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C RURAL WIRE

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C Rural Wire is the Bell System code name for a one pair wire facility consisting of two parallel conductors insulated with polyethylene and intended for aerial use in rural areas.

C Rural Wire, together with tools, hardware, attachments and requisite handling instructions, was made available to the Bell System in the summer of 1956 (six months ago). Since that time, only about 10 million linear feet of this wire have been used. Field experience in placing this new facility is, therefore, quite limited. Maintenance experience is non-existent.

C Rural Wire is intended principally for aerial distribution plant in rural exchange areas and was produced for use in locations where one or two pairs of open wire on brackets would otherwise be used. Data from trial installations indicate that, although material costs are slightly higher they are largely offset by lower construction costs, and as a result the cost-in-place of this wire is essentially the same as that of an open wire pair. When C Rural Wire is installed in coastal areas, it offers greatly improved insulation resistance and resistance to corrosion. When used in wooded areas, the amount of tree trimming required will be greatly reduced as compared with that required for open wire.

The wire has physical characteristics such that it can be used in spans of 350, 450 and 600 feet in heavy, medium, and light storm loading areas respectively, as recommended for standard 109H Steel Line Wire. Its electrical characteristics are such that, where carrier transmission is not anticipated, it can generally be used in exchange plant as though it were 19 gauge exchange cable or open wire. A more detailed description of the wire and its important characteristics are as follows:

CONSTRUCTION: This wire consists of two parallel No. 14 AWG (.064") 30% conductivity, extra high strength copper-steel conductors insulated with polyethylene. The polyethylene is an insulating grade compounded for outdoor use, of high molecular weight and with about 2-1/2% carbon black. The finished wire is flat-oval shaped with semi-circular edges and opposite flat parallel faces as illustrated in Fig. 1. A single ridge is molded in the insulation on one edge to provide conductor identification. The dimensions of the flat oval are approximately 0.15" x 0.28" on the minor and major axes respectively. The

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separation between conductor centers is approximately 0.140". The thickness of insulation is 0.035" minimum.

BREAKING STRENGTH: 1,100 pounds (550 pounds per conductor).

WEIGHT: 35 pounds per 1000 feet.

PACKING: The wire is furnished on reels containing 17,000 feet.

ELECTRICAL CHARACTERISTICS:

Conductor Resistance - 17 ohms per 1000 circuit feet at 68° F.

Spark Test - Tested at 7,100 volts, (rms).

Insulation Resistance - minimum 5000 megohms - 1000 feet, wet, to ground.

Mutual Capacitance - 0.025 uf per 1000 feet, wet.

Attenuation - 0.30 db per 1000 circuit feet at 1000 cps, wet.

Breakdown - 20,000 volts rms, conductor to conductor or to ground.

From a transmission standpoint, at voice frequency, C Rural Wire is comparable to B Rural Wire or when dry to 19 gauge exchange cable. When wet, C Rural Wire is somewhat inferior to the cable and of course sheathed cable does not change electrical characteristics with the weather whereas both B Rural and C Rural Wires do change. Where more than one C Rural Wire is on the same pole line the wires should be placed and sagged to maintain at least a 3 inch separation in order to meet crosstalk objectives. Preliminary data at higher frequencies indicate that because of high attenuation, particularly when wet, and because of its large change in attenuation from dry to wet, C Rural Wire will not be an economic base facility for carrier service. It may, however, be used as links in carrier circuits (in limited lengths up to about 2,000 feet) for special construction purposes such as tree clearance and the like. The primary and secondary constants, over a frequency range up to 200 kc, for C Rural Wire dry and immersed are shown in the following Table 1.

Although the immersed condition is not usually encountered in service installations it is a handy state for measuring and is readily reproducible. There is some evidence that when the wire is suspended in the air, as in service, a greater attenuation can be expected during rain storms than is shown for the wire in the immersed condition. This difference is not significant at voice frequencies but may be appreciable at carrier frequencies. For example, at 100 kc the attenuation for the immersed condition is 5.8 db per mile, but when suspended in air during a rain storm some measurements were made which indicate an attenuation of 8.8 db per mile. If the various exposure conditions are studied a possible explanation for this becomes apparent. The dry structure has the lowest capacitance and conductance because the ground is remote and the dielectric in the ground path consists of polyethylene and air. When a thin film of water surrounds the suspended wire, a relatively poor dielectric (high power factor and dielectric constant) is introduced in the path to ground.

This raises the direct capacitance and conductance to ground and consequently the mutual capacitance and conductance of the structure. When completely immersed the large mass of water represents a relatively lower conductance and much higher capacitance in the ground path compared with the thin water film on the suspended structure. This results in a lower mutual conductance and higher capacitance than obtained with the film of water.

Wire of this type of construction, where there is no appreciable adhesion between the insulation and the conductor, requires attachments different from the usual compression clamp. There are available for use with C Rural Wire two types of supports: namely, the Deadend Support and the Rural Wire Support. Both are preformed wire types made of corrosion resistant steel (430 alloy) and coated with neoprene. These supports are illustrated in Fig. 2.

One type of tool consisting of a steel blade clamped in a two piece aluminum body, with a guide and thumb screw has been used to slit the insulation as C Rural Wire when bridging, terminating, or splicing this wire. This tool is illustrated in Fig. 3. Other types of tools are also available.

The ease with which this wire can be installed cannot be appreciated unless it has been observed. In the trial installations, the linemen were quite enthusiastic about it. When placed from a moving reel, the wire may be lifted with a wire raising tool and laid over a drive hook. When placed from a stationary reel it may be payed out over drive hooks.

When C Rural Wire is being placed on jointly used poles, or in locations where contact with power wires is possible, precautions such as apply for handling open wire, are taken. Objectionable induced voltages during stringing operations may be encountered and it is recommended that the conductors be grounded because grounding will reduce these voltages substantially.

The polyethylene insulation on C Rural Wire has relatively low crushing strength and precautions are, therefore, necessary when placing the wire. Vehicular traffic should not be allowed to pass over the wire. The wire must not be tensioned around corners over drive hooks or other small radius supports. Where downward grade changes exceed 10 percent or at corners where the wire pulls against the hook, the wire is supported in snatch blocks during the placing and tensioning operations. C Rural Wire will resist light abrasion from tree branches and the like, but it is recommended that if the wire must be placed where it will come in contact with tree branches larger than 3/4 inch, tree guards be used. At corners where the wire pulls against the pole, a length of polyethylene cable guard is placed over the wires.

After the wire has been pulled up to proper sag, it is supported at in-line poles, or at wide angle corners by the Rural Wire Support. At sharp corners, double dead ending with the Deadend Support is required, but the C Rural Wire is not necessarily cut at these points because it can be looped through without difficulty. Details concerning the use of these attachments are shown in Figures 4, 5, 6, and 7. Before these attachments are secured, it is necessary to introduce at least ten complete twists into the wire in each span in order to reduce noise from power line induction and to reduce dancing of the wire in high winds. These twists can be placed in two spans at the same time by lifting the line support attachment at the intermediate pole and rotating the wire and support ten complete turns before replacing it on the drive hook. Dead ending with the proper support, and terminating in an ordinary wire terminal are done in a conventional manner. From the station protection standpoint C Rural Wire is classed as open wire and it therefore requires a fuse-type station protector. The need for lightning protection at junctions of C Rural Wire and cable depends on the degree of exposure. If the wire run is 1/2 mile or more, protectors will be required at the junction of the wire and cable.

As previously stated, C Rural Wire may be used in long spans of up to 600 ft. When the wire is to be placed on existing pole lines of such long spans, its extra high strength is an advantage. It should be recognized, however, that for new construction the longest span is not necessarily the most desirable or economical. Such factors as pole height, ground clearance, stringing tensions, fatigue endurance, strain at maximum storm load, sag at maximum load and recovery after storm condition can all be calculated. They must then be additionally evaluated with respect to each other to effect an economic compromise.

In spans up to 250 ft. in all loading areas and up to 350 ft. in medium and light loading areas, the stringing tensions are kept under 200 pounds at 60°F. At 0°F when the vibration effect of winds is apt to be most severe the resulting stress is not over 35,000 psi and fatigue failure is therefore not expected to be a serious factor. The storm load under these span conditions is calculated to be 65% of the wire strength in the heavy loading area and down as low as 35% in the light loading area. It is not expected that retensioning will be necessary to re-establish clearances even after severe storms.

For longer spans increased stringing tensions are necessary in order to avoid excessive sag. Under the worst conditions stringing tensions up to 300 pounds are used. The resulting stress in the wire at 0°F is 56,000 psi (about 30% of ultimate tensile strength) but it is considered acceptable from the fatigue endurance standpoint because of the damping effect which the insulation and the twists placed in the wire have on wind induced vibration. The maximum storm loaded tensions calculated for long span conditions are as high as 80% of the minimum breaking strength of the wire. Resagging and cutting out slack after maximum storm loading will probably be necessary in some cases in order to restore proper tensions and clearances. When retensioning it is important that the twists in the wire be retained for noise reduction reasons.

Attached:
Table I
Figures 1, 2, 3, 4, 5, 6, & 7

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TABLE I

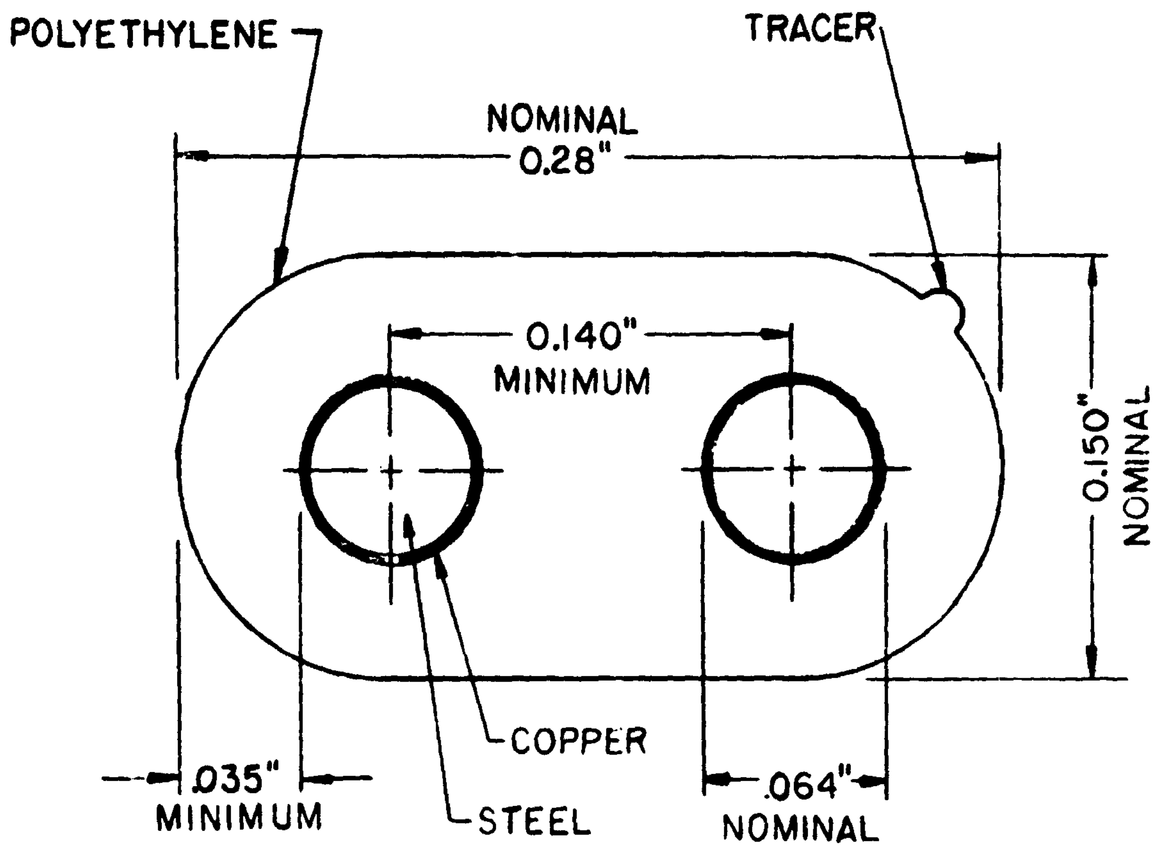
ELECTRICAL CHARACTERISTICS OF C RURAL WIRE
(Smooth Curve Values 75° F.)

PRIMARY CONSTANTS PER LOOP-MILE

FREQ. KC	DRY R (ohms)	DRY L (mh)	DRY C (uf)	DRY G (u mhos)	IMMERSED R (ohms)	IMMERSED L (mh)	IMMERSED C (uf)	IMMERSED G (u mhos)
1	88.70	1.320	.0677	.34	No Change	Dry to Wet	.1315	0.44
2	90.80	1.270	.0676	.61			.1314	1.05
5	94.00	1.182	.0676	1.35			.1314	2.61
10	98.22	1.080	.0676	2.35			.1314	5.59
20	102.00	1.015	.0676	5.20			.1313	11.35
50	110.00	0.969	.0676	13.80			.1312	29.00
75	114.00	0.955	.0676	21.50			.1311	45.00
100	114.92	0.949	.0676	28.69			.1311	63.40
150	117.86	0.948	.0676	44.60			.1310	96.15
200	120.61	0.947	.0676	63.12			.1309	137.03

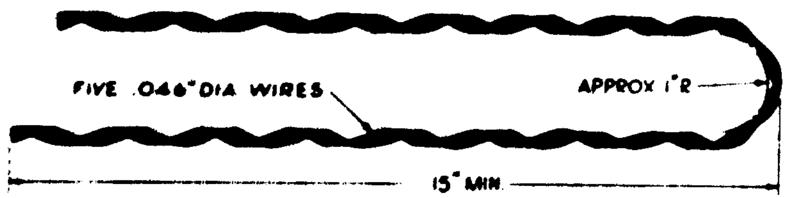
SECONDARY CONSTANTS PER LOOP-MILE

FREQ. KC	DRY Z_0	DRY a (db/mi)	DRY B (rad/mi)	DRY λ (miles)	DRY V (mi/sec)	IMMERSED Z_0	IMMERSED a (db/mi)	IMMERSED B (rad/mi)	IMMERSED λ (miles)	IMMERSED V (mi/sec)
1	332-j313	1.14	0.14	43.70	43,700	238-j225	1.58	0.20	31.40	31,400
2	249-j208	1.61	0.21	29.00	58,000	179-j150	2.16	0.30	21.14	42,228
5	179-j123	2.33	0.37	16.00	81,000	129-j88	3.18	0.53	11.73	58,650
10	148-j77	2.87	0.63	9.94	99,410	107-j55	3.97	0.88	7.09	70,900
20	130-j45	3.29	1.10	5.30	111,000	93-j33	4.74	1.55	4.05	81,080
50	121-j21	3.95	2.40	2.40	121,500	88-j15	5.40	3.50	1.70	87,000
75	119-j14	4.10	3.70	1.60	123,000	86-j10	5.70	5.20	1.20	88,000
100	119-j11	4.20	5.06	1.24	124,100	85-j8	5.85	7.04	0.89	89,100
150	118-j7	4.35	7.57	0.83	124,455	85-j5	6.02	10.52	0.59	89,400
200	118-j6	4.45	10.07	0.62	124,660	85-j4	6.17	14.00	0.45	89,600

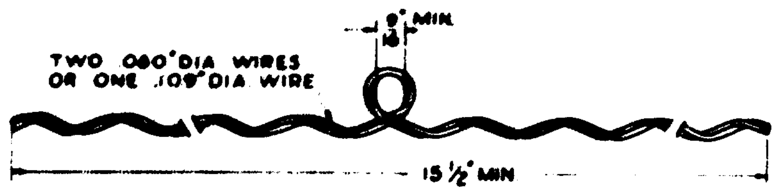


CROSS SECTION OF "C" RURAL WIRE

FIG. 1

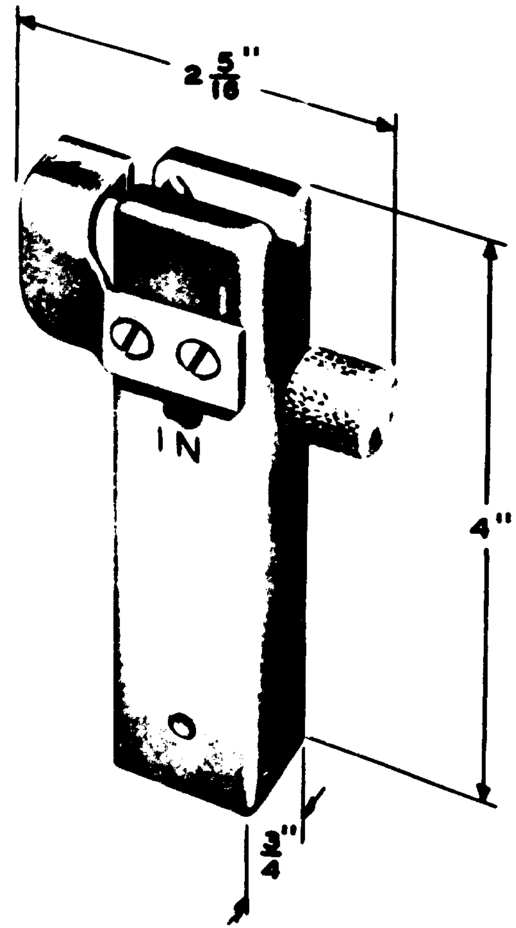


DEADEND SUPPORT



RURAL WIRE SUPPORT

Figure 2: These neoprene coated corrosion resistant steel wire supports are for use in supporting C Rural Wire. The deadend support is used where a deadend attachment is required. The rural wire support is used at intermediate poles.



B WIRE SLITTER

Figure 3: This slitter is for making longitudinal cuts in the insulation of parallel types of wire, and for removing insulation from the wire ends after a longitudinal cut is made.

IN LINE POLE OR PULL AWAY FROM POLE OF 10 FEET OR LESS.

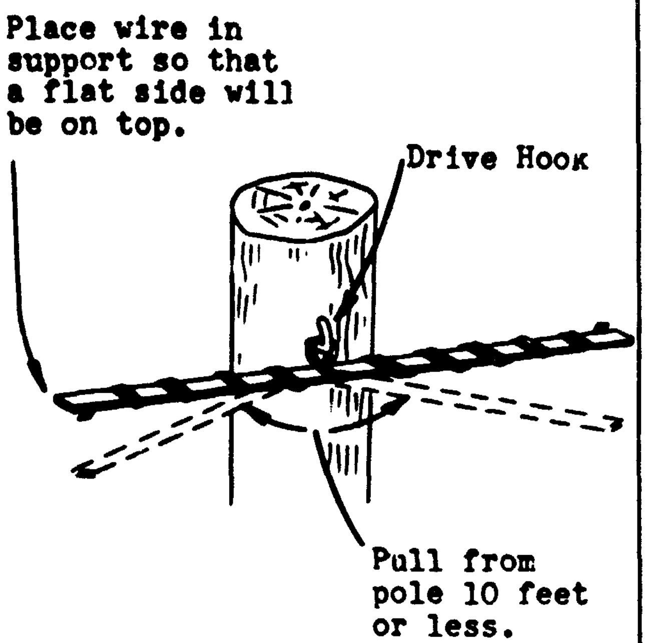


Fig. 4

OUTSIDE CORNER OF A 10-FOOT PULL OR LESS.

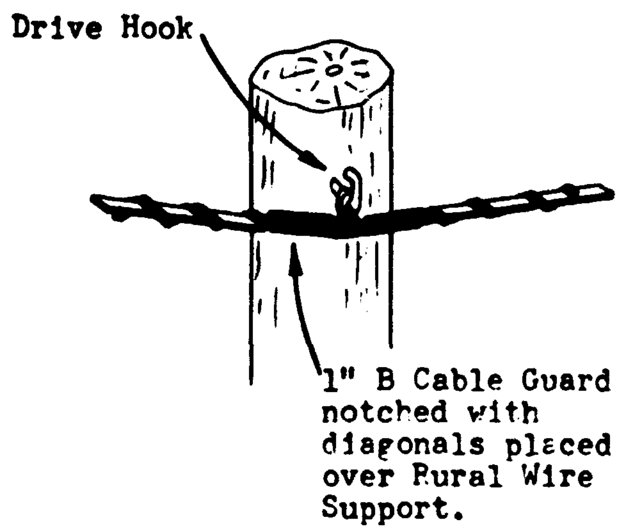


Fig. 5

INSIDE CORNER OF MORE THAN A 10-FOOT PULL.

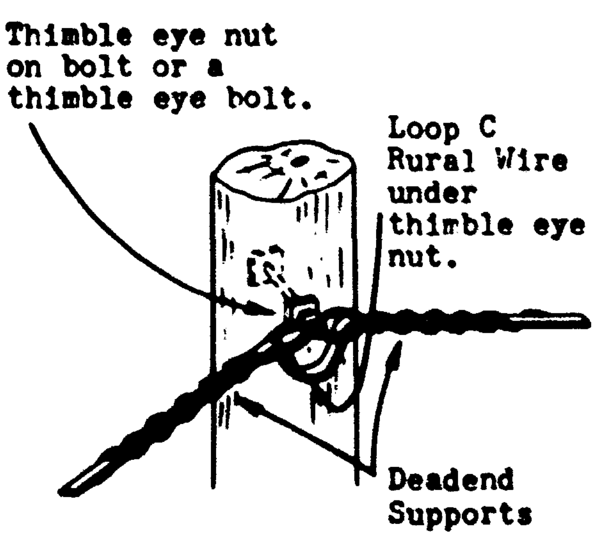


Fig. 6

WIRE DEAD-ENDED WITH GUY.

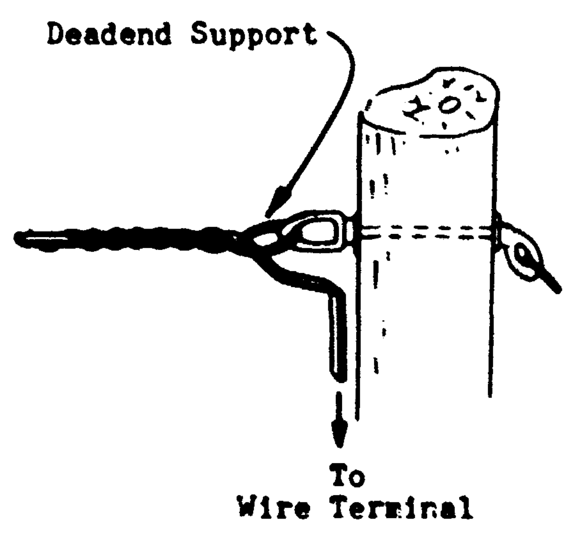


Fig. 7