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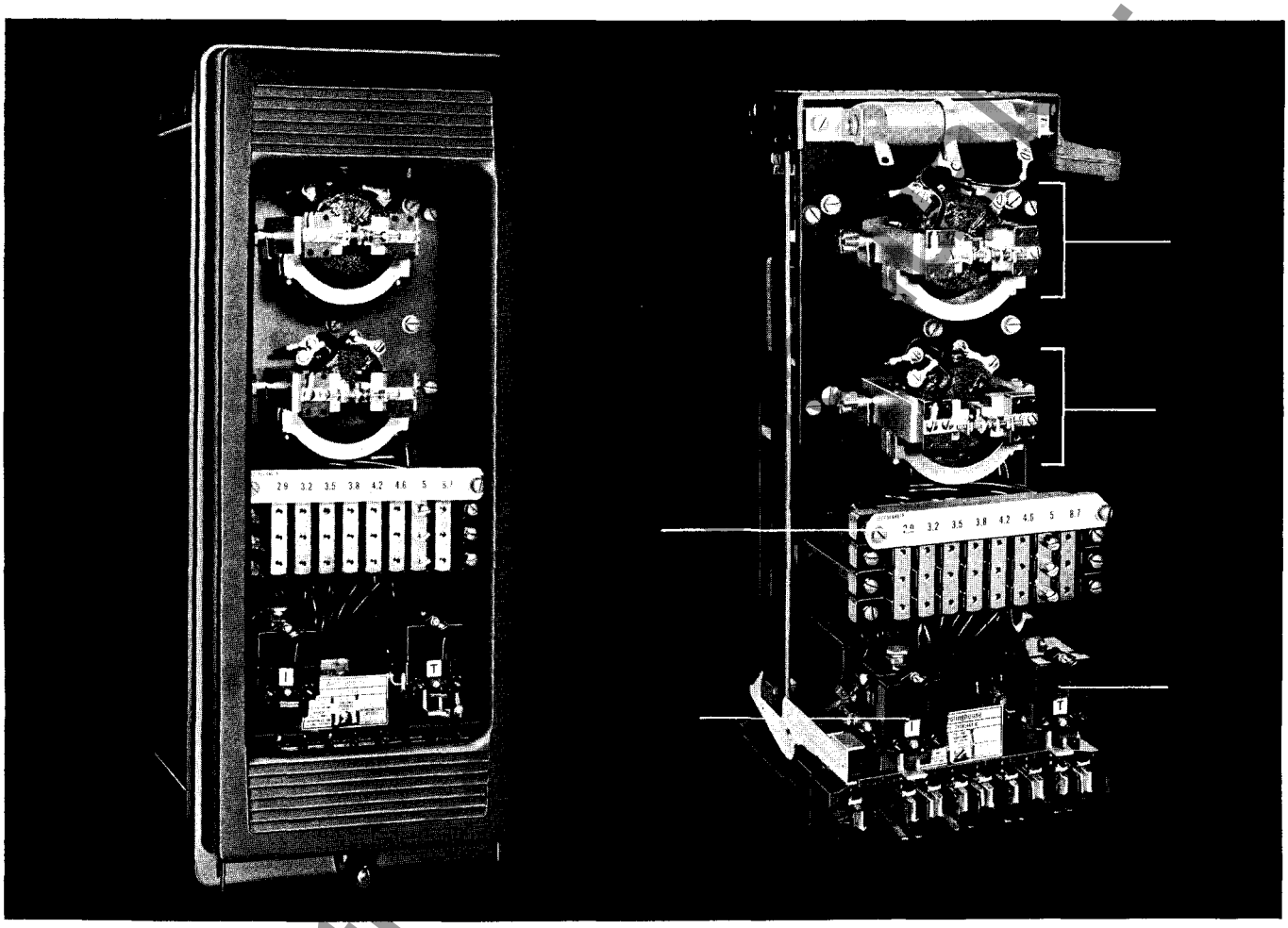
Types HU, HU-1, HU-4 Relays

Single Phase Instantaneous
Variable Percentage



Application

Types HU, HU-1, and HU-4 relays are high speed differential units with two, three, or four restraint circuits respectively; all incorporating a harmonic restraint circuit to prevent false tripping on magnetizing inrush currents associated with transformer energization.

All are designed with a variable ratio characteristic which provides high sensitivity at low current magnitudes with an increase in percentage ratio at higher currents. Each of the relays then, will detect light internal faults within the transformer and, at the same time, prevent false tripping on heavy external fault currents which may cause variation in the current transformer performance at high currents. This is particularly desirable when severe saturation of current transformers occurs due to the dc component of asymmetrical short circuits.

The harmonic restraint feature of these relays prevents false tripping on magnetizing inrush currents which appear at the relay as an internal fault. Such inrush currents are rich in harmonics, with the second harmonic being predominant. Since this second harmonic is always present in magnetizing inrush currents and not in internal fault current waves the harmonic restraint unit will not close its contacts unless second harmonic content is less than 15 percent of the fundamental. Normal application of these relays is:

2-Winding Transformer: Type HU
3-Winding Transformer: Type HU-1
4-Winding Transformer: Type HU-4
4-Circuit Bus: Type HU-4

The HU relay has two restraint transformers and is for use with 2-winding transformer protection. The HU-1 has a third restraint transformer and is used for three winding application. The HU-4 has four restraint circuits, and may be applied to three-winding transformers with a tertiary winding, or a transformer and bus section combination.

The Type HU-4 may be applied to any bus circuit where the external fault current through the bus is twenty times tap value secondary current or less—e.g., 100 amperes on the 5 ampere tap. Occasionally an auxiliary current balance transformer is used on the line side of the power transformer to adjust the current transformer secondary currents to the bus sections included in the protected zone.

Taps are supplied to compensate for main current transformer mismatch. The relays are available with a sensitivity of either 0.30 or 0.35 times tap setting. The 30% sensitivity relay satisfactorily handles up to 15% mismatch (e.g., ±10% transformer tap changing, plus 5% current transformer mismatch). The 35% unit handles up to 20% mismatch. See Figures 4, 5, 9, and 10.

January, 1974
Supersedes DB 41-347, dated March, 1971
E. D. C/2015/DB

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Features

1. High security due to variable ratio characteristic – The relay detects light internal faults within the transformer and at the same time prevents false tripping on heavy external faults which may cause variation in the current transformer performance at high currents.

2. Fast operating speed limits fault damage to the protected transformer. With the continuing trend toward larger and more costly power transformers, the user is best suited to apply protective relays offering the fastest operating speeds.

3. Greater security during external faults – Faults external to the transformer produce large magnitude through currents which cause unsymmetrical saturation to the current transformers on each side of the power transformer. The higher designed burden of the HU relay's operating coil forces the "strong" CT on one side of protected power transformer to more effectively support the "weak" CT on the other side as desired for secure operation.

4. Second harmonic filter circuits are used to prevent false tripping of the relays during magnetizing inrush current at start-up – The HU relays use the filtered input for the instantaneous unit as well as the main differential unit. Therefore, the instantaneous unit can be set more sensitively, still being secure from false trips due to second harmonic inrush.

5. The type HU relays are designed thermally to allow currents of 2.5 to 3.4 times tap value.

Operation

External Fault Conditions

With the relay connected as shown in Figure 3a, external fault currents will flow in the restraint transformers of the differential unit. If the line current transformers are below saturation and with correct tap settings, no effective current flows in the operating transformer of the relay. Hence, a contact opening torque is produced in the differential polar unit.

On heavy external faults where a main transformer saturates, current will flow in the operating circuit of the relay. Under these conditions the harmonic restraint unit may close its contacts depending on the harmonics present in the false operating current. Operation of the differential unit is prevented by its variable percentage characteristic, since a large differential current is required to close the contacts during heavy external faults.

Internal Fault Conditions

On internal faults the restraint of the differential unit is proportional to the largest restraint current flowing. The sum of the two restraint currents flows into the operating transformer, producing an excess of operating torque, and the differential unit operates. (See Figure 3b.)

If the internal fault is fed from one source only, the fault current flows in one restraint transformer and the operating transformer. An excess of operating torque is again produced to operate the differential unit.

On heavy internal faults, the Instantaneous Indicating Trip Unit will operate before the main differential unit. Since this unit is connected to an air gap transformer, essentially only the sine wave component of an internal fault is applied to the IIT unit. The dc component is bypassed by the transformer primary. For example, an internal fault with a first peak of 28 times tap value (50% dc component) is reduced to 14 times tap value (dc component absent) in the transformer secondary. As the IIT unit is set to operate at 10 times rms tap value, it will just operate under these conditions.

The varistor is connected across the dc side of the restraint rectifier of the harmonic restraint unit to prevent excessive voltage peaks from appearing across the rectifiers caused by transformer action of the polar unit coils during heavy internal faults.

When a magnetizing inrush wave is applied to the relay, the dc component of the wave is bypassed by the air gap operating transformer. The other components of the inrush wave are fed into the filter circuits. The "block" and "pass" characteristics of the filter circuits feed the second harmonic component of the wave into the restraint coil of the polar unit, and the other components into the operating coil. The polar unit will not close its contacts unless the second harmonic content is less than 15% of the fundamental component. The Indicating Instantaneous Trip will not operate on inrush.

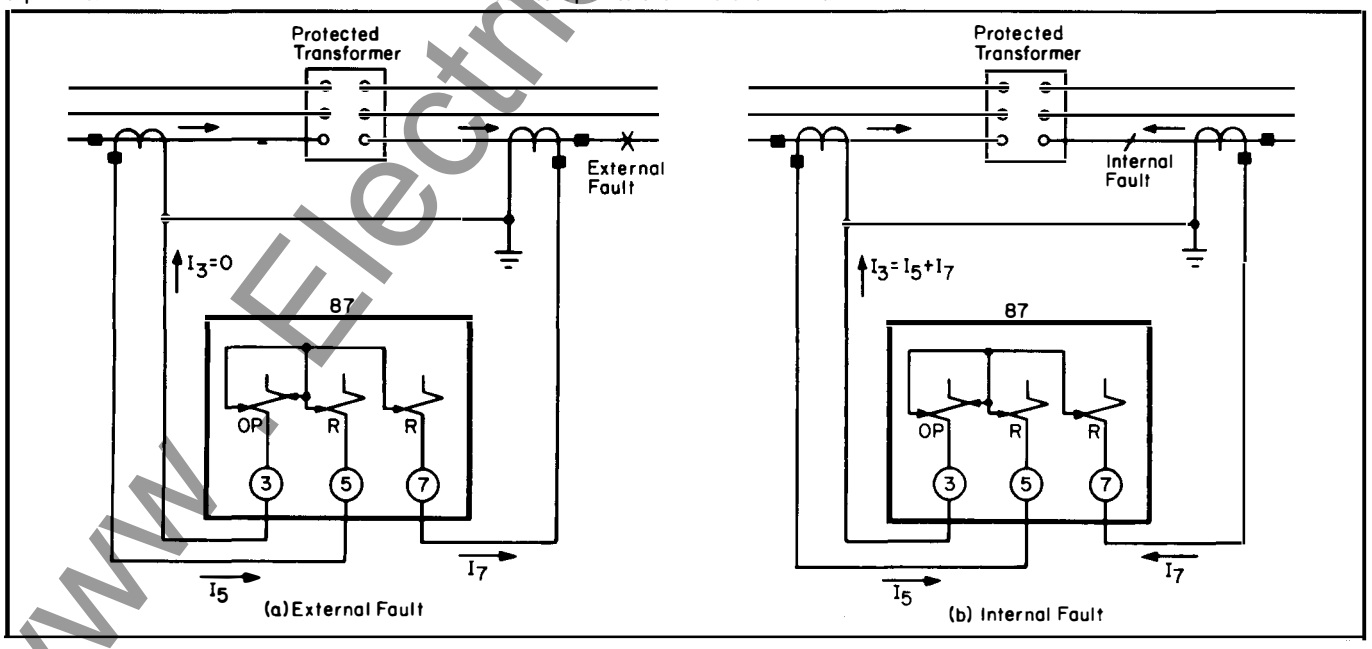

Fig. 3: HU-4 simplified external connections showing current distribution for external and internal faults.

Types HU, HU-1, HU-4 Relays

Single Phase Instantaneous
Variable Percentage

Characteristics

Single phase, 60 hertz, spst-cc contacts

Operating Time

See Figure 6.

Restraint Circuits

Two in HU, three in HU-1, 4 in HU-4; plus one harmonic restraint and one operating circuit in each.

Ratio Taps

2.9, 3.2, 3.5, 3.8, 4.2, 4.6, 5.0, 8.7 amperes.

Variable Percentage Characteristics

HU, HU-1: See Figures 8 and 10

Minimum Trip

30% or 35% of tap value.

Performance

See Figures 6 and 7.

Relay Settings

Select the ratio in matching taps. No other settings are required. To calculate the required tap settings and check current transformer performance, follow the steps outlined on pages 31-34 of Application Data 41-300.

The HU-4 relay is applicable to circuits where the current transformer ratio error is 10% or less with maximum symmetrical external fault current flowing, or with eight times relay tap current flowing.

Taps are provided in the relay restraint and operating circuits to compensate for main current transformer mismatch. These taps are rated in terms of secondary amperes with the ratings mentioned under "Ratio Taps."

Effective unbalance should not exceed the values indicated by the 15% mismatch curve, Figure 4, or 20% mismatch curve, Figure 5.

Sensitivity

Relays are available with either 0.30 or 0.35 times tap rating.

The 30% sensitivity relay will accommodate up to 15% mismatch; and the 35% unit will handle as much as 20% mismatch. See Figure 8 for comparison of the 30% and 35% sensitivity.

Energy Requirements

Tap	Continuous Rating	Pf Angle ①	Volt-Amperes②		
			At Tap Value	8 Times Tap Value	20 Times Tap Value
Each Restraint Circuit					
2.9	10	71	.88	50	191
3.2	12	70	.89	51	211
3.5	13	66	.90	51	203
3.8	14	65	.91	53	220
4.2	15	58	.91	53	235
4.6	16	57.5	.91	55	248
5.0	18	52.5	.92	59	280
8.7	22	30	1.28	94	340
Operating Circuit					
2.9	10	35	2.26	76	487
3.2	12	34	2.30	78	499
3.5	13	33	2.30	81	504
3.8	14	33	2.30	83	547
4.2	15	31	2.30	84	554
4.6	16	30	2.40	88	598
5.0	18	29	2.50	92	640
8.7	22	23	3.18	132	850

① Degrees current lags voltage at tap value current.
② Voltage taken with Rectox type voltmeter.

Indicating Contactor Switch (ICS)

Has 0.2 and 2.0 ampere taps. Will close 30 amperes and carry this long enough to trip circuit breaker.

Indicating Instantaneous Trip (IIT)

HU, HU-1
Set to operate at 10 times rms tap value. Will close 30 amperes and carry long enough to trip a circuit breaker.

HU-4
Set to operate at 15 times rms tap value. Will close 30 amperes and carry long enough to trip a circuit breaker.

Thermal Capability

One-second thermal rating: 300 amperes. Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

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Differential Voltage Characteristic With Pickup of 0.30 Times Tap

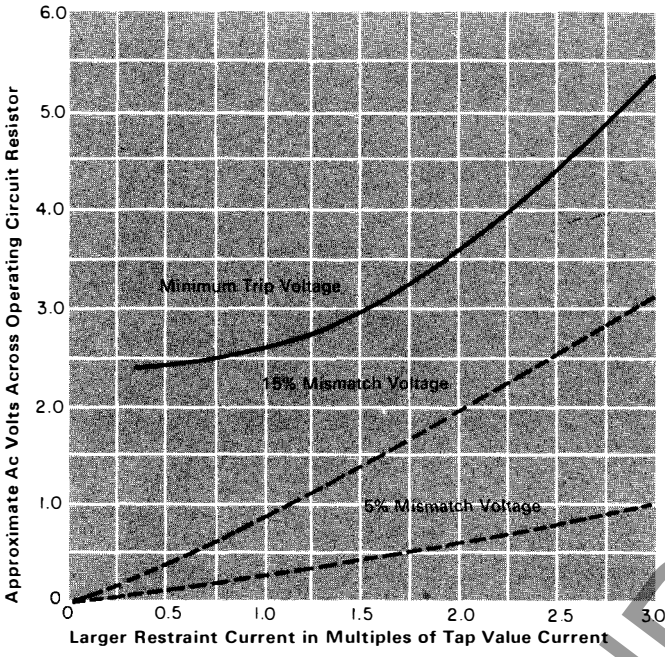

Fig. 4 471132

Differential Voltage Characteristic With Pickup of 0.35 Times Tap

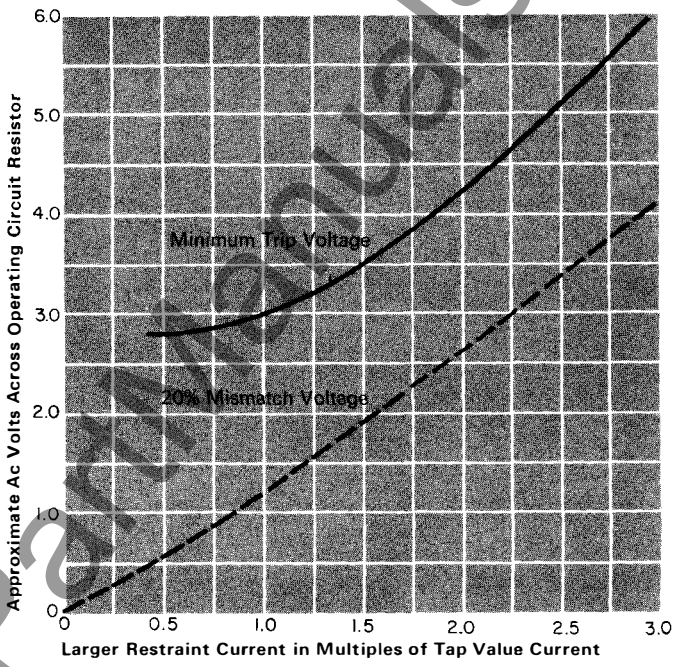

Fig. 5 471135

Operating Time Curve (60 Hz Base)

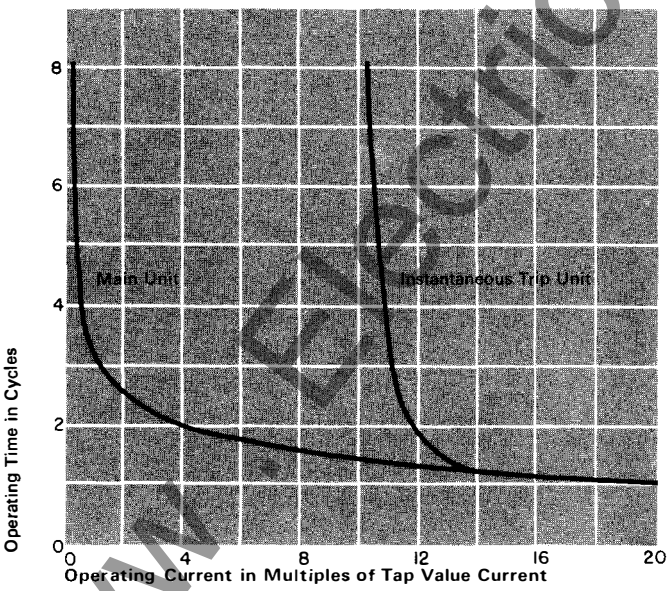

Fig. 6 538029

Frequency Response Curve

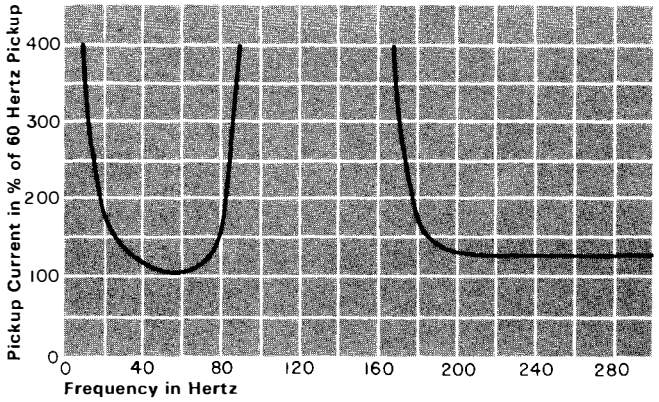

Fig. 7 471052

Types HU, HU-1, HU-4 Relays

Single Phase Instantaneous
Variable Percentage

Comparison of the Differential Characteristic of HU and HU-1 Differential Unit With Pickups of 0.30 And 0.35 Times Tap

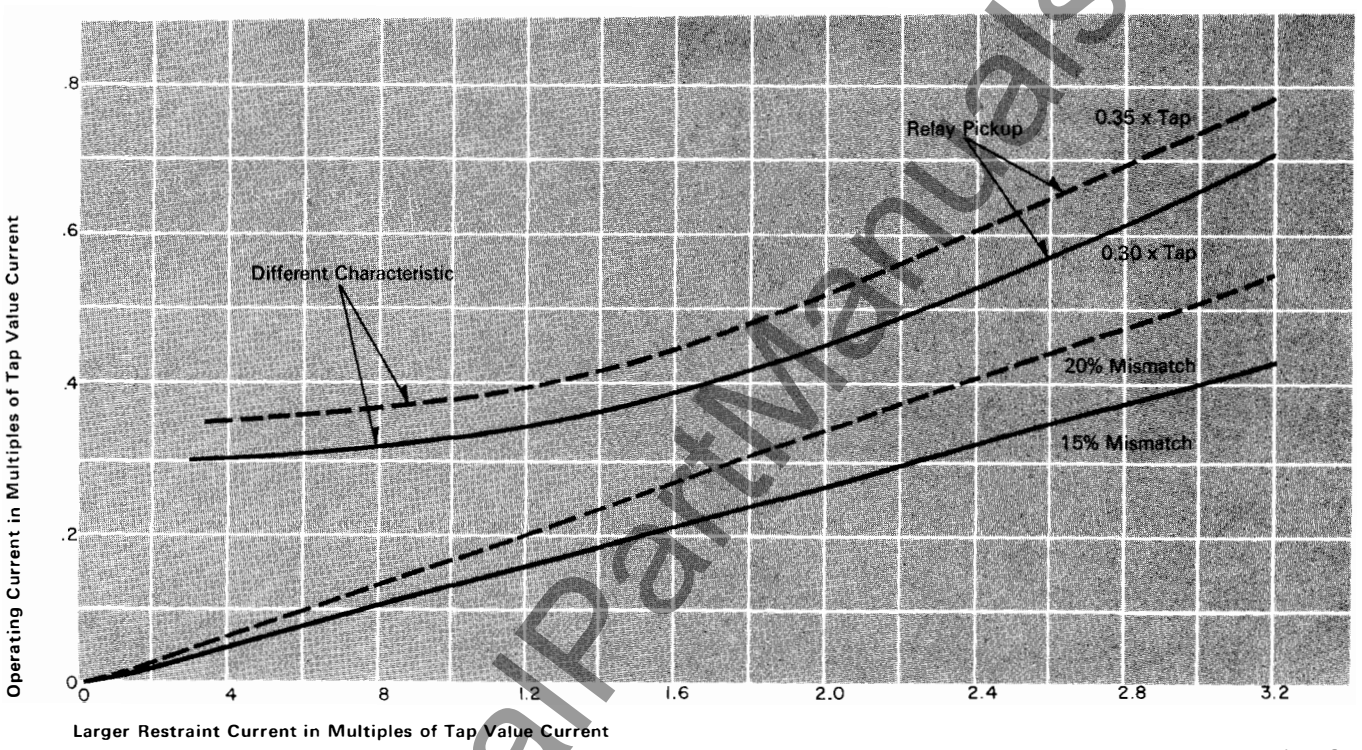

Fig. 8 471136

Typical Differential Characteristic of HU-4 Differential Unit

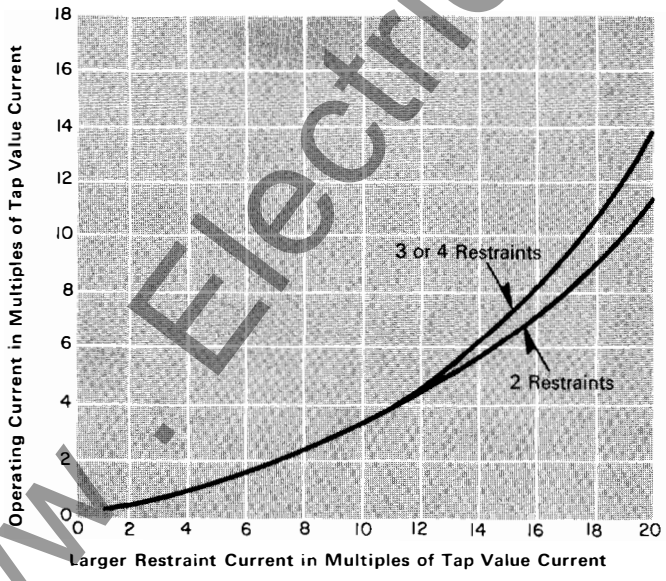

Fig. 9 538033

Typical Differential Characteristic of HU and HU-1 Differential Unit

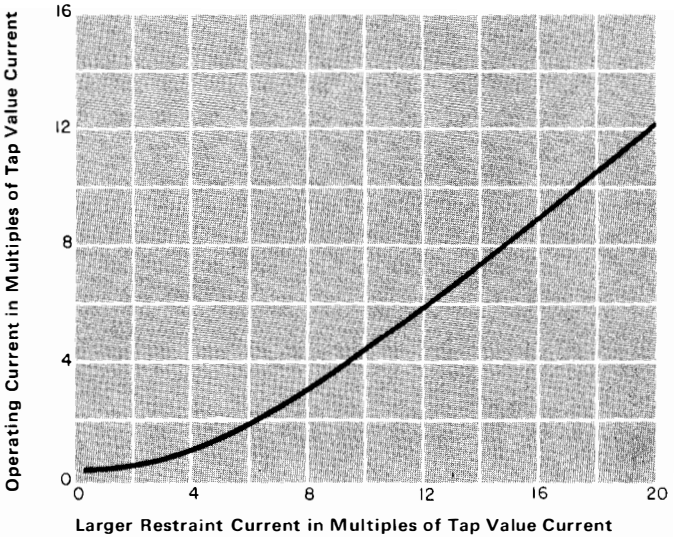

Fig. 10 471050

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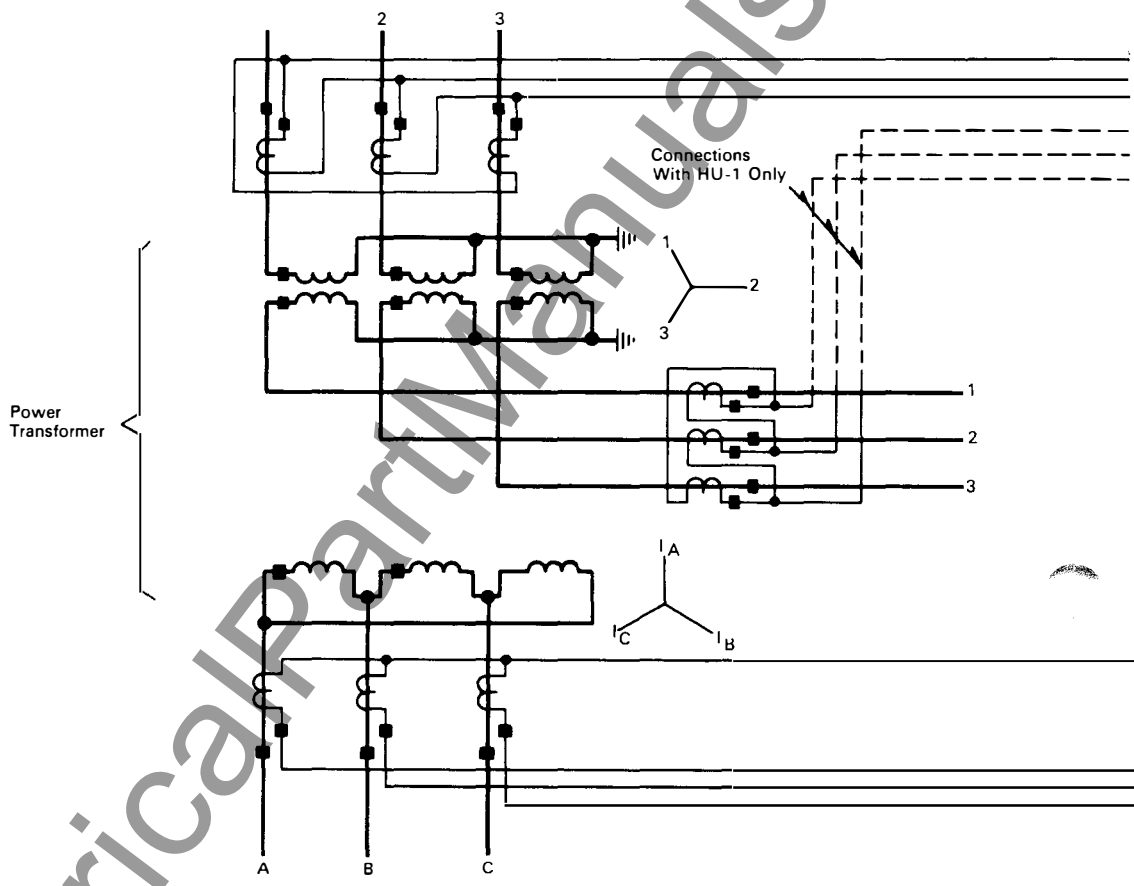
External Wiring HU, HU-1 Relays, Wye-Wye Delta Bank



Device Number Chart

43—Trip Cutoff Switch
86—Type WL Auxiliary Tripping Relay
87—Type HU or HU-1 Differential Relay
DU—Differential Unit
O—Operating Coil
R—Restraint Coil

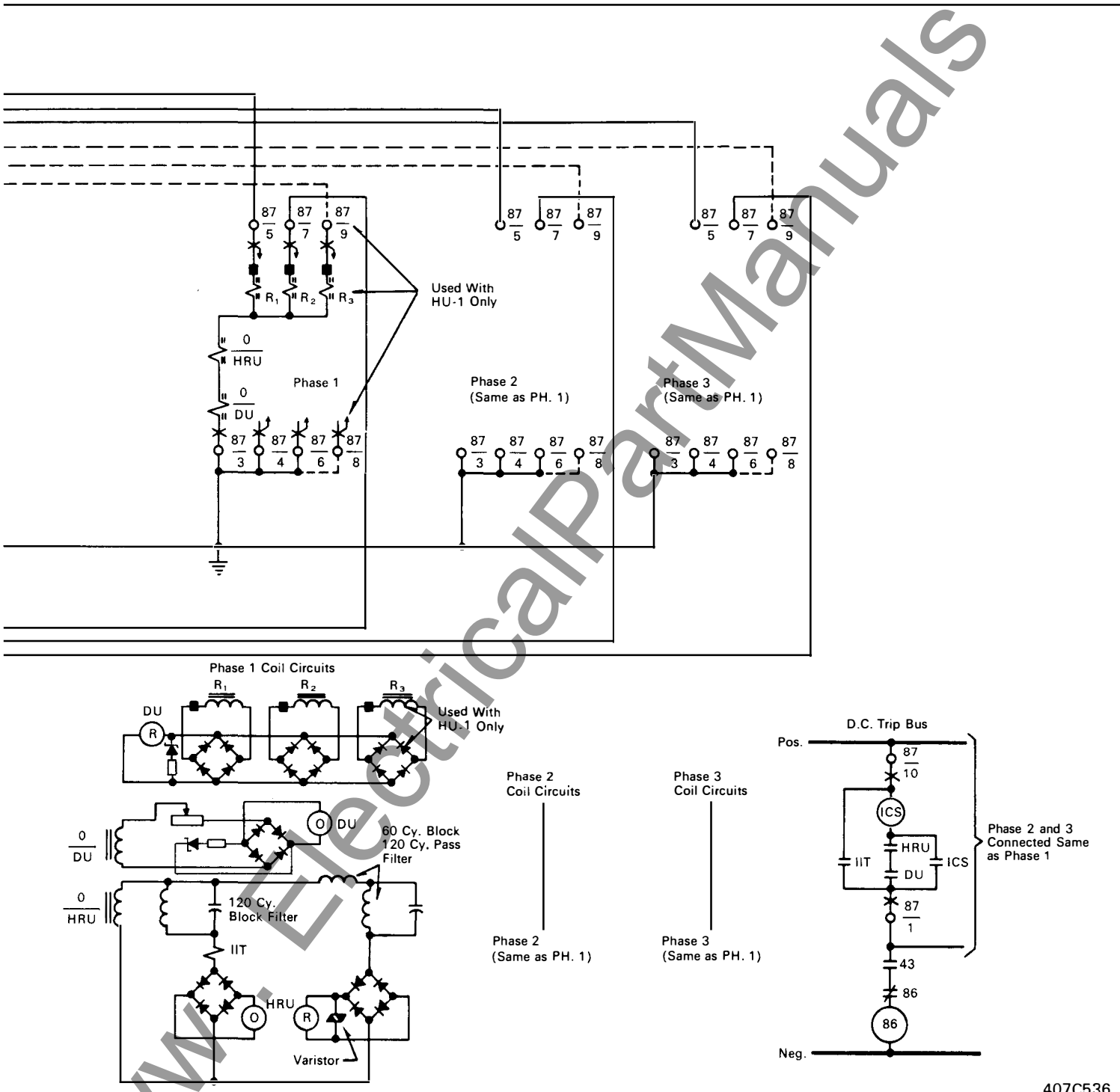
R_1, R_2, R_3 } Through Restraint Transformers

HRU—Harmonic Restraint Unit
O—Operating Coil
R—Restraint Coil
ICS—Indicating Contactor Switch
IIT—Indicating Instantaneous Trip

Fig. 11

Types HU, HU-1, HU-4 Relays

Single Phase Instantaneous
Variable Percentage



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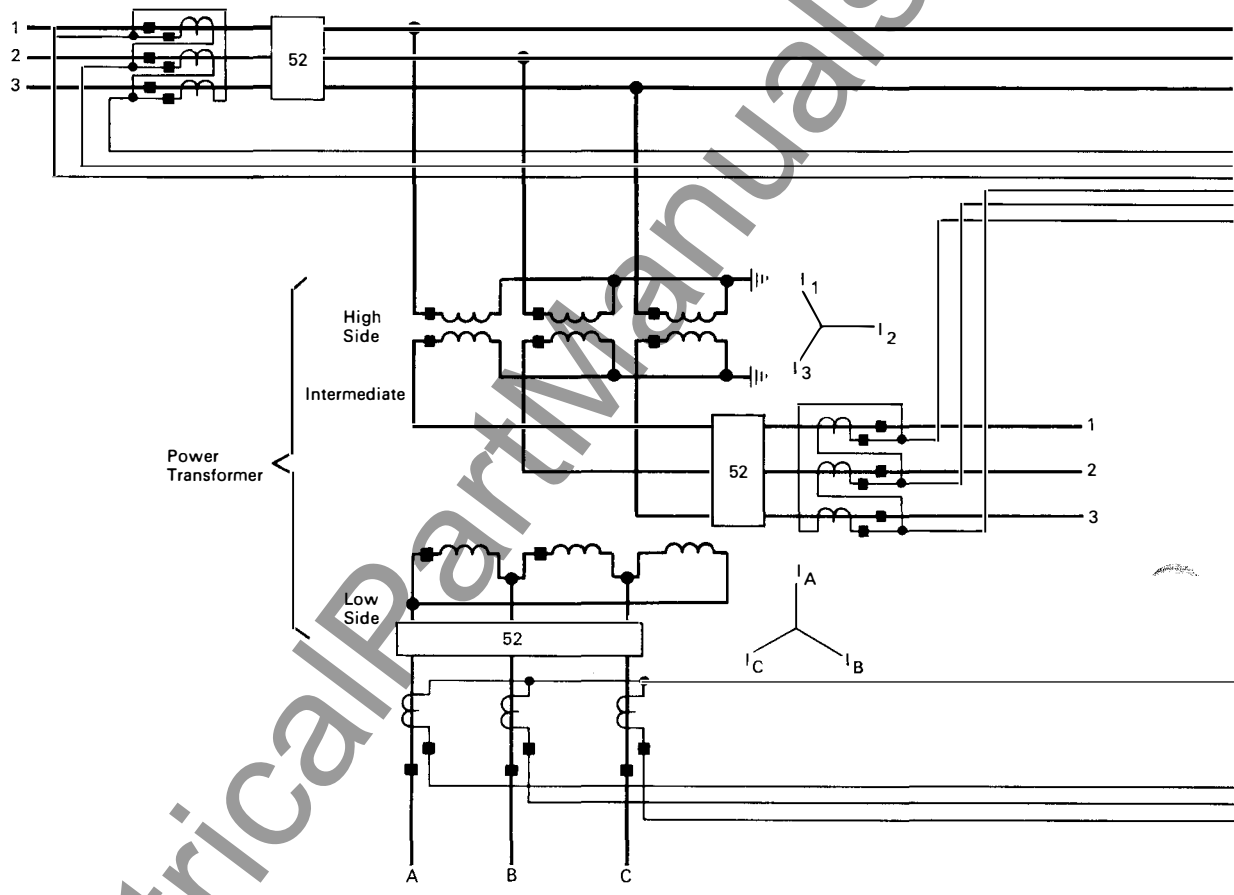
Sub. 5

Westinghouse

External Wiring HU-4 Relay Wye-Wye Delta Bank



Device Number Chart

43—Trip Cutoff Switch
86—Type WL Auxiliary Tripping Relay
87—Type HU-4
DU—Differential Unit
O—Operating Coil
R—Restraint Coil

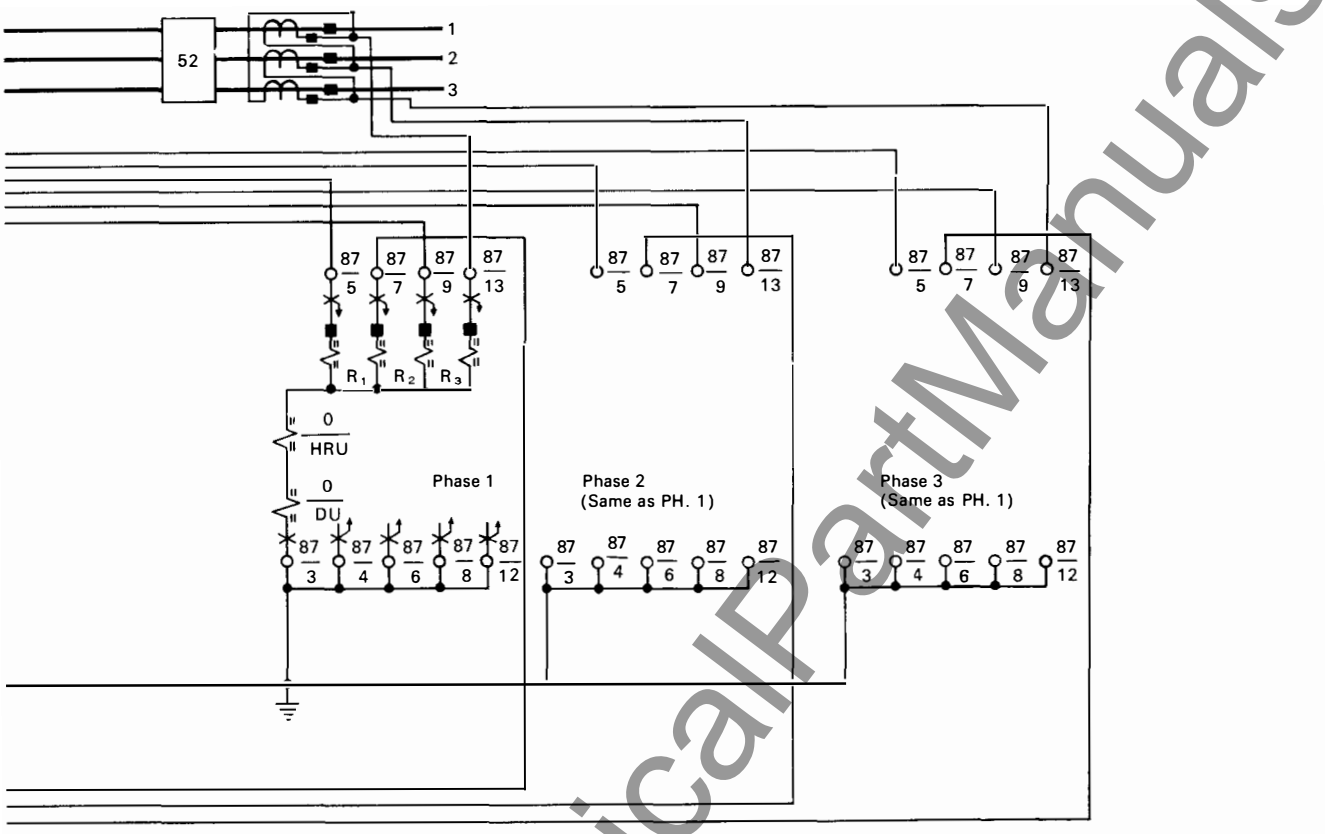
R_1, R_2, R_3 } Through Restraint Transformers

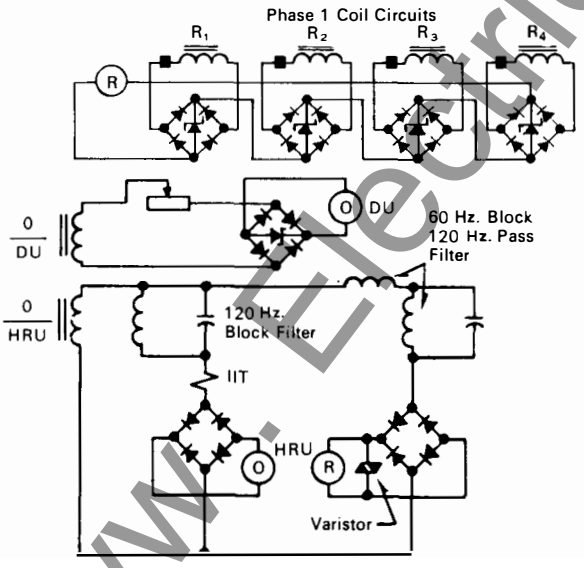
HRU—Harmonic Restraint Unit
O—Operating Coil
R—Restraint Coil
ICS—Indicating Contactor Switch
IIT—Indicating Instantaneous Trip

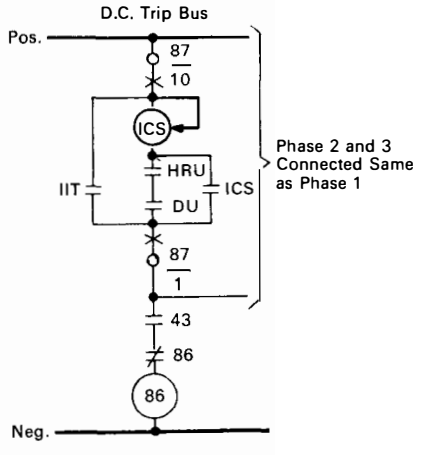
Fig. 12

Types HU, HU-1, HU-4 Relays

Single Phase Instantaneous
Variable Percentage







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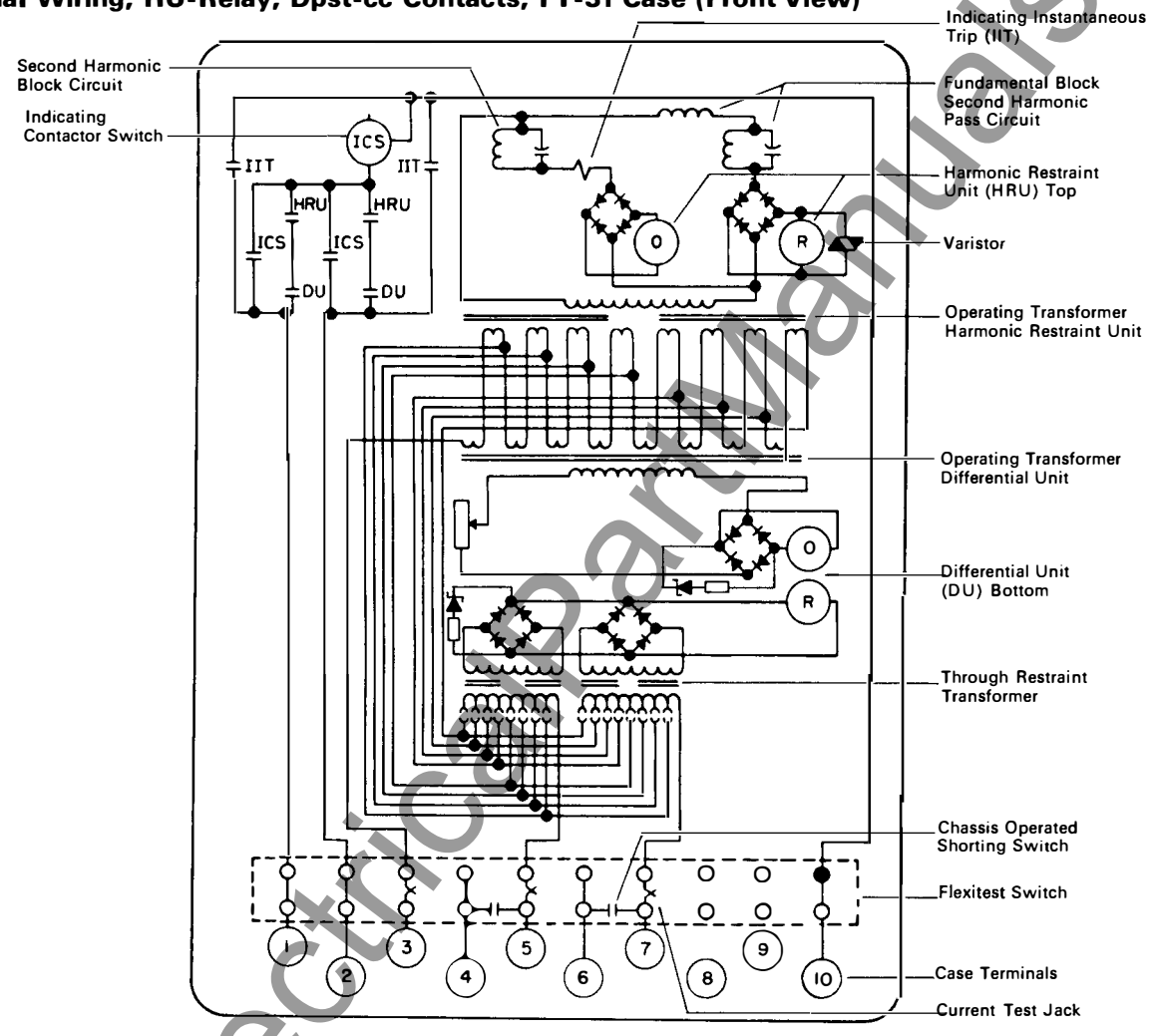
Internal Wiring, HU-Relay, Dpst-cc Contacts, FT-31 Case (Front View)



Note:
Terminals 3-4-6
are to be Jumped at Relay Case

Terminal	Tap Connection
5	Top
7	Middle

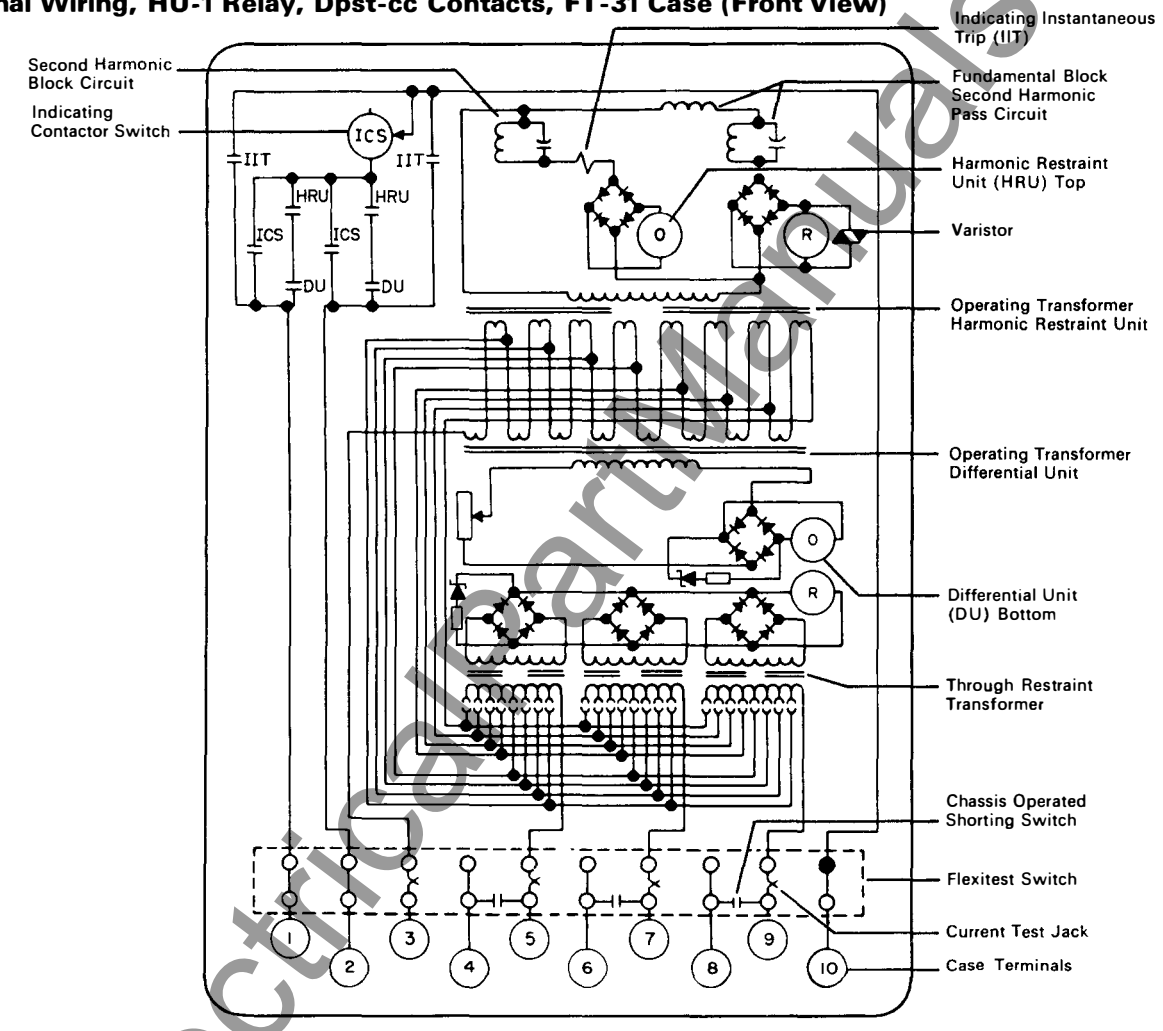
Fig. 13

185A036
Sub. 2

Types HU, HU-1, HU-4 Relays

Single Phase Instantaneous
Variable Percentage

Internal Wiring, HU-1 Relay, Dpst-cc Contacts, FT-31 Case (Front View)



Note:
Terminals 3-4-6-8
are to be Jumped at Relay Case

Terminal	Tap Connection
5	Top
7	Middle
9	Bottom

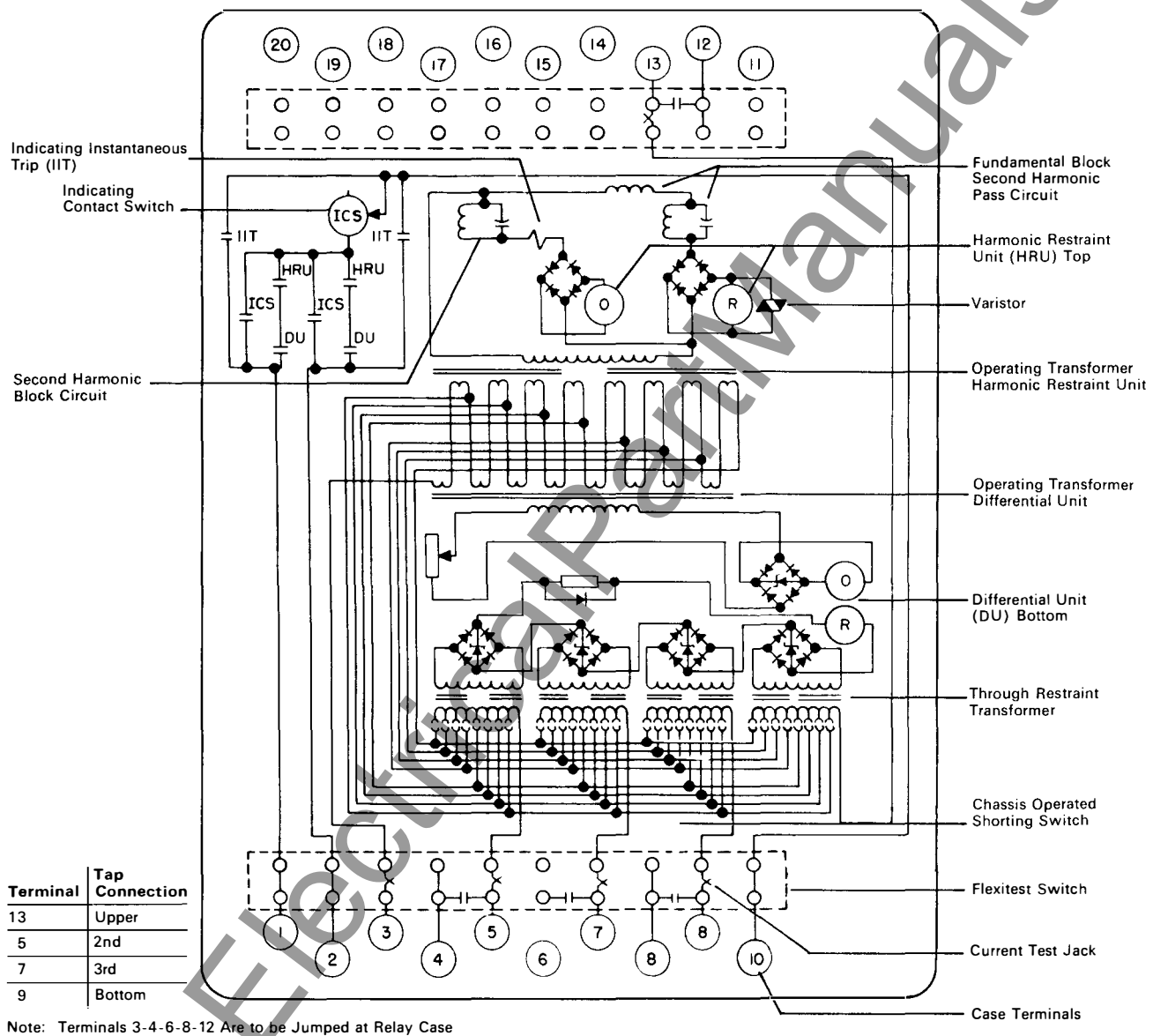
Fig. 14

185A037
Sub. 2

Types HU, HU-1, HU-4 Relays

Single Phase Instantaneous
Variable Percentage

Internal Wiring, HU-4 Relay, Dpst-cc Contacts, With Second Harmonic Restraint, FT-42 Case (Front View)



Terminal	Tap Connection
13	Upper
5	2nd
7	3rd
9	Bottom

Note: Terminals 3-4-6-8-12 Are to be Jumped at Relay Case

Fig. 15 188A542 Sub 4

Further Information

Prices and Ordering Information: PL 41-020
Flexitest Case: DB 41-075
Application Data: AD 41-300
General Instructions:
HU and HU-1: IL 41-347.1/HU-4; L-639965
Other Protective Relays: SG 41-000

Westinghouse Electric Corporation
Relay-Instrument Division: Newark Plant, Newark, N.J. 07101
Printed in U.S.A.

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Relay and Telecommunications Division
Coral Springs, FL 33065

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Mailed to: E, D, C/41-400B

Single Phase Instantaneous Variable Percentage Relays

Types HU, HU-1, HU-4

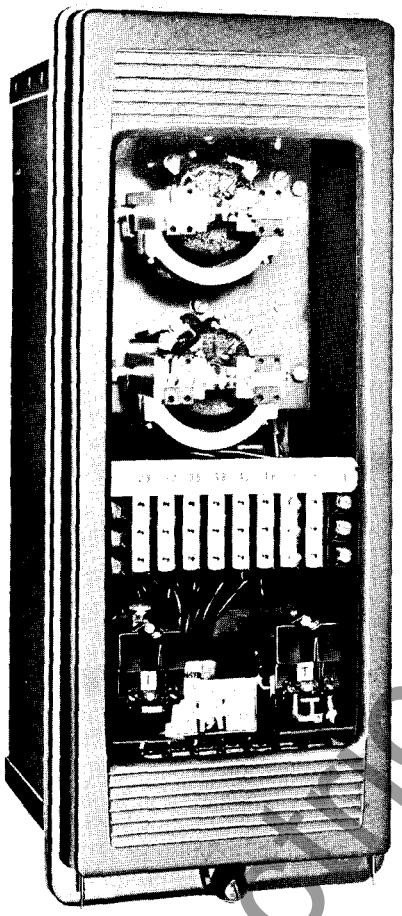

Figure 1

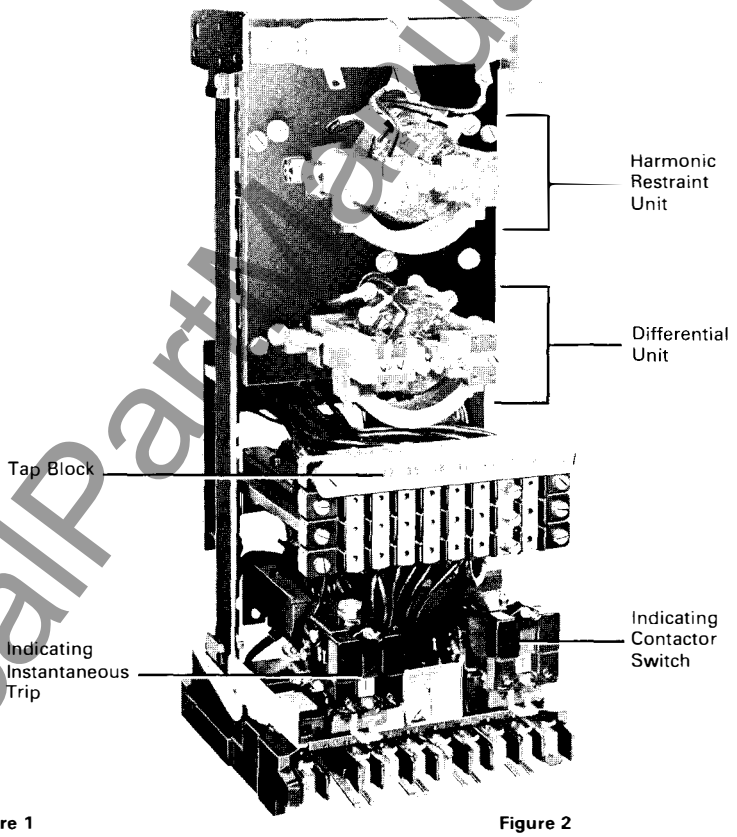

Figure 2

Application

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Features

1. High security due to variable ratio characteristic — The relay detects light internal faults with the transformer and at the same time prevents false tripping on heavy external faults which may cause variation in the current transformer performance at high currents.

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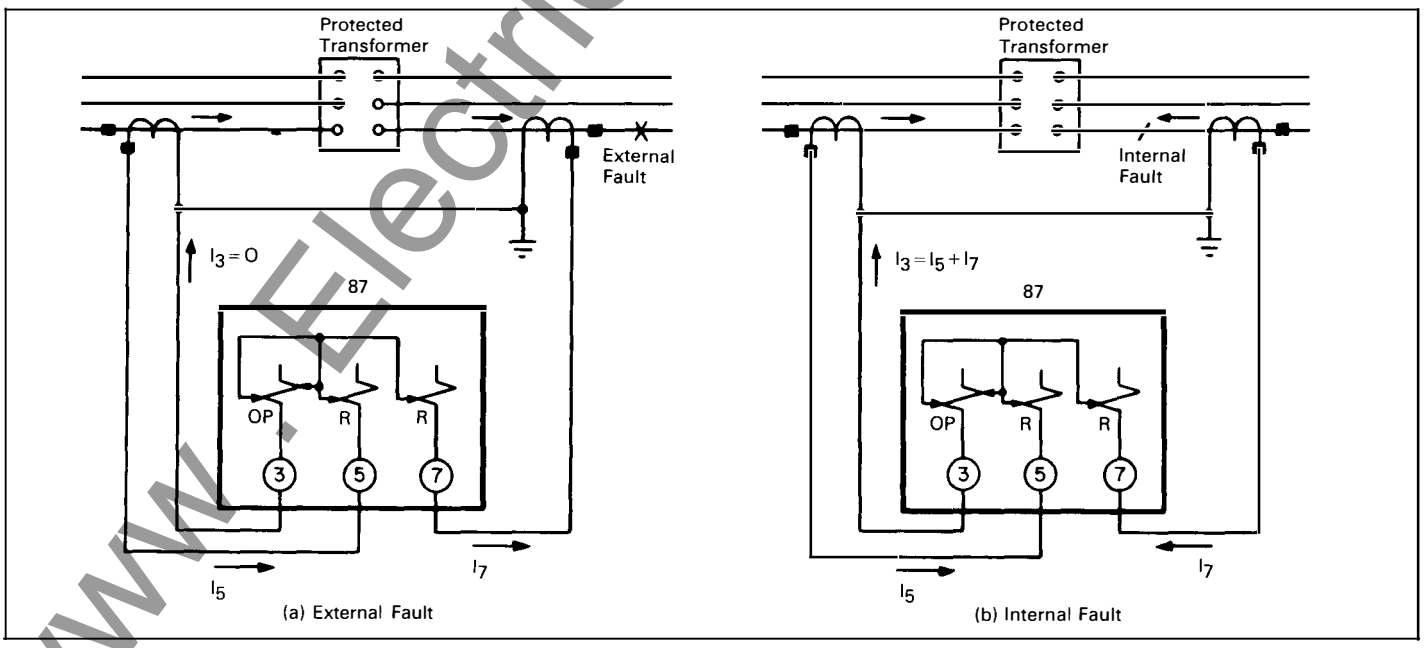

Figure 3. HU-4 simplified external connections showing current distribution for external and internal faults.