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MILITARY STANDARD

MARKING OF CONNECTIONS FOR ELECTRIC ASSEMBLIES

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON 25, D. C.

Supply and Logistics

Marking of Connection for Electric Assemblies

MIL-STD-195

1. This standard has been approved by the Department of Defense for use by the Departments of the Army, the Navy, and the Air Force.

2. In accordance with established procedure, this Standardization Division has designated the Corps of Engineers, Bureau of Ships, and the Air Force, respectively, as Army-Navy-Air Force custodians of this standard.

3. This standard is mandatory for use effective 1 February 1956, by the Departments of the Army, the Navy, and the Air Force.

4. Recommended corrections, additions, or deletions should be addressed to the Standardization Division, Office of the Assistant Secretary of Defense (Supply and Logistics), Washington 25, D. C.

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TABLES

1. SCOPE

1.1 Scope. — This standard covers uniform connection marking for the following equipment:

- Direct-current generators.
- Direct-current motors.
- Alternating-current generators.
- Alternating-current motors.
- Synchronous converters.
- Dynamotors.
- Transformers, power.
- Controllers.
- Starters.
- Brakes.
- Metallic rectifier type power supplies.
- Regulator sets, generator voltage.

This standard does not necessarily apply to the marking of connections used to interconnect the devices within the enclosure.

1.2 Purpose. — The purpose of this standard is to establish uniform connection marking for electric power assemblies. The standard, when used, will aid in making connections between the assemblies and other parts of the electric power system, and will prevent improper connections which may result in unsatisfactory operation or damage.

2. REFERENCED DOCUMENTS

2.1 The following standard, of the issue in effect on date of invitation for bids, shall form a part of this standard.

STANDARD

MILITARY

MIL-STD-104—Limits for Electrical Insulation Color.

3. DEFINITIONS

3.1 Definitions (for the purpose of this standard).

3.1.1 *Assembly.* — An assembly is a number of parts or subassemblies, or both, combined to perform a specific function.

3.1.2 *Connection.* — Connection refers terminal leads (with or without lug terminals), terminal boards, stud terminals, fee through terminals, and bus bars which for a part of the assemblies specified in 1.1.

3.1.3 *Connection, negative.* — The negtive connection is the one from which dire current enters a direct-current generat rectifier or the output side of a converter a from which direct current leaves a dire current (d.c.) motor, input side of an i verter, d.c. field winding or other d.c. pow consuming device. By this definition, the el tron flow is from the commutator to negati brush in the case of a d.c. generator, fro negative brush to commutator in the case a d.c. motor, or from negative brush to c lector ring in the case of a rotating fi alternating-current a.c. generator or mot

3.1.4 *Connection, positive.* — The posit connection is the one from which d.c. lea a d.c. generator, rectifier or the output s of a converter and into which d.c. enter d.c. motor input side of an inverter, d.c. f winding or other d.c. power consuming vice. By this definition, the electron flow from the positive brush to the commuta in the case of a d.c. generator, from the co mutator to the positive brush in the case c d.c. motor, or from a collector ring to posit brush in the case of a rotating field a.c. g erator or motor.

3.1.5 *Marking.* — Marking refers to lette numbers, symbols, and colors applied to assembly for identification or informatio

3.1.6 *Phase sequence.* — For polyphase generating machines, phase sequence is order in which the voltages successively re their maximum positive values between c nections.

3.1.7 *Standard direction of rotation.*— less otherwise required by the applicat machines shall be connected for standard direction of shaft rotation.

Motors. — The standard direction of shaft rotation for motors is counterclockwise when facing the end opposite the drive.

Generators. — The standard direction of shaft rotation for generators is clockwise when facing the end opposite the drive.

3.1.7.1 *Exceptions to standard direction of shaft rotation.* — Where more than two machines are mechanically coupled, this rule may not apply to all machines.

4. GENERAL REQUIREMENTS

4.1 Use of letters, numerals and symbols.

4.1.1 *General.* — The markings shall consist of the following forms or combinations of forms specified herein:

(a) Sans-serif (Gothic) capital letter of the alphabet.

(b) Arabic number used as a subscript to a letter.

(c) Symbol, usually arithmetical. The use of symbols is limited in this standard.

(d) Color coding, conforming to Standard MIL-STD-104 of the following types, for dynamotors and aircraft motors.[1]

(1) Solid colors.

(2) Tracer colors on a background of cream to white to light gray. Tracer width shall be varied to assist in distinguishing colors.

4.2 **Marking nomenclature.** — Markings shall conform to table I, which lists the functional part primarily associated with the connection to be marked. Table I also assigns forms, and representative subscripts or other appropriate marking, when applicable.

[1] This standard is not intended to establish color coding for cable supplying power to portable electric or electronic equipment, color coding for resistors, or color coding for electronic equipment.

TABLE I. *Marking nomenclature summary*

Functional part	Marking (examples)	Color code for dynamotors and aircraft motors[1]	
		Color code[2]	Width of tracer where used[3]
Alternating-current generators and motors	T_1	Black	Narrow
	T_2	Red	Narrow
	T_3	Green	Wide
	T_4	Blue	Narrow
	T_5	Orange	Wide
	T_6	Brown	Wide
	T_7	White (cream to white to light gray)	....
Bias winding connections (rectifier power supply)	BC_1, BC_2, BC_3	————	————
Brake	B_1, B_2, B_3	Brown	Wide
Brush on armature commutator	A_1	White (cream to white to light gray)	————
	A_2	Black	Narrow
		Green	Wide
		Blue	Narrow
	A_3	....	....

TABLE I. *Marking nomenclature summary*—Continued

Functional part	Marking (examples)	Color code for dynamotors and aircraft systems	
		Color code	Width of tracer where used
Brush on armature commutator connected internally to shunt field	A_1F_1	White (cream to white to light gray)	....
	A_2F_2	Black	Narrow
Brush on collector ring (except to d.c. field)	M_1, M_2, M_3	....	....
Control winding connection other than feedback and bias (rectifier power supply)	OC_1, OC_2, OC_3	....	....
Current feedback signal connections (rectifier power supply)	CF_1, CF_2, CF_3	....	....
Dynamotors:			
Single input (or lowest voltage):			
Positive	....	White	Narrow
Negative	....	Black	Narrow
Dual input (next higher votage; if any):			
Positive	....	Green	Narrow
Negative	....	Brown	Narrow
Single output (or lowest voltage):			
Positive	....	Red	Narrow
Negative	....	Blue	Narrow
Dual output (second highest voltage):			
Positive	....	Red	Green, narrow
Negative	....	Green	Green, narrow
Triple output (highest voltage):			
Positive	....	Red	Black, narrow
Negative	....	Blue	Black, narrow
Equalizing lead	= (equality sign)	....	....
Field, commutating	C_1, C_2	....	....
Field, series	S_1	Red	Narrow
	S_2	Black	Narrow
Field, shunt	F_1	Green	Wide
	F_2	Red	Narrow
Field, series and shunt field connected internally	S_2F_2	Black	Narrow
Field, series, for engine starter generator	ST+, ST−	....	....
Line	L_1, L_2, L_3	Orange	Wide
Metallic rectifier stack assembly; a.c. input connections	AC_1, AC_2, AC_3	....	....
Neutral connections (except 3-wire generator)	Appropriate letter designation with subscript numeral 0	White (cream to white to light gray)	....
Neutral connection from balance coil on 3-wire d.c. generator	±	....	

TABLE I. *Marking nomenclature summary*—Continued

Functional part	Marking (examples)	Color code for dynamotors and aircraft motors[1]	
		Color code[2]	Width of tracer where used[3]
Potential feedback signal connections (rectifier power supply)	PF_1, PF_2, PF_3	....	
Power supply, rectifier type, output connections	D_1, D_2, D_3	....	
Reactor for motor starting	0, 1, 2, 3	....	
Resistor, armature and miscellaneous	R_1, R_2, R_3	....	
Resistor, dynamic braking	DR_1, DR_2, DR_3	....	
Resistor, shunt brake	BR_1, BR_2, BR_3	....	
Resistor, shunt field adjusting	V_1, V_2, V_3	....	
Transformer, power, auto, *for motor starting*	Mark in percent of full voltage. Example: 0, 50, 65, 80, 100	....	....
Transformer, power, winding No. 1 (single-phase/single-phase and 3-phase/3-phase, highest voltage winding and 3-phase/6-phase, 3-phase winding)	H_1, H_2, H_3	....	....
Transformer, power, winding No. 2	X_1, X_2, X_3	....	....
Transformer, power, winding No. 3	Y_1, Y_2, Y_3	....	....
Transformer, power, winding No. 4	Z_1, Z_2, Z_3	....	....

[1] Aircraft motors shall be identified as in section 3 or through the lead lengths by this code.

[2] Colors shall conform to Standard MIL-STD-104.

[3] Tracer colors shall be on a background of cream to white to light gray.

4.3 Method of permanently marking specific types of connections.

4.3.1 *Terminal leads.* — In the case of terminal leads, the letters, numerals and symbols shall be etched, engraved, stamped or cast in (a) a fiber, metal or plastic piece which shall be securely attached to the lead or (b) that part of the lug terminal not intended to make electrical contact; metal pieces shall not be utilized to identify aircraft terminal leads.

4.3.2 *Terminal boards.* — In the case of terminal boards, the letters and numerals shall be etched, engraved, stamped or cast in the terminal board adjacent to the terminal or in a terminal marking strip or designation plate adjacent to the terminals.

4.3.3 *Stud and feedthrough terminals.* — In the case of stud terminals or feedthrough terminals, the marking shall be etched, engraved, stamped or cast in the equipment adjacent to the terminal or in a terminal marking strip or designation plate adjacent to the terminals.

4.3.4 *Bus bars.* — In the case of bus bars, the marking shall be stamped in the bus bar at a location which is near to, but not a part of, that area which is required to make the actual electrical connection. In addition, the marking shall be etched, engraved, stamped or cast in the enclosure or frame directly adjacent to the point of entry in an appropriate designation plate similarly located.

4.4 Size of marking. — The depth of letters, numbers and subscripts shall be not less than 0.003 inch. Exclusive of subscripts, the preferred size of each letter, number, and symbol shall be as follows:

4.4.1 *Terminal leads.* — The marking shall be not less than 1/16 inch in height when the outside diameter, including any insulation, of the terminal lead is 1/16 inch or less. The marking shall be not less than 1/8 inch in height, if lead diameter is greater than 1/16 inch.

4.4.2 *Terminal boards.* — The marking shall be not less than 1/16 inch in height when the outside diameter, including any insulation, of the internal leads connected to the board is 1/16 inch or less. The marking shall be not less than 1/8 inch when outside diameter of leads is larger than 1/16 inch.

4.4.3 *Stud and feedthrough terminals.* — The marking shall be not less than 1/16 inch in height when the diameter of the studs or terminals is 1/8 inch or less, when the diameter of the studs or terminals is larger, the markings shall be not less than 1/8 inch.

4.4.4 *Bus bars.* — The marking shall be not less than 1/8 inch in height or one-fourth the width of the bus bar, whichever is greater.

4.5 Size and location or subscripts. — Subscripts shall be at least half the height but not more than the full height of the basic letter which they follow. The position of the subscript shall be such that it is bisected by a horizontal line tangent to the base of the letter which the subscript follows:

4.6 Use of subscript numerals.

4.6.1 *Subscript numerals on connection d.c. machines and converters.* — The m
ings on the connections of a d.c. machine a
indicate the relation of circuits within
machine. Subscript numerals shall be de
mined on the following basis:

(a) The subscript numerals of con
tions of d.c. machines shall be
lected so that with current di
tion in any single exciting wind
from a lower to a higher subsc
numeral, the generated vol
(counter electromotive forc
the case of a motor) in the a
ature from this excitation a
for standard rotation, make a
ature connection A_1 positive
connectionn A_2 negative.

(b) Markings of auxiliary exci
windings (such as series field,
dual shunt fields) shall be a
that the excitation of the au
iary windings is cumulative w
current flow in the same di
tion, with respect to the subsc
numerals, as the main field wi
ing.

(c) On d.c. machines, when an a
ture lead passes through the
mutating, compensating, or s
field or any combination of t
fields before being brought ou
connection to the external cir
the connection marking of
lead shall be an A_1, A_2, A_3 a
plicable, provided all internal
nections are permanently m
and that no leads (including l
to shunt fields) from junction
combinations of these fields
also brought out for connec
to an external circuit. If l
from such junctions are bro
out, the one used as an equ
shall be marked with an equ
sign, thus =, and all leads
used as equalizers shall be ma

with the designation for the winding or windings to which the leads are connected.

(d) When only one side of the shunt field is connected internally to an armature circuit lead, this armature circuit lead shall have a dual marking (A_1F_1, S_1F_1) indicating its armature circuit function and its shunt field function. Armature circuit leads need not have this dual markings on machines having both sides of the shunt field internally connected.

4.6.2 *Subscript numerals on connections of a.c. machines.* —

4.6.2.1 In a.c. generators, the subscript numerals, indicate the order in which the voltages at the connections reach their maximum positive values (phase sequence) with standard rotation; hence for counterclockwise shaft rotation when facing the same end, the phase sequence will be 1, 3, 2.

4.6.2.2 In a synchronous converter, the sequence of the subscript numerals 1, 2, 3, 4, 5 and 6 applied to the collector ring connections M_1, M_2, M_3, M_4, M_5 and M_6 indicates that when the transformer leads on which phase sequence is 1, 2, 3, 4, 5 and 6 are connected to correspondingly numbered collector ring connections on which the phase sequence is 1, 2, 3, 4, 5 and 6, the shaft rotation of the converter shall be clockwise when viewed from the d.c. or commutator end.

4.6.2.3 *Subscript numerals on connections of polyphase induction motors.* — In the case of polyphase single-speed motors equipped with integral terminal boxes, the subscript numerals on line terminals L_1, L_2, L_3, shown in the table accompanying the three-phase motor diagrams, the phase sequence of the incoming power leads shall be indicated. When the leads are connected as shown in the table, the motor shall have the standard direction of rotation. For two-phase motors, regardless of the class of motor or the type of winding, odd subscript numbers shall be in one phase and even subscript numbers shall be in the other phase.

5. DETAIL REQUIREMENTS

5.1 D. c. generators shall be marked according to figures 1 to 11 inclusive.

5.1.1 *Two-wire (see figures 1 to 6 inclusive).* — Direction of shaft rotation shall be standard. For differential connection of the series fields, no change shall be made on the field leads or connection markings on the machine, but the series field connection to the armature shall be shown reversed. (Commutating, compensating, and series field windings are shown on the A_1 side of the armature but this location although preferred, is not standardized). These windings may be connected on one side of the armature or may be divided part on either side.

5.1.2 *Three-wire (see figures 7 to 11).*— Direction of rotation shall be standard. When three collector rings are used they shall be marked M_1, M_2, and M_3; two collector rings shall be marked M_1 and M_2; one collector ring shall be marked M. For differential connection of the series fields, no change shall be made on the field leads or connection markings on the machine, but the connection of the series field to the armature shall be shown reversed.

5.1.3 *Additional marking requirements.* — When facing the end opposite the drive end and when reading from front (the end opposite drive) to back, right to left, or top to bottom, the connection markings shall be arranged in the following order for clockwise rotation: Positive (+), neutral, if provided (±) negative (−) for counterclockwise rotation: negative (−), neutral, if provided (±), and positive (+)

5.1.4 *Gasoline or Diesel driven generators with series cranking winding.*—Series windings shall be marked "ST" followed by the appropriate polarity marking.

5.1.5 *Rotary amplifiers.* — The markings shall conform to 5.1. The output load leads shall be marked A_1 (−) and A_2 (+).

5.2 D. c. motors shall be marked in accordance with figures 12 to 30 inclusive.

5.2.1 *Shunt-wound (see figures 12 to 17 inclusive).* — Direction of shaft rotation for nonreversing motors shall be standard. Connections shown in these diagrams will give standard shaft rotation. (Commutating field windings are shown on the A_1 side of the armature, but this location, although preferred, is not standardized.) This winding may be connected on one side of the armature or may be divided part on either side.

5.2.2 *Series-wound (see figures 18 to 22).* —Direction of shaft rotation for nonreversing motors shall be standard. Connections shown in these diagrams will give standard shaft rotation. (Commutating and series field windings are shown on the A_1 side of the armature but this location, although preferred, is not standardized.) These windings may be connected on one side of the armature or may be divided part on either side.

5.2.3 *Compound-wound and stabilized shunt-wound (see figures 23 to 30 inclusive).* —Direction of shaft rotation for nonreversing motors shall be standard. Connections shown in these diagrams will give standard shaft rotation. (Compensating, commutating and series field windings are shown on the A_1 side of the armature but this location, although preferred, is not standardized.) These windings may be connected on one side of the armature or may be divided part on either side. For differential connection of the series fields no change shall be made on the field leads or connection markings on the machine, but the connection of the series field to armature shall be shown reversed.

5.3 A. c. generators and synchronous motors.

5.3.1 *Three- two- and single-phase.*—
phase a.c. generator and synchronous
a.c. windings shall have connection
ings as described in 5.4.3 for three
induction motors.

Two-phase a.c. generator and sy
nous motor a.c. windings shal
connection markings as descri
5.4.6 for two-phase induction

Single-phase a.c. generator and
chronous motor a.c. winding
have connection markings as ab
figure 31.

The connection markings of d.c.
windings shall be F_1 and F_2.

5.3.1.1 *Additional requirements for*
phase generators. — When facing t
opposite the drive end, and when
from front (the end opposite drive) t
right to left, or top to bottom, the
tion markings shall be arranged in t
lowing order for clockwise rotation:
T_3, for rotating field generators and
M_3 for rotating armature generators
the following order for counterclockw
tation: T_1, T_3, T_2 for rotating field gen
and M_1, M_3, M_2) for rotating armatu
erators.

5.3.2 *A.c. single-phase motors sh*
marked in accordance with figures 31
inclusive.

5.3.3 *Dual-voltage motors.* — Regard
the type of single-phase motor, where
ries or parallel connection of any wind
necessary, the following procedures sh
as shown on figure 32. Divide into two
and T_1T_2 shall be assigned to one ha
T_3T_4 to the other half of running w
T_5T_6 shall be assigned to one half an
to the other half of starting or rev
winding.

5.3.4 *Single-voltage motors.* — Th
ning winding shall be designated by T_1
the starting winding by T_5T_8. (This
guishes it from a two-phase motor

seen odd subscript numbers in one-phase and even subscript numbers in the other phase.)

5.4 Marking of a. c. polyphase induction motors shall be marked in accordance with figures 49 to 75 inclusive.

5.4.1 *Classes of polyphase induction motors.* — Induction motors of the collector-ring or squirrel-cage type are divided into the following classes for determining connection markings:

Class 1 — Three-phase motors having one synchronous speed. (See 5.4.3.)

Class 2 — Three-phase motors having two synchronous speeds obtained from a reconnectible winding. (See 5.4.4.)

Class 3 — Three-phase motors having two or more synchronous speeds obtained from two or more independent windings. (See 5.4.5.)

Class 4 — Two-phase motors having one synchronous speed. (See 5.4.6.)

Class 5 — Two-phase motors having two synchronous speeds obtained from a reconnectible winding. (See 5.4.7.)

Class 6 — Two-phase motors having two or more synchronous speeds obtained from two or more independent windings. (See 5.4.8.)

5.4.2 *Purpose of rules applying to induction motors.* — Since the windings of a motor are seldom accessible, the markings of the connections are used to show the relations of the windings within the motor. A clockwise rotation in the sequence of connection numbering shall be used as described in subsequent paragraphs. For three-phase motors having two synchronous speeds obtained from a reconnectible winding, it is undesirable to adhere to the clockwise system of numbering for all connections, as this would cause the motor to run with clockwise shaft rotation on one speed and counterclockwise on the other speed if the power lines are connected to each set of connections in the same sequence. For two-phase motors, regardless of the class of motor or the type of winding, the rules are such that odd subscript numbers are in one phase and even subscript numbers are in the other phase. The markings of all motors except those for two-speed motors using a single reconnectible winding, are based, as are the rules for three-phase windings, on a clockwise spiral system of rotation in the sequence of connection numbering.

5.4.3 *Class 1 induction motors.* — The following rules apply in determining the connection markings of any three-phase induction motor stator having only one synchronous speed regardless of how many circuits per phase there may be or how they are connected and they determine definitely which circuits belong in the same phase and also the polarity of the circuits.

5.4.3.1 *Wye-connected windings.*

(a) A schematic vector diagram shall be drawn showing an inverted wye connection with the individual circuits in each phase arranged for series connection with correct polarity relation of circuits. The diagram for two circuits per phase, for example, shall be marked as shown on figure 49.

(b) Starting with T_1 at the outside and top of the diagram, the ends of the circuits shall be numbered consecutively in a clockwise direction proceeding on a spiral towards the center of the diagram. For two circuits per phase, for example, the connections shall be marked as shown on figure 50.

(c) A schematic diagram shall now be drawn showing the particular interconnection of circuits for the motor under consideration and the connection markings, as determined from the preceding paragraphs, shall be arranged to give the correct polarity relation of circuits. If the winding on figure 5 is to be connected with two circuits in parallel per phase, the diagram and markings shall be as shown on figure 51.

(d) The highest numbers shall be dropped and only the lowest number retained where two or more terminals are permanently connected together. If the winding on figure 51 is to have the two circuits in each phase permanently connected together with three line leads and three neutral leads brought out, the connection markings shall be as shown on figure 52. If the winding on figure 50 is to be arranged for either a series or a parallel connection, the diagram and connection markings shall be as shown on figure 53.

(e) Where the ends of three coils are connected together to form a permanent neutral, the connection markings of the three leads so connected shall be dropped. If the neutral point is brought out it shall be marked T_0.

5.4.3.2 *Delta-connected windings.*—Where a winding is to be delta-connected, the inverted wye diagram shall be rotated 30 degrees counterclockwise as shown on figure 49. T_1 shall be assigned to the outer end of the top leg and the numbering shall conform to item b under 5.4.3.1 and figure 50. There shall then be constructed, a schematic delta in which the T_1 leg of the rotated wye becomes the right-hand side of the delta, the T_2 leg becomes the bottom (horizontal) side and the T_3 leg becomes the left side of the delta. Items c, d and e under 5.4.3.1 shall be applied as far as they are applicable to a delta connection as shown on figure 54.

5.4.4 *Class 2 induction motors.*—Inasmuch as part of the connections follow a clockwise rotation and part a counterclockwise rotati[on] in order to obtain the same direction of rot[a]tion for both speeds when the line leads a[re] connected in the same sequence, it is diffic[ult] to give a written rule for connection mar[k]ings. As a consequence, schematic diagram[s] for connection markings are shown for th[e] few types of reconnectible windings on f[ig]ures 48, 49, 50, 51, and 52. T_1, T_2 and T_3 [are] clockwise in all cases and are always the li[ne] connections for low speed. If a neutral le[ad] is brought out it shall be marked T_0.

5.4.5 *Class 3 induction motors.*

5.4.5.1 If each independent winding gi[ves] only one synchronous speed, the winding g[iv]ing the lowest speed shall take the same co[n]nection markings as determined in 5.4.3 f[or] class 1 motors for the particular windi[ng] used. The connection markings for t[he] higher speed windings shall be obtained [by] adding 10, 20, or 30, to the connection mar[k]ings as determined in 5.4.3 for class 1 moto[rs] for the particular winding used, the sequen[ce] being determined by progressing each ti[me] to the next higher speed. Figure 61 is [an] example of the connection markings fo[r a] three-speed motor using three windings.

5.4.5.2 If each independent winding is [re]connectible to give two synchronous spee[ds]:

(a) Diagrams of the windings to [be] used shall be drawn and e[ach] winding shall be given the c[on]nection markings shown in 5[.4.4] for class 2 motors.

(b) No further change shall be mad[e to] any of the connection marki[ngs] of the winding giving the low[est] speed, irrespective of whether t[he] other speed obtained from t[his] winding is an intermediate or [the] highest speed.

(c) Ten shall be added to all connec[tion] markings of the winding gi[ving] the next higher speed, and [an] additional 10 is added to all connection markings for each secutively higher speed winding. Figure 61 is an example of the connections markings for a four-speed motor using two windings.

5.4.5.3 If two or more types of independent windings are used, part of which give only one synchronous speed and the rest give two synchronous speeds by reconnection:

(a) Each winding shall be given the markings as determined in 5.4.3 for class 1, and 5.4.4 for class 2 motors, as the case may be.

(b) No further change shall be made in any of the connection markings of the winding giving the lowest speed, irrespective of whether the other speeds obtained from this winding are an intermediate or the highest speed.

(c) Ten shall be added to all connection markings of the winding giving the next higher speed and an additional 10 shall be added to all the connection markings of each consecutively higher speed winding. Figure 62 is an example of the connection markings for a three-speed motor using two windings.

5.4.5.4 If, under any of the paragraphs of the rule for class 3 motors, the addition of 10, 20, or 30, to the basic connection markings causes a duplication of markings due to more than 9 leads being brought out on any one winding, then 20, 40, or 60, shall be added instead of 10, 20, or 30, to obtain the markings for the higher speeds.

5.4.5.5 The figures shown for class 3 motors apply when stator connections of all windings are at the same end of the motor. Where one or more of the windings has stator connections at one end of the motor and part on the other end, the sequence of the connection markings for connections at one end may be shown on the diagram as shown on the illustrative figures, and the connection markings for those brought out on the opposite end may be shown reversed in rotation. Where diagrams use this reversed rotation of markings, an explanatory note shall be included for the benefit of the controller of supplies in showing that when L_1, L_2, and L_3 are connected to any winding with the same sequence of subscript numbers (T_1, T_2, T_3 or T_4, T_5, T_6 or T_{11}, T_{12}, or T_{13}), the shaft rotation will be the same.

5.4.6 *Class 4 induction motors.*—The following rules may be applied to determine the connection marking of any two-phase induction motor stator having only one synchronous speed regardless of how many circuits per phase there may be or how they are connected and they determine definitely which circuits belong in the same phase, and also the polarity of the circuits. A schematic diagram shall be drawn with the individual circuits in each phase arranged for series connection with correct polarity relation of circuits as shown on figure 63. Starting with T_1 at the outside and top of the diagram, the ends of the circuits shall be numbered consecutively in a clockwise direction proceeding on a spiral towards the center of the diagram. For three circuits per phase, for example, the connections shall be marked as shown on figure 64.

5.4.6.1 A schematic diagram shall now be drawn showing the particular interconnection of circuits for the motor under consideration, and the connection markings as determined in the preceding paragraphs shall be arranged to give correct polarity relation of circuits. Where the winding on figure 64 is to be connected with three circuits in multiple per phase, the diagram and markings shall be as shown on figure 65.

5.4.6.2 The highest numbers shall be dropped and only the lowest number retained where two or more connections are permanently connected. Where the winding on figure 65 is to have the three circuits in each phase permanently connected together with a single line lead brought out from each end of each phase, the connection markings shall be as shown on figure 66.

5.4.6.3 Where a two-phase three-wire power supply is used, T[illegible] and T[illegible] shall be together and only the T[illegible] marking retained for the common wire.

5.4.6.4 Where the two phases are to be interconnected at the midpoint to connect to a two-phase five-wire system, the midpoint connection shall be marked T_0.

5.4.7 *Class 5 induction motors (see figure 66)*[1]. — These windings do not readily lend themselves to the use of a written rule for determining their connection markings. Accordingly, each schematic diagram is shown with its markings. Connection markings for class 5 motors shall be as shown on figure 66.

5.4.8 *Class 6 induction motors.*

5.4.8.1 Where each independent winding gives only one synchronous speed, the winding giving the lowest speed shall take the same connection markings as determined in 5.4.6, for class 4 motors for the particular winding used. The connection markings for the higher speed windings shall be obtained by adding 10, 20 or 30, to the connection markings determined by rule specified in 5.4.6 for class 4 motors for the particular winding used. The sequences shall be determined by progressing each time to the next higher speed. The connection markings for a two-speed motor using two single-speed winding shall be as shown on figure 68.

5.4.8.2 If each independent winding is reconnectible to give two synchronous speeds:

(a) Vector diagrams of the windings to be used shall be drawn and each winding shall be given the markings shown in 5.4.7 for class 5 motors.

(b) No further change shall be made any of the markings of the win ing giving the lowest speed, ir spective of whether the oth speed obtained from this windi is an intermediate or the high speed.

(c) Ten shall be added to markings the winding giving the next hig er speed and an additional shall be added to all the markin for each consecutively high speed winding. Figure 69 is example of the markings for four-speed motor using t windings.

5.4.8.3 If two or more types of independ ent windings are used, part of which giv only one synchronous speed and the rest g two synchronous speeds by reconnection

(a) Each winding shall be given markings as determined fr 5.4.6, for class 4 motors and 5. for class 5 motors, as the c may be.

(b) No change shall be made in any the connection markings of winding giving the lowest spe irrespective of whether the otl speeds obtained from this wind are an intermediate or the hi est speed.

(c) Ten shall be added to all connecti markings of the winding givi the next higher speed and additional 10 shall be added to the markings of each consec tively higher speed windi Figure 70 is an example of connection markings for a th speed motor using two windi

5.4.8.4 If, under any of the sections of rule for class 6 motors, the addition of 10, or 30, to the basic connection marki causes a duplication of markings due to m than nine leads being brought out on

[1] Other diagrams for class 5 motors will be added as necessary.

one winding, then 20, 40, or 60, shall be added instead of 10, 20, 30 to obtain the markings for the higher speeds.

5.4.8.5 *Connection markings — collector ring motors, two- and three-phase rotor connection.* — The markings shown on figures 74 and 75 shall apply.

5.5 Synchronous converters and dynamotors.

5.5.1 Synchronous converters shall be marked as shown on figures 76 to 83 inclusive. The direction of rotation shall be standard.

5.5.2 Dynamotors shall be marked as shown in Table I.

5.6 Constant potential transformers shall be marked as shown on figures 84 to 104 inclusive.

5.6.1 *Application of rules.* — These rules specify the markings of leads brought out of the enclosure but not the markings of winding connections inside the enclosure, except that these connections shall be marked with numbers in any manner which will permit convenient reference, and which cannot be confused with the markings of the leads brought out of the enclosures.

5.6.2 *Marking of connections and identification of windings.*

(a) In general, the windings of a transformer shall be distinguished by numbering No. 1, No. 2, No. 3. The highest voltage winding shall always be No. 1 except for three-phase to six-phase transformers. (See 5.6.1.) The sequence of winding numbers after No. 1 may be by voltage or by kilovolt-amperes.

(b) After the letters identifying leads have been assigned, the winding to which the respective leads are connected then may be designated by that letter.

(c) A neutral lead of a three-phase transformer shall be marked with the proper letter followed by the zero subscript.

(d) *Exception.* — A lead brought out from the middle of the winding for some use other than that of a neutral lead (for example, a 50 percent starting tap) shall be marked as a tap lead.

5.6.3 *Diagrammatic sketch of connections.* — The manufacturer shall furnish with each transformer a complete diagram showing the leads and internal connections and their markings and the voltages obtainable with the various connections.

5.6.4 *Single-phase transformers.*

5.6.4.1 *Order of numbering leads in any winding.*

(a) The leads of any winding brought out of the enclosure shall be numbered for example, 1, 2, 3, 4, 5, the lowest and highest numbers marking the full winding and the immediate numbers marking fractions of winding or taps. Numbers shall be so applied that the potential difference from any lead having a lower number toward any lead having a higher number shall have the same sign at any instant, as specified in 5.7 and shown on figures 84, 85, 97 and 98.

(b) If a winding is divided into two or more parts for series parallel connections, and the leads of these parts are brought out of the enclosure, the above rule shall apply for the series connection with the addition that the leads of each portion of the winding shall be given consecutive numbers as specified in 5.7 and shown on figures 89 and 90, for four or more leads brought out and figures 89, 90, 91, 92, 101 and 102 for two or three leads brought out.

(c) When two leads are brought out of the enclosure through one bushing, the connections shall be marked in accordance with 5.7 and figures 97 and 98. When in addition a lead must be brought out from the midpoint, for three-wire operation the connections shall be identified in accordance with 5.7 and figures 101 and 102.

5.6.4.2 *Order of numbering leads of different windings.*

(a) The numbering of the leads of the H winding and the leads of the X winding shall be applied so that when H_1 and X_1 are connected together and voltage applied to the transformer, the voltage between the highest numbered H lead and the highest numbered X lead shall be less than the voltage of the H winding.

(b) When more than two windings are used, the same relationship shall apply between each pair of windings.

5.6.4.3 *Polarity.* — When leads are marked in accordance with the foregoing rules, the polarity of a transformer shall be:

(a) Subtractive when H_1 and X_1 are adjacent in accordance with 5.7 and figure 103; also figures 84 and 86.

(b) Additive when H_1 is diagonally located with respect to X_1, in accordance with 5.7 and figures 85 and 97.

(c) The same rule applies between the H and Y winding, and between the H and Z winding; for example, when Y_1 or Z_1 is on the left wh facing the Y or Z side of the ca respectively, the polarity is su tractive, and additive if on th right.

5.6.4.4 *Location of H_1 lead.* — The conne tion on the right-hand side facing the high voltage side of the enclosure shall be des nated H_1, and other H connections shall designated in numerical order from right left.

5.6.4.5 *Auto-transformer.* — Single-ph auto-transformer leads shall, so far as pr ticable, be marked in accordance with t requirements for subtractive polarity shown on figure 88.

5.6.5 *Three-phase transformers.*

5.6.5.1 *Marking of full winding leads.* The three leads for each winding which c nect to the full phase windings shall marked, for example, H_1, H_2, H_3, X_1, X_2, X Y_1, Y_2, Y_3, respectively.

5.6.5.2 *Relation between highest volt winding and other windings.*

(a) The markings shall be so app that if the phase sequence of v age on the highest voltage wi ing is in the time order H_1, H_3, it will be in the time or for example, X_1, X_2, X_3, and Y_2, Y_3, on the other winding

(b) In order that the markings of connections between phase three-phase transformers indicate definite phase relati they shall conform to one of three-phase groups as specifie 5.7.2 and shown on figures 107 and 108. The angular placement between the H w ing and the X winding is angle in each of the voltage v diagrams as specified in 5.7. shown on figures 106, 107

108 between the lines passing from its neutral point through H_1 and X_1 respectively.

(c) When more than one low voltage winding is used, the angular displacement between the H winding and each of the other low voltage windings is established in the same manner, using for example H_1 and Y_1, H_1 and Z_1, respectively.

5.6.5.3 *Tap leads.*

(a) *General.* — Where tap leads, except neutral lead, are brought out of the enclosure, they shall be marked with the proper letter followed by the numbers 4, 7, for example, for one phase; 5, 8, for another phase; and 6, 9, for the third phase, as specified in 5.7.2 and shown on figure 108.

(b) *Delta connection.* — The order of numbering tap leads shall be as follows: 4, 7, from lead 1 toward lead 2; 5, 8, from lead 2 toward lead 3; and 6, 9, from lead 3 toward lead 1 as specified in 5.7.2 and shown on figure 108.

(c) *Wye connection.* — The order of numbering tap leads shall be as follows: 4, 7, from lead 1 toward neutral; 5, 8 from lead 2 toward neutral; and 6, 9, from lead 3 toward neutral, as specified in 5.7.2 and shown on figure 108.

5.6.5.4 *Interphase connection made outside of enclosure.*

(a) Where the interphase connections are outside the enclosure, the leads shall be marked with the proper letter followed by the numbers for example, 1, 4, 7, 10, for one phase; 2, 5, 8, 11, for the second phase; and 3.6.9.12, for the third phase.

(b) The markings shall be so applied that when a wye connection is made by joining together the highest numbered leads of each phase all rules here given apply except item d of 5.6.2.

5.6.5.5 *Location of external leads.*

(a) The H_1 lead shall be brought out on the right-hand side facing the highest voltage side of the enclosure. The H_2 and H_3 leads shall be brought out so that the three leads are arranged in numerical order reading from right to left when facing the highest voltage side of the enclosure (see 5.7.5). The H_0 lead, if present, will be located to the right of the H_1 lead when facing the highest voltage side of the enclosure.

(b) The X_1 lead shall be brought out on the left-hand side of the enclosure facing the X winding side of the enclosure. The X_2 and X_3 leads shall be brought out so that the three leads are arranged in numerical order reading from left to right when facing the X winding side of the enclosure (see 5.7.5). The X_0 lead, if present, will be located to the left of the X_1 lead facing the X winding side of the enclosure.

(c) The Y winding and Z winding leads, if present, shall be brought out and numbered in the same manner as the X winding leads.

(d) The location of the external leads specified in items a, b, and c above shall apply to only one connection, such as a wye or a delta, of a given winding.

(e) *Auto-transformer.* — Auto-transformer leads shall, so far as practicable, be marked in accordance with the corresponding multi-winding transformers, as specified in 5.7.5 and shown on figure 113.

5.6.6 *Three-phase to six-phase transformers.*

5.6.6.1 *Basis of rules.*—The rules for three-phase to six-phase transformers are set up on the basis that the three-phase winding is always the H winding.

5.6.6.2 *Marking of full winding leads.*—The three leads which connect to the three-phase winding shall be marked H_1, H_2, H_3, and the six leads which connect to the full six-phase winding shall be marked X_1, X_2, X_3, X_4, X_5, X_6, as specified in 5.7.6 and shown on figures 114 to 116.

5.6.6.3 *Relation between three-phase and six-phase windings.*

(a) The markings shall be so applied that if the phase sequence of voltage on the three-phase connections is in the order H_1, H_2, H_3, it is in the time order X_1, X_2, X_3, X_4, X_5, X_6 on the six-phase connections.

(b) In order that the markings of connections between phases shall indicate definite phase relations, they shall conform to one of the four six-phase groups specified in 5.7.6 and shown on figures 114 and 115. The angular displacement between the three-phase and six-phase windings is the angle in each of the voltage vector diagrams between the lines passing from its neutral through H_1 and X_1, respectively.

5.6.6.4 *Tap leads.* — Where tap leads from the six-phase windings are brought out of the case (neutral lead excepted), they shall be marked as follows:

(a) *Wye connection.* — Tap leads shall be marked from the two ends of each phase winding toward the middle or neutral point in the following order as specified in 5.
and shown on figure 116:

X_7, X_{13}, for example, from X_1;
X_8, X_{14}, for example, from X_2;
X_9, X_{15}, for example, from X_3;
X_{10}, X_{16}, for example, from X_4;
X_{11}, X_{17}, for example, from X_5;
X_{12}, X_{18}, for example, from X_6;

A tap from the middle point
any phase winding, not inten
as a neutral, shall be given
number determined by counti
from X_1, X_2, or X_3 and not fro
X_4, X_5 or X_6; for example, if t
only taps brought out are 50 pe
cent starting taps, they shall
numbered X_7, X_8, X_{11}.

(b) *Double delta connection.* — T
leads shall be marked in the f
lowing order as specified in 5.7
and shown on figure 116:

X_7, X_{13}, for example, from X_1 toward X
X_8, X_{14}, for example, from X_2 toward X
X_9, X_{15}, for example, from X_3 toward X
X_{10}, X_{16}, for example, from X_4 toward X
X_{11}, X_{17}, for example, from X_5 toward X
X_{12}, X_{18}, for example, from X_6 toward X

5.7 Connection diagrams lead markings
single-phase transformers. — The rules o
lead markings to transformers having sub
tractive and additive polarity shall be
shown on figures 84 to 104 inclusive. (T
ground connection shown in broken lines a
plies to single-phase installations only.)

5.7.1 *Polarity and connections — singl
phase transformers.* — The connection
single-phase transformers of additive p
larity, subtractive polarity, and combinatio
of additive and subtractive polarity shall
as shown on figure 105.

5.7.2 *Lead markings and voltage vect
diagrams — three-phase transformer co
nections.* — The method of marking tra
former leads which are brought out of t
enclosure shall be as shown on figures 106
108 inclusive.

5.7.3 *Angular displacement and connections — single-phase transformers connected delta-delta and Y-Y in three-phase banks with 0 degree angular displacement.* — Connections of single-phase-transformers of additive polarity, subtractive polarity, and combinations of additive and subtractive polarity in banks shall be as shown on the figures under 109.

5.7.4 *Angular displacement and connections — single-phase transformers connected delta-Y and Y-delta in three-phase banks with 30 degrees angular displacement.* — Connections of single-phase transformers of additive polarity, subtractive polarity, and combinations of additive and subtractive polarity in banks shall be as shown on figures under 112.

5.7.5 *Angular displacement and lead markings for three-phase transformers.* — These connections shall be as shown on figures 111, 112 and 113.

5.7.6 *Lead markings and voltage vector diagrams— usual six-phase transformer connections.* — The method of marking transformer leads brought out of the enclosure shall be as shown on figures 114 to 116 inclusive.

5.8 Motor starters and controllers.

5.8.1 *External connections.* — External connections shall be marked as indicated:

Line – A.c. – Single-phase: L_1, L_2.
3-phase: L_1, L_2, L_3.
2-phase, 3-wire: L_1, L_2, L_3.
(L_3 to be the common line.)
2-phase, 4-wire: L_1, L_2, L_3, L_4.
(L_1, L_3 = phase 1;
L_2, L_4 = phase 2.)
D.c. – L_1 – L_2.
(Plus and minus signs may be added when desirable to indicate polarity, or distinguish from a.c. circuits.)

5.8.2 *Rotating equipment.* — Unless otherwise specified herein, connections to rotating equipment shall be marked the same as the rotating equipment based on standard direction of rotation.

D.c. generators	See 5.1
D.c. motors	See 5.2
A.c. generators and synchronous motors	See 5.3
A.c. single-phase motors	See 5.3.2
A.c. polyphase motors	See 5.4
A.c. synchronous converters and dynamotors	See 5.5

5.8.3 *Transformers.* — Connections to transformers shall be marked the same as the transformers.

(a) *Constant potential transformers.* — (See 5.6.)

(b) *Autotransformers for motor starters.* — The taps and the coils of autotransformer motor starters shall be marked as follows: The end of the winding which is connected to the wye or delta point, and which is the start of the winding shall be marked 0. The intermediate taps shall be marked with the approximate percentage of line voltage that will be delivered under the load condition as specified. The end connection, which goes to the line, shall be marked 100. (Example: 0-50-65-80-100.)

5.8.4 *Reactors.* — The start of the winding shall be marked 0, and the taps shall be marked for example, 1, 2, 3, 4. The identification plate, or terminal board, shall show the connection to be used for each of the specified voltages.

5.8.5 *Resistors.* — The connection markings for resistors shall be as follows:

Armature and miscellaneous	R_1, R_2, R_3
Shunt field adjusting:	
Fixed resistors with taps	V_1, V_2, V_3
Adjustable resistors (rheostatic)	V_1, V_2
Shunt brake	BR_1, BR_2, BR_3
Dynamic braking only	DR_1, DR_2, DR_3
End connections	When a resistor is made of two or more units and it is necessary to connect these units, the use of the letters A to A, B to B, is recommended.

5.8.6 *Brake.* — Connection markings for brakes shall be as follows: B_1, B_2, B_3.

5.8.7 *Control circuit.* — Numbers shall be used to indicate and identify the connections on controllers for external control circuits.

5.9 Power supplies metallic rectifier.

5.9.1 Metallic rectifier power supplies shall be marked as shown on figures 117 to 128 inclusive.

5.9.1.1 Power input connections of a metallic rectifier type power supply equipment which are intended for connection to the primary line source of a.c. power (a.c. line) shall be marked as follows:

1 phase (two-wire)	L_1, L_2
1 phase (three-wire, center tap)	L_1, L_2, L_3 (L_3 = center tap.)
3 phase (three-wire)	L_1, L_2, L_3
3 phase (four-wire)	L_1, L_2, L_3, L_0 (L_0 = neutral.)

5.9.1.2 Input connections of a metallic rectifier stack assembly forming a separately mounted or demountable unit of a rectifier power supply, which are not intended for connection directly to the a.c. line shall be marked as specified herein.

5.9.1.2.1 Connections to be made to a single power supply transformer shall be marked the same as the corresponding output connection of the transformer.

5.9.1.2.2 Connections to be made to mo[re] than one separately assembled and mount[ed] transformers shall be marked the same [as] the corresponding connections of the tra[ns]formers with the addition of a letter in [pa]rentheses identifying the particular tra[ns]former. For example:

	Connection marking metallic rectifier stack assembly
Transformer (A)	
Connection X_1	X_1(A)
Connection X_2	X_2(A)
Connection X_3	X_3(A)
Transformer (B)	
Connection X_1	X_1(B)
Connection X_2	X_2(B)
Connection X_3	X_3(B)

5.9.1.2.3 Connections to be made direc[tly to] the output connections of an a.c. gener[ator] (or other rotating machine furnishing alternating current to be rectified) with[out] use of an intermediate disconnect dev[ice] shall be marked the same as the corresp[ond]ing connections of the a.c. machine.

5.9.1.2.4 Connections to be made other [than] to units as described in 5.9.1.2.1 to 5.9.[illegible] inclusive shall be marked as follows:

1 phase (two-wire)	AC_1, AC_2
1 phase (three-wire, center tap)	AC_1, AC_2, AC_0 (AC_0 = center tap.)
3 phase (three-wire)	AC_1, AC_2, AC_3
3 phase (four-wire)	AC_0, AC_1, AC_2, AC_3 (AC_0 = neutral.)
6 phase (six-wire)	AC_1, AC_2, AC_3, AC_4, AC_5, AC_6
6 phase (seven-wire)	AC_0, AC_1, AC_2, AC_3, AC_4, AC_5, AC_6 (AC_0 = neutral.)

5.9.1.3 Power output connections of a metallic rectifier type power supply equipment which are intended for connection directly to a specific equipment, such as a d.c. motor or the field of an a.c. generator, shall be marked the same as the corresponding input connections of the connected equipment.

5.9.1.4 Power output connections of a rectifier type power supply equipment which are not intended for connection to a specific equipment or which may furnish d.c. power to a variety of equipments or devices shall be marked D_1, D_2, D_3 and so on. D_1 shall apply to the DC negative lead and D_2 shall apply to the DC positive lead. Equalizing connections shall be marked with an equality sign (=).

5.9.1.5 Output connections of a separately mounted or demountable unit of a rectifier type power supply which is to be connected between the primary power source and the rectifier stack assembly and which is not one of the units referred to in 5.9.1.2.1 to 5.9.1.2.3 inclusive shall be marked the same as the corresponding rectifier stack assembly input connections.

5.9.1.6 *Subscript numerals.*

Input side, or polyphase inputs, the subscript numerals 1, 2, 3 and so on shall indicate the order in which the voltages at the connections reach their maximum positive values (phase sequence).

Output side. — The marking shall be so applied that the lowest subscript is applied to the negative connection and the highest subscripts shall then be applied to any intermediate taps such that the subscript numbers increase consecutively in the order of increase in potential of the connections. If there is more than one independent d.c. output, the one of lowest power rating shall be marked as indicated herein. The other outputs shall be marked similarly except that 10, 20, 30 and so on, shall be used as the subscript numbers, when determined as shown herein, in the order of increasing power output.

Control connections. — The markings of the control connections shall correspond to the above output markings.

5.10 **Regulator sets, generator voltage.** — Unless otherwise specified herein, connections to generators, including field windings, shall be marked the same as the leads of the generators based on standard direction of rotation:

D.c. generators	(See 5.1.)
A.c. generators	(See 5.2.)
Rotary amplifiers	(See 5.1.)

Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.

Copies of this standard for Military use may be obtained as indicated in the foreword to the Index of Military Specifications and Standards.

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Custodians:

Army—Corps of Engineers
Navy—Bureau of Ships
Air Force

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Army—MOQSigT
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specified in 5.7 and shown on figures 89 and 90, for four or more leads brought out and figures 89, 90, 91, 92, 101 and 102 for two or three leads brought out.

(c) When two leads are brought out of the enclosure through one bushing, the connections shall be marked in accordance with 5.7 and figures 97 and 98. When in addition a lead must be brought out from the midpoint, for three-wire operation the connections shall be identified in accordance with 5.7 and figures 101 and 102.

5.6.4.2 *Order of numbering leads of different windings.*

(a) The numbering of the leads of the H winding and the leads of the X winding shall be applied so that when H_1 and X_1 are connected together and voltage applied to the transformer, the voltage between the highest numbered H lead and the highest numbered X lead shall be less than the voltage of the H winding.

(b) When more than two windings are used, the same relationship shall apply between each pair of windings.

5.6.4.3 *Polarity.* — When leads are marked in accordance with the foregoing rules, the polarity of a transformer shall be:

(a) Subtractive when H_1 and X_1 are adjacent in accordance with 5.7 and figure 103; also figures 84 and 86.

(b) Additive when H_1 is diagonally located with respect to X_1, in accordance with 5.7 and figures 85 and 97.

(c) The same rule applies between the H and Y winding, and between the H and Z winding; for example, when Y_1 or Z_1 is on the left wh facing the Y or Z side of the ca respectively, the polarity is su tractive, and additive if on t right.

5.6.4.4 *Location of H_1 lead.* — The conn tion on the right-hand side facing the highe voltage side of the enclosure shall be desi nated H_1, and other H connections shall designated in numerical order from right left.

5.6.4.5 *Auto-transformer.* — Single-pha auto-transformer leads shall, so far as pra ticable, be marked in accordance with t requirements for subtractive polarity shown on figure 88.

5.6.5 *Three-phase transformers.*

5.6.5.1 *Marking of full winding leads* The three leads for each winding which c nect to the full phase windings shall marked, for example, H_1, H_2, H_3, X_1, X_2, Y_1, Y_2, Y_3, respectively.

5.6.5.2 *Relation between highest volt winding and other windings.*

(a) The markings shall be so app that if the phase sequence of v age on the highest voltage wi ing is in the time order H_1, H_3, it will be in the time or for example, X_1, X_2, X_3, and Y_2, Y_3, on the other winding

(b) In order that the markings of l connections between phases three-phase transformers sl indicate definite phase relati they shall conform to one of three-phase groups as specifi 5.7.2 and shown on figures 107 and 108. The angular placement between the H w ing and the X winding is angle in each of the voltage v diagrams as specified in 5.7.2 shown on figures 106, 107

108 between the lines passing from its neutral point through H_1 and X_1 respectively.

(c) When more than one low voltage winding is used, the angular displacement between the H winding and each of the other low voltage windings is established in the same manner, using for example H_1 and Y_1, H_1 and Z_1, respectively.

5.6.5.3 *Tap leads.*

(a) *General.* — Where tap leads, except neutral lead, are brought out of the enclosure, they shall be marked with the proper letter followed by the numbers 4, 7, for example, for one phase; 5, 8, for another phase; and 6, 9, for the third phase, as specified in 5.7.2 and shown on figure 108.

(b) *Delta connection.* — The order of numbering tap leads shall be as follows: 4, 7, from lead 1 toward lead 2; 5, 8, from lead 2 toward lead 3; and 6, 9, from lead 3 toward lead 1 as specified in 5.7.2 and shown on figure 108.

(c) *Wye connection.* — The order of numbering tap leads shall be as follows: 4, 7, from lead 1 toward neutral; 5, 8 from lead 2 toward neutral; and 6, 9, from lead 3 toward neutral, as specified in 5.7.2 and shown on figure 108.

5.6.5.4 *Interphase connection made outside of enclosure.*

(a) Where the interphase connections are outside the enclosure, the leads shall be marked with the proper letter followed by the numbers for example, 1, 4, 7, 10, for one phase; 2, 5, 8, 11, for the second phase; and 3.6.9.12, for the third phase.

(b) The markings shall be so applied that when a wye connection is made by joining together the highest numbered leads of each phase all rules here given apply except item d of 5.6.2.

5.6.5.5 *Location of external leads.*

(a) The H_1 lead shall be brought out on the right-hand side facing the highest voltage side of the enclosure. The H_2 and H_3 leads shall be brought out so that the three leads are arranged in numerical order reading from right to left when facing the highest voltage side of the enclosure (see 5.7.5). The H_0 lead, if present, will be located to the right of the H_1 lead when facing the highest voltage side of the enclosure.

(b) The X_1 lead shall be brought out on the left-hand side of the enclosure facing the X winding side of the enclosure. The X_2 and X_3 leads shall be brought out so that the three leads are arranged in numerical order reading from left to right when facing the X winding side of the enclosure (see 5.7.5). The X_0 lead, if present, will be located to the left of the X_1 lead facing the X winding side of the enclosure.

(c) The Y winding and Z winding leads, if present, shall be brought out and numbered in the same manner as the X winding leads.

(d) The location of the external leads specified in items a, b, and c above shall apply to only one connection, such as a wye or a delta, of a given winding.

(e) *Auto-transformer.* — Auto-transformer leads shall, so far as practicable, be marked in accordance with the corresponding multi-winding transformers, as specified in 5.7.5 and shown on figure 113.

5.6.6 *Three-phase to six-phase transformers.*

5.6.6.1 *Basis of rules.*—The rules for three-phase to six-phase transformers are set up on the basis that the three-phase winding is always the H winding.

5.6.6.2 *Marking of full winding leads.*—The three leads which connect to the three-phase winding shall be marked H_1, H_2, H_3, and the six leads which connect to the full six-phase winding shall be marked X_1, X_2, X_3, X_4, X_5, X_6, as specified in 5.7.6 and shown on figures 114 to 116.

5.6.6.3 *Relation between three-phase and six-phase windings.*

(a) The markings shall be so applied that if the phase sequence of voltage on the three-phase connections is in the order H_1, H_2, H_3, it is in the time order X_1, X_2, X_3, X_4, X_5, X_6 on the six-phase connections.

(b) In order that the markings of connections between phases shall indicate definite phase relations, they shall conform to one of the four six-phase groups specified in 5.7.6 and shown on figures 114 and 115. The angular displacement between the three-phase and six-phase windings is the angle in each of the voltage vector diagrams between the lines passing from its neutral through H_1 and X_1, respectively.

5.6.6.4 *Tap leads.* — Where tap leads from the six-phase windings are brought out of the case (neutral lead excepted), they shall be marked as follows:

(a) *Wye connection.* — Tap leads shall be marked from the two ends of each phase winding toward the middle or neutral point in the following order as specified in 5.
and shown on figure 116:

X_7, X_{13}, for example, from X_1;
X_8, X_{14}, for example, from X_2;
X_9, X_{15}, for example, from X_3;
X_{10}, X_{16}, for example, from X_4;
X_{11}, X_{17}, for example, from X_5;
X_{12}, X_{18}, for example, from X_6;

A tap from the middle point
any phase winding, not intend
as a neutral, shall be given
number determined by counti
from X_1, X_3, or X_5 and not fr
X_2, X_4 or X_6; for example, if t
only taps brought out are 50 pe
cent starting taps, they shall
numbered X_7, X_9, X_{11}.

(b) *Double delta connection.* — T
leads shall be marked in the f
lowing order as specified in 5.
and shown on figure 116:

X_7, X_{13}, for example, from X_1 toward X
X_8, X_{14}, for example, from X_2 toward X
X_9, X_{15}, for example, from X_3 toward X
X_{10}, X_{16}, for example, from X_4 toward X
X_{11}, X_{17}, for example, from X_5 toward X
X_{12}, X_{18}, for example, from X_6 toward X

5.7 Connection diagrams lead markings – single-phase transformers. — The rules o lead markings to transformers having sub tractive and additive polarity shall be a shown on figures 84 to 104 inclusive. (Th ground connection shown in broken lines a plies to single-phase installations only.)

5.7.1 *Polarity and connections — singl phase transformers.* — The connection f single-phase transformers of additive p larity, subtractive polarity, and combinatio of additive and subtractive polarity shall b as shown on figure 105.

5.7.2 *Lead markings and voltage vect diagrams — three-phase transformer co nections.* — The method of marking tran former leads which are brought out of th enclosure shall be as shown on figures 106 t 108 inclusive.

5.7.3 *Angular displacement and connections — single-phase transformers connected delta-delta and Y-Y in three-phase banks with 0 degree angular displacement.* — Connections of single-phase-transformers of additive polarity, subtractive polarity, and combinations of additive and subtractive polarity in banks shall be as shown on the figures under 109.

5.7.4 *Angular displacement and connections — single-phase transformers connected delta-Y and Y-delta in three-phase banks with 30 degrees angular displacement.* — Connections of single-phase transformers of additive polarity, subtractive polarity, and combinations of additive and subtractive polarity in banks shall be as shown on figures under 112.

5.7.5 *Angular displacement and lead markings for three-phase transformers.* — These connections shall be as shown on figures 111, 112 and 113.

5.7.6 *Lead markings and voltage vector diagrams— usual six-phase transformer connections.* — The method of marking transformer leads brought out of the enclosure shall be as shown on figures 114 to 116 inclusive.

5.8 Motor starters and controllers.

5.8.1 *External connections.* — External connections shall be marked as indicated:

Line – A.c. – Single-phase: L_1, L_2.
3-phase: L_1, L_2, L_3.
2-phase, 3-wire: L_1, L_2, L_3.
(L_2 to be the common line.)
2-phase, 4-wire: L_1, L_2, L_3, L_4.
(L_1, L_3 = phase 1;
L_2, L_4 = phase 2.)
D.c. – L_1 – L_2.
(Plus and minus signs may be added when desirable to indicate polarity, or distinguish from a.c. circuits.)

5.8.2 *Rotating equipment.* — Unless otherwise specified herein, connections to rotating equipment shall be marked the same as the rotating equipment based on standard direction of rotation.

D.c. generators	See 5.1
D.c. motors	See 5.2
A.c. generators and synchronous motors	See 5.3
A.c. single-phase motors	See 5.3.2
A.c. polyphase motors	See 5.4
A.c. synchronous converters and dynamotors	See 5.5

5.8.3 *Transformers.* — Connections to transformers shall be marked the same as the transformers.

(a) *Constant potential transformers.* — (See 5.6.)

(b) *Autotransformers for motor starters.* — The taps and the coils of autotransformer motor starters shall be marked as follows: The end of the winding which is connected to the wye or delta point, and which is the start of the winding shall be marked 0. The intermediate taps shall be marked with the approximate percentage of line voltage that will be delivered under the load condition as specified. The end connection, which goes to the line, shall be marked 100. (Example: 0-50-65-80-100.)

5.8.4 *Reactors.* — The start of the winding shall be marked 0, and the taps shall be marked for example, 1, 2, 3, 4. The identification plate, or terminal board, shall show the connection to be used for each of the specified voltages.

5.8.5 *Resistors.* — The connection markings for resistors shall be as follows:

Armature and miscellaneous	R_1, R_2, R_3
Shunt field adjusting:	
Fixed resistors with taps	V_1, V_2, V_3
Adjustable resistors (rheostatic)	V_1, V_3
Shunt brake	BR_1, BR_2, BR_3
Dynamic braking only	DR_1, DR_2, DR_3
End connections	When a resistor is made of two or more units and it is necessary to connect these units, the use of the letters A to A, B to B, is recommended.

5.8.6 *Brake.* — Connection markings for brakes shall be as follows: B_1, B_2, B_3.

5.8.7 *Control circuit.* — Numbers shall be used to indicate and identify the connections on controllers for external control circuits.

5.9 Power supplies metallic rectifier.

5.9.1 Metallic rectifier power supplies shall be marked as shown on figures 117 to 123 inclusive.

5.9.1.1 Power input connections of a metallic rectifier type power supply equipment which are intended for connection to the primary line source of a.c. power (a.c. line) shall be marked as follows:

1 phase (two-wire)	L_1, L_2
1 phase (three-wire, center tap)	L_1, L_2, L_3 (L_3 = center tap.)
3 phase (three-wire)	L_1, L_2, L_3
3 phase (four-wire)	L_1, L_2, L_3, L_0 (L_0 = neutral.)

5.9.1.2 Input connections of a metallic rectifier stack assembly forming a separately mounted or demountable unit of a rectifier power supply, which are not intended for connection directly to the a.c. line shall be marked as specified herein.

5.9.1.2.1 Connections to be made to a single power supply transformer shall be marked the same as the corresponding output connection of the transformer.

5.9.1.2.2 Connections to be made to m than one separately assembled and mou transformers shall be marked the same the corresponding connections of the tra formers with the addition of a letter in ' rentheses identifying the particular tra former. For example:

	Connection marking metallic rectifier stack assembly
Transformer (A)	
Connection X_1	X_1(A)
Connection X_2	X_2(A)
Connection X_3	X_3(A)
Transformer (B)	
Connection X_1	X_1(B)
Connection X_2	X_2(B)
Connection X_3	X_3(B)

5.9.1.2.3 Connections to be made direct the output connections of an a.c. genera (or other rotating machine furnishing alternating current to be rectified) witl use of an intermediate disconnect de shall be marked the same as the corresp ing connections of the a.c. machine.

5.9.1.2.4 Connections to be made other t to units as described in 5.9.1.2.1 to 5.9.1

inclusive shall be marked as follows:

1 phase (two-wire)	AC_1, AC_2
1 phase (three-wire, center tap)	AC_1, AC_2, AC_0 (AC_0 = center tap.)
3 phase (three-wire)	AC_1, AC_2, AC_3
3 phase (four-wire)	AC_0, AC_1, AC_2, AC_3 (AC_0 = neutral.)
6 phase (six-wire)	AC_1, AC_2, AC_3, AC_4, AC_5, AC_6
6 phase (seven-wire)	AC_0, AC_1, AC_2, AC_3, AC_4, AC_5, AC_6 (AC_0 = neutral.)

5.9.1.3 Power output connections of a metallic rectifier type power supply equipment which are intended for connection directly to a specific equipment, such as a d.c. motor or the field of an a.c. generator, shall be marked the same as the corresponding input connections of the connected equipment.

5.9.1.4 Power output connections of a rectifier type power supply equipment which are not intended for connection to a specific equipment or which may furnish d.c. power to a variety of equipments or devices shall be marked D_1, D_2, D_3, and so on. D_1 shall apply to the DC negative lead and D_2 shall apply to the DC positive lead. Equalizing connections shall be marked with an equality sign (=).

5.9.1.5 Output connections of a separately mounted or demountable unit of a rectifier type power supply which is to be connected between the primary power source and the rectifier stack assembly and which is not one of the units referred to in 5.9.1.2.1 to 5.9.1.2.3 inclusive shall be marked the same as the corresponding rectifier stack assembly input connections.

5.9.1.6 *Subscript numerals.*

Input side, or polyphase inputs, the subscript numerals 1, 2, 3 and so on shall indicate the order in which the voltages at the connections reach their maximum positive values (phase sequence).

Output side. — The marking shall be so applied that the lowest subscript is applied to the negative connection and the highest subscripts shall then be applied to any intermediate taps such that the subscript numbers increase consecutively in the order of increase in potential of the connections. If there is more than one independent d.c. output, the one of lowest power rating shall be marked as indicated herein. The other outputs shall be marked similarly except that 10, 20, 30 and so on, shall be used as the subscript numbers, when determined as shown herein, in the order of increasing power output.

Control connections. — The markings of the control connections shall correspond to the above output markings.

5.10 **Regulator sets, generator voltage.** — Unless otherwise specified herein, connections to generators, including field windings, shall be marked the same as the leads of the generators based on standard direction of rotation:

D.c. generators	(See 5.1.)
A.c. generators	(See 5.2.)
Rotary amplifiers	(See 5.1.)

Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.

Copies of this standard for Military use may be obtained as indicated in the foreword to the Index of Military Specifications and Standards.

Copies of this standard may be obtained for other than official use by individuals, firms, and contractors from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Both the title and identifying symbol number should be stipulated when requesting copies of Military standards.

Custodians:
- Army—Corps of Engineers
- Navy—Bureau of Ships
- Air Force

Other interest:
- Army—MOQMgT
- Navy—AMCOrY

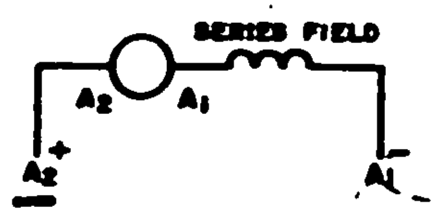


Figure 1 - Series generator without commutating field.

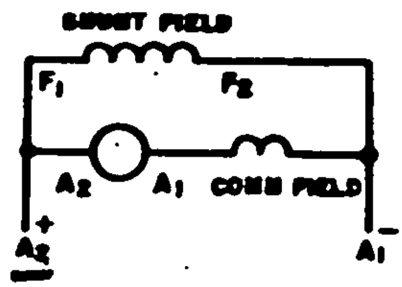


Figure 2 - Shunt generator with commutating field.

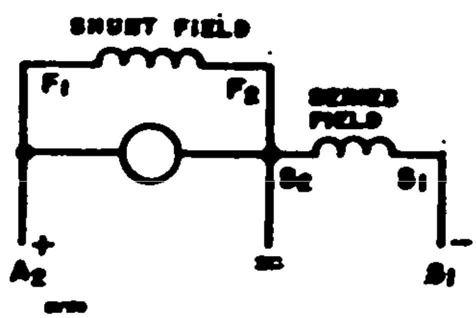


Figure 3 - Compound generator without commutating field.

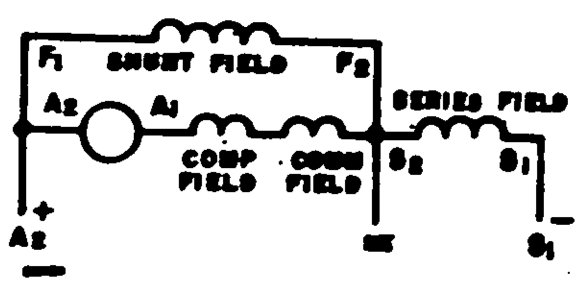


Figure 4 - Compound generator with commutating and compensating fields.

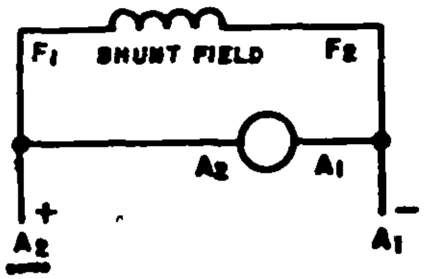


Figure 5 - Shunt generator without commutating field.

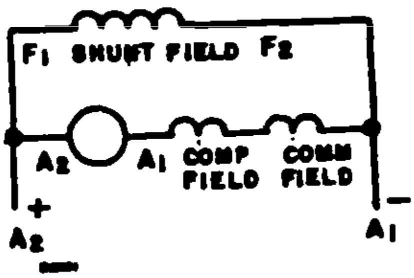


Figure 6 - Shunt generator with commutating and compensating fields.

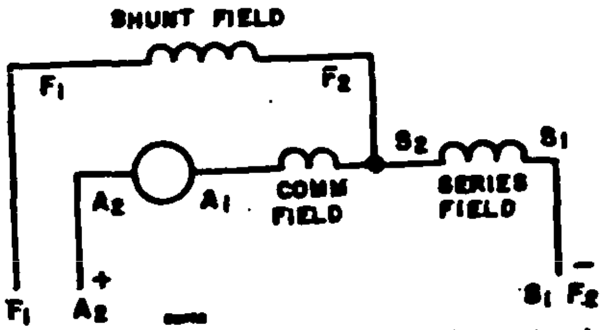


Figure 7 - Compound generator with commutating field, but without equalizer connection.

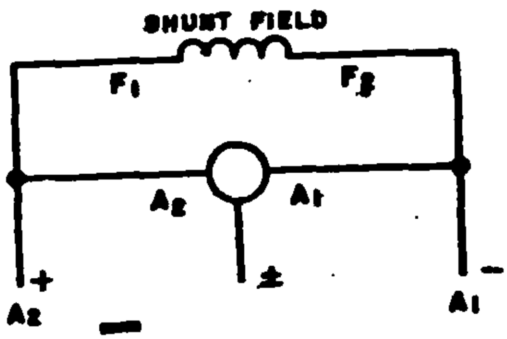
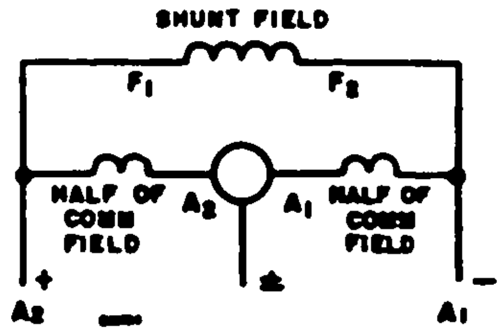


Figure 8 - Three-wire shunt generator without commutating field.



Figures 9 - Three-wire shunt generator with commutating field.

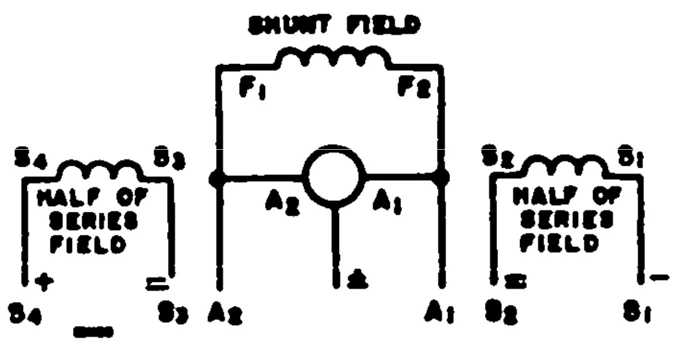


Figure 10 - Three-wire compound generator without commutating field.

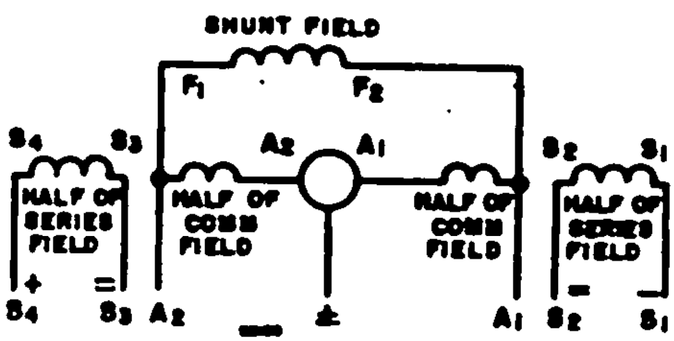


Figure 11 - Three-wire compound generator with commutating field.

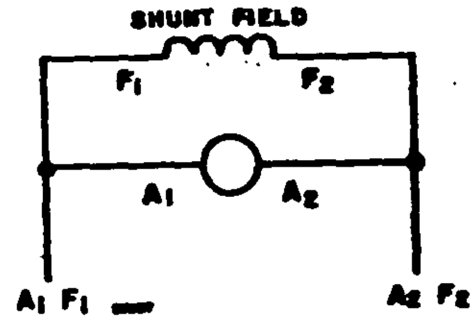


Figure 12 - Shunt motor, nonreversing, without commutating field, two leads brought out.

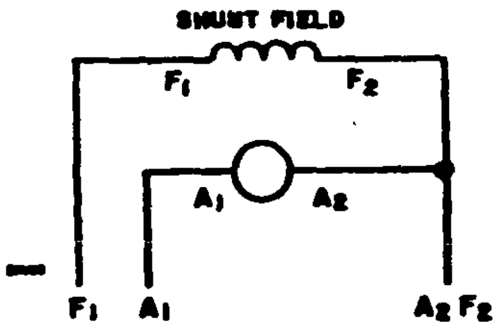


Figure 13 - Shunt motor, nonreversing, without commutating field, three leads brought out.

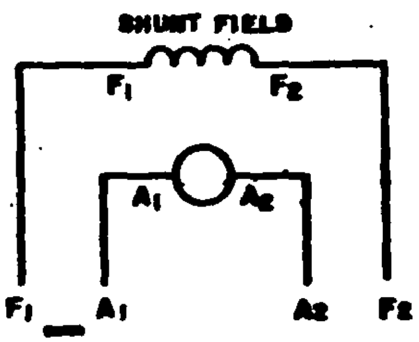


Figure 14 - Shunt motor, reversing without commutating field.

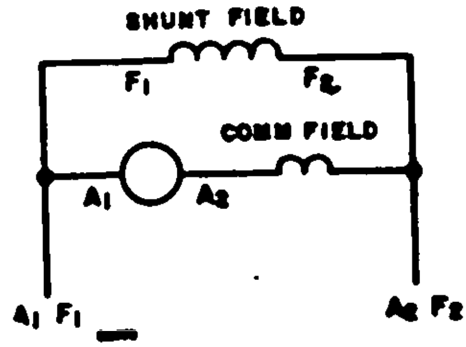


Figure 15 - Shunt motor, nonreversing, with commutating field, two leads brought out.

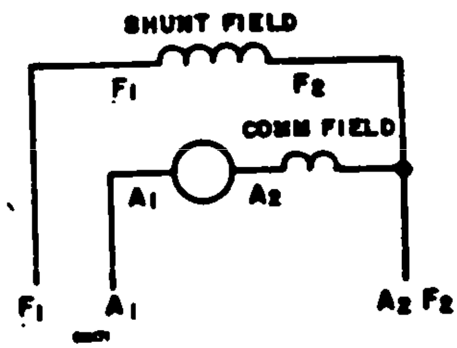


Figure 16 - Shunt motor, nonreversing, with commutating field, three leads brought out.

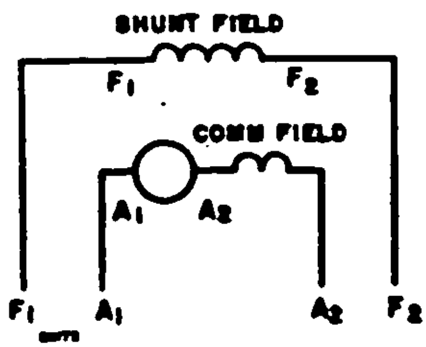


Figure 17 - Shunt motor, reversing, with commutating field.

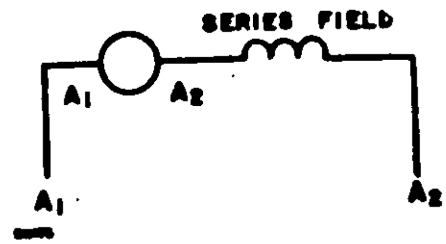


Figure 18 - Series motor, nonreversing, without commutating field.

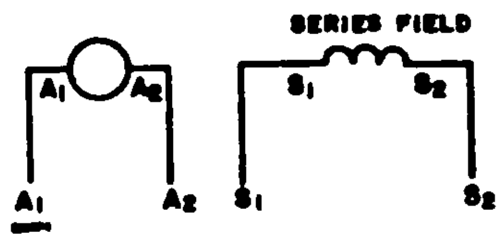


Figure 19 - Series motor, reversing, without commutating field.

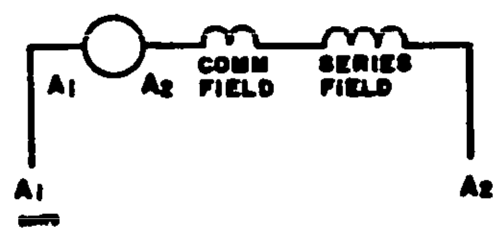


Figure 20 - Series motor, nonreversing, with commutating field.

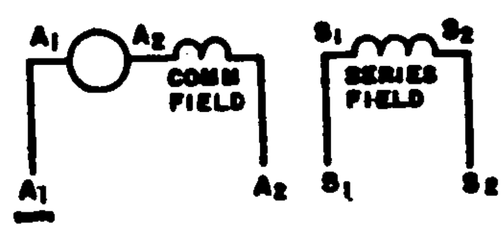


Figure 21 - Series motor, reversing, with commutating field.

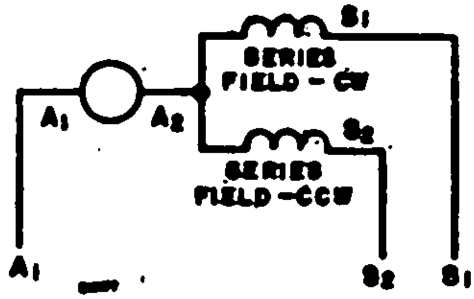


Figure 22 - Series motor, reversing, without commutating field, split-series.

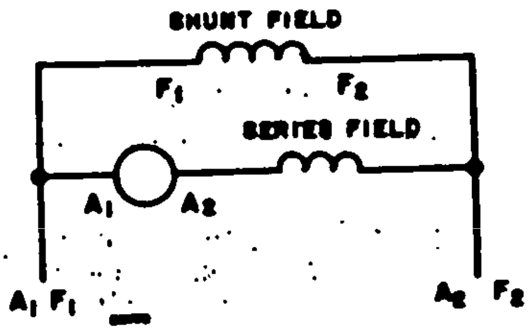


Figure 23 - Compound motor, nonreversing, without commutating field, two leads brought out.

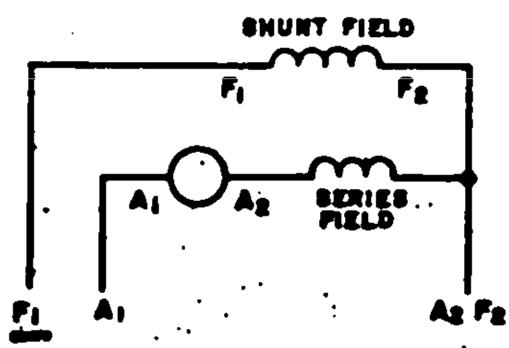


Figure 24 - Compound motor, nonreversing, without commutating field, three leads brought out.

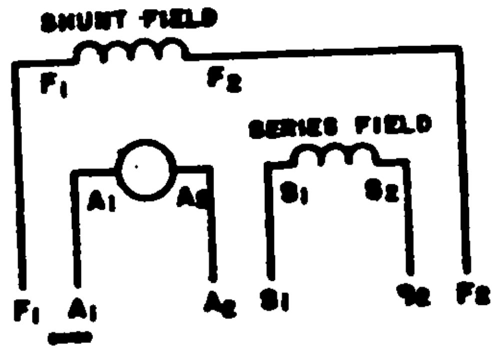


Figure 25 - Compound motor, reversing, without commutating field.

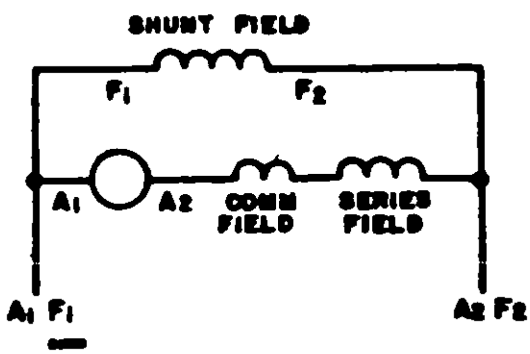


Figure 26 - Compound motor, nonreversing, with commutating field, two leads brought out.

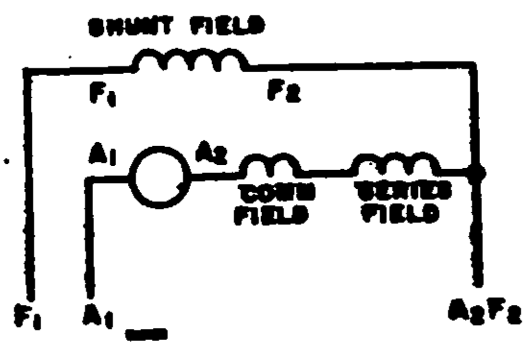


Figure 27 - Compound motor, nonreversing, with commutating field, three leads brought out.

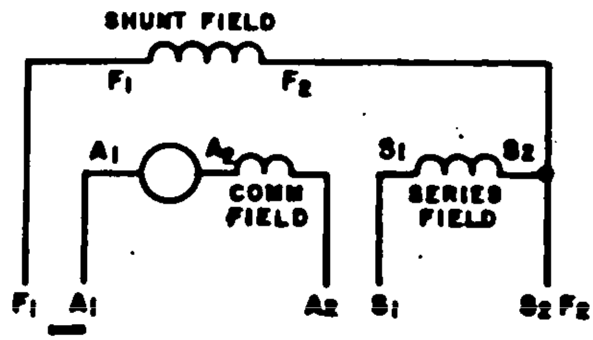


Figure 28 - Compound motor, reversing, with commutating field, five leads brought out.

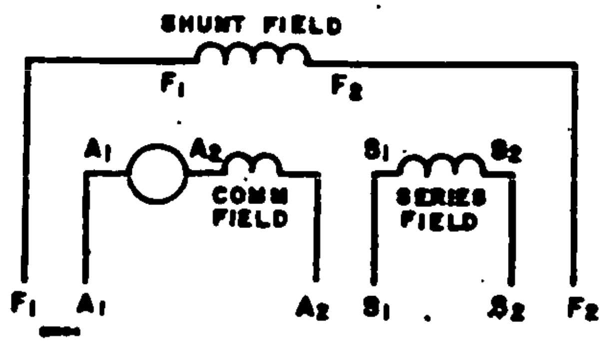


Figure 29 - Compound motor, reversing, with commutating field, six leads brought out.

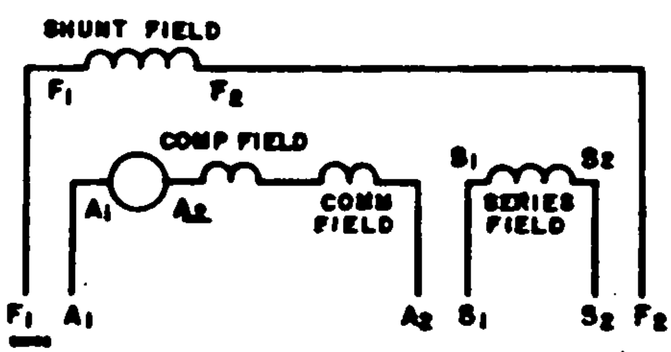


Figure 30 - Compound motor, reversing, with compensating and commutating fields, six leads brought out.

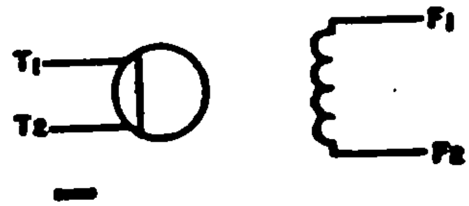


Figure 31 - Single-phase synchronous generator or motor.

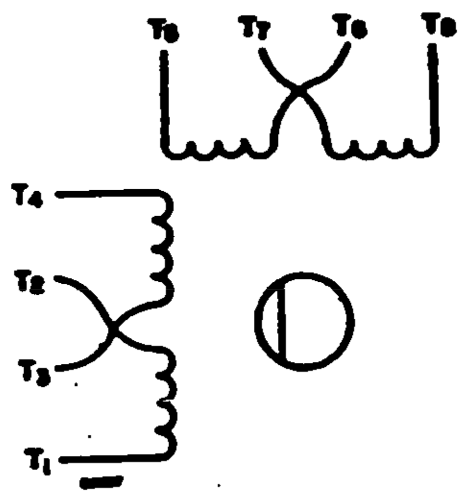
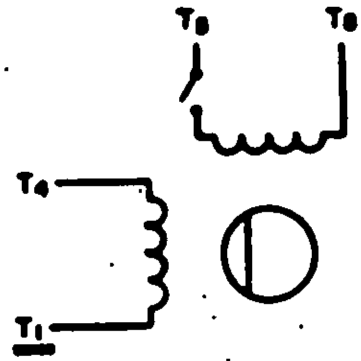


Figure 32 Single-phase, dual-voltage motor.



		L_1	L_2
One direction rotation	Start	T_1, T_5	T_4, T_8
	Run	T_1	T_4
Other direction rotation	Start	T_4, T_5	T_1, T_8
	Run	T_4	T_1

Figure 33 - Single-phase motor, reversible split-phase with automatic cut-out

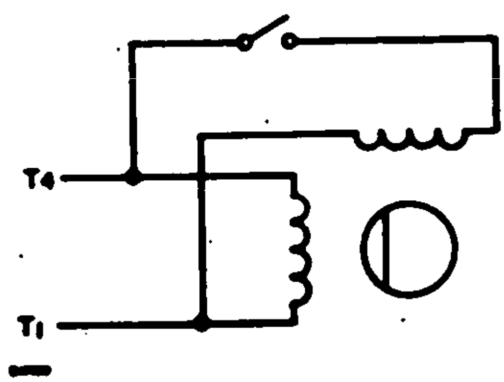
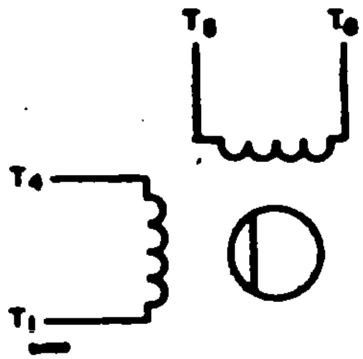
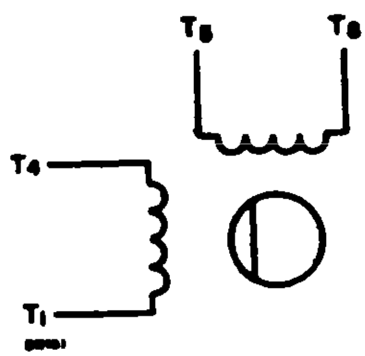


Figure 34 - Single-phase motor, nonreversible, split-phase with automatic cut-out.



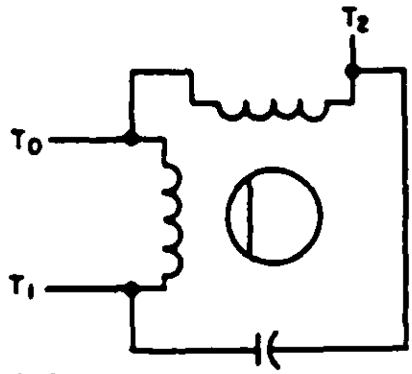
		L1	L2	Open
One direction rotation	Start	T_1, T_5	T_4, T_8	------
	Run	T_1	T_4	T_5, T_8
Other direction rotation	Start	T_4, T_5	T_1, T_8	------
	Run	T_4	T_1	T_5, T_8

Figure 35 - Single-phase motor, reversible, split-phase, with manual cut-out.



NOTE: To be connected to capacitors in accordance with manufacturer's diagram.

Figure 36 - Single-phase capacitor-start capacitor-run motor and single-phase capacitor-start induction-run motor.



	L1	L2
One direction of rotation	T1	T0
Other direction of rotation	T2	T0

Figure 37 - Single-phase motor, reversible, split-phase, permanent capacitor.

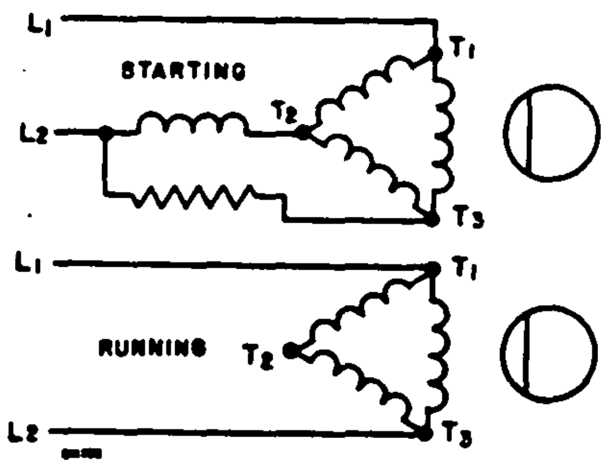


Figure 38 - Single-phase motor, induction with starter non-reversibility.

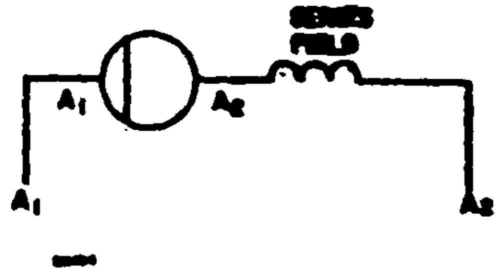
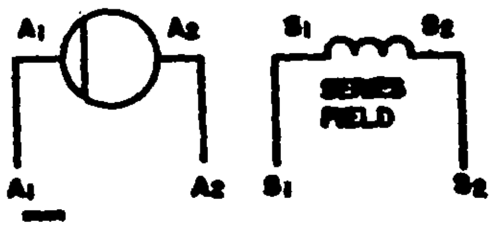


Figure 39 - Single-phase motor, series universal, nonreversing, without compensating fields.



	L_1	L_2	Tie together
One direction rotation	A_1	S_2	A_2, S_1
Other direction rotation	A_1	S_1	A_2, S_2

Figure 40 - Single-phase motor, series universal, reversing, without compensating fields.

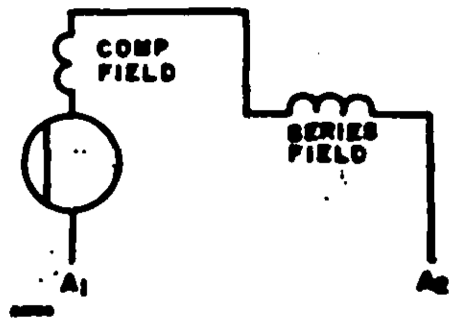
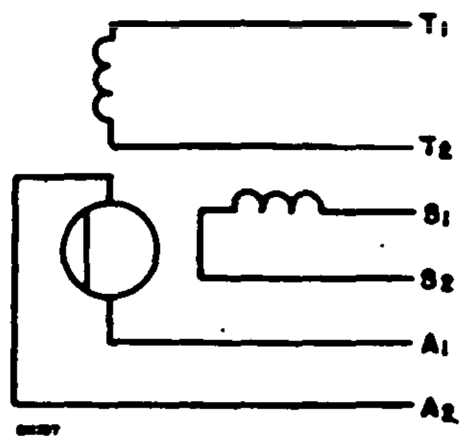


Figure 41 - Single-phase motor, series, with conductively compensated separate stator windings.



	L_1	L_2	Tie together
One direction rotation	A_1	S_1	S to T_1 and A_2 to T_2
Other direction rotations	A_1	S_2	S_1 to T_1 and A_2 to T_2

Figure 42 - Single-phase motor, series, reversible, with conductively compensated separate stator windings.

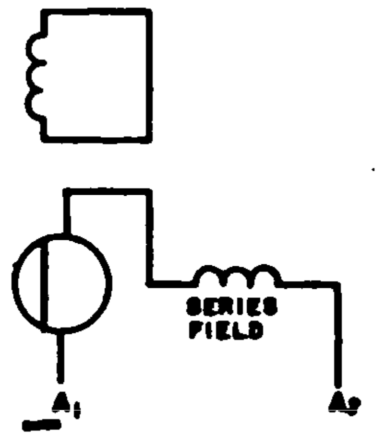


Figure 43 - Single-phase motor, series, with inductively compensated separate stator windings.

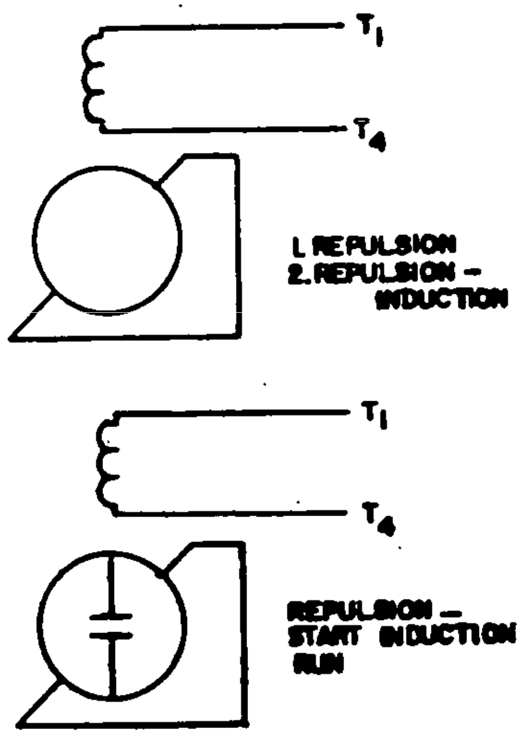
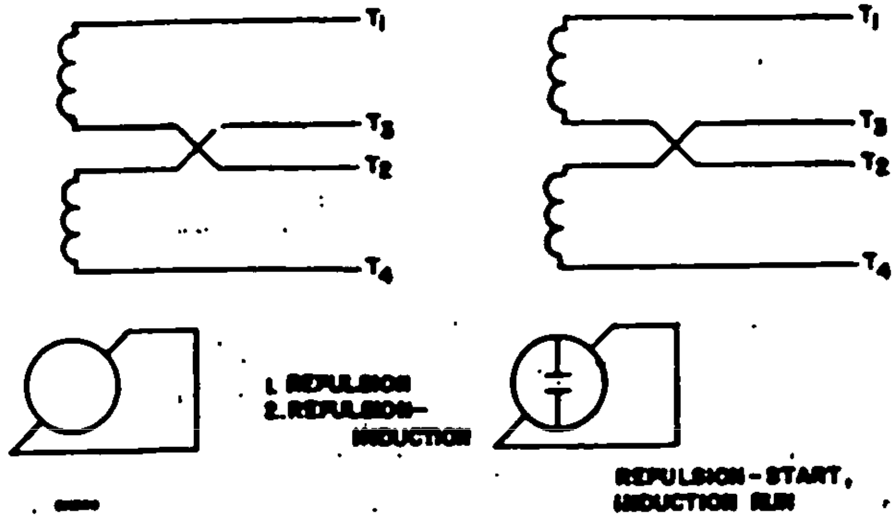
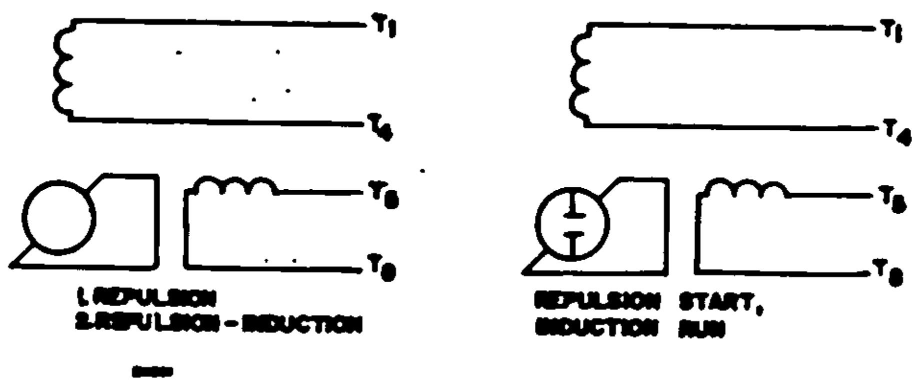


Figure 44 - Repulsion, replusion-induction and repulsion-start induction run, all single-voltage and without compensating windings.



	L_1	L_2	Tie together
Low voltage	T_1, T_3	T_2, T_4	--------
High voltage	T_1	T_4	T_2, T_3

Figure 45 - Repulsion, repulsion-induction and repulsion-start induction run, all double voltage and without compensating windings.



	L_1	L_2	Tie together
One direction rotation	T_1	T_8	T_4, T_5
Other direction rotation	T_1	T_5	T_4, T_8

Figure 46 - Repulsion, repulsion-induction and repulsion-start induction run, all single-voltage reversible.

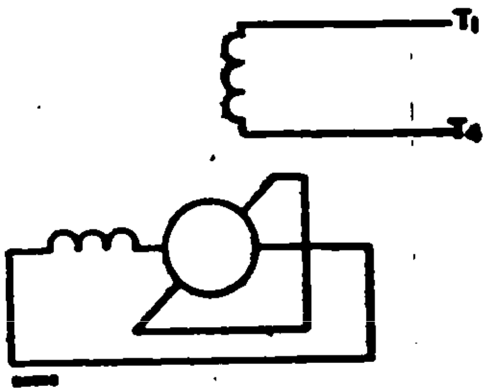
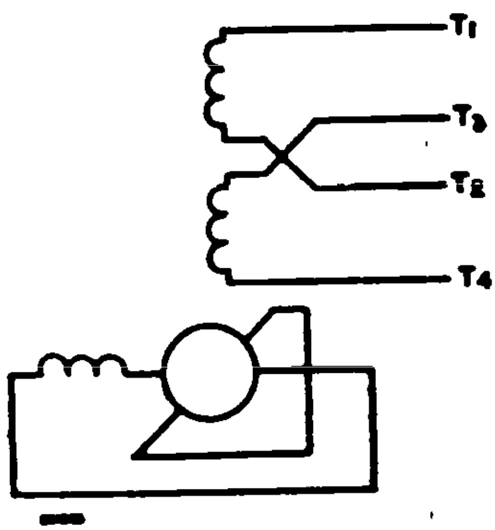


Figure 47 - Repulsion motor, single voltage, inductively compensated.



	L_1	L_2	Tie together
Low voltage	T_1, T_3	T_2, T_4	------
High voltage	T_1	T_4	T_2, T_3

Figure 48 - Repulsion motor, double voltage, inductively compensated.

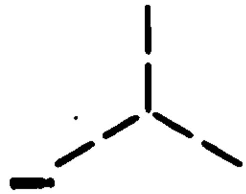


Figure 49 - Diagram for two circuit per phase.

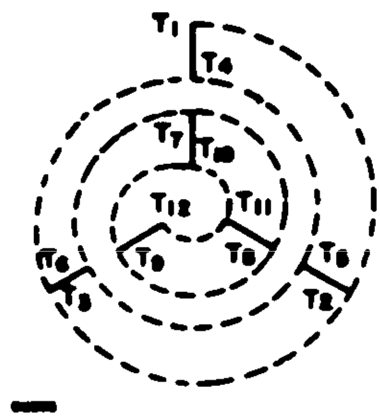


Figure 50 - Connection markings for two circuits per phase.

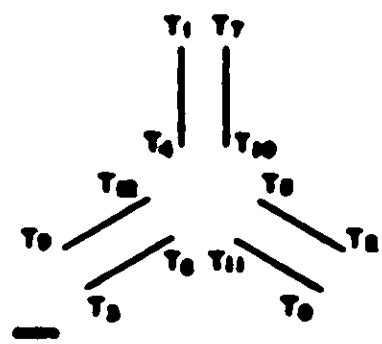


Figure 51 - Connection markings for two circuits in parallel per phase.

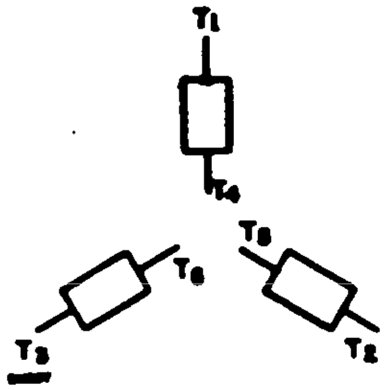


Figure 52 - Connection markings for two circuits in parallel per phase, permanently connected.

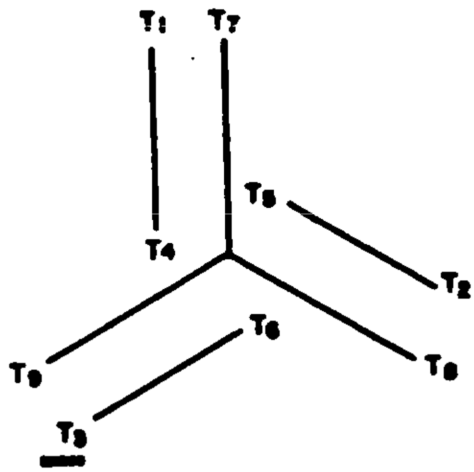


Figure 53 - Connection markings for series or parallel connections.

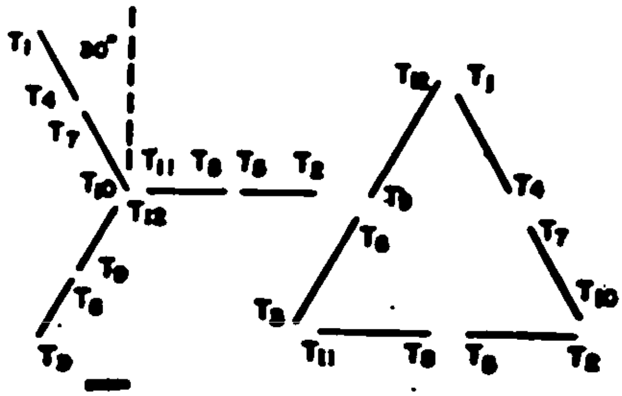
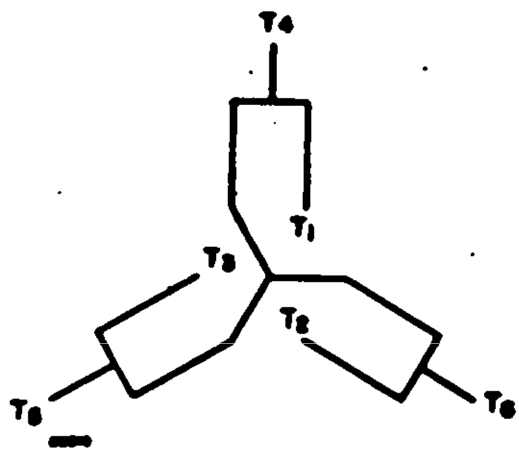
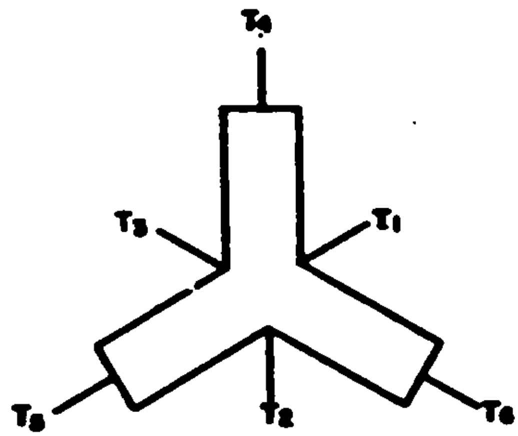


Figure 54 - Connection markings for delta-connected windings.



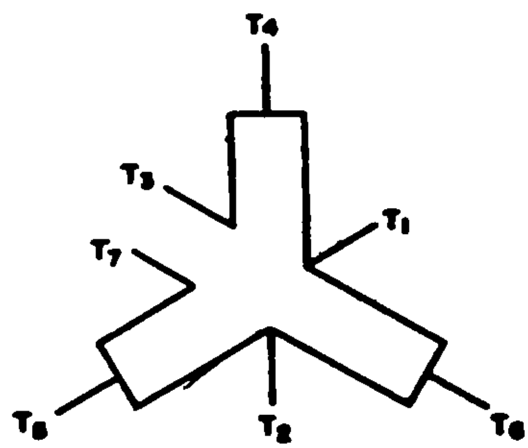
Speed	L1	L2	L3	Open	Tie together
Low	T_1	T_2	T_3	T_4, T_5, T_6	----------
High	T_6	T_4	T_5	----------	T_1, T_2, T_3

Figure 55 - Variable torque motor.



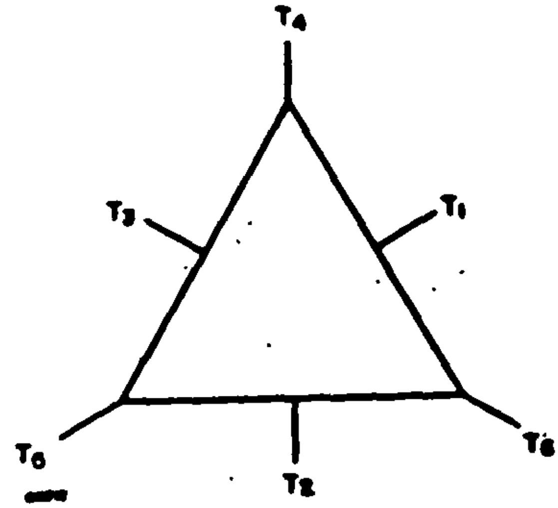
Speed	L1	L2	L3	Open	Tie together
Low	T1	T2	T3	T4, T5, T6	----------
High	T6	T4	T5	----------	T1, T2, T3

Figure 56 - Constant torque motor, arrangement 1.



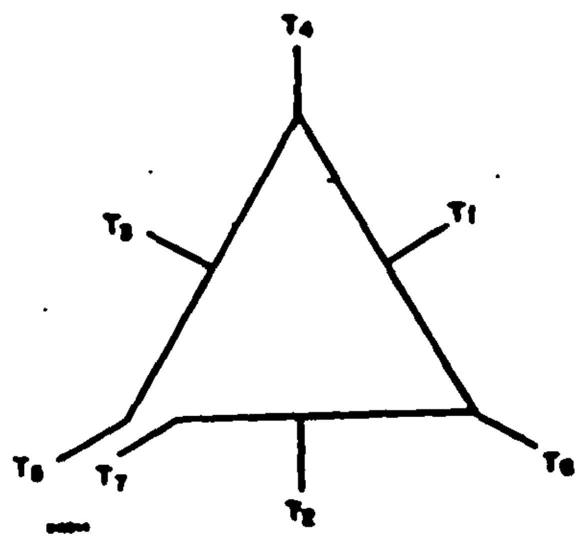
Speed	L1	L2	L3	Open	Tie together
Low	T1	T2	T3, T7	T4, T5, T6	----------
High	T6	T4	T5	----------	T1, T2, T3, T7

Figure 57 - Constant torque motor, arrangement 2.



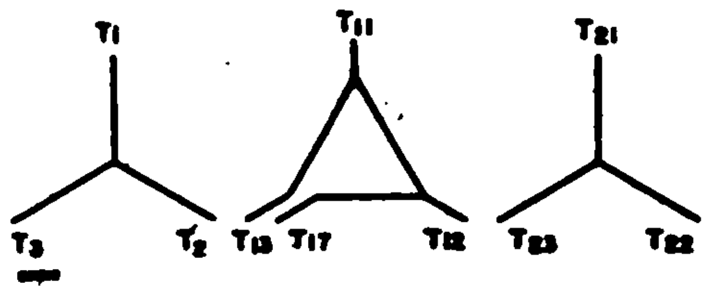
Speed	L_1	L_2	L_3	Open	Tie together
Low	T_1	T_2	T_3	----------	T_4, T_5, T_6
High	T_6	T_4	T_5	T_1, T_2, T_3	----------

Figure 58 - Constant horsepower motor, arrangement 1.



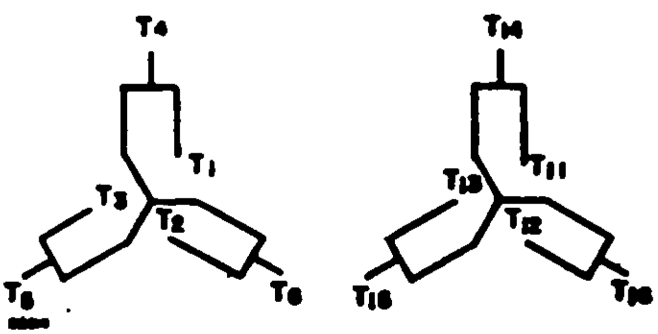
Speed	L_1	L_2	L_3	Open	Tie together
Low	T_1	T_2	T_3	----------	T_4, T_5, T_6, T_7
High	T_6	T_4	T_5, T_7	T_1, T_2, T_3	----------

Figure 59 - Constant horsepower motor, arrangement 2.



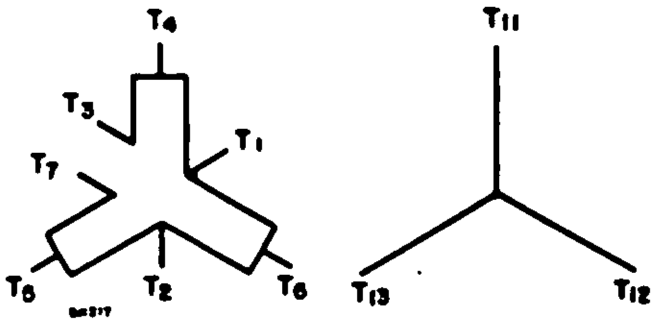
Speed	L_1	L_2	L_3	Open	Tie together
Low	T_1	T_2	T_3	T_{11}, T_{12}, T_{13}, T_{17}, T_{21}, T_{22}, T_{23}	--------
Second	T_{11}	T_{12}	T_{13}, T_{17}	T_1, T_2, T_3, T_{21}, T_{22}, T_{23}	--------
High	T_{21}	T_{22}	T_{23}	T_1, T_2, T_3, T_{11}, T_{12}, T_{13}, T_{17}	--------

Figure 60 - Three-speed motor using three windings.



Speed	L_1	L_2	L_3	Open	Tie together
Low	T_1	T_2	T_3	T_4, T_5, T_6	-------------
Second	T_{11}	T_{12}	T_{13}	T_{14}, T_{15}, T_{16}	-------------
Third	T_6	T_4	T_5	-------------	T_1, T_2, T_3
High	T_{16}	T_{14}	T_{15}	-------------	T_{11}, T_{12}, T_{13}

Figure 61 - Four-speed motor using two windings.



Speed	L_1	L_2	L_3	Open	Tie together
Low	T_1	T_2	T_3, T_7	T_4, T_5, T_6	T_1, T_2, T_3, T_7
Second	T_6	T_4	T_5	----------	--------------
High	T_{11}	T_{12}	T_{13}	----------	--------------

Figure 62 - Three-speed motor using two windings.

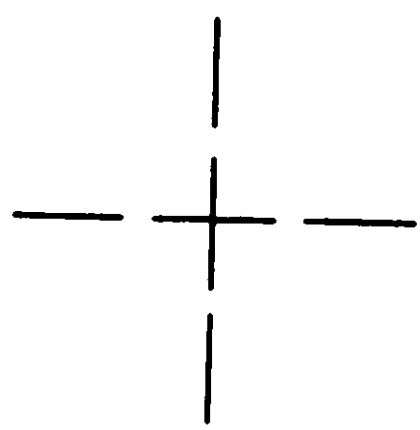


Figure 63 - Diagram for three circuits per phase.

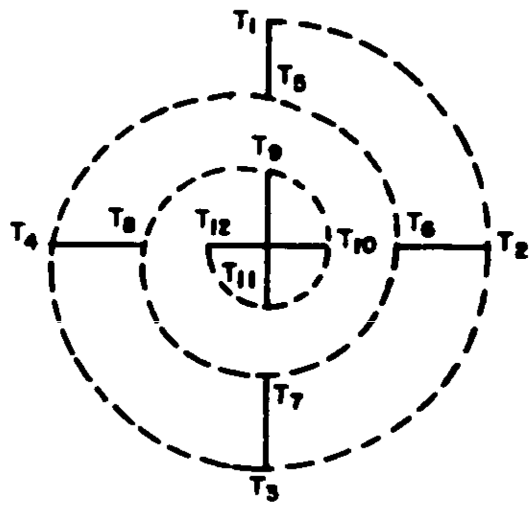


Figure 64 - Connection markings for three circuits per phase.

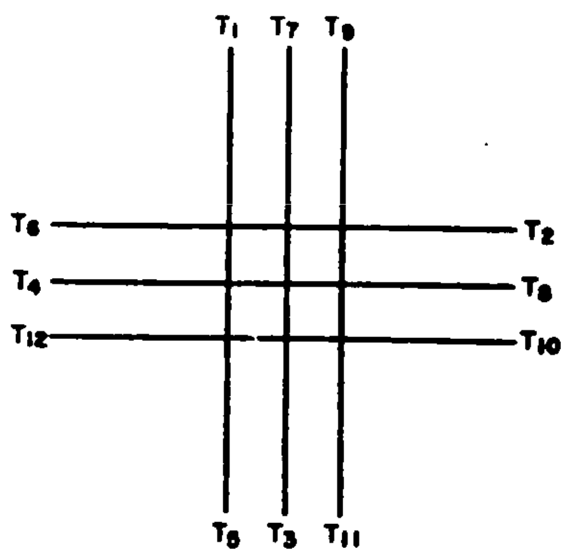


Figure 65 - Connection markings for three circuits in parallel per phase - all circuit leads brought out.

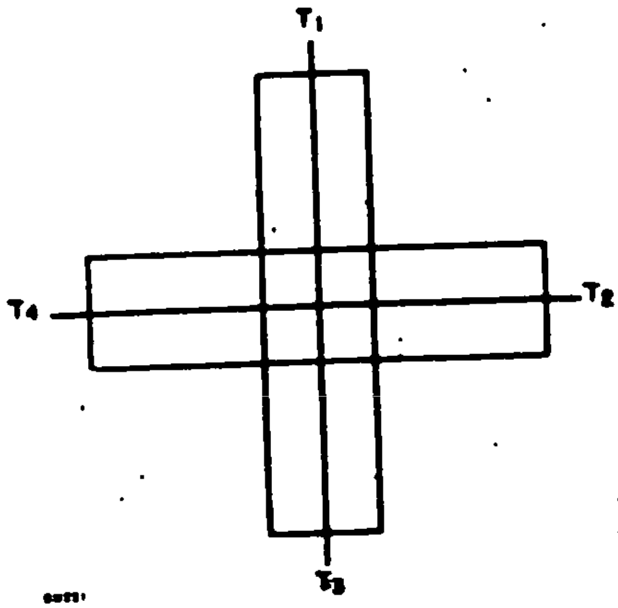
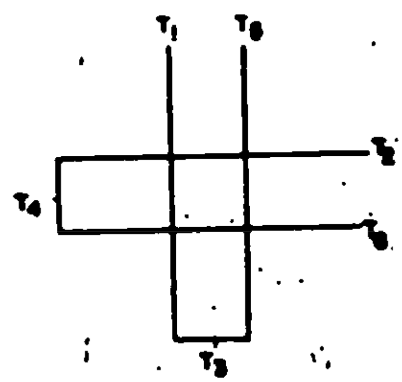


Figure 66 - Connection markings for three circuits per phase connected in parallel inside the motor.



Speed	L1	L3	L2	L4	Open
Low	T1	T5	T2	T6	T3, T4
High	T1, T5	T3	T2, T6	T4	------

Figure 67 - Two-speed, two-phase variable torque.

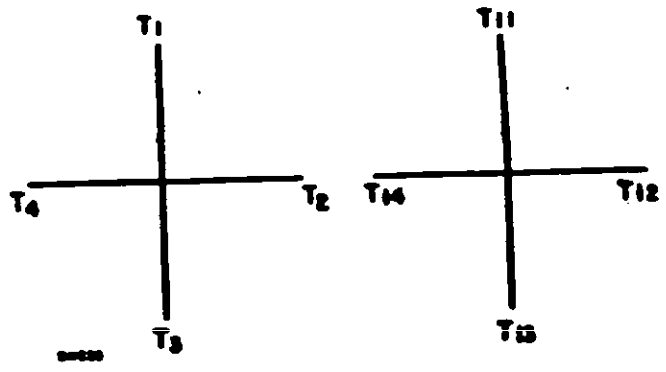
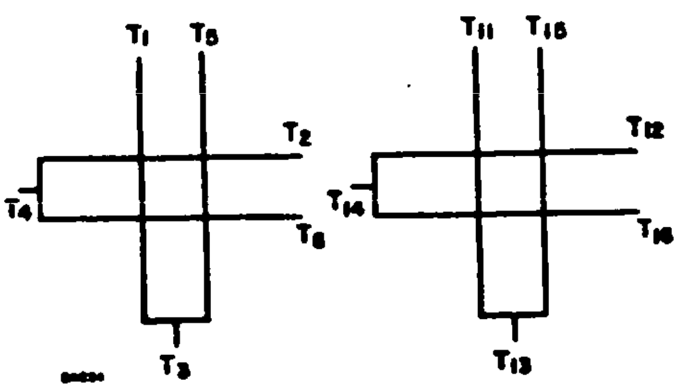
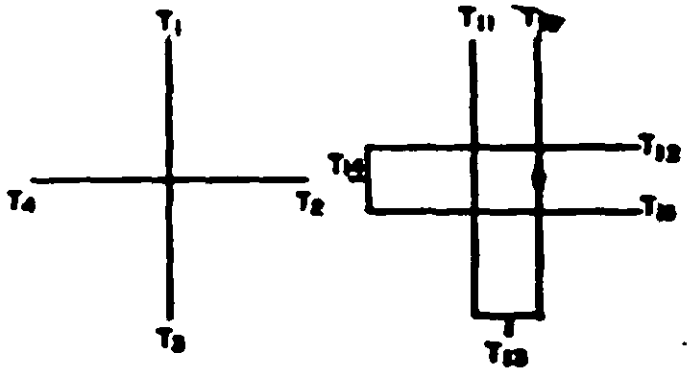


Figure 68 - Two-speed motor using two single-speed windings.



Speed	L1	L3	L2	L4	Open
Low	T_1	T_5	T_2	T_6	T_3, T_4
Second	T_{11}	T_{15}	T_{12}	T_{16}	T_{13}, T_{14}
Third	T_1, T_5	T_3	T_2, T_6	T_4	--------
High	T_{11}, T_{15}	T_{13}	T_{12}, T_{16}	T_{14}	--------

Figure 69 - Four-speed motor using two windings.



Speed	L1	L3	L2	L4	Open
Low	T1	T3	T2	T4	
Second	T11	T15	T12	T16	T13, T14
High	T11, T15	T13	T13, T16	T14	

Figure 70 - A three-speed motor using two windings.

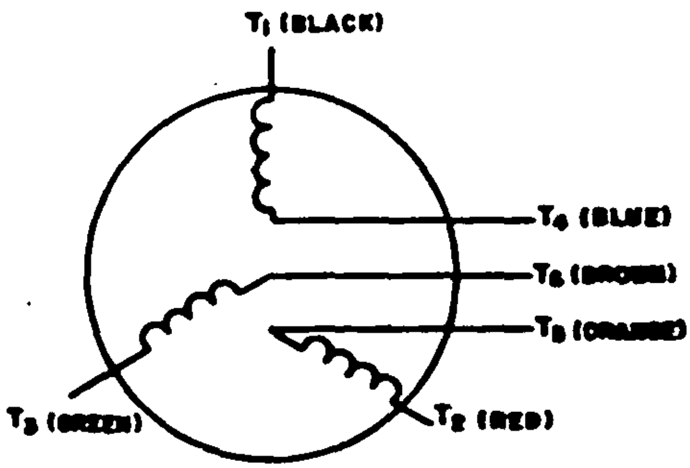


Figure 71 - Three-phase, wye-connected aircraft motor with six leads brought out.

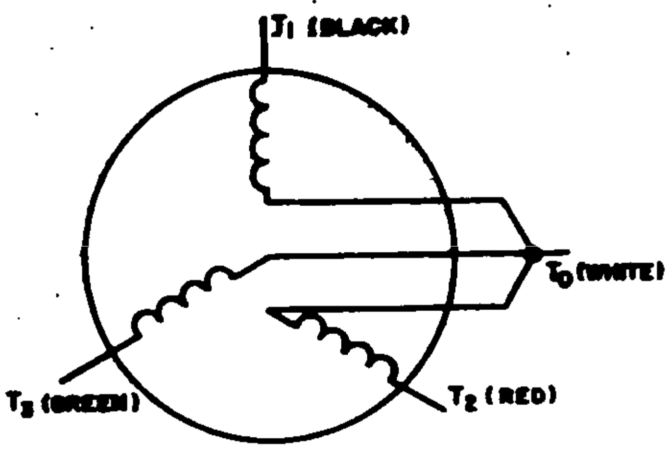


Figure 72 - Three-phase, wye-connected aircraft motor with phases initially separated for dielectric tests.

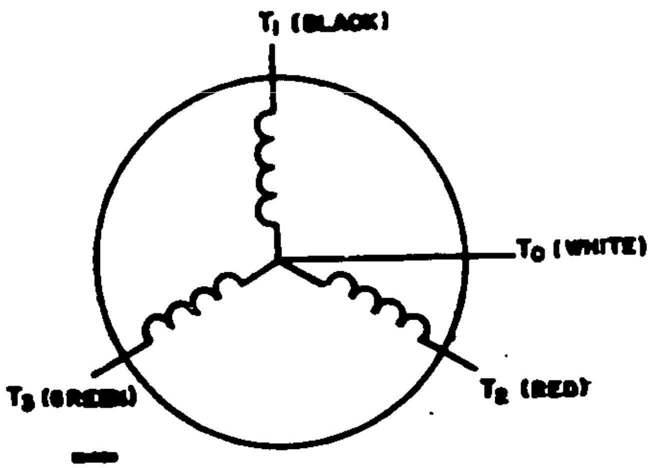


Figure 73 - Three-phase, wye-connected aircraft motor.

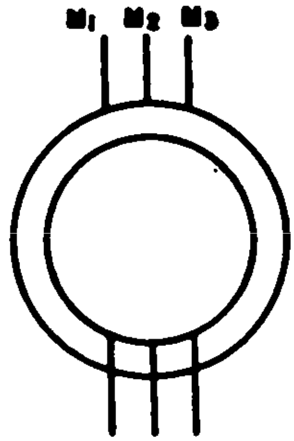


Figure 74 - Standard two- and three-phase collector ring motor (usual connection wye).

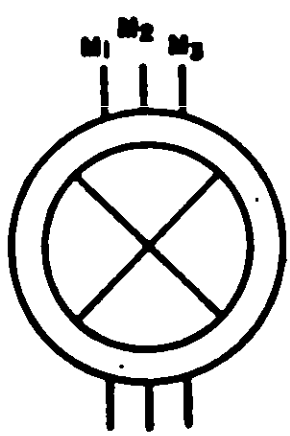


Figure 75 - Two- and three-phase collector ring induction motors, with two-phase rotor.

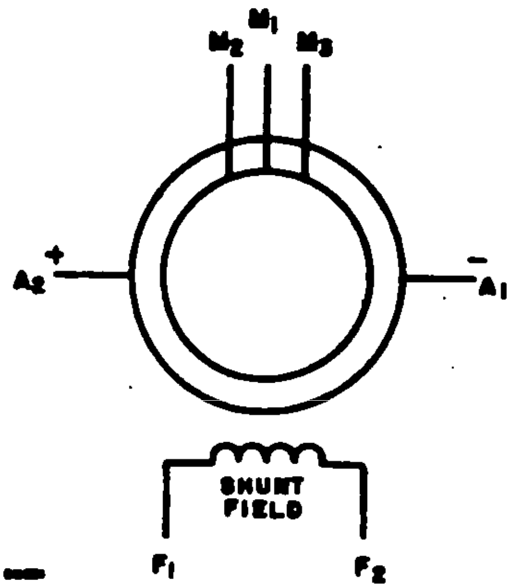


Figure 76 - Shunt-wound three-phase synchronous converter without commutating field.

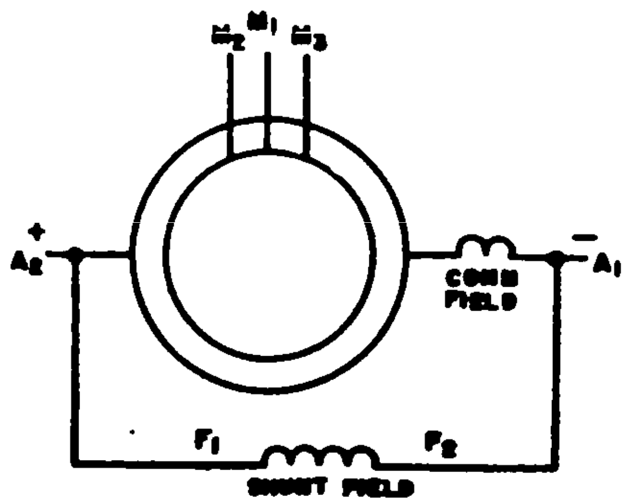


Figure 77 - Shunt-wound three-phase synchronous converter with commutating field.

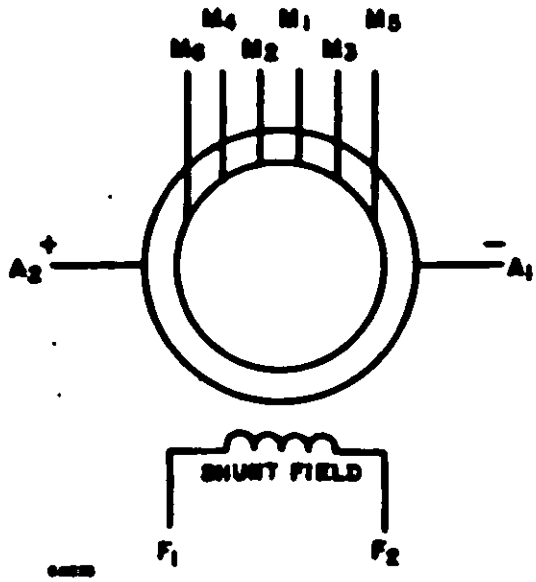


Figure 78 - Shunt-wound six-phase synchronous converter without commutating field.

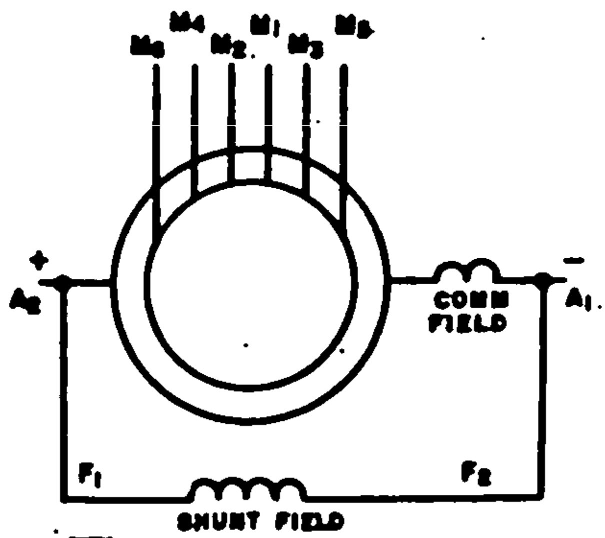


Figure 79 - Shunt-wound six-phase synchronous converter with commutating field.

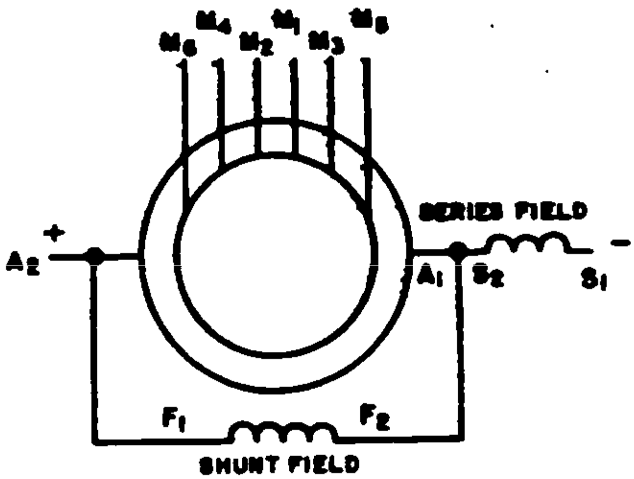


Figure 80 - Compound-wound six-phase synchronous converter without commutating field.

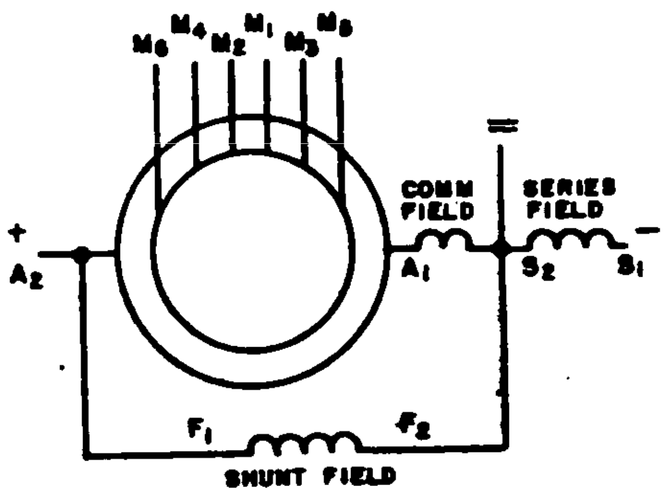


Figure 81 - Compound-wound six-phase synchronous converter with commutating field.

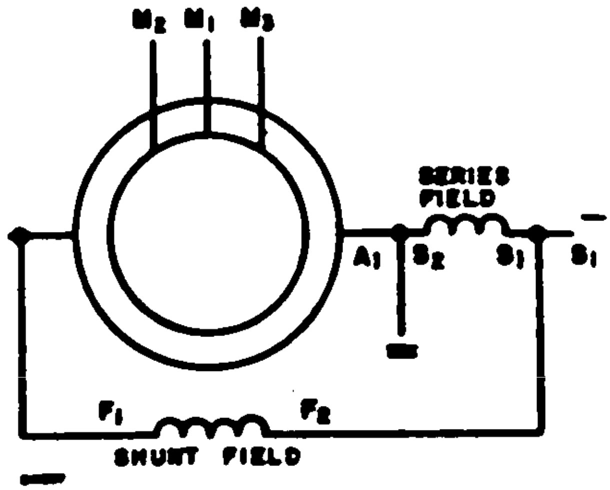


Figure 82 - Compound-wound three-phase synchronous converter without commutating field.

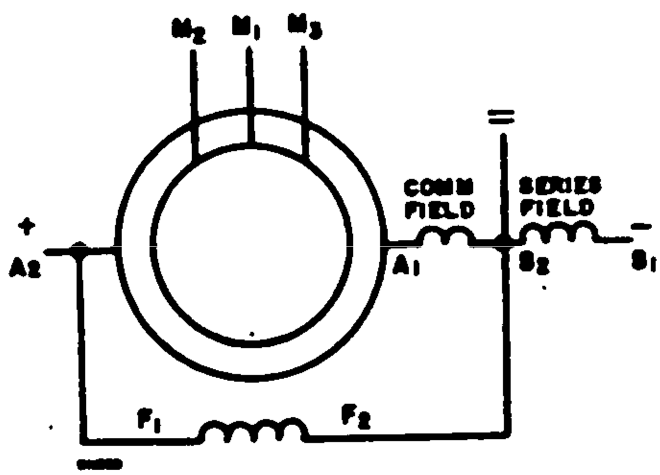


Figure 83 - Compound-wound three-phase synchronous converter with commutating field.

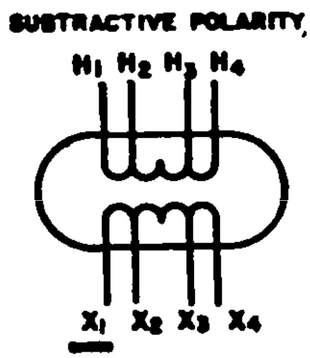


Figure 84

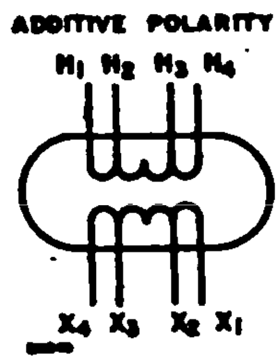


Figure 85

Single-phase transformers, simple H and X windings with taps.

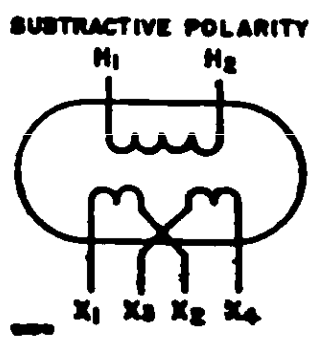


Figure 86 - Single-phase transformers, series multiple X windings without taps.

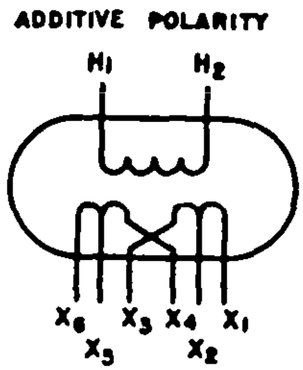


Figure 87 - Single-phase transformers, series multiple X winding with taps.

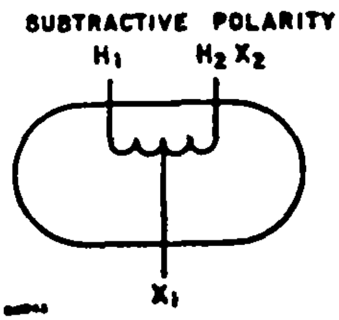


Figure 88 - Auto-transformer.

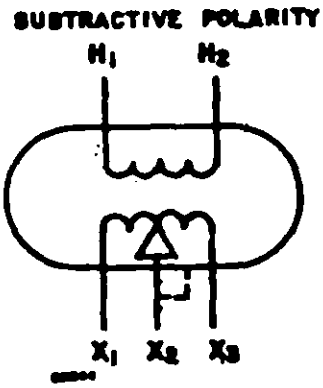


Figure 89

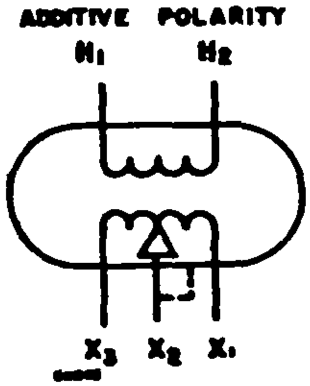


Figure 90

Single-phase transformers, three-wire series connection where neutral is brought out between other two leads.

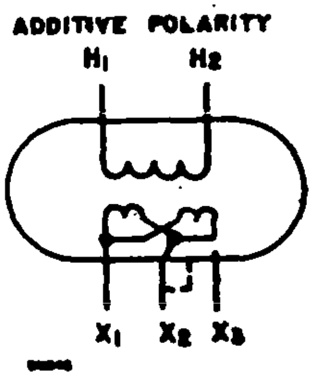


Figure 91

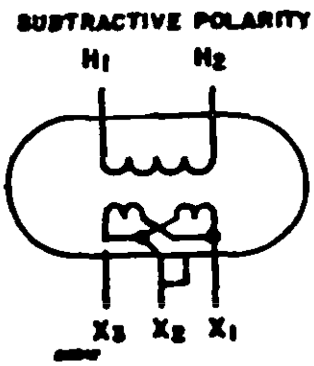


Figure 92

Single-phase transformers, two-wire parallel connection where neutral is brought out between other two leads.

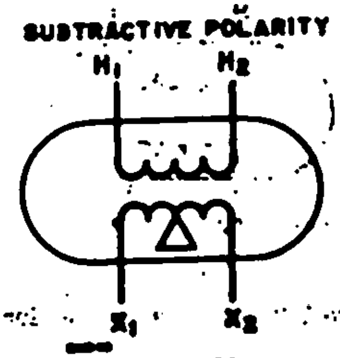


Figure 93

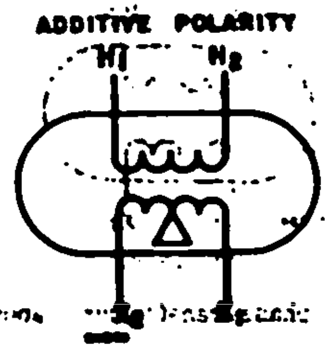


Figure 94

Single-phase transformers, two-wire series connection.

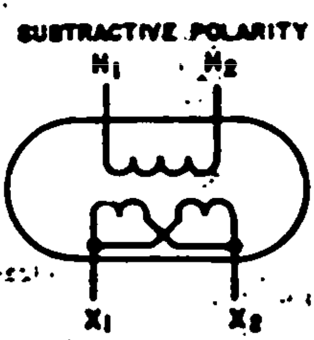


Figure 95

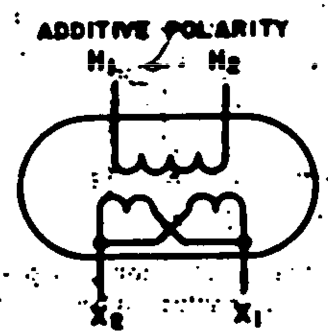


Figure 96

Single-phase transformers, two-wire parallel connection.

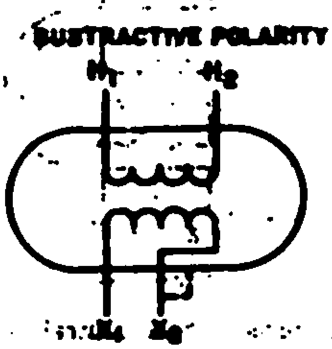


Figure 97

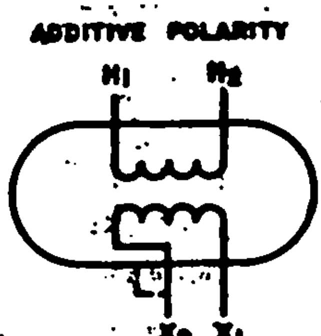


Figure 98

Single-phase transformers, 120-volt class connection.

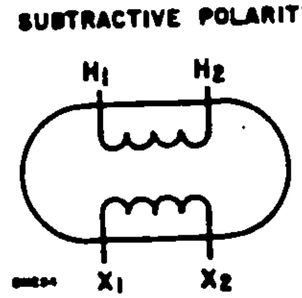


Figure 99

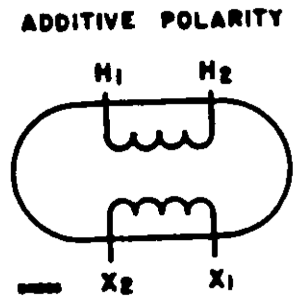


Figure 100

Single-phase transformers, above 120-volt class connection.

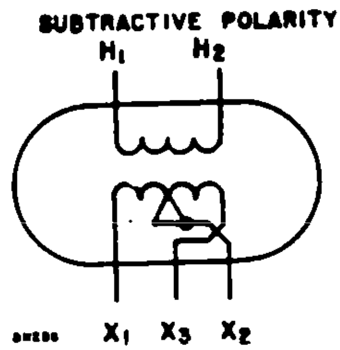


Figure 101

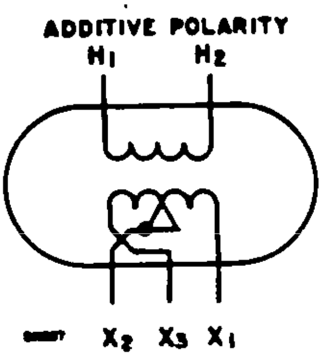


Figure 102

Single-phase transformers, three-wire series connection transformer where neutral is brought out to side.

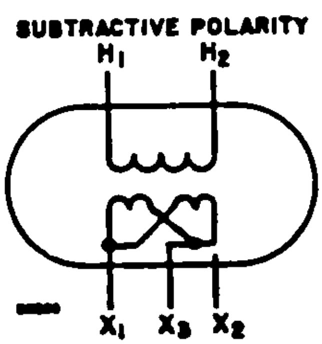


Figure 103

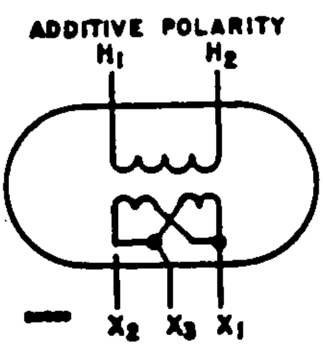


Figure 104

Two-wire parallel connection transformer where neutral is brought out to side.

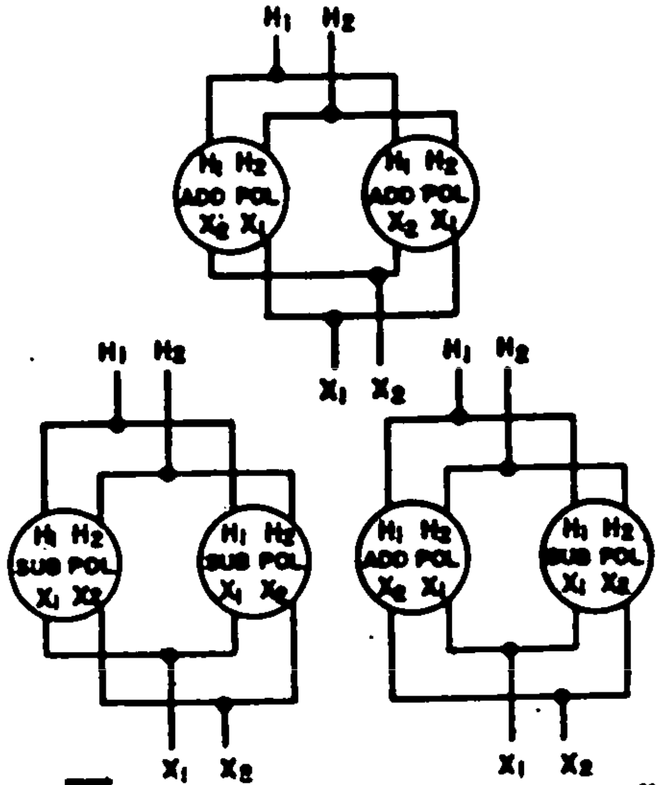


Figure 105 - Connections for transformers in parallel.

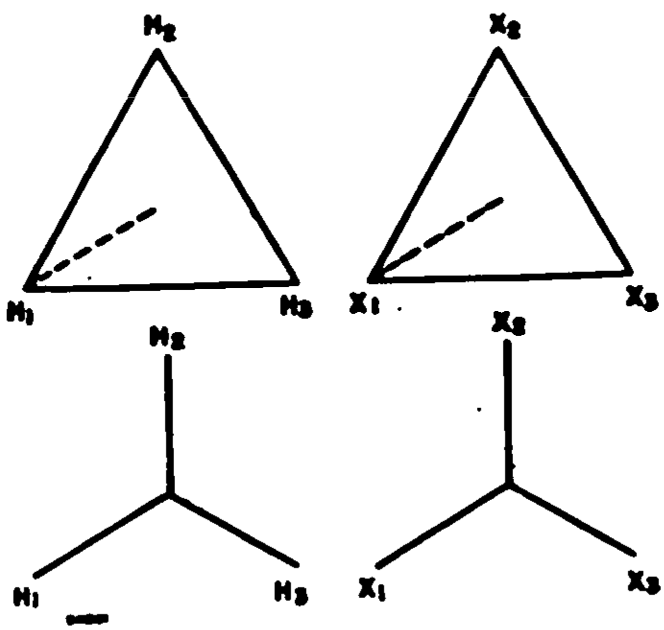


Figure 106 - Three-phase transformers without taps, angular displacement 0 degree.

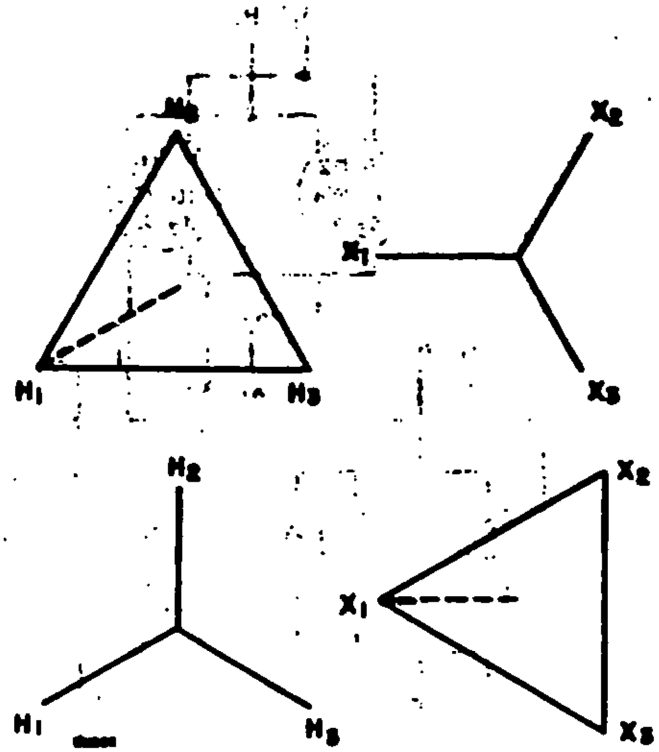


Figure 107 - Three-phase transformers without taps, angular displacement 30 degrees.

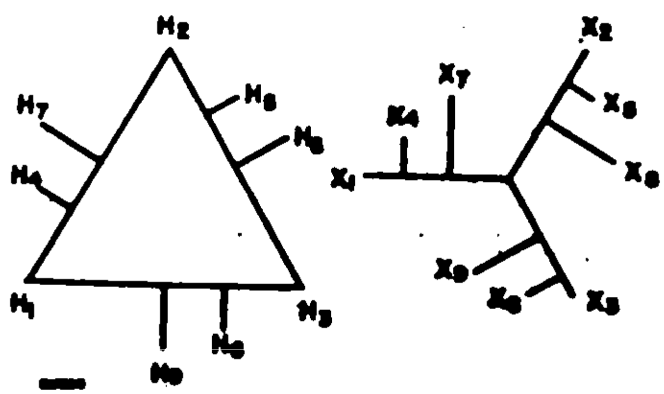


Figure 108 - Three-phase transformers with taps, angular displacement 30 degrees.

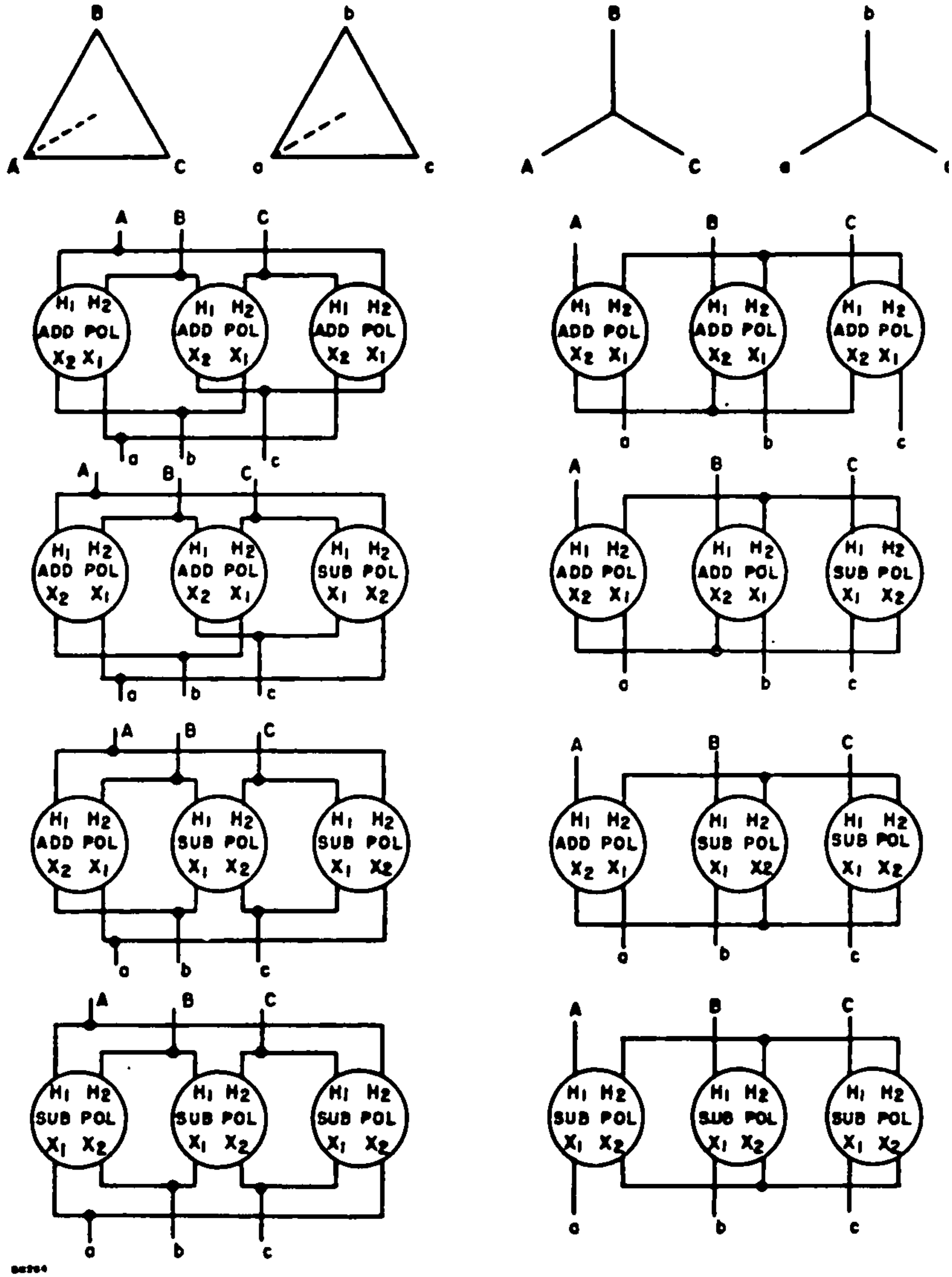


Figure 109 - Angular displacement and connections - single-phase transformers connected delta-delta and wye-wye in three-phase banks with 0 degree angular displacement.

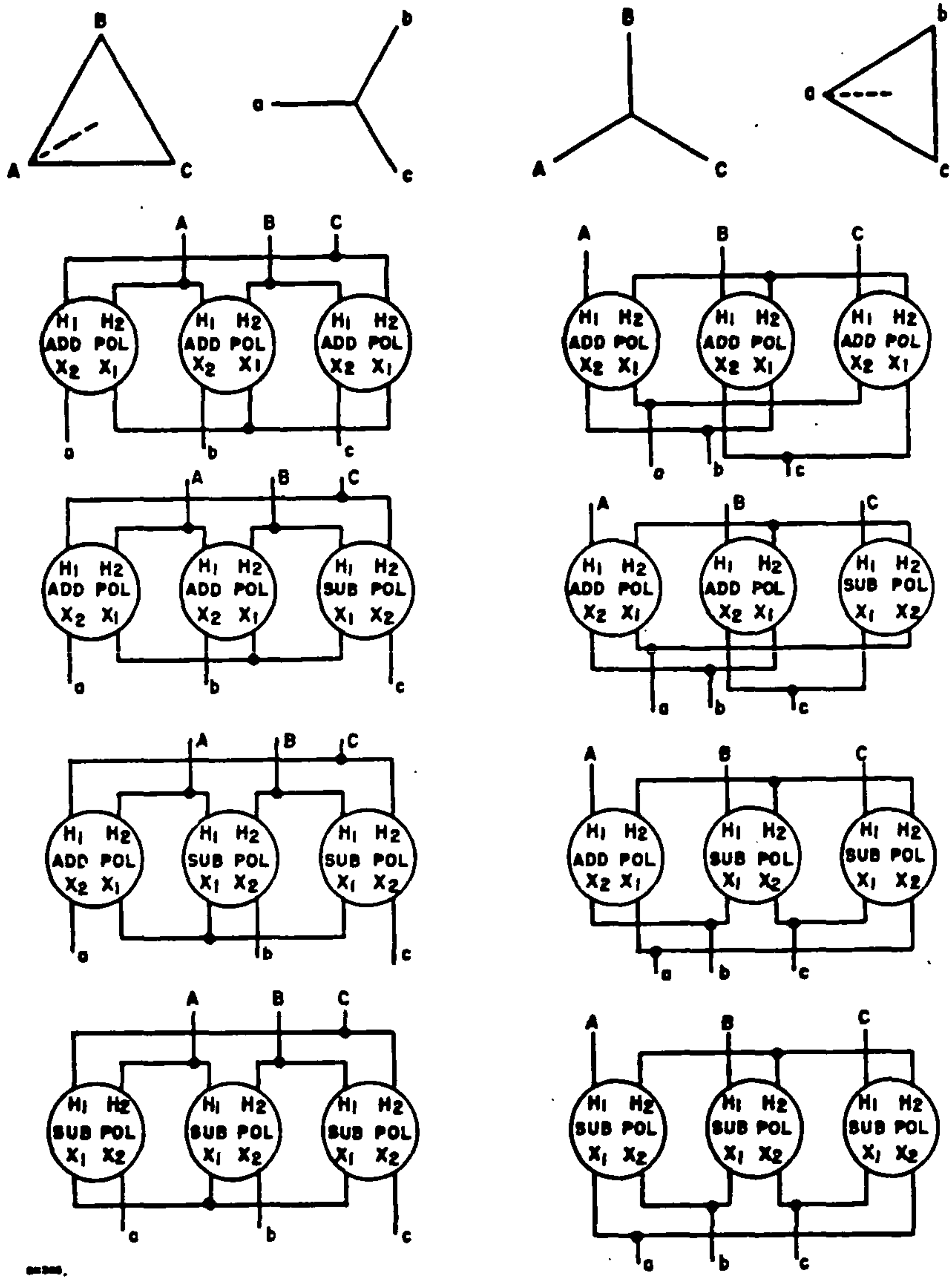


Figure 110 - Angular displacement and connections - single-phase transformers connected delta-wye and wye-delta in three-phase banks with 30 degrees angular displacement.

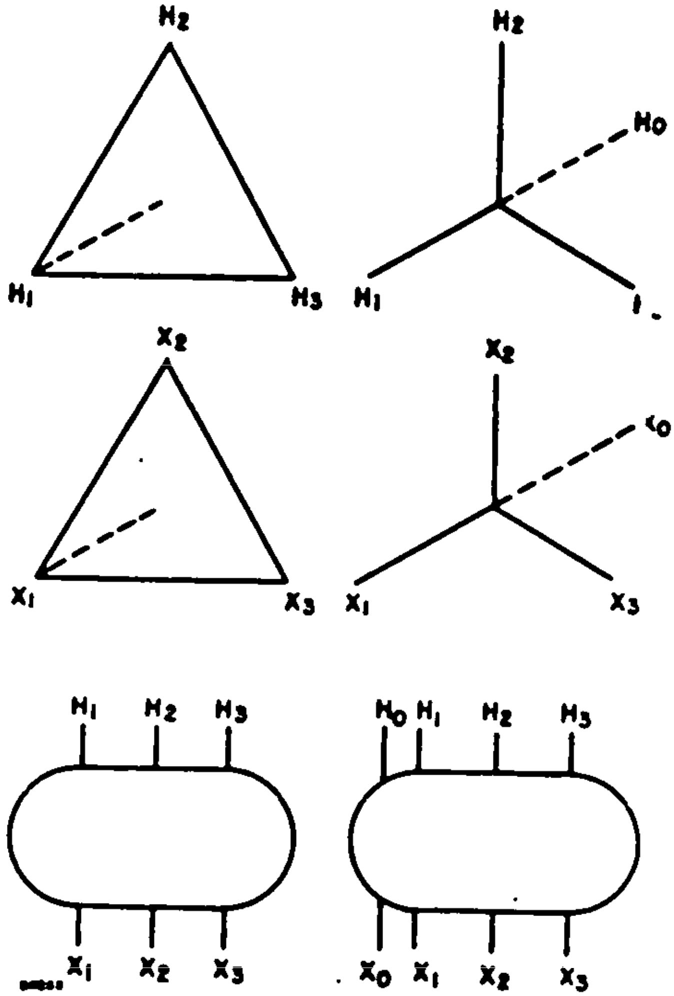


Figure 111 - Three-phase transformers connected delt - delta and wye-wye with 0 degree angula displacement.

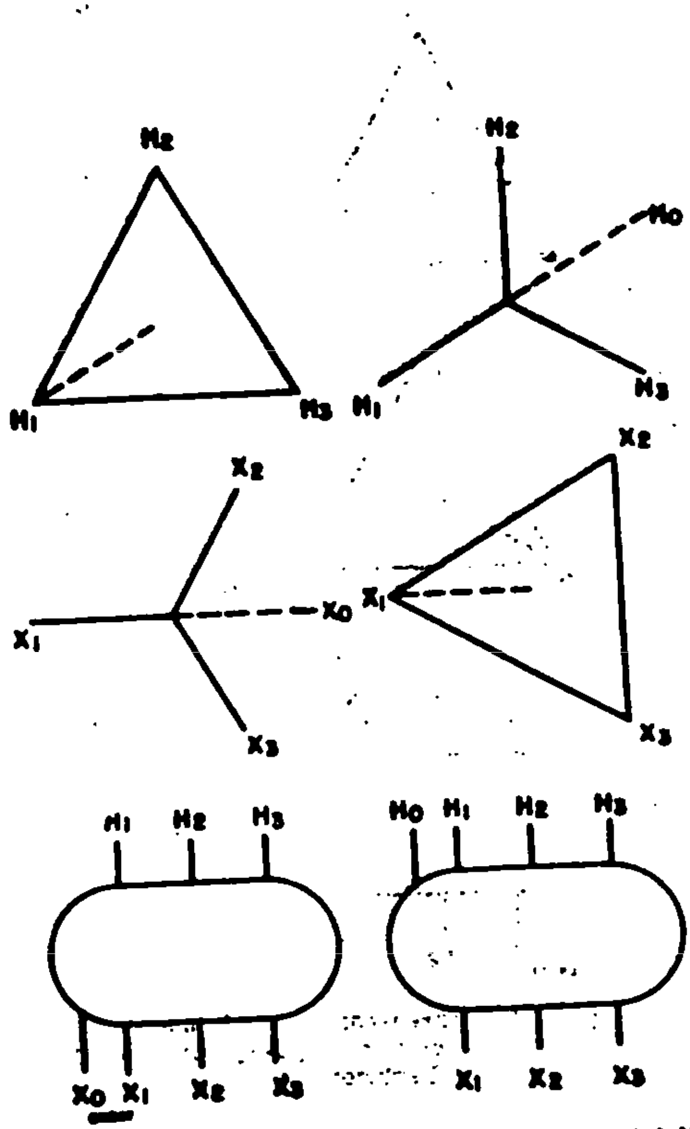


Figure 112 - Three-phase transformers connected delta-wye and wye-delta with 30 degrees angular displacement.