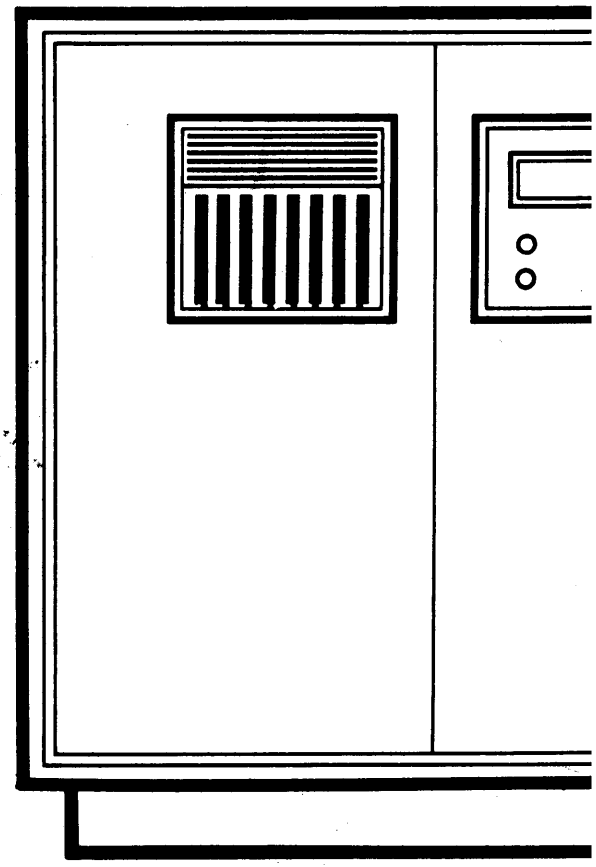
TECHNICAL DATA



SERIES 4000 DISC FILE

BRYANT COMPUTER PRODUCTS

A DIVISION OF EX-CELL-O CORPORATION

GENERAL INFORMATION AND SPECIFICATIONS
STANDARD BRYANT SERIES 4000 DISC FILES

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INTRODUCTION

Bryant Computer Products Division of Ex-Cell-O Corporation presents the Series 4000 Disc Files -- a family of production mass random access memories which have been thoroughly proven in many installations on a wide range of computer and data processing equipment.

Designed and built in the unique tradition of precision mechanical construction and sophisticated magnetic engineering that has made Bryant the leading independent manufacturer of disc files and magnetic drums, the Series 4000 Disc Files provide the optimum solution to the growing need for fast random access storage. High data transfer rates, low access times and modest cost are the most outstanding of their many features.

Three basic units make up the family, namely:

- Series 4000A -- a memory which provides up to 390,000,000 bits using 600 BPI (bits-per-inch), block-format recording or 186,000,000 bits using 285 BPI, single-bit alteration recording.

- Series 4000B -- a memory which provides up to 845,000,000 bits using 600 BPI, block-format recording or 403,000,000 bits using 285 BPI, single-bit alteration recording.

- Series 4000C -- a memory which provides up to 1,625,000,000 bits using 600 BPI, block-format recording or 775,000,000 bits using 285 BPI, single-bit alteration recording.

Modularly constructed, the Series 4000 Disc Files are available in one-disc multiples ranging in capacity from 65,000,000 bits using 600 BPI, block-format recording

to 31,000,000 bits using 285 BPI, single-bit alteration recording.

All Series 4000 Disc Files are readily expandable in the field by adding modules until the maximum number of discs for each family has been reached. The "A" model has a capacity of six data discs (modules); the "B" model, a capacity of 13 data discs; and the "C" model, a capacity of 25 data discs.

Features and advantages of the whole family of Series 4000 Disc Files are as follows:

- Widest range of capacities.
- Fastest access time.
- Series and parallel recording.
- Unrestricted programming flexibility.
- Optimized cylinder-mode operation.
- Unrestricted record length.
- Discrete clocked or self-clocked recording.
- Wide operating temperature range.
- Minimum maintenance.
- Precision, digital head positioner.
- Fast access channels available.
- Fail-safe data protection in event of power failure.
- Parallel operation without de-skewing registers.

GENERAL CONSIDERATIONS

Basic storage element in Bryant's Series 4000 Disc Files is a disc 39 inches in diameter which is coated on both sides with a proprietary magnetic oxide material. The "A" model employs from one to six of these discs for data storage; the "B", one to 13; and the "C", one to 25. All these files also include an additional clock disc.

Externally, the Series 4000 Disc Files appear as is shown in Figure 1; over-all dimensions are given in Figure 2. Discs in a given unit are rotated at either 900 or 1,200 rpm on a horizontal shaft cantilevered to facilitate the addition or removal of discs in the field, as is graphically illustrated in Figure 3.

Data Storage — Information is recorded within 768 concentric tracks on each disc face by six magnetic read/write heads. A digital hydraulic positioner moves the heads to any one of the 128 tracks accessed by each head.

One digital positioner is supplied for an entire file; thus, all heads on all disc faces are moved simultaneously. This action permits the use of an extremely efficient drum (or cylinder) operating mode in which each positioning operation accesses 1/128th of the full file capacity. In this mode of operation, the file can be pictured as 128 magnetic drums which means -- for a maximum capacity file -- each can store over 12,000,000 bits.

Access Time — Random access time within each drum or cylinder is extremely fast -- averaging 25 milliseconds -- because this period includes only disc latency, that is, the delay involved as a memory location rotates around to a position under the magnetic head. Positioning

TABLE I -- Typical Random Access Times for a File with Twelve Data Discs

Type of Movement	Positioning Time (in ms)	Track Verification Time (in ms)	Latency Average (in ms)	Access Time (in ms)
Single-Track	23	20	25	68
64-Track	70	20	25	115
128-Track	97	20	25	142
Average	74	20	25	119

time is added only when switching from one drum to another.

Operating Speeds — Disc file operating speeds are best measured in terms of transactions per unit of time. This rate, of course, varies with the computer used, the type of transaction and the size of the file. Rates of Bryant files in operational use have exceeded 25,000 transactions per hour on a full random access basis. Significantly higher rates have been obtained by minimizing the number of positioning operations and the distances moved (see Table I). Optimum utilization of the cylinder mode permits rates up to 144,000 transactions per hour.

File Organization — Data organization in the 768 tracks on each disc face is completely unrestricted. Tracks may or may not be divided into equal record lengths at the customer's option. Discrete-bit clocks, character clocks, word markers, sector pulses and address data are prerecorded by Bryant to meet individual user requirements.

To accomodate the clock tracks, each Bryant disc file incorporates an additional clock disc. One face of this disc is accessed by fixed-position clock heads and, when specified, fast access track heads. The other face is accessed by six positionable data heads in the same manner as are the data discs and may be used for any customer purpose. Where additional clocks or fast access

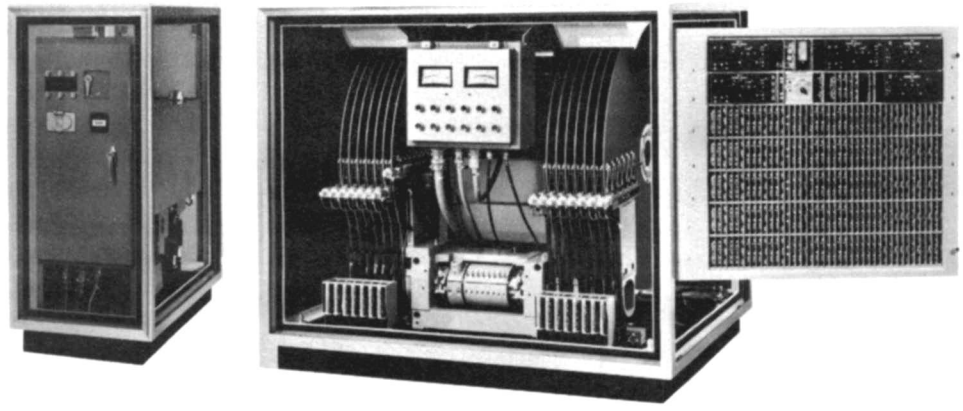
tracks are required, another clock disc can be supplied in place of a data disc on the "B" and "C" models.

Track Verification — Confirmation that the positioning system has moved the heads to the addressed track and that the heads have stabilized for read/write operation is provided in either of two ways at the user's option. Address data can be prerecorded in each track for comparison with applied addresses and, when a predetermined number of these compare successfully, a track verification signal is generated to initiate read/write operations. Alternatively, the address data can be prerecorded in the 128 tracks under one of the heads on the spare disc face. This one head, then, provides the track verification control for the entire file.

Both track verification techniques permit the computer to proceed with other operations once it has transmitted a new address to the file and until a track verification signal is received by the computer to indicate that the file is ready for read/write operations.

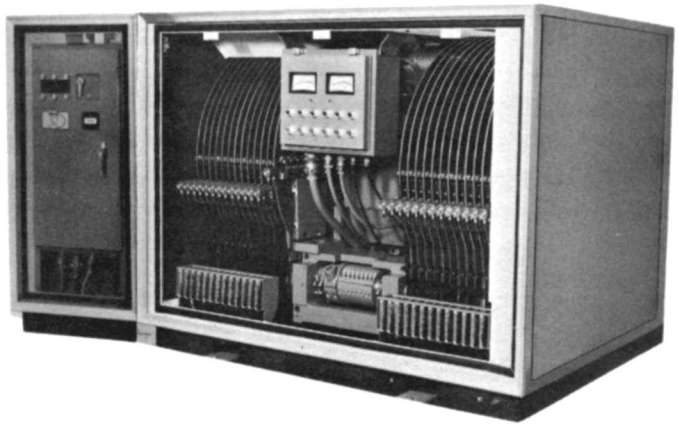
Quality Assurance — Long-term reliability and maintainability are built into all Bryant Series 4000 Disc Files. From the rugged mechanical structure to the precision of the discs and flying heads, the conservative design is keyed to long life, high reliability and ease of maintenance. Thorough testing and quality control procedures insure compliance of all components and of the complete system to rigid manufacturing and acceptance standards.

Operational Flexibility — The rigid precision construction of the Bryant Series 4000 Disc Files also provides unmatched operating flexibility. Block-format recording, which permits high packing densities, can be used to achieve large disc capacities. Self-clocking can be used to permit wider operating temperature ranges and to eliminate starting and warm up time requirements. Fully-clocked techniques can be used to permit single-bit alteration, bit interlacing, and parallel operation without de-skewing buffers.



"B"-SIZE DISC FILE

"A"-SIZE DISC FILE



"C"-SIZE DISC FILE

FIGURE 1 - OVER-ALL VIEWS OF BRYANT SERIES 4000 DISC FILES. THE 6-DATA-DISC "A" MODEL IS A SELF-CONTAINED UNIT; THE 13-DATA-DISC "B" AND 25-DATA-DISC "C" MODELS HAVE SEPARATE CABINETS FOR THE POWER CONTROL UNIT AND THE DISC FILE ASSEMBLY

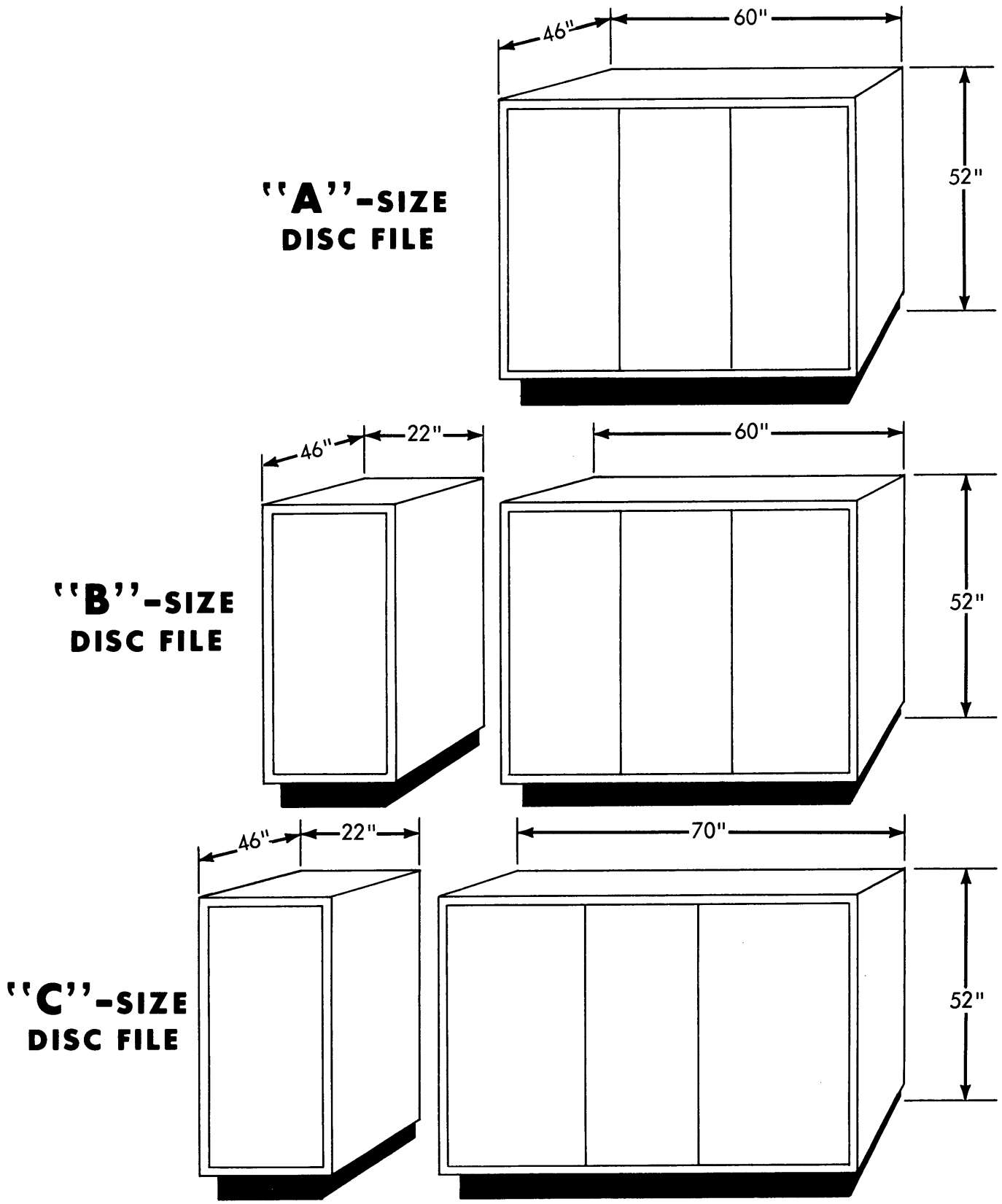


FIGURE 2 - EXTERNAL DIMENSIONS OF THE BRYANT SERIES 4000 DISC FILES

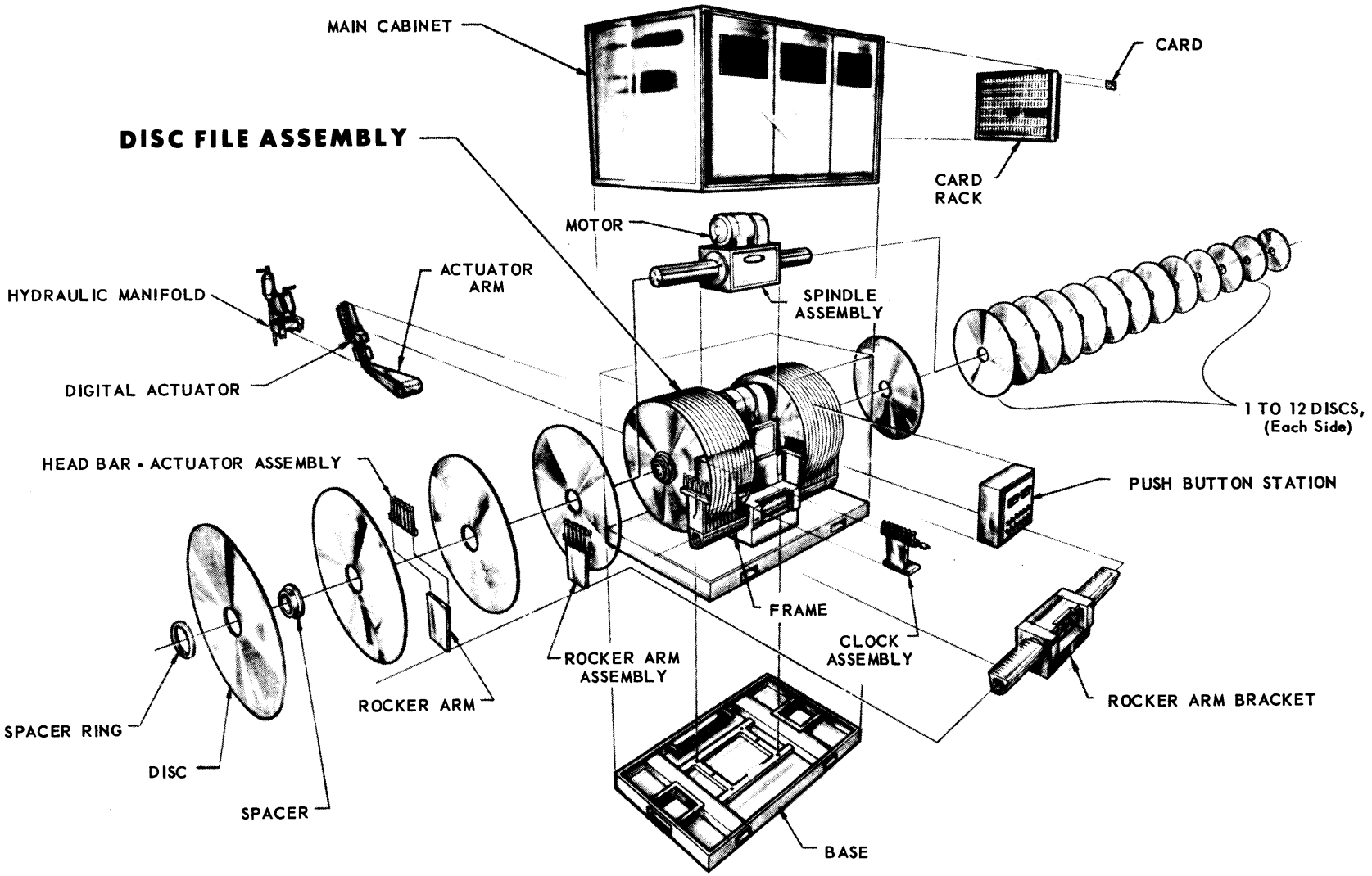


FIGURE 3 - EXPLODED VIEW OF A BRYANT SERIES 4000C DISC FILE

FILE ORGANIZATION

To maximize capacity while at the same time limiting the variety of recording frequencies, the 768 concentric tracks on each disc face are grouped in zones with all tracks in a zone having the same record length (or capacity) and frequency. Six zones -- one for each head -- is the maximum normally utilized, although each head could handle two or more zones merely by adding clocks. Typical six-, three-, two-, and one-zone arrangements are shown in Figures 4, 5, 6 and 7, respectively.

Track lengths of the zones can be related only in that they are all multiples of the basic record or word length, or they can be more intimately related. An outward zone can be divided into separately addressable channels of the same length and data frequency as an inward zone through bit interlacing as shown in Figure 8. Track lengths of the zones can also be arranged to achieve long storage blocks by adding tracks of two or more zones together in tandem as shown in Figure 9. A somewhat more complex relationship between track lengths frequently is required to satisfy the requirements of parallel systems; Figures 10 and 11 illustrate typical parallel arrangements designed to acheive specific data transfer rates.

Only one rule must be observed in laying out the discs to meet system requirements -- the maximum bit density recommended for the type of recording to be used should not be exceeded. Aside from this consideration, any layout which achieves the desired frequency, capacity and format is permitted. Table II gives the recommended

capacity and frequency data for both clocked, single-bit alteration and block-format recording techniques.

Organization of the file begins with the basic data record to be stored, namely:

- Data record length in bits.
- Range of acceptable record transfer rates.
- Required record storage capacity.

Efficiency of file organization dictates the use of a minimum number of maximum capacity discs to fit the requirement. Economic considerations dictate serial operation wherever it can satisfy the technical requirements.

In the simplest case, serial block-format recording is adequate because the record length is short providing a high degree of utilization of the available track lengths, and the six resultant track lengths and frequencies are acceptable. If fewer frequencies and track lengths are required, a three-, two-, or even a one-zone system may be specified. If higher record transfer rates are needed, a parallel system must be designed.

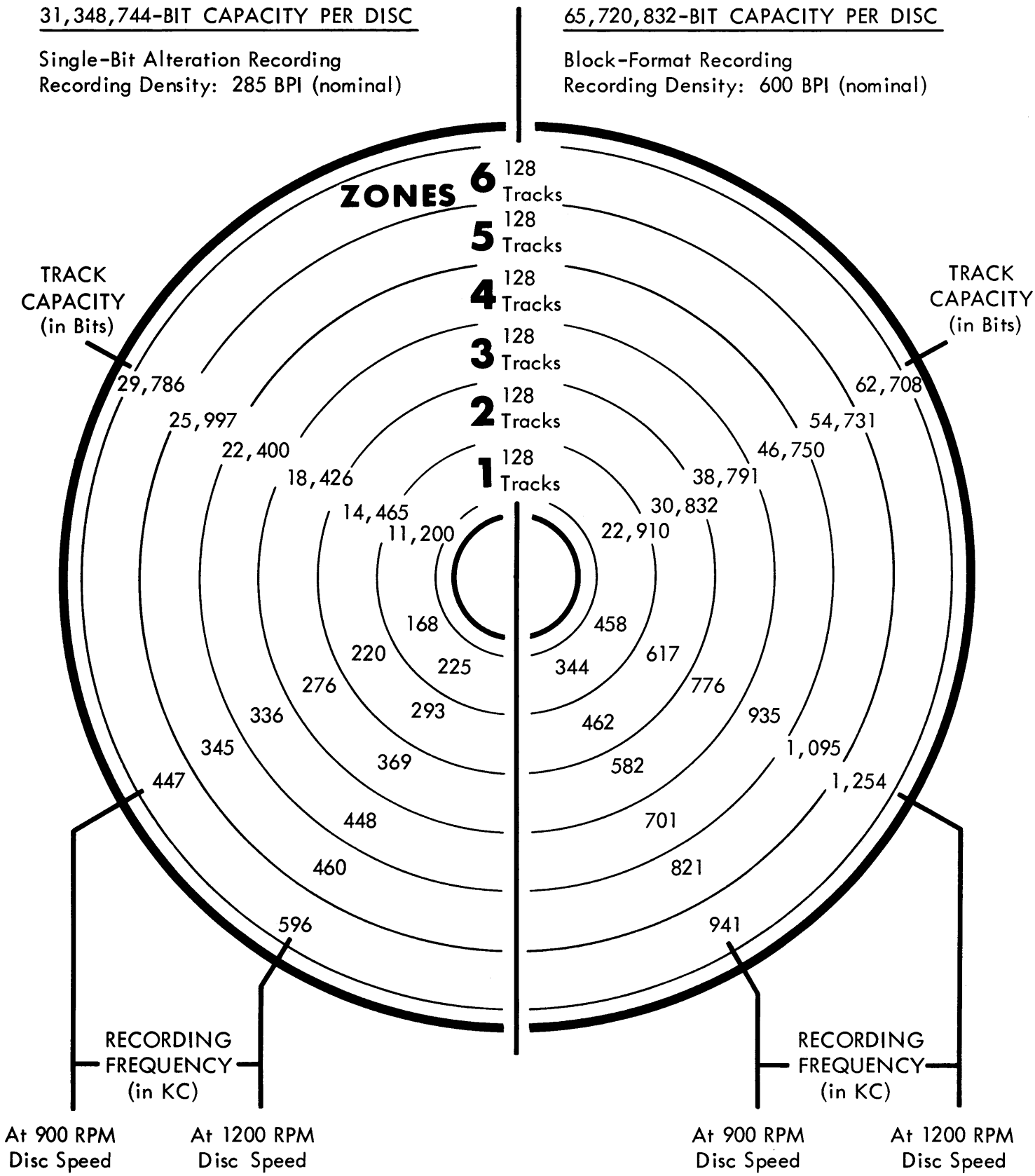


FIGURE 4 - MAXIMUM CAPACITIES OBTAINED WITH SIX-ZONE DISC FORMAT.

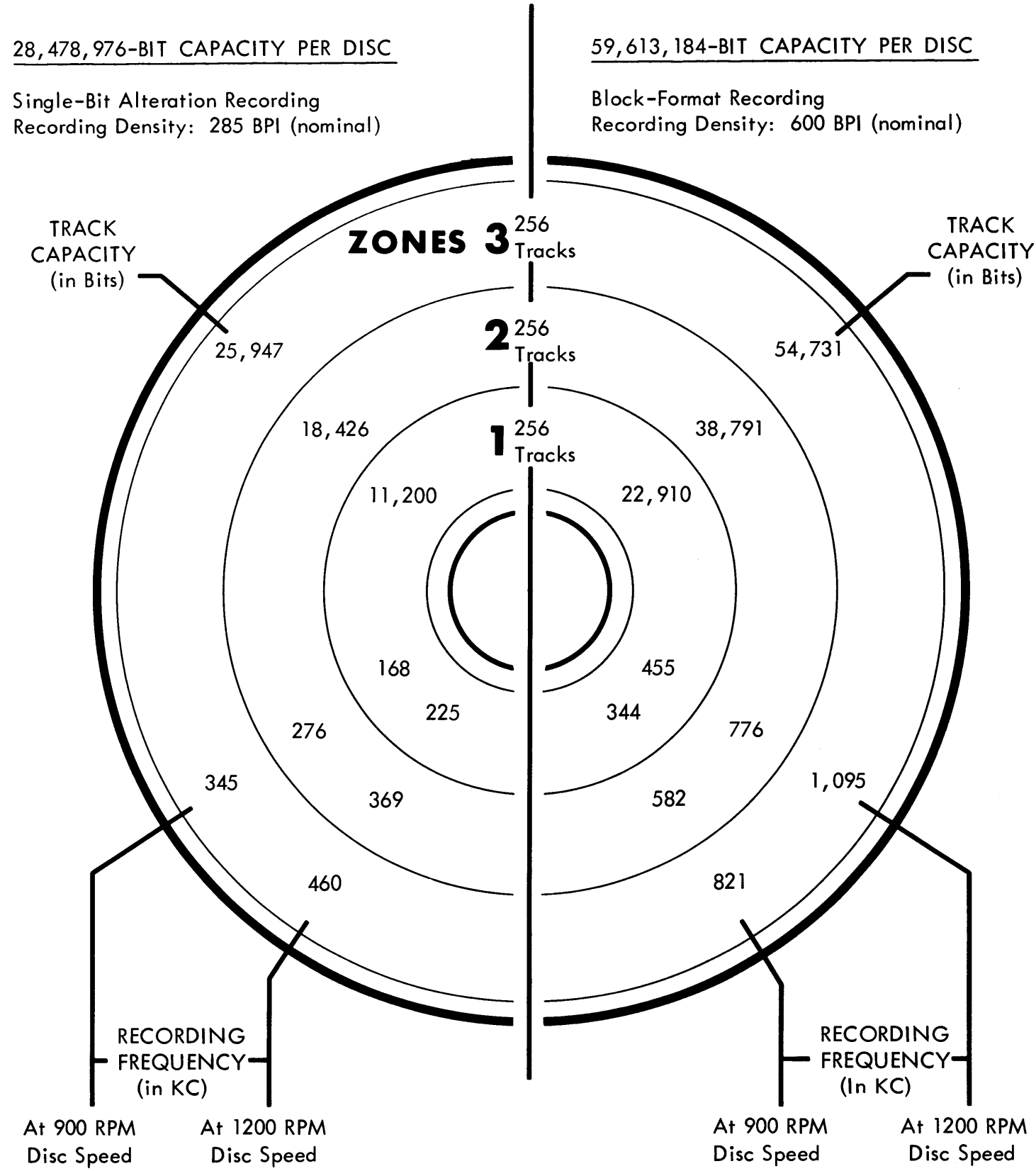


FIGURE 5 - MAXIMUM CAPACITIES OBTAINED FROM THREE-ZONE DISC FORMAT.

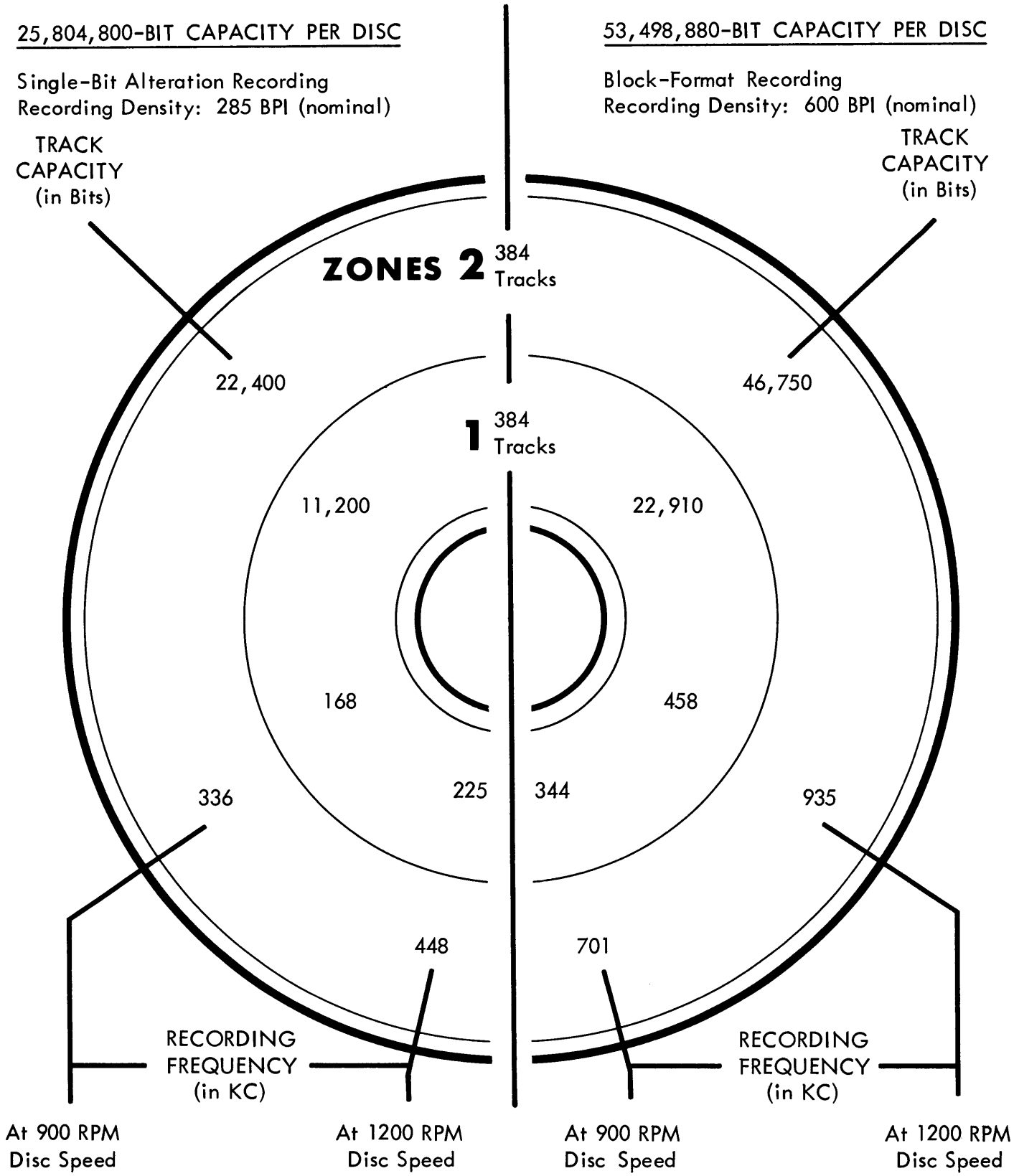
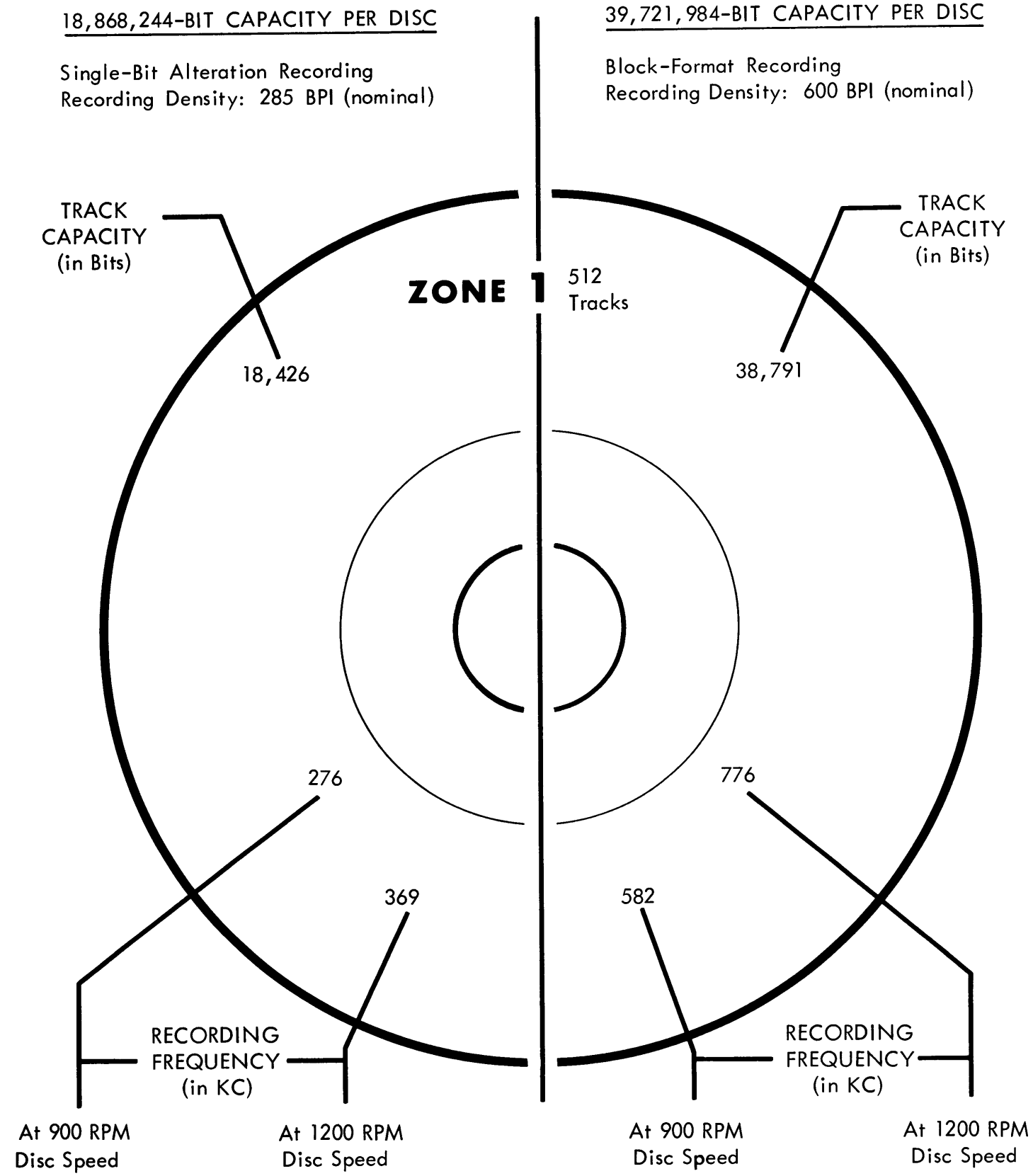


FIGURE 6 - MAXIMUM CAPACITIES OBTAINED WITH TWO-ZONE DISC FORMAT



Note: Maximum single-zone capacities are achieved by using only the four outermost heads serving each disc face and the total of 512 tracks they access (128 tracks per head). In short, $768n<512N$ where n and N are the maximum permissible track capacities in bits for the innermost and the third head out, respectively.

FIGURE 7 - MAXIMUM CAPACITY OBTAINED WITH ONE-ZONE DISC FORMAT

25,203,200-BIT CAPACITY PER DISC

Single-Bit Alteration Recording
Recording Density: 285 BPI (nominal)

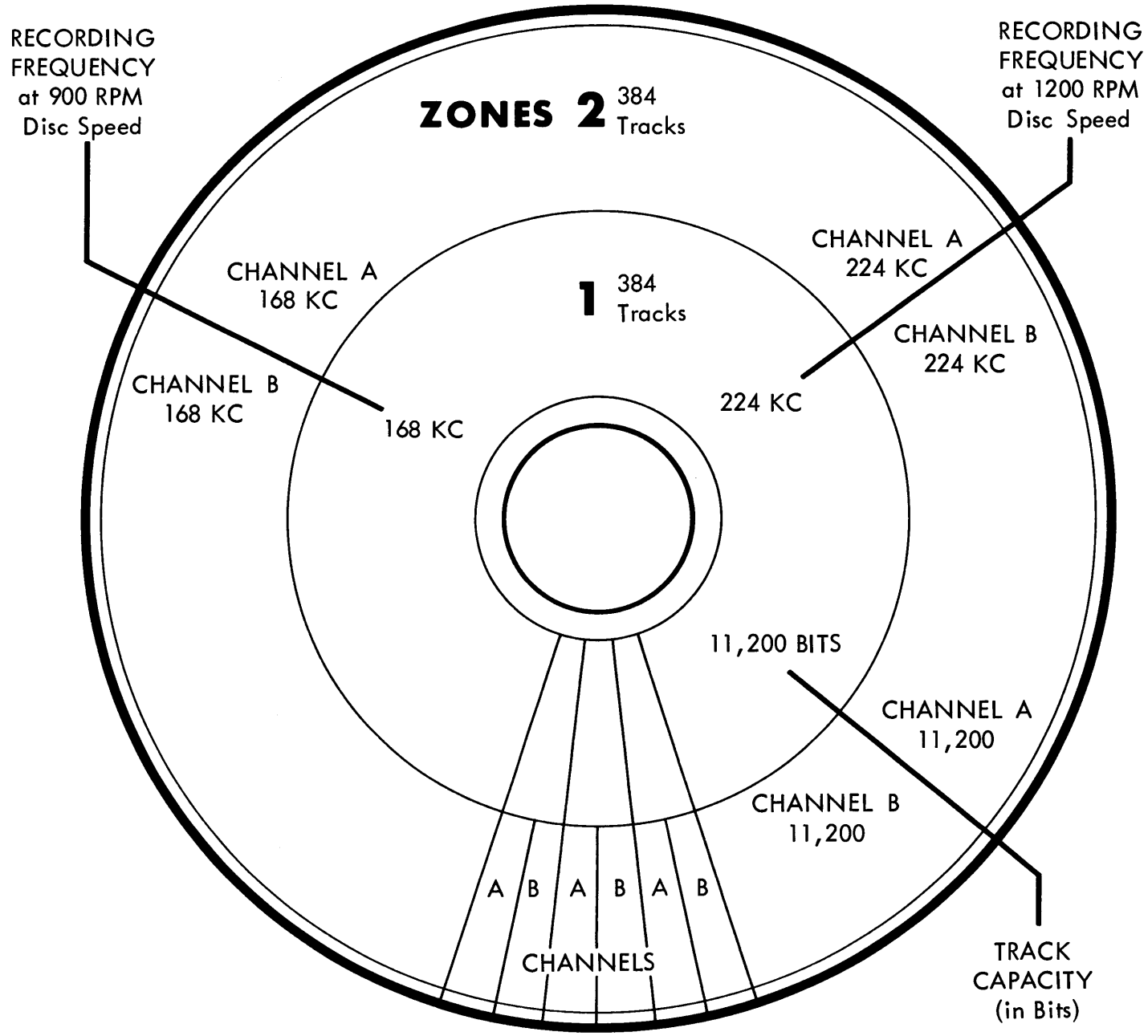


FIGURE 8 - MAXIMUM CAPACITIES OBTAINED WITH TWO-ZONE BIT INTERLACE FORMAT

65,280,000-BIT CAPACITY PER DISC

Block-Format Recording
Recording Density: 600 BPI (nominal)

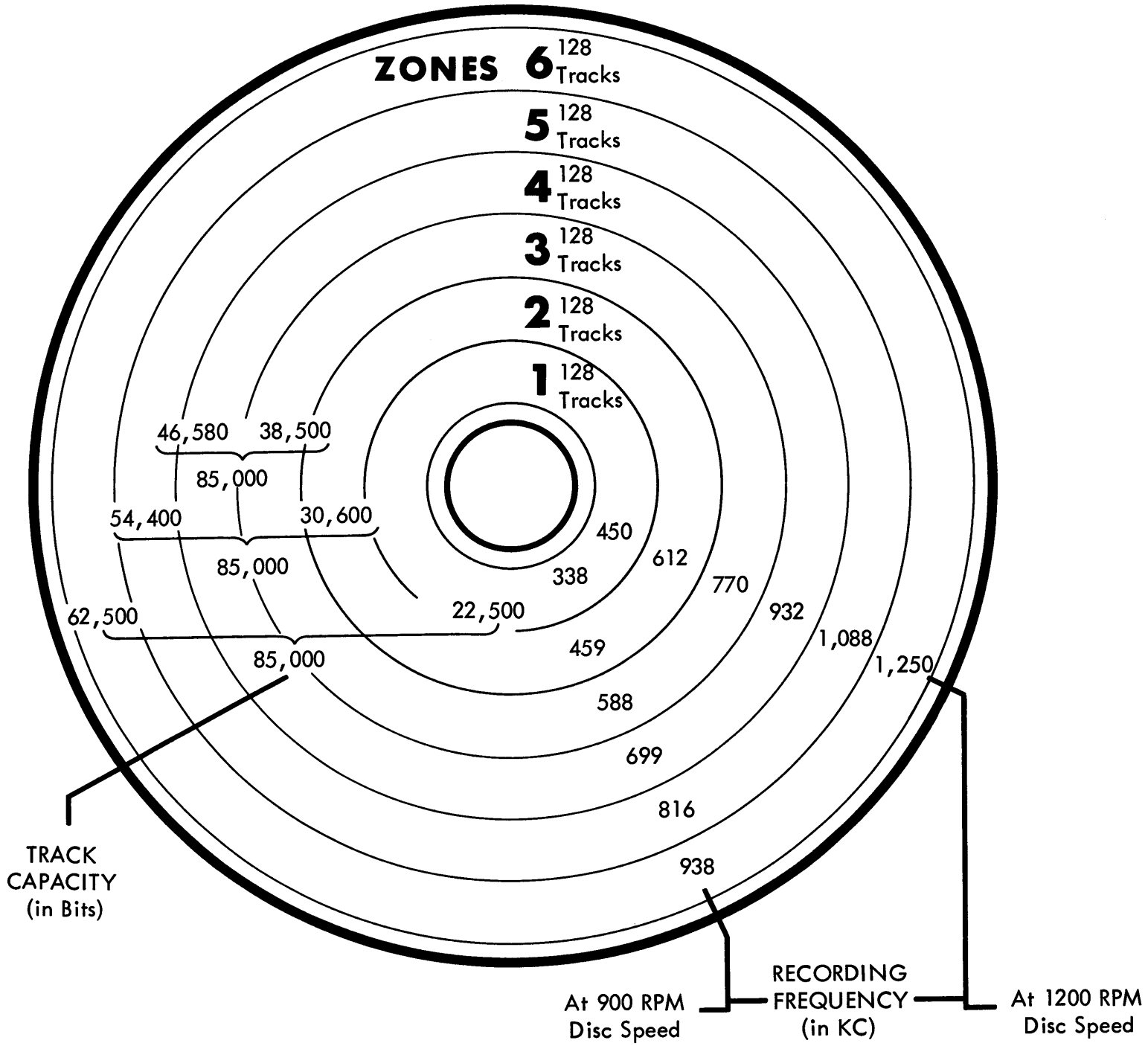
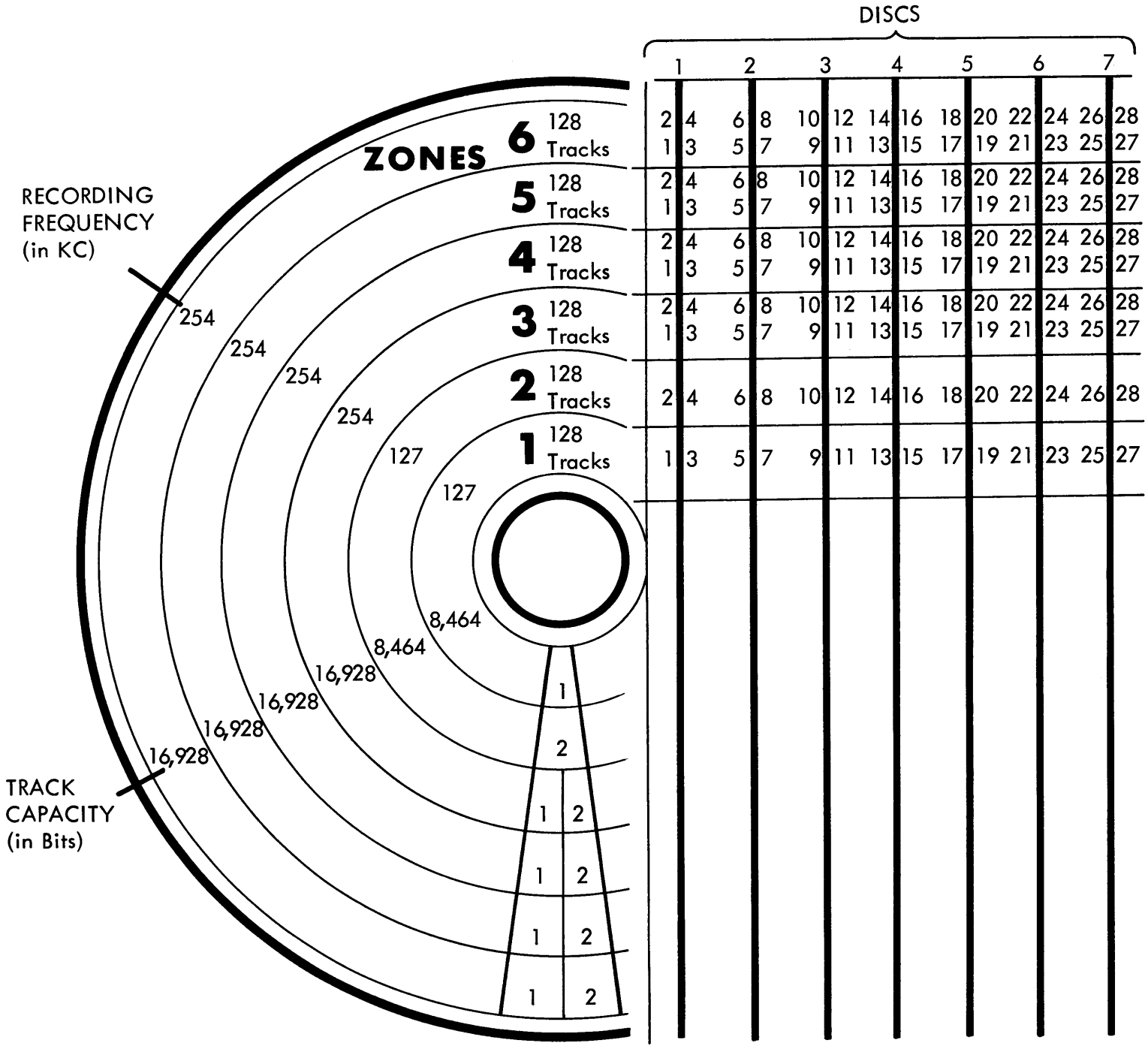


FIGURE 9 - MAXIMUM CAPACITIES OBTAINED WITH COMBINED TRACK LENGTHS OF 85,000 BITS.

21,667,840-BIT CAPACITY PER DISC (at 900 RPM)

Parallel-Format Recording
Recording Density: Zone Variable

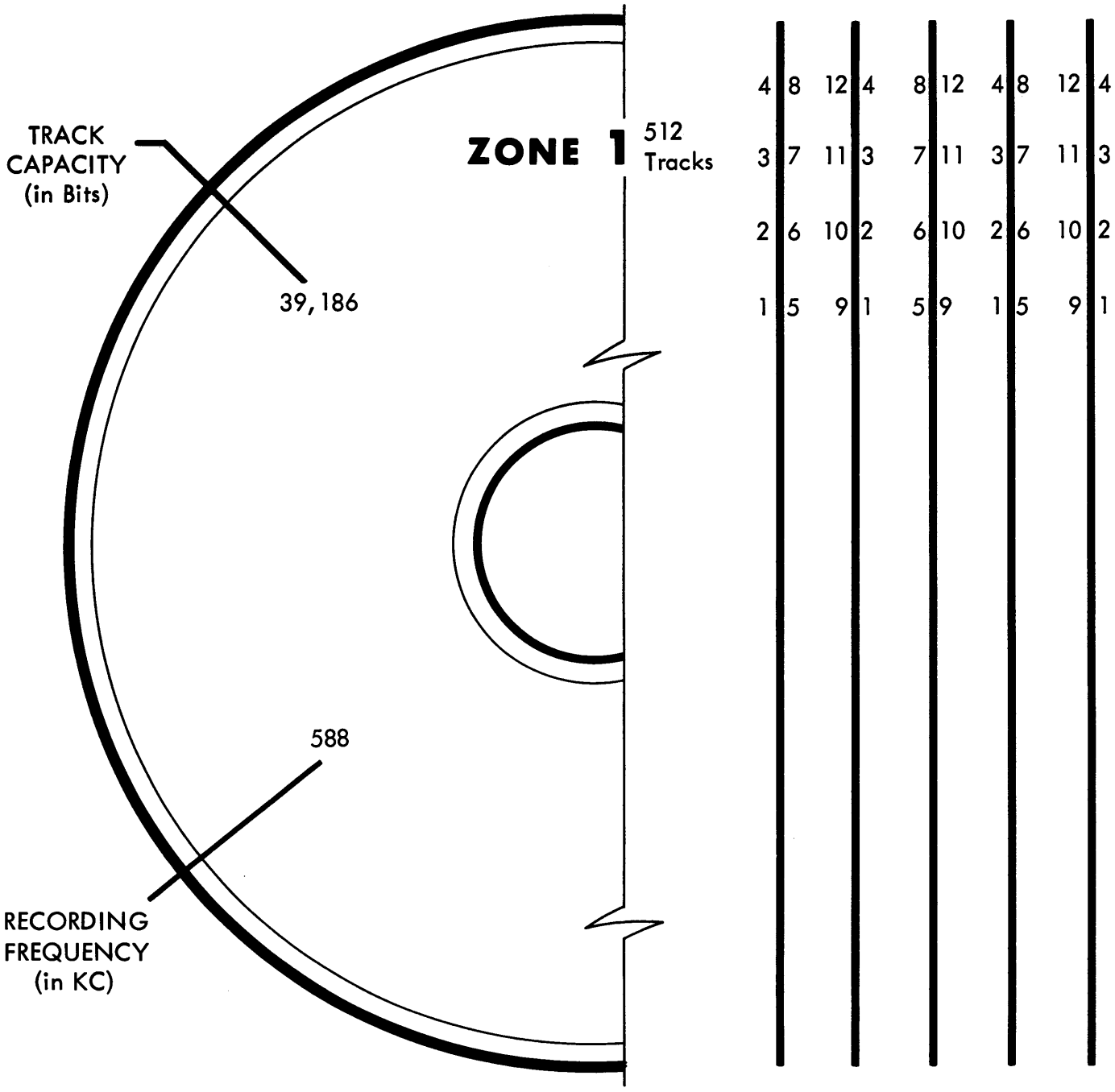


Note: Zones 1 and 2 are used together to achieve 28-bit parallel recording across 14 disc surfaces (7 discs). Zones 3, 4, 5 and 6 are used individually to the same end at double the frequency of zone 1 or 2.

FIGURE 10 - TYPICAL 28-BIT PARALLEL DISC FORMAT

40,126,464-BIT CAPACITY PER DISC (at 900 RPM)

Parallel-Format Recording
Recording Density: 600 BPI (nominal)



Note: Only four heads used per disc surface. Twelve heads on three surfaces operate in parallel.

FIGURE 11 - MAXIMUM CAPACITIES OBTAINED WITH 12-BIT PARALLEL, HIGH-DENSITY DISC FORMAT

TABLE II - CAPACITY AND FREQUENCY DATA FOR BRYANT SERIES 4000 DISC FILES

DISC CAPACITY

	285 BPI	600 BPI
6 Zones	31,348,744	65,720,832
2 Zones	25,804,800	53,498,880
1 Zone - 4 Heads	18,868,224	39,721,984

TRACK CAPACITY

ZONE	INNERMOST TRACK LENGTH (in inches)	TRACK CAPACITY AT 285 BPI (in bits, nominal)	TRACK CAPACITY AT 600 BPI (in bits, nominal)
1	38.183	11200	22910
2	51.386	14645	30832
3	64.652	18426	38791
4	77.918	22400	46750
5	91.219	25997	54731
6	104.513	29786	62708

ZONE CAPACITY

ZONE	TOTAL BITS (285 BPI, nominal)	TOTAL BITS (600 BPI, nominal)
1	1,433,600	2,932,480
2	1,874,560	3,946,496
3	2,358,528	4,965,248
4	2,867,200	5,984,000
5	3,327,616	7,005,568
6	3,812,608	8,026,624

RECORDING FREQUENCY (in KC, nominal)

	285 BPI		600 BPI	
ZONE	900 RPM	1200 RPM	900 RPM	1200 RPM
1	168	225	344	458
2	220	293	462	617
3	276	369	582	776
4	336	448	701	935
5	345	460	821	1,095
6	447	596	941	1,254

ADDRESSING

File addressing is conveniently divided into two subjects -- position addressing and head-sector addressing. A seven-bit binary position address is required to access all 128 positions, or tracks, in a zone. However, the head-sector address is variable depending upon the number of discs in the file and the number of sectors or records per track.

A six-disc file with a maximum of 16 sectors per track requires an 11-bit head-sector address. A 12-disc file with a maximum of 16 sectors per track requires a 12-bit head-sector address; a 24-disc file requires a 13-bit head-sector address. In all three of these examples, four bits of address are used for selecting the sector or record within a track; the remaining bits are used to select the appropriate head.

COMPUTER INTERFACE

Disc files normally are connected to a computer by a controller which incorporates read/write circuits, address decoding networks, a data timing system and operational controls. The controller may be supplied by the computer manufacturer or by Bryant at the option of the former. A typical controller for a fully-clocked, serial system is shown in Figure 12; a controller for a simple parallel system is shown in Figure 13.

In addition to the basic read/write and selection functions, a number of control functions can also be incorporated. For example, the controller could be provided with the ability to search sequentially through all the heads and through all positions in ascending order beginning with any assigned address. This operation basically involves an "add one" circuit which increases the count in the address register by one at the end of each cycle. A comparator can also be added to end the sequential search routine when the desired information or an end-of-search code is detected.

The controller can also be provided with simple parity checking circuits to detect errors in the data transmitted to and from the computer, or with more sophisticated Hamming or Fire code systems capable of not only detecting such errors, but also of correcting them.

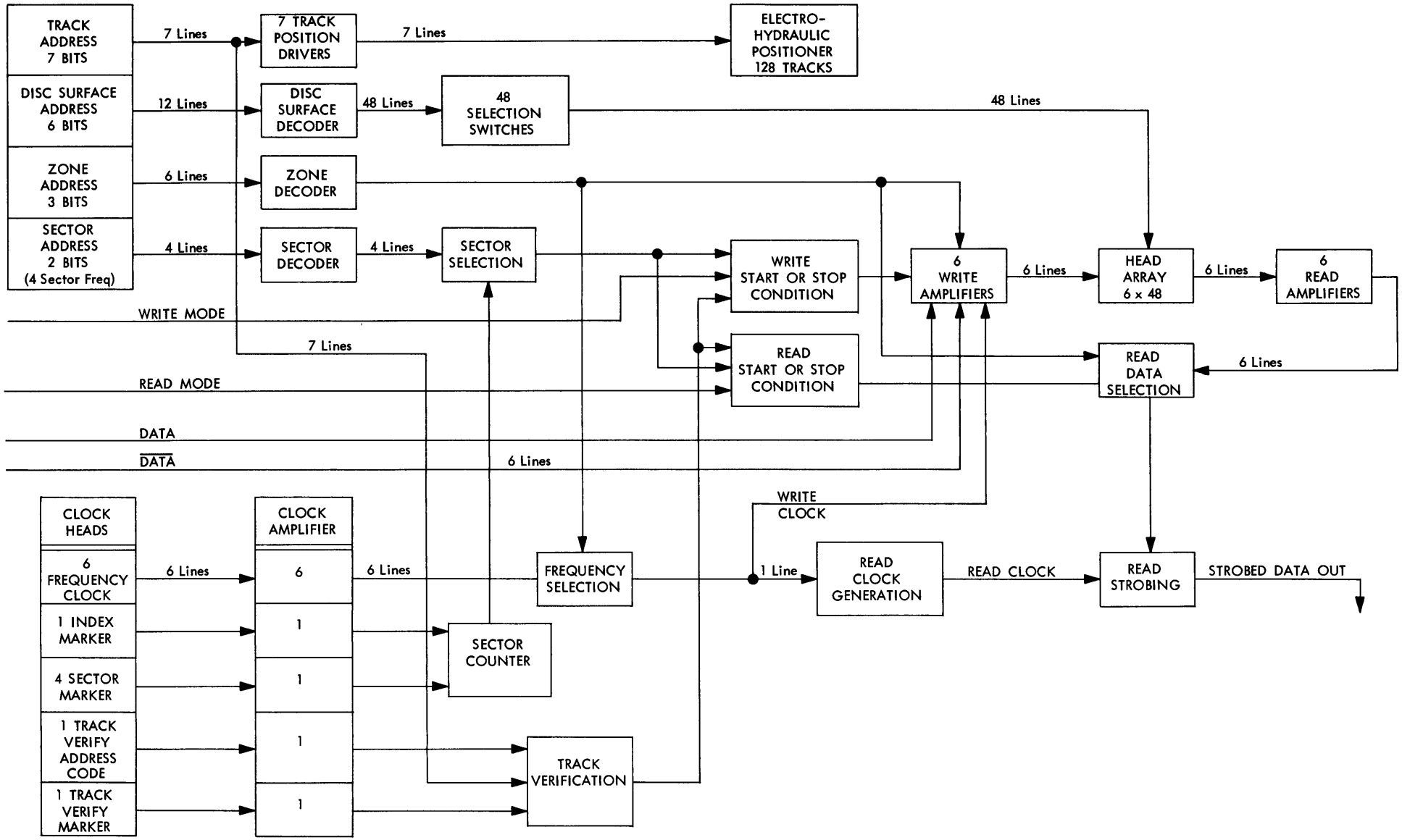


FIGURE 12 - TYPICAL SERIAL SIX-FREQUENCY ZONE SYSTEM FOR A 25-DATA-DISC SERIES 4000C DISC FILE

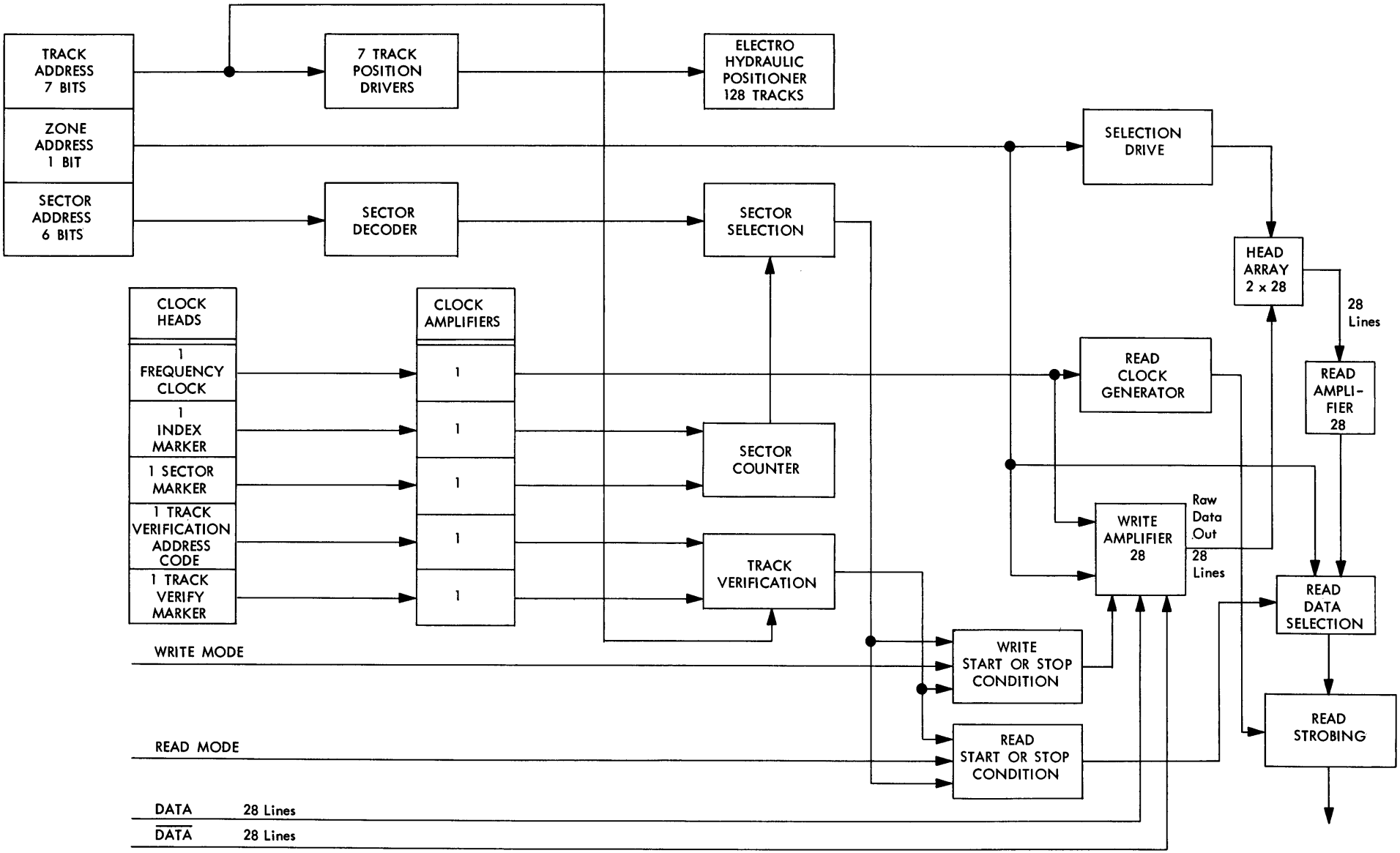


FIGURE 13 - TYPICAL 28-BIT PARALLEL SYSTEM FOR A 6-DATA-DISC SERIES 4000A DISC FILE

MAGNETIC HEADS

Aerodynamic read/write heads (see Figure 14) used with the Series 4000 Disc File are standard Bryant magnetic head structures in an aerodynamic head body which flies on a laminar film of air produced alongside the disc as it rotates. All heads include centertapped, balanced coils. No erase head is required because the Bryant positioner is a reliable precision-built device -- instead, old information can be erased simply by writing new information over it. Each head body is mounted on a self-aligning, precision axle; the head face adjacent to the disc is provided with an optically lapped surface of low-friction material. (Complete head performance data are available in Bryant Specification ES-174.)

Each head axle is mounted in the free end of a spring reed which normally urges the head away from the disc face. The twelve data heads accessing the opposite faces of adjacent discs are supported on a single head bar. Individual data head bars with only six functional heads are provided for the outer faces of the end discs.

All data heads on a bar are urged toward the discs and into their "flying" position by hydraulic actuator which activiates a cam slide on the bar. Safety interlocks retract the heads instantly in the event of a power or drive system failure. Individual adjustments are provided to control the camming action on each data head.

Clock heads (see Figure 15) are mounted on a head bar similar to that used for data heads, but which supports a maximum of eight head pad assemblies, each incorporating one or two clock or fast-access channel heads. The clock head bars unlike data head bars, are rigidly supported on the center pedestal with their heads flying on the innerface of the inside disc. A total of 32 heads for clocks and fast access can be provided, 16 on each inside disc face.

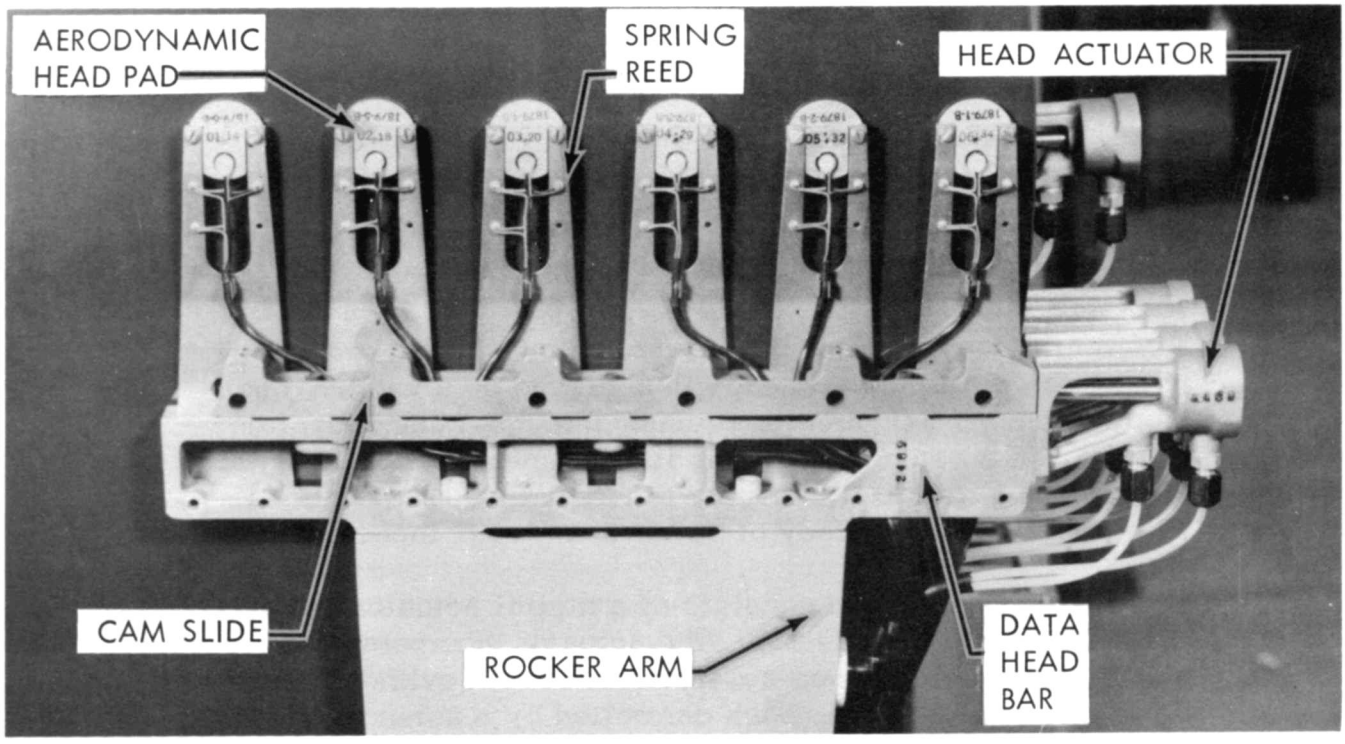


FIGURE 14 - HEAD BAR ASSEMBLY FOR BRYANT SERIES 4000 DISC FILE

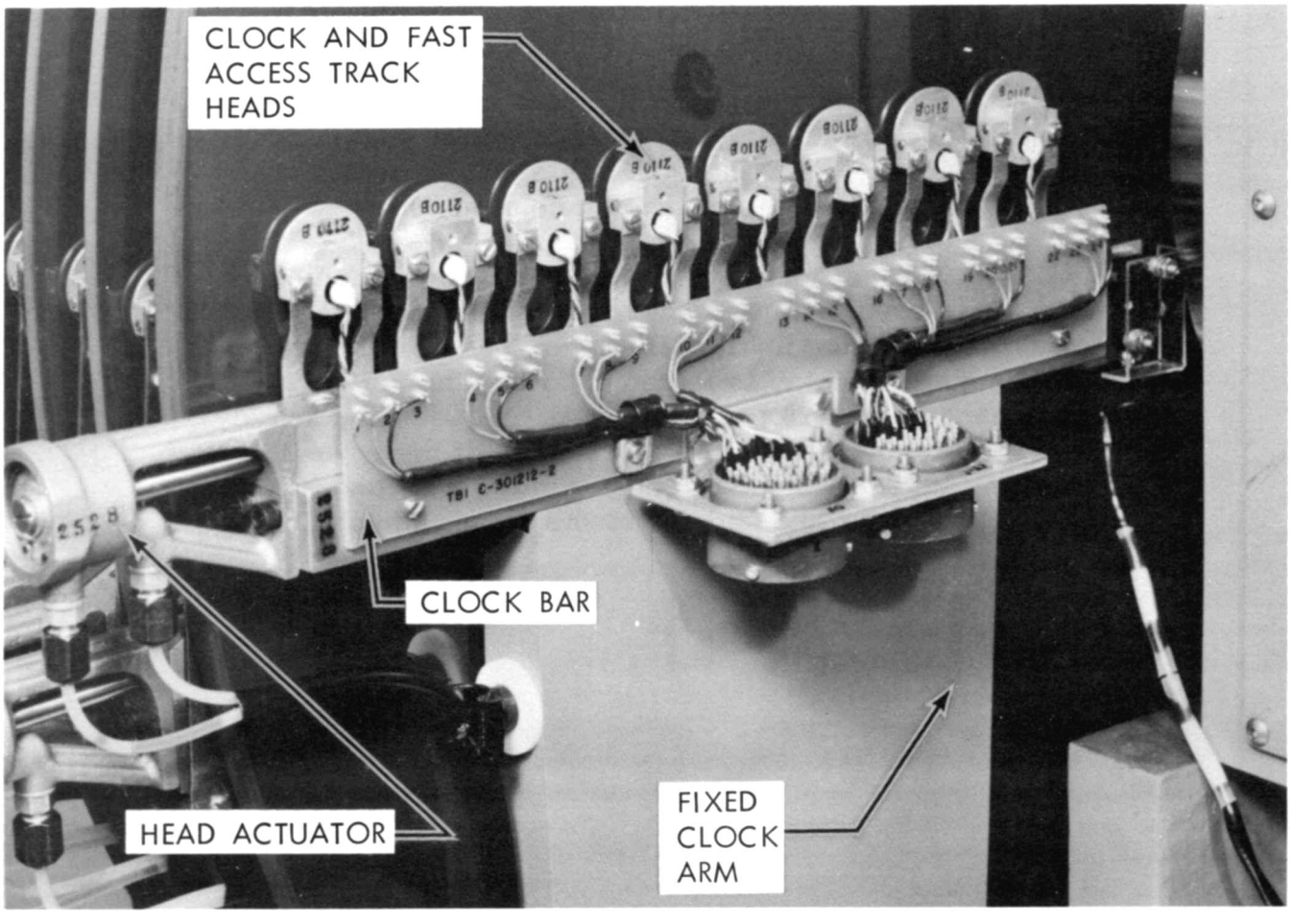


FIGURE 15 - CLOCK HEAD ASSEMBLY FOR A BRYANT SERIES 4000 DISC FILE

POSITIONING SYSTEM

Differential movement of the rocker arm shaft used to selectively position the magnetic heads is achieved by a unique, open-loop, mechanical/hydraulic actuator through a backlash-free linkage. The actuator produces linear movements to swing all of the head bars simultaneously to any one of 128 positions with a long-term accuracy of better than 0.001 inch.

The positioning system consists of a digital actuator and a power boost (see Figure 16). The actuator incorporates a housing containing seven separate piston and cylinder assemblies in a common bore, each controlled by a solenoid valve.

When the actuator is energized, the solenoid valve gates hydraulic fluid to the pistons to extend or retract them as dictated by a seven-bit,logic-level binary address. Precision stops restrict the movement of the pistons within their cylinders to distances proportional to the binary values 1, 2, 4, 8, 16, 32 and 64. However, each piston carries with it -- as it is extended and retracted -- all of the cylinder-piston assemblies ahead of it. Thus, the movements of the pistons are additive and 128 discrete setting can be obtained.

The 128 discrete settings produce differential positioning of a servo valve spool in the power boost which attempts to set the boost piston accordingly. However, because the piston is fixed, the boost housing is forced to follow the servo valve spool to each of its 128 positions (with an over-all accuracy of better than $\pm$ 0.0001 inch). Movements of the power boost are transmitted to the heads through a rigid actuating arm pivoted to the boost and secured to the rocker arm shaft.

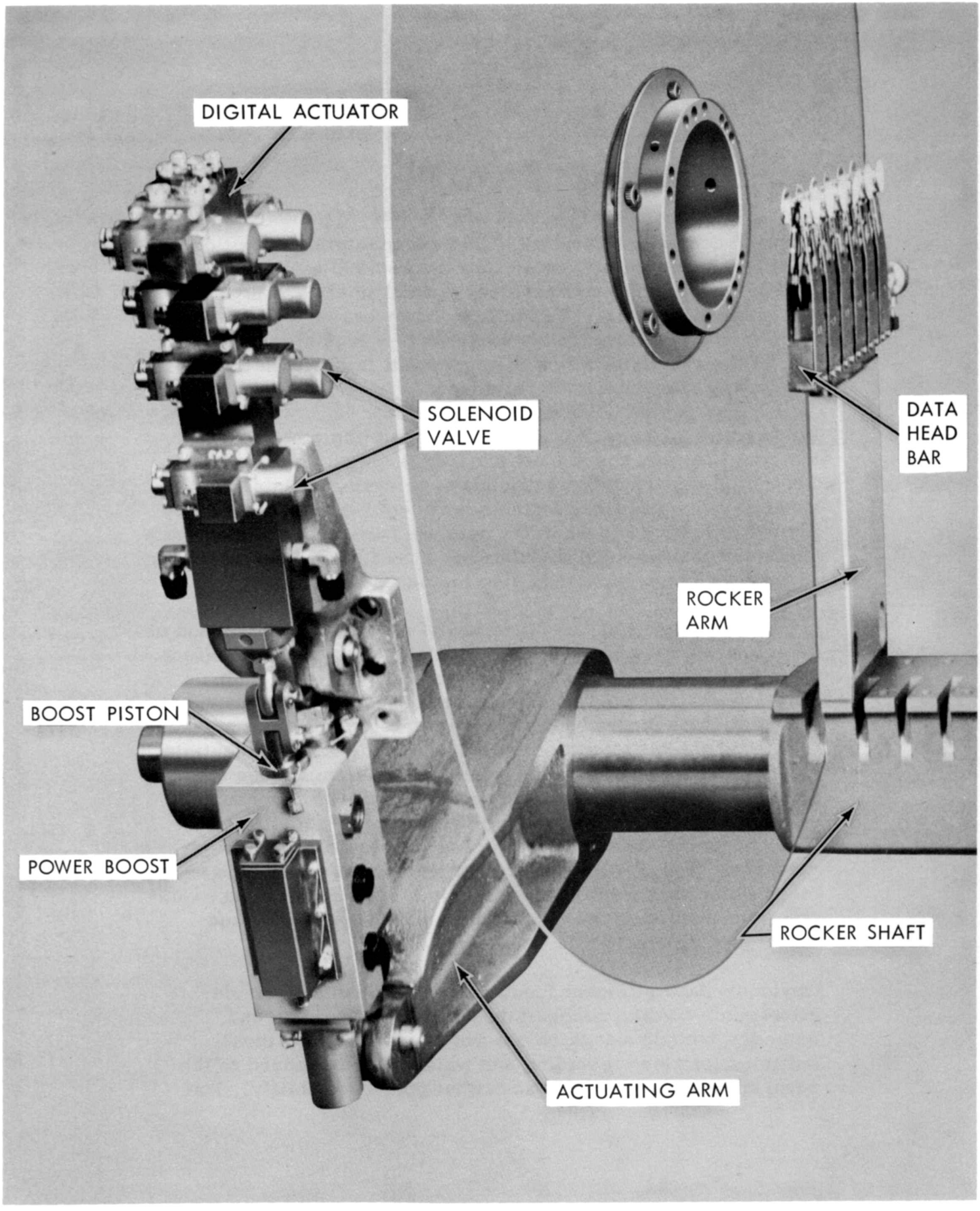


FIGURE 16 - VIEW OF THE POSITIONING SYSTEM FOR BRYANT SERIES 4000 DISC FILES SHOWING A DISC PHANTOMED IN TO ILLUSTRATE THE ACTUAL OPERATING ATTITUDE

RELIABILITY

Exacting design philosophies, rigid manufacturing specifications, stringent quality control procedures and exhaustive testing are all utilized to ensure inherent reliability of each Bryant Series 4000 Disc File. Reliability, however, is not merely a built-in characteristic of the equipment -- it is also a function of the manner in which the equipment is operated and of the quality of maintenance provided.

Checkout Procedures -- The simple operating procedure of performing a read check after each write operation and rewriting, if necessary, greatly improves system reliability. Without this procedure, a single write error may appear as any number of read errors when the data are accessed time and again. The practice of re-reading following a read error and proceeding, if the error is not repeated, also increases reliability.

Recording Techniques -- Methods of recording on discs and of detecting the recorded intelligence also have a profound effect on reliability. Phase-modulation recording provides high signal-to-noise ratios, and therefore, improves reliability. Return-to-bias recording produces less deterioration of adjacent bits in single-bit alteration recording, but is more susceptible to the effects of noise. Threshold detection techniques are simple and straightforward, but can only accommodate modest variations in signal amplitude; however, peak-detection or zero-crossover-detection techniques can accommodate wide variations in signal amplitude. Fully-clocked techniques -- required for single-bit alteration -- are subject to timing problems resulting from temperature changes; self-clocked techniques eliminate this problem.

Obviously, the stringent functional requirements of single-bit alteration recording necessitate the use of recording and detection techniques which are more sensitive than those sufficing for block recording and which, when exposed to the same environment, exhibit somewhat poorer reliability. For

example, the relatively narrow amplitude accommodation range of threshold-detection circuits "creates" bad spots or dropouts out of low amplitude areas of the discs which are read reliably by peak-detection circuits. In short, discs which are perfect using peak-detection techniques frequently exhibit bad spots using threshold techniques.

Bryant guarantees perfect discs for detection systems capable of accommodating normal signal amplitude variations down to four millivolts.

Maintenance Requirements -- Proper maintenance -- particularly with regard to its effect on reliability -- cannot be over-emphasized. Bryant's recommended preventive maintenance schedule of 16 hours per month will ensure reliable operation. Omission of any of the maintenance tasks ultimately will lead to higher error rates. For example, neglecting to clean air filters or discs as scheduled results in a higher dirt level in the file which eventually results in transient errors from any heads affected by the dirt.

File Size Considerations -- Reliability of modular files, like those in the Bryant 4000 Series, is also a function of the size and capacity of the particular file. A 25-data-disc file with a capacity of a billion and a half bits (utilizing block-format recording) includes many more components and, therefore, has a somewhat lower reliability in terms of operating time than does a single-data-disc file with a sixty-million-bit capacity. Thus, reliability information must be keyed to capacity as well as to time.

Recoverable Errors* -- Recoverable error rates of Bryant Series 4000 Disc Files now in operational use vary in accordance with the size of the file, the complexity of the file electronics, the mode of file operation, the method of recording and the quality of maintenance. The range of variation is from one error occurrence in 10^{11} bits processed to one error occurrence in 10^{8} bits processed.

Mean-Time-To-Failure** -- The mean-time-to-failure of Bryant Series 4000 Disc Files now in operational use also varies in accordance with the size of the file, the complexity of the file electronics, the mode of file operation, the method of recording and the quality of maintenance. The range of variation is from 500 hours to 100 hours.

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*Recoverable errors are defined as those which are corrected automatically by the equipment without operator intervention using read-after-write, read-after-read and similar error recovery techniques.

**A failure is defined as any equipment malfunction which interrupts scheduled file operation whether data is lost, or is recoverable by equipment adjustment or replacement.

PRODUCT ASSURANCE

At Bryant, product assurance means assuring that products delivered fully satisfy the purchase specifications with regard to capability, reliability and quality. A complete product assurance organization reporting directly to general management has been established to carry out this function.

The Product Assurance Organization -- Responsibilities of the product assurance organization begin during equipment design when reliability engineering personnel assist in development of hardware specifications and component selection. This early effort is followed by rigid quality control activity which assures that vendors and fabricating departments fully comply with the specifications. A quality control section also enforces adherence to production and assembly procedures, and conducts preliminary and final acceptance tests of the deliverable equipment. Finally, the product assurance organization is responsible for operational failure analysis and the subsequent feedback of their conclusions to design engineering.

This product assurance program is in full effect for the Bryant Series 4000 Disc Files. In addition to the above mentioned functions, the program requires thorough testing of all sub-assemblies prior to installation on the file.

Magnetic Discs -- The product assurance program for magnetic discs begins with rigid specifications on the flatness, porosity, surface finish and other characteristics of the raw metal blanks. Strict compliance to these specifications is ensured by 100 percent inspection. Blanks which meet specifications are coated with Bryant's proprietary magnetic oxide and inspected optically for surface defects.

Acceptable discs are baked to set the coating and then given an extremely fine surface finish. Another optical

inspection is made for surface defects before the discs are moved along to the electrical testing facility. Electrical tests are made on an automatic digital system which writes binary ONES and binary ZEROES on the discs and compares the resultant playback with specified standard criteria. Radially overlapping tracks are written to ensure thorough testing of the complete surface. Discs passing this test are then balanced and installed on a production disc file.

Magnetic Heads -- The product assurance program for magnetic heads starts with complete specifications on the physical dimensions, and electrical and magnetic characteristics of the components. One hundred percent inspection is made on all components. Rigid batch and lot control is exercised on the ferrite pole pieces. One hundred percent in-process inspection is made during the assembly of the basic head.

All head assemblies are tested for physical compliance to specifications and then are qualified as to aerodynamic and recording capabilities on a standard disc in a test fixture. Heads passing these tests are assembled in head bars which are then qualified as assemblies on standard discs in a test file. Acceptable head bars are then installed on production files and are completely retested using the discs with which they are to work.

Digital Actuator -- The product assurance program for the digital actuator and boost begins with specifications of the materials, hardness, finish and precision dimensions. One hundred percent incoming and in-process inspection is made. Each solenoid valve is tested as an assembly; positioner and boosts are tested as complete assemblies on hydraulic test stands. Positioner and boost combinations are cycled many thousands of operations in all combinations of positions to ensure accuracy, speed of operation, repeatability of movement and tightness of seals. Acceptable positioners and boosts are

installed on files and are given an additional 16 hours or more of continuous cycling through all positions to ensure accuracy, speed, repeatability and seal tightness of the complete systems.

Similar product assurance programs are in force for all major assemblies and subassemblies.

Final Testing -- Final testing of a completely assembled disc file is accomplished in two phases. First, a 40-hour preliminary test is used to check all of the functions and features of the file using a variety of automatic test and exercise equipment. All automatic and manual controls are tested, exhaustive positioning tests are run, all heads are checked, test recordings are made to check the integrity of the disc-head-positioning systems, environmental checks are accomplished, start-and-run power readings are taken, all meters are checked and the hydraulic supply system is tested.

Finally, the entire file is tested dynamically on the customer's computer using operational programs to exercise the file through all its operating modes. An eight-hour test exercising all the file's capabilities is recommended, followed by a three-day stability test simulating normal operational file usage.

TABLE III -- General Specifications for Bryant Series 4000 Disc Files*

Characteristic	Self-Clocking, Block-Format Recording	Single-Bit Alteration Recording
Heads per Recording Surface	6	6
Zones per Recording Surface	6	6
Track Capacity (Maximum)		
Zone 1	23,580 Bits	11,200 Bits
Zone 2	31,140 Bits	14,800 Bits
Zone 3	38,640 Bits	18,354 Bits
Zone 4	46,200 Bits	22,400 Bits
Zone 5	53,700 Bits	25,507 Bits
Zone 6	61,260 Bits	29,098 Bits
Tracks per Surface	768	768
Disc Capacity (Maximum)	65×10^6 Bits	31×10^6 Bits
Number of Discs	1 to 25	1 to 25
File Capacity (Maximum)	1625×10^6 Bits	775×10^6 Bits
Rotational Speed	900 to 1200 rpm	900 to 1200 rpm
Frequency at Maximum Capacity	900 rpm | 1200 rpm	900 rpm | 1200 rpm
Zone 1	354 KC | 472 KC	168 KC | 224 KC
Zone 2	468 KC | 623 KC	222 KC | 296 KC
Zone 3	579 KC | 773 KC	276 KC | 367 KC
Zone 4	693 KC | 924 KC	336 KC | 448 KC
Zone 5	806 KC | 1.074 MC	383 KC | 510 KC
Zone 6	923 KC | 1.23 MC	437 KC | 582 KC
Tracks per Zone	128	128
Disc Diameter	39 inches	39 inches
Track Density	64 per inch	64 per inch
Recording Density	600 BPI, maximum	285 BPI, maximum
Disc Dropouts	Zero	5 Maximum, per Disc
Warmup Time	Zero	30 Minutes
Operating Temperature	50°F to 90°F	60°F to 80°F

*Complete technical specifications are contained in Bryant technical specification ES-174