CHAPTER XI

ECONOMICS

Introduction

This section deals with the economics of relay design for specific applications in switching systems. The subject is quite involved, with many of the factors obscure and difficult to price without some broad assumptions. It is assumed that the relay structure has been standardized and consequently this section deals in changes in variable relay design details only. No attempt will be made herein to include all of the steps and assumptions that were made in arriving at cost factors, but the conclusions reached will be used as the basis for establishing the cost figures and economic design data shown in this section. The problems will be discussed in general terms.

The subject may be broadly divided into the following parts:

A. When to Code a New Relay
B. Economic Selection of Coils
C. Cost of Power
D. Economics of Standardization

Part A provides the necessary data to determine whether to code a new relay or to use an existing relay for a specific circuit application. Parts B, C, and D provide a brief background of the problems involved.

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A. When To Code a New Relay

For each relay structure there is a winding depth that results in the lowest overall relay and power cost. For example: a low-turn winding is best for speed applications; a partially full winding is best for local circuit use where the holding time, and consequently the power cost, is low; a full winding is best where sensitivity is paramount; and a full, high-resistance winding would be chosen for long holding times where the power cost would be high.

For all such conditions, it is possible to evaluate each individual design by considering the variable winding costs and the cost of speed and of consumed power in terms of the equivalent relay first cost. The resulting net first-cost value of the relay winding is then the primary figure for comparison with other designs and can be used to estimate whether to create a new code or to use one of the existing designs.

In selecting a relay for a circuit condition where a relay exactly meeting the conditions is not available, two courses of action are open: Plan A (no new code) or Plan B (new code).

Plan A would use an existing relay that most nearly meets the circuit requirements. It would have the cost advantage of existing production but the disadvantage of too many contacts, or higher power drain, or too slow action, etc. Each of these extra items can be evaluated.

Plan B would have a new code, which, though it might have the possible disadvantage of an additional code with relatively low production, would satisfy the circuit conditions and thus have no performance penalties. The effect of a low demand is felt in two ways: the new code is more costly to manufacture, due to the low demand and the relays of the code that might be used with Plan A are more costly to manufacture because their demand was not increased. Both of these costs must be charged against the new code. These effects have been evaluated and are shown as the cost penalty in Fig. XI-1.

The cost figures to be used in determining the cost of extra features on a relay for the purpose of deciding whether or not to code a new relay are:

Additional combination	17.6¢
Extra spring pairs	2.2¢
Buffer spring	3.9¢
Extra features associated with long life	12.5¢
Extra adjustments	
Nonoperate	0.9¢
Release or hold (no buffer spring)	0.9¢
Hold (with buffer spring)	4.4¢
Release (with buffer spring)	4.4¢
Soak	0.4¢
Intermediate armature travel	0.7¢
Long armature travel	1.6¢
Max 60-gram back tension*	1.5¢
Sleeves	
0.046-in. Aluminum	5.6¢
0.046-in. Copper	9.1¢
0.091-in. Copper	11.5¢
0.147-in. Copper	18.1¢
Laminations	5.2¢
Long armature (AG and AJ relays)	2.0¢
Coil comparison costs	
Wire cost	Fig. XI-2
Winding on turns	Fig. XI-3
Additional winding connections	9.2¢
Pri A & pri B	9.2¢
Power per KWH (C_p)	40.0¢ (Fig. XI-4B)
Cost per millisecond of marker holding time	$38.50 (Fig. XI-5)

$$KWH = \frac{E^2 t}{1000\ R}$$ where t = hours per year that the relay is energized.

*This applies to all 4.4-, 16-, 270-, 395-, 400-, and 700-ohm coils.

If the costs of the extra features exceed the amount determined from Fig. XI-1, a new code should be used instead of the existing code.

The following examples show the method of determining whether or not to code a relay.

Example 1

Required: a local circuit relay with 3M and 3B springs with a holding time of 360 seconds per busy hour. Demand 50 per 10,000 lines. No speed requirements. With 3000 busy hours per year, the yearly holding time is

$$3000 \times \frac{360}{3600} = 300 \text{ hours per year.}$$

Available relay - 700ω - 5050 turns 39E
Springs 4M, 3B - total 7
Short travel
700ω coil has max 60-gram armature back tension

New design - 2500ω - 19400 turns 38E
Springs - 3M, 3B - total 6
Short travel

Costs - available relay		
700ω 39E -	2.9¢	
5050 turns, short coil	3.0¢	
One extra spring	2.2¢	
60-gram back tension	1.5¢	
Total relay cost	9.6¢	

$$\text{Power cost} = \frac{E^2t}{1000R} C_p$$

$$= \frac{48^2 x300}{1000x700} \times 0.40 = 39.5¢$$

Total power + relay cost	49.1¢	49.1¢
Costs - new design		
2500ω 38E	14.0¢	
19400 turns, long coil	6.1¢	
Total relay cost	20.1¢	

Power cost

$$\frac{48^2 x300}{1000x2500} \times 0.40 = 11.0¢$$

Total power + relay cost	31.1¢	31.1¢
Cost difference		18.0¢

From Fig. XI-1, a demand of 50 per 10,000 lines shows a cost penalty of 8.3 cents; therefore, a new code is justified since the existing relay will cost 18.0 cents more than the new relay and only 8.3 cents can be justified before coding a new relay.

Example 2

Required: a local circuit relay with 4M, 3EBM, and 1EM springs with a holding time of 100 seconds per busy hour. Demand 100 per 10,000 lines. No speed requirements.

The yearly holding time is

$$3000 \times \frac{100}{3600} = 83 \text{ hours.}$$

Available relay - 950ω - 11850 turns 36E
Springs - 5M, 3EBM, 1EMB - total 13

New design - 2500ω - 19400 turns 38E
Springs - 4M, 3EBM, 1EM - total 11

Costs - available relay		
950ω 36E	10.2¢	
11850 turns, long coil	4.3¢	
2 extra springs	4.4¢	
Total relay cost	18.9¢	

$$\text{Power cost} - \frac{E^2t}{1000R} \times C_p$$

$$= \frac{48^2 x83}{1000x950} \times 0.40 = 8.0¢$$

Total power + relay cost	26.9¢	26.9¢
Costs - new design		
2500ω 38E	14.0¢	
19400 turns, long coil	6.1¢	
Total relay cost	20.1¢	

Power cost

$$\frac{48^2 x83}{1000x2500} \times 0.40 = 3.1¢$$

Total power + relay cost	23.2¢	23.2¢
Cost difference		3.7¢

From Fig. XI-1, a demand of 100 per 10,000 lines shows a cost penalty of 4.6 cents. A new code is not justified since the existing relay costs only 3.7 cents more than a new code and 4.6 cents can be spent before a new code is justified. The same procedure as shown in the two examples can be used to find the cheaper of two existing relays.

B. Economic Selection of Coils

Basically, the selection of a relay for any specific circuit application involves the following steps:

1. Establish the work requirements imposed by the desired contact functions (spring combination load).
2. Choose a favorable magnet structure that is capable of delivering the necessary amount or kind of work (select type of relay, ie, AF, AG, or AJ relay).

3. Select a coil to match the characteristics of the previous page to the desired circuit application, taking account of voltage, speed, heating, economy, and other special problems.

In service, relay operation must be assured even when the battery is minimum, the resistance is maximum, and all other possible conditions are adverse; thus it is necessary to build the relay so that it will function on a current considerably less than that obtained with average circuit constants. The usual variations requiring consideration, assuming local circuit operation of the relay but neglecting any resistance rise due to heat dissipation in the relay winding, are:

Office battery	±5%
Coil resistance	±10%
Resistance rise due to change from rated value at 68° F to that at ambient 100° F.	+7%
Deterioration from test operate to worst circuit	+5%
Deterioration from the readjust operate to the test	+5%

For the relay to operate under all adverse conditions, it must be capable of operating on 72 percent of the current that may pass through its circuit on nominal conditions.

When comparing various coil designs, certain common operations such as soldering the leads on the primary winding, attaching spoolheads, dipping, etc, are common to all coils; consequently, only the difference due to the varying amount of copper, which is paid for by the pound (or for any particular size by the ohm), the cost of sleeves or laminations, the cost of additional winding terminals, the cost of winding on the turns, etc, must be considered. The cost per ohm and the cost of winding the turns for the various wire gauges are shown in Fig. XI-2 and XI-3. To find the variable portion of the cost of any coil, it is only necessary to find the cost of the wire and the cost of winding on the turns (using the proper curve of Fig. XI-3 for the coil being considered) and add a factor for any extras such as sleeves and extra windings. The costs of these additional factors have been shown in the paragraphs on When to Code a New Relay. For any particular resistance, it is obvious that the cheapest coil results when the finest size wire that will provide the desired resistance and required minimum number of turns is used. For any given resistance, each change of one wire gauge changes the variable part of the coil cost between 20 and 30 percent.

The most common use of relays is in circuits where they are required simply to operate their contact load and then remain operated, consuming power for a specific holding time. In such cases, the actual cost is made up of two factors: the first cost of the coil, and the cost of the power consumed. The first cost of the coil decreases as the coil resistance decreases, but the power cost increases. There is an optimum point where the sum of the two costs is the lowest, and that is the point to strive for, other considerations permitting. Factors affecting the cost of power will be discussed later in this section.

There will be many cases in practice where the optimum resistance for sensitivity and power will not be used for such reasons as standardization of coil resistances, need for speed, or insufficient winding space. The cost penalty for deviations from the optimum may be found by comparing the costs for the coil used and the optimum resistance coil.

Fig. XI-6 shows the cost of power for the commonly used single-wound coils with different holding times and also the combined cost of power plus the coil cost for wire spring relays. From this figure, the cheapest coil for any holding time can easily be determined. For example, the 700-ohm coil is cheaper than the 2500-ohm coil up to 200 seconds holding time per busy hour, and cheaper than the 950-ohm coil up to 350 seconds per busy hour. The most economical coil use, ignoring all other circuit considerations, would be the use of the 700-ohm coil up to 200 seconds per busy hour holding time and the 2500-ohm coil above this value. Circuit operating conditions and the economics of coding a new relay where a relay with the best coil is not available can sometimes make the use of the most economical coil undesirable from an overall cost standpoint.

The speed of operation of a relay is a function of the power applied to the relay, the circuit resistance, and the relay inductance. For the fastest operation, there is an optimum number of turns for each value of coil resistance. The speed may be increased by increasing the power supplied to the relay, but, where faster action is obtained at the expense of more power consumption, there evidently must be some point for which the cost of power and the worth of the speed are economically optimum.

The worth of a saving in operating time is greatest in a common control circuit where the holding time of the circuit per call is very short and the cost of the circuit is high. The marker of crossbar systems is an outstanding example of such a circuit. The value of time saved is important only insofar as it saves marker holding time.

The value of a millisecond of marker holding time is not a simple figure to obtain. The fractional part of a marker that must be provided per line per millisecond of work time is almost directly proportional to the holding time of the marker. The value of a millisecond of marker work time will therefore vary with the holding time as well as the cost of the marker. The shorter the marker holding time, the more valuable a millisecond becomes since it becomes a greater percentage of the total time. Assuming a $17,000.00 marker with a holding time of 300 msec, the value of a millisecond of marker time is equivalent to a relay first cost of $38.50. With a holding time of 500 msec, the value drops to $24.00. Fig. XI-5 shows how the value of a millisecond of marker holding time varies with marker work time and cost.

C. Cost of Power

For every relay in the telephone switching system, one must allocate a small portion of the cost of the power plant and the building to house it. These, together with the cost of power purchased from the power companies, represent concrete costs which it may be possible to minimize by suitable design of the relay to consume less power.

The problem of power cost must be considered in two parts:

1. For a major systems development involving new apparatus where the design of the relay may exert a large influence on the size of the power plant required.

2. Where only a small change in the amount of power consumed is involved.

Equivalent First Cost of Power Plant

The price of a power plant will vary in two ways as shown in Fig. XI-7:

1. In fairly large steps as the basic plant size is changed.

2. In a fairly uniform manner as any particular basic plant size varies within its lower and upper limits.

If a major systems development permits a reduction in power consumption, such that the size of the plant can be reduced to the next lower basic size, an appreciable saving may be realized, whereas if the plant must stay within the same basic size, the savings are materially reduced.

If it is assumed that by the magnet design a given fraction (P) of the power may be saved, then for any particular range of power, a power plant operating near the top of its range will save a larger quantity of plant capacity than one operating near the bottom of its range. On the other hand, the one operating near the bottom of its range may be converted into the next cheaper range, thus realizing a base-price saving. The net-price saving per kilowatt of power saved has been found by determining the dollar value of the plant saved and dividing by the total amount of power saved. This saving was then averaged for all plants in the range. The results for each range were then weighted on the assumption that telephone power-plant sizes were uniformly distributed between 30 and 200 kilowatts. Fig. XI-4A shows a plot of the results for different percentages of power saved. Studies show that the power plant price-saving per kilowatt of savable power varies from $1420.00 for small percentages of power saved to a maximum of $1900.00. Even though the precise amount of power to be saved may not be accurately known, the resulting power plant price-savings per kilowatt of power saved will not vary widely from a value somewhere around $1700.00 in most practical cases.

The distribution of power used to operate magnets in a No. 5 crossbar office is approximately as follows:

Use	Percent of Power	
Talking channels, transmission	18	Power largely unaffected by relay design (24 percent)
Speed relays	6	
Nontransmission relays energized during conversation	20	Available for design changes to reduce power costs (76 percent)
Nontransmission hold magnets energized during conversation	29	
Relays	27	

thus, about three-fourths of the power in the office is subject to reduction by relay and switch design.

The annual power may be found from the busy-hour power. The daily load in an office has been broken down as follows:

Hours per Day	Percent of Busy-Hour Load	Total Load Hours
2	100	200
4	78	312
6	65	390
3	27	81
9	2	18
Total 24		1001

Thus, one busy hour accounts for 10 percent of the power drain. Assuming 10 busy hours per day and 300 days per year, the annual power taken by any particular unit will be 3000 times the power consumption in one busy hour.

Cost of Power Per Kilowatt Supplied

The installed power plant price per kilowatt, together with the annual charges, have been translated into equivalent first costs in terms of relay costs for different percentages of power saved and are shown in Fig. XI-4B.

The same figures have also been translated into the equivalent price of power supplied, and this is shown in Fig. XI-4C, also on the basis of the percentage of the power saved.

The cost per kilowatt hour is shown for two conditions: new equipment and additions. The figures for new equipments would apply only when new apparatus developments cause a major change in the size of the power plant installed. For comparisons between the costs of different relay coils, the more realistic approach is to use the figures for additions and consider that the percentage of power saved is practically zero. The equivalent first cost of a kilowatt hour of power in terms of relay first cost is thus $0.40 (Fig. XI-4B). The $0.40 figure results from the fact that the 8.2-cent price per KWH is an annual charge on the initial investment and the cost of ac power supplied. The price of power is an annual charge and should be related to the relay charge which is a first cost. The comparable cost of a KWH of power, therefore, should be an amount which when amortized over a period of years, will result in an annual cost of 5.6 cents $\left(\frac{\text{8.2-cent price}}{1.456}\right)$. This results in the first cost for power of $0.40 per KWH.

D. Economics of Standardization

If enough information were available to the circuit engineer, he should be able to choose a relay for any particular application by considering:

1. The penalties due to standardization, ie, the penalties in performance and cost resulting from having only a certain limited number of available relay combinations as against sufficient combinations for complete flexibility.

2. The penalties due to not standardizing, ie, the penalties in first cost resulting from many variations of a basic type, as compared with a limited number of combinations.

By weighing both the penalties and the advantages of standardization in each case, it should be possible to maintain them in approximate balance and to obtain an economical number of codes. The cost penalties of standardization involve, mainly, factors such as value of speed, power consumption, kinds of contact metal, use of extra springs. The penalties of not standardizing involve extra costs due to a large number of codes and production in small-size lots.

What appear to be major ways in which the number of codes affect relay costs are:

1. Administration effort in maintaining information on each code and

2. Manufacture by more small lots.

Administration Costs

Administration costs for relay codes have been taken to be those costs that are incurred each year on the relay type in question. Such costs result from design activity on the relay type and are almost entirely due to the issuance of change orders, mainly at Bell Laboratories, but also in the Western Electric Company. Some of the change orders are to improve the product, or to effect cost savings so that the administration costs are to some extent self-supporting. There are, of course, some general change orders that affect all relays of a type, and the amount of work involved depends on the number of codes of that type of relay; thus, administration costs would be less if there were fewer codes.

Various forms of expense enter into the full administration costs; those incurred at Bell Laboratories and in Hawthorne Merchandise which are recovered in the pricing markup above the bulletin costs, and those incurred in the Hawthorne E of M organization which would affect the bulletin cost. The objective is to develop cost figures in terms of bulletin costs which then can be compared with similarly developed figures for the worth of power, operate time, windings, contacts, etc. For this reason, it has been concluded that Bell Laboratories and Hawthorne Merchandise figures should not be included in the administration cost figures.

During the early part of 1951, a comprehensive review of coding costs of the U relay was made by the Hawthorne engineers. It was concluded that a cost of $127.00 per-code-per-year would give a fairly accurate picture of the "bulletin cost" administration expense. This study also resulted in a figure of $90.00 as the cost of introducing a new code.

Assuming a code life (not relay life) of fifteen years, the $90.00 cost converts to an annuity value of $10.00, based on 7-percent interest.

It is believed that the wire spring relay, with its unitized components, would require considerably less attention per code than other types of relays. A 25-percent reduction seemed reasonable to the

Western Electric Company engineers. A cost of 75 percent of \$127.00 + \$10.00 annual coding cost, or \$105.00, per-code-per-year has, therefore, been suggested for the administration cost of the wire-spring relay.

Manufacturing Costs as Affected by Lot Size

If only one kind of relay were needed, it could be built continuously in the same way, with no time lost for change-over to other parts, no special bookkeeping necessary to control the proper flow of different parts, and with more automatic and conveyor-type action. This would represent the height of manufacturing economy, but unfortunately this cannot be realized in the current relay programs.

There are three major phases of relay manufacture affecting the lot-size costs, each involving separate treatment; they are:

Assembly of the complete relay

Winding and assembly of the coil

Molding and welding of the spring blocks.

There are many codes of a basic type required to fill circuit needs, and the codes are not built in large quantities but only as ordered on a periodic basis. The periodic ordering is used to maintain a smooth flow of apparatus into the wiring department, where an even load is also assured by planning on a periodic basis. If relays were to be made in large quantities and then stored until they were needed, it would build up a large inventory investment, which is considered uneconomical. It appears that certain codes are made on an average of once in two weeks, while the more active ones are made on a daily or a weekly basis.

There are three methods of assembly for the U relay. Given in descending order of productivity they are progressive conveyor method, assemble complete method, and bench method. The wire spring relay, however, was designed with the specific objective of building complete molded assemblies of the spring blocks and thus greatly simplifying the final relay assembly compared to the U relay assembly. As now planned, only two assembly methods will be used for the wire spring relay: a conveyor assembly line for relays produced at a rate in excess of 12,000 annually, and a bench assembly method for relays produced at annual rates of less than 12,000.

Filled coils may be wound by two processes: by having either one or two winding machines under control of one operator. The loading rates for the two methods will be different since the operator controlling one machine is working on low turn coils and must of necessity spend more time in setting up the machine for different coils.

The choice of which method is to be used is summarized, approximately, by the following rules:

Method A

Two machines, one operator	For single windings only, when the turns >9000.

Method B

One machine, one operator	For all double windings and single windings where the turns are <9000.

The contact spring arrangement for the wire spring relay is different from any of the existing types of relays in that the spring assembly is molded in a block. For any change in molding, it will be necessary to shut down the molding machines for about 6 hours. To reduce the number of machine stoppages, the spring blocks will probably be molded with a full complement of wires and the extra twin wires clipped off in the finishing operation. The single-wire blocks always have a full complement of wires.

It is planned to complete the molded spring blocks in a separate line where the blocks will be fed into a machine and progressively stepped along while the finishing operations are performed. Since these operations will include clipping off the surplus wires and welding contacts, any change in the spring block will require stopping the machine. There will be flexibility within the machine for rapid changes from one condition to another. Some changes, however, may cause machine stops of as much as 45 minutes. This emphasizes the desirability of keeping the number of spring combinations to a minimum in order to minimize machine time loss.

Relation of Cost Penalty to Total Number of Codes

A picture of the cost penalty due to having more than one code averaged over the entire product can be gained if the distribution of demand for each code is known. Such information has been compiled for a particular type of No. 5 crossbar office. The number of codes and the quantity of each code were known, which was easily translated into an annual demand for each code. With the annual demand for each code, the cost penalty was found from a chart similar to Fig. XI-1. All such penalties were added and divided by the number of relays to give the average penalty per relay for the number of codes involved. By a process of combining codes and demands, a series of points were obtained showing how the cost penalty varied with the number of codes.

Figures were obtained in a similar manner for the number of coils used. These penalties were comparatively small, indicating that there is no great disadvantage in a moderate number of coils, except as they may increase the number of codes. Where a new code is required for some circuit condition, a new coil which offers some circuit advantage would not appreciably affect the average relay cost.

Choice of Number of Codes

The previous paragraphs discussed the cost penalty of diversifying the design as compared with the ideal of manufacturing only one design. As more and more codes are introduced, it is possible to estimate the effect on the cost. There is a point at which no more codes would be added, representing the condition where all circuit conditions are ideally satisfied. Any fewer codes cause performance penalties in one form or another, such as extra power drain, extra springs, slower operation, etc. As more and more codes are consolidated into smaller groups of codes, the sum of the cost penalties, averaged over all the relays in the office, will steadily increase. These can be stated in terms of first cost of the apparatus and will be called the performance, or standardization, cost penalty. The total cost penalty of a certain number of codes will be the sum of the coding cost penalty and the performance cost penalty at this point. One cost increases with the number of codes and the other decreases so that a minimum cost may be expected to result corresponding to some most favorable number of codes.

The difference in cost penalty with deviations from the optimum number of codes does not vary greatly. This indicates that the optimum number of codes is not very critical. It appears that the best procedure is to design so as to minimize the number of codes so that as much economy as possible can be realized in times of low output by manufacturing fewer varieties of relays without sacrificing more than a fraction of a cent in periods of large volume production. With this in mind, Fig. XI-1 has been prepared showing the amount that can be spent on an existing code before taking out a new code.

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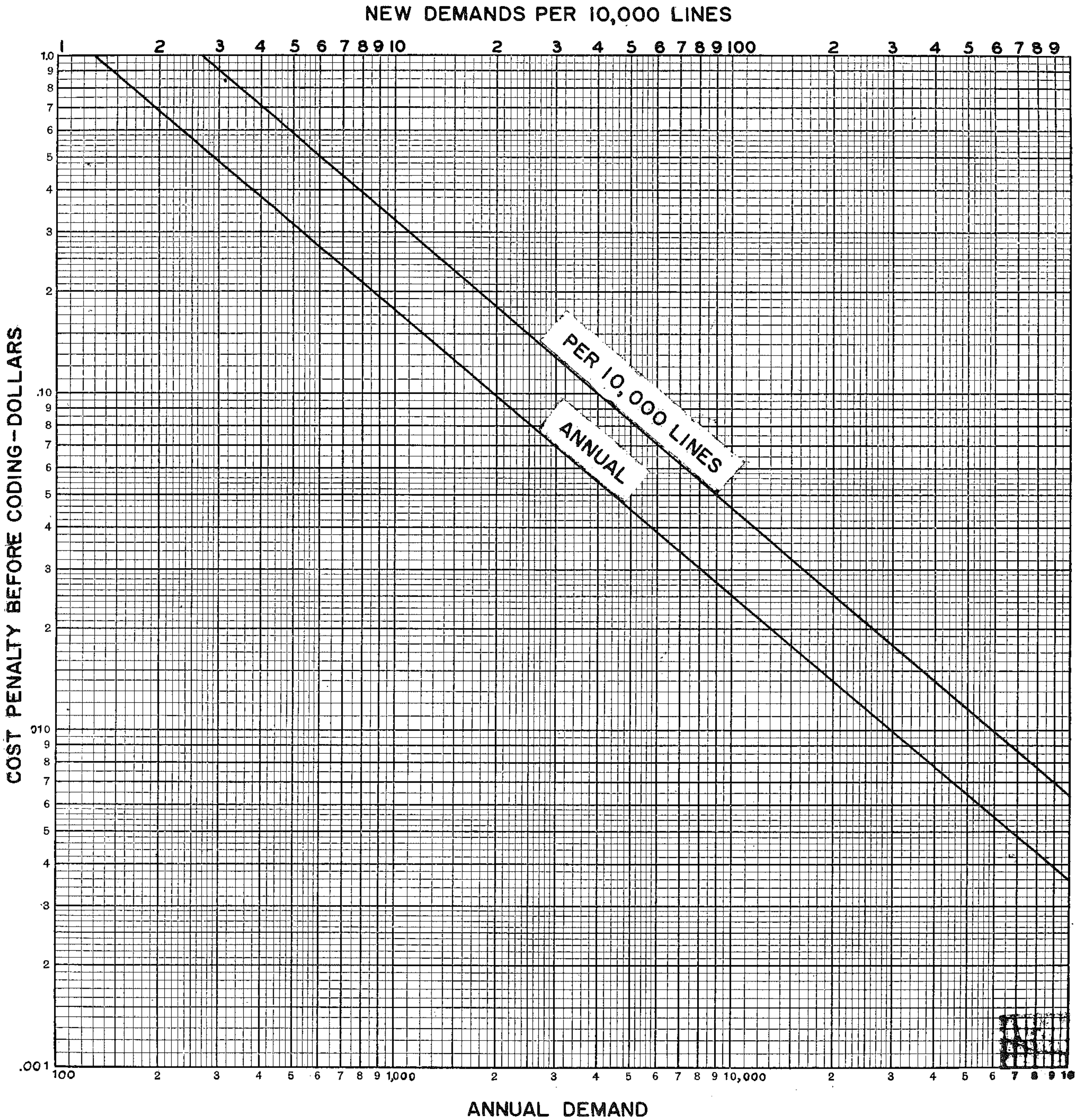

FOR NO. 5 CROSSBAR USE 10,000 LINE DEMAND.
FOR ALL OTHER SYSTEMS USE ANNUAL DEMAND.

Fig. XI-1 - Coding Cost Penalty

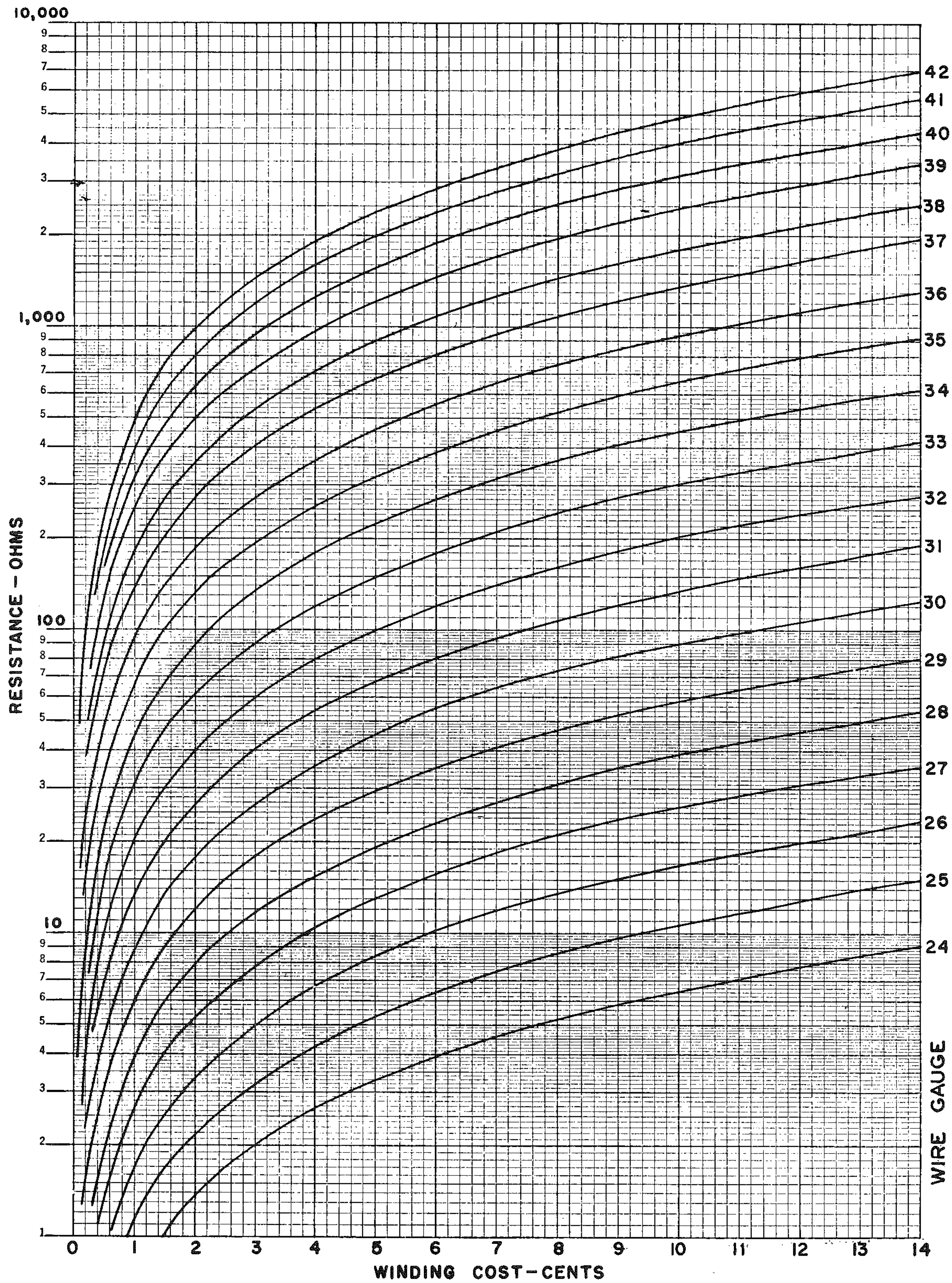

Fig. XI-2 - Wire Cost

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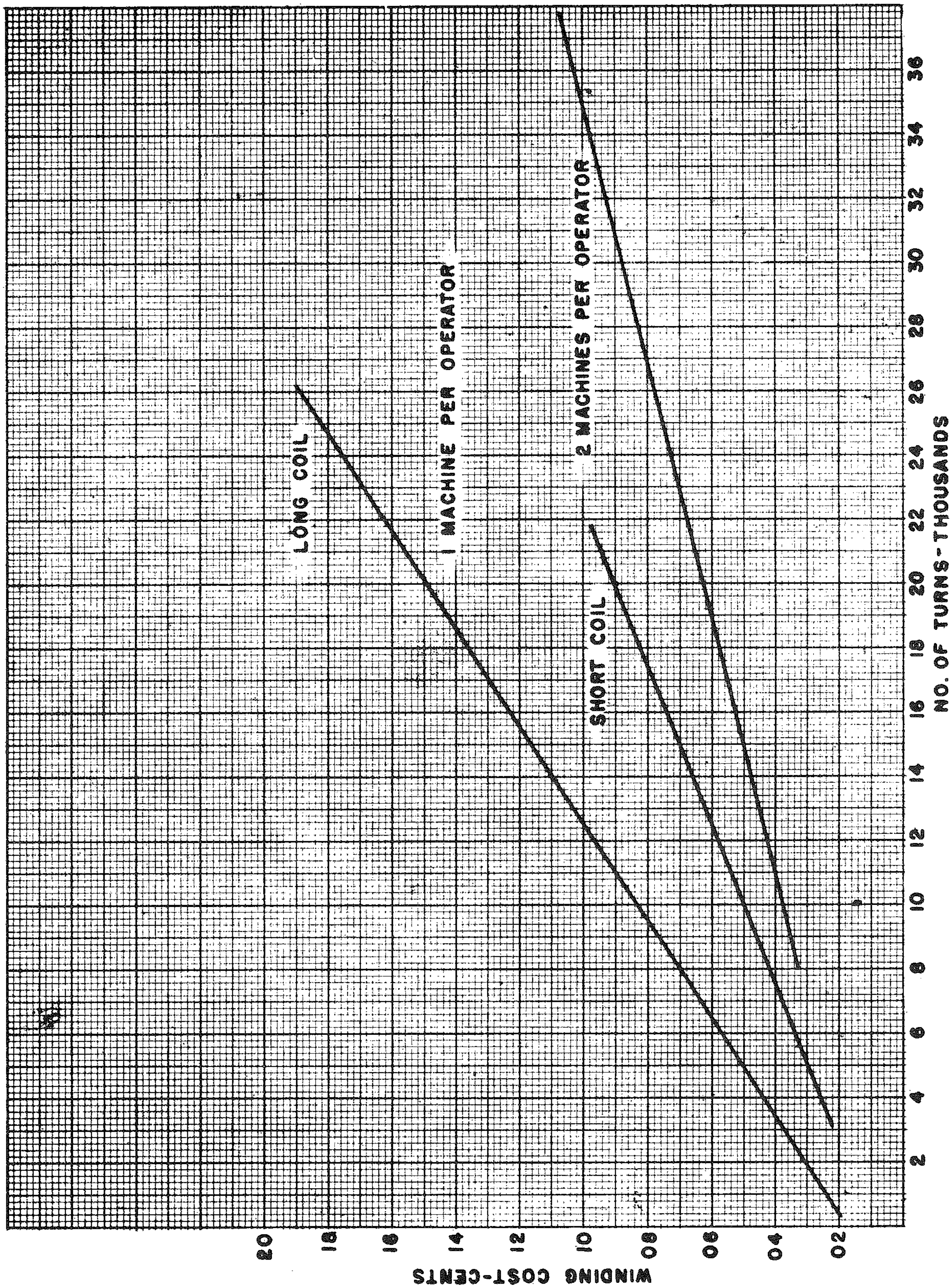

Fig. XI-3 - Coil Winding Cost

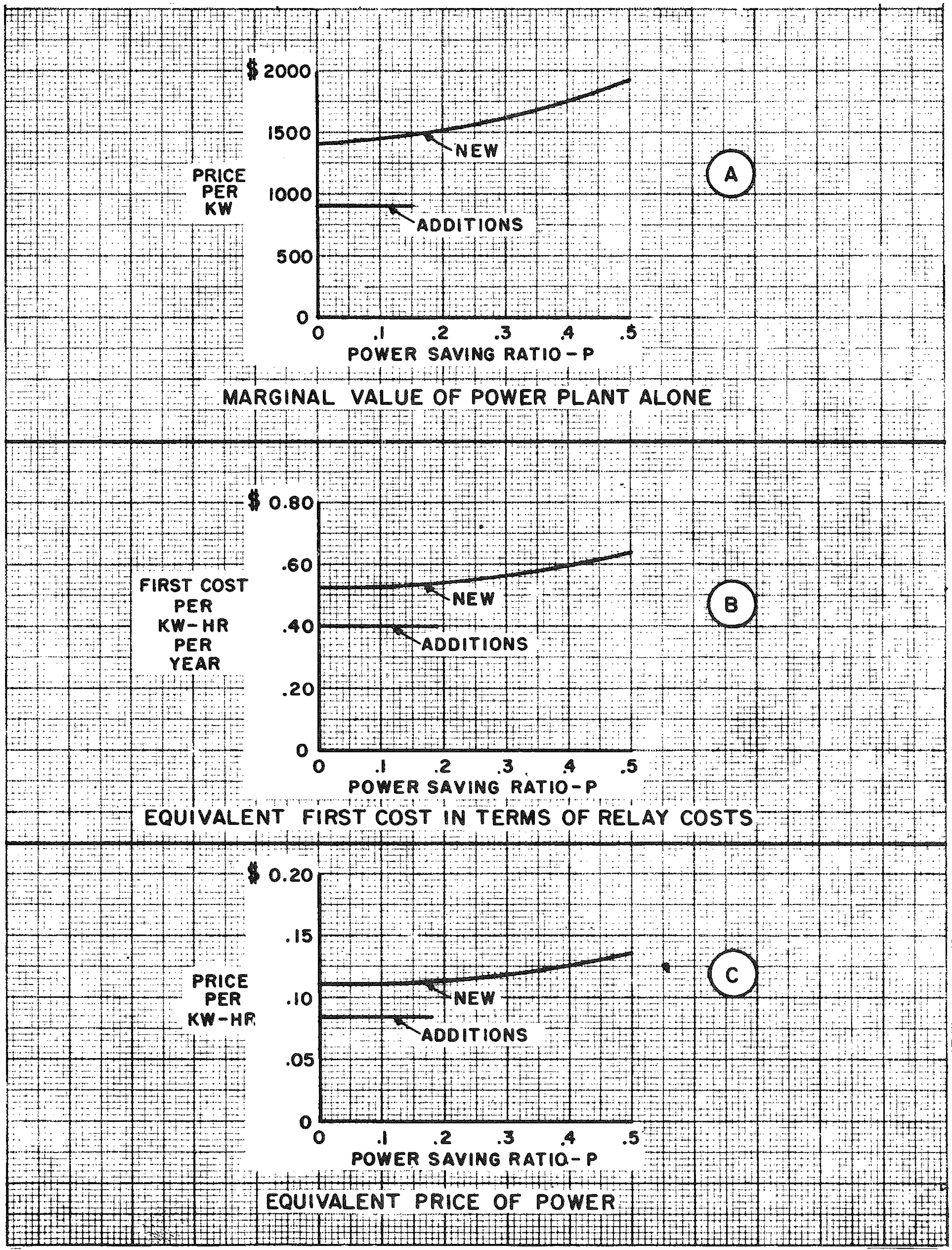

Fig. XI-4 - Power Cost

WORK TIME IN SECS.	MKRS. PER LINE	$25000 MARKER PRICE			$17000 MARKER PRICE			$10000 MARKER PRICE		
		PER LINE (MKR. COST)	PER LINE PER M.S.	PER MKR. PER M.S.	PER LINE (MKR. COST)	PER LINE PER M.S.	PER MKR. PER M.S.	PER LINE (MKR. COST)	PER LINE PER M.S.	PER MKR. PER M.S.
0.5	.001	$25.0	$.050	$50.0	$17.0	$.034	$34.0	$10.0	$.020	$20.0
0.4	.0008	20.0	.050	62.5	13.6	.034	42.5	8.0	.020	25.0
0.3	.0006	15.0	.050	83.3	10.2	.034	56.7	6.0	.020	33.4
0.2	.0004	10.0	.050	125.0	6.8	.034	85.0	4.0	.020	50.0
0.1	.0002	5.0	.050	250.0	3.4	.034	170.0	2.0	.020	100.0

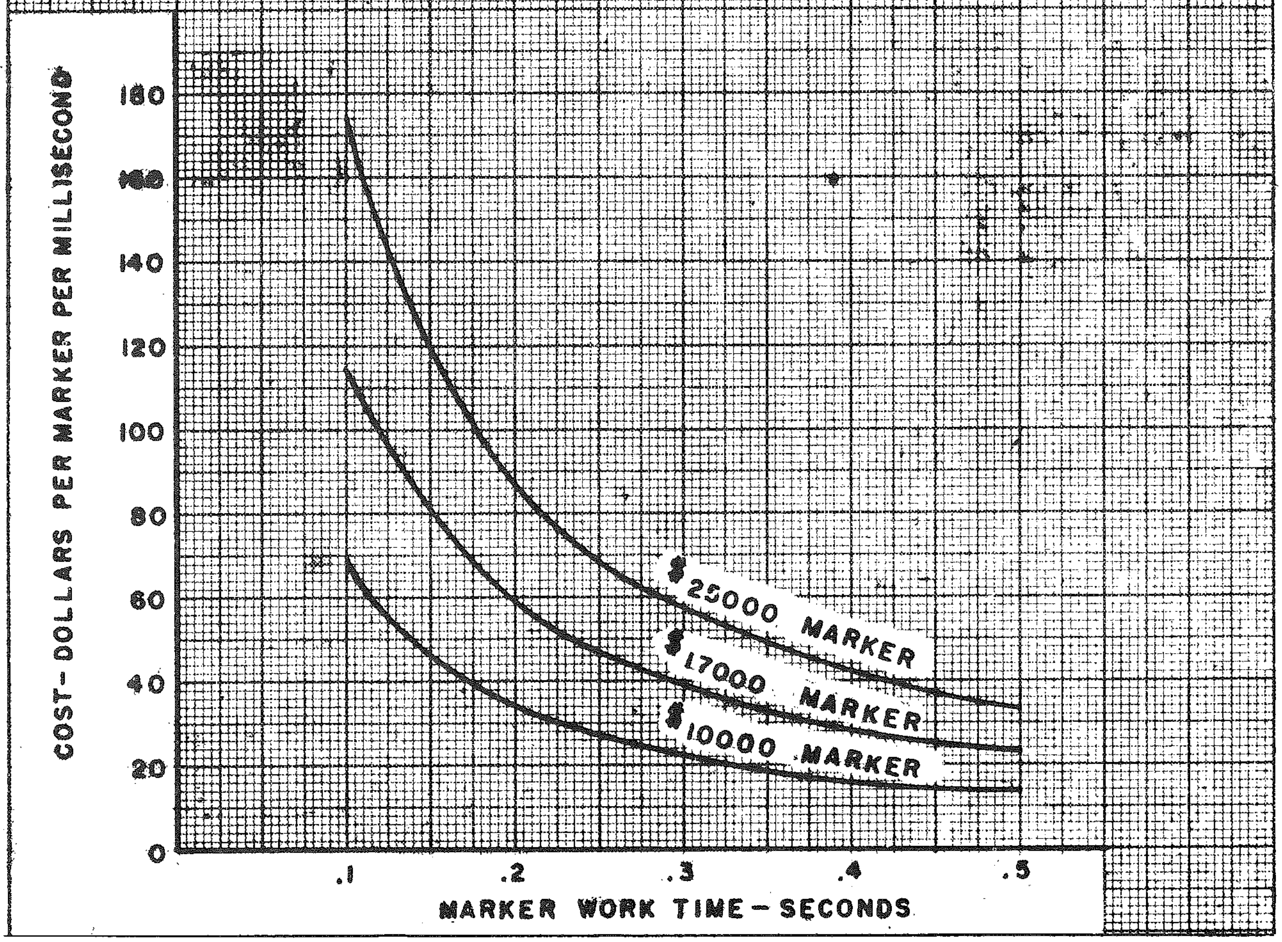

Fig. XI-5 - Cost of Marker Holding Time

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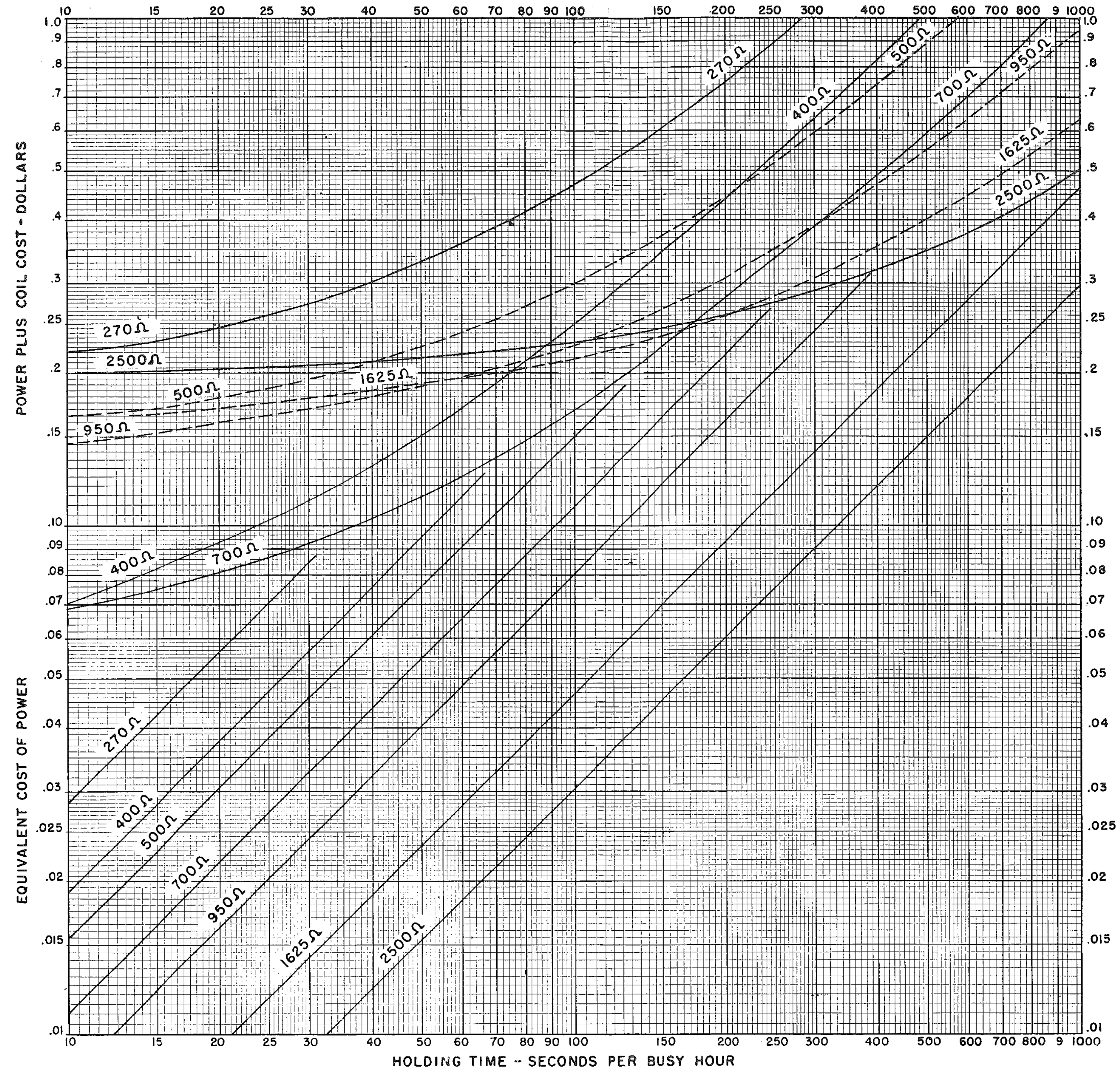
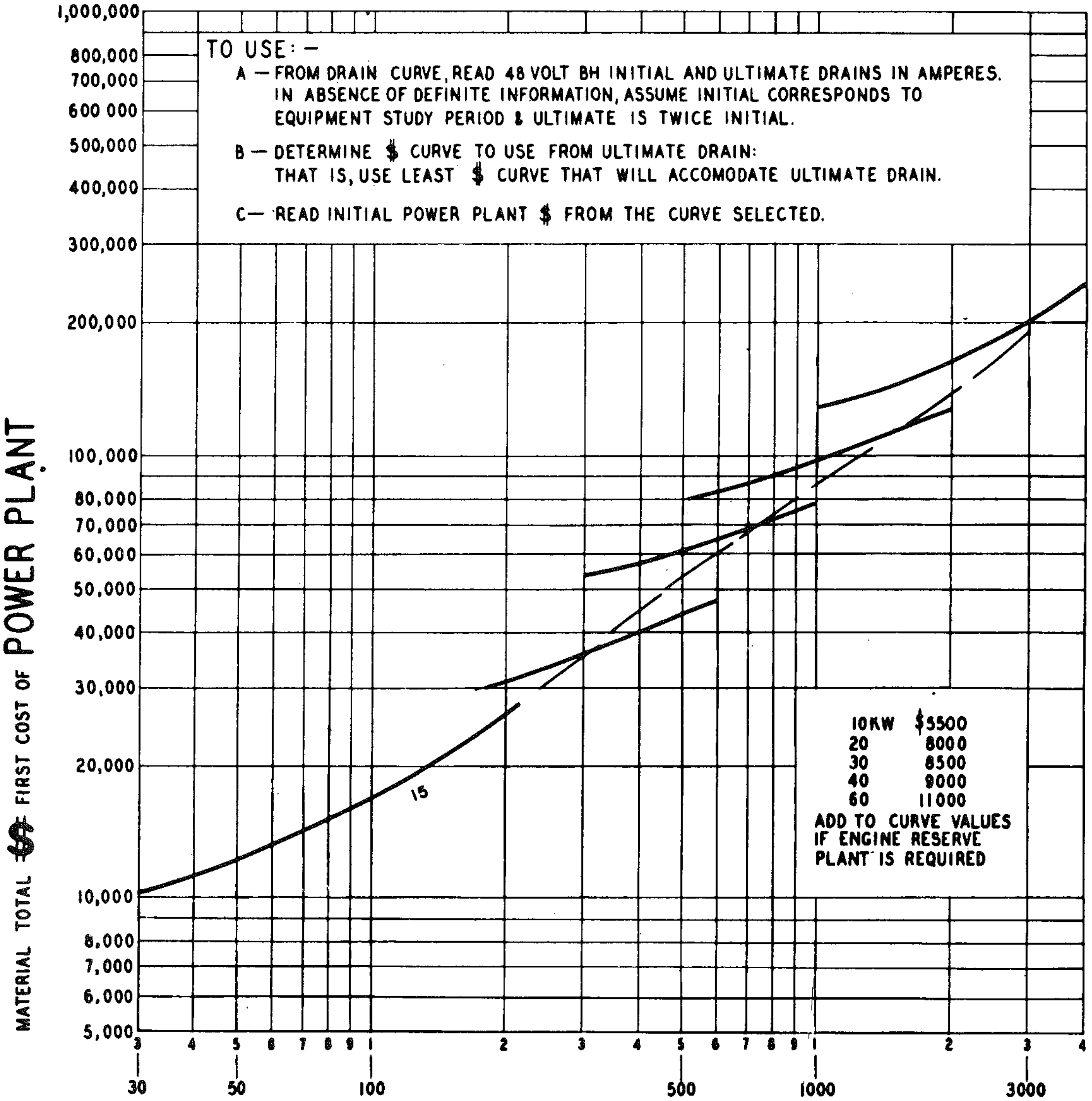


Fig. XI-6 - Power and Coil Costs

POWER PLANT



NOTE VALUES ARE FOR NEW STANDARD POWER PLANTS IN MEDIUM SIZE BUILDINGS AND ARE INTENDED TO REFLECT AVERAGE CONDITIONS, THEY TEND TO UNDERSTATE THE PROBABLE PRICE WHERE:

PBX DEVELOPMENT IS LARGE; BATTERY RESERVES ARE OVER 4 BUSY HOURS; THE POWER PLANT ALSO SERVES REPEATERS, LARGE TOLL BOARDS, CENTRAL "A" BOARDS, TEST CENTERS, ETC.; THE BUILDING IS LARGE WITH LONG AC SERVICE LEADS, LONG DC DISTRIBUTION, ETC.

VALUES TEND TO OVERSTATE THE PROBABLE PRICE WHERE:

PBX DEVELOPMENT IS SMALL; BATTERY RESERVES ARE UNDER 4 BUSY HOURS: SWITCHBOARD IS NOT SERVED BY THE POWER PLANT; MANUAL CONTROL IS TO BE USED; GROWTH OF LESS THAN 2 OFFICES IS TO BE PROVIDED FOR.

PRICING FOR POWER PLANTS DEVIATING FROM STANDARD, AND FOR ADDITIONS, REQUIRES MODIFICATIONS AND ADJUSTMENTS TO RECOGNIZE THESE DEPARTURES.

Fig. XI-7 - Power Plant Cost

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