SECTION V

MAGNETIC INTERFERENCE

General

The performance of a relay, or the adjustment applied to a relay, may be affected by the leakage or stray flux from adjacent energized apparatus. The magnitude of the effect on the relay performance or operation depends on:

1. The ampere turn energization and amount of leakage flux of the adjacent apparatus.
2. The function of the relay, ie, whether operate, nonoperate, hold, or release is involved.
3. The spacing between the relay and the interfering apparatus.
4. The amount and polarity of the leakage flux from the adjacent relays.
5. The extent to which the relay is affected by stray magnetic fields.
6. The use of covers on the interfering, or interfered with, apparatus.

The stray field from a relay varies with its ampere turn energization, increasing as the ampere turns are increased, up to the saturation point of the relay. The effect of the stray field on a relay will vary with the adjusting ampere turns. Thus, hold or release values of slow releasing AG relays, which are relatively low ampere turns, will be affected more on a percentage basis than the operate or nonoperate.

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Only the adjacent relays 1, 2, 3, 4, 6, 7, 8, and 9 in the interference pattern shown below, will significantly affect relay No. 5, which is the one under consideration.

Interference Pattern

1	2	3
4	5	6
7	8	9

The mounting centers for the relays in the interference pattern are:

AF relays 1-1/2 inches horizontal

U relays 1-1/4 inches horizontal

U and AF relays 2 inches vertical

Relays outside the interference pattern are 2-1/2 inches or more away, and their field has no effect on the relay in position No. 5. Thus, magnetic interference may (if necessary) be eliminated by a suitable location of the energized relays. This method generally involves no penalty in circuits with a large number of mounting plates, eg, senders or registers, but may involve space penalties for trunk circuits. Trunk circuits may have only one or two mounting plates, in which case the adjacent relays may not be readily controlled as they may be in other circuits.

There are two effects of magnetic interference: the effect on the adjustment of a relay when it is adjusted with adjacent relays energized, and the effect on the performance of the relay.

Effect on the Relay Adjustment

This effect on the adjustment would be noted when the relay is adjusted with or without the interfering relays energized, and then checked, using approximately the same current flow values, with the opposite interfering condition. This effect will occur generally in trunk circuits or similar circuits in which a relay may be adjusted when relays in adjacent circuits are energized. Adjacent energized relays may be avoided by making the adjacent circuits busy or by locating the critical relays on the middle plate of a 3-plate 2- or 3-trunk unit. The first method is undesirable since it may require making a trunk busy at another office. The latter method imposes restrictions on the equipment design and may waste space. The latter method was used in the No. 5 crossbar trunks using U and Y relays. The interference in these circuits was so great that it could not be ignored.

This interference effect is present on all adjustments of AF, AG, and AJ relays - operate, nonoperate, hold, and release. However, the effect is so small on all adjustments, except the hold and release of the AG relay, that the interference effect can be ignored. Table V-1 shows the effect of interference from adjacent AF and U relays on the operate or nonoperate of AF, AG, and AJ relays and on the hold or release of AF and AJ relays.

Table V-1 shows that the U relay has a negative, or aiding, effect on the wire spring relay instead of a positive, or opposing, effect. When U and wire spring relays are energized with ground on the inner end of the winding, in accordance with the standard wiring practice, the U relay is poled opposite to the wire spring relay. The U and wire spring relay coils are wound in the same direction, and the winding leads are terminated at the same end of the coil. However, the U relay coil is assembled on the core so that the terminals are brought out at the rear spoolhead, and the wire spring relay coil is assembled

so that the terminals appear at the front spoolhead. This means that the direction of the magnetism of the wire spring relay is opposite to that of the U relay. Thus, the interference from surrounding AF or AJ relays has an opposing effect, whereas that from surrounding U relays has an aiding effect on the adjustment and performance of the wire spring relays.

The effect of AF and U interfering relays on the hold or release of the AG relay is shown in Fig. V-1. This effect, although small in comparison to Y relays, requires some consideration. The comparison in the effect on the release with one relay above and one relay below, energized at 600-ampere turns, for the AG relay with AF interfering relays and the Y relay with U interfering relays is:

NI Release With No Interference	Interference Effect On AG	Y
6.3	9.5%	75%
18.7	5.0%	27%
24	4.0%	23%

It can be noted from the above that the effect on AG relays is considerably less than it is on the Y relays. For example, with one AF relay energized at 600-ampere turns, above and below an AG relay, the maximum interference effect is 9.5 percent, whereas with a U relay energized at 600-ampere turns above and below a Y relay, the maximum effect is 75 percent. Actually, very few AF relays can be energized at 600-ampere turns, but several U relay coils can be. With 300-ampere turns on the interfering relays, the maximum effect on the AG relay is 6.4 percent instead of 9.5 percent.

The minimum interference effect occurs with a weak adjustment or at the release end of the hold-release adjustment band. With a stiff adjustment, or at the hold end of the adjustment band, the interference effect on an AG relay with one AF relay above and one below energized at 300-ampere turns is not over 5 percent. With a U interfering relay above and below, the comparable effect on a stiff Y relay is above 25 percent.

In view of the marked reduction in the interference effect for the AG relay, as compared with the Y relay, it has been agreed that magnetic interference considerations should not impose any penalties on the equipment design of wire spring relay trunk circuits.

It has also been agreed not to recommend in the BSP that adjacent circuits be made busy when readjusting or testing AG relays. There is a small risk in these agreements, but it is believed that the risk is justified on the basis that (1) a marginal adjustment is rare; (2) there is a 5-percent margin between the hold readjust and test and 5-percent or more margin between the release readjust and test; and (3) the interference generally will not exceed that from one relay above and below. Actually, as long as there is any interference effect, it cannot be safeguarded for successive checks with and without interference, using the same test current; however, it is believed that relays will meet the test requirements with interference if they have been adjusted to the readjust requirements without interference. It is also believed that the adjustment trouble caused by interference that was experienced with the Y relay was aggravated by the aging of the magnetic iron that was used prior to the introduction of hydrogen-annealed iron.

Effect on Performance of the Relay

The effects of magnetic interference on the performance of wire spring relay circuits is generally insignificant. Since more ampere turns may be required to operate a relay under the influence of magnetic interference from relays poled alike, the normal margin between the test and the worst circuit operate may be reduced. In no case is this sufficient to impair the operating margin of the wire spring relay. The reduced operating margin has the effect of increasing the maximum operating time, but in no case is this increase significant.

The releasing times of the slow-releasing AG relays may be either increased or decreased depending on whether the interference comes from surrounding AF or U relays. The minimum releasing time of an AG relay with three AF relays above and below may be decreased in the order of 10 percent which, usually, is not serious. The worst effect of U interfering relays is an increase in the maximum releasing time which, ordinarily, is not critical. If both AF and U relays create interference, the effects tend to neutralize each other.

In critical cases, such as the slow release (RA) relay in the originating register circuit, it may be found desirable to locate noninterfering apparatus adjacent to an AG relay. These cases should not occur very often.

The effect of magnetic interference on the releasing time of AG relays may be found from the release time curve in Section IX by reading the release time corresponding to (1) the release-ampere turns without interference, and (2) the release-ampere turns with interference. The release ampere turns with interference are obtained from Fig. V-1.

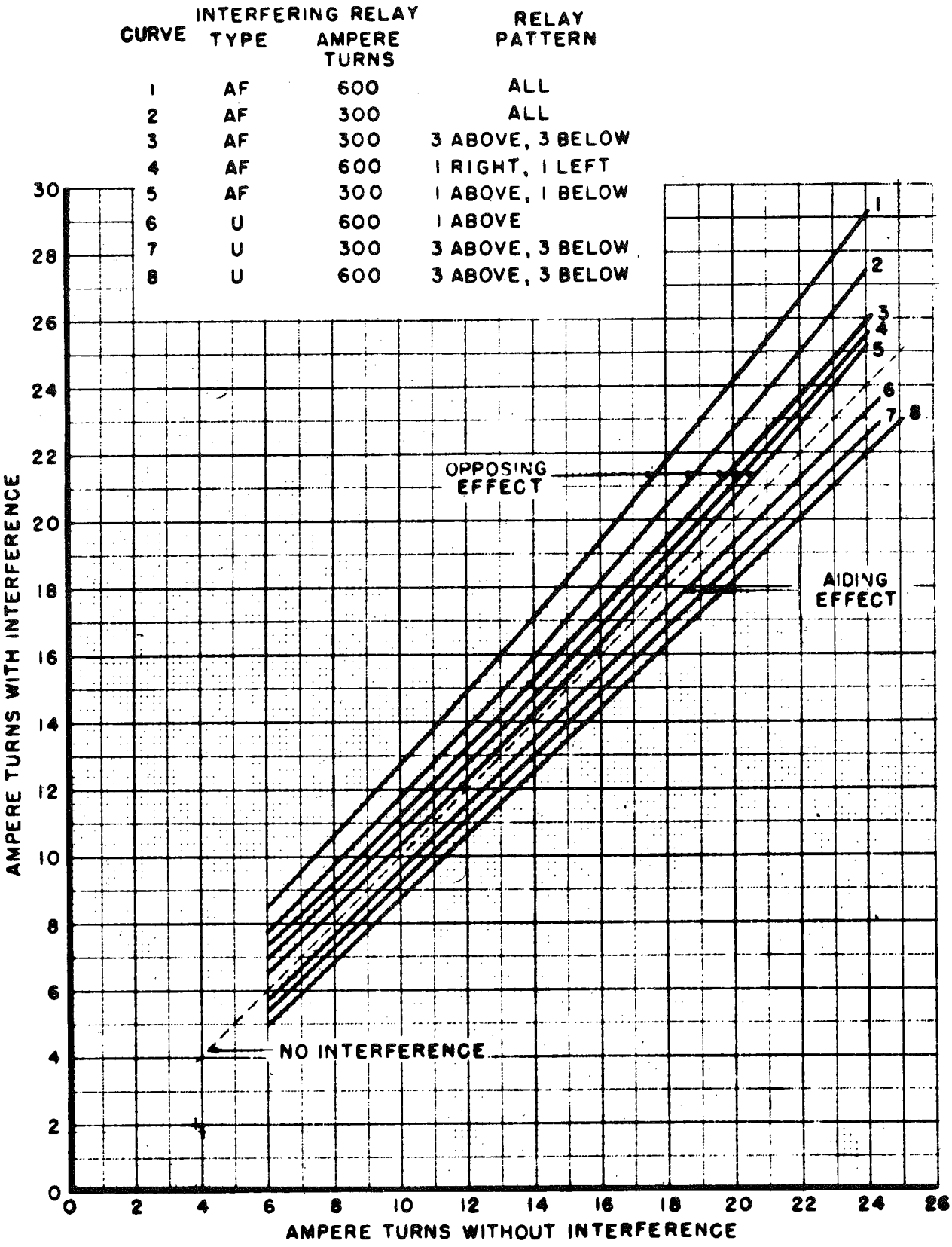

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Fig. V-1 - AC Relay - Magnetic Interference Effect on Hold or Release

Effect on AK Relays

Magnetic interference on the AK relay must be considered from two aspects: that from surrounding relays and that from one coil of the relay on the other coil. The first condition, interference from surrounding relays, is negligible. Magnetic interference between two coils of an individual relay, equipped with stop discs, may be as much as ±10 ampere-turns on the operate and -5 ampere turns on the release where both coils are poled in the same direction. The leakage flux from the interfering coil reduces the pull above the knee of the operate pull curve and increases the pull below the knee. Since most of the relays have the operate point near the knee of the pull curve, approximately 150 ampere turns, the interference effect on the operate is usually much less than the maximum of 10 ampere turns and can be neglected. The -5 ampere turns interference effect on the release applies at high values of release ampere turns and becomes less at lower values of release, so it has practically no effect on the relay performance.

Magnetic interference of either half of an AK relay on the other half of the relay, if equipped with a domed armature, may be appreciable and should be taken into consideration when figuring release times. This effect is shown in Fig. VII-14B and VII-14C. The relay adjustment should not be affected since one half of the relay should be adjusted with the other half de-energized. In Fig. VII-14B and VII-14C, positive interference assumes both coils poled in the same direction and negative interference the coils poled in the opposite direction. To obtain the release time with interference, read the hold or release gram loads on the hold or release pull curve with interference and obtain the hold or release-ampere turns. The time can be obtained by reading these values on the minimum or maximum time curves.

Crosstalk

Another important effect of stray magnetic fields is crosstalk between transmission relays of adjacent trunk circuits. The wire spring relay is about 5 db better than the UA relay. This is not sufficient to permit mounting transmission relays in different circuits on 2-inch vertical centers, but will permit 4-1/2- instead of 6-inch mounting centers. Where the transmission relays of different circuits are closer than 4-1/2 inches, the relays are equipped with magnetic shields. Fig. V-2 shows the shields which may be used on the AF, AG, or AJ relays.

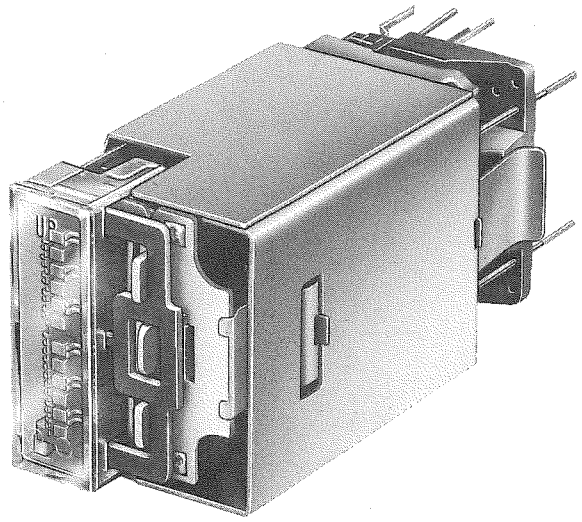

Fig. V-2 - AJ Relay with Shield

The crosstalk with wire spring relays equipped with shields is approximately the same as that of UA relays equipped with crosstalk covers.

Where there are wire spring transmission relays in the same circuit, crosstalk is neutralized to some extent and battery noises suppressed by mounting the relays side by side. They are connected to the tip and ring of the trunk or subscriber line with the battery winding of one relay and the ground winding of the other relay connected to the same side of the trunk or line.

TABLE V-1

INTERFERENCE EFFECT ON THE
AF, AG, AND AJ RELAYS

Effect on Operate or Nonoperate of AF, AG, and AJ Relays

Operate or Nonoperate NI Without Interference	50	120	170
AF Interfering Relays (600 NI)			
1, 2, 3, 4, 6, 7, 8, 9	4.4%	4.0%	3.3%
2, 4, 6, 8	2.0%	1.8%	1.0%
U Interfering Relays (600 NI)			
1, 2, 3	-1.7%	-1.6%	-1.5%
2	-1.5%	-1.1%	-1.0%

Effect on Hold or Release of AF and AJ Relays

Hold or Release NI Without Interference	16	57	90
AF Interfering Relays			
1, 2, 3, 4, 6, 7, 8, 9 (300 NI)	4.4%	2.5%	2.5%
1, 2, 3, 4, 6, 7, 8, 9 (600 NI)	6.3%	5.1%	4.1%
U Interfering Relays			
1, 2, 3 (300 NI)	-3.7%	-1.8%	-1.8%
1, 2, 3 (600 NI)	-5.0%	-2.0%	-2.0%
2 (300 NI)	-1.9%	-1.1%	-1.0%
2 (600 NI)	-2.5%	-1.6%	-1.3%

A negative sign indicates an aiding effect.

Test Pattern

1	2	3
4	5	6
7	8	9

Relay No. 5 under test.

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