# Westinghouse



# **Protective Relays**

Type CO-2, 5, 6, 7, 8, 9, 11 In FT-11 Flexitest Case®



Type CO-2 Overcurrent Relay

#### **Ordering Information**

- · Name the part and give its style number.
- · Give the complete nameplate reading.
- · State method of shipment desired.
- Send all orders or correspondence to nearest sales office of the company.

# Style Numbers of Circuit Closing Relays (50 or 60 Hertz)

Style Num	bers of Circuit	Closing			
Relays (50	or 60 Hertz)	Closing	1956 683 1956 716 1956 751	183A803A26 183A803A27 183A803A28	184A004A14 184A004A17 184A004A18
Single Trip			1956 752 1956 779	183A804A05 183A804A06	184A004A19 184A004A20
1875 221	1875 251	1875 281	1956 782		
1875 222	1875 252	1875 282	1956 837	183A804A07	184A004A21
1875 223	1875 253	1875 283	1956 869	183A804A08 183A804A09	184A004A25
1875 224	1875 254	1875 284	1956 871	183A804A09	184A004A26
1875 225	1875 255	1875 285	1961 014	183A804A10	184A004A27 184A004A28
1875 226	1875 256	1875 286	1961 025	183A804A18	288B545A16
1875 227	1875 257	1875 287	1961 061	183A804A19	288B545A26
1875 228	1875 258	1875 288	1961 339	183A804A20	288B545A27
1875 229	1875 259	1875 289	1961 351	183A804A21	288B545A29
1875 230	1875 260	1875 290	1961 551	183A804A22	288 <b>B545A</b> 30
1875 231	1875 261	1875 291	1961 557	183A804A25	288B545A31
1875 232	1875 262	1875 292	1961 859	183A804A26	288B548A16
1875 233	1875 263	1875 293	1961 911	183A804A27	288B548A27
1875 234	1875 264	1875 294	1962 378	183A804A28	288B548A28
1875 235	1875 265	1875 295	1962 880	183A805A05	288B548A29
1875 236	1875 266	1875 296	1962 989	183A805A06	288B548A30
1875 237	1875 267	1875 297	183A801A05	183A805A07	288B548A31
1875 238	1875 268	1875 298	183A801A06	183A805A08	288B548A32
1875 239	1875 269	1875 299	183A801A07	183A805A09	288B553A20
1875 240	1875 270	1875 300	183A801A08	183A805A10	288B553A25
1875 241	1875 271	1875 301	183A801A09	183A805A11	288B553A26
1875 242	1875 272	1875 302	183A801A10	183A805A12	288B553A27
1875 243	1875 273	1875 303	183A801A17	183A805A13	288B553A28
1875 244	1875 274	1876 900	183A801A18	183A805A15	288B553A31
1875 245	1875 275	1876 901	183A801A19	183A805A17	288B553A32
1875 246	1875 276	1876 902	183A801A20	183A805A18	288B553A33
1875 247	1875 277	1876 903	183A801A21	183A805A19	288B553A34
1875 248	1875 278	1876 904	183A801A25	183A805A20	288B554A25
1875 249	1875 279	1876 905	183A801A26	183A805A21	288B554A33
1875 250	1875 280	1876 906	183A801A27	183A805A22	288B554A34

Non-Torque Control Relays Single Trip, Continued

183A801A28 183A802A05

183A802A06

183A802A07

183A802A08

183A802A09 183A802A10

183A802A13

183A802A14

183A802A17

183A802A18

183A802A19

183A802A20

183A802A21

183A802A25

183A802A26 183A802A27

183A802A28

183A803A05

183A803A06

183A803A07

183A803A08

183A803A09

183A803A13

183A803A17

183A803A18

183A803A19 183A803A20

183A803A21

183A803A25

183A805A23 183A805A25 183A805A26

183A805A27

183A805A28

183A805A29

183A805A30 183A806A05

183A806A06

1876 907 1877 981

1878 040

1878 041 1878 042

1878 043

1878 044

1878 045

1878 046

1878 943

1955 358

1955 701

1956 000

1956 030

1956 116

1956 119

1956 125

1956 174

1956 345

1956 405

1956 406

1956 492

1956 516

1956 547

1956 548

1956 634

1956 635

1956 641 1956 642

1956 682

Non-Torque	Control	Relays
Single Trip,	Continued	<i>i</i>

288B560A16	288 <b>B561A3</b> 0
288B560A26	288B561A31
288B561A12	288B561A32
288B561A16	288B562A16
288B561A26	

#### Non-Torque Control Relays Double Trip

184A004A07       1875       331       1875       376       288B880A2:         184A004A09       1875       332       1875       377       288B880A2:         184A004A09       1875       333       1875       378       288B880A2:         184A004A10       1875       334       1875       379       288B880A3:         184A004A13       1875       335       1875       380       288B880A3:         184A004A14       1875       336       1875       381       288B887A2:         184A004A17       1875       337       1875       382       288B887A2:         184A004A17       1875       336       1875       381       288B887A2:         184A004A19       1875       339       1875       382       288B888A2:         184A004A20       1875       339       1875       384       288B888A2:         184A004A21       1875       341       1875       386       288B890A2:         184A004A25       1875       342       1875       387       288B890A2:         184A004A26       1875       344       1875       389       288B890A2:         184A004A27       1875       344       1875	183A806A08         1875         315         1875         360           183A806A09         1875         317         1875         361           183A806A10         1875         317         1875         362           183A806A10         1875         318         1875         363           183A806A17         1875         318         1875         363           183A806A18         1875         319         1875         364           183A806A19         1875         320         1875         365           183A806A20         1875         321         1875         366           183A806A21         1875         322         1875         368           183A806A22         1875         323         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         324         1875         370           183A806A26         1875         322         1875         371           183A806A27         1875         322         1875         372           183A806A28         1875         322         1875         373           184A004A06	1878 892 1878 934 1878 941 1878 942 1878 942 1878 987 1955 309 1955 325 1956 303 1956 840 1961 36 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27
1875 315 1875 360 1878 392 183A806A08 1875 316 1875 361 1878 934 183A806A09 1875 317 1875 362 1878 941 183A806A10 1875 318 1875 363 1878 942 183A806A17 183A806A18 1875 319 1875 365 1955 309 183A806A19 1875 320 1875 365 1955 309 183A806A20 1875 321 1875 366 1955 325 183A806A21 1875 322 1875 367 1956 303 183A806A21 1875 322 1875 367 1956 303 183A806A21 1875 324 1875 368 1956 840 183A806A22 1875 324 1875 370 1962 348 183A806A25 1875 324 1875 370 1962 348 183A806A26 1875 324 1875 370 1962 348 183A806A26 1875 324 1875 370 1962 348 183A806A26 1875 326 1875 371 1962 569 183A806A27 1875 327 1875 372 1963 234 183A806A28 1875 328 1875 373 1963 496 1875 330 1875 374 1963 294 184A004A06 1875 331 1875 376 2888880A2: 184A004A07 1875 331 1875 376 2888880A2: 184A004A09 1875 333 1875 376 2888880A2: 184A004A10 1875 331 1875 376 2888880A2: 184A004A10 1875 331 1875 379 2888880A2: 184A004A11 1875 336 1875 380 2888880A2: 184A004A12 1875 331 1875 380 2888880A2: 184A004A14 1875 336 1875 381 2888880A2: 184A004A15 1875 331 1875 380 2888880A2: 184A004A16 1875 331 1875 380 2888880A2: 184A004A17 1875 331 1875 380 2888880A2: 184A004A18 1875 339 1875 381 2888880A2: 184A004A20 1875 339 1875 381 2888880A2: 184A004A21 1875 339 1875 381 2888880A2: 184A004A21 1875 339 1875 382 2888880A2: 184A004A21 1875 341 1875 389 28888890A1: 184A004A21 1875 341 1875 389 28888890A2: 184B8545A21 1875 341 1875 390 28888891A2: 2888545A31 1875 361 1875 390 2888891A3: 2888545A31 1875 361 1875 390 2888891A3: 2888545A31 1875 361 1875 390 2888891A3: 2888548A29 1875 369 1876 911 2888548A29 1875 353 1876 912 2888548A29 1875 353 1876 912 2888548A29 1875 353 1876 914 2888548A29 1875 353 1876 914 2888553A20 2888553A27 2888553A26 2888553A27	1875         315         1875         360           183A806A08         1875         316         1875         361           183A806A09         1875         317         1875         362           183A806A10         1875         318         1875         363           183A806A17         1875         319         1875         364           183A806A18         1875         320         1875         365           183A806A19         1875         321         1875         366           183A806A20         1875         322         1875         367           183A806A21         1875         323         1875         368           183A806A22         1875         323         1875         368           183A806A22         1875         322         1875         370           183A806A25         1875         324         1875         370           183A806A26         1875         322         1875         371           183A806A27         1875         322         1875         373           184A004A05         1875         328         1875         373           184A004A06         1875         329 <td>1878 892 1878 934 1878 941 1878 942 1878 942 1878 987 1955 309 1955 325 1956 303 1956 840 1961 36 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27</td>	1878 892 1878 934 1878 941 1878 942 1878 942 1878 987 1955 309 1955 325 1956 303 1956 840 1961 36 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27
183A806A08       1875       316       1875       361       1878       934         183A806A10       1875       317       1875       362       1878       941         183A806A10       1875       318       1875       362       1878       941         183A806A17       1875       319       1875       364       1878       942         183A806A18       1875       320       1875       365       1955       309         183A806A20       1875       321       1875       366       1955       325         183A806A21       1875       322       1875       367       1956       303         183A806A22       1875       324       1875       368       1956       840         183A806A25       1875       324       1875       369       1961       036       186       186       348       1956       840         183A806A27       1875       322       1875       370       1962       348       183       1963       394       1875       372       1963       234       1875       372       1863       394       1875       373       1963       394       1875       373 <td>183A806A08         1875         316         1875         361           183A806A09         1875         317         1875         362           183A806A10         1875         318         1875         363           183A806A17         183A806A18         1875         319         1875         364           183A806A19         1875         320         1875         366           183A806A20         1875         321         1875         367           183A806A21         1875         322         1875         367           183A806A22         1875         323         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         325         1875         370           183A806A26         1875         322         1875         371           183A806A27         1875         322         1875         372           183A806A28         1875         327         1875         372           183A806A28         1875         328         1875         373           184A004A06         1875         329         1875         374</td> <td>1878 934 1878 941 1878 942 1878 987 1955 309 1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A26 288B880A26</td>	183A806A08         1875         316         1875         361           183A806A09         1875         317         1875         362           183A806A10         1875         318         1875         363           183A806A17         183A806A18         1875         319         1875         364           183A806A19         1875         320         1875         366           183A806A20         1875         321         1875         367           183A806A21         1875         322         1875         367           183A806A22         1875         323         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         325         1875         370           183A806A26         1875         322         1875         371           183A806A27         1875         322         1875         372           183A806A28         1875         327         1875         372           183A806A28         1875         328         1875         373           184A004A06         1875         329         1875         374	1878 934 1878 941 1878 942 1878 987 1955 309 1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A26 288B880A26
183A806A09 1875 317 1875 362 1878 941 183A806A17 183A806A17 1875 318 1875 363 1878 942 183A806A17 183A806A18 1875 319 1875 364 1878 942 1875 320 1875 365 1955 309 183A806A20 1875 322 1875 367 1956 303 183A806A21 1875 322 1875 367 1956 303 183A806A22 1875 323 1875 368 1956 840 183A806A22 1875 324 1875 369 1961 036 1875 325 1875 370 1962 348 183A806A22 1875 326 1875 371 1962 569 183A806A26 1875 326 1875 371 1962 569 183A806A27 1875 327 1875 372 1963 234 183A806A28 1875 328 1875 372 1963 234 184A004A06 1875 329 1875 373 1963 496 184A004A06 1875 330 1875 375 288B880A2 184A004A01 1875 330 1875 376 288B880A2 184A004A01 1875 331 1875 376 288B880A2 184A004A01 1875 333 1875 378 288B880A2 184A004A01 1875 336 1875 380 288B880A2 184A004A11 1875 336 1875 380 288B880A2 184A004A11 1875 336 1875 381 288B880A2 184A004A12 1875 339 1875 381 288B880A2 188A004A11 1875 340 1875 381 288B880A2 188A004A1 1875 340 1875 380 288B880A2 188A004A1 1875 341 1875 360 288B880A2 1875 342 1875 381 288B880A2 188A004A1 1875 341 1875 380 288B880A2 188B80A2 188B80A	183A806A09         1875         317         1875         362           183A806A10         1875         318         1875         363           183A806A17         1875         319         1875         364           183A806A19         1875         321         1875         365           183A806A20         1875         322         1875         367           183A806A21         1875         322         1875         368           183A806A22         1875         322         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         325         1875         370           183A806A26         1875         326         1875         371           183A806A27         1875         327         1875         372           183A806A28         1875         322         1875         373           184A004A05         1875         328         1875         373           184A004A06         1875         329         1875         375           184A004A07         1875         331         1875         376           184A004A08	1878 941 1878 942 1878 987 1955 309 1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A26 288B880A27
183A806A10       1875       318       1875       363       1878       342         183A806A18       1875       319       1875       364       1878       987         183A806A19       1875       320       1875       365       1955       309         183A806A20       1875       321       1875       366       1955       325         183A806A21       1875       322       1875       367       1966       303         183A806A22       1875       322       1875       368       1956       840         183A806A25       1875       322       1875       369       1961       036         183A806A26       1875       322       1875       370       1962       348         183A806A27       1875       322       1875       371       1962       2569         183A806A28       1875       322       1875       371       1962       2569         183A806A28       1875       322       1875       371       1962       234         184A004A05       1875       329       1875       373       1963       294         184A004A07       1875       331       1875	183A806A10         1875         318         1875         363           183A806A17         1875         319         1875         364           183A806A18         1875         320         1875         365           183A806A19         1875         320         1875         365           183A806A20         1875         322         1875         367           183A806A21         1875         322         1875         368           183A806A22         1875         322         1875         369           183A806A25         1875         324         1875         370           183A806A26         1875         326         1875         370           183A806A27         1875         322         1875         371           183A806A28         1875         328         1875         373           184A004A05         1875         329         1875         374           184A004A06         1875         331         1875         376           184A004A07         1875         331         1875         377           184A004A09         1875         333         1875         378	1878 942  1878 987 1955 309 1955 325 1956 303 1956 840  1961 036 1962 348 1962 569 1963 234 1963 496  1963 914 288B880A26 288B880A27 288B880A27
183A806A17 183A806A18 1875 1875 1875 1875 1875 1875 1875 18	183A806A17         1875 319         1875 364           183A806A18         1875 320         1875 365           183A806A19         1875 321         1875 366           183A806A20         1875 322         1875 367           183A806A21         1875 322         1875 368           183A806A22         1875 324         1875 369           183A806A25         1875 325         1875 370           183A806A26         1875 326         1875 371           183A806A27         1875 327         1875 372           183A806A28         1875 328         1875 372           183A806A28         1875 328         1875 373           184A004A06         1875 329         1875 374           184A004A07         1875 330         1875 375           184A004A08         1875 332         1875 375           184A004A09         1875 332         1875 377           184A004A09         1875 333         1875 378	1878 987 1955 309 1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27
183A806A18         1875         319         1875         366         1875         320           183A806A19         1875         321         1875         366         1955         325           183A806A20         1875         322         1875         367         1956         303           183A806A22         1875         323         1875         368         1966         840           183A806A22         1875         324         1875         369         1961         036           183A806A25         1875         326         1875         370         1962         348           183A806A26         1875         322         1875         371         1962         569           183A806A28         1875         328         1875         372         1962         234           183A806A28         1875         328         1875         372         1962         234           183A806A28         1875         328         1875         372         1963         234           184A004A06         1875         329         1875         374         1963         248           184A004A08         1875         331         1875	183A806A18         1875         319         1875         364           183A806A19         1875         320         1875         365           183A806A20         1875         322         1875         367           183A806A21         1875         323         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         324         1875         370           183A806A26         1875         326         1875         371           183A806A27         1875         327         1875         372           183A806A28         1875         328         1875         373           184A004A05         1875         329         1875         374           184A004A06         1875         330         1875         375           184A004A08         1875         331         1875         376           184A004A09         1875         333         1875         378	1955 309 1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27
183A806A19 1875 320 1875 366 1955 309 183A806A20 1875 321 1875 366 1955 309 183A806A21 1875 322 1875 367 1956 303 183A806A22 1875 323 1875 368 1956 840 183A806A22 1875 325 1875 370 1962 348 1875 325 1875 370 1962 348 1875 325 1875 370 1962 348 183A806A26 1875 326 1875 371 1962 569 183A806A27 1875 328 1875 371 1962 569 183A806A27 1875 328 1875 371 1962 569 184A004A05 1875 328 1875 373 1963 496 184A004A06 1875 329 1875 373 1963 496 184A004A06 1875 330 1875 375 288B880A2 184A004A08 1875 331 1875 376 288B880A2 184A004A09 1875 331 1875 376 288B880A2 184A004A10 1875 333 1875 378 288B880A2 184A004A10 1875 336 1875 378 288B880A2 184A004A10 1875 336 1875 381 288B880A2 184A004A11 1875 336 1875 381 288B880A2 184A004A11 1875 336 1875 381 288B880A2 184A004A19 1875 331 1875 379 288B880A2 184A004A19 1875 331 1875 379 288B880A2 184A004A19 1875 336 1875 381 288B880A2 188A8004A1 1875 381 288B880A2 188A8004A2 1875 341 1875 382 288B880A2 188A8004A2 1875 343 1875 383 288B880A2 188A8004A2 1875 343 1875 383 288B880A2 188A8004A2 1875 343 1875 384 288B880A2 188A8004A2 1875 343 1875 384 288B880A2 188A8004A2 1875 343 1875 389 288B880A2 188A8004A2 1875 348 1875 391 288B880A2 188A8004A2 1875 349 1875 391 288B880A2 188A8004A2 1875 391 288B880A2 188A80A2 188A80A2 188A80A2 188A80A2 188A80A2 188A80A2 1	1875         320         1875         365           183A806A19         1875         321         1875         366           183A806A20         1875         322         1875         367           183A806A21         1875         323         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         325         1875         370           183A806A26         1875         327         1875         372           183A806A27         1875         327         1875         373           184A004A05         1875         328         1875         373           184A004A06         1875         329         1875         375           184A004A07         1875         331         1875         376           184A004A08         1875         332         1875         377           184A004A09         1875         333         1875         378	1955 309 1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27
183A806A19       1875       321       1875       366       1955       325         183A806A20       1875       322       1875       368       1956       803         183A806A22       1875       323       1875       368       1956       840         183A806A22       1875       324       1875       369       1961       036         183A806A26       1875       326       1875       371       1962       569         183A806A27       1875       327       1875       372       1963       234         183A806A28       1875       328       1875       372       1963       234         183A806A28       1875       328       1875       373       1963       496         184A004A06       1875       329       1875       374       1963       496         184A004A07       1875       331       1875       376       288B880A2       184A004A09       1875       331       1875       377       288B880A2         184A004A10       184A004A11       1875       334       1875       380       288B880A3         184A004A14       1875       336       1875       381       28	183A806A19         1875         321         1875         366           183A806A20         1875         322         1875         367           183A806A21         1875         323         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         325         1875         370           183A806A26         1875         326         1875         372           183A806A27         1875         327         1875         372           183A806A28         1875         328         1875         373           184A004A05         1875         329         1875         374           184A004A06         1875         330         1875         375           184A004A08         1875         331         1875         377           184A004A09         1875         332         1875         378	1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27
183A806A19       1875       321       1875       366       1956       303         183A806A20       1875       322       1875       368       1956       840         183A806A21       1875       323       1875       368       1956       840         183A806A22       1875       324       1875       369       1961       036         183A806A26       1875       326       1875       370       1962       248         183A806A27       1875       322       1875       371       1963       234         183A806A27       1875       322       1875       372       1963       234         183A806A28       1875       328       1875       373       1963       294         184A004A06       1875       329       1875       375       288B880A2       184A004A0       1875       331       1875       376       288B880A2         184A004A08       1875       332       1875       377       288B880A2       184A004A0       1875       333       1875       378       288B880A2       184A004A1       1875       334       1875       379       288B8880A2       1875       381       288B8880A3	183A806A20         1875         322         1875         367           183A806A21         1875         323         1875         368           183A806A22         1875         324         1875         369           183A806A25         1875         325         1875         370           183A806A26         1875         326         1875         371           183A806A27         1875         327         1875         372           183A806A28         1875         328         1875         373           184A004A05         1875         328         1875         373           184A004A06         1875         329         1875         375           184A004A07         1875         331         1875         376           184A004A08         1875         332         1875         377           184A004A09         1875         333         1875         378	1955 325 1956 303 1956 840 1961 036 1962 348 1962 569 1963 234 1963 496 1963 914 288B880A26 288B880A27 288B880A27
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183A806A28         1875         328         1875         373         1963         496           184A004A06         1875         329         1875         374         1963         914           184A004A07         1875         330         1875         375         288B880A2           184A004A08         1875         331         1875         376         288B880A2           184A004A09         1875         332         1875         377         288B880A2           184A004A10         1875         333         1875         378         288B880A3           184A004A13         1875         336         1875         380         288B880A3           184A004A14         1875         336         1875         381         288B880A3           184A004A17         1875         336         1875         381         288B887A2           184A004A19         1875         338         1875         382         288B888A2           184A004A19         1875         349         1875         384         288B888A2           184A004A29         1875         341         1875         384         288B888A2           184A004A25         1875         342	183A806A28     1875     328     1875     373       184A004A05     1875     329     1875     374       184A004A07     1875     330     1875     375       184A004A07     1875     331     1875     376       184A004A08     1875     332     1875     377       184A004A09     1875     333     1875     378	1963 496 1963 914 288B880A26 288B880A27 288B880A28
184A004A05         1875 329         1875 374         1963 914           184A004A06         1875 330         1875 375         288B880A2           184A004A07         1875 331         1875 376         288B880A2           184A004A08         1875 332         1875 377         288B880A2           184A004A10         1875 333         1875 379         288B880A2           184A004A13         1875 334         1875 379         288B880A3           184A004A13         1875 335         1875 380         288B880A3           184A004A14         1875 336         1875 381         288B880A3           184A004A17         1875 337         1875 382         288B88A23           184A004A18         1875 338         1875 381         288B88A23           184A004A19         1875 339         1875 384         288B88A23           184A004A20         1875 340         1875 386         288B88A23           184A004A21         1875 342         1875 387         288B890A21           184A004A25         1875 342         1875 388         288B890A21           184A004A26         1875 343         1875 389         288B890A21           184A004A27         184A004A26         1875 344         1875 390         288B891A21 <td>184A004A05       184A004A06     1875 329     1875 374       1875 330     1875 375       184A004A07     1875 331     1875 376       184A004A08     1875 332     1875 377       184A004A09     1875 333     1875 378</td> <td>1963 914 288B880A26 288B880A27 288B880A28</td>	184A004A05       184A004A06     1875 329     1875 374       1875 330     1875 375       184A004A07     1875 331     1875 376       184A004A08     1875 332     1875 377       184A004A09     1875 333     1875 378	1963 914 288B880A26 288B880A27 288B880A28
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184A004A10 184A004A13 1875 334 1875 335 1875 380 288B880A31 184A004A14 1875 336 1875 381 288B887A21 184A004A17 1875 337 1875 382 288B887A21 184A004A18 1875 338 1875 383 288B88A23 184A004A19 184A004A20 1875 339 1875 340 1875 340 1875 340 1875 340 1875 385 288B889A21 184A004A21 1875 340 1875 340 1875 386 288B89A21 184A004A25 1875 341 1875 386 288B89A21 184A004A26 1875 342 1875 387 288B890A11 184A004A27 184A004A26 1875 344 1875 388 288B890A21 184A004A27 184A004A28 1875 344 1875 389 288B89A21 288B8545A16 1875 344 1875 390 288B89A21 288B8545A26 1875 344 1875 391 288B891A21 288B8545A27 288B545A27 1875 348 1875 393 288B891A31 288B891A32 288B894A21 1875 350 1875 394 288B894A21 288B84A29 288B54A21 1875 350 1875 394 288B894A21 1875 351 1875 396 288B894A21 288B854A21 1875 351 1876 390 288B891A32 288B894A31 1875 351 1876 390 288B894A31 1875 351 1876 391 288B894A31 288B894A31 1875 351 1876 390 288B894A31 288B894A31 1875 351 1876 391 288B894A31 2	4044004440	288B880 <b>A</b> 29
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184A004A14         1875         336         1875         381         288B887A2!           184A004A17         1875         337         1875         382         288B887A2!           184A004A19         1875         338         1875         383         288B888A2!           184A004A20         1875         339         1875         384         288B889A2!           184A004A21         1875         341         1875         386         288B890A1!           184A004A25         1875         342         1875         387         288B890A2!           184A004A26         1875         343         1875         388         288B890A2!           184A004A27         1875         344         1875         389         288B890A2!           184A004A27         1875         344         1875         389         288B891A2!           288B545A26         1875         344         1875         399         288B891A2!           288B545A26         1875         344         1875         390         288B891A2!           288B545A27         1875         348         1875         391         288B891A3!           288B545A29         1875         349         1875 <t< td=""><td></td><td></td></t<>		
184A004A17         1875         337         1875         382         288B887A21           184A004A18         1875         338         1875         383         288B888A21           184A004A19         1875         339         1875         384         288B888A21           184A004A20         1875         340         1875         386         288B890A21           184A004A21         1875         341         1875         386         288B890A11           184A004A26         1875         342         1875         387         288B890A21           184A004A26         1875         343         1875         388         288B890A21           184A004A26         1875         343         1875         388         288B890A21           184A004A27         1875         344         1875         389         288B890A22           288B545A16         1875         345         1875         390         288B891A22           288B545A26         1875         347         1875         392         288B891A22           288B545A27         1875         348         1875         393         288B891A32           288B548A31         1875         348         1875 <t< td=""><td></td><td></td></t<>		
184A004A18         1875         338         1875         383         288B888A2:           184A004A19         1875         339         1875         384         288B889A2:           184A004A20         1875         340         1875         385         288A889A2:           184A004A21         1875         341         1875         386         288B890A1:         288B890A1:           184A004A25         1875         342         1875         387         288B890A2:         288B890A2:           184A004A26         1875         342         1875         389         288B890A2:           184A004A27         1875         344         1875         389         288B890A2:           184A004A28         1875         344         1875         390         288B890A2:           288B545A16         1875         344         1875         391         288B891A2:           288B545A29         1875         348         1875         392         288B891A3:           288B545A29         1875         348         1875         394         288B891A3:           288B548A29         1875         350         1875         394         288B891A3:           288B548A21         1875 <td></td> <td></td>		
184A004A19       1875 339       1875 384       288B889A2*         184A004A20       1875 340       1875 385       288A889A2*         184A004A21       1875 341       1875 386       288B890A1*         184A004A25       1875 342       1875 387       288B890A1*         184A004A26       1875 343       1875 388       288B890A2*         184A004A27       1875 344       1875 389       288B890A2*         288B545A16       1875 345       1875 390       288B891A2*         288B545A26       1875 346       1875 391       288B891A2*         288B545A27       1875 348       1875 392       288B891A3*         288B545A29       1875 349       1875 393       288B891A3*         288B545A31       1875 349       1875 394       288B891A3*         288B548A29       1875 351       1875 396       288B891A3*         288B548A28       1875 352       1876 908       288B548A2*         288B548A29       1875 354       1876 910       1875 355         288B548A29       1875 356       1876 912       188B548A2*         288B548A29       1875 356       1876 912       188B548A2*         288B548A31       1875 356       1876 912       188B548A2*		288B887A28
184A004A20         1875         339         1875         384         288B889A2:         288A889A21         184A004A21         1875         340         1875         386         288A889A21         288A889A21         184A004A25         1875         341         1875         386         288B890A1:         288B890A21         184A004A26         1875         342         1875         387         288B890A22         288B890A22 <td< td=""><td>184A004A18</td><td>288B888A29</td></td<>	184A004A18	288B888A29
184A004A21         1875         340         1875         385         288A889A21           184A004A25         1875         341         1875         386         288B890A1           184A004A25         1875         342         1875         387         288B890A21           184A004A26         1875         343         1875         388         288B890A21           184A004A27         1875         343         1875         389         288B890A21           184A004A28         1875         344         1875         390         288B890A22           288B545A21         1875         346         1875         391         288B891A21           288B545A26         1875         347         1875         392         288B891A22           288B545A27         1875         348         1875         392         288B891A31           288B545A31         1875         349         1875         394         288B891A31           288B548A31         1875         350         1875         394         288B891A32           288B548A28         1875         353         1876         908           288B548A28         1875         354         1876         910		
1875         340         1875         385         288A889A28           184A004A21         1875         341         1875         386         288B890A12           184A004A25         1875         342         1875         387         288B890A12           184A004A26         1875         343         1875         388         288B890A29           184A004A27         1875         344         1875         389         288B890A29           288B545A16         1875         344         1875         390         288B891A29           288B545A26         1875         346         1875         391         288B891A29           288B545A27         1875         348         1875         392         288B891A31           288B545A29         1875         348         1875         392         288B891A31           288B545A31         1875         349         1875         394         288B891A32           288B548A31         1875         350         1875         394         288B891A32           288B548A29         1875         353         1876         909           288B548A31         1875         354         1876         909           288B548A32 <td>184A004A20 1875 339 1875 384</td> <td>2888889427</td>	184A004A20 1875 339 1875 384	2888889427
184A004A21         1875         341         1875         386         288B890A12           184A004A25         1875         342         1875         387         288B890A12           184A004A26         1875         343         1875         388         288B890A22           184A004A27         1875         344         1875         389         288B890A22           184A004A28         1875         344         1875         390         288B891A22           288B545A16         1875         346         1875         391         288B891A22           288B545A26         1875         347         1875         392         288B891A32           288B545A27         1875         348         1875         392         288B891A32           288B545A29         1875         348         1875         393         288B891A32           288B545A31         1875         349         1875         394         288B891A32           288B548A29         1875         350         1875         396         288B891A32           288B548A28         1875         353         1876         908         288B548A28           288B548A29         1875         354         1876 <t< td=""><td></td><td></td></t<>		
184A004A25         1875         342         1875         387         288B890A12           184A004A26         1875         343         1875         388         288B890A22           184A004A27         1875         344         1875         389         288B890A22           184A004A28         1875         344         1875         390         288B891A2           288B545A16         1875         346         1875         391         288B891A2           288B545A26         1875         347         1875         392         288B891A2           288B545A27         1875         348         1875         392         288B891A2           288B545A29         1875         348         1875         393         288B891A3           288B545A31         1875         350         1875         394         288B891A3           288B548A31         1875         351         1875         396         288B548A2           288B548A29         1875         352         1876         908         288B548A2           288B548A29         1875         354         1876         910         1875         355         1876         911           288B548A31         1875		
184A004A26         1875         343         1875         388         288B890A20           184A004A27         184A004A28         1875         344         1875         389         288B890A20           288B545A16         1875         345         1875         390         288B891A20           288B545A26         1875         346         1875         391         288B891A20           288B545A27         1875         348         1875         392         288B891A31           288B545A29         1875         348         1875         392         288B891A31           288B545A31         1875         348         1875         393         288B891A31           288B548A31         1875         350         1875         394         288B891A32           288B548A29         1875         351         1875         396         288B891A32           288B548A29         1875         352         1876         908         288B548A29           288B548A29         1875         353         1876         909         288B548A31         1875         356         1876         91           288B548A31         1875         356         1876         912         288B548A32         <	100000000000000000000000000000000000000	
184A004A27       1875 344       1875 389       288B890A21         1875 345       1875 390       288B891A27         288B545A16       1875 346       1875 391       288B891A27         288B545A26       1875 347       1875 392       288B891A32         288B545A27       1875 348       1875 393       288B891A33         288B545A30       1875 349       1875 394       288B891A33         288B545A31       1875 351       1875 396       288B548A26         288B548A27       1875 352       1876 908       288B548A28         288B548A28       1875 354       1876 909       288B548A28         288B548A31       1875 356       1876 910         288B548A31       1875 356       1876 911         288B548A31       1875 357       1876 912         288B548A32       1875 358       1876 913         288B553A20       288B553A25          288B553A26       288B553A27		
184A004A28     1875     344     1875     389     288B890A22       288B545A16     1875     346     1875     390     288B891A2       288B545A26     1875     346     1875     391     288B891A2       288B545A26     1875     347     1875     392     288B891A2       288B545A29     1875     393     288B891A3       288B545A30     1875     350     1875     394     288B891A3       288B548A11     1875     351     1875     396     288B848A3       288B548A27     1875     352     1876     908     288B548A3       288B548A28     1875     353     1876     909       288B548A29     1875     354     1876     910       288B548A31     1875     356     1876     911       288B548A31     1875     357     1876     913       288B553A20     288B553A20     288B553A26       288B553A26     288B553A27		288B890A28
288B545A16 1875 345 1875 390 288B891A22 288B545A26 1875 347 1875 391 288B891A22 288B545A27 1875 348 1875 393 288B891A32 288B545A29 288B545A30 1875 349 1875 395 288B891A32 288B545A31 1875 350 1875 395 288B545A31 1875 351 1875 396 288B548A31 1875 351 1875 396 288B548A32 1875 353 1876 908 288B548A32 1875 353 1876 909 288B548A30 1875 354 1876 910 288B548A30 1875 356 1876 911 288B548A31 1875 356 1876 911 288B548A32 1875 358 1876 912 288B548A32 1875 358 1876 912 288B553A25 288B553A26 288B553A26 288B553A26		
288B545A16       1875       346       1875       391       288B891A2         288B545A26       1875       347       1875       392       288B891A3         288B545A27       1875       348       1875       392       288B891A3         288B545A29       1875       348       1875       394       288B891A3         288B545A31       1875       350       1875       396       288B548A1       288B548A2       1875       352       1876       908       288B548A28       288B548A28       1875       353       1876       909       288B548A28       1875       354       1876       909       288B548A31       1875       355       1876       910       1875       356       1876       911       288B548A31       1875       357       1876       912       288B548A31       1875       358       1876       914       288B553A20       288B553A20       288B553A25       288B553A27		288B890A29
288B545A16       1875       346       1875       391       288B891A26         288B545A26       1875       347       1875       392       288B891A32         288B545A27       1875       348       1875       393       288B891A32         288B545A29       288B545A30       1875       349       1875       394       288B891A32         288B545A31       1875       350       1875       395       288B84A8A6       288B54A8A7       1875       352       1876       908         288B548A28       1875       353       1876       909       288B548A28       288B548A29       1875       355       1876       910         288B548A30       1875       356       1876       911       288B548A31       1875       356       1876       912         288B548A31       1875       358       1876       914       288B553A20         288B553A25       288B553A27       288B553A27       288B553A27		288B891A27
288B545A26 1875 347 1875 392 288B891A30 288B545A29 1875 348 1875 393 288B891A30 288B545A30 1875 349 1875 394 288B545A31 1875 350 1875 395 288B545A31 1875 351 1875 396 288B548A27 1875 352 1876 908 288B548A28 288B548A28 288B548A29 1875 354 1876 909 288B548A28 288B548A31 1875 356 1876 910 1875 356 1876 911 288B548A31 1875 356 1876 911 288B548A31 1875 357 1876 911 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A27	288B545A16 1875 346 1875 391	
288B545A27 1875 348 1875 393 288B891A32 288B545A29 288B545A30 1875 349 1875 394 288B891A32 288B545A31 1875 350 1875 395 288B548A16 1875 352 1876 908 288B548A27 1875 353 1876 909 288B548A28 1875 355 1876 910 288B548A29 1875 355 1876 911 288B548A30 1875 356 1876 911 288B548A31 1875 357 1876 912 288B548A32 1875 358 1876 914 288B553A26 288B553A26 288B553A26 288B553A26	288B545A26 1875 347 1875 392	
288B545A29 288B545A30 1875 349 1875 350 1875 394 288B545A31 1875 351 288B548A31 1875 352 1876 908 288B548A27 288B548A27 1875 353 1876 909 288B548A28 288B548A29 1875 355 1876 910 288B548A30 1875 356 1876 911 288B548A31 1875 356 1876 912 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A26 288B553A26 288B553A27		
288B545A30 1875 349 1875 394 288B891A32 288B545A31 1875 350 1875 396 288B548A16 1875 351 1875 396 288B548A27 1875 352 1876 908 288B548A28 288B548A29 1875 354 1876 910 288B548A30 1875 356 1876 911 288B548A31 1875 356 1876 912 288B548A31 1875 357 1876 913 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A26 288B553A27		200B03TA3T
1875 350 1875 395 288B545A31 1875 351 1875 396 288B548A16 1875 352 1876 908 288B548A27 1875 353 1876 909 288B548A28 1875 354 1876 910 1875 355 1876 911 288B548A30 1875 356 1876 912 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A26 288B553A26 288B553A26 288B553A26		2000004400
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288B548A27 1875 353 1876 909 288B548A28 1875 354 1876 910 1875 355 1876 911 288B548A30 1875 356 1876 912 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A26 288B553A26		
288B548A28 288B548A29 1875 355 1876 910 1875 355 1876 911 288B548A30 288B548A31 288B548A31 288B548A32 288B553A20 288B553A25 288B553A26 288B553A26 288B553A27		
288B548A29 1875 354 1876 910 1875 355 1876 911 288B548A30 1875 356 1876 912 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A27	2000010,12,	
1875 355 1876 911 288B548A30 1875 356 1876 912 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A26 288B553A27		
288B548A30 1875 356 1876 912 288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A26 288B553A27		
288B548A31 1876 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A27	1875 355 1876 9 <b>1</b> 1	
288B548A31 1875 357 1876 913 288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A27	288B548A30 1875 356 1876 912	
288B548A32 1875 358 1876 914 288B553A20 288B553A25 288B553A26 288B553A27		
288B553A20 288B553A25 288B553A26 288B553A27		
288B553A25 288B553A26 288B553A27		
288B553A26 288B553A27		
288B553A27	288B553A25	
	288B553A26	
	288B553A27	
288B553A28	288B553A28	
288B553A31		
	288B553A32	

① Refer to RPD 41-076A1 for parts information on type FT-11 Flexitest cases.

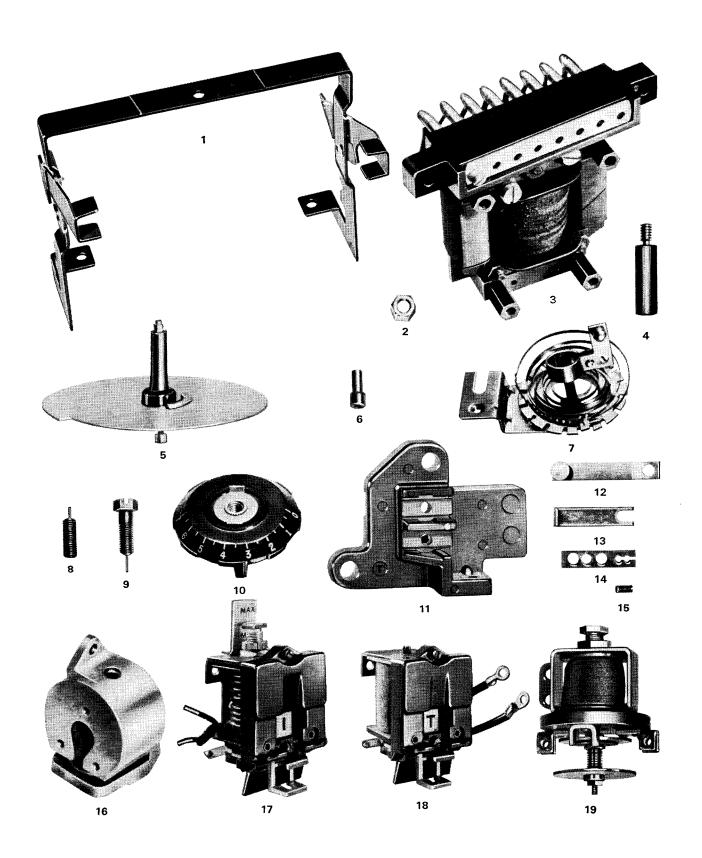
# Westinghouse



Style Numbe Relavs (50 o	ers of Circuit ( r 60 Hertz)	Closing	Reference Number	Description of	Part		Style Number of Part
• •	•		1	Handle With Do	uble Latch Assemb	oly	289B882G01
Forque Control	i Relays		2	Nut for Frame at	nd Handle Screws		1155 351
Single Trip				Flectromagnet w	ith Tan Block and	Tap Plate	See Table Pg. 4
			<b>★</b> 3	Inculated Tap Sc	TELL TOP DIOCK and		1545 282
1955 860	288B717A17	289B094A16	4	Illisulated Tap oc			
1956 685	288B717A18	289B094A17	-	Dice and Shaft	Accomply with Las	wer Bearing	880A772G12
956 768	288B717A19	289B094A18	5	Disc and Strait A	455embly With Lov		184A440G01
1962 747	288B717A20	289B094A19	. 6	Lower Bearing	C-i and Adim	ster Assembly	Soo Table Belov
1963 114	288B717A21	289B094A20	<b>★</b> 7	Ivioving Contact	, Spring and Adju		2/00/37600
			8	Lower Bearing	crew and Pin	• • • • • • • • • • • • • • • • • • • •	E2D6201G02
1963 215	288B717A22	289B094A21	9	Upper Bearing S	crew and Pin		52D6251G03
1963 216	288B717A23	289B094A22		1			1070 001
288B715A09	288B717A24	289B094A23	10	Dial Assembly.			220211000
288B715A10	288B717A25	289B094A24	11	Insulation for St	ationary Contact.		1722 778
288B715A12	288B717A29	289B094A25	<b>★</b> 12	Stationary Conta	act (2 Required to	Double Trip)	1/32 //0
100D/10/12	2005/1//20	20000047120					4700 750
288B715A13	288B717A30	289B094A26	13	Contact Plate, S	ingle Trip Relay		, 1/32 /59
			14	Contact Plate, D	ouble Trip Relay.		. 818 /94
288B715A14	288B717A31	289B094A27	15	Adjusting Screv	v		. 718 931
288B715A15	288B717A32	289B094A28					
288B715A16	288B718A09	289B094A29	16	Permanent Mag	net		See Table Pg.
288B715A17	288B718A10	289B432A09	<b>★</b> 17	1.1.T. Unit (wher	n used)		See Table Pg.
		0000400440	<del>1</del> 18	LCS Unit			See Table Pg. 4
288B715A18	288B718A11	289B432A10	<del>★</del> 19	I.T.H. Unit (whe	en used)		See Table Pg.
288B715A19	288B718A13	289B432A12					
288B715A21	288B718A14	289B432A13	Parts indented a	re included in the pa	art under which the	ey are indented.	
288B715A22	288B718A15	289B432A14					
288B715A23	288B718A16	289B432A15	★ Recommende	ed for stock.			
		0000400446					
288B715A24	288B718A17	289B432A16	Moving Conta	ict,			
288B715A25	288B718A18	289B432A17	Spring, and A	djuster Assembly			
288B715A26	288B718A19	289B432A18	Relay	Style Numbers			
288B715A27	288B718A20	289B432A19			I Dauble Trin		
288B715A28	288B718A21	289B432A21	Type	Single Trip	Double Trip		
0000745400	0000740400	2000422422		0004704040	000 4721 015		
288B715A30	288B718A22	289B432A22	CO-2	880A721G10	880A721G15		
288B715A31	288B718A23	289B432A23	CO-5	880A721G09	880A721G14		
288B715A32	288B718A24	289B432A24	CO-6	880A721G09	880A721G14		
288B716A09	288B718A27	289B432A25					
288B716A10	288B718A28	289B432A28	CO-7	880A721G09	880A721G14		
		0000700400	CO-8	880A721G09	880A721G14		
288B716A11	288B718A29	292B728A09			000 4 704 04 5		
288B716A13	288B718A30	292B728A10	CO-9	880A721G09	880A721G14		
288B716A14	288B718A31	292B728A11	CO-11	880A721G11	880A721G16		
288B716A15	288B718A32	292B728A13					
288B716A16	288B718A33	292B728A14					
2000710417	2000002402	2020720415					
288B716A17	289B093A09	292B728A15					
288B716A18	289B093A10	292B728A16					
288B716A19	289B093A11	292B728A17					
288B716A20	289B093A13	292B728A18					
288B716A21	289B093A14	292B728A19					
2000716822	2000002445	292B728A20					
288B716A22	289B093A15						
288B716A23	289B093A17	292B728A21					
288B716A24	289B093A18	292B728A22					
288B716A26	289B093A19	292B728A23					
288B716A27	289B093A20	292B728A24					
2000716420	2000002421						
288B716A28	289B093A21						
288B716A29	289B093A22						
288B716A30	289B093A23						
288B717A09	289B093A24						
288B717A10	289B094A09						
2000717411	2000004410						
288B717A11	289B094A10						
288B717A13	289B094A11						
0000004044							
288B717A14	289B094A13						
288B717A14 288B717A15 288B717A16	289B094A14 289B094A15						

# **Protective Relays**

Type CO-2, 5, 6, 7, 8, 9, 11 In FT-11 Flexitest Case®



# **Protective Relays**

Type CO-2, 5, 6, 7, 8, 9, 11 In FT-11 Flexitest Case®

# Magnet Style Numbers

Relay Type

| Style Numbers

		Electromagnet (Reference 3) Ampere Rating							
Non Torque Control		.1 to 5	.5 to 2.5	2 to 6	4 to 12	Permanent Magnet (Reference 16)			
CO-2 CO-5 CO-6 CO-7 CO-8 CO-9 CO-11	50 And 60 Hertz	876A616G08 876A616G09 878A616G09 183A475G20	183A475G05 183A475G06 183A475G06 183A475G07 183A475G08 183A475G08 183A475G09	183A475G10 774B310G12 774B310G12 183A475G12 774B310G18 774B310G18 183A475G14	183A475G15 774B310G13 774B310G13 774B310G15 774B310G19 774B310G19 183A475G19	1732 780 1732 777 1732 779 1732 780 1732 777 1732 777 1732 777			
With Torqu	ue Control								
CO-2 CO-5 CO-6 CO-7 CO-8 CO-9 CO-11	50 And 60 Hertz 60 Hz 60 Hz		183A476G05 183A476G06 183A476G06 183A476G07 183A476G08 183A476G08 183A476G09 878A616G05	183A476G10 774B310G12 774B310G12 183A476G12 774B310G18 774B310G18 183A476G14 878A616G06	183A476G15 774B310G13 774B310G15 774B310G15 774B310G19 774B310G19 183A476G19 878A616G07	1732 780 1732 777 1732 779 1732 780 1732 777 1732 777 1732 777 1732 777			

# IIT Unit (Reference 17) when used Less Stationary Contacts

Amperes	Style Numbers					
A-c	Single Trip	Double Trip				
1.5-6	3491A24G14	3491A24G22				
2-8	3491A24G13	3491A24G21				
4-16	3491A24G09	3491A24G17				
10-40	3491 A24G10	3491 A24G18				
20-80	3491 A24G11	3491 A24G19				
40-160	3491 A24G12	3491 A24G20				

Refer to RPD 41-852A1 for complete breakdown of parts and stationary contacts.

# ICS Unit (Reference 18) Less Stationary Contacts Target | Style Num

larget	Style Numbers  Ampere Rating 0.2 to 2.0 D-c				
Marking					
	Single Trip	Double Trip			
None T	3491A37G17 3491A37G09	3491A37G18 3491A37G10			

Refer to RPD 41-852A1 for complete breakdown of parts and stationary contacts.

#### ITH Unit (Reference 19) When Used **Less Stationary Contacts**

Ampere Rating	Style Number
.255	3491A23G15
.5-1.0	3491A23G15
1-2	
• =	3491A23G05
2-4	3491A23G06
4-8	3491A23G07
6-12	3491 A23 G21
8-16	3491A23G08
16-32	3491A23G19

Refer to RPD 41-852A1 for complete breakdown of parts.



# INSTALLATION • OPERATION • MAINTENANCE INSTALLATION • OPERATION • MAINTENANCE

# TYPE CO OVERCURRENT RELAY

#### CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

# **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

#### **CONTENTS**

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

# CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

#### Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

# Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

#### Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range. The minimum and maximum pick-up points are indicated on the scale which is located to the rear of the core screw.

# **CHARACTERISTICS**

The relays are generally available in the following current ranges:

SUPERSEDES I.L. 41-101

\* Denotes changed from superseded issue.

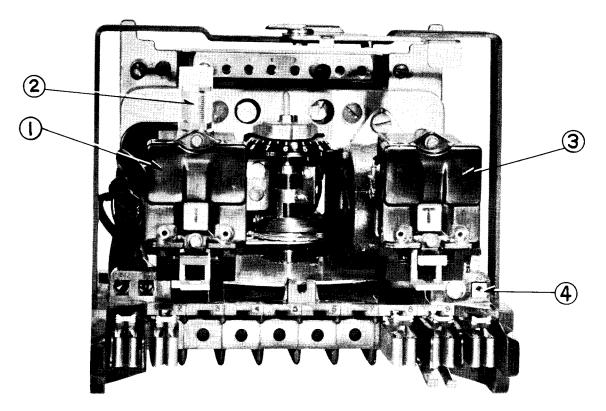


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

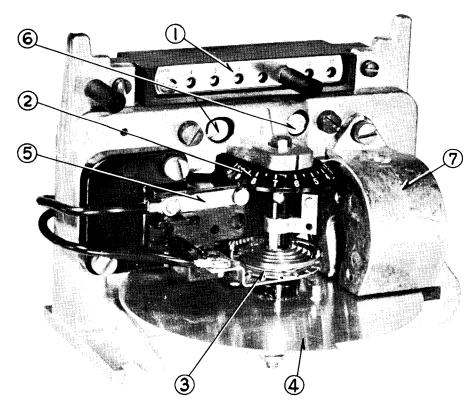
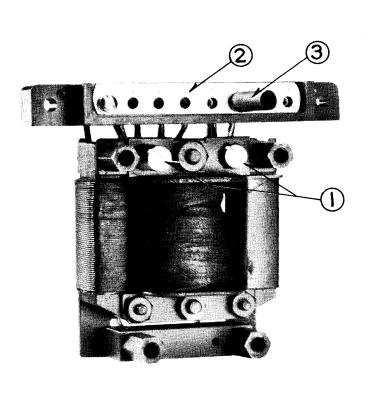
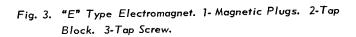


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.





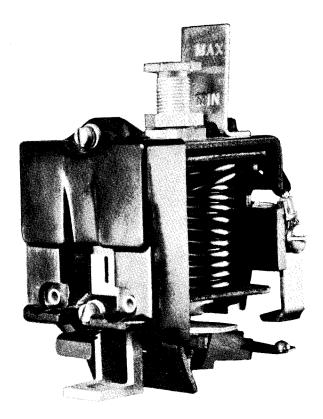


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

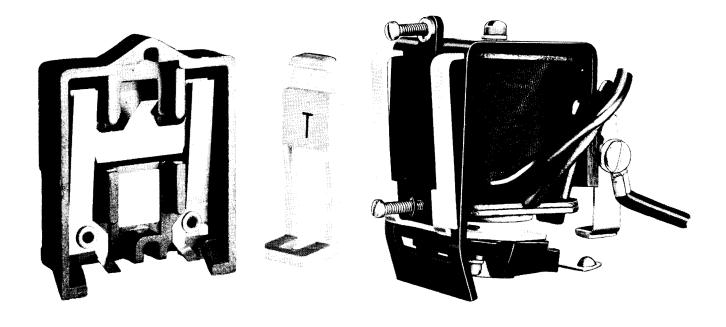


Fig. 5. Indicating Contactor Switch (ICS).

Range				Taps			
.5 - 2.5	0.5	0.6	8.0	1.0	1.5	2.0	2.5
2 - 6	2	2.5	3	3.5	4	5	6
4 - 12	4	5	6	7	8	10	12

The tap value is the minimum current required to just close the relay contacts.

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

# Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indi-

cating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

#### Trip Circuit Constants

Contactor Switch -

- 0.2 ampere tap 6.5 ohms d-c resistance
- 2.0 ampere tap 0.15 ohms d-c resistance

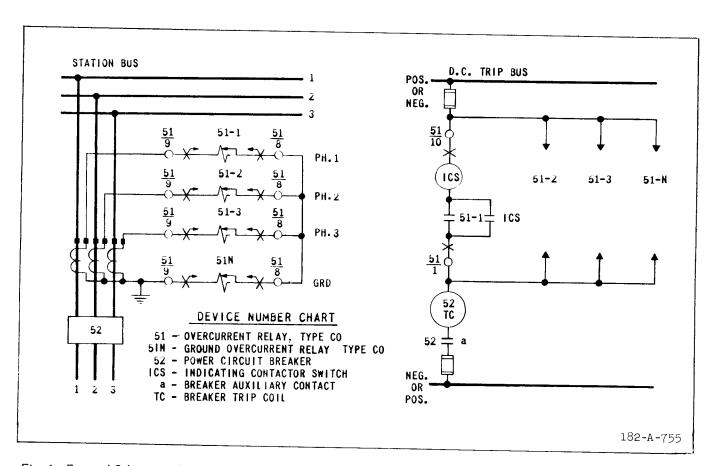


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

TYPE CO-2 RELAY

					VOLT AMPERES**			
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	0.5	0.91	28	58	4.8	39.6	256	790
	0.6	0.96	28	57	4.9	39.8	270	851
	0.8	1.18	28	53	5.0	42.7	308	1024
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220
0.0, 2.0	1.5	1.95	28	40	6.2	54.4	435	1740
	2.0	2.24	28	36	7.2	65.4	580	2280
	2.5	2.50	28	29	7.9	73.6	700	2850
	2.0	3.1	110	59	5.04	38.7	262	800
	2.5	4.0	110	55	5.13	39.8	280	920
	3.0	4.4	110	51	5.37	42.8	312	1008
2/6	3,5	4.8	110	47	5.53	42.8	329	1120
_, ,	4.0	5.2	110	45	5.72	46.0	360	1216
	5.0	5.6	110	41	5.90	50.3	420	1500
	6.0	6.0	110	37	6.54	54.9	474	1800
	4.0	7.3	230	65	4.92	39.1	268	848
	5.0	8.0	230	50	5.20	42.0	305	1020
	6.0	8.8	230	47	5.34	44.1	330	1128
4/12	7.0	9.6	230	46	5.35	45.8	364	1260
1/ 12	8.0	10.4	230	43	5.86	49.9	400	1408
	10.0	11.2	230	37	6.6	55.5	470	1720
	12.0	12.0	230	34	7.00	62.3	528	2064

<sup>\*</sup> 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.

φ Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2 2.2 2.5 2.8 3.4 4.0 4.4	56 56 56 56 56 56 56	69 68 67 66 62 60 58	3.92 3.96 3.96 4.07 4.19 4.30	20.6 20.7 21 21.4 23.2 24.9 26.2	103 106 114 122 147 168 180	270 288 325 360 462 548 630	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	67 66 64 63 62 59	3.88 3.87 3.93 4.09 4.08 4.20 4.38	21 21.6 22.1 23.1 23.5 24.8 26.5	110 118 126 136 144 162 183	308 342 381 417 448 540 624	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	65 63 61 59 56 53 47	4.00 4.15 4.32 4.27 4.40 4.60 4.92	22.4 23.7 25.3 26.4 27.8 30.1 35.6	126 143 162 183 204 247 288	376 450 531 611 699 880 1056	

#### CO-7 MODERATELY INVERSE TIME RELAY

					VOLT AMPERES**			
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2 2.2 2.5 2.8 3.4 4.0 4.4	56 56 56 56 56 56	68 67 66 64 61 58 56	3.88 3.93 3.93 4.00 4.08 4.24 4.38	20.7 20.9 21.1 21.6 22.9 24.8 25.9	103 107 114 122 148 174	278 288 320 356 459 552 640
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	66 63 63 62 61 59	4.06 4.07 4.14 4.34 4.34 4.40 4.62	21.3 21.8 22.5 23.4 23.8 25.2 27	111 120 129 141 149 163 183	306 342 366 413 448 530 624
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	64 61 60 58 55 51	4.24 4.30 4.62 4.69 4.80 5.20 5.40	22.8 24.2 25.9 27.3 29.8 33 37.5	129 149 168 187 211 260 308	392 460 540 626 688 860

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

# CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2 2.2 2.5 2.8 3.4 4.0 4.4	56 56 56 56 56 56	72 71 69 67 62 57 53	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180 198	360 395 430 470 500 580 660	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	68 63 60 57 54 48	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850 1020	

#### TYPE CO-11 RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
	0.5	1.7	56	36	0.72	6.54	71.8	250	
	0.6	1.9	56	34	0.75	6.80	75.0	267	
	0.8	2.2	56	30	0.81	7.46	84.0	298	
0.5/2.5	1.0	3.5	56	27	0.89	8.30	93.1	330	
	1.5	3.0	56	22	1.13	10.04	115.5	411	
	2.0	3.5	56	17	1.30	11.95	136.3	502	
	2.5	3.8	56	16	1.48	13.95	160.0	610	
	2.0	7.0	230	32	0.73	6.30	74.0	264	
	2.5	7.8	230	30	0.78	7.00	78.5	285	
	3.0	8.3	230	27	0.83	7.74	84.0	309	
2/6	3.5	9.0	230	24	0.88	8.20	89.0	340	
	4.0	10.0	230	23	0.96	9.12	102.0	372	
	5.0	11.0	230	20	1.07	9.80	109.0	430	
	6.0	12.0	230	20	1.23	11.34	129.0	504	
	4.0	14	460	29	0.79	7.08	78.4	296	
	5.0	16	460	25	0.89	8.00	90.0	340	
	6.0	17	460	22	1.02	9.18	101.4	378	
4/12	7.0	18	460	20	1.10	10.00	110.0	454	
. ==	8.0	20	460	18	1.23	11.1	124.8	480	
	10.0	22	460	17	1.32	14.9	131.6	600	
	12.0	26	460	16	1.8	16.3	180.0	720	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

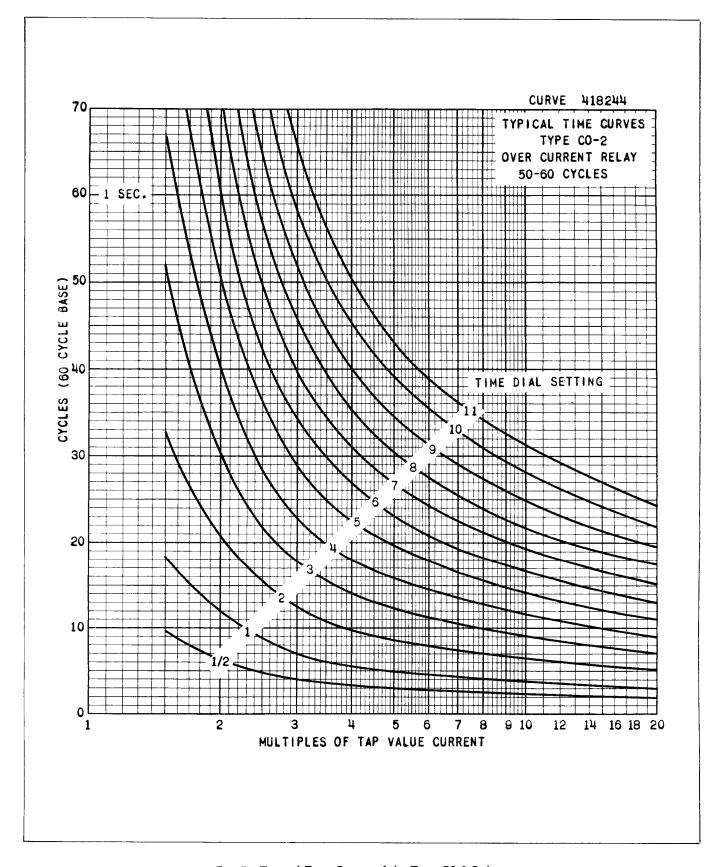


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

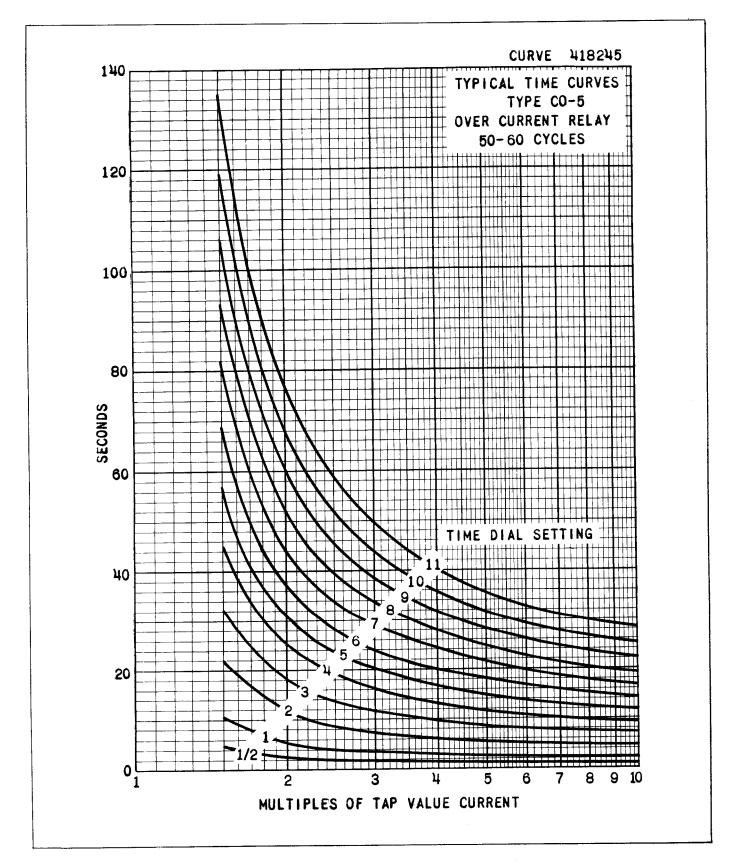


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

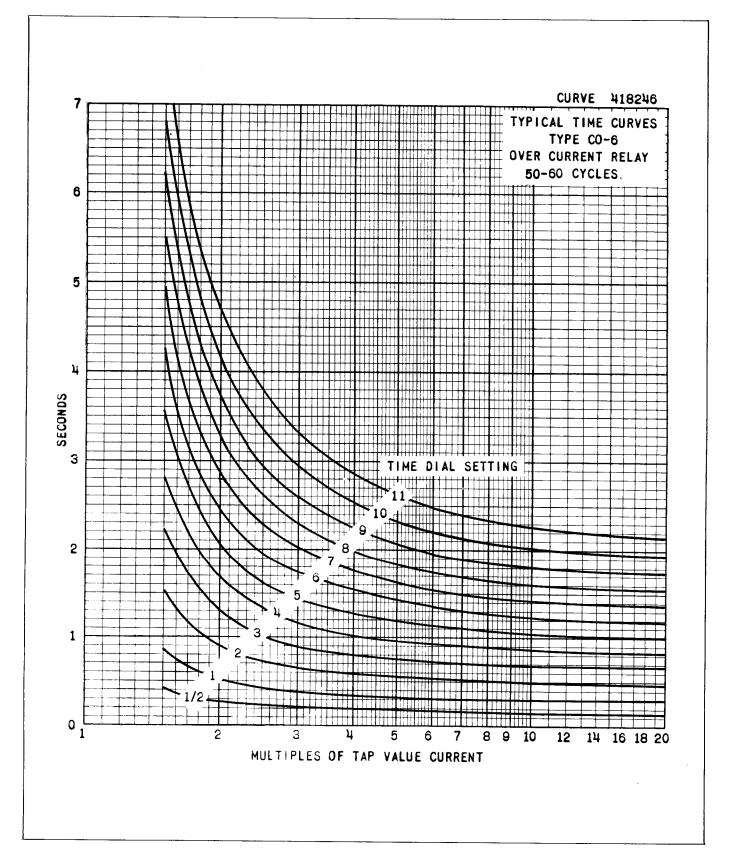


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

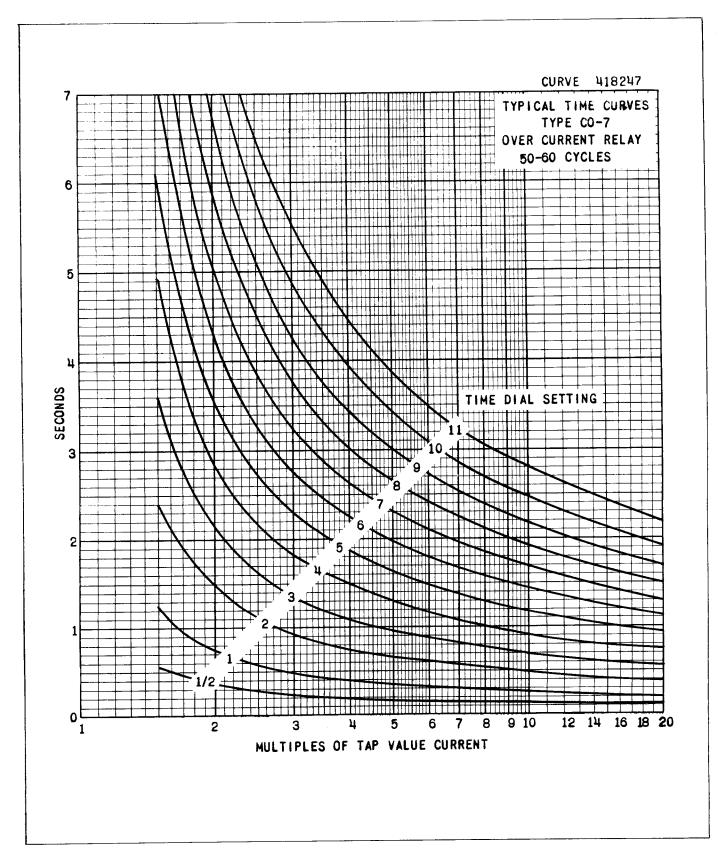


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

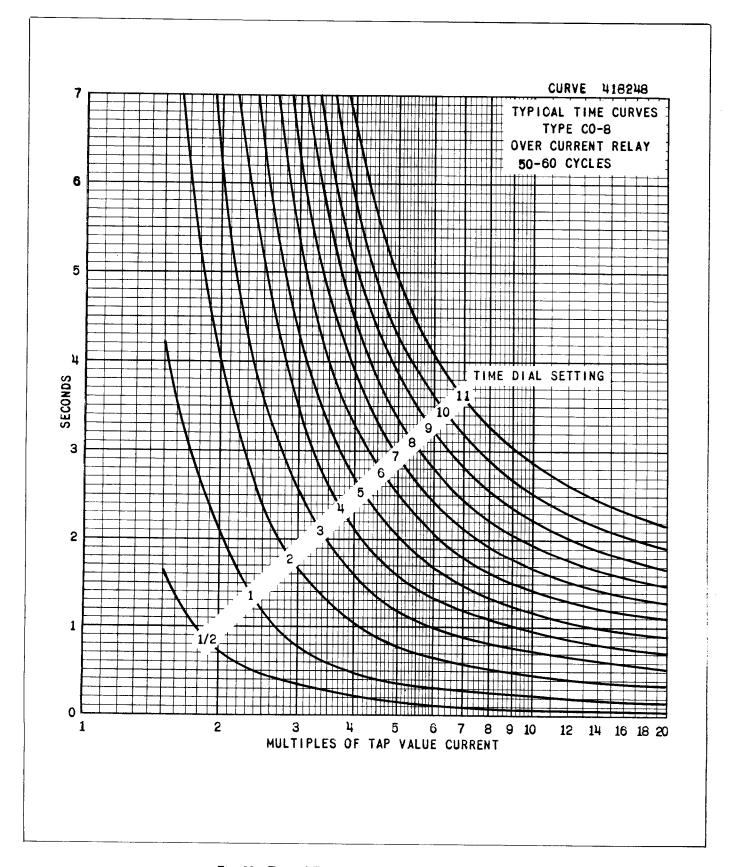


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

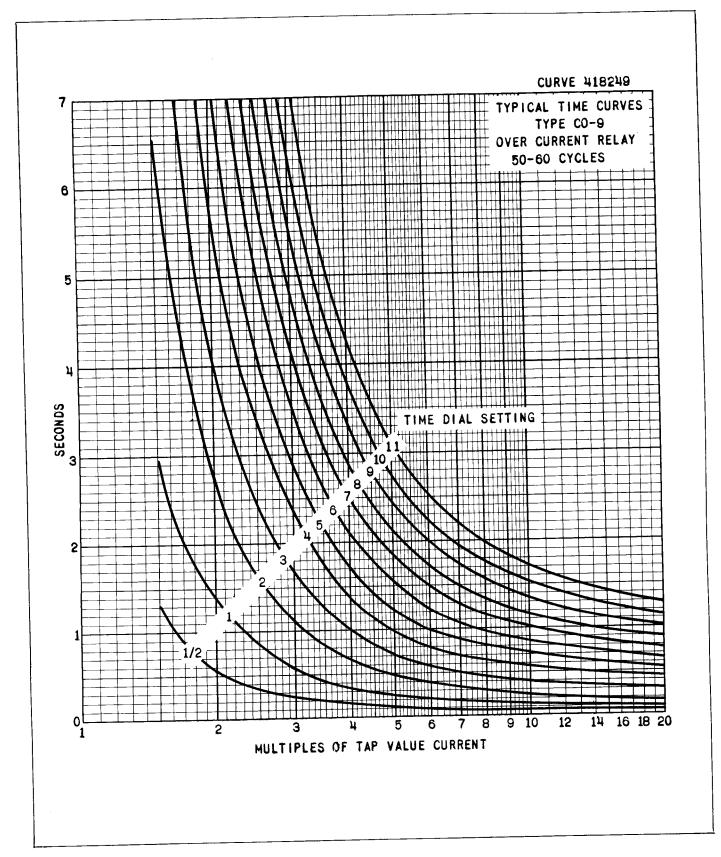


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

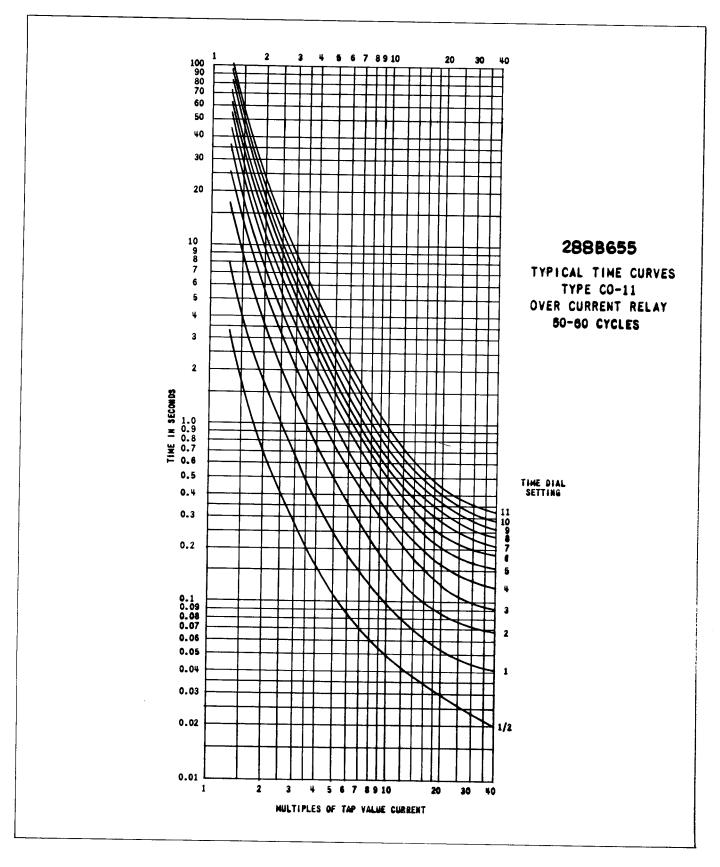


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

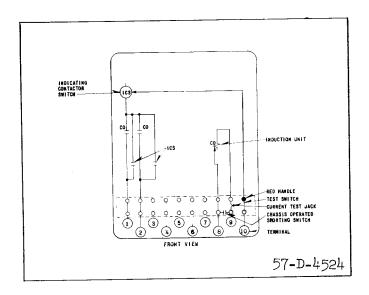
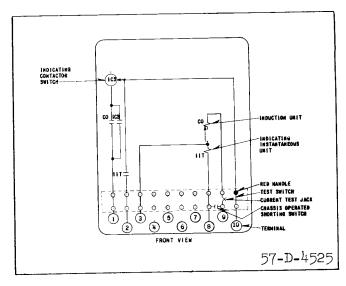


Fig. 14. Internal Schematic of the Double Trip Circuit
Closing Relay. For the Single Trip Relay the
Circuits Associated with Terminal 2 are Omitted.



\* Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

#### **SETTINGS**

#### CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will just close its contacts at the corresponding current 4-5-6-7-8-10-12 amperes, or as marked on the terminal plate.

# Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

# Instantaneous Reclosing

The factory adjustment of the CO unit contact

provides a contact follow. Where instantaneous circuit breaker reclosing will be initiated upon the closure of the CO contact, this contact follow must be eliminated by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring. With this change and the contact mounting screw tightened, the stationary contact will rest solidly against its backstop.

\* For double trip relays, the upper stationary contact is adjusted such that the contact rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

# Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

# Indicating Instantaneous Trip (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT. unit.

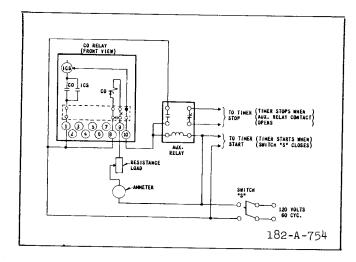


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

# **INSTALLATION**

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically be means of the mounting stud for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

# **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

#### Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

- Contacts By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is just resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
  - 2. Minimum Trip Current Set the time dial to position 6. Alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
  - 3. <u>Time Curve</u> Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5 percent.
  - 4. <u>Indicating Instantaneous Trip Unit (IIT)</u> The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

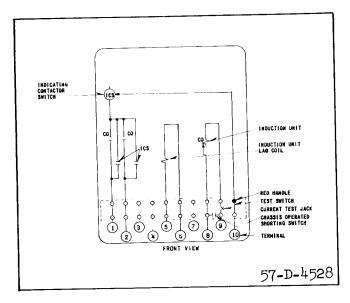
Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

#### Routine Maintenance

All relays should be inspected periodically and the time of operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application. Phantom loads should not be used in testing induction-type relays because of the resulting distorted current wave form which produces an error in timing.

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.



\* Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

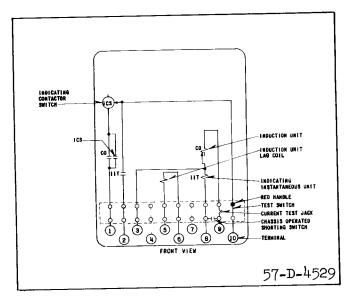


Fig. 18. Internal Schematic of the Single Trip Circuit
Closing Relay with Torque Control Terminals
and Indicating Instantaneous Trip Unit.

# CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

# CO\_Unit

- 1) Contacts By turning the time dial move the moving contacts until they deflect the stationary contact to a position where the stationary contact is just resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial.
- For double trip relays only, the follow on the stationary contacts is obtained through the use of the stationary contact adjusting screw. The upper stationary contact is adjusted first such that there is approximately 1/64" follow. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.
  - 2) Minimum Trip Current The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

- 3.  $\underline{\text{Time Curve Calibration}}$  Install the permanent magnet.
- \* Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment. 4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

# 5. Indicating Instantaneous Trip Unit (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

# **RENEWAL PARTS**

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give, the complete nameplate data.

TABLE 1

TIME CURVE CALIBRATION DATA - 50 & 60 CYCLES

	PERMANEN	Γ MAGNET ADJUSTM	ELECTROMAGN	NET PLUGS	
RELAY TYPE	TIME DIAL POSITION	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS
CO-2	6	3	0.57	20	0.22
CO-5	6	2	37.80	10	14.30
CO-6	6	2	2.46	20	1.19
CO-7	6	2	4.27	20	1.11
CO-8	6	2	13.35	20	1.11
CO-9	6	2	8.87	20	0.65
CO-11	6	2	11.27	20	0.24

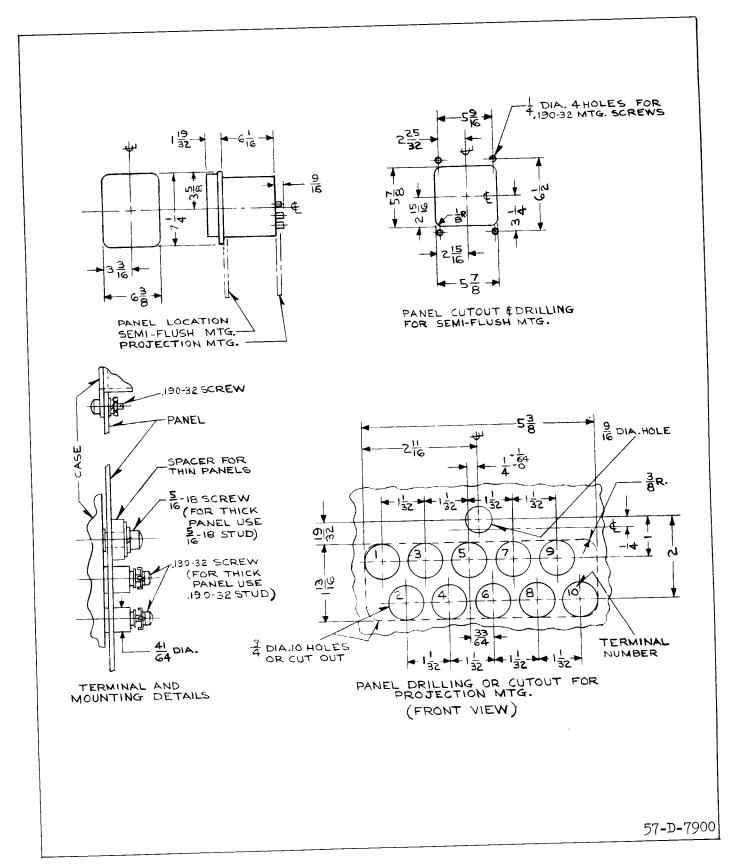


Fig. 19. Outline and Drilling Plan for the Type CO Relay.



WESTINGHOUSE ELECTRIC CORPORATION
METER DIVISION . NEWARK, N.J.



# INSTALLATION • OPERATION • MAINTENANCE INSTALLATION • OPERATION • MAINTENANCE

# TYPE CO OVERCURRENT RELAY

# CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

# **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

## **CONTENTS**

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

# CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

# Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

# Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

#### Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

# **CHARACTERISTICS**

The relays are generally available in the following current ranges:

SUPERSEDES I.L. 41-101D

\* Denotes change from superseded issue.

**EFFECTIVE JUNE 1959** 

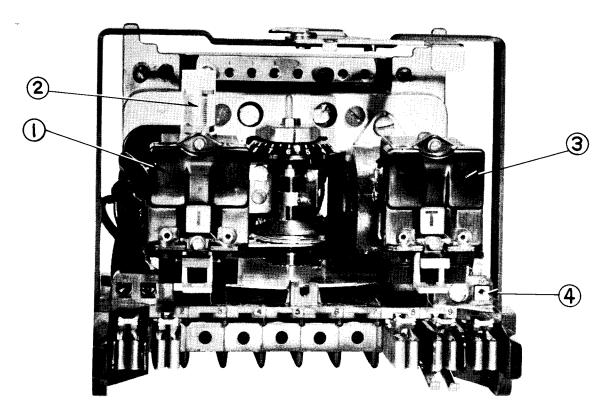


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

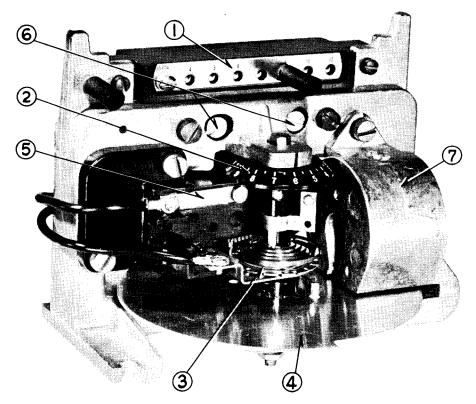
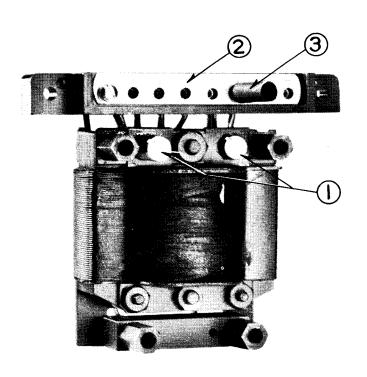


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.



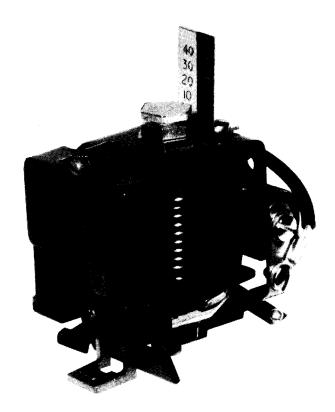


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap \*
Block. 3-Tap Screw.

Fig. 4. Indicating Instantaneous Trip Unit (IIT).

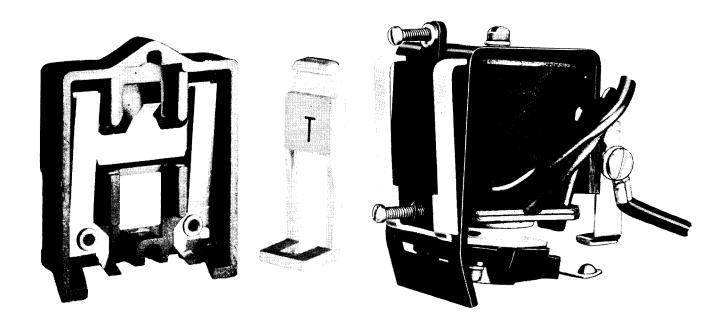


Fig. 5. Indicating Contactor Switch (ICS).

Range				Taps			
.5 - 2.5	0.5	0.6	0.8	1.0	1.5	2.0	2.5
2 - 6	2	2.5	3	3.5	4	5	6
4 - 12	4	5	6	7	8	10	12

The tap value is the minimum current required to just close the relay contacts.

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

# Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indi-

cating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

#### Trip Circuit Constants

Contactor Switch -

- 0.2 ampere tap 6.5 ohms d-c resistance
- 2.0 ampere tap 0.15 ohms d-c resistance

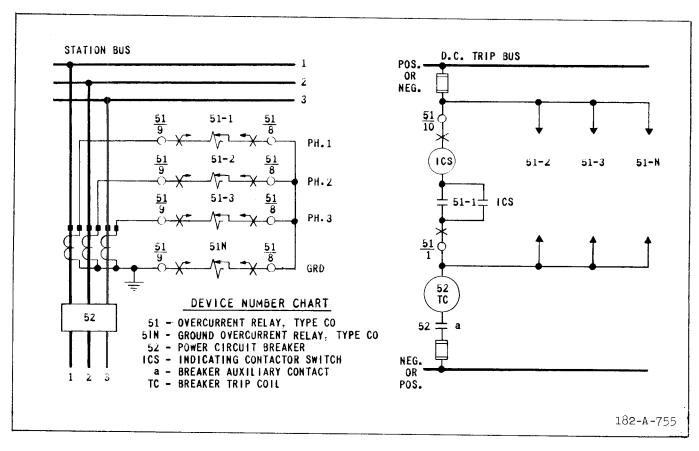


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

TYPE CO-2 RELAY

						VOLT A	MPERES**	
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	0.5	0.91	28	58	4.8	39.6	256	790
	0.6	0.96	28	57	4.9	39.8	270	851
	0.8	1.18	28	53	5.0	42.7	308	1024
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220
	1.5	1.95	28	40	6.2	54.4	435	1740
	2.0	2,24	28	36	7.2	65.4	580	2280
	2.5	2.50	28	29	7.9	73.6	700	2850
	2.0	3.1	110	59	5.04	38.7	262	800
	2.5	4.0	110	55	5.13	39.8	280	920
	3.0	4.4	110	51	5.37	42.8	312	1008
2/6	3.5	4.8	110	47	5.53	42.8	329	1120
	4.0	5.2	110	45	5.72	46.0	360	1216
	5.0	5.6	110	41	5.90	50.3	420	1500
	6.0	6.0	110	37	6.54	54.9	474	1800
	4.0	7.3	230	65	4.92	39.1	268	848
	5.0	8.0	230	50	5,20	42.0	305	1020
	6.0	8.8	230	47	5.34	44.1	330	1128
4/12	7.0	9,6	230	46	5.35	45.8	364	1260
,	8.0	10.4	230	43	5.86	49.9	400	1408
	10.0	11.2	230	37	6.6	55.5	470	1720
	12.0	12.0	230	34	7.00	62.3	528	2064

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

# CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

VOLT AMPERES\*\*

		CONTINUOUS	ONE SECOND	POWER	$\mathbf{AT}$	AT 3 TIMES	AT 10 TIMES	AT 20 TIMES
AMPERE		RATING	RATING*	FACTOR	TAP VALUE	TAP VALUE	TAP VALUE	TAP VALUE
RANGE	TAP	(AMPERES)	(AMPERES)	ANGLE $\phi$	CURRENT	CURRENT	CURRENT	CURRENT
	(0.5	2	88	69	3.92	20.6	103	270
	(0.6)	2.2	88	68	3.96	20.7	106	288
	(0.8	2.5	88	67	3.96	21	114	325
0.5/2.5	(1.0	2.8	88	66	4.07	21.4	122	360
	(1.5	3.4	88	62	4.19	23.2	147	462
	(2.0	4.0	88	60	4.30	24.9	168	548
	(2.5	4.4	88	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.87	21.6	113	342
	(3	9.7	230	64	3.93	22.1	126	381
2/6	(3.5	10.4	230	63	4.09	23.1	136	417
	(4	11.2	230	62	4.08	23.5	144	448
	(5	12.5	230	59	4.20	24.8	162	540
	(6	13.7	230	57	4.38	26.5	183	624
	(4	16	460	65	4.00	22.4	126	376
	(5	18.8	460	63	4.15	23.7	143	450
	(6	19.3	460	61	4.32	25.3	162	531
4/12	(7	20.8	460	59	4.27	26.4	183	611
	(8	22.5	460	56	4.40	27.8	204	699
	(10	25	460	53	4.60	30.1	247	880
	(12	28	460	47	4.92	35.6	288	1056

#### CO-7 MODERATELY INVERSE TIME RELAY

VOLT AMPERES\*\* CONTINUOUS ONE SECOND POWER ΑT AT 3 TIMES AT 10 TIMES AT 20 TIMES TAP VALUE TAP VALUE TAP VALUE TAP VALUE AMPERE RATING\* FACTOR RATING CURRENT RANGE TAP (AMPERES) (AMPERES) ANGLE  $\phi$ CURRENT CURRENT CURRENT (0.5)88 68 3.88 20.7 103 278 (0.6 67 3.93 20.9 107 288 2.2 88 21.1 320 3.93 114 8.0) 2.5 88 66 0.5/2.5(1.0 2.8 88 64 4.00 21.6 122 356 22.9 148 459 61 4.08 (1.5)3.4 88 174 552 24.8 (2.0 4.088 58 4.24 (2.5 4.4 56 4.38 25.9 185 640 88 4.06 21.3 111 306 (2 8 230 66 230 63 4.07 21.8 120 342 (2.5 8.8 22.5 129 366 63 230 4.14 (3 9.72/6 (3.5 10.4 230 62 4.34 23.4 141 413 448 61 4.34 23.8 149 230 (4 11.2 163 530 25,2 (5 12.5 230 59 4.40 4.62 27 183 624 230 58 (6 13.7 460 64 4.24 22.8 129 392 16 (4 460 24.2 149 (5 18.8 460 61 4.30 4/12 19.3 460 60 4.62 25.9 168 540 (6 27.3 187 626 (7 20.8 460 58 4.69 22.5 460 55 4.80 29.8 211 688 (8 860 5.20 33 260 (10 25 460 51 5.40 37.5 308 1032 (12 28 460 46

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

# CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2 2.2 2.5 2.8 3.4 4.0 4.4	88 88 88 88 88 88	72 71 69 67 62 57 53	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180	360 395 430 470 500 580 660	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25 28	460 460 460 460 460 460	68 63 60 57 54 48	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850 1020	

# TYPE CO-11 RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING AP (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
	0.5	1.7	88	36	0.72	6.54	71.8	250	
	0.6	1.9	88	34	0.75	6.80	75.0	267	
	0.8	2.2	88	30	0.81	7.46	84.0	298	
0.5/2.5	1.0	3.5	88	27	0.89	8.30	93.1	330	
010, 210	1.5	3.0	88	22	1.13	10.04	115.5	411	
	2.0	3.5	88	17	1.30	11.95	136.3	502	
	2.5	3.8	88	16	1.48	13.95	160.0	610	
	2.0	7.0	230	32	0.73	6.30	74.0	264	
	2.5	7.8	230	30	0.78	7.00	78.5	285	
	3.0	8.3	230	27	0.83	7.74	84.0	309	
2/6	3.5	9.0	230	24	0.88	8.20	89.0	340	
-, -	4.0	10.0	230	23	0.96	9.12	102.0	372	
	5.0	11.0	230	20	1.07	9.80	109.0	430	
	6.0	12.0	230	20	1.23	11.34	129.0	504	
	4.0	14	460	29	0.79	7.08	78.4	296	
	5.0	16	460	25	0.89	8.00	90.0	340	
	6.0	17	460	22	1.02	9.18	101.4	378	
4/12	7.0	18	460	20	1.10	10.00	110.0	454	
1/12	8.0	20	460	18	1.23	11.1	124.8	480	
	10.0	22	460	17	1.32	14.9	131.6	600	
	12.0	26	460	16	1.8	16.3	180.0	720	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

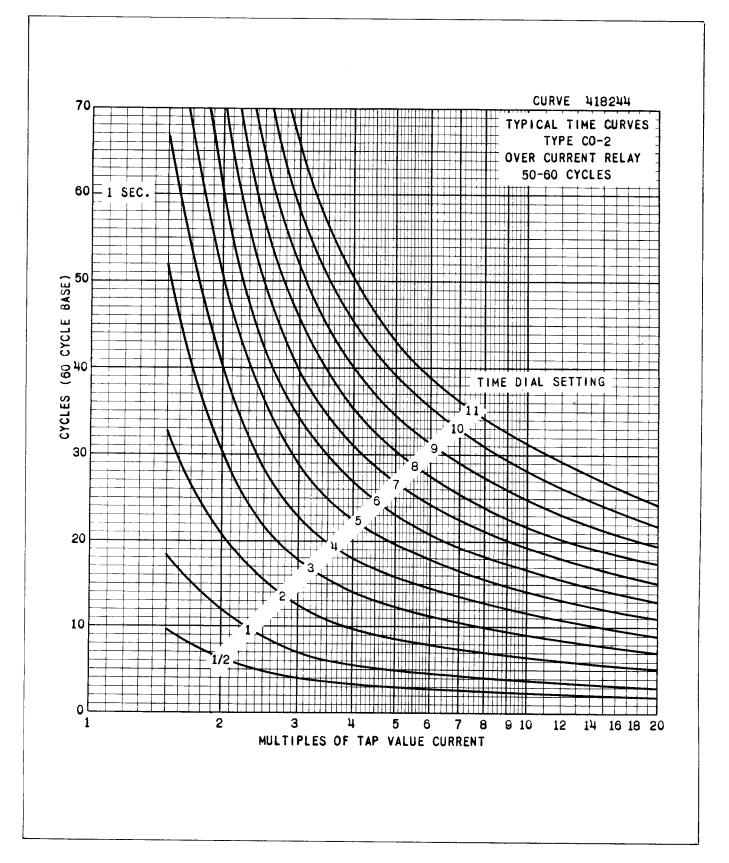


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

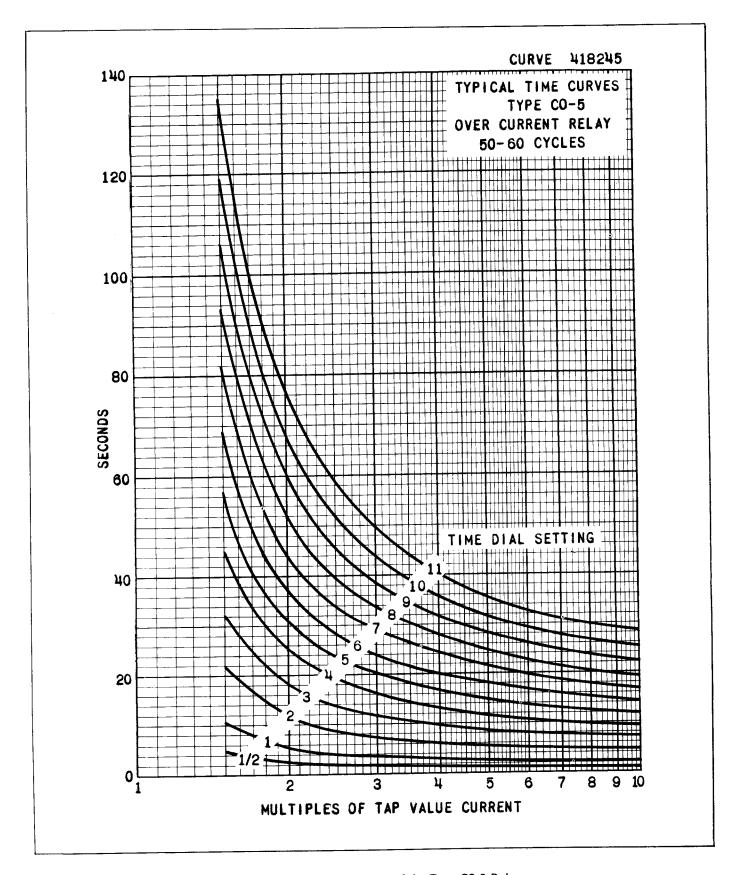


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

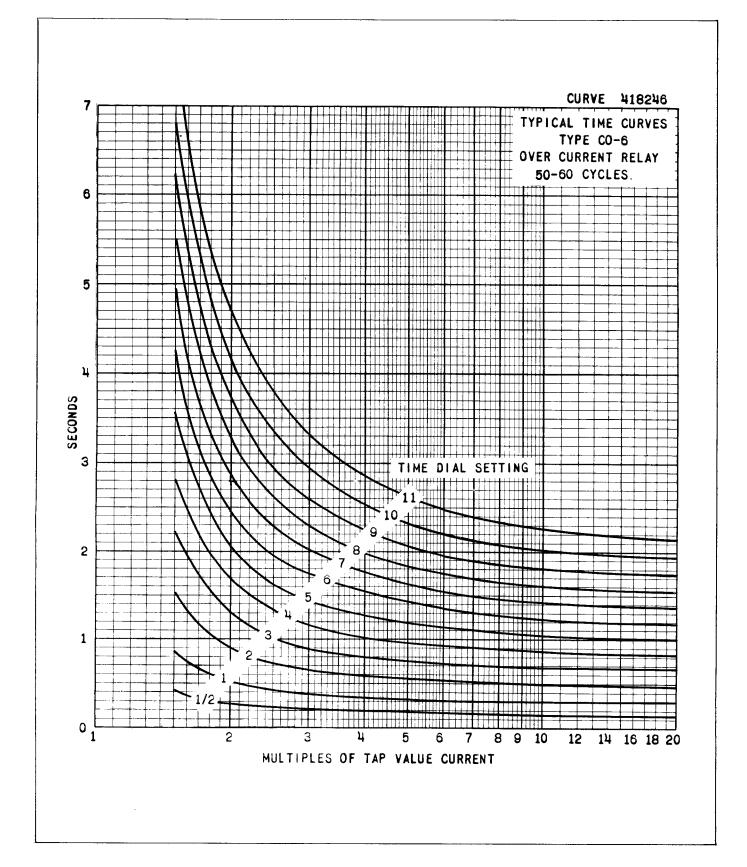


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

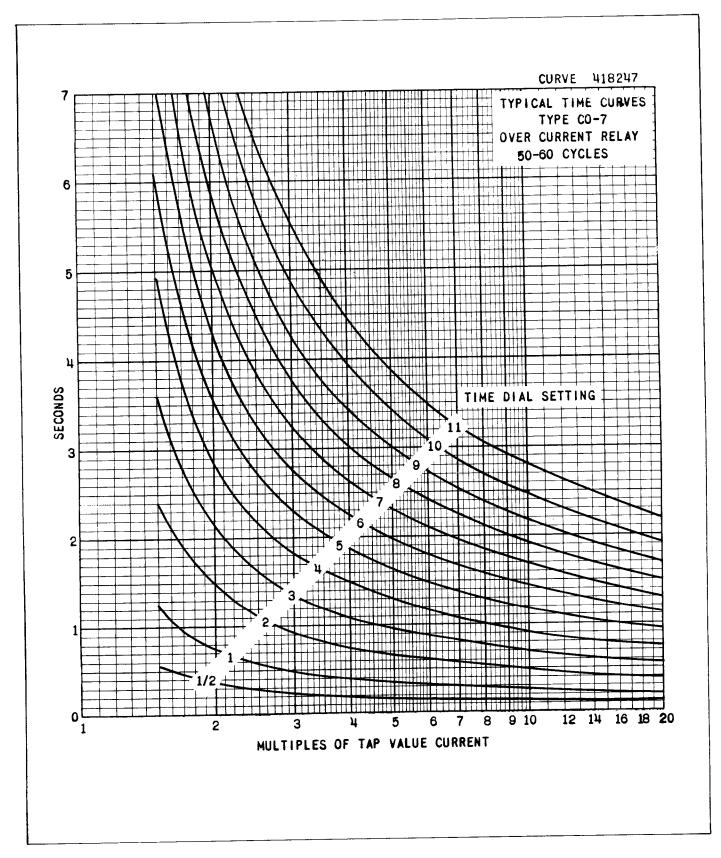


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

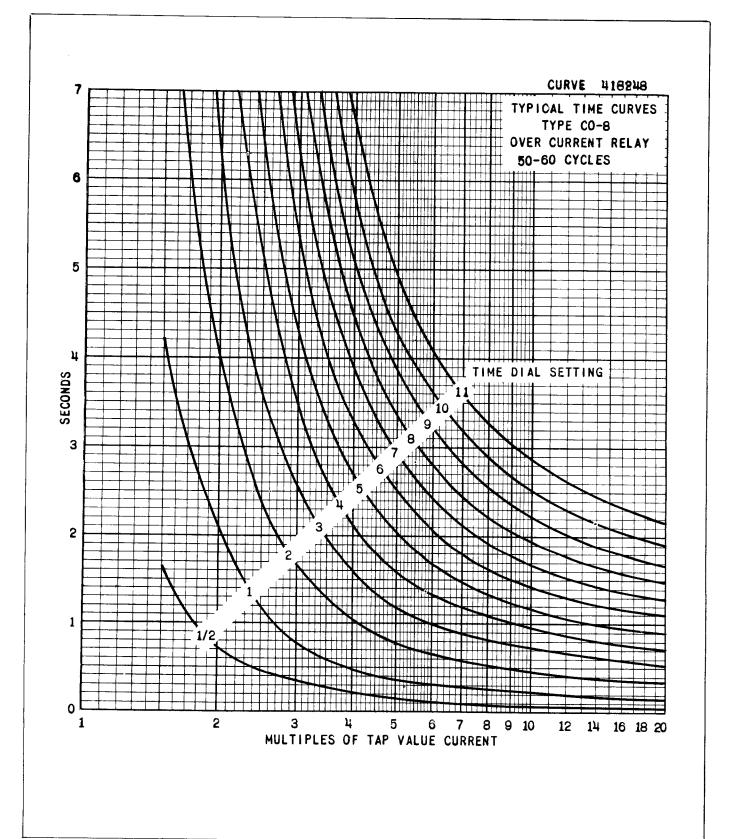


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

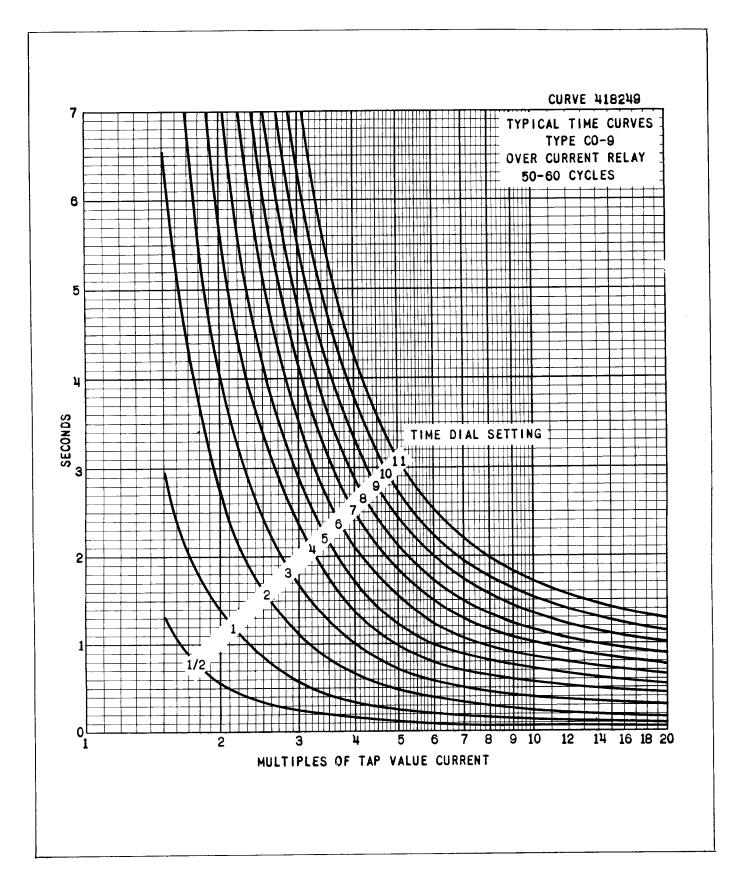


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

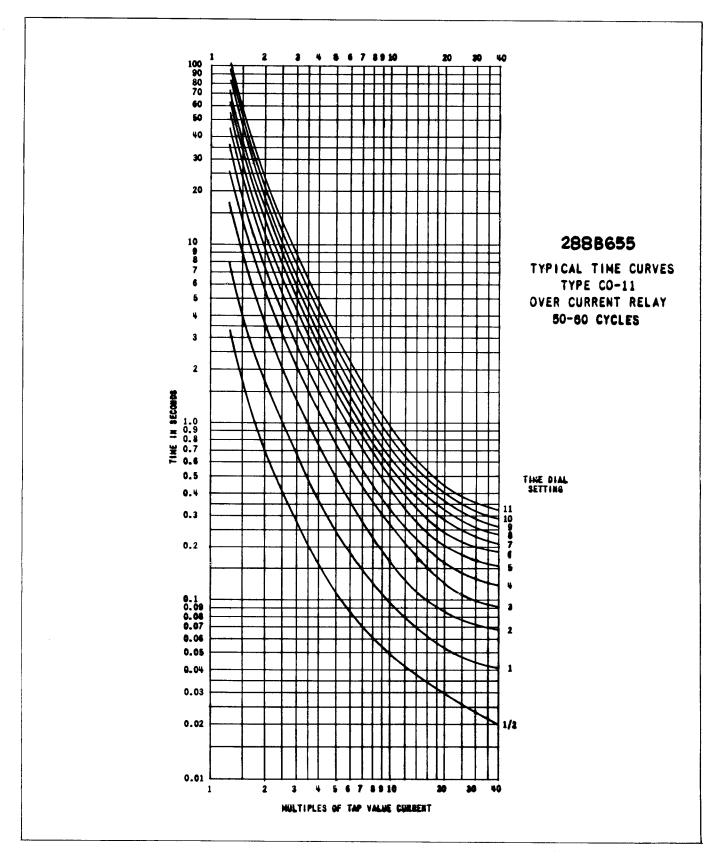


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

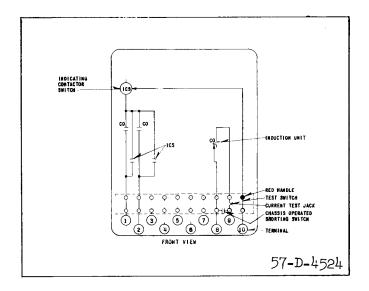


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted.

#### **SETTINGS**

#### CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will just close its contacts at the corresponding current 4-5-6-7-8-10-12 amperes, or as marked on the terminal plate.

#### Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

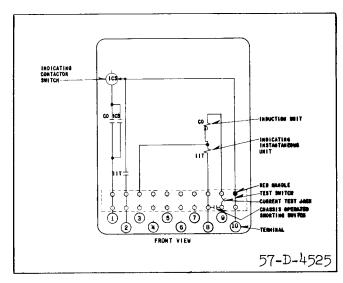


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

#### Instantaneous Reclosing

The factory adjustment of the CO unit contact provides a contact follow. Where instantaneous circuit breaker reclosing will be initiated upon the closure of the CO contact, this contact follow must be eliminated by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring. With this change and the contact mounting screw tightened, the stationary contact will rest solidly against its backstop.

For double trip relays, the upper stationary contact is adjusted such that the contact rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

#### Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

#### Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT. unit.

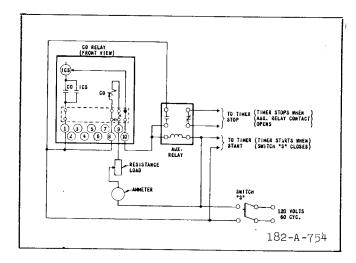


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

#### INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically be means of the mounting stud for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

#### **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

#### Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

- 1. Contacts By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- 2. Minimum Trip Current Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. Time Curve Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I, (E.G. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5%.

For Type CO-11 Relay only, the 1.3 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds.

4. <u>Indicating Instantaneous Trip Unit (IIT)</u> - The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

#### Routine Maintenance

All relays should be inspected periodically and

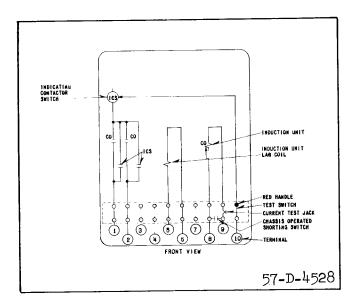


Fig. 17. Internal Schematic of the Double Trip Circuit
Closing Relay with Torque Control Terminals.
For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

the time of operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application. The use of phantom loads, in testing induction-type relays, should be avoided, since the resulting distorted current wave form will produce an error in timing.

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

#### CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

#### CO Unit

1) Contacts — By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial.

For double trip relays only, the follow on the stationary contacts is obtained through the use of the stationary contact adjusting screw. The upper stationary contact is adjusted first such that there is ap-

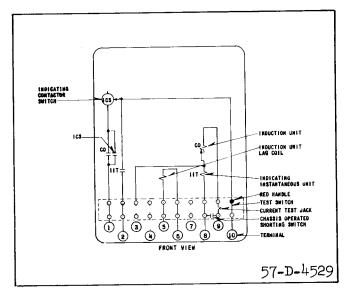


Fig. 18. Internal Schematic of the Single Trip Circuit
Closing Relay with Torque Control Terminals
and Indicating Instantaneous Trip Unit.

proximately 1/64" follow. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

2) Minimum Trip Current - The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. <u>Time Curve Calibration</u> - Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For Type CO-11 Relay only, the 1.3 times tap value operating time from the number 6 time dial position is  $54.9\pm5\%$  seconds. If the operating time

at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment. 4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

## 5. Indicating Instantaneous Trip Unit (III)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

#### **RENEWAL PARTS**

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

TABLE 1

TIME CURVE CALIBRATION DATA - 50 & 60 CYCLES

	PERMANENT	Γ MAGNET ADJUSTM	IENT	ELECTROMAGNET PLUGS			
RELAY TYPE	TIME DIAL POSITION	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS		
CO-2	6	3	0.57	20	0.22		
CO-5	6	2	37.80	10	14.30		
CO-6	6	2	2.46	20	1.19		
CO-7	6	2	4.27	20	1.11		
CO-8	6	2	13.35	20	1.11		
CO-9	6	2	8.87	20	0.65		
CO-11	6	2	11.27	20	0.24		

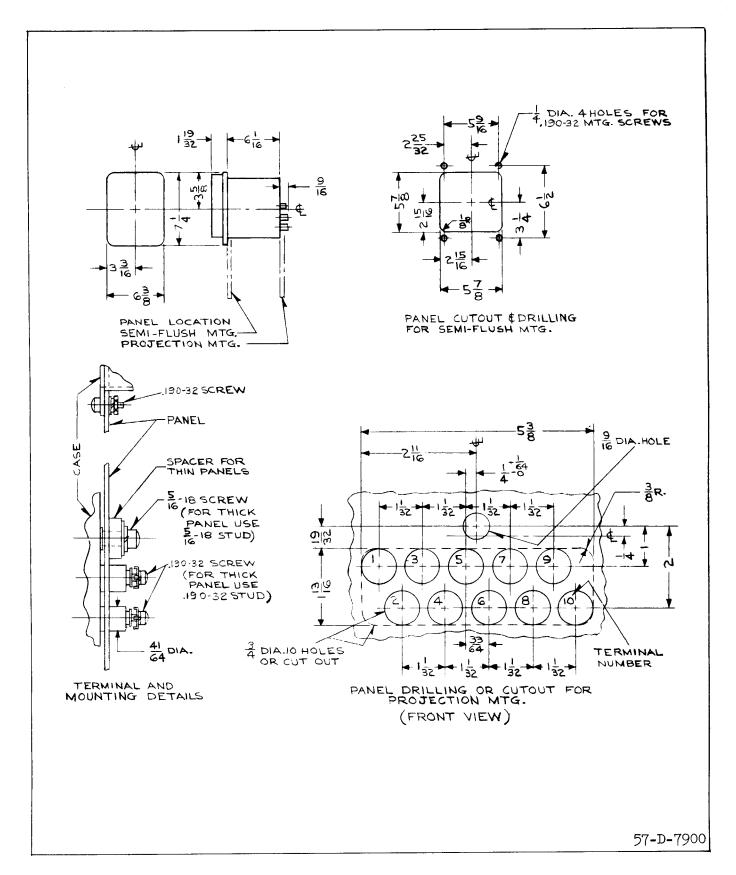


Fig. 19. Outline and Drilling Plan for the Type CO Relay.



WESTINGHOUSE ELECTRIC CORPORATION RELAY DEPARTMENT NEWARK, N. J.

Printed in U.S.A.



## INSTALLATION . OPERATION . MAINTENANCE

# INSTRUCTIONS

## TYPE CO OVERCURRENT RELAY

#### CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

#### **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

#### **CONTENTS**

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

#### CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

#### Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

## Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

#### Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

#### **CHARACTERISTICS**

The relays are generally available in the following current ranges:

**EFFECTIVE SEPTEMBER 1960** 

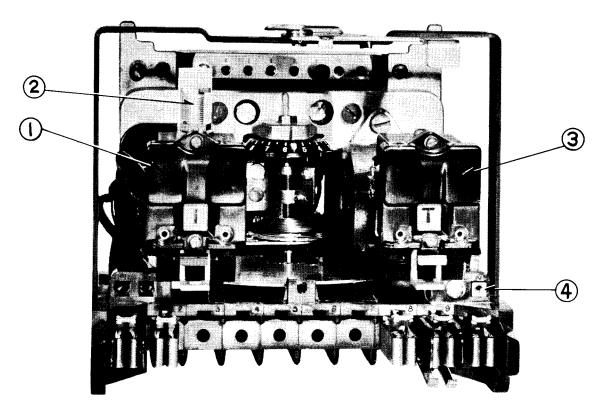


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

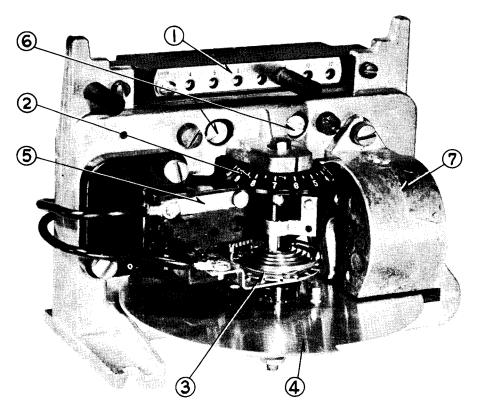
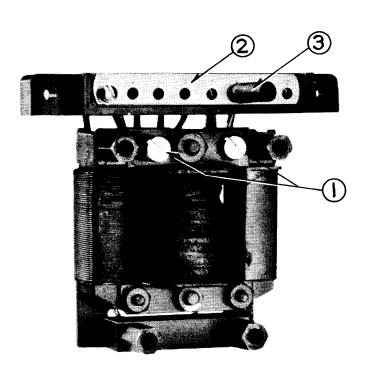


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.



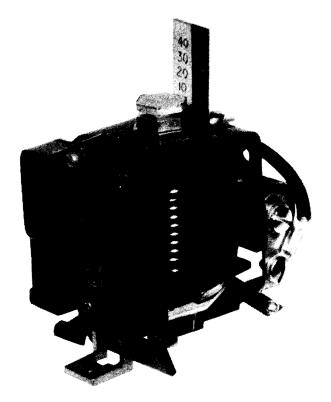


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

Fig. 4. Indicating Instantaneous Trip Unit (IIT).

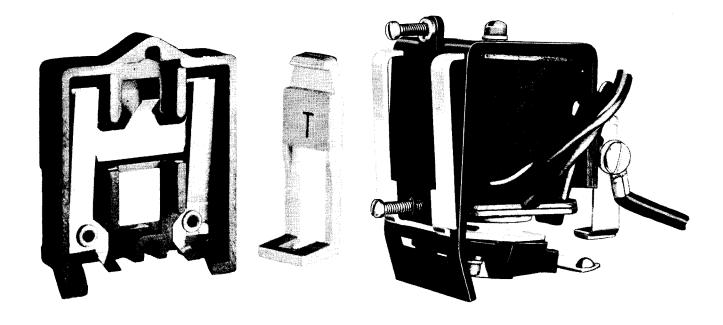


Fig. 5. Indicating Contactor Switch (ICS).

Range				Taps			
.5 - 2.5	0.5	0.6	0.8	1.0	1.5	2.0	2.5
2 - 6	2	2.5	3	3.5	4	5	6
4 - 12	4	5	6	7	8	10	12

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

#### Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indi-

cating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

#### Trip Circuit Constants

Contactor Switch -

0.2 ampere tap - 6.5 ohms d-c resistance

2.0 ampere tap - 0.15 ohms d-c resistance

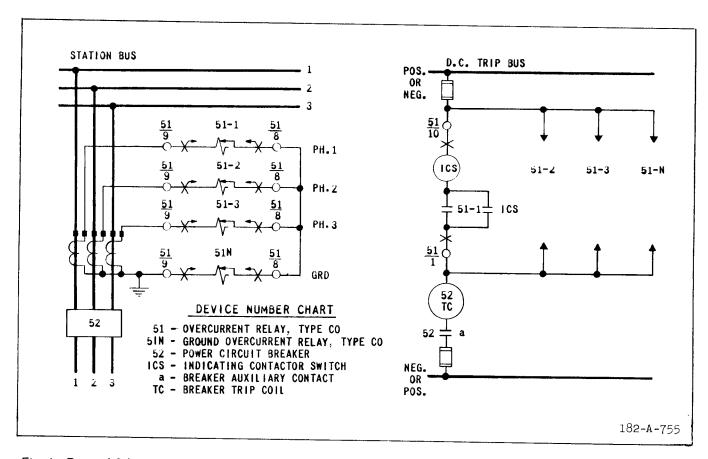


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

TYPE CO-2 RELAY

						VOLT A	AMPERES**	·,
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	0.5	0.91	28	58	4.8	39.6	256	790
	0.6	0.96	28	5 <b>7</b>	4.9	39.8	270	851
	0.8	1.18	28	53	5.0	42.7	308	1024
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220
	1.5	1.95	28	40	6.2	54.4	435	1740
	2.0	2.24	28	36	7.2	65.4	580	2280
	2.5	2.50	28	29	7.9	73.6	700	2850
	2.0	3.1	110	59	5.04	38.7	262	800
	2.5	4.0	110	55	5.13	39.8	280	920
	3.0	4.4	110	51	5.37	42.8	312	1008
2/6	3.5	4.8	110	47	5.53	42.8	329	1120
	4.0	5.2	110	45	5.72	46.0	360	1216
	5.0	5.6	110	41	5.90	50.3	420	1500
	6.0	6.0	110	37	6.54	54.9	474	1800
	4.0	7.3	230	65	4.92	39.1	268	848
	5.0	8.0	230	50	5.20	42.0	305	1020
	6.0	8.8	230	47	5.34	44.1	330	1128
4/12	7.0	9.6	230	46	<b>*</b> 5.53	45.8	364	1260
-,	8.0	10.4	230	43	5.86	49.9	400	1408
	10.0	11.2	230	37	6.6	55.5	470	1720
	12.0	12.0	230	34	7.00	62.3	528	2064

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

## CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

					VOLT AMPERES**					
AMPERE RANGE	ТАР	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT		
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	69 68 67 66 62 60 58	3.92 3.96 3.96 4.07 4.19 4.30 4.37	20.6 20.7 21 21.4 23.2 24.9 26.2	103 106 114 122 147 168 180	270 288 325 360 462 548 630		
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	67 66 64 63 62 59	3.88 * 3.90 3.93 4.09 * 4.12 4.20 4.38	21 21.6 22.1 23.1 23.5 24.8 26.5	110 118 126 136 144 162 183	308 342 381 417 448 540 624		
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	65 63 61 59 56 53	4.00 4.15 4.32 * 4.35 4.40 4.60 4.92	22.4 23.7 25.3 26.4 27.8 30.1 35.6	126 143 162 183 204 247 288	376 450 531 611 699 880 1056		

#### CO-7 MODERATELY INVERSE TIME RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	68 67 66 64 61 58	3.88 3.93 3.93 4.00 4.08 4.24 4.38	20.7 20.9 21.1 21.6 22.9 24.8 25.9	103 107 114 122 148 174 185	278 288 320 356 459 552 640	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	66 63 63 62 61 59	4.06 4.07 4.14 4.34 4.34 4.40	21.3 21.8 22.5 23.4 23.8 25.2	111 120 129 141 149 163 183	306 342 366 413 448 530 624	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	64 61 60 58 55 51	4.24 4.30 4.62 4.69 4.80 5.20 5.40	22.8 24.2 25.9 27.3 29.8 33	129 149 168 187 211 260 308	392 460 540 626 688 860 1032	

<sup>\*</sup> 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.

φ Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

## CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88	72 71 69 67 62 57 53	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180	360 395 430 470 500 580 660
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	68 63 60 57 54 48 45	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850 1020

#### TYPE CO-11 RELAY

						VOLT A	AMPERES**	
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	0.5	1.7	88	36	0.72	6.54	71.8	250
	0.6	1.9	88	34	0.75	6.80	75.0	267
	0.8	2.2	88	30	0.81	7.46	84.0	298
0.5/2.5	1.0	<b>*</b> 2.5	88	27	0.89	8.30	93.1	330
0.0, 2.0	1.5	3.0	88	22	1.13	10.04	115.5	411
	2.0	3.5	88	17	1.30	11.95	136.3	502
	2.5	3.8	88	16	1.48	13.95	160.0	610
	2.0	7.0	230	32	0.73	6.30	74.0	264
	2.5	7.8	230	30	0.78	7.00	78.5	285
	3.0	8.3	230	27	0.83	7.74	84.0	309
2/6	3.5	9.0	230	24	0.88	8.20	89.0	340
2, 0	4.0	10.0	230	23	0.96	9.12	102.0	372
	5.0	11.0	230	20	1.07	9.80	109.0	430
	6.0	12.0	230	20	1.23	11.34	129.0	504
	4.0	14	460	29	0.79	7.08	78.4	296
	5.0	16	460	25	0.89	8.00	90.0	340
	6.0	17	460	22	1.02	9.18	101.4	378
4/12	7.0	18	460	20	1.10	10.00	110.0	454
4/12		20	460	18	1.23	11.1	124.8	480
	8.0		460	17	1.32	14.9	131.6	600
	10.0 12.0	22 26	460	16	1.8	16.3	180.0	720

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

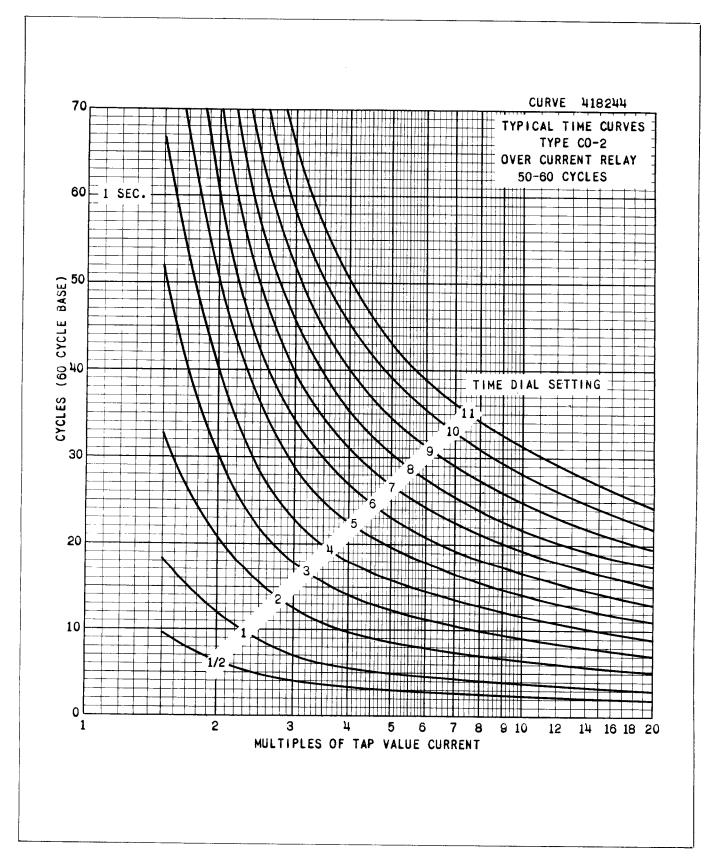


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

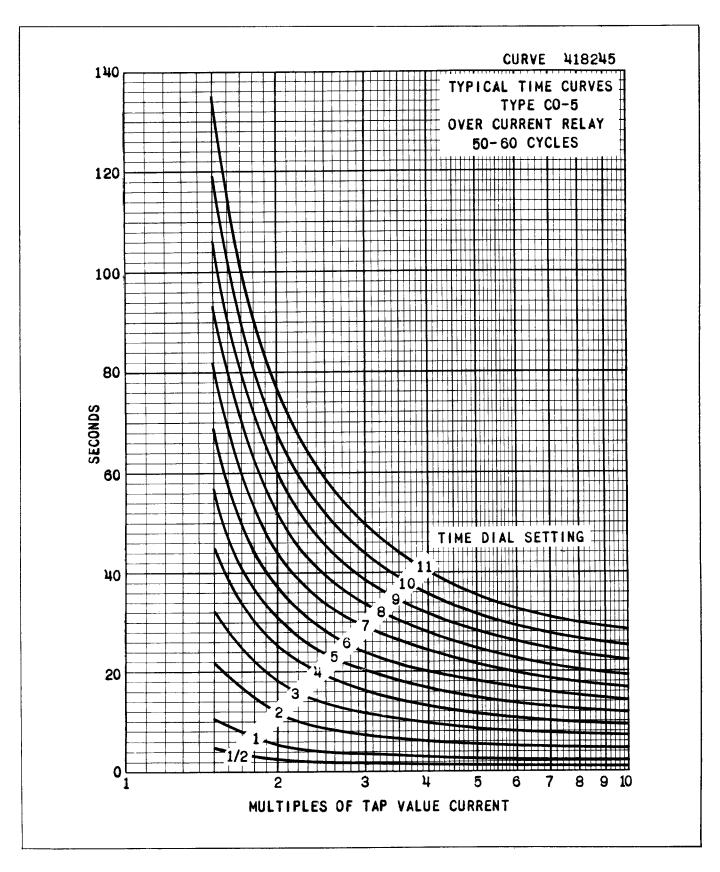


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

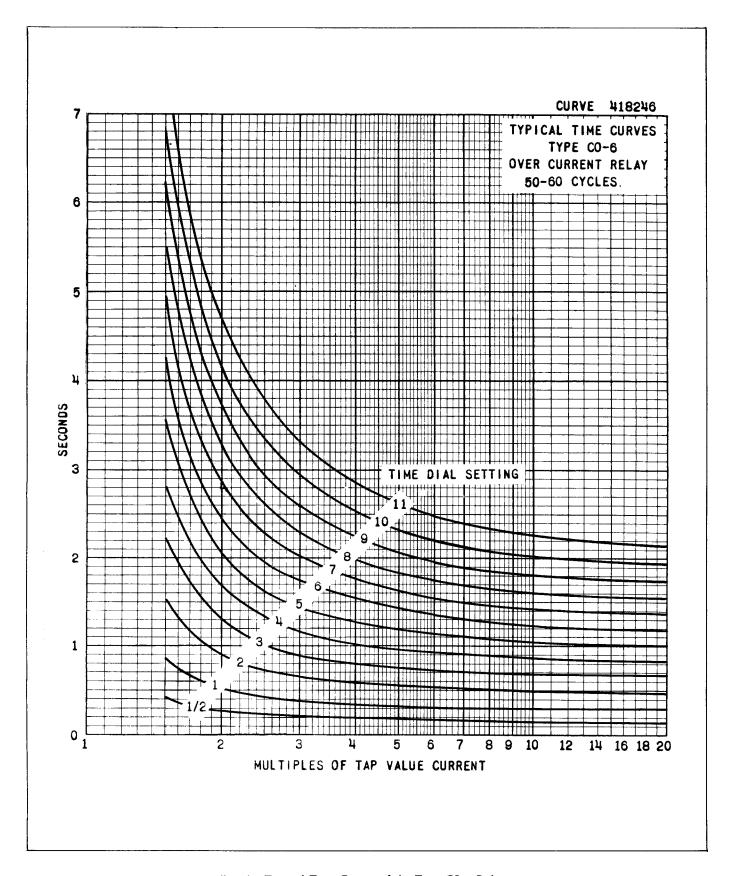


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

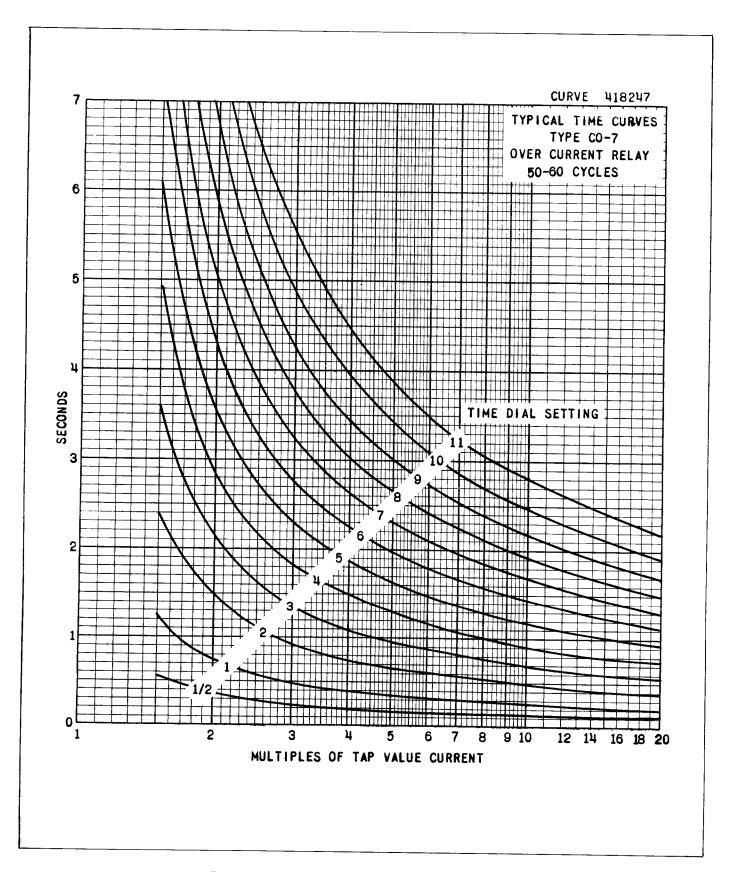


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

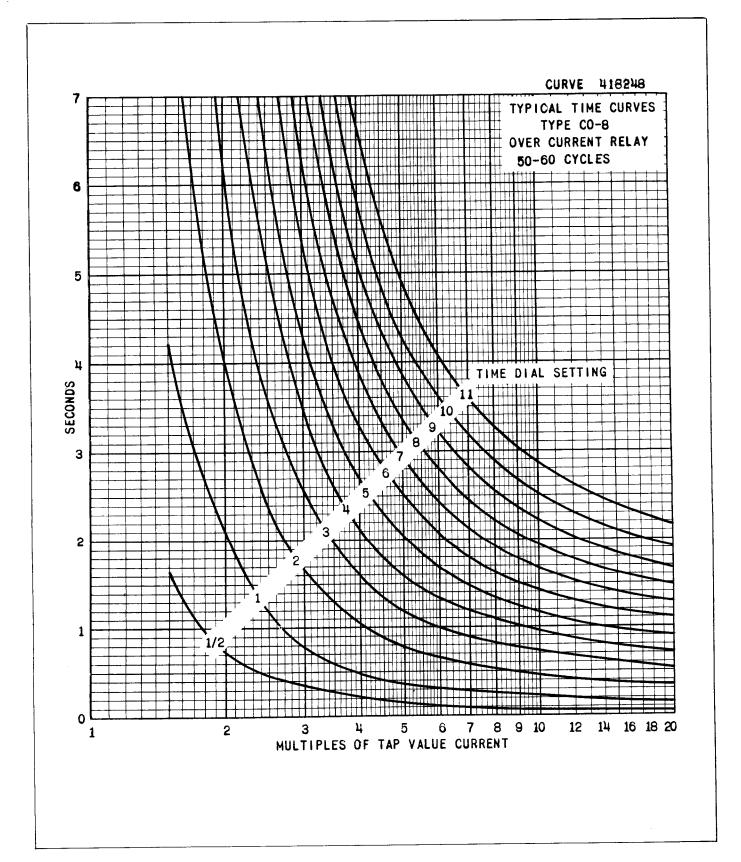


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

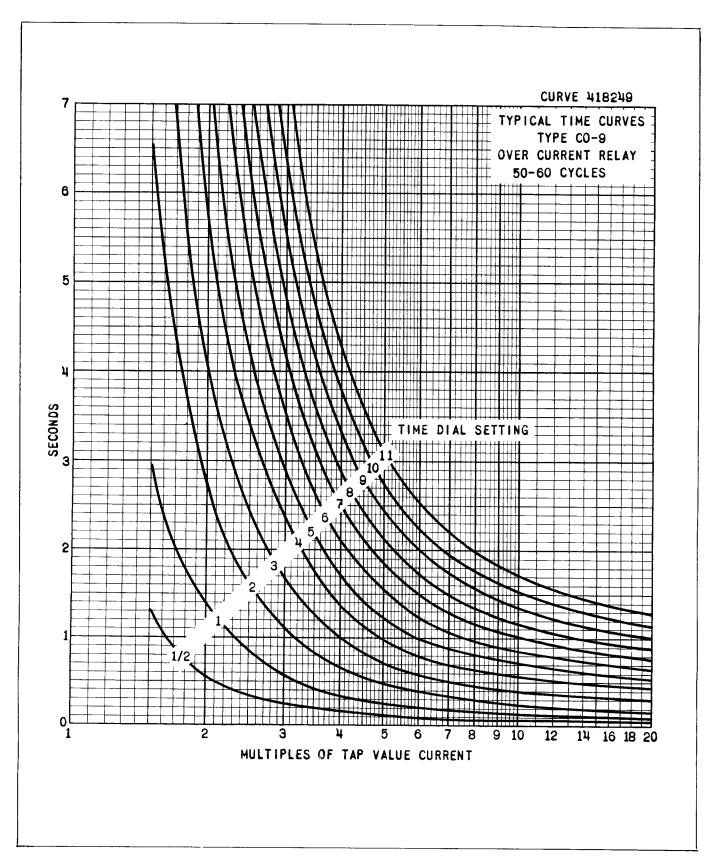


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

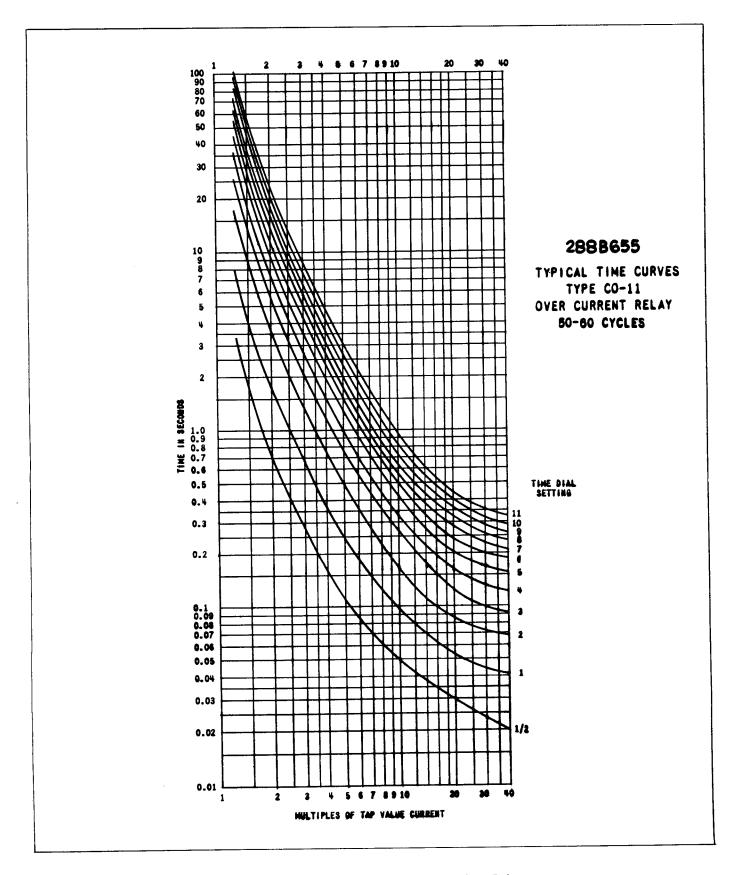


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

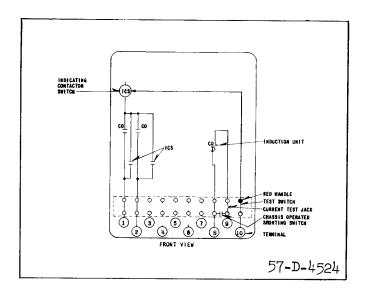


Fig. 14. Internal Schematic of the Double Trip Circuit
Closing Relay. For the Single Trip Relay the
Circuits Associated with Terminal 2 are Omitted.

#### **SETTINGS**

#### CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

#### Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

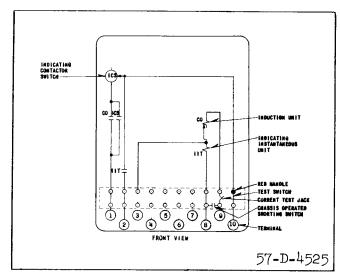


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

#### Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

#### Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

## Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT. unit.

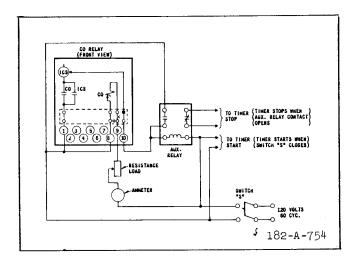


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

#### INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

#### **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

#### Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. Minimum Trip Current Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. <u>Time Curve</u> Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5%.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the the nominal operating time by approximately 4%.

4. <u>Indicating Instantaneous Trip Unit (IIT)</u> - The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

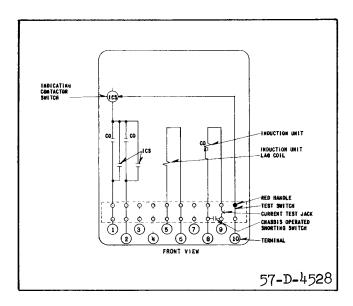


Fig. 17. Internal Schematic of the Double Trip Circuit
Closing Relay with Torque Control Terminals.
For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

#### Routine Maintenance

All relays should be inspected periodically and the time of operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application. The use of phantom loads, in testing induction-type relays, should be avoided, since the resulting distorted current wave form will produce an error in timing.

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for

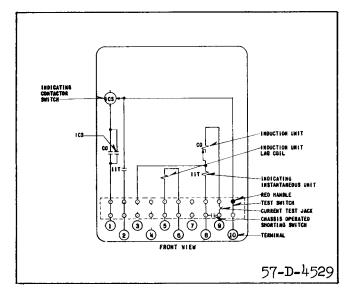


Fig. 18. Internal Schematic of the Single Trip Circuit
Closing Relay with Torque Control Terminals
and Indicating Instantaneous Trip Unit.

cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

#### CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

#### CO Unit

- 1. Contact
- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The

placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2) Minimum Trip Current - The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. <u>Time Curve Calibration</u> - Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the

correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

#### 5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

#### RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

TABLE 1

TIME CURVE CALIBRATION DATA = 50 & 60 CYCLES

	PERMANENT	Γ MAGNET ADJUSTM	<u>IENT</u>	ELECTROMAGNET PLUGS			
RELAY TYPE	TIME DIAL POSITION	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS		
CO-2	6	3	0.57	20	0.22		
CO-5	6	2	37.80	10	14.30		
CO-6	6	2	2.46	20	1.19		
CO-7	6	2	4.27	20	1.11		
CO-8	6	2	13.35	20	1.11		
CO-9	6	2	8.87	20	0.65		
CO-11	6	2	11.27	20	0.24 △		

 $\triangle$  For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, -5%.

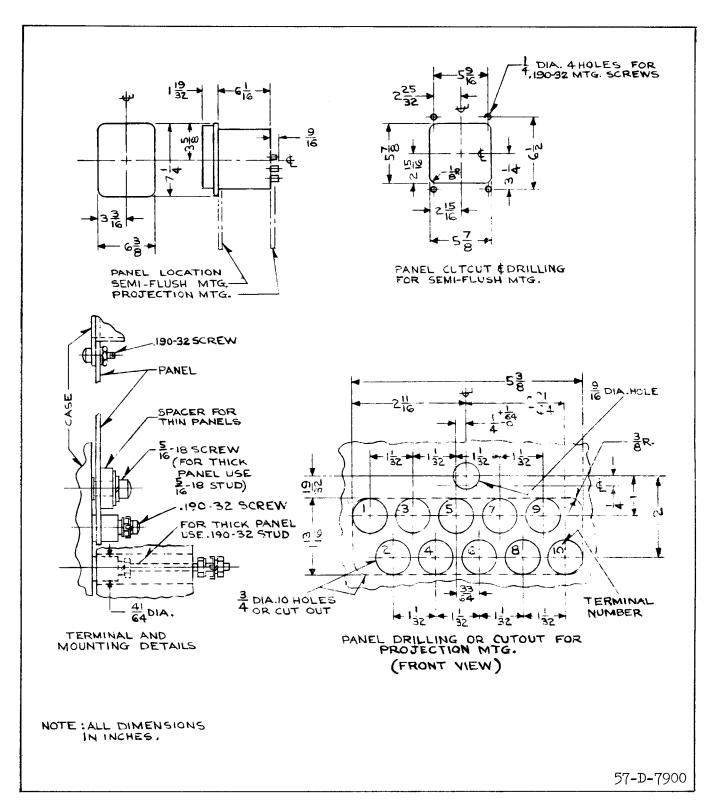


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

# WESTINGHOUSE ELECTRIC CORPORATION RELAY DEPARTMENT NEWARK, N. J.



## INSTALLATION . OPERATION . MAINTENANCE

# INSTRUCTIONS

## TYPE CO OVERCURRENT RELAY

#### CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

## **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

#### **CONTENTS**

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

## CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

#### Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

## Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

## Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

## CHARACTERISTICS

The relays are generally available in the following current ranges:

**EFFECTIVE FEBRUARY 1962** 

CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

					VOLT AMPERES**					
AMPERE RANGE	ТАР	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT		
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	69 68 67 66 62 60 58	3.92 3.96 3.96 4.07 4.19 4.30	20.6 20.7 21 21.4 23.2 24.9 26.2	103 106 114 122 147 168 180	270 288 325 360 462 548 630		
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	67 66 64 63 62 59	3.88 3.90 3.93 4.09 4.12 4.20 4.38	21 21.6 22.1 23.1 23.5 24.8 26.5	110 118 126 136 144 162	308 342 381 417 448 540 624		
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	65 63 61 59 56 53 47	4.00 4.15 4.32 4.35 4.40 4.60 4.92	22.4 23.7 25.3 26.4 27.8 30.1 35.6	126 143 162 183 204 247 288	376 450 531 611 699 880 1056		

#### CO-7 MODERATELY INVERSE TIME RELAY

					VOLT AMPERES**					
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT		
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	68 67 66 64 61 58	3.88 3.93 3.93 4.00 4.08 4.24 4.38	20.7 20.9 21.1 21.6 22.9 24.8 25.9	103 107 114 122 148 174	278 288 320 356 459 552 640		
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	66 63 63 62 61 59	4.06 4.07 4.14 4.34 4.34 4.40	21.3 21.8 22.5 23.4 23.8 25.2	111 120 129 141 149 163 183	306 342 366 413 448 530 624		
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	64 61 60 58 55 51	4.24 4.30 4.62 4.69 4.80 5.20 5.40	22.8 24.2 25.9 27.3 29.8 33 37.5	129 149 168 187 211 260 308	392 460 540 626 688 860 1032		

<sup>\*</sup> Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the

φ Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

#### CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

						MPERES**		
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88	72 71 69 67 62 57 53	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180	360 395 430 470 500 580 660
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	68 63 60 57 54 48 45	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850

#### TYPE CO-11 RELAY

						VOLT AMPERES**					
AMPERE RANGE	TAP		RATING RATING* FAC	RATING	RATING*	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
	0.5	1.7		56	36	0.72	6.54	71.8	250		
	0.6	1.9		56	34	0.75	6.80	75.0	267		
	0.8	2.2		56	30	0.81	7.46	84.0	298		
0.5/2.5	1.0	2.5	*	56	27	0.89	8.30	93.1	330		
	1.5	3.0		56	22	1.13	10.04	115.5	411		
	2.0	3.5		56	17	1.30	11.95	136.3	502		
	2.5	3.8		56	16	1.48	13.95	160.0	610		
	2.0	7.0		230	32	0.73	6.30	74.0	264		
	2.5	7.8		230	30	0.78	7.00	78.5	285		
	3.0	8.3		230	27	0.83	7.74	84.0	309		
2/6	3.5	9.0		230	24	0.88	8.20	89.0	340		
2, 0	4.0	10.0		230	23	0.96	9.12	102.0	372		
	5.0	11.0		230	20	1.07	9.80	109.0	430		
	6.0	12.0		230	20	1.23	11.34	129.0	504		
	4.0	14		460	29	0.79	7.08	78.4	296		
	5.0	16		460	25	0.89	8.00	90.0	340		
	6.0	17		460	22	1.02	9.18	101.4	378		
4/12	7.0	18		460	20	1.10	10.00	110,0	454		
4/12		20		460	18	1.23	11.1	124.8	480		
	8.0			460	17	1.32	14.9	131.6	600		
	10.0	22			16	1.8	16.3	180.0	720		
	12.0	26		460	10	1.0	10.0	100.0	.20		

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

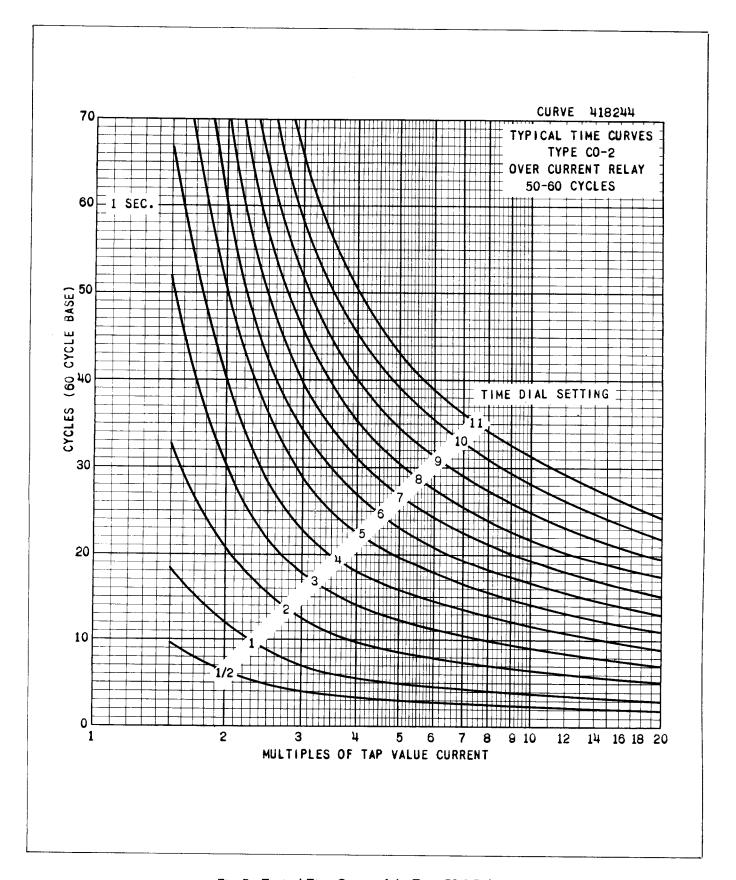


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

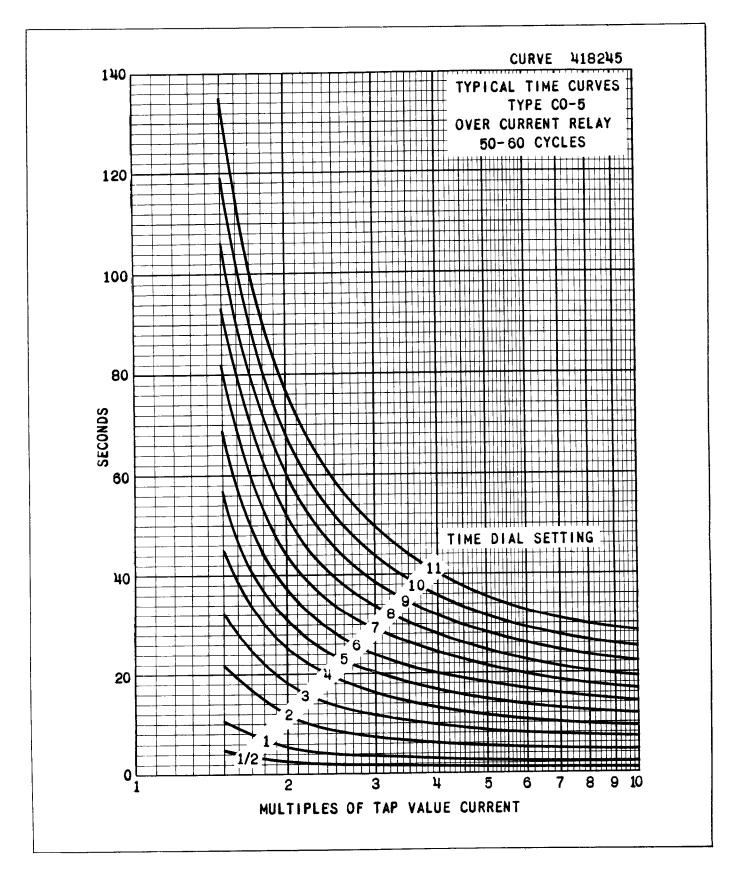


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

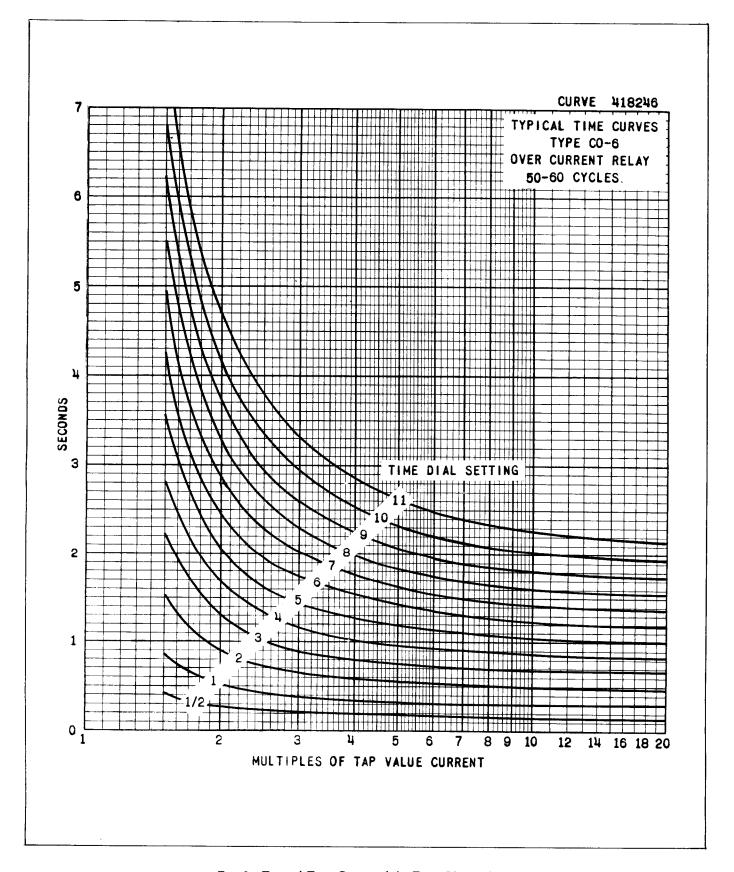


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

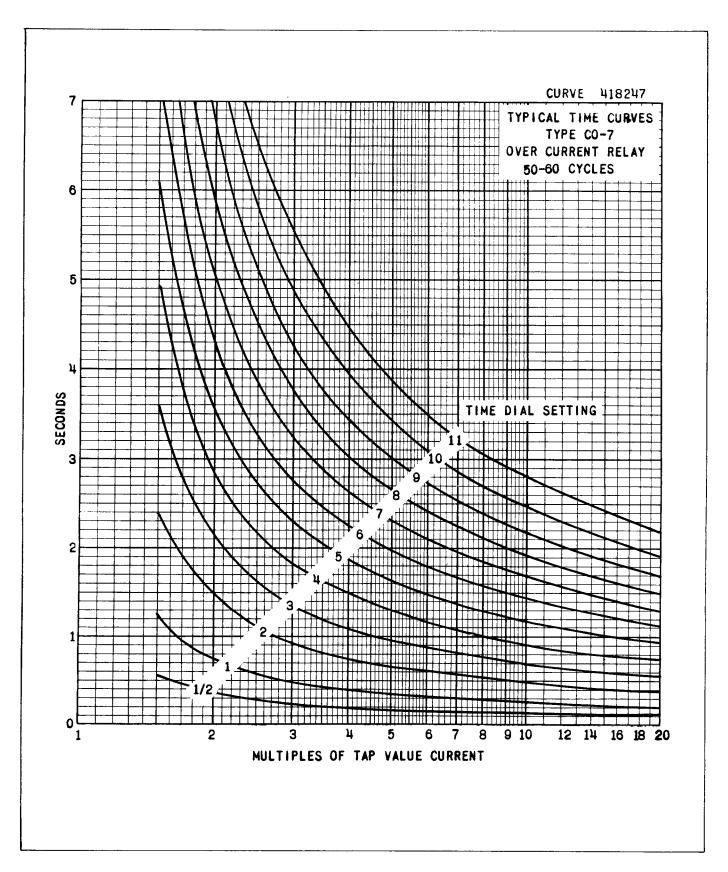


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

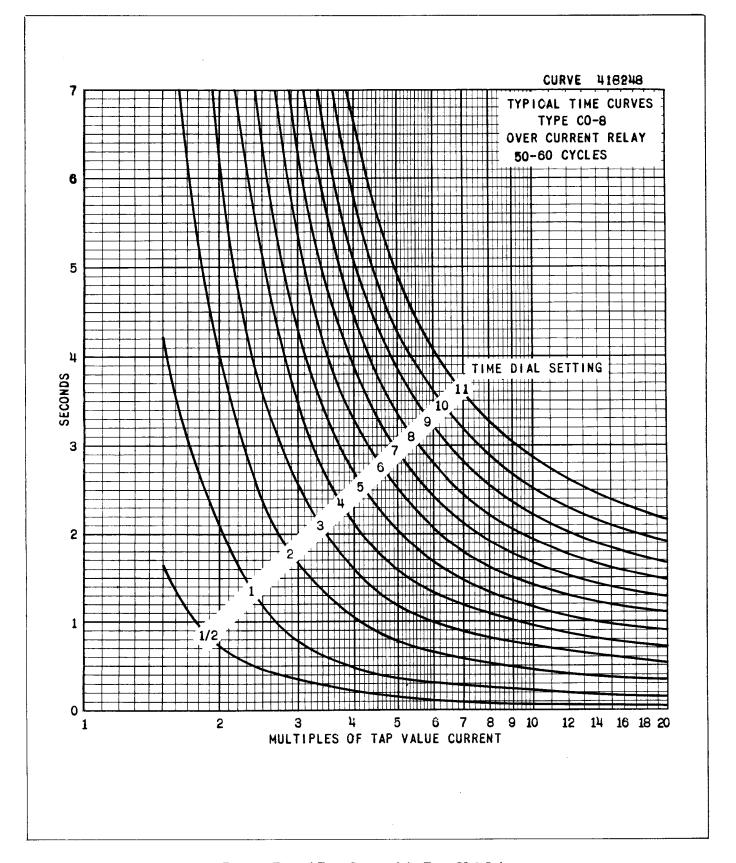


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

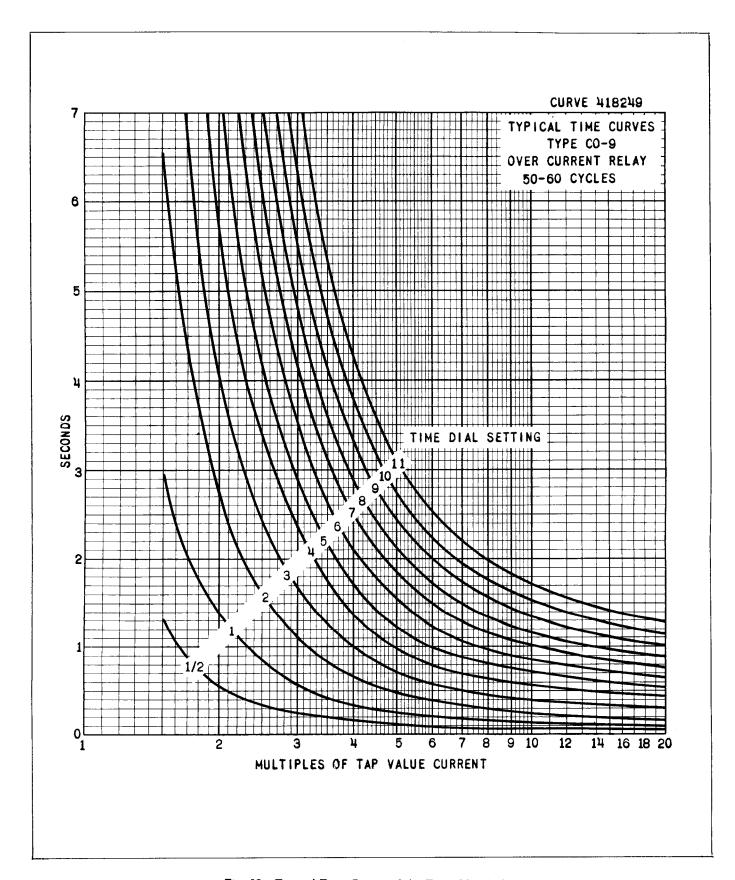


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

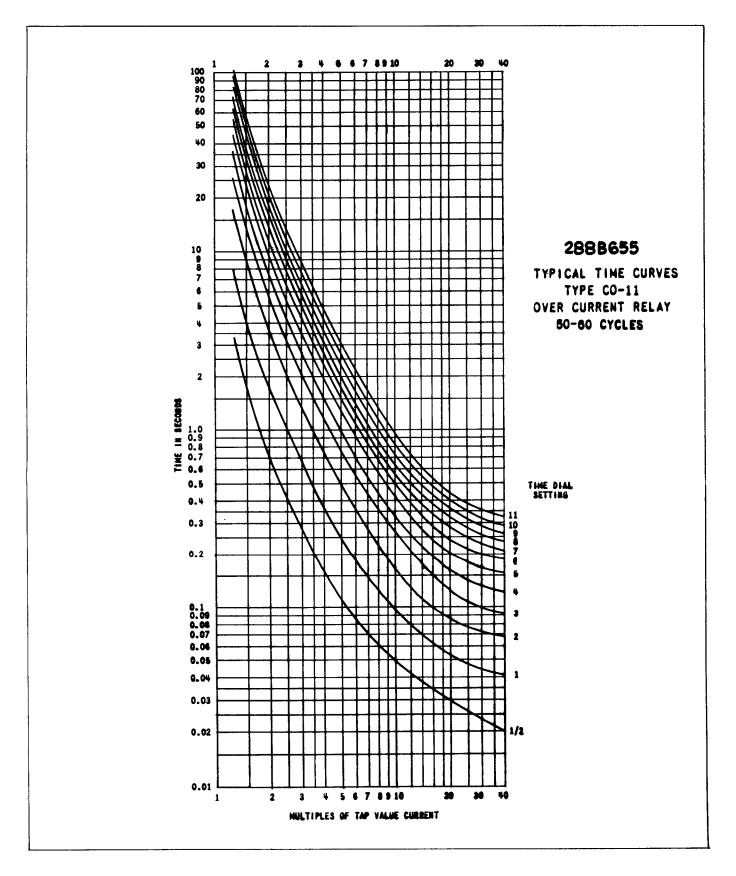


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

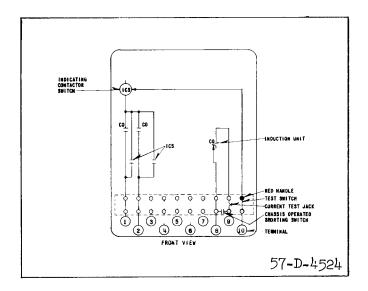


Fig. 14. Internal Schematic of the Double Trip Circuit
Closing Relay. For the Single Trip Relay the
Circuits Associated with Terminal 2 are Omitted.

## **SETTINGS**

### CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

### Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

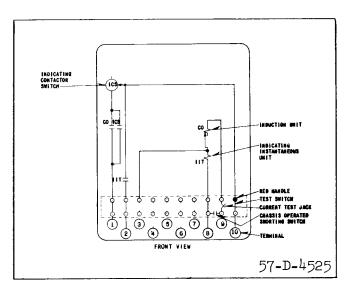


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

#### Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

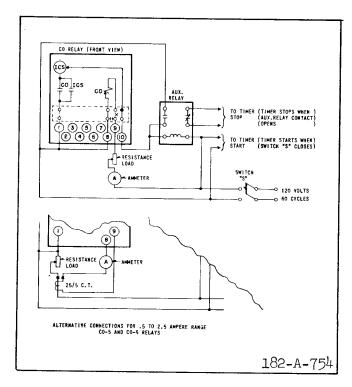
## Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

## Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT. unit.



\* Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

## INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

## **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

## Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. Minimum Trip Current Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. <u>Time Curve</u> Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5%.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds. It is important that the 1.30 times tap value current be maintained ac-

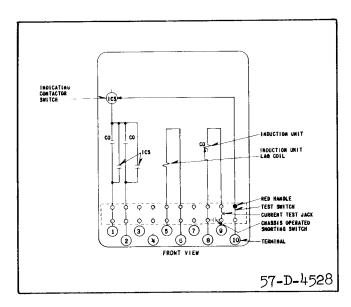


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

curately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the the nominal operating time by approximately 4%.

4. <u>Indicating Instantaneous Trip Unit (IIT)</u> The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

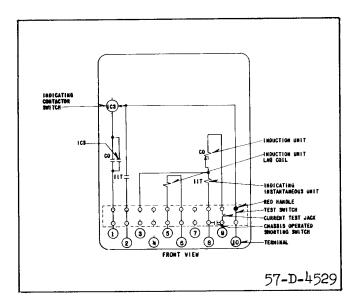


Fig. 18. Internal Schematic of the Single Trip Circuit
Closing Relay with Torque Control Terminals
and Indicating Instantaneous Trip Unit.

#### Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

## **CALIBRATION**

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or

the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

#### CO Unit

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2) Minimum Trip Current The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. <u>Time Curve Calibration</u> - Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the timecurrent characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

## 5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the HT unit.

### **RENEWAL PARTS**

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

TABLE 1

TIME CURVE CALIBRATION DATA = 50 & 60 CYCLES

	PERMANENT	Γ MAGNET ADJUSTM	MENT	ELECTROMAGNET PLUGS			
RELAY TYPE	TIME DIAL POSITION	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS		
CO-2	6	3	0.57	20	0.22		
CO-5	6	2	37.80	10	14.30		
CO-6	6	2	2.46	20	1.19		
CO-7	6	2	4.27	20	1.11		
CO-8	6	2	13.35	20	1.11		
CO-9	6	2	8.87	20	0.65		
CO-11	6	2	11.27	20	0.24 △		

 $\triangle$  For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, -5%.

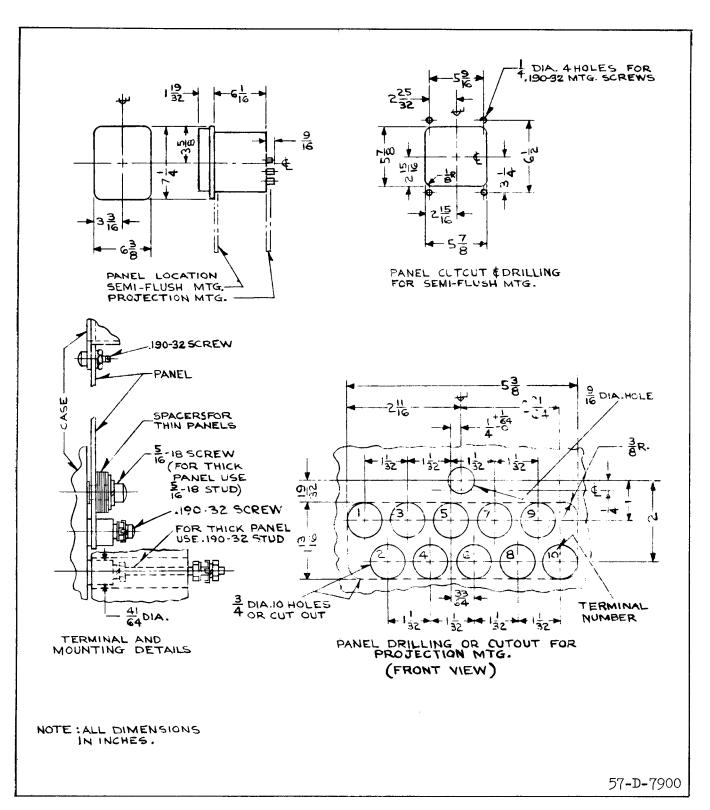


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

# WESTINGHOUSE ELECTRIC CORPORATION RELAY - INSTRUMENT DEPARTMENT NEWARK, N. J.



## INSTALLATION

## OPERATION . MAINTENA

# INSTRUCTIONS

# TYPE CO OVERCURRENT RELAY

## CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

#### **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

## **CONTENTS**

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

## CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

### Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

#### Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

## Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

## **CHARACTERISTICS**

The relays are generally available in the following current ranges:

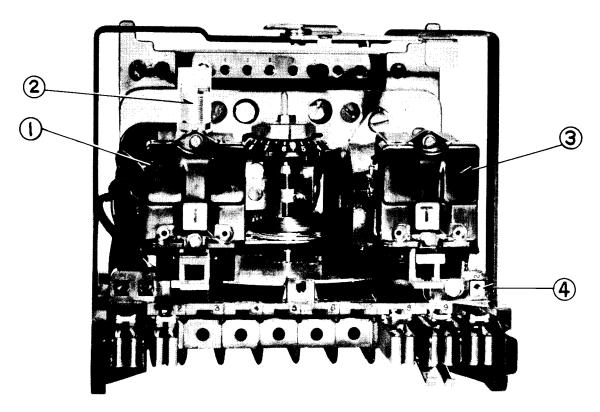


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

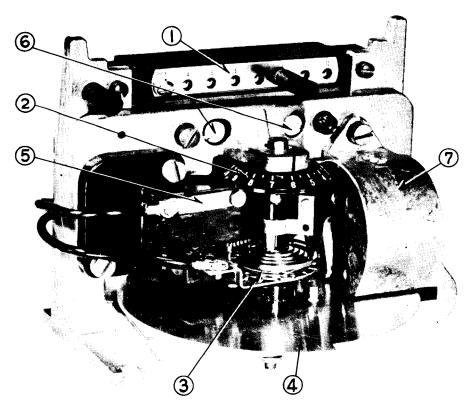
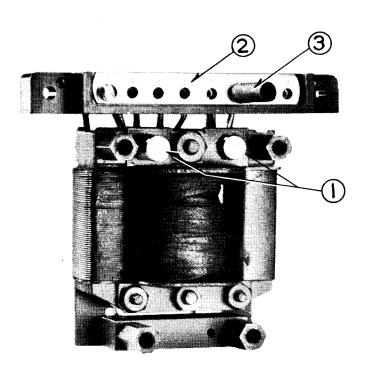


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.



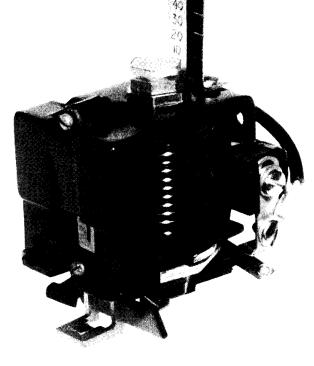


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

Fig. 4. Indicating Instantaneous Trip Unit (IIT).

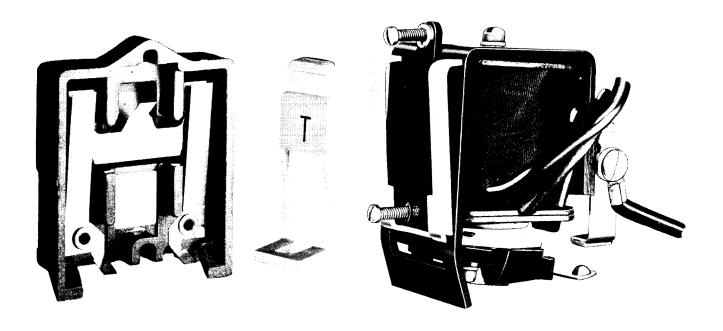


Fig. 5. Indicating Contactor Switch (ICS).

Range				Taps			
.5 - 2.5	0.5	0.6	0.8	1.0	1.5	2.0	$^{2.5}$
2 - 6	2	$^{2.5}$	3	3.5	4	5	6
4 - 12	4	5	6	7	8	10	12

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

## Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indi-

cating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

## Trip Circuit Constants

Contactor Switch -

0.2 ampere tap - 6.5 ohms d-c resistance

2.0 ampere tap - 0.15 ohms d-c resistance

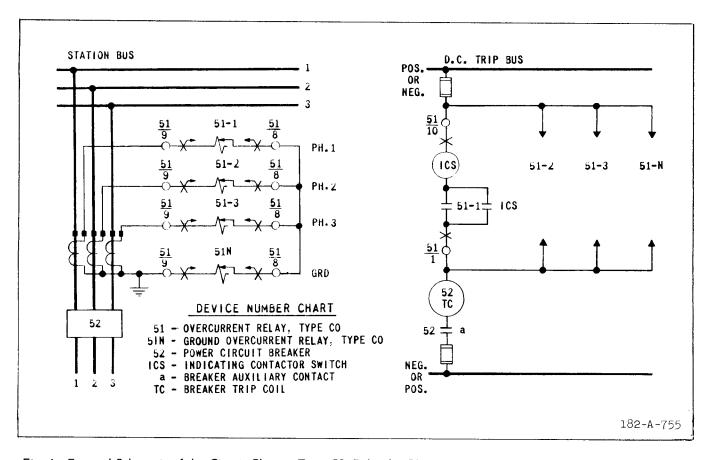


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

TYPE CO-2 RELAY

				POWER FACTOR ANGLE $\phi$	VOLT AMPERES**					
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)		AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT		
	0.5	0.91	28	58	4.8	39.6	256	790		
	0.6	0.96	28	57	4.9	39.8	270	851		
	0.8	1.18	28	53	5.0	42.7	308	1024		
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220		
	1.5	1.95	28	40	6.2	54.4	435	1740		
	2.0	2.24	28	36	7.2	65.4	580	2280		
	2.5	2.50	28	29	7.9	73.6	700	2850		
	2.0	3.1	110	59	5.04	38.7	262	800		
	2.5	4.0	110	55	5.13	39.8	280	920		
	3.0	4.4	110	51	5.37	42.8	312	1008		
2/6	3.5	4.8	110	47	5.53	42.8	329	1120		
	4.0	5.2	110	45	5.72	46.0	360	1216		
	5.0	5.6	110	41	5.90	50.3	420	1500		
	6.0	6.0	110	37	6.54	54.9	474	1800		
	4.0	7.3	. 230	65	4.92	39.1	268	848		
	5.0	8.0	230	50	5.20	42.0	305	1020		
	6.0	8.8	230	47	5.34	44.1	330	1128		
4/12	7.0	9.6	230	46	5.53	45.8	364	1260		
	8.0	10.4	230	43	5.86	49.9	400	1408		
	10.0	11.2	230	37	6.6	55.5	470	1720		
	12.0	12.0	230	34	7.00	62.3	528	2064		

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

VOLT AMPERES\*\* CONTINUOUS ONE SECOND POWER AΤ AT 3 TIMES AT 10 TIMES AT 20 TIMES AMPERE RATING RATING\* FACTOR TAP VALUE TAP VALUE TAP VALUE TAP VALUE RANGE TAP ANGLE  $\phi$ (AMPERES) (AMPENES) CURRENT CURRENT CURRENT CURRENT 88 (0.5 2.7 69 3.92 20.6 103 270 (0.6)3.1 88 68 3.96 20.7 106 288 (0,8 3.7 88 67 3.96 21 114 325 0.5/2.5(1.0 4.1 88 66 4.07 21.4 122 360 (1.5 5.7 88 62 4.19 23.2 147 462 6.8 (2.0)88 60 4.30 24.9 168 548 7.7 (2.5 88 58 4.37 26.2 180 630 (2 230 67 3.88 21 110 308 (2.5 8.8 230 66 3.90 21.6 118 342 (3 9.7 230 64 3.93 22.1 126 381 2/6 (3.5 10.4 230 63 4.09 23.1 136 417 (4 11.2 230 62 4.12 23.5 144 448 (5 12.5 230 59 4.20 24.8 162 540 (6 13.7 230 57 4.38 26.5183 624 (4 16 460 65 4.00 22.4 126 376 (5 18.8 460 63 4.15 23.7 143 450 (6 19.3 460 61 4.32 25.3 162 531 4/12 (7 20.8 460 59 4.35 26.4 183 611 (8 22.5 460 56 4.40 27.8 204 699 (10 25 460 53 4.60 30.1 247 880 (12 28 460 47 4.92 35.6

## CO-7 MODERATELY INVERSE TIME RELAY

288

1056

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE	AT 3 TIMES TAP VALUE	AT 10 TIMES TAP VALUE	AT 20 TIMES TAP VALUE	
MINGE		(AMEERED)	(AMPERES)	ANGLE $\phi$	CURRENT	CURRENT	CURRENT	CURRENT	
	(0.5 (0.6	2.7 3.1	88 88	68 67	3.88 3.93	20.7 20.9	103 107	278 288	
	(0.8	3.7	88	66	3.93	21.1	114	320	
0.5/2.5	(1.0	4.1	88	64	4.00	21.6	122	320 356	
	(1.5	5.7	88	61	4.08	22.9	148	459	
	(2.0	6.8	88	58	4.24	24.8	174	552	
	(2.5	7.7	88	56	4.38	25.9	185	640	
	(2	8	230	66	4.06	21.3	111	306	
	(2.5	8.8	230	63	4.07	21.8	120	342	
	(3	9.7	230	63	4.14	22.5	129	366	
2/6	(3.5	10.4	230	62	4.34	23.4	141	413	
	(4	11.2	230	61	4.34	23.8	149	448	
	(5	12.5	230	59	4.40	25.2	163	530	
	(6	13.7	230	58	4.62	27	183	624	
	(4	16	460	64	4.24	22.8	129	392	
	(5	18.8	460	61	4.30	24.2	149	460	
4/12	(6	19.3	460	60	4.62	25.9	168	540	
	(7	20.8	460	58	4.69	27.3	187	626	
	(8	22.5	460	55	4.80	29.8	211	688	
	(10	25	460	51	5.20	33	260	860	
	(12	28	460	46	5.40	37.5	308	1032	

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.

φ Degrees current lags voltage at tap value current.

Voltages taken with Rectox type voltmeter.

## CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	72 71 69 67 62 57	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180	360 395 430 470 500 580 660	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	68 63 60 57 54 48 45	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850 1020	

## TYPE CO-11 RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
	0.5	1.7	56	36	0.72	6.54	71.8	250	
	0.6	1.9	56	34	0.75	6.80	75.0	267	
	0.8	2.2	56	30	0.81	7.46	84.0	298	
0.5/2.5	1.0	2.5	56	27	0.89	8.30	93.1	330	
	1.5	3.0	56	22	1.13	10.04	115.5	411	
	2.0	3.5	56	17	1.30	11.95	136.3	502	
	2.5	3.8	56	16	1.48	13.95	160.0	610	
					2	2.00	<b>7.</b> 0	264	
	2.0	7.0	230	32	0.73	6.30	74.0		
	2.5	7.8	230	30	0.78	7.00	78.5	285	
	3.0	8.3	230	27	0.83	7.74	84.0	309	
2/6	3.5	9.0	230	24	0.88	8.20	89.0	340	
	4.0	10.0	230	23	0.96	9.12	102.0	372	
	5.0	11.0	230	20	1.07	9.80	109.0	430	
	6.0	12.0	230	20	1.23	11.34	129.0	504	
	4.0	14	460	29	0.79	7.08	78.4	296	
	5.0	16	460	25	0.89	8.00	90.0	340	
	6.0	17	460	22	1.02	9.18	101.4	378	
4/12	7.0	18	460	20	1.10	10.00	110.0	454	
-, 12	8.0	20	460	18	1.23	11.1	124.8	480	
	10.0	22	460	17	1.32	14.9	131.6	600	
	12.0	26	460	16	1.8	16.3	180.0	720	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

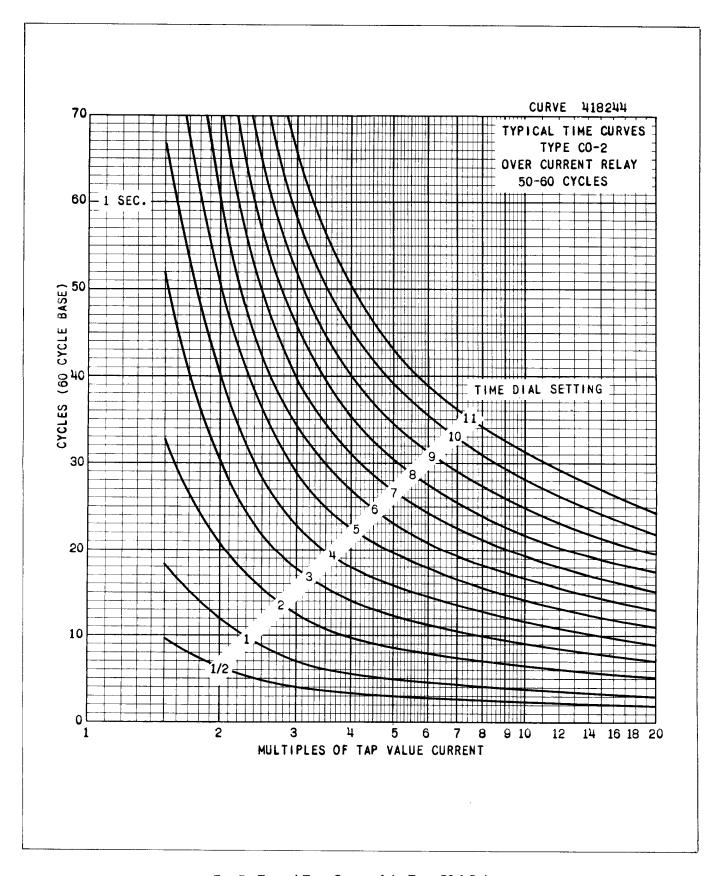


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

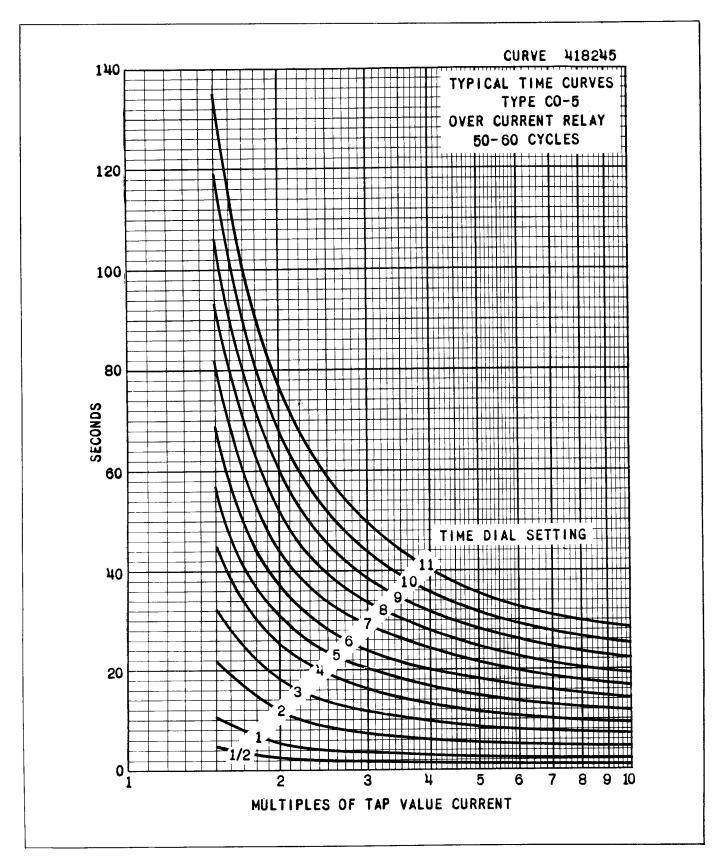


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

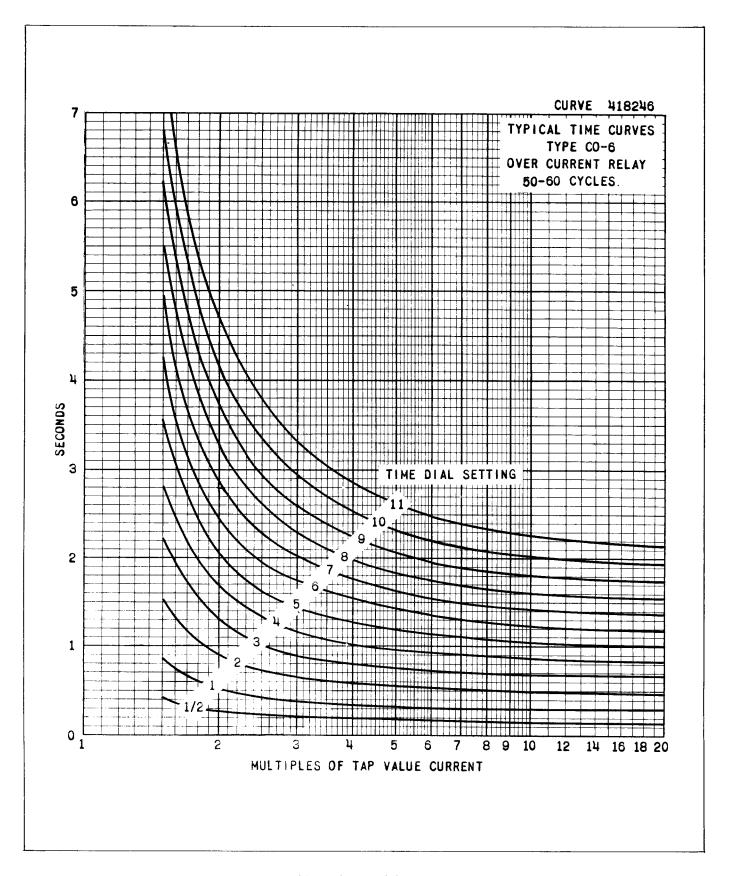


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

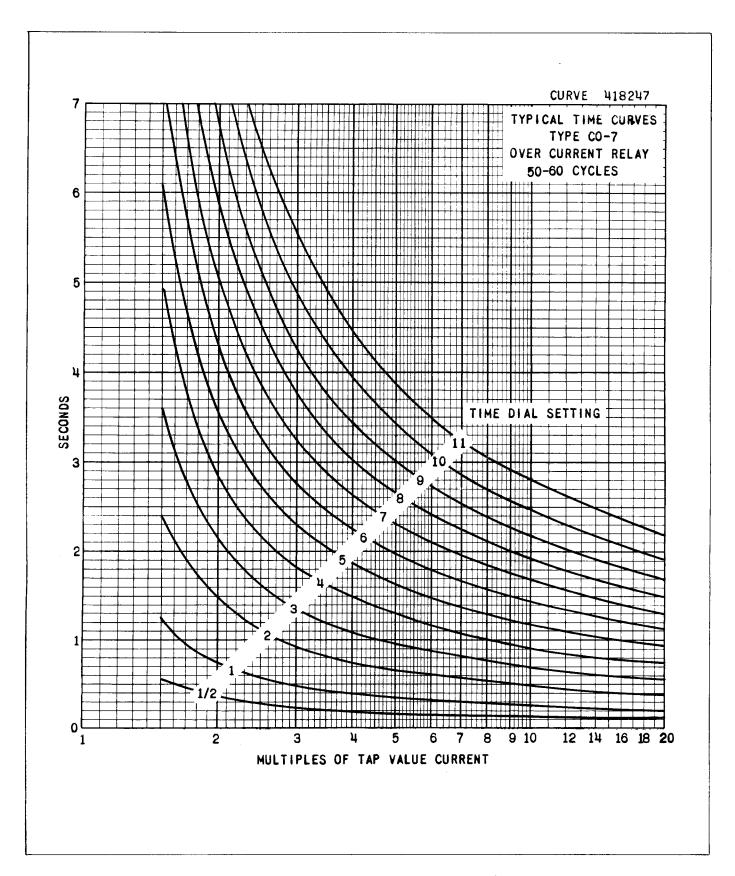


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

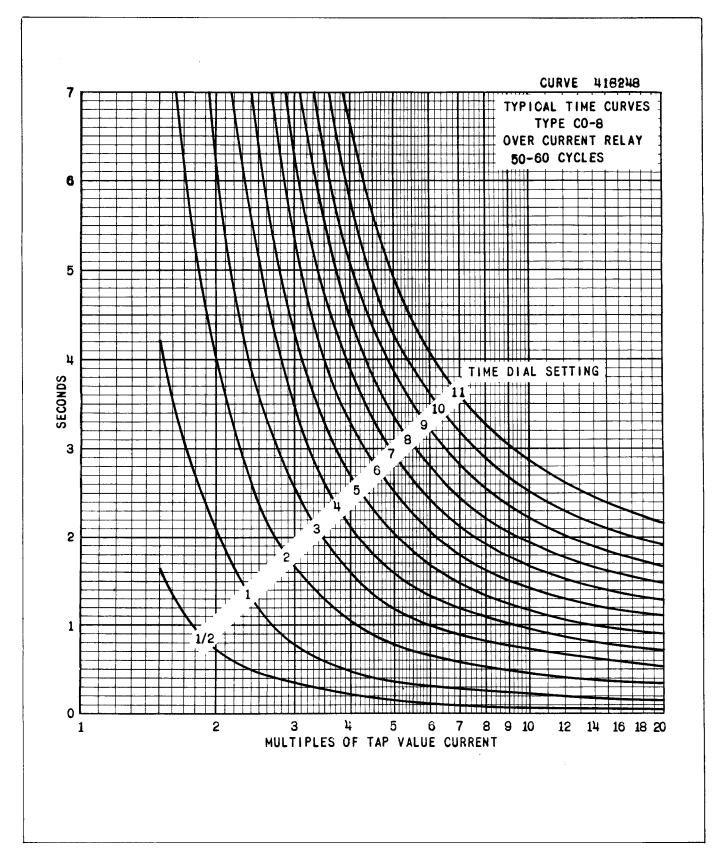


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

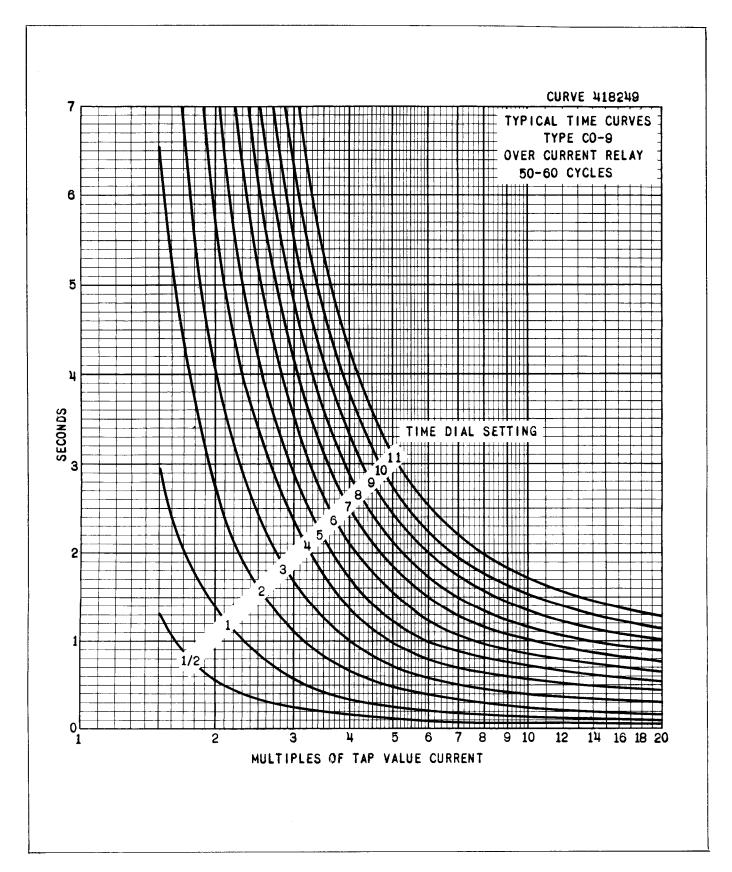


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

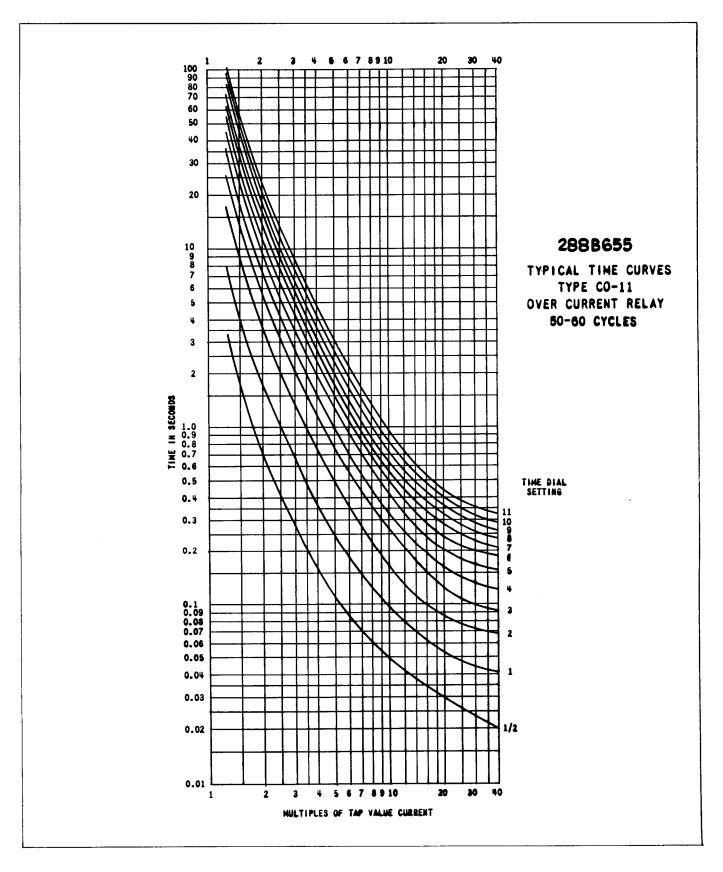


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

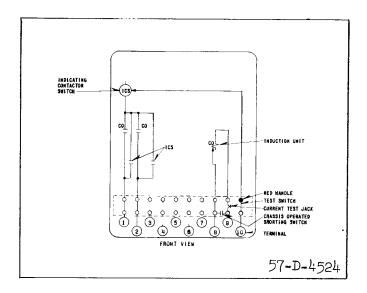


Fig. 14. Internal Schematic of the Double Trip Circuit
Closing Relay. For the Single Trip Relay the
Circuits Associated with Terminal 2 are Omitted.

## **SETTINGS**

## CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

### Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

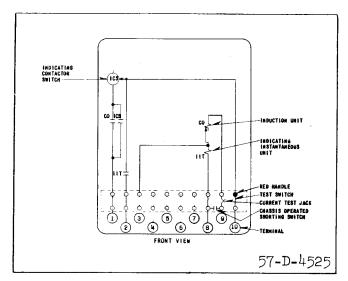


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

## Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

## Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

#### Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT. unit.

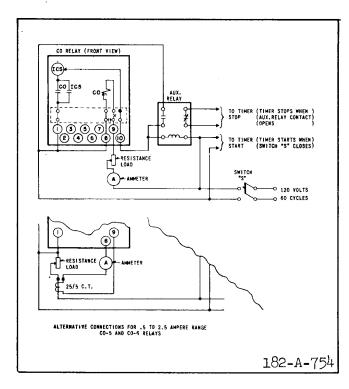


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

## INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

## **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

#### Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. <u>Minimum Trip Current</u> Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. Time Curve For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time

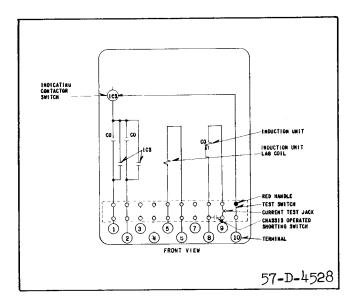


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5%

4. <u>Indicating Instantaneous Trip Unit (IIT)</u> - The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

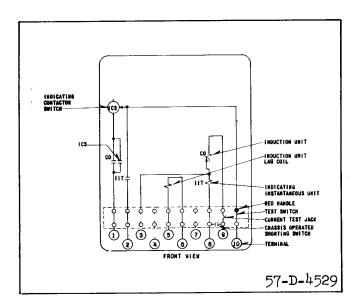


Fig. 18. Internal Schematic of the Single Trip Circuit
Closing Relay with Torque Control Terminals
and Indicating Instantaneous Trip Unit.

### Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

## **CALIBRATION**

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or

the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

## CO Unit

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2) Minimum Trip Current The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position  $\boldsymbol{6}$ .

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. <u>Time Curve Calibration</u> - Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the timecurrent characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

#### 5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual curtent range that may be obtained from the IIT unit.

### **RENEWAL PARTS**

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

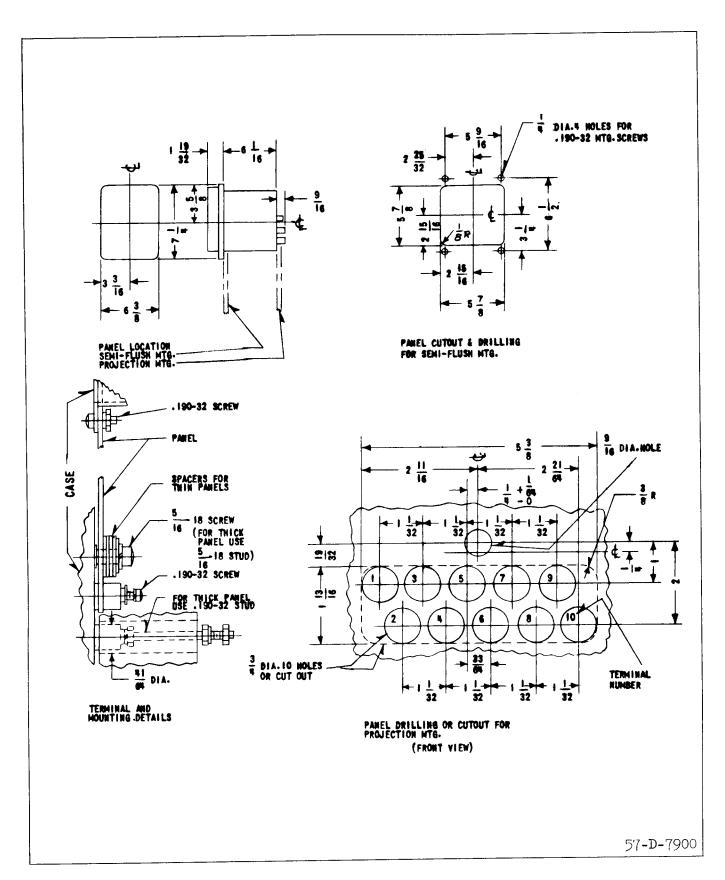


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA - 50 & 60 CYCLES

#### PERMANENT MAGNET ADJUSTMENT ELECTROMAGNET PLUGS TIME CURRENT **OPERATING** CURRENT **OPERATING** RELAY DIAL (MULTIPLES OF TIME (MULTIPLES OF TIME TYPE POSITION TAP VALUE) SECONDS TAP VALUE) SECONDS CO-2 6 0.57 20 0.22 CO-5 2 37.80 10 14.30 CO-6 2 2.46 20 1.19 CO-7 2 4.27 20 1.11 CO-8 2 13.35 20 1.11 CO-9 6 8.87 20 0.65 CO-11 6 11.27 20 0.24 $\triangle$

 $\Delta \, \text{For 50}$  cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, -5%.

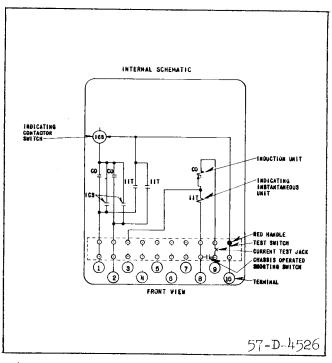
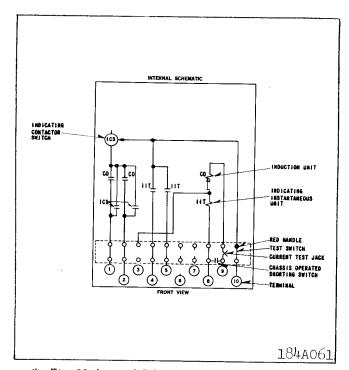


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.



\* Fig. 21 Internal Schematic of the Double Trip
Circuit Closing Realy with Indicating
Instantaneous Trip Unit to Separate
Terminals.

WESTINGHOUSE ELECTRIC CORPORATION RELAY-INSTRUMENT DIVISION NEWARK, N. J.



## INSTALLATION . OPERATION . MAINTENANCE

# INSTRUCTIONS

# TYPE CO OVERCURRENT RELAY

#### CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

## **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

### **CONTENTS**

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

#### CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

#### Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

## Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

## Indicating Instantaneous Trip Unit (IIT)

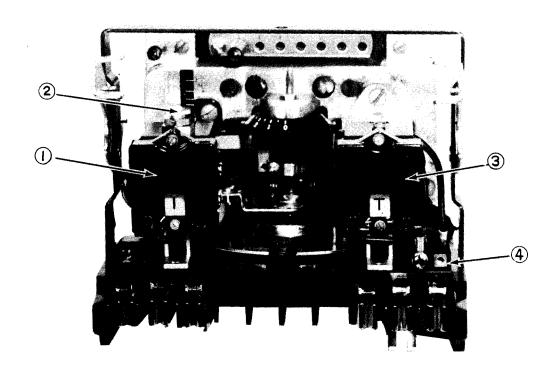
The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

## **CHARACTERISTICS**

The relays are generally available in the following current ranges:

## SUPERSEDES I.L. 41-101K



\*Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

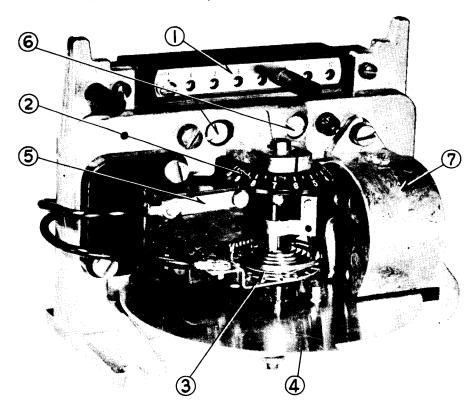
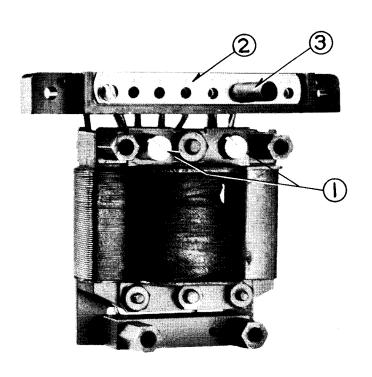
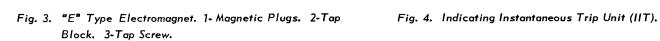
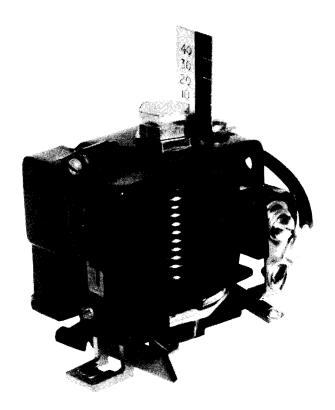


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.







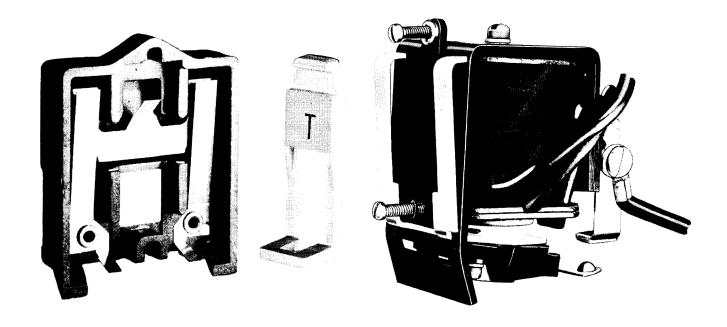


Fig. 5. Indicating Contactor Switch (ICS).

Range	Taps						
.5 - 2.5	0.5	0.6	0.8	1.0	1.5	2.0	2.5
2 - 6	2	2.5	3	3.5	4	5	6
4 - 12	4	5	6	7	8	10	12

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

#### Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indi-

cating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

#### Trip Circuit Constants

Contactor Switch -

0.2 ampere tap - 6.5 ohms d-c resistance

2.0 ampere tap - 0.15 ohms d-c resistance

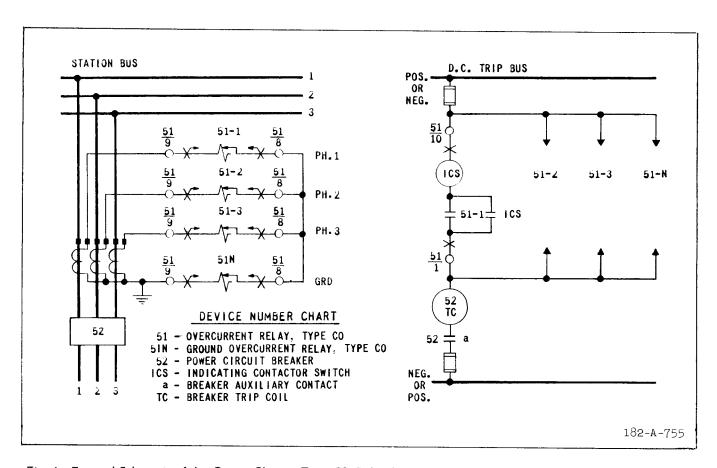


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

## \* Instantaneous Trip Unit (IIT)

RANGE IN	BURDEN IN VOLT-AMPS. AT					
AMPERES	MINIMUM SETTING	MAXIMUM SETTING				
2 - 8	4.5	32				
4 - 16	4.5	32				
10 - 40	4.5	40				
20 - 80	6.5	70				
40 - 160	9.0	144				

#### TYPE CO-2 RELAY

					VOLT AMPERES**					
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT		
	0.5	0.91	28	58	4.8	39.6	256	790		
	0.6	0.96	28	57	4.9	39.8	270	851		
	0.8	1.18	28	53	5.0	42.7	308	1024		
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220		
-10, -10	1.5	1.95	28	40	6.2	54.4	435	1740		
	2.0	2.24	28	36	7.2	65.4	580	2280		
	2.5	2.50	28	29	7.9	73.6	700	2850		
	2.0	3.1	110	59	5.04	38.7	262	800		
	2.5	4.0	110	55	5.13	39.8	280	920		
	3.0	4.4	110	51	5.37	42.8	312	1008		
2/6	3.5	4.8	110	47	5.53	42.8	329	1120		
_, -	4.0	5.2	110	45	5.72	46.0	360	1216		
	5.0	5.6	110	41	5.90	50.3	420	1500		
	6.0	6.0	110	37	6.54	54.9	474	1800		
	4.0	7.3	230	65	4.92	39.1	268	848		
	5.0	8.0	230	50	5.20	42.0	305	1020		
	6.0	8.8	230	47	5.34	44.1	330	1128		
4/12	7.0	9.6	230	46	5.53	45.8	364	1260		
-•	8.0	10.4	230	43	5.86	49.9	400	1408		
	10.0	11.2	230	37	6.6	55.5	470	1720		
	12.0	12.0	230	34	7.00	62.3	528	2064		

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMFERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	69 68 67 66 62 60 58	3.92 3.96 3.96 4.07 4.19 4.30	20.6 20.7 21 21.4 23.2 24.9 26.2	103 106 114 122 147 168 180	270 288 325 360 462 548 630	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	67 66 64 63 62 59	3.88 3.90 3.93 4.09 4.12 4.20 4.38	21 21.6 22.1 23.1 23.5 24.8 26.5	110 118 126 136 144 162 183	308 342 381 417 448 540 624	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	65 63 61 59 56 53 47	4.00 4.15 4.32 4.35 4.40 4.60 4.92	22.4 23.7 25.3 26.4 27.8 30.1 35.6	126 143 162 183 204 247 288	376 450 531 611 699 880 1056	

## CO-7 MODERATELY INVERSE TIME RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	68 67 66 64 61 58	3.88 3.93 3.93 4.00 4.08 4.24 4.38	20.7 20.9 21.1 21.6 22.9 24.8 25.9	103 107 114 122 148 174	278 288 320 356 459 552 640	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230 230	66 63 63 62 61 59	4.06 4.07 4.14 4.34 4.34 4.40	21.3 21.8 22.5 23.4 23.8 25.2	111 120 129 141 149 163 183	306 342 366 413 448 530 624	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	64 61 60 58 55 51	4.24 4.30 4.62 4.69 4.80 5.20 5.40	22.8 24.2 25.9 27.3 29.8 33 37.5	129 149 168 187 211 260 308	392 460 540 626 688 860	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

## CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ATING RATING* FACTO	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	72 71 69 67 62 57 53	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180	360 395 430 470 500 580 660	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	68 63 60 57 54 48 45	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850 1020	

### TYPE CO-11 RELAY

		CONTINUOUS RATING P (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	VOLT AMPERES**			
AMPERE RANGE	TAP				AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	0.5 0.6 0.8 1.0 1.5 2.0 2.5	1.7 1.9 2.2 2.5 3.0 3.5 3.8	56 56 56 56 56 56	36 34 30 27 22 17 16	0.72 0.75 0.81 0.89 1.13 1.30	6.54 6.80 7.46 8.30 10.04 11.95 13.95	71.8 75.0 84.0 93.1 115.5 136.3 160.0	250 267 298 330 411 502 610
2/6	2.0 2.5 3.0 3.5 4.0 5.0 6.0	7.0 7.8 8.3 9.0 10.0 11.0	230 230 230 230 230 230 230	32 30 27 24 23 20	0.73 0.78 0.83 0.88 0.96 1.07 1.23	6.30 7.00 7.74 8.20 9.12 9.80 11.34	74.0 78.5 84.0 89.0 102.0 109.0 129.0	264 285 309 340 372 430 504
4/12	4.0 5.0 6.0 7.0 8.0 10.0 12.0	14 16 17 18 20 22 26	460 460 460 460 460 460	29 25 22 20 18 17 16	0.79 0.89 1.02 1.10 1.23 1.32	7.08 8.00 9.18 10.00 11.1 14.9 16.3	78.4 90.0 101.4 110.0 124.8 131.6 180.0	296 340 378 454 480 600 720

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

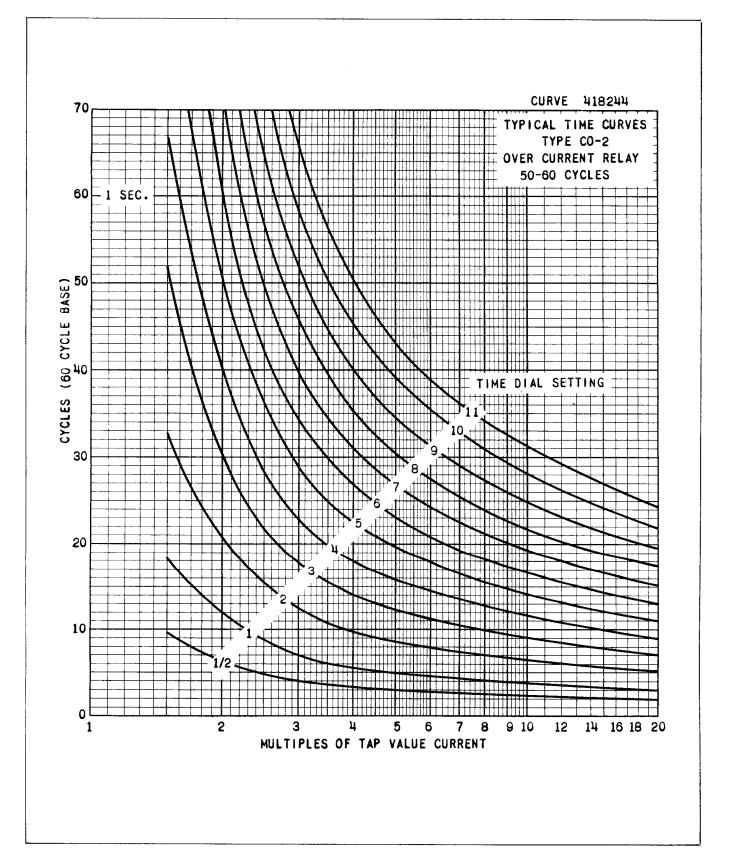


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

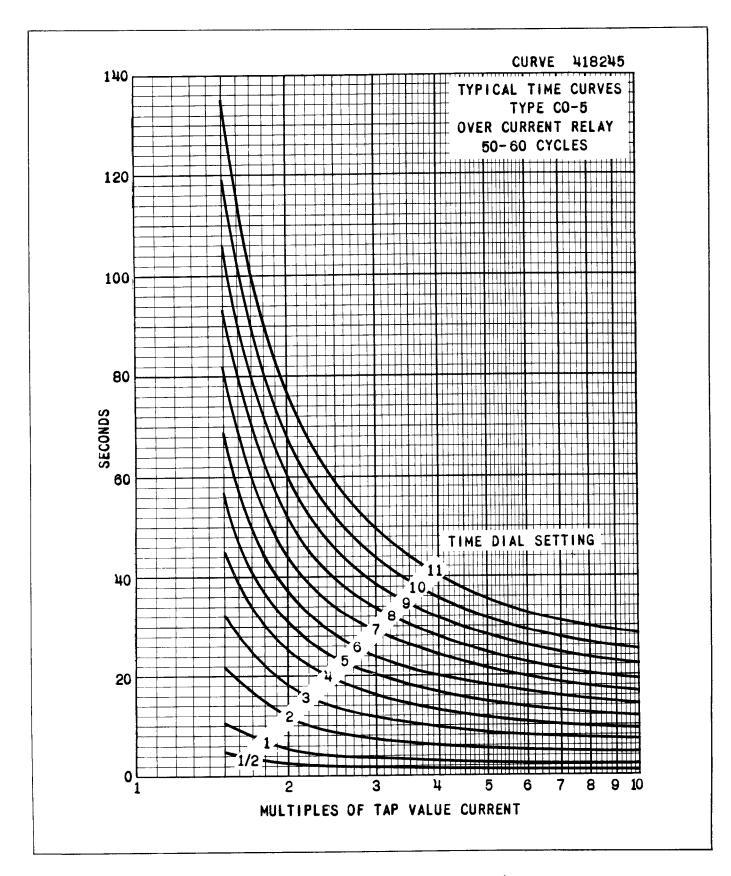


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

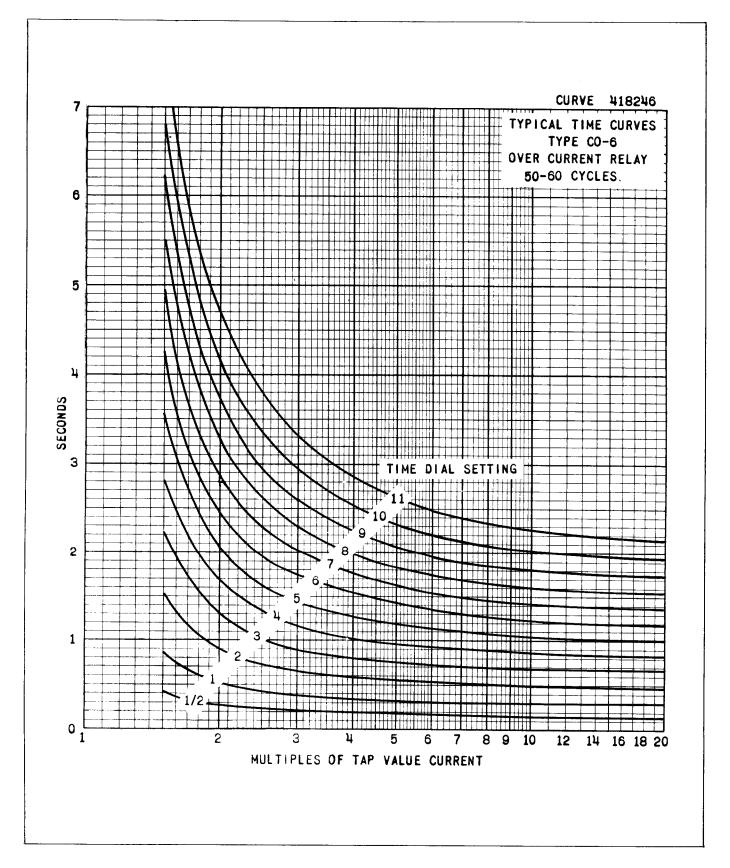


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

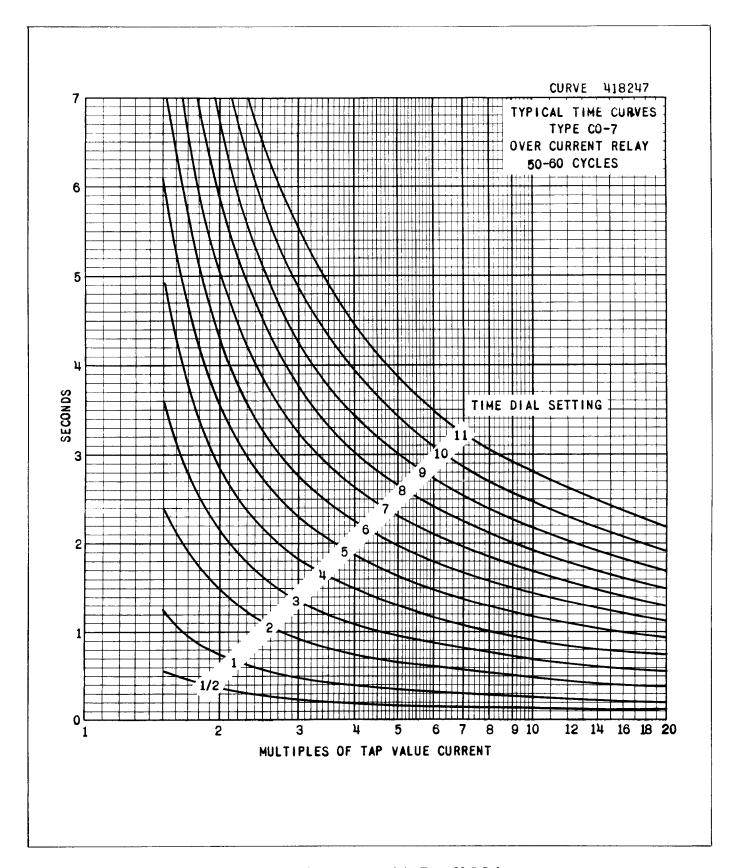


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

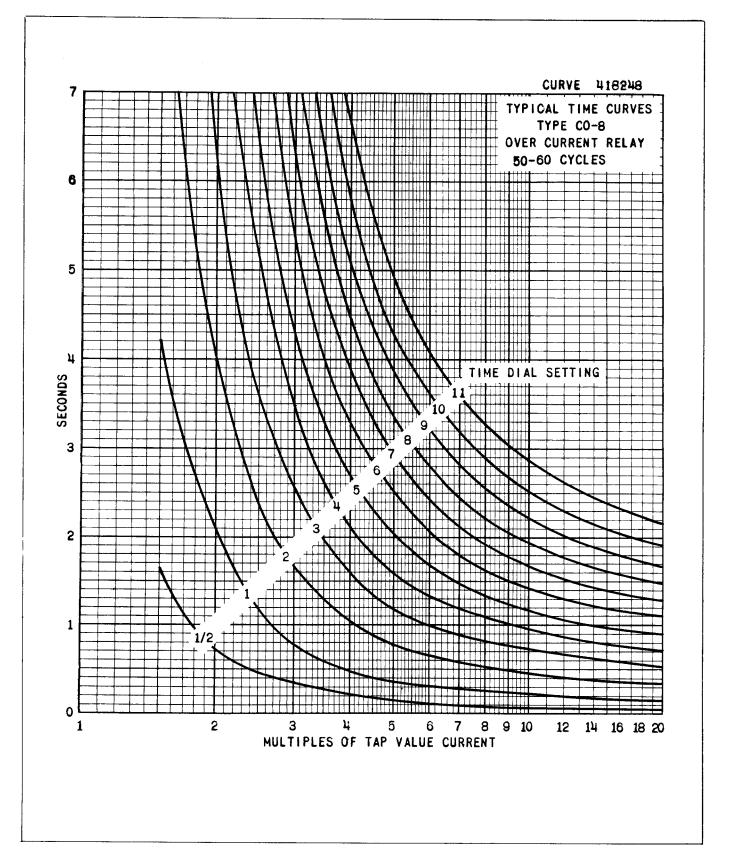


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

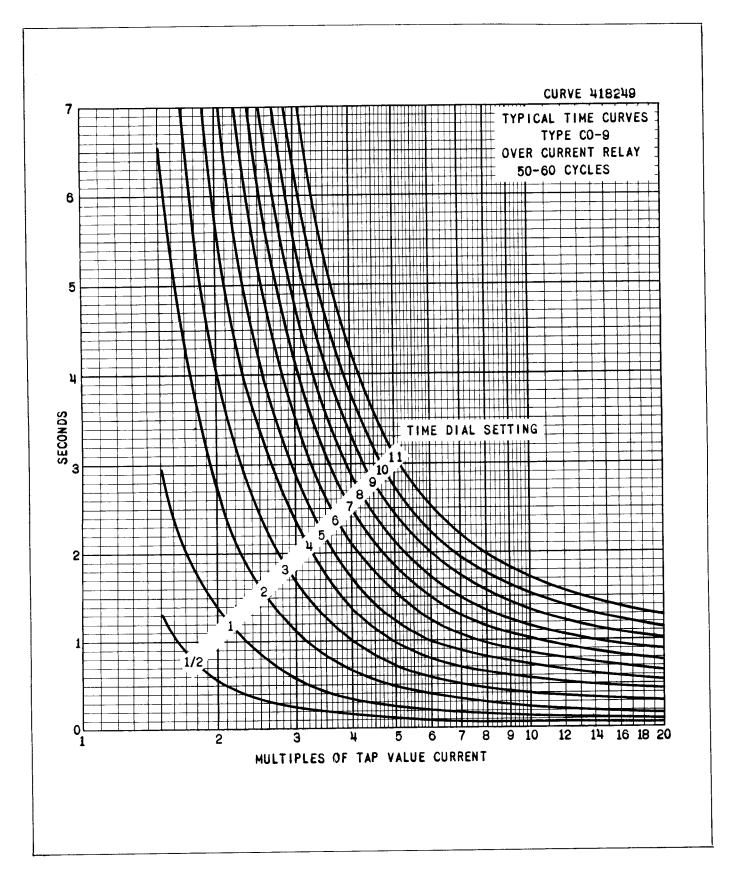


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

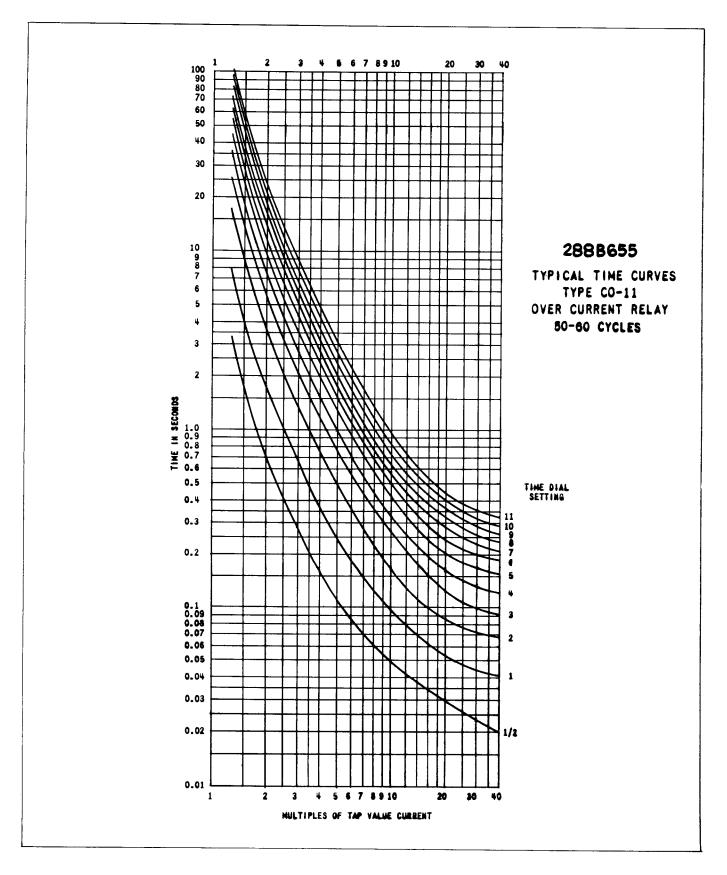


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

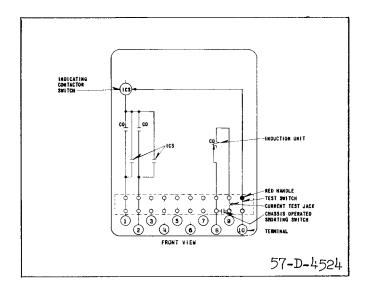


Fig. 14. Internal Schematic of the Double Trip Circuit
Closing Relay. For the Single Trip Relay the
Circuits Associated with Terminal 2 are Omitted.

#### **SETTINGS**

#### CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

#### Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

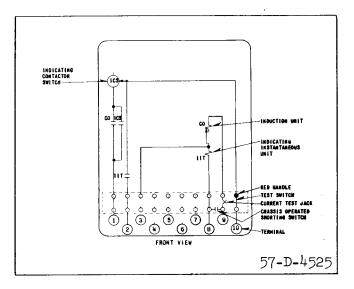


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

#### Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

#### Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

#### Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT. unit.

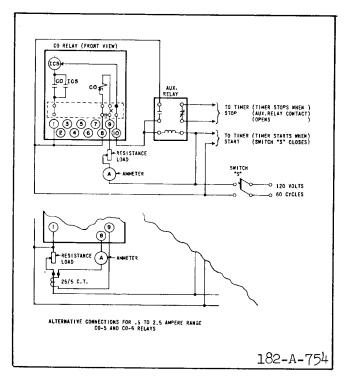


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

#### INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

#### **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

#### Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. Minimum Trip Current Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. Time Curve For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time

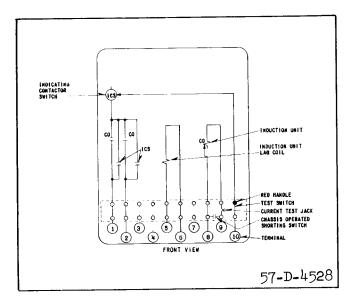


Fig. 17. Internal Schematic of the Double Trip Circuit
Closing Relay with Torque Control Terminals.
For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5%

4. <u>Indicating Instantaneous Trip Unit (IIT)</u> The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

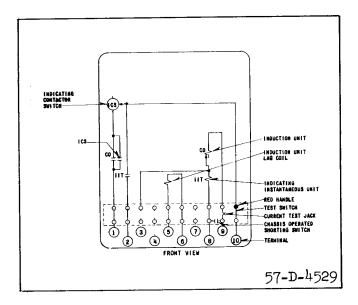


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

#### Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

#### CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or

the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

#### CO Unit

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2) Minimum Trip Current The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. <u>Time Curve Calibration</u> - Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the timecurrent characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

#### 5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

#### **RENEWAL PARTS**

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

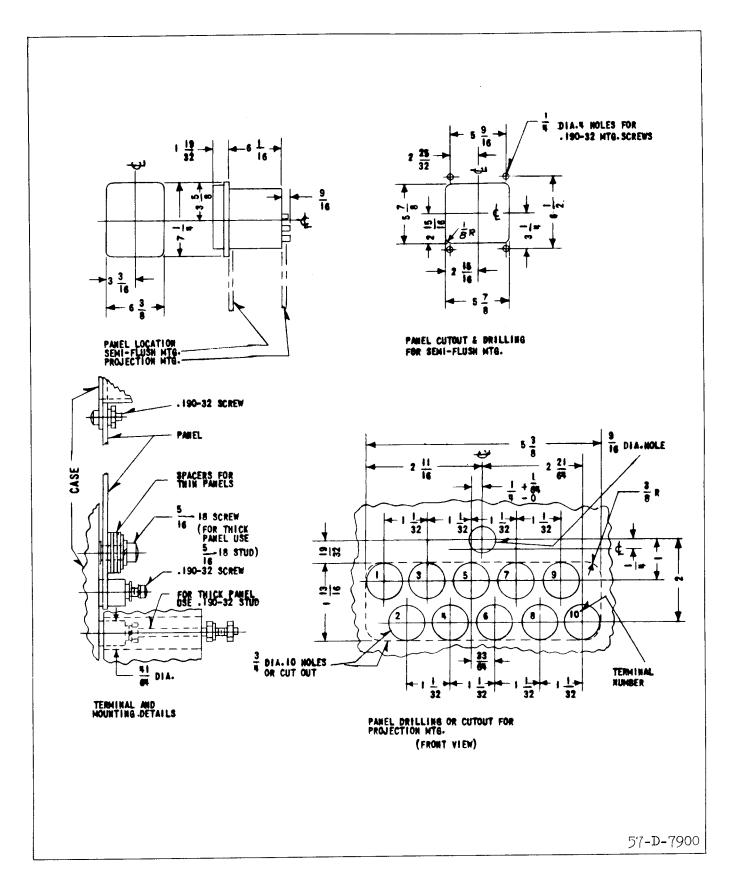


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA = 50 & 60 CYCLES

	PERMANEN'	r magnet adjustm	MENT	ELECTROMAGN	NET PLUGS
RELAY TYPE	TIME DIAL POSITION	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS
CO-2	6	3	0.57	20	0.22
CO-5	6	2	37.80	10	14.30
CO-6	6	2	2.46	20	1.19
CO-7	6	2	4.27	20	1.11
CO-8	6	2	13.35	20	1.11
CO-9	6	2	8.87	20	0.65
CO-11	6	2	11.27	20	0.24 △

 $\Delta$  For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, -5%.

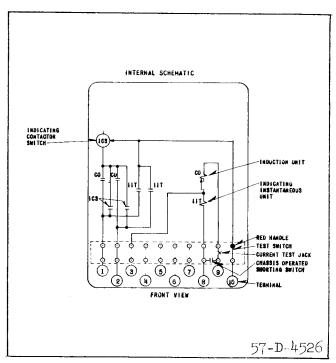


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

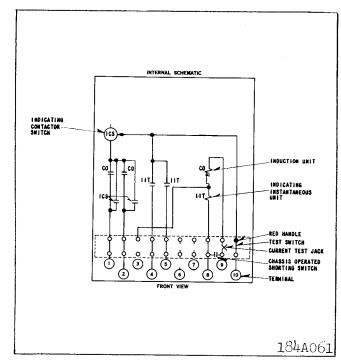


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

WESTINGHOUSE ELECTRIC CORPORATION RELAY-INSTRUMENT DIVISION NEWARK, N. J.



## INSTALLATION . OPERATION . MAINTENANCE

# INSTRUCTIONS

## TYPE CO OVERCURRENT RELAY

#### CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

#### **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

#### CONTENTS

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

#### CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

#### Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

## Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

## Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

#### **CHARACTERISTICS**

The relays are generally available in the following current ranges:

SUPERSEDES 1.L. 41-101L
\* Denotes change from superseded issue.

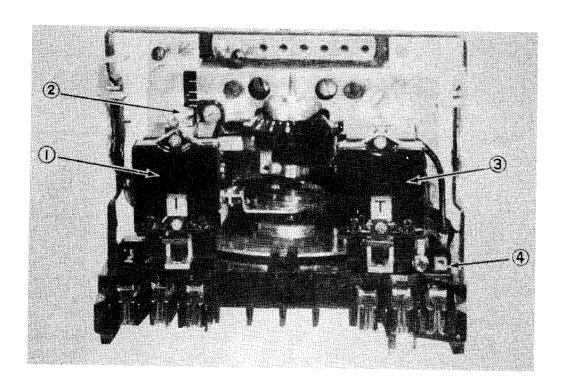


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

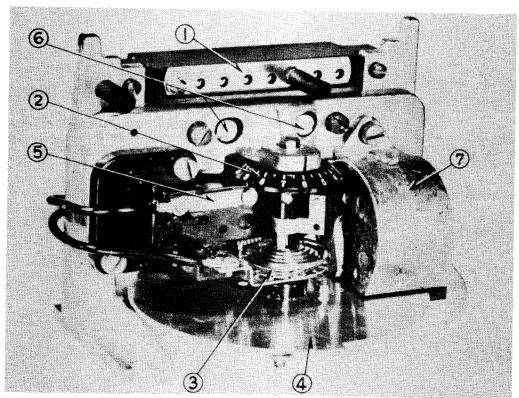


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

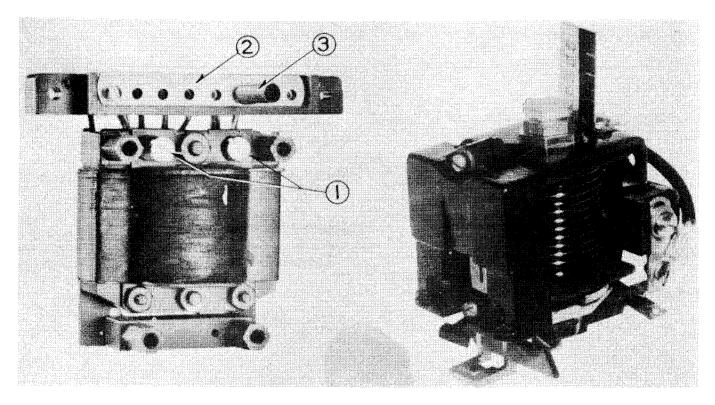


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Fig. 4. Indicating Instantaneous Trip Unit (IIT). Block. 3-Tap Screw.

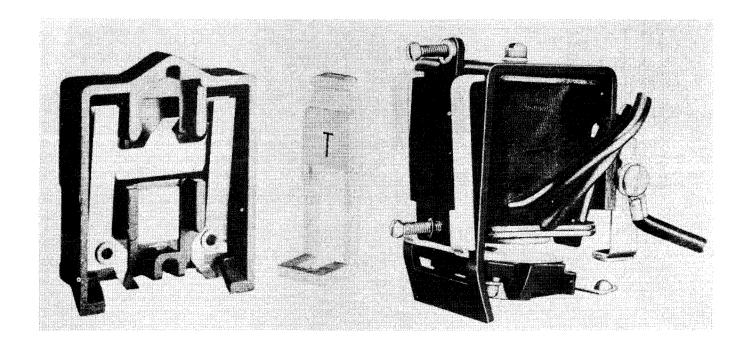


Fig. 5. Indicating Contactor Switch (ICS).

Range	Taps						
.5 - 2.5	0.5	0.6	0.8	1.0	1.5	2.0	2.5
2 - 6	2	2.5	3	3.5	4	5	6
4 - 12	4	5	6	7	8	10	12

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

#### Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indi-

cating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

#### Trip Circuit Constants

Contactor Switch -

0.2 ampere tap - 6.5 ohms d-c resistance

2.0 ampere tap - 0.15 ohms d-c resistance

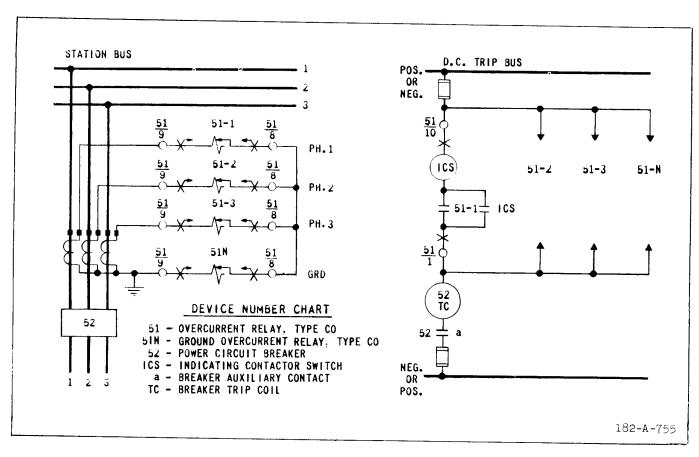


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

#### **ENERGY REQUIREMENTS**

#### \* Instantaneous Trip Unit (IIT)

RANGE IN	BURDEN IN VOLT-AMPS. AT						
AMPERES	MINIMUM SETTING	MAXIMUM SETTING					
2 - 8	4.5	32					
4 - 16	4.5	32					
10 - 40	4.5	40					
20 - 80	6.5	70					
40 - 160	9.0	144					

#### TYPE CO-2 RELAY

		CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	VOLT AMPERES**				
AMPERE RANGE	TAP				AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
	0.5	0.91	28	58	4.8	39.6	256	790	
	0.6	0.96	28	5 <b>7</b>	4.9	39.8	270	851	
	0.8	1.18	28	53	5.0	42.7	308	1024	
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220	
	1.5	1.95	28	40	6.2	54.4	435	1740	
	2.0	2.24	28	36	7.2	65.4	580	2280	
	2.5	2.50	28	29	7.9	73.6	700	2850	
	2.0	3.1	110	59	5.04	38.7	262	800	
	2.5	4.0	110	55	5.13	39.8	280	920	
	3.0	4.4	110 .	51	5.37	42.8	312	1008	
2/6	3.5	4.8	110	47	5.53	42.8	329	1120	
	4.0	5.2	110	. 45	5.72	46.0	360	1216	
	5.0	5.6	110	41	5.90	50.3	420	1500	
	6.0	6.0	110	37	6.54	54.9	474	1800	
	4.0	7.3	230	65	4.92	39.1	268	848	
	5.0	8.0	230	50	5.20	42.0	305	1020	
	6.0	8.8	230	47	5.34	44.1	330	1128	
4/12	7.0	9.6	230	46	5.53	45.8	364	1260	
-7	8.0	10.4	230	43	5.86	49.9	400	1408	
	10.0	11.2	230	37	6.6	55.5	470	1720	
	12.0	12.0	230 .	34	7.00	62.3	528	2064	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

## ENERGY REQUIREMENTS

## CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

						VOLT A	MPERES**	
AMPERE RANGE	ТАР	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	69 68 67 66 62 60 58	3.92 3.96 3.96 4.07 4.19 4.30 4.37	20.6 20.7 21 21.4 23.2 24.9 26.2	103 106 114 122 147 168 180	270 288 325 360 462 548 630
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	67 66 64 63 62 59	3.88 3.90 3.93 4.09 4.12 4.20 4.38	21 21.6 22.1 23.1 23.5 24.8 26.5	110 118 126 136 144 162	308 342 381 417 448 540
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	65 63 61 59 56 53 47	4.00 4.15 4.32 4.35 4.40 4.60 4.92	22.4 23.7 25.3 26.4 27.8 30.1 35.6	126 143 162 183 204 247	624 376 450 531 611 699 880 1056

## CO-7 MODERATELY INVERSE TIME RELAY

					VOLT AMPERES**			
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	68 67 66 64 61 58	3.88 3.93 3.93 4.00 4.08 4.24 4.38	20.7 20.9 21.1 21.6 22.9 24.8 25.9	103 107 114 122 148 174	278 288 320 356 459 552 640
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230 230	66 63 63 62 61 59	4.06 4.07 4.14 4.34 4.34 4.40 4.62	21.3 21.8 22.5 23.4 23.8 25.2	111 120 129 141 149 163 183	306 342 366 413 448 530 624
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	64 61 60 58 55 51	4.24 4.30 4.62 4.69 4.80 5.20 5.40	22.8 24.2 25.9 27.3 29.8 33 37.5	129 149 168 187 211 260 308	392 460 540 626 688 860

<sup>\*</sup> 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.

φ Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

## **ENERGY REQUIREMENTS**

#### CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

		·			VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88	72 71 69 67 62 57 53	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180	360 395 430 470 500 580 660	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	68 63 60 57 54 48 45	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850 1020	

#### TYPE CO-11 RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
	0.5	1.7	56	36	0.72	6.54	71.8	250	
	0.6	1.9	56	34	0.75	6.80	75.0	267	
	0.8	2.2	56	30	0.81	7.46	84.0	298	
0.5/2.5	1.0	2.5	56	27	0.89	8.30	93.1	330	
	1.5	3.0	56	22	1.13	10.04	115.5	411	
	2.0	3.5	56	17	1.30	11.95	136.3	502	
	2.5	3.8	56	16	1.48	13.95	160.0	610	
	2.0	7.0	230	32	0.73	6.30	74.0	264	
	2.5	7.8	230	30	0.78	7.00	78.5	285	
	3.0	8.3	230	27	0.83	7.74	84.0	309	
2/6	3.5	9.0	230	24	0.88	8.20	89.0	340	
	4.0	10.0	230	23	0.96	9.12	102.0	372	
	5.0	11.0	230	20	1.07	9.80	109.0	430	
	6.0	12.0	230	20	1.23	11.34	129.0	504	
	4.0	14	460	29	0.79	7.08	78.4	296	
	5.0	16	460	25	0.89	8.00	90.0	340	
	6.0	17	460	22	1.02	9.18	101.4	378	
4/12	7.0	18	460	20	1.10	10.00	110.0	454	
	8.0	20	460	18	1.23	11.1	124.8	480	
	10.0	22	460	17	1.32	14.9	131.6	600	
	12.0	26	460	16	1.8	16.3	180.0	720	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

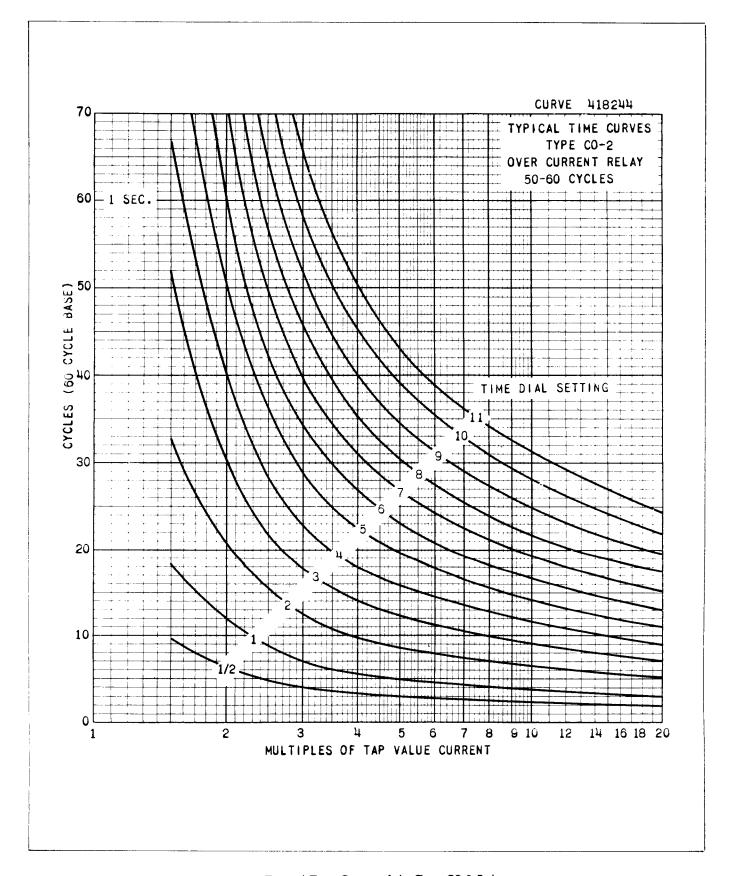


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

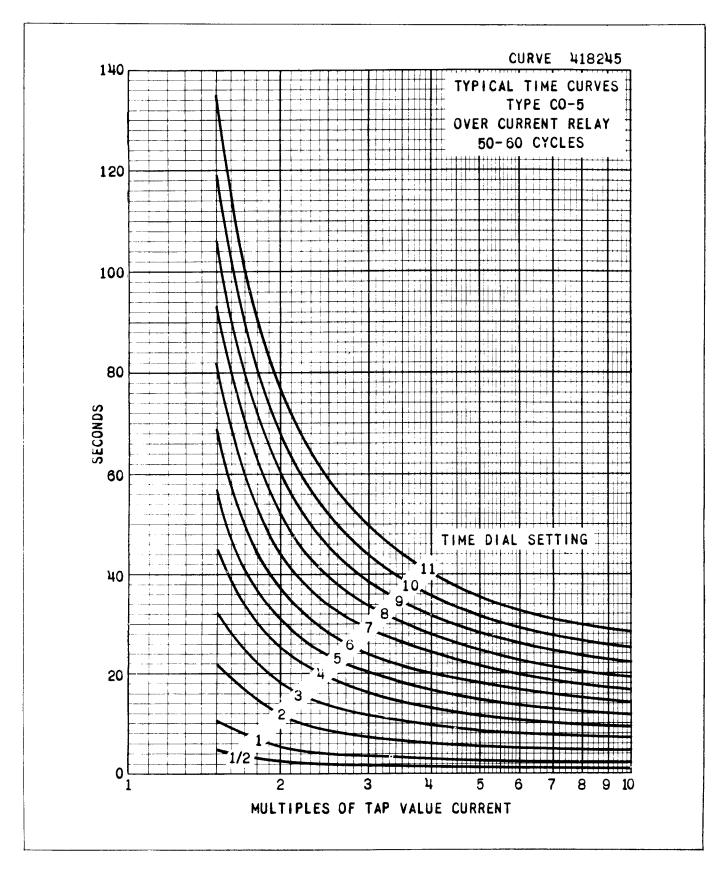


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

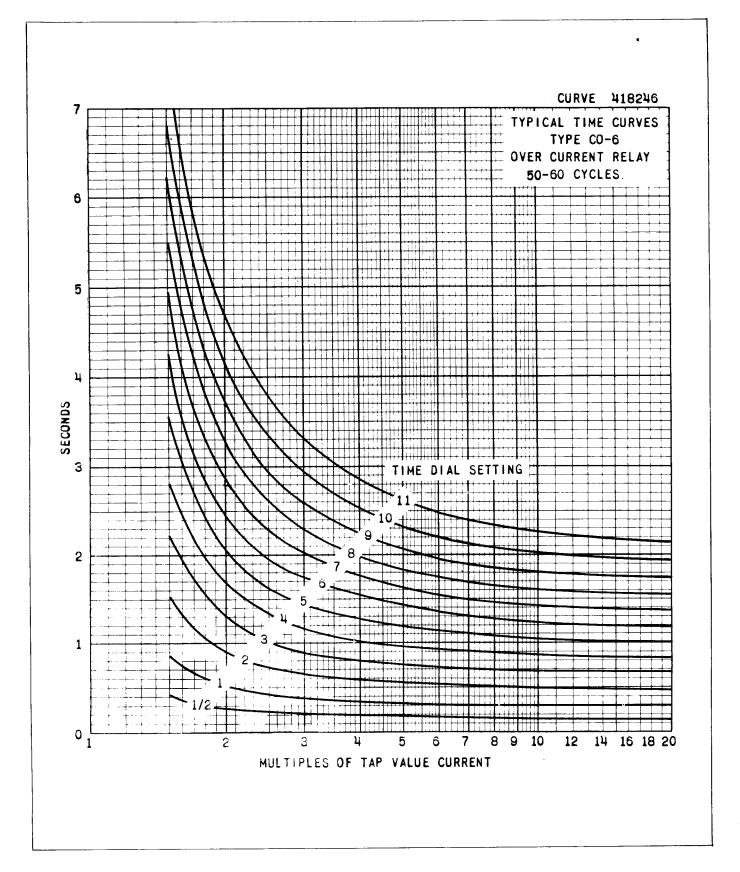


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

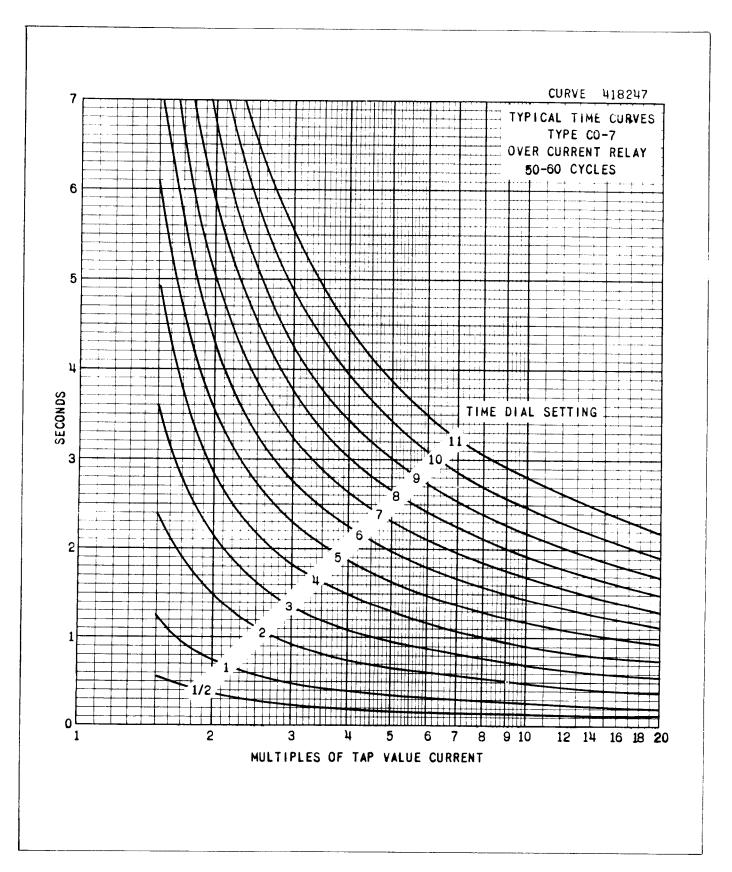


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

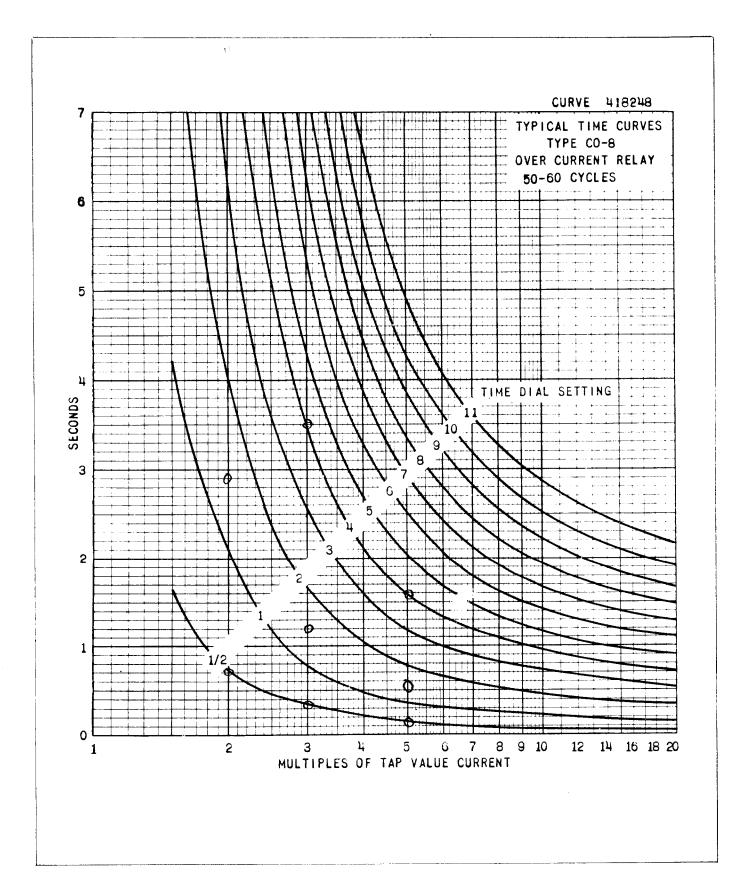


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

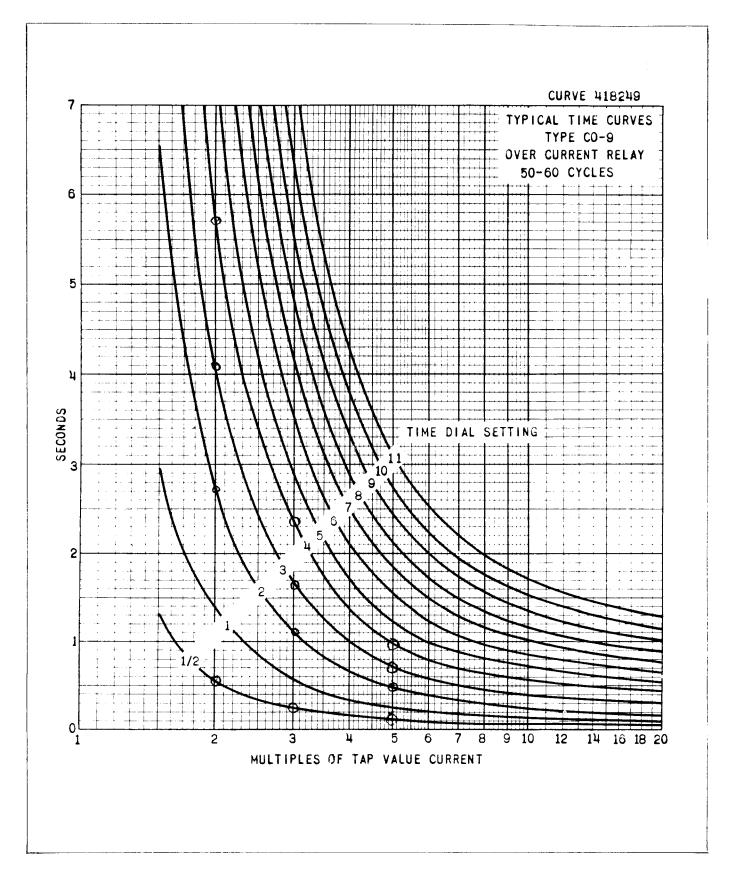


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

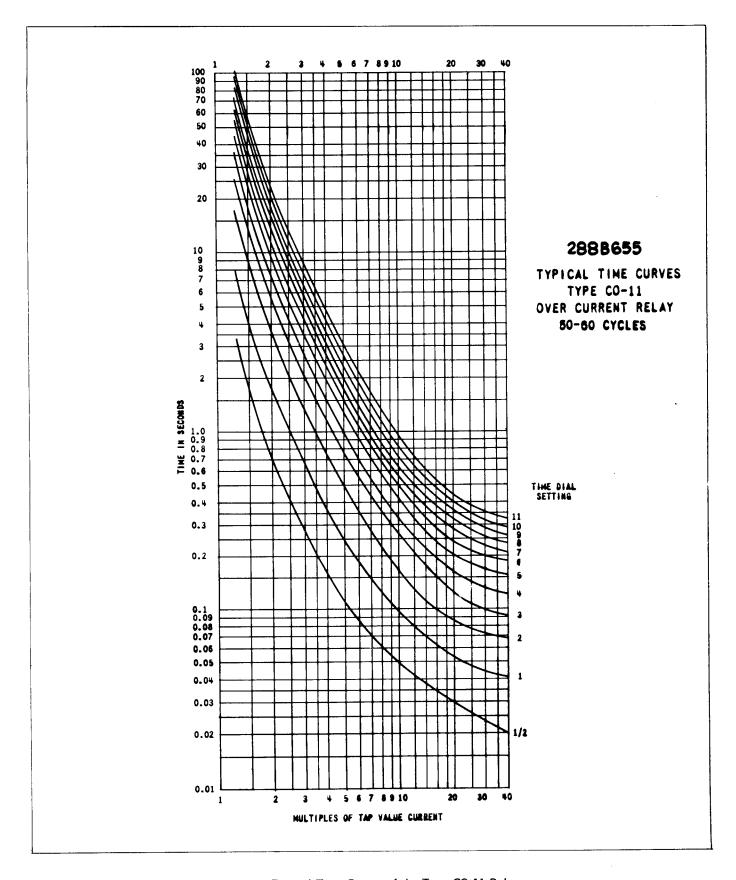
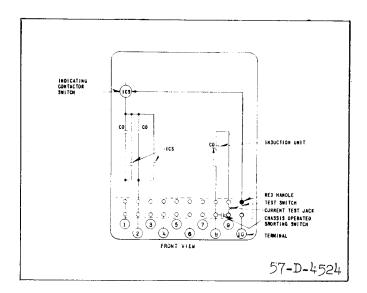


Fig. 13. Typical Time Curves of the Type CO-11 Relay.



\* Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.

#### **SETTINGS**

#### CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

#### Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

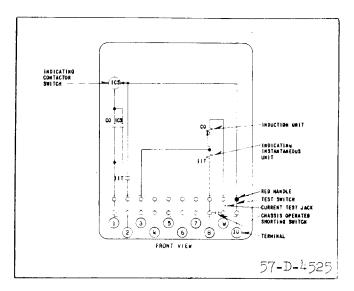


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

#### Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

#### Indicating Contactor Switch (ICS)

The only setting required on the ICS unit—is the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

#### Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT, unit.

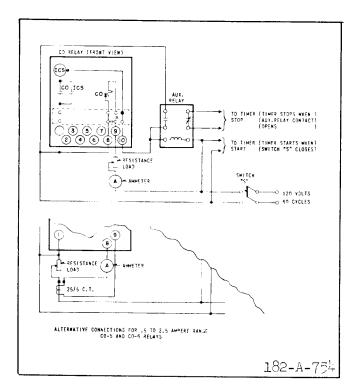


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

#### INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

#### **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

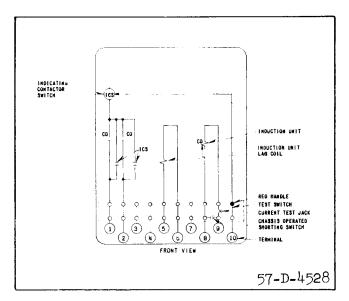
#### Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. Minimum Trip Current Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. Time Curve For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time



\* Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.

dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I. (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5%

4. <u>Indicating Instantaneous Trip Unit (IIT)</u> The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

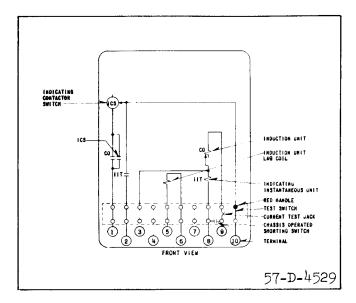


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

#### Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

#### **CALIBRATION**

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or

the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

#### CO Unit

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2) Minimum Trip Current The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. <u>Time Curve Calibration</u> - Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the timecurrent characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

#### 5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

#### RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

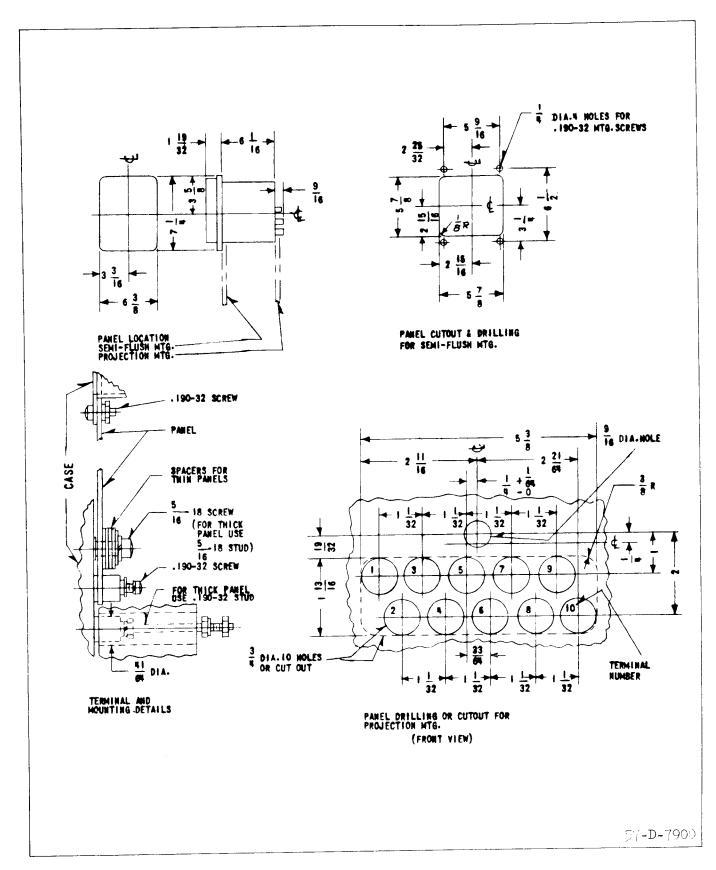


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA - 50 & 60 CYCLES

#### PERMANENT MAGNET ADJUSTMENT ELECTROMAGNET PLUGS TIME CURRENT **OPERATING** CURRENT **OPERATING** RELAY DIAL (MULTIPLES OF TIME (MULTIPLES OF TIME TYPE **POSITION** TAP VALUE) SECONDS TAP VALUE) SECONDS CO-2 6 3 0.57 20 0.22 CO-5 6 37.80 10 14.30 CO-6 6 2.46 20 1.19 CO-7 4.27 20 1.11 CO-8 13.35 1.11 CO-9 8.87 20 0.65 CO-11 6 11.27 20 $0.24 \wedge$

 $\Delta$  For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, -5%.

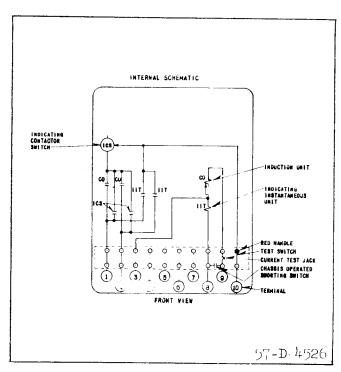


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

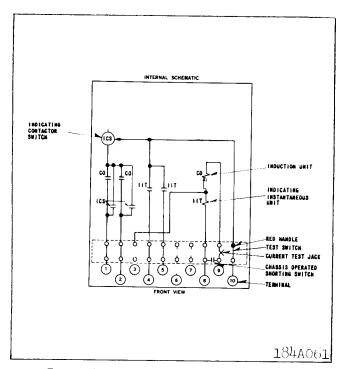


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

WESTINGHOUSE ELECTRIC CORPORATION RELAY-INSTRUMENT DIVISION NEWARK, N. J.



## INSTALLATION . OPERATION . MAINTENANCE

# INSTRUCTIONS

## TYPE CO OVERCURRENT RELAY

#### CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

#### **APPLICATION**

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

#### CONTENTS

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

#### CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

#### Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap

\* cause a contact closing torque. A torque controlled CO has the lag coil connections of the electromagnet brought out to separate terminals. This permits control of the closing torque such that only when these terminals are connected together will the unit operate.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

## Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

## Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

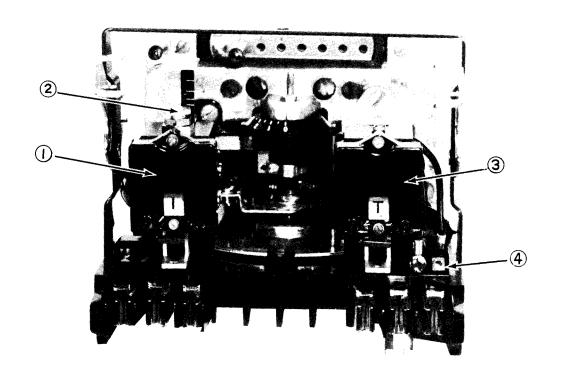


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

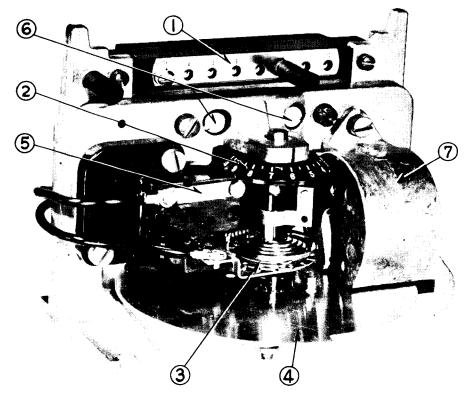
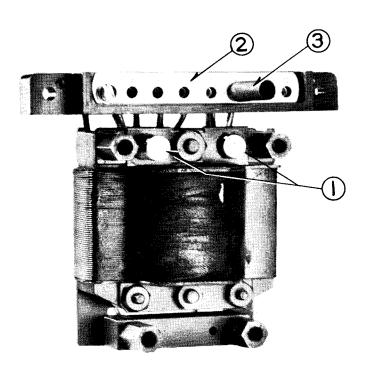


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.



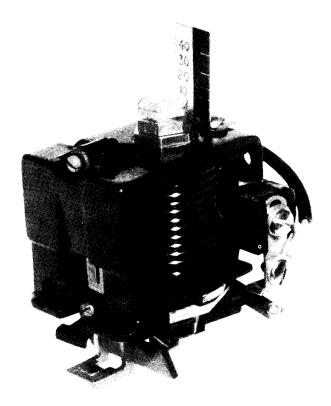


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

Fig. 4. Indicating Instantaneous Trip Unit (IIT).

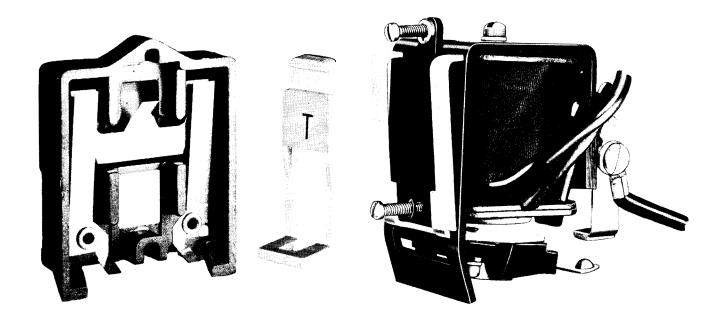


Fig. 5. Indicating Contactor Switch (ICS).

#### CHARACTERISTICS

The relays are generally available in the following current ranges:

Range	Taps							
.5 - 2.5	0.5	0.6	8.0	1.0	1.5	2.0	2.5	
2 - 6	2	2.5	3	3.5	4	5	6	
4 - 12	4	5	6	7	8	10	12	

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

#### Trip Circuit

The main contacts will safely close 30 amperes

at 250 volts d-c and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

#### Trip Circuit Constants

Contactor Switch -

- 0.2 ampere tap 6.5 ohms d-c resistance
- 2.0 ampere tap 0.15 ohms d-c resistance

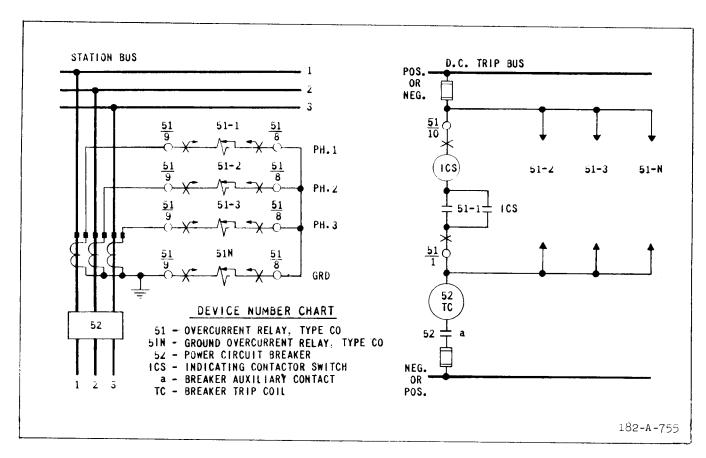


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

## ENERGY REQUIREMENTS $\Delta$

#### Instantaneous Trip Unit (IIT)

RANGE IN	BURDEN IN VOLT-AMPS. AT				
AMPERES	MINIMUM SETTING	MAXIMUM SETTING			
2 - 8	4.5	32			
4 - 16	4.5	32			
10 - 40	4.5	40			
20 - 80	6.5	70			
40 - 160	9.0	144			

#### TYPE CO-2 RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
	0.5	0.91	28	58	4.8	39.6	256	<b>7</b> 90	
	0.6	0.96	28	57	4.9	39.8	270	851	
	0.8	1.18	28	53	5.0	42.7	308	1024	
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220	
0.0, 2.0	1.5	1.95	28	40	6.2	54.4	435	1740	
	2.0	2.24	28	36	7.2	65.4	580	2280	
	2.5	2.50	28	29	7.9	73.6	700	2850	
	2.0	3.1	110	59	5.04	38.7	262	800	
	2.5	4.0	110	55	5.13	39.8	280	920	
	3.0	4.4	110	51	5.37	42.8	312	1008	
2/6	3.5	4.8	110	47	5.53	42.8	329	1120	
2, 0	4.0	5.2	110	45	5.72	46.0	360	1216	
	5.0	5.6	110	41	5.90	50.3	420	1500	
	6.0	6.0	110	37	6.54	54.9	474	1800	
	4.0	7.3	230	65	4.92	39.1	268	848	
	5.0	8.0	230	50	5.20	42.0	305	1020	
	6.0	8.8	230	47	5.34	44.1	330	1128	
4/12	7.0	9.6	230	46	5.53	45.8	364	1260	
7/12	8.0	10.4	230	43	5.86	49.9	400	1408	
	10.0	11.2	230	37	6.6	55.5	470	1720	
	12.0	12.0	230	34	7.00	62.3	528	2064	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

 $<sup>\</sup>Lambda$  Further information can be obtained in Performance Data 41-100.

# CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	ТАР	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	69 68 67 66 62 60 58	3.92 3.96 3.96 4.07 4.19 4.30	20.6 20.7 21 21.4 23.2 24.9 26.2	103 106 114 122 147 168 180	270 288 325 360 462 548 630	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	67 66 64 63 62 59	3.88 3.90 3.93 4.09 4.12 4.20 4.38	21 21.6 22.1 23.1 23.5 24.8 26.5	110 118 126 136 144 162 183	308 342 381 417 448 540 624	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	65 63 61 59 56 53 47	4.00 4.15 4.32 4.35 4.40 4.60 4.92	22.4 23.7 25.3 26.4 27.8 30.1 35.6	126 143 162 183 204 247 288	376 450 531 611 699 880 1056	

#### CO-7 MODERATELY INVERSE TIME RELAY

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5) (0.6) (0.8) (1.0) (1.5) (2.0) (2.5)	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	68 67 66 64 61 58	3.88 3.93 3.93 4.00 4.08 4.24 4.38	20.7 20.9 21.1 21.6 22.9 24.8 25.9	103 107 114 122 148 174	278 288 320 356 459 552 640	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230 230	66 63 63 62 61 59	4.06 4.07 4.14 4.34 4.34 4.40 4.62	21.3 21.8 22.5 23.4 23.8 25.2	111 120 129 141 149 163 183	306 342 366 413 448 530 624	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25	460 460 460 460 460 460	64 61 60 58 55 51	4.24 4.30 4.62 4.69 4.80 5.20 5.40	22.8 24.2 25.9 27.3 29.8 33 37.5	129 149 168 187 211 260 308	392 460 540 626 688 860	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

# CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

					VOLT AMPERES**				
AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5/2.5	(0.5 (0.6 (0.8 (1.0 (1.5 (2.0 (2.5	2.7 3.1 3.7 4.1 5.7 6.8 7.7	88 88 88 88 88 88	72 71 69 67 62 57 53	2.38 2.38 2.40 2.42 2.51 2.65 2.74	21 21 21.1 21.2 22 23.5 24.8	132 134 142 150 170 200 228	350 365 400 440 530 675 800	
2/6	(2 (2.5 (3 (3.5 (4 (5 (6	8 8.8 9.7 10.4 11.2 12.5 13.7	230 230 230 230 230 230 230	70 66 64 62 60 58 56	2.38 2.40 2.42 2.48 2.53 2.64 2.75	21 21.1 21.5 22 22.7 24 25.2	136 142 149 157 164 180	360 395 430 470 500 580 660	
4/12	(4 (5 (6 (7 (8 (10 (12	16 18.8 19.3 20.8 22.5 25 28	460 460 460 460 460 460 460	68 63 60 57 54 48 45	2.38 2.46 2.54 2.62 2.73 3.00 3.46	21.3 21.8 22.6 23.6 24.8 27.8 31.4	146 158 172 190 207 248 292	420 480 550 620 700 850 1020	

#### TYPE CO-11 RELAY

				VOLT AMPERES**				
TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE $\phi$	AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT	
0.5	1 7	56	36	0.72	6.54	71.8	250	
		56	34	0.75	6.80	75.0	267	
		56	30	0.81	7.46	84.0	298	
		56	27	0.89	8.30	93.1	330	
		56	22	1.13	10.04	115.5	411	
		56		1.30	11.95	136.3	502	
2.5	3.8	56	16	1.48	13.95	160.0	610	
2.0	7.0	230	32	0.73	6.30	74.0	264	
	7.8	230	30	0.78	7.00	78.5	285	
		230	27	0.83	7.74	84.0	309	
		230	24	0.88	8.20		340	
		230	23	0.96	9.12	102.0	372	
		230	20	1.07	9.80	109.0	430	
6.0	12.0	230	20	1.23	11.34	129.0	504	
4.0	1.4	460	29	0.79	7.08	78.4	296	
			25	0.89	8.00	90.0	340	
				1.02	9.18	101.4	378	
					10.00	110.0	454	
					11.1	124.8	480	
				-		131.6	600	
12.0	22 26	460	16	1.8	16.3	180.0	720	
	0.5 0.6 0.8 1.0 1.5 2.0 2.5 2.0 2.5 3.0 3.5 4.0 5.0 6.0 7.0 8.0 10.0	RATING (AMPERES)  0.5 1.7 0.6 1.9 0.8 2.2 1.0 2.5 1.5 3.0 2.0 3.5 2.5 3.8  2.0 7.0 2.5 7.8 3.0 8.3 3.5 9.0 4.0 10.0 5.0 11.0 6.0 12.0  4.0 14 5.0 16 6.0 17 7.0 18 8.0 20 10.0 22	RATING (AMPERES)         RATING* (AMPERES)           0.5         1.7         56           0.6         1.9         56           0.8         2.2         56           1.0         2.5         56           1.5         3.0         56           2.0         3.5         56           2.5         3.8         56           2.0         7.0         230           2.5         7.8         230           3.0         8.3         230           3.5         9.0         230           4.0         10.0         230           5.0         11.0         230           6.0         12.0         230           4.0         14         460           5.0         16         460           6.0         17         460           7.0         18         460           8.0         20         460           10.0         22         460	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	CONTINUOUS RATING RATING*         RATING*         FACTOR TAP VALUE CURRENT         AT 3 TIMES TAP VALUE CURRENT           0.5         1.7         56         36         0.72         6.54           0.6         1.9         56         34         0.75         6.80           0.8         2.2         56         30         0.81         7.46           1.0         2.5         56         27         0.89         8.30           1.5         3.0         56         22         1.13         10.04           2.0         3.5         56         17         1.30         11.95           2.5         3.8         56         16         1.48         13.95           2.0         7.0         230         32         0.73         6.30           2.5         7.8         230         30         0.78         7.00           3.0         8.3         230         27         0.83         7.74           3.5         9.0         230         24         0.88         8.20           4.0         10.0         230         23         0.96         9.12           5.0         11.0         230         20         1.07	TAP         CONTINUOUS RATING* (AMPERES)         ONE SECOND RATING* FACTOR (AMPERES)         POWER FACTOR TAP VALUE CURRENT         AT 3 TIMES TAP VALUE CURRENT         AT 10 TIMES TAP VALUE CURRENT           0.5         1.7         56         36         0.72         6.54         71.8           0.6         1.9         56         34         0.75         6.80         75.0           0.8         2.2         56         30         0.81         7.46         84.0           1.0         2.5         56         27         0.89         8.30         93.1           1.5         3.0         56         22         1.13         10.04         115.5           2.0         3.5         56         17         1.30         11.95         136.3           2.5         3.8         56         16         1.48         13.95         160.0           2.0         7.0         230         32         0.73         6.30         74.0           2.5         7.8         230         30         0.78         7.00         78.5           3.0         8.3         230         27         0.83         7.74         84.0           3.5         9.0         230	

<sup>\*</sup> 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.

 $<sup>\</sup>phi$  Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

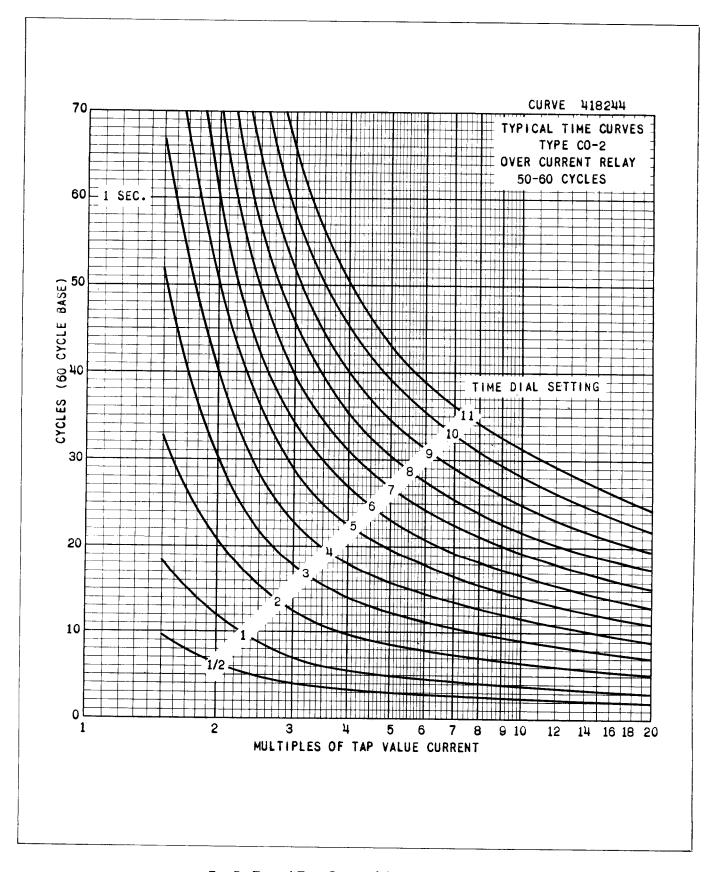


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

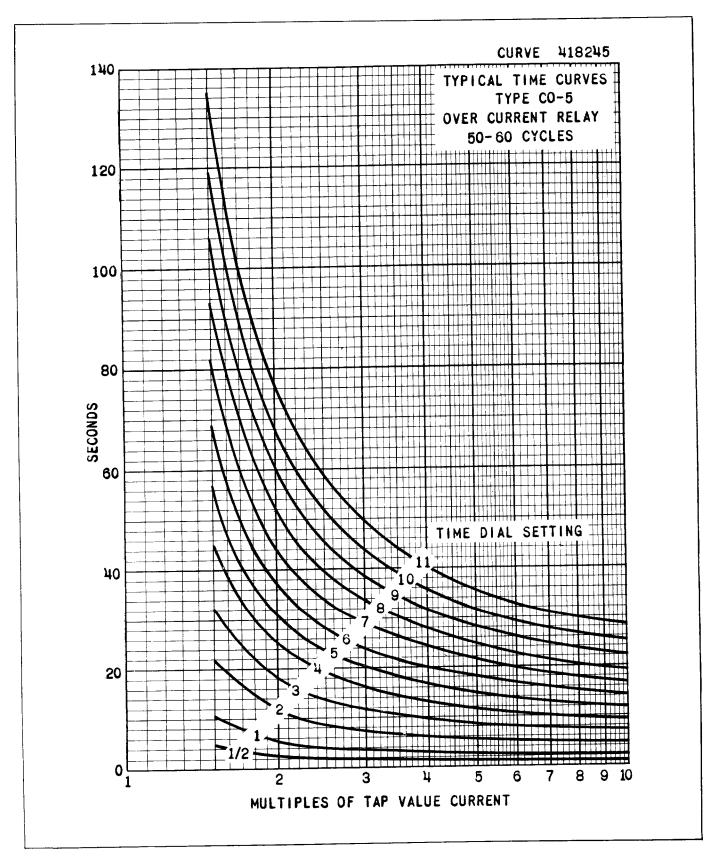


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

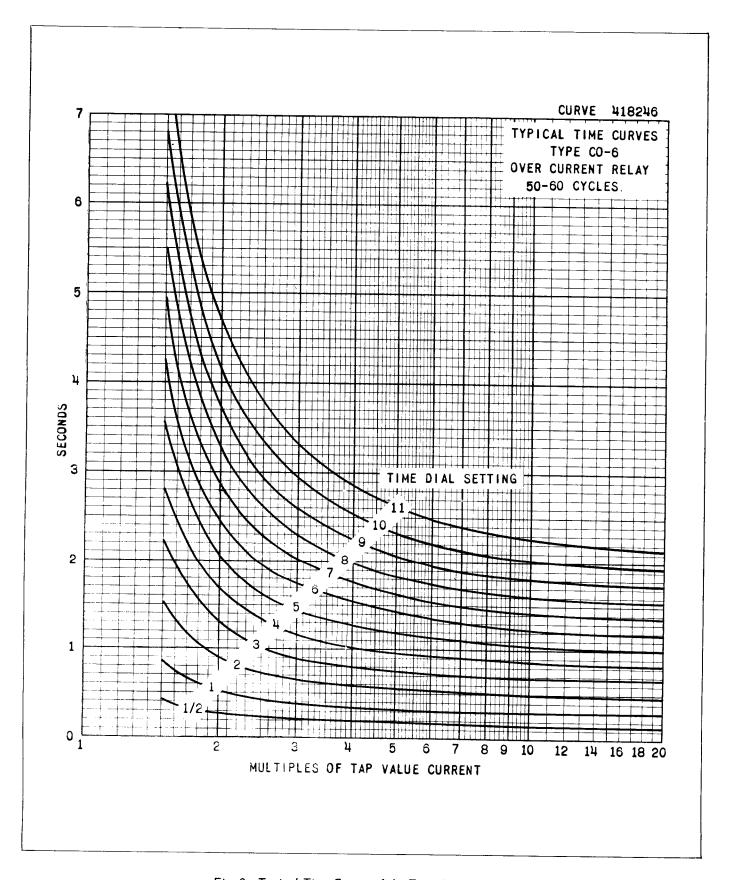


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

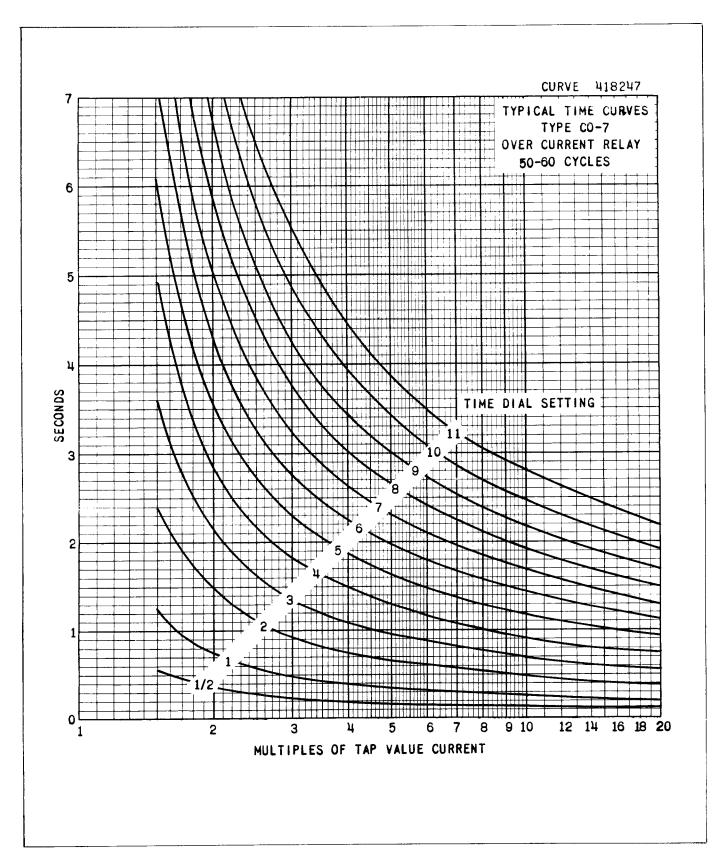


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

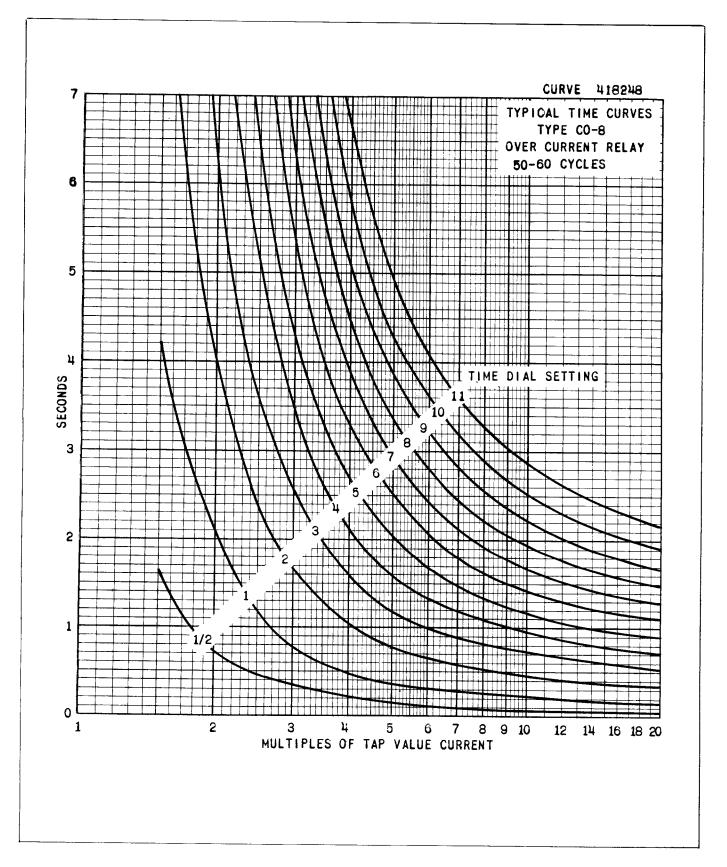


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

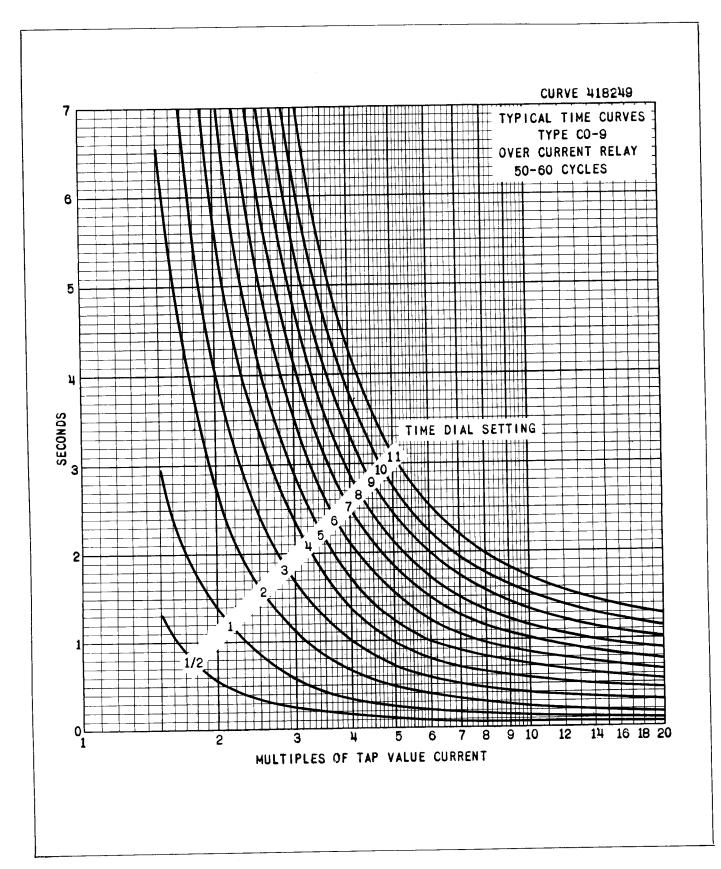


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

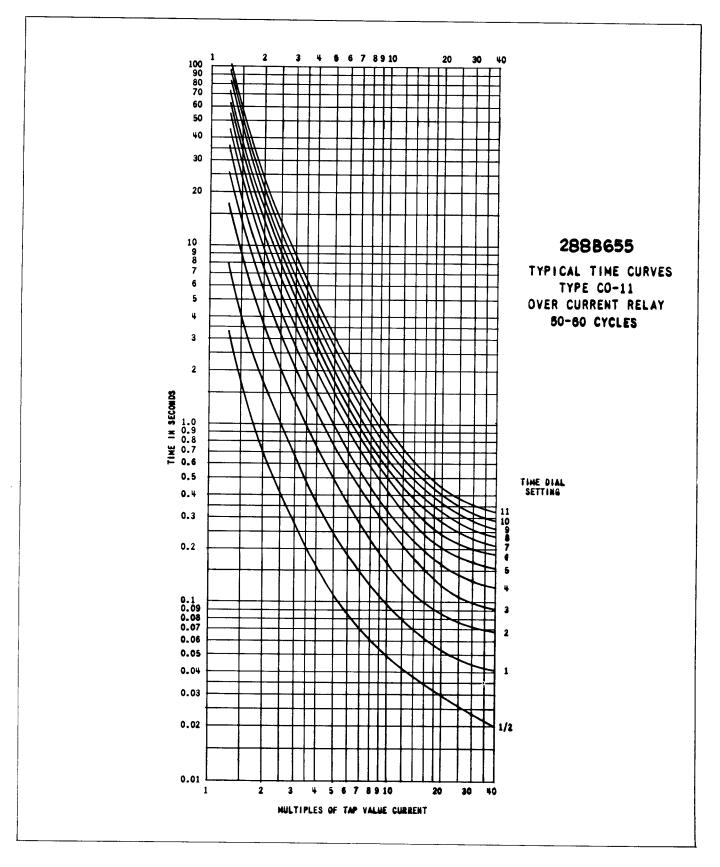


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

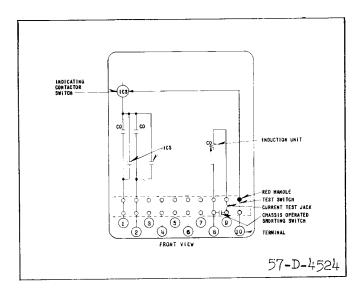


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.

#### **SETTINGS**

#### CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

#### Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

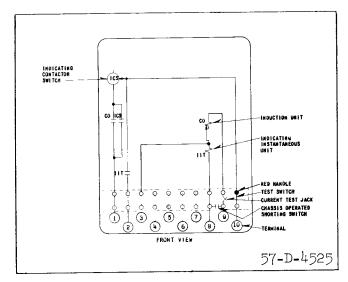


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

#### Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

#### Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

#### Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT. unit.

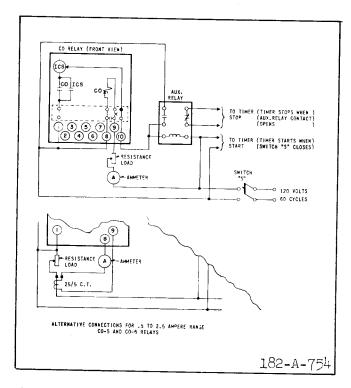


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

#### INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

## **ADJUSTMENTS AND MAINTENANCE**

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

#### Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. <u>Minimum Trip Current</u> Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. Time Curve For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time

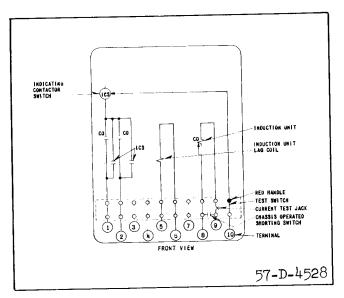


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.

dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5%

4. <u>Indicating Instantaneous Trip Unit (IIT)</u> The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

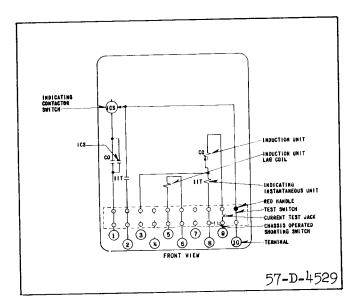


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

#### Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

#### CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or

the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

#### CO Unit

#### 1. Contact

- a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2) Minimum Trip Current The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. <u>Time Curve Calibration</u> - Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the timecurrent characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

4. Indicating Contactor Switch (ICS) - Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

# 5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

#### RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

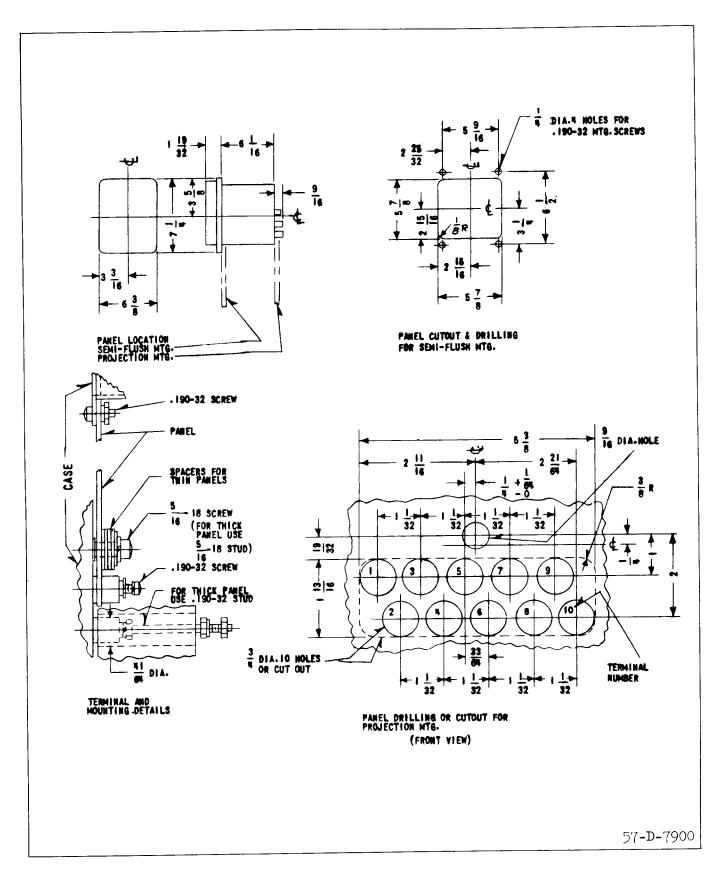


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA \_ 50 & 60 CYCLES

#### PERMANENT MAGNET ADJUSTMENT **ELECTROMAGNET PLUGS** TIME CURRENT **OPERATING** CURRENT **OPERATING** RELAY DIAL (MULTIPLES OF TIME (MULTIPLES OF TIME TYPE **POSITION** TAP VALUE) **SECONDS** TAP VALUE) SECONDS CO-2 6 3 0.57 20 0.22 CO-5 6 2 37.80 10 14.30 CO-6 6 2 2.46 20 1.19 CO-7 6 4.27 20 1.11 CO-8 6 13.35 20 1.11 CO-9 6 2 8.87 20 0.65 CO-11 6 11.27 20 0.24 $\triangle$

 $\Delta$  For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, -5%.

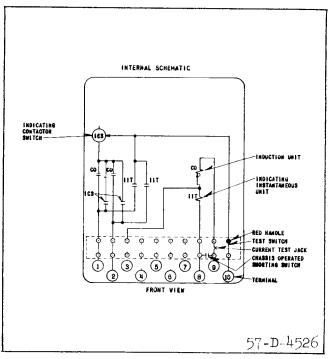


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

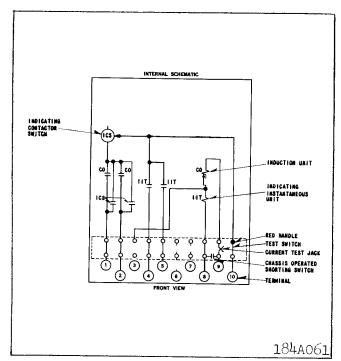


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

WESTINGHOUSE ELECTRIC CORPORATION RELAY-INSTRUMENT DIVISION NEWARK, N. J.



# INSTALLATION . OPERATION . MAINTENANCE

# INSTRUCTIONS

# monte

# TYPE CO OVERCURRENT RELAY

#### CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

# O APPLICATION

These induction type of relays are single phase, nondirectional, ac current sensitive devices. They are used for phase or ground overcurrent protection of feeders, transmission lines, ac machines, transformers, capacitors, reactors, and in other application where a relay is required whose operating time inversely is related to operating current.

For selective coordination between relays, 7 different types of relays are available as listed below. Their time curves are as shown in figures 7 to 13.

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

In general, the application will indicate the use of a specific type of CO relay. Short time relays act fast to avoid equipment damage. Long time relays hold off tripping on heavy initial overload or more extended moderate overloads. At higher fault currents, definite-time and moderately inverse relays maintain more nearly constant operating time, despite variation in fault currents. Inverse and extremely inverse relays operate respectively faster on higher fault currents.

#### **CONTENTS**

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay

CO-5 Long Time Relay

CO-6 Definite Minimum Time Relay

CO-7 Moderately Inverse Time Relay

CO-8 Inverse Time Relay

CO-9 Very Inverse Time Relay

CO-11 Extremely Inverse Time Relay

## **CONSTRUCTION AND OPERATION**

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

#### **ELECTROMAGNET**

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap cause a contact closing torque. A torque controlled CO has the lag coil connections of the electromagnet brought out to separate terminals. This permits control of the closing torque such that only when these terminals are connected together will the unit operate.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

# INDICATING CONTACTOR SWITCH UNIT (ICS)

The dc indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

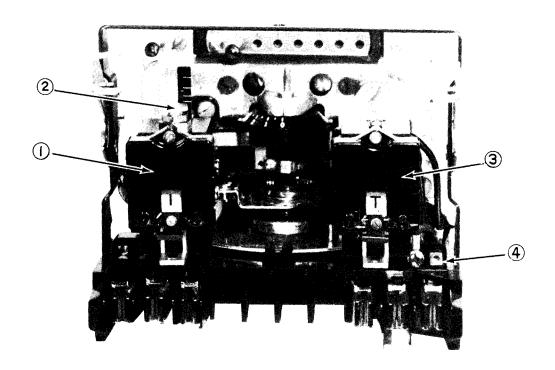


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous Trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

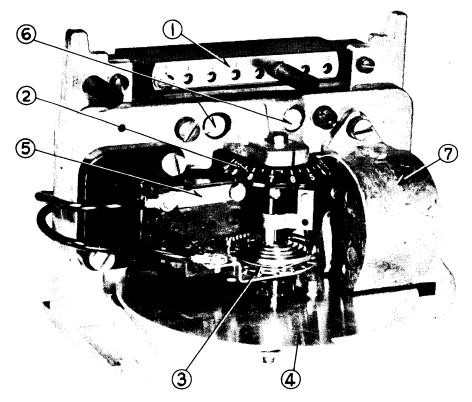


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

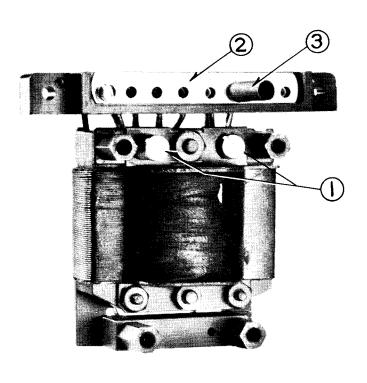


Fig. 3. "E" Type Electromagnet. 1-Magnet Plugs. 2-Tap Block. 3-Tap Screw.

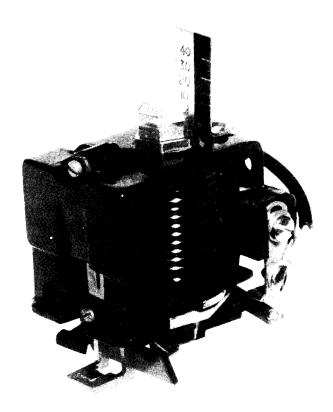


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

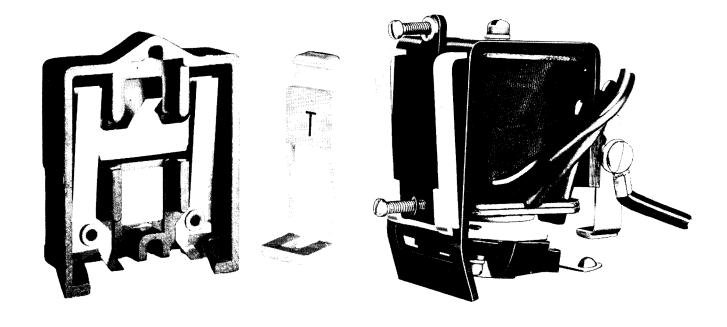


Fig. 5. Indicating Contactor Switch (ICS).

energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

# INDICATING INSTANTANEOUS TRIP UNIT (IIT)

The instantaneous trip unit is a small ac operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range.

#### **CHARACTERISTICS**

The relays are generally available in the following current ranges.

Range		Taps						
† .15	0.1	0.12	0.16	0.2	0.3	0.4	0.5	
.5 - 2.5	0.5	0.6	0.8	1.0	1.5	2.0	2.5	
2 - 6	2	2.5	3	3.5	4	5	6	
4 - 12	4	5	6	7	8	10	12	
† Available f	or Typ	e CO-	11 Rela	ıy.				

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

#### **TRIP CIRCUIT**

The main contacts will safely close 30 amperes at 250 volts dc and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts dc, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 to 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

#### TRIP CIRCUIT CONSTANTS

Contactor Switch -

- 0.2 ampere tap -6.5 ohms dc resistance
- 2.0 ampere tap -0.15 ohms dc resistance

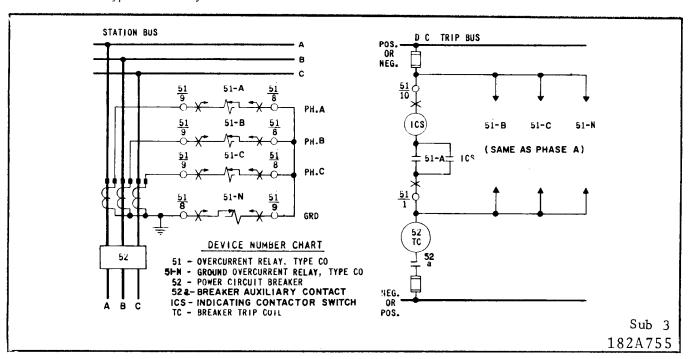


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

## **TYPE CO-2 RELAY**

VOLT	AMPERES**
------	-----------

ap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle Ø	At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
		28	58	4.8	39.6	256	790
					39.8	270	851
						308	1024
						348	1220
1.0						435	1740
						580	2280
2.0							2850
2.5	2.50	28	29				800
2.0	3.1	110	59	5.04			
			55	5.13			920
			51	5.37	42.8		1008
			47	5.53	42.8		1120
				5.72	46.0		1216
				5.90	50.3	420	1500
					54.9	474	1800
6.0	0.0	110			20.1	269	848
4.0	7.3	230					1020
	8.0	230					1128
	8.8	230	47				1260
		230	46				1408
		230	43				
		230	37	6.6			1720
			34	7.00	62.3	528	2064
1	1.5 2.0 2.5 2.0 2.5 3.0 3.5 4.0 5.0 6.0	Apperes         (Amperes)           0.5         0.91           0.6         0.96           0.8         1.18           1.0         1.37           1.5         1.95           2.0         2.24           2.5         2.50           2.0         3.1           2.5         4.0           3.0         4.4           3.5         4.8           4.0         5.2           5.0         5.6           6.0         4.0           7.3         5.0           8.0         6.0           8.8         7.0           9.6         8.0           10.4         10.4           10.0         11.2	Appendix         (Amperes)         (Amperes)           0.5         0.91         28           0.6         0.96         28           0.8         1.18         28           1.0         1.37         28           1.5         1.95         28           2.0         2.24         28           2.5         2.50         28           2.0         3.1         110           2.5         4.0         110           3.0         4.4         110           3.5         4.8         110           4.0         5.2         110           5.0         5.6         110           6.0         6.0         110           4.0         7.3         230           5.0         8.0         230           6.0         8.8         230           7.0         9.6         230           8.0         10.4         230           0.0         11.2         230	ap         (Amperes)         (Amperes)         Angle f           0.5         0.91         28         58           0.6         0.96         28         57           0.8         1.18         28         53           1.0         1.37         28         50           1.5         1.95         28         40           2.0         2.24         28         36           2.5         2.50         28         29           2.0         3.1         110         59           2.5         4.0         110         55           3.0         4.4         110         51           3.5         4.8         110         47           4.0         5.2         110         45           5.0         5.6         110         41           4.0         7.3         230         64           5.0         8.0         230         50           6.0         8.8         230         47           7.0         9.6         230         46           8.0         10.4         230         43           0.0         11.2         230         37 </td <td>Apple (Amperes)         (Amperes)         Angle f         Current           0.5         0.91         28         58         4.8           0.6         0.96         28         57         4.9           0.8         1.18         28         53         5.0           1.0         1.37         28         50         5.3           1.5         1.95         28         40         6.2           2.0         2.24         28         36         7.2           2.5         2.50         28         29         7.9           2.0         3.1         110         59         5.04           2.5         4.0         110         55         5.13           3.0         4.4         110         51         5.37           3.5         4.8         110         47         5.53           4.0         5.2         110         45         5.72           5.0         5.6         110         41         5.90           6.0         6.0         110         37         6.54           4.0         7.3         230         64         4.92           5.0         8.0         <td< td=""><td>ap         (Amperes)         (Amperes)         Angle 6         Current         Current           0.5         0.91         28         58         4.8         39.6           0.6         0.96         28         57         4.9         39.8           0.8         1.18         28         53         5.0         42.7           1.0         1.37         28         50         5.3         45.4           1.5         1.95         28         40         6.2         54.4           2.0         2.24         28         36         7.2         65.4           2.5         2.50         28         29         7.9         73.6           2.0         3.1         110         59         5.04         38.7           2.5         2.50         28         29         7.9         73.6           2.0         3.1         110         55         5.13         39.8           2.0         3.1         110         55         5.13         39.8           3.0         4.4         110         51         5.37         42.8           3.5         4.8         110         47         5.53         42.8<!--</td--><td>  Amperes   Angle 6   Current   Current   Current    </td></td></td<></td>	Apple (Amperes)         (Amperes)         Angle f         Current           0.5         0.91         28         58         4.8           0.6         0.96         28         57         4.9           0.8         1.18         28         53         5.0           1.0         1.37         28         50         5.3           1.5         1.95         28         40         6.2           2.0         2.24         28         36         7.2           2.5         2.50         28         29         7.9           2.0         3.1         110         59         5.04           2.5         4.0         110         55         5.13           3.0         4.4         110         51         5.37           3.5         4.8         110         47         5.53           4.0         5.2         110         45         5.72           5.0         5.6         110         41         5.90           6.0         6.0         110         37         6.54           4.0         7.3         230         64         4.92           5.0         8.0 <td< td=""><td>ap         (Amperes)         (Amperes)         Angle 6         Current         Current           0.5         0.91         28         58         4.8         39.6           0.6         0.96         28         57         4.9         39.8           0.8         1.18         28         53         5.0         42.7           1.0         1.37         28         50         5.3         45.4           1.5         1.95         28         40         6.2         54.4           2.0         2.24         28         36         7.2         65.4           2.5         2.50         28         29         7.9         73.6           2.0         3.1         110         59         5.04         38.7           2.5         2.50         28         29         7.9         73.6           2.0         3.1         110         55         5.13         39.8           2.0         3.1         110         55         5.13         39.8           3.0         4.4         110         51         5.37         42.8           3.5         4.8         110         47         5.53         42.8<!--</td--><td>  Amperes   Angle 6   Current   Current   Current    </td></td></td<>	ap         (Amperes)         (Amperes)         Angle 6         Current         Current           0.5         0.91         28         58         4.8         39.6           0.6         0.96         28         57         4.9         39.8           0.8         1.18         28         53         5.0         42.7           1.0         1.37         28         50         5.3         45.4           1.5         1.95         28         40         6.2         54.4           2.0         2.24         28         36         7.2         65.4           2.5         2.50         28         29         7.9         73.6           2.0         3.1         110         59         5.04         38.7           2.5         2.50         28         29         7.9         73.6           2.0         3.1         110         55         5.13         39.8           2.0         3.1         110         55         5.13         39.8           3.0         4.4         110         51         5.37         42.8           3.5         4.8         110         47         5.53         42.8 </td <td>  Amperes   Angle 6   Current   Current   Current    </td>	Amperes   Angle 6   Current   Current   Current

# CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

# **VOLT AMPERES\*\***

					VOLI AMPERES				
Ampere Range	Тар	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle Ø	At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current	
		2.7	88	69	3.92	20.6	103	270	
	0.5		88	68	3.96	20.7	106	288	
	0.6	3.1	88	67	3.96	21	114	325	
	0.8	3.7	88	66	4.07	21.4	122	360	
0.5/2.5	1.0	4.1	88	62	4.19	23.2	147	462	
	1.5	5.7	88	60	4.30	24.9	168	548	
	2.0	6.8	88	58	4.37	26.2	180	630	
	2.5	7.7	00				110	308	
	2	8	230	67	3.88	21	110	342	
	2.5	8.8	230	66	3.90	21.6	118	381	
	3	9.7	230	64	3.93	22.1	126	417	
2/6	3.5	10.4	230	63	4.09	23.1	136	448	
2/0	4	11.2	230	62	4.12	23.5	144	540	
	5	12.5	230	59	4.20	24.8	162		
	6	13.7	230	57	4.38	26.5	183	624	
			460	65	4.00	22.4	126	376	
	4	16	460	63	4.15	23.7	143	450	
	5	18.8	460		4.32	25.3	162	531	
	6	19.3	460	61	4.35	26.4	183	611	
4/12	7	20.8	460	59		27.8	204	699	
	8	22.5	460	56	4.40	30.1	247	880	
	10	25	460	53	4.60		288	1056	
	12	28	460	47	4.92	35.6	200	.000	

<sup>\*</sup>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.

Degrees current lags voltage at tap value current.

<sup>\*\*</sup> Voltages taken with Rectox type voltmeter.

# **CO-7 MODERATELY INVERSE TIME RELAY**

VOLT AMPERES
--------------

Ampere Range	Тар	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle Ø	At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current	
	0.5	2.7	88	68	3.88	20.7	103		
	0.6	3.1	88	67	3.93	20.7	103	278	
0.5.10.5	0.8	3.7	88	66	3.93	21.1	114	288	
0.5/2.5	1.0	4.1	88	64	4.00	21.6	122	320	
	1.5	5.7	88	61	4.08	22.9	148	356	
	2.0	6.8	88	58	4.24	24.8	174	459	
	2.5	7.7	88	56	4.38	25.9	185	552	
	2	8	230	66				640	
	2.5	8.8	230	63	4.06	21.3	111	306	
	3	9.7	230	63	4.07	21.8	120	342	
2/6	3.5	10.4	230	62	4.14	22.5	129	366	
•	4	11.2	230	61	4.34	23.4	141	413	
	5	12.5	230	59	4.34	23.8	149	448	
	6	13.7	230	58	4.40	25.2	163	530	
	4			20	4.62	27	183	624	
	4	16	460	64	4.24	22.8	129	392	
	5	18.8	460	61	4.30	24.2	149	460	
4/12	6	19.3	460	60	4.62	25.9	168	540	
4/12	7 8	20.8	460	58	4.69	27.3	187	626	
		22.5	460	55	4.80	29.8	211	688	
	10	25	460	51	5.20	33	260	860	
	12	28	460	46	5.40	37.6	308	1032	

# CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

#### **VOLT AMPERES\*\***

Ampere Range	Тар	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø				
					At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
0.5/2.5	0.5	2.7	88	72	2.38	21		
	0.6	3.1	88	71	2.38	21	132 134	350
	0.8	3.7	88	69	2.40	21.1	142	365
	1.0	4.1	88	67	2.42	21.2	150	400
	1.5	5.7	88	62	2.51	22	170	440
	2.0	6.8	88	57	2.65	23.5	200	530
	2.5	7.7	88	53	2.74	24.8	228	675 800
2/6	2	8	230	70	2.38	21		
	2.5	8.8	230	66	2.40		136	360
	3	9.7	230	64	2.42	21.1 21.5	142	395
	3.5	10.4	230	62	2.48	21.3	149	430
	4	11.2	230	60	2.53		157	470
	5	12.5	230	58	2.64	22.7	164	500
	6	13.7	230	56	2.75	24	180	580
4/12				50	2.73	25.2	198	660
	4	16	460	68	2.38	21.3	146	420
	5	18.8	460	63	2.46	21.8	158	480
	6	19.3	460	60	2.54	22.6	172	550
	7	20.8	460	57	2.62	23.6	190	
	8	22.5	460	54	2.73	24.8	207	620
	10	25	460	48	3.00	27.8	248	700
	12	28	460	45	3.46	31.4	292	850
						31.4	272	1020

<sup>\*</sup>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.

Degrees current lags voltage at tap value current.

<sup>\*\*</sup>Voltages taken with Rectox type voltmeter.

#### **TYPE CO-11 RELAY**

Ampere Range	Тар	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle Ø	VOLT AMPERES**			
					At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
0.1/0.5	0.1	0.4	11.5	34	0.64	6.5	70.3	240
	0.12	0.4	11.5	32	0.67	6.66	75.4	264
	0.16	0.4	11.5	30	0.76	7.3	82.4	297
	0.20	0.4	11.5	26	0.83	8.3	87.8	336
	0.30	0.4	11.5	22	1.01	10.3	117.6	420
	0.40	0.4	11.5	18	1.21	11.22	140.0	520
	0.50	0.4	11.5	16	1.38	13.8	168.0	630
	0.5	1.7	56	36	0.72	6.54	71.8	250
	0.6	1.9	56	34	0.75	6.80	75.0	267
	0.8	2.2	56	30	0.81	7.46	84.0	298
0.5/2.5	1.0	2.5	56	27	0.89	8.30	93.1	330
VII.9 211	1.5	3.0	56	22	1.13	10.04	115.5	411
	2.0	3.5	56	17	1.30	11.95	136.3	502
	2.5	3.8	56	16	1.48	13.95	160.0	610
	2.0	7.0	230	32	0.73	6.30	74.0	264
	2.5	7.8	230	30	0.78	7.00	78.5	285
	3.0	8.3	230	27	0.83	7.74	84.0	309
2/6	3.5	9.0	230	24	0.88	8.20	89.0	340
-/0	4.0	10.0	230	23	0.96	9.12	102.0	372
	5.0	11.0	230	20	1.07	9.80	109.0	430
	6.0	12.0	230	20	1.23	11.34	129.0	504
4/12	4.0	14	460	29	0.79	7.08	78.4	296
	5.0	16	460	25	0.89	8.00	90.0	340
	6.0	17	460	22	1.02	9.18	101.4	378
	7.0	18	460	20	1.10	10.00	110.0	454
	8.0	20	460	18	1.23	11.1	124.8	480
	10.0	22	460	17	1.32	14.9	131.6	600
	12.0	26	460	16	1.8	16.3	180.0	720

<sup>\*</sup>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.

## O INSTANTANEOUS TRIP UNIT (IIT)

RANGE IN	BURDEN IN VOLT-AMPS. AT				
AMPERES	MINIMUM SETTING	MAXIMUM SETTING			
2 - 8	4.5	32			
4 - 16	4.5	32			
10 - 40	4.5	40			
20 - 80	6.5	70			
40 - 160	9.0	144			

Degrees current lags voltage at tap value current.

<sup>\*\*</sup>Voltages taken with Rectox type voltmeter.

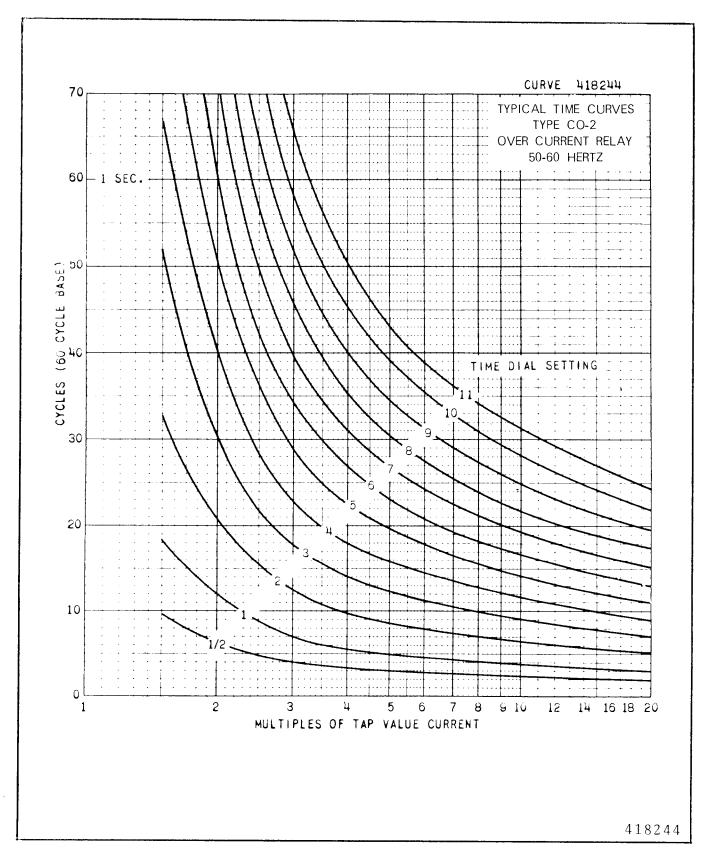


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

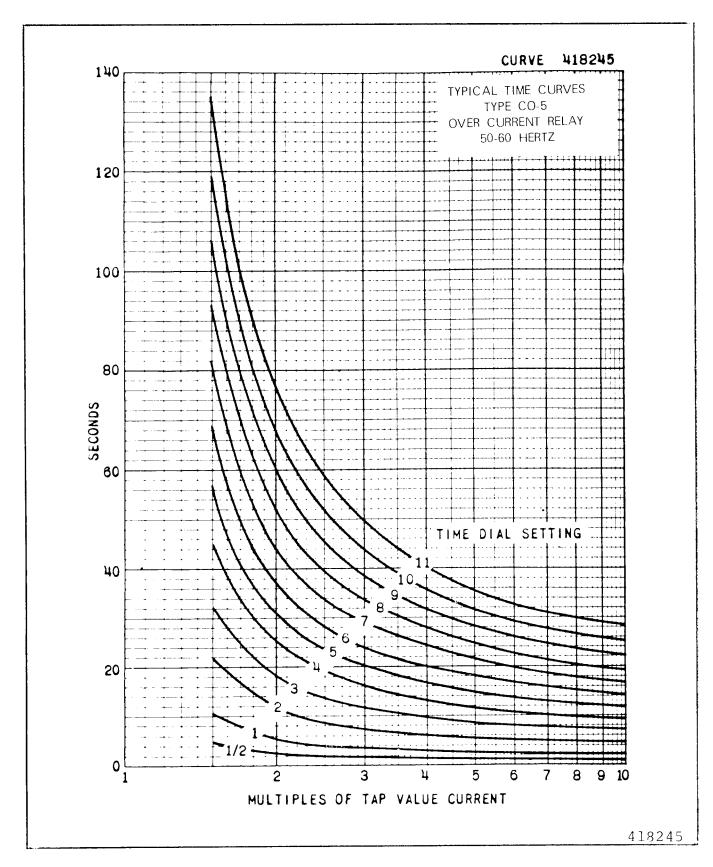


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

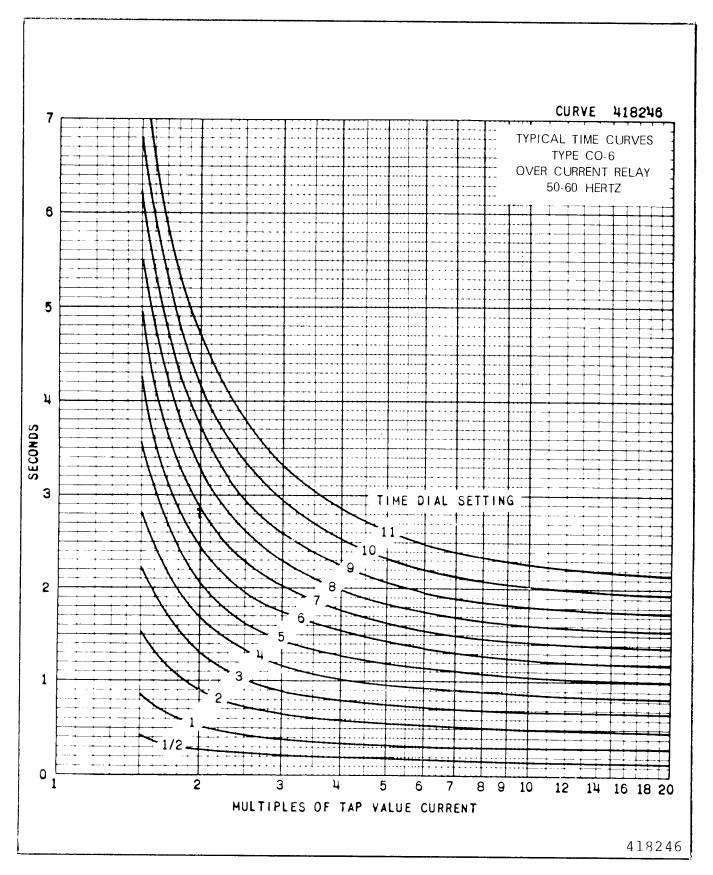


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

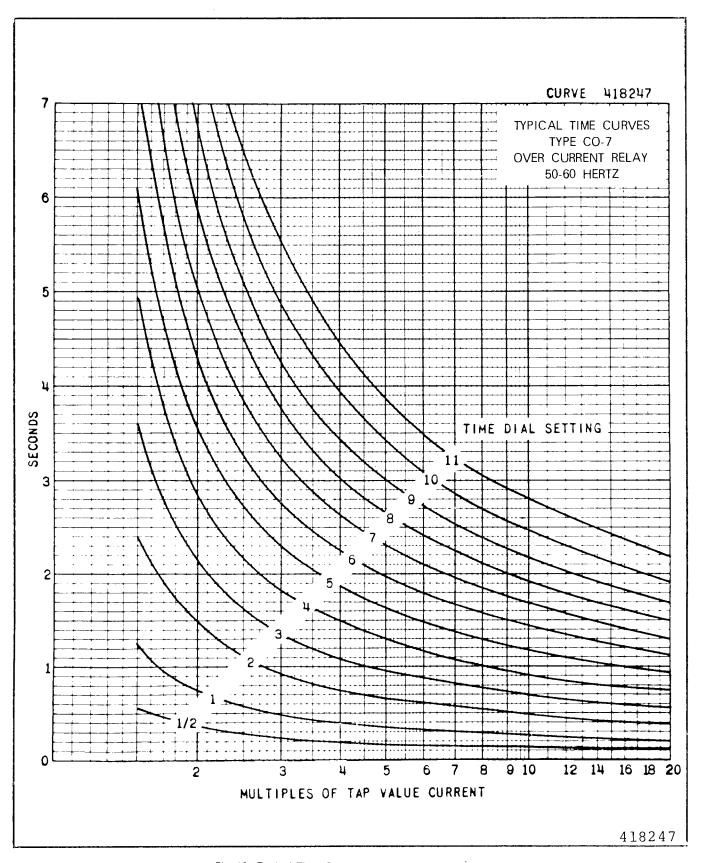


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

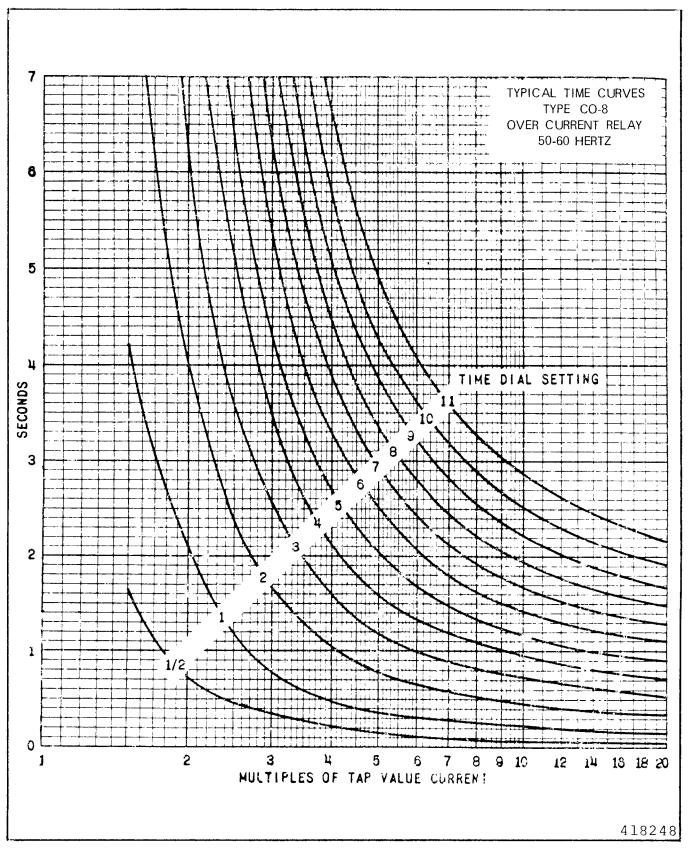


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

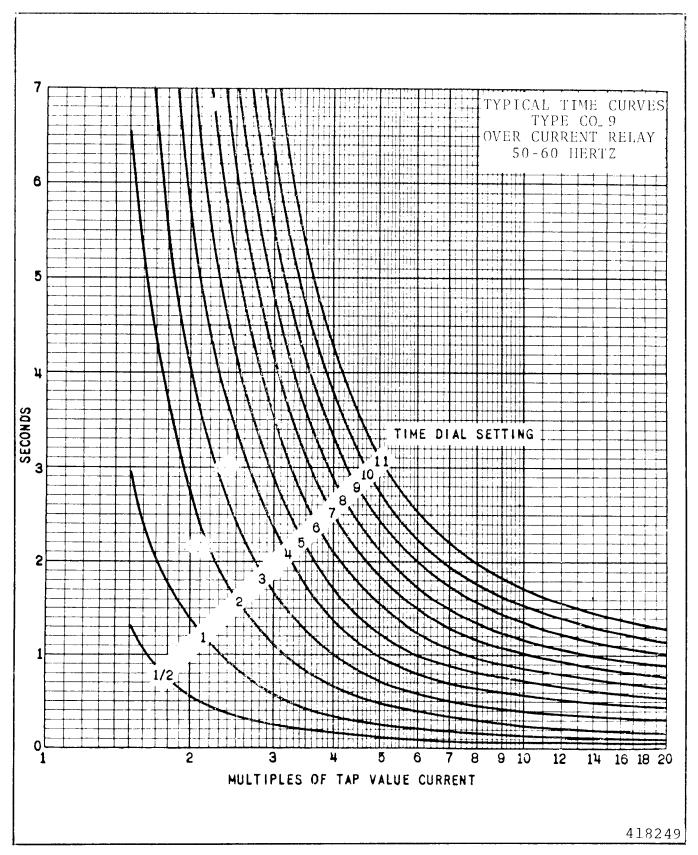


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

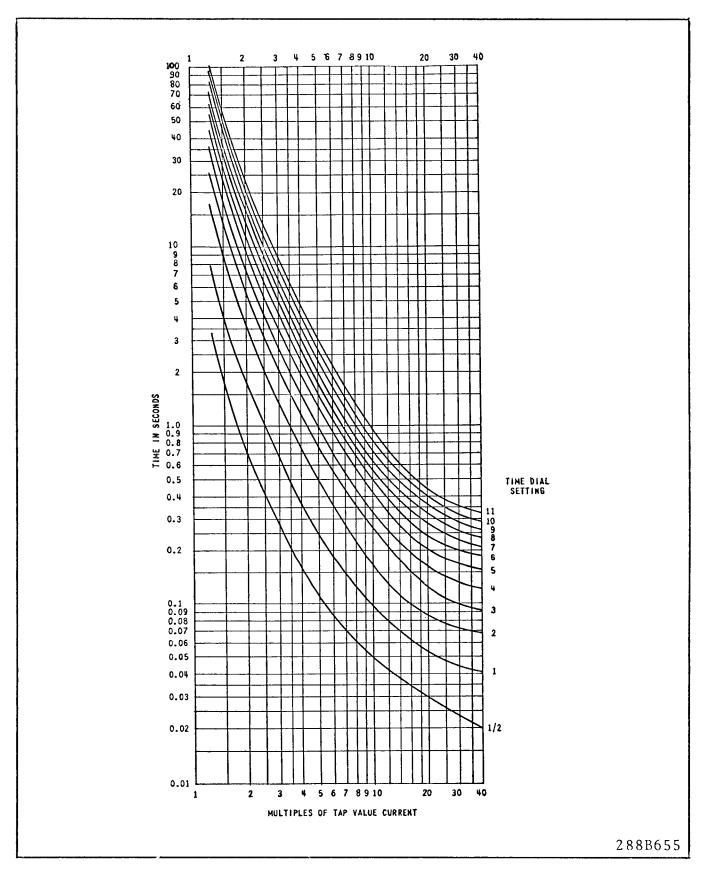


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

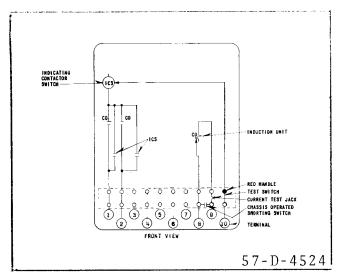


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.

#### **SETTINGS**

#### **COUNIT**

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current mutliple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current)

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

#### CAUTION

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

#### **INSTANTANEOUS RECLOSING**

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

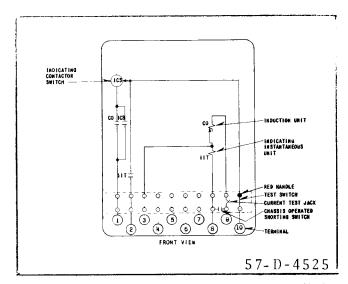


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Taip Unit.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

#### INDICATING CONTACTOR SWITCH (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 2.0 ampere setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

#### **INDICATING INSTANTANEOUS TRIP (IIT)**

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the HT unit.

#### O INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the rear mounting stud or studs for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground Wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections

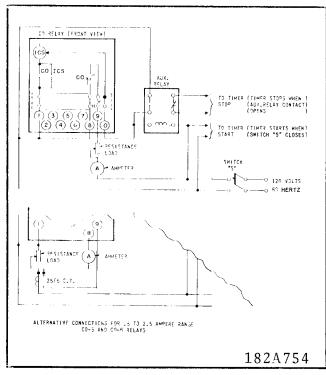


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

may be made directly to the terminals by means of screws for steel panel mounting or to the terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to I.L. 41-076.

#### ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

For relays which include an indicating instantaneous trip unit (ITT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

#### **ACCEPTANCE CHECK**

The following check is recommended to insure that the relay is in proper working order:

#### 1. Contact

 a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. Minimum Trip Current Set the time dial to position 6 using the lowest tap setting, alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.
- 3. Time Curve For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is  $54.9 \pm 5\%$  seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5% (Use .5 tap for .1 to .5 range).

4. Indicating Instantaneous Trip Unit (IIT) — The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridg-

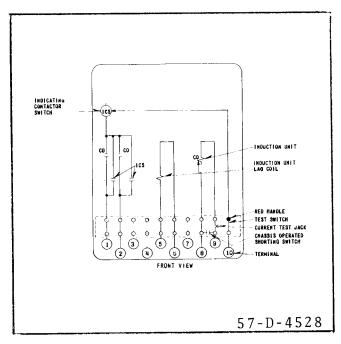


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.

ing moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

5. Indicating Contactor Switch (ICS) — Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

#### **ROUTINE MAINTENANCE**

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It

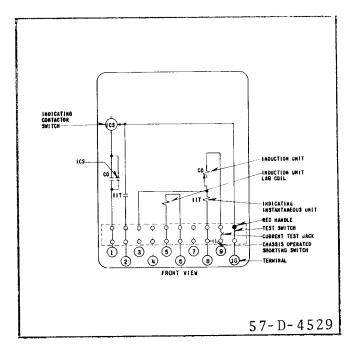


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

All contacts should be periodically cleaned. A contact burnisher #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

#### **CALIBRATION**

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

#### **COUNIT**

#### 1. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a posi-

tion where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

- b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".
- 2. **Minimum Trip Current** The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current  $\pm 1.0\%$  and will return to the backstop at tap value current  $\pm 1.0\%$ .

3. Time Curve Calibration – Install the permanent magnet.

Apply the indicated current per Table I for permanent magnet adjustment (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9  $\pm 5\%$  seconds. It is important that the 1.30 times tap value

current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has been completed.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

4. Indicating Contactor Switch (ICS) — Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

## 5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

#### **RENEWAL PARTS**

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

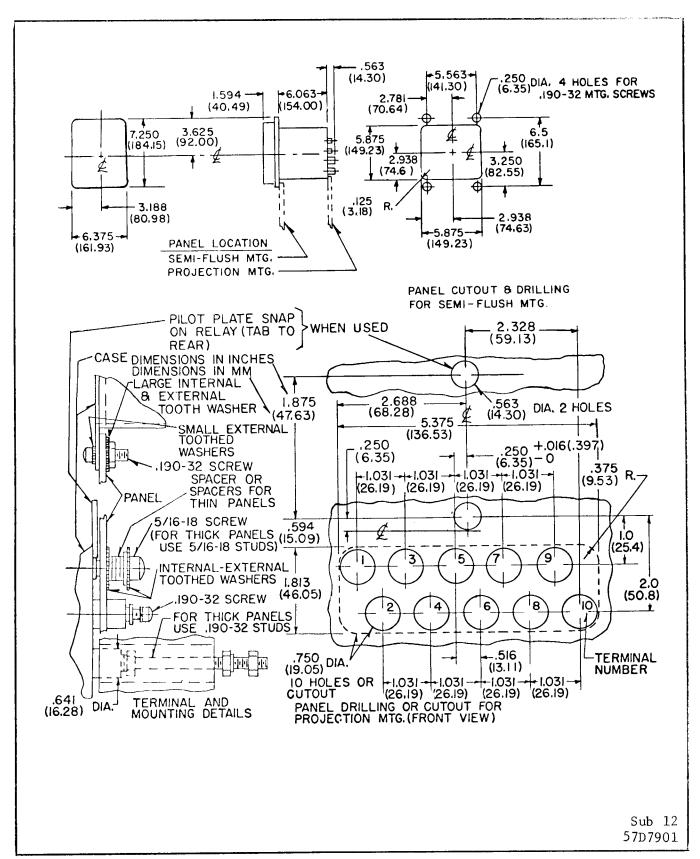


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

**TABLE 1 TIME CURVE CALIBRATION DATA - 50 & 60 HERTZ** 

#### PERMANENT MAGNET ADJUSTMENT **ELECTROMAGNET PLUGS** TIME **CURRENT OPERATING CURRENT OPERATING** RELAY DIAL (MULTIPLES OF TIME (MULTIPLES OF TIME **TYPE POSITION** TAP VALUE) **SECONDS** TAP VALUE) **SECONDS** CO-2 3 0.57 20 0.22 CO-5 37.80 10 14.30 CO-6 2.46 20 1.19 CO-7 4.27 20 1.11 CO-8 13.35 20 1.11 CO-9 8.87 20 0.65 CO-11 11.27

 $\bullet$  AFor 50 hertz CO-11 relay 20 times operating time limits are 0.24 + 10%, -5%.

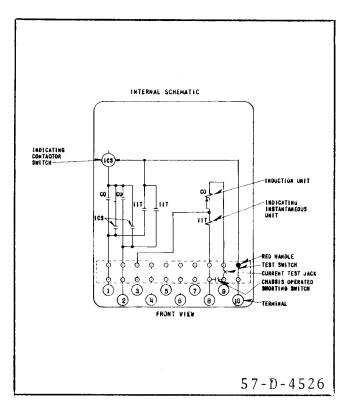
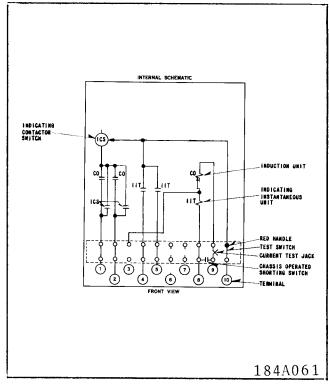


Fig. 20. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.



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 $0.24\,\Delta$ 

Fig. 21. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit to Separate Terminals.