTION: When the receiver goes out of range, the friction clutch should slip with little additional applied torque. Check for constant friction in the clutch by rotating it through one complete revolution.

9. Check the oil level. Rotate the differential cone until one of the two filler plugs is directly below the output shaft. Remove the plug and check the oil level. The housing gear case should be filled with SAE-140 or equivalent weight oil until level with the bottom edge of the filler plug hole. Replace the plug. The chain drive idler and gear train should have a light coating of light weight machine oil.

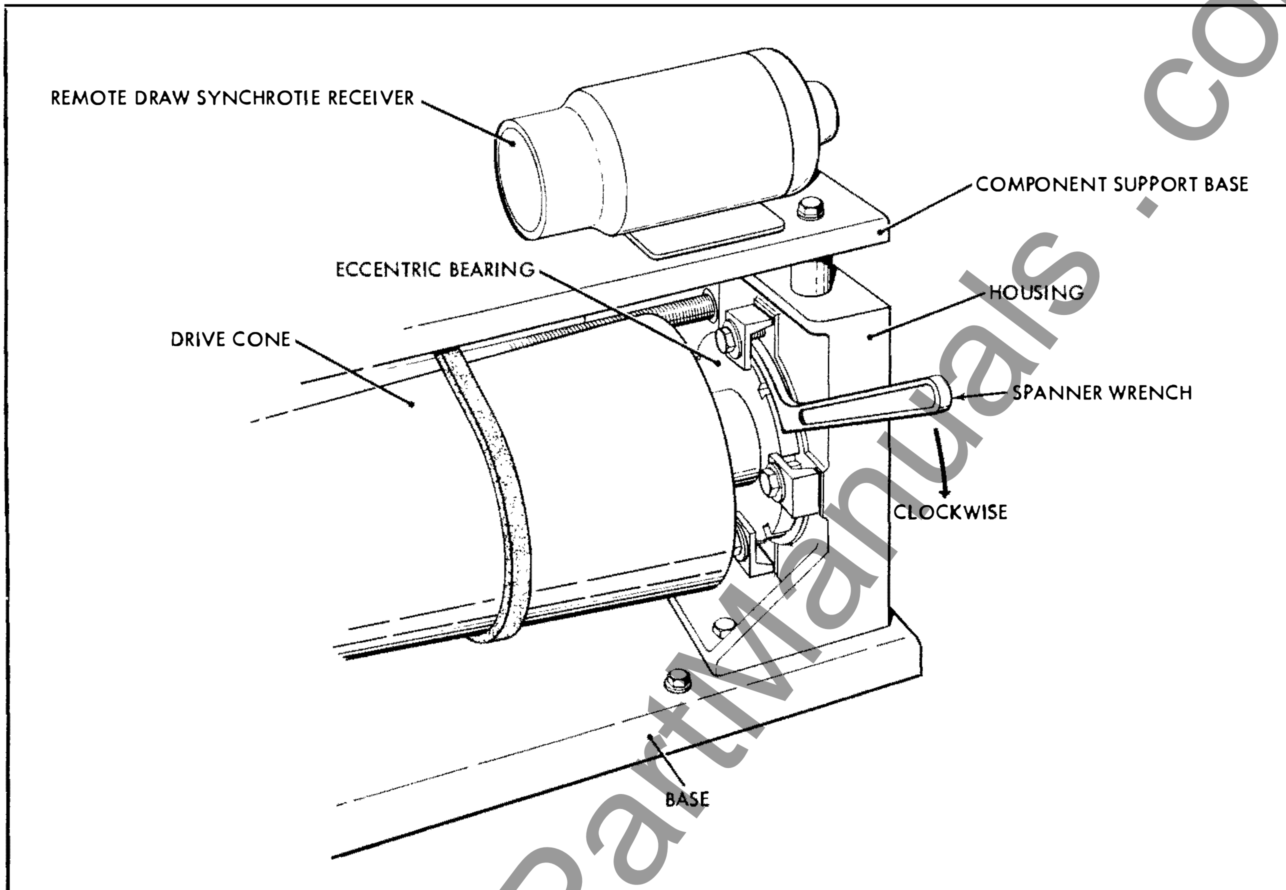


FIG. 5. Adjustment of Drive Cone Eccentric

10. Check the belt shifter for binding and mechanical interference. Rotate the cones and move the belt shifter throughout its complete range by the draw adjusting crank handle. The belt should move freely to the extreme ends of the cones.

11. Slack Take-up. Check the belt shifter shaft for freedom of movement in the horizontal direction.

ADJUST J ENTS

The following adjustments for setting up and/or checking the electrical components of the unit are to be performed before actual operation:

Pilot Generator. Check the two brushes for type and fit. They should be No. AGC-10 silver graphite brushes. Move the brushes in and out of the brush holders. **There must be neither binding nor excessive clearance.** Measure the shunt field voltage—this should be approximately 90 to 100 volts. Disconnect the PGP (Figure 6) lead on the pilot generator side of the terminal block and measure the pilot generator armature voltage as the drive cone sheave is turned in the direction the mechanical input sheave will drive it. The PGP lead should be positive. If the polarity is wrong, reverse either the armature or the field leads. With the control circuit deenergized, measure the resistance of the circuit to the external amplifier. (This should be 2 ohms maximum unless the normally closed contact of the Transfer relay (refer to main schematic diagram) is not making good contact.)

Positon Inductor. Rotate the drive cone sheave in the direction that the mechanical input sheave will drive it. Note the direction the pointer moves and mark this side "FAST." Mark the opposite side "SLOW." These designations refer to section motor speed; for example, if the section motor is running too slow, the pointer will move toward "SLOW." Excite the position inductor with the voltage specified by the main schematic diagram and measure the voltage of the phase connected to the **external** amplifier. When the pointer is in "FAST" position, the a-c voltage should be zero, and should increase as the pointer is moved to the "SLOW" position. If the output is not zero, remove the pointer on the clutch assembly and relocate it so that zero (or essentially zero) volts are obtained when the pointer is in the "FAST" position. The voltage must not reverse as the pointer is moved through its range.

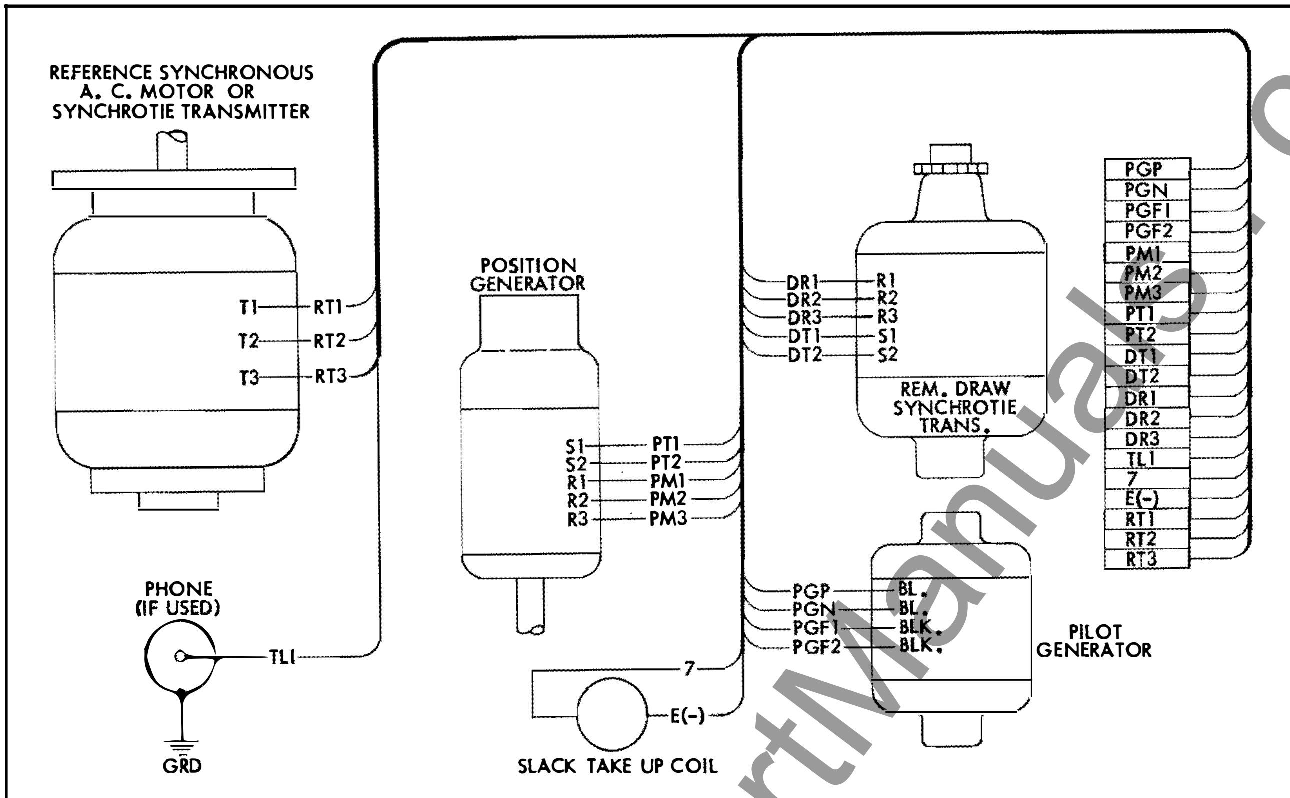


FIG. 6. Wiring Diagram for the Mechanical Differential Speed Error Detecting Unit

Reference Synchronous Motor or Synchrotie Receiver. Energize the reference bus and momentarily excite the reference motor or receiver by manually closing the transfer relay. The pointer should move to the "SLOW" position. If the rotation is wrong, interchange two of the three motor or receiver leads.

Remot Draw Control. With the motor running and the regulator in operation, check the voltage applied to the Remote Draw Control circuit. Refer to the main schematic diagram for the proper voltage. Turn the crank handle of the remote draw Synchrotie transmitter at the operator's station in the direction in which the material is flowing. This should cause the cone belt to move away from the housing of the unit and the section drive motor should increase its speed. If the resultant action is reversed, interchange two of the three stator leads.

Slack Take-up. With the motor running and the unit in operation, depress the slack takeup pushbutton at the operator's control station. The cone belt should move approximately 1/4 inch away from the housing of the unit and the section drive motor should increase its speed.

MAINTENANCE

Preventive Maintenance. The mechanical differential speed error detecting units have been designed and constructed to perform satisfactory service for an extended period. To insure efficient operation, it is necessary to accomplish routine mechanical and electrical inspections that will reveal unsatisfactory conditions and prevent disturbances to the control circuits.

SERVICE Weekly	Monthly	
x	x	Belts. Inspect for excessively worn, cracked, or frayed belts. Check belt tension.
	x	Sheaves. Check condition and alignment of sheaves.
	x	Chains. Check for wear and cracked or broken links.
	x	Sprocket. Check sprockets for excessive wear, broken teeth, loose mounting and alignment.
x		Cones. Check cones for oil, liquids or dirt on external surfaces.
		O l. Drain and refill when dirty or gritty.

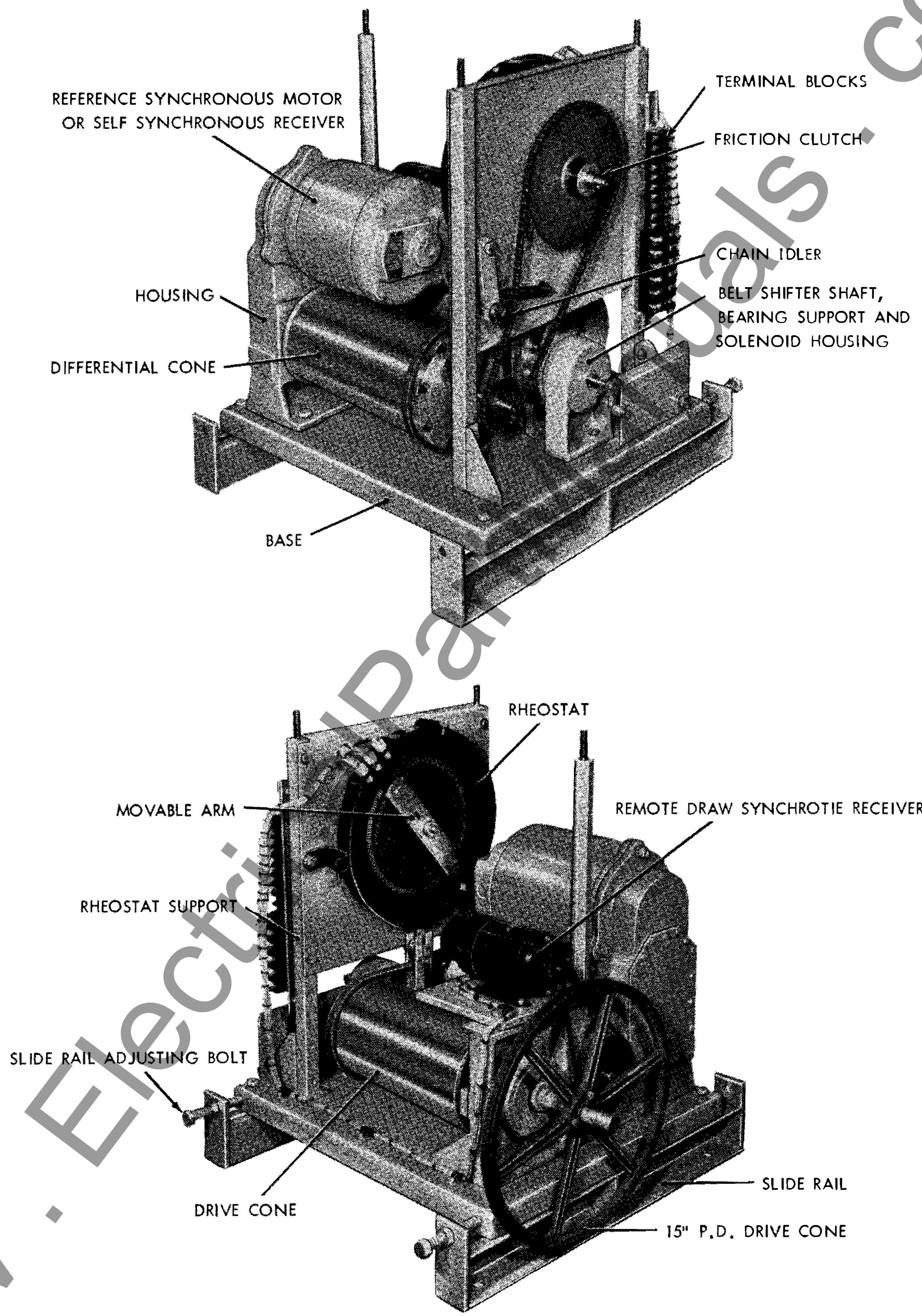


FIG. 7. Mechanical Differential Rheostatic Type Position Regulator

Replacement of Cone Belt. 1. With the drive cone turning, rotate the crank handle until the belt shifter has moved the cone belt to the ends of the cones near the crank handle.

2. Reduce the tension in the belt by turning the drive cone eccentric bearing. (Refer to step 6 under Installation.)

3. Release the chain idler and remove the output shaft drive chain.

4. Remove the belt tension bearing from the belt shifter.

5. Remove the bolts securing the belt shifter shaft bearing support to the base.

6. Remove the belt from the cones and slip the belt under the bearing support.

7. Replace the new belt in a reverse order to that given above.

VARIATION IN DESIGN AND APPLICATION

The basic mechanical differential error detecting unit (Figure 2) and the remote draw control (Figure 3) can be combined with specific equipment to form a Mechanical Differential Rheostatic Type Position Regulator as shown in Figures 7 and 8.

The required equipment is shown in Figure 8 and listed below.

1. A 26-tooth sprocket attached to the output shaft.

2. A variable rheostat whose contact arm is chain-connected to the output shaft of the differential cone.

3. The necessary frame and supports for the variable rheostat.

4. A reference synchronous motor or Synchrotie receiver to provide a mechanical reference input into the differential cone.

The chain connection between the output shaft of the differential and the rheostat provides the proper rotation of the contact arm in relation to the electrical and mechanical requirements.

The 26-tooth sprocket chain-drives a 72-tooth sprocket that is secured to the contact arm of the rheostat. A friction clutch is inserted between the sprocket and contact arm to provide protection for the rheostat and control system in case the arm is stopped at either of its extreme limits of travel.

A typical simplified control circuit (Figure 8) will be described to illustrate the operation when using the mechanical differential rheostatic type position regulator.

A mechanical drive input to the reference synchronous generator or Synchrotie transmitter provides the reference speed for the regulator. This generator or transmitter supplies power to the reference synchronous motor or Synchrotie receiver. This motor or receiver drives the sun gear of the differential cone to provide the reference.

A mechanical input to the drive cone provides the variable speed to the regulator. The drive cone imparts a rotation to the differential cone and its ring gear through the movement of the cone belt.

If the ring gear is not rotating exactly one-third the speed of the sun gear, the planetary gear will receive rotational motion and force the output shaft to rotate. The mechanical connection between the rheostat and the output shaft causes a change in position of the rheostat arm. This action results in a change of voltage across the field of the controlled motor or generator. The resultant effect will change the speed of the machine providing the mechanical drive input to the drive cone.

The above sequence will take place until the ring gear is rotating exactly one-third as fast as the sun gear. At this point, the mechanical input to the drive cone is speed matched to the mechanical input of the reference.

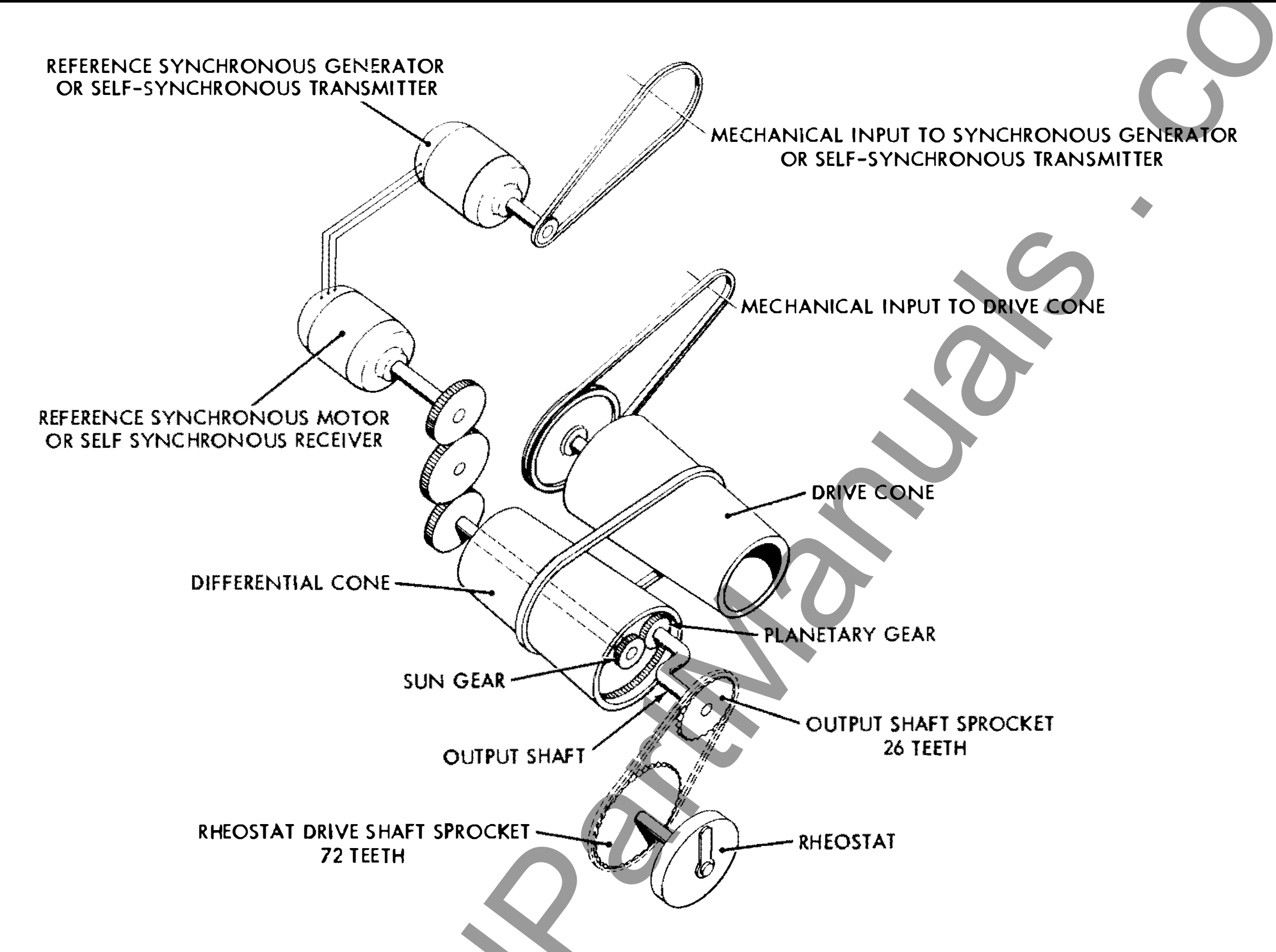


FIG. 8. Simplified Control Circuit Incorporating Mechanical Differential Rheostat Type Regulator

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