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Remreed Switching Networks for No. 1 and No. 1A ESS:

System Overview

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This paper is an introduction to a series of detailed technical articles that describe the remreed switching network for No. 1 and No. 1A ESS. *The developmental background, technological advances, design constraints and guidelines, objectives, advantages and status of the remreed network are outlined.*

I. INTRODUCTION

More than 650 No. 1 ESS offices are now in service. Since the first cutover of No. 1 ESS at Succasunna, New Jersey, on May 30, 1965, constant attention has been given to improving system performance, increasing call capacity, and providing new features and services while holding down system costs.

In the process of developing any new system, compromises must be made in using existing technology as well as new developments to satisfy all the system objectives. It often happens that, following introduction of the system, continued progress in the development of components and devices reaches a point where new technologies can be applied successfully to improve the system. To capitalize on these new developments, either a new system can be designed or the existing system can be modified through an evolutionary process. The latter course was chosen for the No. 1 Electronic Switching System (No. 1 ESS).

As the needed new technologies became available in recent years, opportunities were created for markedly reducing the cost and size of the original No. 1 ESS. In that system, the switching network accounted for about 40 percent of the office floor space and about 40 percent of the material cost of the office.

One new component design studied was a remanent reed contact (commonly referred to as a remreed contact) based on a better understanding of the processing and working of the magnetic alloy remendur. At the same time, electronic control of reed networks had also been under study for several years. After further study showed that large-scale reductions in size and cost could be realized using these new developments, the decision was made early in 1971 to redesign the network for No. 1 ESS. The new network design would take full advantage of the advances made with the remreed contact, electronic control, hybrid integrated circuits, and connectorization.

II. DESIGN GUIDELINES

Three important constraints were imposed on this project. Because a substantial amount of capital was invested in the manufacturing facilities for the ferreed contacts and switches used in the original No. 1 ESS, the first constraint was that a major portion of these facilities had to be capable of manufacturing the new designs. The second constraint was that the physical design used to apply electronic control to the network must make use of either the same technology used for No. 1 ESS or a new technology that could be shared with other projects. Because of the investment in software development for No. 1 ESS, the third constraint was that the building blocks of the new switching network must be compatible with those of the existing network and must function with the same call processing and maintenance software. These constraints limited the design options to some extent, yet they permitted meeting the major goals of the development—reduction in cost and size.

As a result of preliminary studies, some important design principles evolved that set the course for the final design. With respect to the contact design, it was anticipated that the cost of the contact would be approximately the same as the 237B. However, the size and performance of the contact would be such that it would permit other major cost reductions, such as the use of electronic network control by means of low-cost components. With respect to the size of the contact, only moderate reductions were anticipated so that it would be possible to use the same type of processing and assembly machinery as that used for the 237B contact, yet the contact would be small enough to permit major savings in switch packaging.

The overall size of the switch package was to be such that a 1:1 trunk link network could be built and tested in the factory and shipped as an entity. To save the cost of mounting and wiring, many pulse-steering components were to be mounted in the switch packages.

Each line served by No. 1 and No. 1A ESS requires a scan point. Therefore, the design of an electronically controlled scanner was made an important and integral part of the line link network development. Again, to save the cost of mounting and wiring, the scan point and cut-off devices, as well as many of the pulse-steering components, were mounted in the switch packages.

The frame depth and height were to match the existing ferreed frames, while the maximum width to be shipped as an entity was 6 ft, 6 in. The switch packages were to be assembled in modules that could be removed from the front of the frame. All cables that interconnected these modules and the electronic circuit packs were to be connectorized. The module size was chosen so that the terminal hours of downtime due to module replacement to remove a fabric fault would be less than or equal to that experienced with ferreed. Based on this criterion and considering also the cost and reliability trade-offs at different levels of module connectorization, it was decided to make the grids and concentrators the modules.

Following these principles, a study of the 1:1 trunk link network resulted in a forecast that approximately a 4:1 reduction in floor area for the network could be realized with an ultimate savings of about one-third the cost over ferreed. Starting with the 1:1 trunk link network,[1] a complete family of remreed switching networks was then designed and the space reductions realized. An equipment line-up comparison between a 4096 line link network using ferreed frames and the equivalent network using remreed frames is shown in Fig. 1.

III. ADVANTAGES

The advantages of remreed switching networks over ferreed include:

(*i*) Reduced floor space.
(*ii*) Increased cost reduction potential.
(*iii*) Improved maintenance and reliability.
(*iv*) Improved transmission capabilities.
(*v*) Reduced installation effort.

Remreed networks were introduced into the Bell System very rapidly during the last three years so that these design advantages could be realized as soon as possible. The quantity of remreed product

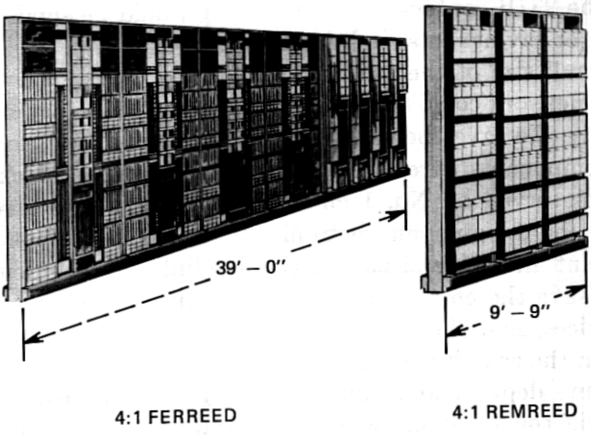

Fig. 1—Line link network comparison.

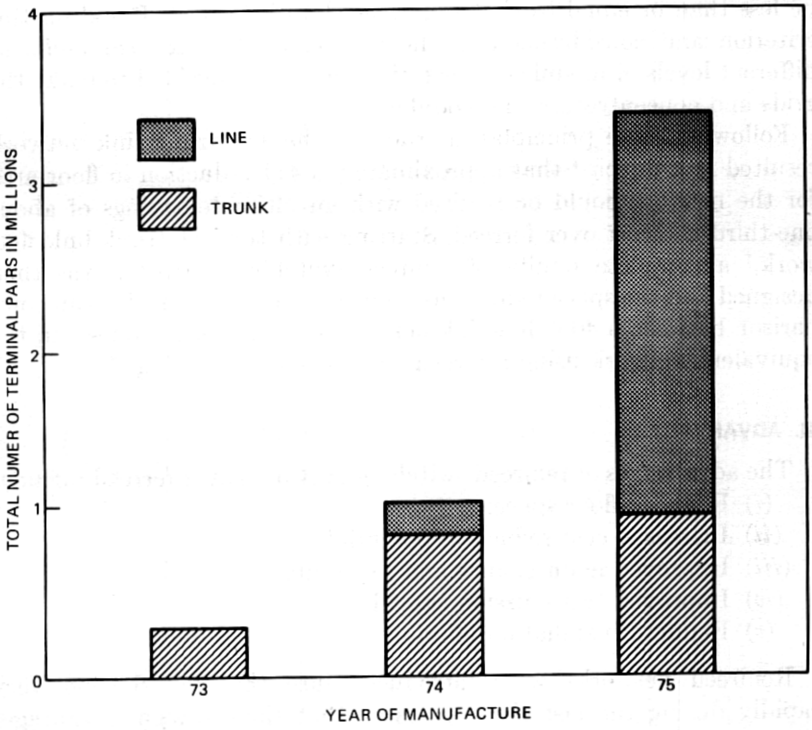

Fig. 2—Production buildup.

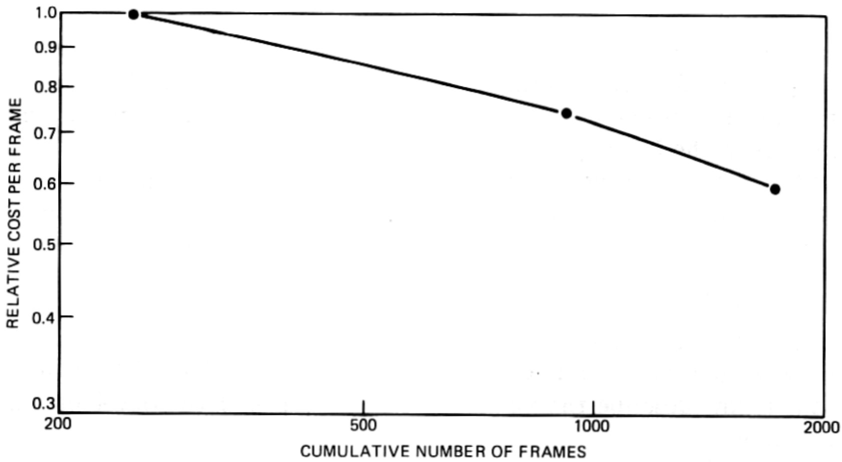

Fig. 3—Trunk link network learning curve.

shipped by Western Electric has approximately tripled each year in 1974 and 1975 (see Fig. 2).

The change to remreed from ferreed has permitted reed space division switching networks to progress on a steeper learning curve because of the opportunities afforded by the newer technologies involved. For example, the relative learning curve for the 1:1 remreed trunk link network is shown in Fig. 3. This curve is not corrected to constant dollars to remove the effects of inflation. Remreed networks

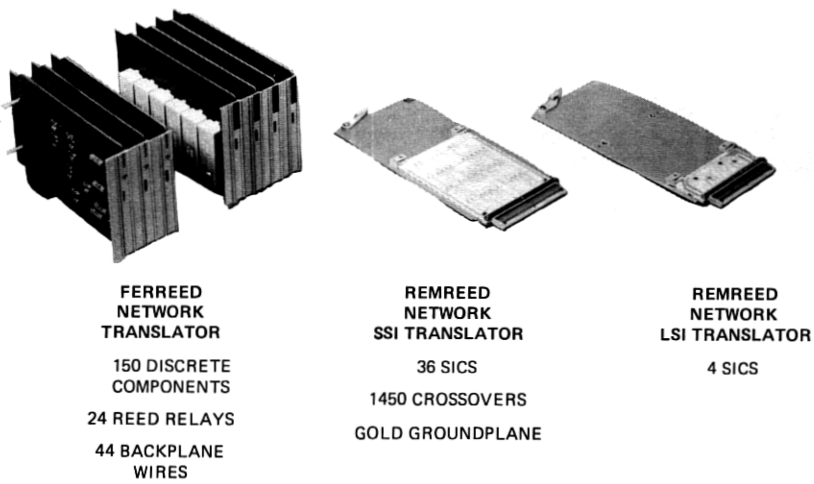

Fig. 4—Network translator comparisons.

are now lower in cost than ferreed networks. Like other major changes in technology, remreed proved more costly than the technology it supplemented during initial production buildup. Classically, this is the transient penalty incurred to make it possible to realize substantial savings in the future.

The network translator comparison shown in Fig. 4 and the network controller-logic comparison shown in Fig. 5 illustrate the opportunities in control hardware afforded by the newer technologies.

IV. SUMMARY

The objectives, design guidelines, and advantages of the new remreed network for No. 1 and No. 1A ESS have been outlined. The papers that follow describe the various detailed aspects of the development program.

The design of the remreed contact is reported first; an important subset of this effort was the work done on the metallurgy of remendur which has been published in this and other journals.[2–7] Next, the design of the switch-code family for the line link and trunk link networks is described. A significant attribute of the remreed contact is that it permits hybrid electronic control. Electronic control accounts for about one-half the space savings and cost-reduction potential of the network and is discussed next. After this, the design of the electronically controlled scanner is described. The next paper deals with the physical design of the complete switching network which presented many challenges with its tightly integrated fabric, control, and scanner. Then transmission and environmental protection design are

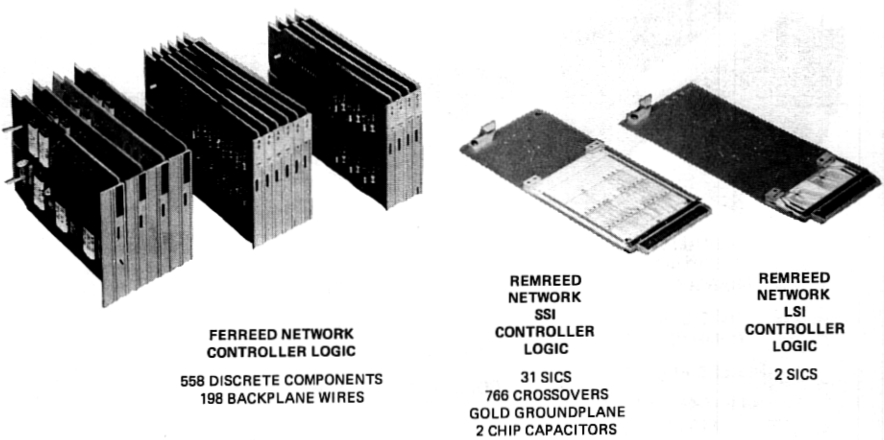

Fig. 5—Network controller-logic comparisons.

discussed. This paper addresses the transmission characteristics of the remreed network that are superior to the ferreed design and thus support a variety of switched services and transmission modes. Protection design was concerned with ensuring that the modern technologies used afforded adequate protection from the environment. Finally, throughout the course of the development, very extensive laboratory and in-service evaluations were done—perhaps more so than for any other switching network project. This is reported on in the last paper.

V. ACKNOWLEDGMENTS

Such a large number of people in Bell Laboratories and Western Electric Company made important contributions to this project that it is not feasible to list them here. We hope it is sufficient to recognize that the success of this development depended very much on their individual contributions and the close working relationships between those in Bell Laboratories with design responsibility and their counterparts in the Western Electric Company with manufacturing responsibility.

REFERENCES

1. E. G. Walsh and G. Haugk, "The Development and Application of Remanent Reed Contacts in Electronic Switching Systems," International Switching Symposium, June 1972.
2. M. R. Pinnel and J. E. Bennett, "The Metallurgy of Remendur: Effects of Processing Variations," B.S.T.J., *52*, No. 8 (October 1973), pp. 1325–1340.
3. M. R. Pinnel and J. E. Bennett, "Aspects of Phase Equilibria in Fe/Co/2.5–3.0 percent V Alloys," J. Matl. Sci., *9* (1974), pp. 1083–1090.
4. S. Mahajan, M. R. Pinnel, and J. E. Bennett, "Influence of Heat Treatments on Microstructures in an Fe-Co-V Alloy," Met. Trans., *5* (June 1974), pp. 1263–1272.
5. M. R. Pinnell and J. E. Bennett, "Correlation of Magnetic and Mechanical Properties with Microstructure in Fe/Co/2–3 percent V Alloys," Met. Trans., *5* (June 1974), pp. 1273–1283.
6. M. R. Pinnel and J. E. Bennett, "Influences of Glass-to-Metal Sealing on the Structure and Magnetic Properties of an Fe/Co/V Alloy," B.S.T.J., *54*, No. 6 (July-August 1975), pp. 997–1009.
7. M. R. Pinnel and J. E. Bennett, "Influence of Annealing Temperature and Times on Hysteresis Parameters and Microstructure of an Fe/Co/V Alloy," IEEE Trans. on Magnetics, *Mag-11* (1975), pp. 901–907.